Expert Comments on the Environmental Impact Assessment Report for the Sisson Project (Tungsten and Molybdenum Mine), New Brunswick
CEAR #11-03-63169

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1. Introduction

1.1 Background to CCNB Action Inc.'s comments on the Environmental Impact Assessment Report for the Sisson Project

Northcliff Resources Ltd. (the proponent) has proposed to construct and operate a 30,000 tonnes per day tungsten and molybdenum mine approximately 60 kilometres northwest of Fredericton, New Brunswick (the Sisson Project). As described in the project's environmental impact assessment (EIA) report, the project would consist of a 145 hectare open pit mine, a 751 hectare tailings impoundment, numerous water management ponds, an ore crushing and processing plant, a water treatment plant, an ore storage area(s), a transmission line to bring power to the project site, and use of provincial roads. As proposed, the construction and operation of the mine will require the destruction of portions of streams that are headwaters of the Nashwaak River. The Nashwaak River, a tributary of the St. John River, is a main refuge for the endangered St. John River population of Atlantic salmon. The Villages of Napadogan and Stanley are located approximately 10 km and 20 km respectively from the proposed mine.

As the Sisson Project will have environmental impacts on areas of both federal and provincial constitutional jurisdiction, it is subject to two environmental assessment processes, one under the *Canadian Environmental Assessment Act* (*CEAA*), and another under the New Brunswick *Environmental Impact Assessment Regulation - Clean Environment Act* (*NB EIA Reg.*). Because the project commenced under the *CEAA,* the federal environmental assessment of the project will continue under that act rather than the *Canadian Environmental Assessment Act, 2012,* which repealed and replaced the *CEAA.* Due to the amount of ore to be processed, the Sisson Project is subject to a "comprehensive study" type of environmental assessment under the *CEAA* (rather than a "screening"). Provincially, the Minister of Environment has determined the Sisson Project is subject to a "comprehensive review" under the *NB EIA Reg*. A provincial comprehensive review sets out a number of steps in the environmental assessment process, such as the development of terms of reference for the EIA report, the writing and filing of the EIA report, and the holding of a public meeting(s) by the Minister of Environment.

The provincial and federal governments have agreed to conduct a "harmonized" environmental impact assessment process for the Sisson Project. The EIA report describes the harmonized process as being:

> "Under this approach, both levels of government have agreed to cooperate in the carrying out of the EIA to meet the requirements of their respective legislation, beginning with Terms of Reference being issued jointly to define the scope of the EIA federally and how Northcliff will meet the Final Guidelines provincially. They have also agreed that a single EIA Report prepared by the Proponent to meet the requirements of the Terms of Reference would suffice to fulfill the respective provincial and federal EIA requirements. The CEA Agency will then prepare its comprehensive study report (CSR), relying upon the EIA Report and the results of the review process." (at p. 4-4).

On August 30, 2013, the Canadian Environmental Assessment Agency (CEA Agency) released the proponent's EIA report for the Sisson Project to the public for review and comment. The public has 45 days (to October 14, 2013) to submit its comments to the Agency, after which the Agency will consider them before writing its CSR for the project. At present, there is no official period of public review and comment under the provincial process although it is expected that comments made under the federal environmental assessment process will be forwarded to New Brunswick regulators for consideration.

The CEA Agency sometimes provides participant funding to individuals, not-for-profit organizations, and Aboriginal groups, to assist them in participating in a federal environmental assessment process, such as the comprehensive study for the Sisson Project. CCNB Action Inc. applied for and received participant funding. The main purpose of this funding was for CCNB Action to hire experts to review and provide comments on sections of the Sisson Project EIA report and later, the comprehensive study report for the project written by the CEA Agency. Funding is not available under the New Brunswick environmental assessment process to assist groups in their review of EIA Reports. *The purpose of this report is to document the findings of CCNB Action's expert reviewers about the EIA report for the Sisson Project and to detail CCNB Action's position as to whether the construction, operation, and closure of the project should receive federal approval.*

1.2 Expert reports commissioned by CCNB Action Inc.

CCNB Action Inc. had experts review and comment on various sections of the EIA report and on some of the different technical studies completed by the proponent in support of the EIA report. The reviewers were asked to focus their reviews primarily on:

- the methods used by the proponent to gather baseline information,
- the methods used by the proponent to conduct environmental effects analyses for the project alone and cumulatively,
- conclusions reached by the proponent, in particular those dealing with the significance of the environmental effects of the project, and
- various technical aspects of the project such as the design of the tailings dam.

Reviewers were asked *not* to comment on the merits of the project.

In order of their appearance in this final report, the experts' reports are:

1. Impacts of the project on the VEC - Atmospheric Environment, re: air quality.
   - Ms. Inka Milewski and Mr. Lawrence Wuest

2. Impacts of the project on the VEC - Public Health with a focus on the methodology used for the baseline public health assessment.
   - Ms. Inka Milewski

3. Impacts of the project on the VEC – Water Resources, re: ground water and ecological water availability.
   - Dr. André St.-Hilaire

4. Impacts of the project on the VEC – Water Resources,
   The VEC – Aquatic Environment (focus on fish and fish habitat),
   The VEC - Accidents, Malfunctions and Unplanned Events, and
   General comments on Executive Summary, Project Description, Summary of Key Predictive Studies.
   - Dr. Allen Curry

5. Comments on Section 3 Project Description (particularly water management and the design of the tailings storage facility),
   Impacts of the project on the VEC – Aquatic Environment,
   The VEC - Accidents, Malfunctions and Unplanned Events,
   Comments on the proposed Follow-Up and Monitoring Program, and
   Comments on the Conceptual Decommissioning, Closure, and Reclamation Plan.
   - Dr. David Chambers and Mr. Stu Levit, M.S., J.D. (Center for Science in Public Participation (CSP2))
   - Note: The report from CSP2 was commissioned by CCNB Action. CSP2 submitted their review directly to the CEA Agency on October 7, 2013, but it has also been included in this report for convenience.

6. Impacts of the project on the VEC – Terrestrial Environment.
   - CCNB Action (primarily the project's impacts on birds)
   - Ms. Tracy Glynn, M.E.S. (primarily the project's impacts on rare forests and wildlife)
   - Mr. Lawrence Wuest (primarily the project's impacts on protected natural areas)

7. Impacts of the project on the VEC – Vegetated Environment.
   - Ms. Tracy Glynn, M.E.S. (primarily the project's impacts on rare forests)

8. Impacts of the project on the VEC – Wetland Environment.
   - Ms. Stephanie Merrill, M.Sc.F. (primarily the project's impacts on regulated wetlands)

9. Impacts of the project on the VEC – Labour and Economy.
   - Dr. Rob Moir

10. General comments on the proposed water management plans for the project during operation and closure.
    - Mr. Roy Parker, M.E.S.

Finally, this report also includes comments on general EIA report requirements such as a discussion of the need for the project and its role in sustainability. These comments were provided primarily by Mr. Ramsey Hart, M.Sc.

1.3 Summaries of experts' main concerns about the EIA report

1.3.1 Summary of the reviewers' main comments about the EIA report: Atmospheric Environment

- Not enough data/information has been collected to say accurately what is the trace metal content of the ore, pit walls, waste rock, overburden, etc. Without this information, the types and amounts of air contaminants released by the project cannot be determined.
- Using the limited trace metal data that is provided in background studies for the EIA report, the reviewers calculate there is more arsenic in the project's ore than what is reported (EIA report = 41 mg/kg of arsenic; Reviewers = 64.8 mg/kg of arsenic).
- The use of 41 mg/kg of arsenic (vs. 64.8 mg/kg) in modeling for predicted air quality results in the under-estimation of the release of this contaminant. Also, the EIA report only uses arsenic concentrations from the ore in its modeling. This is the lowest concentration of arsenic for any of the potential pathways of air contaminants, other than soil. For example, the EIA report provides the mean arsenic concentration in the overburden as 143.3 mg/kg, which was not used in the report's calculation of trace metal air emissions. Arsenic concentrations are significantly higher in all emission pathways than the value used to estimate arsenic releases from the project.
- The drill core assays used to calculate trace metal content were not taken from random locations or locations that are representative of the entire mine site.
- Wind data provided in the EIA report does not reflect prevailing conditions and it was not collected from the highest point of the mine where tailings beaches will be located.
- Emissions of particulate matter (dust) from the site are under-estimated.
- The EIA report does not provide information on how much hydrogen sulfide and other pollutants the ammonium paratungstate (APT) plant will emit. Based on the reviewers' investigation of the predicted releases from an ATP plant in New York, it is clear the Sisson Project ATP plant will be a significant source of air pollutants.
- The Sisson Project will not contribute to the Canadian Council of Minister of the Environment's nationally-supported goal of "keeping clean areas clean".
- No environmental monitoring for future air quality is proposed for the project despite evidence that mines can release annually 5 to 30 times more dust than predicted in an EIA report.

1.3.2 Summary of the reviewer's main comments about the EIA report: Public Health

- The main concerns raised about the EIA report's section on the Atmospheric Environment are also applicable to the Public Health section. Additional concerns follow below.
- The most serious deficiency is that the EIA report did not evaluate the non-cancer health risk of the most common route of exposure to arsenic - ingestion of soil, water and food and dermal contact with soil. The human health risk assessment (HHRA) has incorrectly assumed that the health risks related to ingesting or inhaling arsenic are cancer-related only and that there are no toxicological reference values for non-cancer health effects via the oral or dermal route for adults or toddlers. As a result, the baseline (and project-related) human health risk assessment via ingestion of soil, water and food and dermal contact with soil has not been assessed for arsenic.
- The HHRA modeling domain is too small and does not cover the entire project Local Assessment Area (LAA). As a result, HHRA receptor locations in the community of Napadogan, and other locations at the edges of the LAA where people from Williamsburg, Currieburg, Boyds Corner, Fredericksburg and Stanley may spend recreation time, are not covered by the HHRA.

- Emissions of particulate matter and metals during the construction phase of the project and the potential seepage of metals from overburden piles during the construction phase have been excluded from the assessment.
- The Project + Baseline assessment of maximum acute and chronic human health risks from inhaling PM_{10} emissions are incomplete and inaccurate.
- Particulate emission estimates during the operational phases of the project are significantly underestimated.
- Arsenic emission estimates during operational phases of the project are significantly underestimated.
- Sulphur dioxide (and other) emission estimates from the Project's ammonium paratungstate (APT) facility are significantly underestimated.
- Characterization of health risks for on-site workers are not reported or discussed.
- A sensitivity analysis of the HHRA results has not been done.
- Public and occupational health follow-up or monitoring will not be done.

1.3.3 Summary of the reviewer's main comments about the EIA report: Water Resources

- In spite of the fact that the analyses could benefit from some potential methodological improvements and specifications mentioned above, the assessments provided appear to be technically and scientifically sound. Some (probably small) risks associated with local, perhaps short term, changes in the hydrological budget and water routing for wetlands and aquatic life are scarcely treated.

1.3.4 Summary of the reviewer's main comments about the EIA report: Water Resources

- The EIA report is incomplete in many critical areas. For example, the EIA report was written before the all-important Metal Leaching/Acid Rock Drainage Potential Report (ML/ARD Report) was completed. The EIA report was submitted to the CEA Agency on July 31, 2013, while the ML/ARD was not completed until August 2013.
- This mine will need a water treatment plant (WTP) and this plant is the core of the mine's water management plan. However, the WTP is poorly described and the plans for it are not in the actual EIA report.
- The WTP was designed to deal with arsenic and antimony only, not the other many chemicals that will be in the tailings pond.
- Details for all water management at the mine site are not provided. For example, water management ponds are to collect and pump back any seepage or other surface water to the tailings pond. How will this be managed (e.g., secure pumping when required, overflow conditions) is not made clear in the EIA report.
- There are no plans to put a liner in the tailings pond to prevent seepage. Tailings pond seepage is a major source of acid rock drainage.
- Models used by the proponent do not model natural variability. The proponent uses averages where it has some information, yet the proponent knows and discusses variability in several places. Confidence limits are best estimated to be +- 100% of the average.
- The EIA report speaks to potential outcomes, but gives no probability values of such as would be expected in an objective report on such an operation. Where risk is presented, it is consolidated into just a few categories. These risks are also the proponent's "judgment"; probabilities (%) need to be presented.

- There is no adequate proposal of environmental funding to deal with the water issues for such massive landscape features of the open pit and TSF post-operations. $50M may clean up the site (no details are provided for how this figure was arrived at), but it will never come close to handling the volumes of water in perpetuity.
- A breach of the tailings dam is not assessed in the EIA report. Although the chances of such may be small, they are not insignificant, and the impacts of such a breach on downstream water quality could be catastrophic. This needs to be assessed.

1.3.5 Summary of the reviewer's main comments about the EIA report: Aquatic Environment

- The main concerns raised about the EIA report's section on Water Resources are also applicable to the Aquatic Environment section. Additional concerns follow below.
- Not enough basic field work was done and where done, not always interpreted properly.
- Atlantic salmon in the St. John River are soon to be an endangered species and the Nashwaak River is officially recognized as the critical river for their survival, yet there is no planning for the risk of loss if any/some/all of the water management plans fail.
- The toxicity of water releases from the tailings pond to Sisson Brook has not been addressed fully.
- The EIA report says that fish habitat loss will be compensated by the removal of the Lower Lake Dam. The proponent has been told repeatedly by locals and scientists that this is not needed and as such it should not be proposed as the most likely habitat compensation scenario.
- A breach of the tailings dam is not assessed in the EIA report. Although the chances of such may be small, they are not insignificant, and the impacts of such a breach on downstream water quality could be catastrophic. This needs to be assessed.

1.3.6 Summary of the Center for Science in Public Participation's (CSP2) main comments and recommendations on the EIA report and proposed mine plans

Note: CSP2 submitted their comments on the project directly to the Agency on October 7, 2013, and are reproduced in Section 2.5 below for convenience.

- Regarding design of the tailings storage facility (TSF), CSP2 recommends "*A more sound approach in terms of controlling seepage would be to remove the native soils for use in reclamation, and to compact the remaining material to a specified density.*"
- CSP2 raises concerns about how the tailings dam response to earthquakes has been modeled. They recommend "*If pseudo-static modeling was used to test for seismic stability, then a numerical model should be used to test the dam under seismic loading.*" Their reason for this recommendation is that "It is especially important that dynamic modeling be performed since the dam design has incorporated a modified centerline-type construction (which has an upstream-type component built on seismically unstable tailings). Today, few US regulatory agencies accept pseudostatic methods for seismic design of new dam projects."
- Regarding the issue of alternatives for the design of the tailings dam, CSP2 states, "The EIA does not explain whether the use of cycloned tailings for dam construction, which would probably require downstream-type construction, would provide better seismic stability than for the modified centerline design chosen as the preferred alternative." It subsequently recommends "*It would be appropriate to have a full explanation of why a modified-centerline rockfill dam is better than a downstream dam constructed of tailings.*"

- Like other reviewers, CSP2 discusses the incompleteness of the acid base accounting for the project: "*The overburden should be sampled for sulfur and carbonate to insure that no acid drainage will emanate from the overburden."*
- The EIA report is not clear about how much surplus water will need to be treated. "The TSF will have approximately 2 million m3/year of surplus water starting at about Year 8." (p.3-123) and; "Approximately 6 million m3/year of TSF pond water will be pumped to the WTP during Operation starting in Year 8 under average conditions." (p. 7-80) This is a discrepancy of 4 million m3/year."
- Like other reviewers, CSP2 discusses the cost of future water treatment. "… the volumes possible at Sisson Brook could require a financial surety in the $100's millions. … By failing to declare, whether through lack of information or analysis, it must be assumed that a financial surety for water treatment in perpetuity needs to be established. However, the financial analysis of this outcome is also not addressed in the EIA. Because of the financial risk it places on the public, this is a major omission in the EIA."
- CSP2 is particularly critical of the EIA report's failure to assess the impacts of a tailings dam breach. "Tailings dam failure is a low probability event, but also an event with high consequences. These consequences have never been ignored in any other EIS/EIA I have reviewed. To in essence assert that 'my engineering' could not possibly fail, in light of existing statistics, is arrogantly assuming that it is always the other guy (or gal) that will make a mistake – but not me. This is exactly the attitude that leads to accidents…"
- Regarding the proponent's plan for quarterly water quality monitoring, CSP2 states "Quarterly monitoring is not adequate to capture surface water variations. Weekly sampling is typical at most mines."
- "The [Conceptual Decommissioning, Reclamation and Closure Plan] should be completed at the mine-proposal stage, and certainly prior to permitting, to a sufficient degree to reasonably determine water treatment costs, reclamation costs, and assess the short and long term social, health, and economic impacts from the mine (including post-closure)."
- The CSP2 review contains other recommendations, such as those dealing with groundwater monitoring, determining the cost of the closure bond, and steps for reclaiming the site.

1.3.7 Summary of the reviewer's main comments about the EIA report: Terrestrial and Vegetated Environments

- Overall, sampling for wildlife other than birds is inadequate.
- From the bird surveys done, there are several Threatened Species in the project area whose protection needs to be addressed before the project proceeds: Common Nighthawk, Olive Sided Flycatcher, and Canada Warbler.
- The EIA report does not discuss the importance of insects to the ecosystem and makes no mention of rare butterfly species such as the early hairstreak, hoary elfin and hoary comma.
- How the project will affect the national recovery strategy for long eared bats (Myotis spp.) is not discussed in the EIA report.
- The impacts of habitat fragmentation are downplayed in the EIA report, especially when one considers the cumulative impacts of human activity in that area, the overall declining health of the Acadian forest type in New Brunswick, and the large vegetated area that the project is impacting.
- The project`s impacts on lynx cannot be rated as "not significant" when no numbers are provided about how many lynx may die because of the project and the number of lynx in NB is not provided.

- The EIA report fails to acknowledge how the cumulative environmental effects of the project will contribute to deforestation and forest degradation at a time when the diversity of the Acadian forest should be restored.
- The EIA report fails to describe the potential effects of ecosystems and changes in the biota of terrestrial and freshwater ecosystems as a result of climate change in the future.
- The EIA report fails to develop a systematic approach to documenting how the project's environmental effects, such as to the atmospheric or aquatic environment, overlap with, and consequently impact on, candidate protected natural areas (PNAs). Many of the project's environmental effects will travel outside of the 1.5 km local assessment area chosen by the proponent to predict the impacts of the project on candidate PNAs.
- The EIA report does not assess the economic benefits of candidate PNAs as economic alternatives to the project, or the impact of PNAs as part of the environment's impact on the project.

1.3.8 Summary of the reviewer's main comments about the EIA report: Wetland Environment

- There is an over reliance on adhering strictly to the current provincial wetlands management policy which (as the proponent clearly states) does not regulate a large proportion of wetlands in the project development area, the local assessment area, and the regional assessment area. This leads to an underestimation of impacts due to a lack of requirements for compensation for this loss and an underestimation of the cumulative impacts, particularly when considered with future forestry activity which has the most impact on the unregulated wetlands (forested wetlands).
- The proponent does not go into detail about their proposed wetland compensation approach for mitigating the loss of wetlands functions of government regulated wetlands.
- The proponent relies heavily on future work to identify compensation measures. With a lack of detail it is impossible to comment on such things as watershed thresholds for wetland function loss and appropriate compensation to reflect the watersheds thresholds. This modeling should be undertaken.

1.3.9 Summary of the reviewer's main comments about the EIA report: Labour and Economy

- The EIA report is only dedicated to describing the economic benefits of mine, not its costs.
- The reviewer questions the use of an economic impact model (EIM) used to calculate the benefits of the project. Under EIMs, all expenditures by the project are a benefit. This includes the money spent to clean-up spills and floods of tailings.
- Even if one accepts the use of an EIM in the EIA report, the economic benefits of the mine have likely been over-estimated.
- A traditional cost-benefit analysis should have been used to improve our knowledge about the economic impacts of the mine.
- No details are provided about how the $50 million in closure costs were estimated. The reviewer believes this amount to be a serious under-estimation.
- Based on the proponent's sensitivity analysis, the reviewer states that mineral price movements, especially in the price of APT, will have a significant effect on the viability of this project. He also notes that current prices for molybdenum are far below the proponent's assumed price of $15/lb.

1.3.10 Summary of the reviewer's main comments about the EIA report: comparing the project to other mines

- From the parts of the EIA report the reviewer read, it is his view that overall the EIA report was very thorough and quite well done. He did raise some concerns about the project's plans for water management and the tailings storage facility (TSF). These follow below.
- A condition for allowing the project to proceed should be the requirement of a detailed plan to deal with emergencies such as a power failure, a pump(s) malfunction, and excessive precipitation.
- The EIA report does not provide a description of the spillway on the TSF or describe the design criteria for that spillway.
- It is not clear from the EIA report whether all of the water management components (WMP, pumps, pipes, and spillways) are designed to deal with these types of extreme rainfall events.
- Annual or at a minimum biannual inspections should be carried out to ensure the integrity of the dams surrounding the TSF versus the five year inspection period proposed by the proponent.
- It is not clear to the reviewer whether $50 million is adequate to properly close the mine.
- The reviewer notes that very few mines commence operation and run uninterrupted for the predicted full operational life of the mine. Metal prices, technical problems and labour disputes can all result in temporary or premature closure of a mine. This issue is not discussed in the EIA. The reviewer asks that should an interruption in production occur, how will that affect the water management plan, the operation of the TSF and the treatment of the waste water?

1.3.11 Comments on the failure of the EIA Report to address Need for and Sustainability of the Project

- The business case for the mine is weak, therefore the proponent has failed to demonstrate a clear need for the project in its basic purpose – supplying tungsten.
- The EIA report does not explain how the project supports sustainable development today and meets the needs of future generations.
- The proponent's, Northcliff Resources, relationship with HDI is unclear, i.e., it seems as though HDI is the proponent. Other environmental assessments have raised serious concerns about the quality of the EIA reports for different HDI projects, such as the Prosperity Mine in BC.

1.4 Five significant shortcomings of the EIA report

CCNB Action's reviewers identified many ways the EIA report needs to be improved. However, after CCNB Action's own review, after reading our experts' reports and discussing the EIA report with them, and hearing from the public, CCNB Action has identified five overarching "themes" about the inadequacy of the EIA report. (Many of these same concerns were raised during the federal review panel's hearing for the EIA report for the New Prosperity Mine in B.C., an HDI (the partner of Northclfiff Resources in the Sisson Project) project (see **Appendix F** of this report)).

1.4.1 The EIA report is fundamentally incomplete

There are many examples of how the Sisson Project EIA report is incomplete and as such needs to be revised before any further consideration of approving the project can take place. Some of the most glaring and vital are discussed below.

1.4.1.1 Acid Base Accounting for many potential sources of metal leaching and acid rock drainage were not complete at the time the EIA report was written

Metal leaching and acid rock drainage are two of the biggest and most obvious environmental effects of a metal mine. The assessment of these effects is fundamental to understanding the impacts of the Sisson Project. As such, they should have been top of mind when it came to completing the EIA report. Clearly they were not as the SRK 2013 ML/ARD Potential Characterization Report was not completed until August 2013, while the EIA report was submitted to the Agency on July 31, 2013. How any work or information from the ML/ARD report could have been included in the EIA report is unclear.

Further to this point, even the acid base accounting work in the ML/ARD report is incomplete. For example:

- **SRK ML/ARD Sec. 3.5:** "Additional overburden sampling is planned as part of geotechnical investigations in early fall 2013 and acid-base accounting analyses will be performed at that time."

- **SRK ML/ARD Sec. 4.5:** "Additional geotechnical investigations are planned for the fall of 2013 and ARD characterization is expected to occur at that time."

  "Additional work will be required to understand the mobility of arsenic from overburden. These studies are planned for the fall of 2013. "

Regarding ML/ARD, the Terms of Reference for the EIA Report required that:

> *The discussion of ML/ARD should demonstrate that Northcliff has the necessary understanding, site capacity, technical capability and intent to identify, avoid, mitigate and/or manage ML/ARD in a manner which protects the environment through the life of the mine and after closure of the mine.*

Given the proponent's cavalier treatment of the issue of ML/ARD in the EIA report, it is clear Northcliff has done none of this.

1.4.1.2 Details and statements regarding seepage from the tailings storage facility are either lacking or unsupportable

At pages 7-79 and 7-80, the EIA report states:

> **7.6.2.2.1.3 TSF Embankment Drainage and Seepage Collection**
>
> Steady-state seepage analyses were completed using the finite element computer program SEEP/W to estimate the amount of seepage through the TSF embankments. It was assumed that a portion the embankment drainage and seepage will be captured by the embankment seepage collection system or intercepted and collected by groundwater pump-back wells downstream of the TSF. A small fraction of the total seepage was assumed to bypass the seepage collection systems and be lost to the environment downstream of the TSF.

Nowhere in the EIA report or supporting studies are the results of these analyses or actual rates of seepage provided. What is a "small fraction" is not quantified. Evidence that this information is not shared with the public or decision-makers can be seen in EIA report Figure 3.4.9 (at page 3-124) "Schematic of Mine Operational Water Balance". The legend figure states the source of the figure is Samuel Engineering 2013. However, closer inspection shows the figure was supplied on March 27 to the proponent by Knight Piesold. While similar, Samuel Engineering did not use this figure. Rather, this figure comes from the reference Knight Piésold 2013b. (Sisson Project – Feasibility Study Monthly Operational Water Balance. Prepared for Northcliff Resources Ltd. dated March 27, 2013.) This Feasibility Study was not placed on the CEAR website for this project.

Dr. Chambers (CSP2) 1-2 highlights the need for this information:

> It is noted in the Knight Piesold Baseline Hydrogeology Report that:
>
> "● Till: Surficial geology mapping has identified basal and ablation tills up to about 10 m in the project area. The till is comprised of varying composition of sand, silt, gravel and clay. The ablation till may be more permeable than the basal till.
> ● Shallow, weathered bedrock: The presence of this zone in the upper 10 m to 20 m of rock is based on regional mapping as well as drilling in the project area."
>
> With up to 10 m of till, potentially on top of fractured bedrock that could be an additional 20 m in depth, the likelihood of seepage under the starter (and fully constructed) tailings dam seems probable in some locations.

1.4.1.3 Hydrometeorology data is missing or seemingly ignored

- **Baseline Hydrometeorology Report Sec. 6.0:** A reasonable amount of hydrological and meteorological data has been collected at the project site. However, periods of limited or missing data exist within the records. The most notable of these is the lack of winter precipitation data at the Sisson climate station, as well as limited May freshet runoff data and winter discharge data. It is therefore suggested that ongoing data collection be continued and that the estimated values in this report be reviewed and updated once additional data become available.

- **Baseline Studies: KP hydrogeology Sec. 4:** The rate of groundwater recharge was estimated as about 8 % of the MAP (1350 mm) based on a watershed model for the project that was calibrated to regional streamflows at Narrows Mountain Brook (KP 2012e). The regional stream flow data currently provides the best approximation of the long-term distribution and volume of flow at the site. As additional precipitation and streamflow measurements (especially low flow measurements) are collected on site, the modelling work may be revised to use site data for calibration. Short warming periods in the winter result in a component of the winter snowmelt and therefore winter low flows may reflect both surface runoff and groundwater discharge.

  This flow condition observed during this packer test indicates that the higher take is likely not indicative of the bulk permeability of the test interval. Given the uncertainty with the high take tests, the following was recommended:
  - Identify the packer tests as high take without assigning an actual hydraulic conductivity value, until there is greater certainty regarding the validity of the testing.
  - If required, carry out additional and more than one type of hydraulic testing (e.g. constant head, falling head, lugeon) to better constrain whether the high take results are indicative of the site conditions or were influenced by the testing tool or method.
  - Recognize the implications of potentially high hydraulic conductivity values within the deposit area on engineering and environmental studies until additional testing is completed to gain a better understanding of the hydraulic conductivity values.

From the above quote, is appears as though the proponent chose to ignore results it didn't like and wait for better data. There is no evidence that further testing was done to determine the mine site's hydraulic conductivity values and as such it is unclear how the proponent reached conclusions regarding the rate of groundwater flow for the project.

1.4.1.3 Understanding the toxicity of water released to Sisson Brook

In the EIA report, the water quality at a node for Sisson Brook is not discussed (at page 7-92) despite it being the receiving waters for the water from the TSF and later, open pit. Instead, the closest water quality node that is discussed is at Napadogan Brook 5 (NAP 5), which is below the confluence of Sisson and Napadogan Brook. At NAP 5, the toxicity of Sisson Brook is diluted by Napadogan Brook, thereby not providing the public and decision-makers of what is the final water quality of Sisson Brook. This information is key if we are to understand the impacts of the project on water quality and fish and fish habitat.

The failure to discuss a water quality node at Sisson Brook provides another example of the poor quality of the background work done for the EIA report. The Predictive Water Quality study treats NAP 5 as an effluent discharge point. For example (at Predictive Water Quality Study page 5):

> Beginning in Year 8, 6,000,000 m^3/yr of excess water from the TSF is pumped to a water treatment plant (WTP) and discharged post-treatment to Napadogan Brook at the confluence with Sisson Brook. The WTP discharge rate is generally proportional to the baseline hydrograph of at the point of discharge. The discharge is further reduced during low flow months in late summer and mid-winter.

Everywhere else in the EIA report it is made clear that water will be discharged to Sisson Brook. Why the Predictive Water Quality Study used a different discharge is unclear. This lack of consistency results in vital information being lost to the EIA report.

Finally, the proponent's assertions that it will do future work to address gaps in data and analyses are not in keeping with the Agency's own guidelines regarding the completion of an EIA report:

> "A commitment to implementing adaptive management measures does not eliminate the need for sufficient information regarding the environmental effects of the project, the significance of those effects and the appropriate mitigation measures required to eliminate, reduce or control those effects. Where additional information collection or studies are needed over the life-cycle of the project, such studies in themselves should not be considered "mitigation measures"." (CEA Agency's 2009 Operational Policy Statement, *Adaptive Management Measures under the Canadian Environmental Assessment Act* at page 4, emphasis added)

The spirit of the 2009 OAP is that EIAs are not complete until all necessary baseline data is collected. Without this, the effects of a project cannot be fully assessed.

Recommendation:

- That the CEA Agency require the proponent to revise the EIA report to address all the concerns identified by CCNB experts and in this report.

1.4.2 No economic cost-benefit analysis

Common sense tells us that large open pit mining operations that dig up acid generating and metal leaching rock, emit contaminated dust, destroy the headwaters of clean and ecologically important rivers, fragment terrestrial landscapes, and have massive tailings ponds and dams, cause harm to the environment. These negative environmental effects also impact communities located near these mines. If these impacts and harm are significant, then these projects should not be approved by the public and environmental assessment decision-makers. However, sometimes they are when it is believed the economic benefits of a mine outweigh or justify the damage it causes to the environment and communities. Implicit in these decisions though is that the economic benefits of a mine are large enough to outweigh its environmental and social costs.

As has been detailed by Dr. Moir (see Section 2.9 below), without a cost-benefit analysis we don't have an accurate picture of the economic benefits, if any, of the Sisson Project. As Dr. Moir notes, the use of an economic impact model, like the one used by the proponent, for a different project showed that the project created a positive economic benefit, while using a true cost-benefit analysis showed this same project generated a negative economic loss to the community. Therefore, without an economic cost-benefit analysis for the Sisson Project, the public and decision-makers cannot make an informed decision about whether the economic benefits of the project justify the damage it will cause to the environment. Making this determination becomes even more difficult when the true closure costs of the Sisson Project are not known.

Recommendations:

- In consultation with Dr. Moir, have the proponent prepare an economic cost-benefit analysis for the Sisson Project for inclusion in a revised EIA report.

- Have the proponent provide a fully costed estimate of the long term closure costs of the Sisson Project for inclusion in a revised EIA report.

1.4.3 No assessment of the failure of the tailings dam

As will be detailed more fully below, and as much as the proponent would like this fact to go away, tailings dams fail! The failure of the Sisson tailings dam could release millions of tonnes of tailings and millions of cubic metres of supernatant water into the ecologically valuable Nashwaak watershed. While understated, the EIA Report does recognize the harm such a failure would cause. "At Sisson, a failure of the TSF embankment and resultant tailings or process water release could significantly affect downstream watercourses and habitats that have substantial ecological and societal value …" (EIAR page 3-25, emphasis added). Despite a tailings dam failure posing the project's biggest acute threat to the environment, the proponent chose not to assess its impacts.

> 8.17.2.1.1 Loss of Containment from Tailings Storage Facility (TSF)
>
> "With the application of these standards and rigorous construction methods to ensure the structural integrity of the TSF embankments and components, the implementation of adaptive management measures as necessary over the life of the mine, and the legislated regulatory oversight, the possibility of a structural failure of a TSF embankment is so unlikely that it cannot reasonably be considered a credible accident or malfunction, and is thus not considered further in this EIA Report." (EIAR page 8-698, emphasis added)

In his review of the EIA report for the Sisson Project (see Section 2.5 below), Dr. Chambers, who has 20 years of experience as an advisor on the environmental effects of mining projects both nationally and internationally, clearly explains why the above thinking is flawed.

> This is the first time I have seen this glaringly overconfident statement made in an EIS/EIA.
>
> In the 10 years since the ICOLD 2001[1] report the failure rate of tailings dams has remained at roughly one failure every 8 months (i.e. three failures every two years).[2] These dam failures are not limited to old technology or to countries with scant regulation. Previous research pointed out that most tailings dam failures occur at operating mines, and that 39% of the tailings dam failures worldwide occur in the United States, significantly more than in any other country.[3]
>
> Tailings dam failure is a low probability event, but also an event with high consequences. These consequences have never been ignored in any other EIS/EIA I have reviewed. To in essence assert that 'my engineering' could not possibly fail, in light of existing statistics, is arrogantly assuming that it is always the other guy (or gal) that will make a mistake – but not me. This is exactly the attitude that leads to accidents – as has been proven many times in the aviation world. (emphasis added)

[1] Tailings Dams, Risk of Dangerous Occurrences, Lessons Learnt from Practical Experiences, Bulletin 121, International Commission on Large Dams, 2001.

[2] Data from http://www.wise-uranium.org/mdaf.html "Chronology of major tailings dam failures" as of March 22, 2011.

[3] Reported tailings dam failures, A review of the European incidents in the worldwide context, M. Rico, G. Benito, A.R. Salgueiro, A. D´ıez-Herrero, H.G. Pereira, Journal of Hazardous Materials 152 (2008) p. 848.

Recommendation:

- Have the proponent complete a detailed environmental effects analysis of the failure of the tailings dam for the Sisson Project for inclusion in a revised EIA report. The assessment would include a modeling of the most likely worst case disaster scenario for such a failure describing, for example, the toxicity of the tailings and supernatant water, how much tailings and supernatant water would escape from the tailings storage facility, how far and to what depth the tailings and supernatant water would travel downstream, and what damage this would cause to communities in the watershed and the environment, including Atlantic salmon habitat, and for how long.

1.4.4 The closure plan is missing significant details

Several CCNB Action reviewers discussed the serious deficiencies of the proponent's closure plan. Mines with acid rock drainage and metal leaching leave long term environmental liabilities that must be managed. Without an understanding of the long term future environmental, social, and economic costs of the Sisson Project, we cannot make a fair determination of whether the project is sustainable, i.e., does it meet the needs of today without damaging the opportunities of future generations. Several of the key deficiencies of the closure plan are discussed below.

1.4.4.1 There is no accurate description of how much contaminated water will have to be managed after closure

The EIA report first states "the TSF will have approximately 2 million m^3/year of surplus water starting at about Year 8" (EIAR page 3-123). It then reports, "Approximately 6 million m^3/year of TSF pond water will be pumped to the WTP during Operation starting in Year 8 under average conditions" (EIAR page 7-80). Finally, the SRK (2013) Metal Leaching and Acid Rock Drainage Potential Characterization then describes in Appendix I (conceptual water treatment plant design) that the TSF, and after closure, the open pit will have an annual discharge of 1,280 m^3/hr (or 11 million m^3/year). This wide variation in water that will have to be treated after closure is never explained.

1.4.4.2 There is no accurate description for how long contaminated water will have to managed after closure

The EIA report provides no details about how long post-closure that water will need to be treated, only that it will be treated for "as long as necessary" (EIAR page 143). Is this 1 year, 10 years, 100 years, or more? This is not an idle question, for as Mr. Parker points out (Section 2.10 below), we already have closed mines in New Brunswick whose waste water requires long-term treatment. The lack of detail in the EIA report obviously does not assist in decision-making about the project.

1.4.4.3 Significant details about the conceptual water treatment plant are missing

The water treatment plant (WTP) is the key component of the closure plan for the mine, yet it is not described in any detail in the actual EIA report. Without the WTP, the environmental effects of the project post-closure on the aquatic environment will not be mitigated, in turn increasing their significance. Given the limitations of the conceptual design for the WTP, at present there is *no water treatment plant* for the Sisson Project. As the SRK 2013 report states:

> In the event that water treatment for sodium or fluoride is required … then the water treatment process proposed here will not be adequate. (SRK 2013 Appendix I, emphasis added)

The EIA report shows (at page 7-98) that post-closure, fluoride levels in water from the mine will be 2 to 3 times the CCME FAL guidelines (for the protection of aquatic life). The proponent can have no expectation that this continual exceedence, amongst others, will be permitted in the future. As a result, there is no actual plan for a WTP in the EIA report and a new conceptual WTP needs to be designed. The consequence of this is that any of the proponent's environmental effects analysis that relied on the existence of the flawed conceptual WTP much be redone, and if not redone, then without the mitigation of a WTP, the adverse environmental effects of the project on the aquatic environment must be considered to be significant.

1.4.4.4 The Terms of Reference regarding closure have not been met

> At a minimum, the discussion of alternative means of carrying out the Project shall include a consideration of the following: …
> • alternative options for reclamation and closure. (TOR at page 22-23)

In response to this requirement, the EIA report (at page 3-77) states, "Northcliff has considered various options to achieve decommissioning, reclamation and closure of the Project site at the end of mine life." No details of these other options are provided. Clearly this is not enough information for the public and decision-makers to weigh these alternatives. It is also not in keeping with Environment Canada's 2011 *Guidelines for the Assessment of Alternatives of Mine Waste Disposal*:[4]

> The alternatives assessment should objectively and rigorously consider all available options for mine waste disposal. It should assess all aspects of each mine waste disposal alternative throughout the project life cycle (i.e., from construction through operation, closure and ultimately long-term monitoring and maintenance). (at page 7)

Recommendations:

- Any plan for the decommissioning and closure of the project should be completed at the mine-proposal stage, and certainly prior to permitting, to a sufficient degree to reasonably determine water treatment costs, i.e., how much water and what is in the water, reclamation costs, and assess the short and long term social, health, and economic impacts from the mine (including post-closure).
- Prior to permitting the proponent should identify what long term and permanent water quality treatment may be necessary at the mine site. This includes but not be limited to discharges from the pit (including from pit walls that will not be submerged and pit discharges to groundwater).
- Permanent treatment should be avoided. The closure plan should more fully evaluate this and identify alternatives to perpetual treatment.

[4] Available at: http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=5ECBCE8B-7E50-49E3-B7AD-8C21A575E873.

1.4.5 Costs of closure are not explained

Regarding this issue, Dr. Chambers writes

> If there is surplus pit water that will require treatment it is reasonable to anticipate that this treatment will be required in perpetuity - forever. That presents clear long-term liabilities and costs to the Crown, Province, and public. These liabilities and costs should be fully evaluated and discussed … (Section 2.5 below).

Similar concerns are raised by Dr. Curry (Section 2.4), Dr. Moir (Section 2.9), Mr. Parker (Section 2.10), and Mr. Hart (Section 3.0 Sustainability).

The proponent provides no details about how it arrived at a figure of $50 million to cover the costs of decommissioning, reclamation, and closure of the project. In addition, all of the above reviewers believe this amount to be very inadequate for a project of this size. The average operational costs of water treatment for mines are estimated to be $1.54 per m^3.[5] Accepting the proponent's figure of the project having 6 million m^3 of surplus water/year, one arrives at roughly $9 million/year being required to treat this water. The proposed $50 million would be depleted in less than 6 years, without including reclamation costs such as for revegeatating the site.

Recommendation:

- Have the proponent provide a fully costed estimate of the long term closure costs of the Sisson Project for inclusion in a revised EIA report.

[5] Zinck, J. and W. Griffith. 2013. Review of Mine Drainage Treatment and Sludge Management Operations. MEND Project: 603054. Report: CANMET-MMSL 10-058(CR).

1.4 CCNB Action's position on the EIA report and adverse environmental effects of the Sisson project

CCNB Action's report below shows that the need for the proposed tungsten and molybdenum mine has not been proven adequately. In addition, CCNB Action's expert reviewers collectively are of the opinion that because of missing vital data or data of poor quality, and inadequate sampling, methodology, and modeling done by the proponent, a large number of the Sisson Project's environmental effects cannot actually be determined. As a result, the EIA report does not fulfill the requirements for the conducting and reporting of the environmental assessment for the project as set out in the project's EIA terms of reference. CCNB Action experts are also of the opinion that based on the data that is available in the EIA report, in many instances the proponent has under-estimated the environmental effects of the project and mischaracterized the significance of these impacts, i.e., CCNB Action experts believe these adverse environmental effects of the project should be rated as significant.

From a reading of our report below, it is evident the presently inadequate and incomplete EIA report for the project must be redone so that fundamental questions about the project can be answered, such as what is the actual trace mineral content of the ore, what is the acid generating potential of the mined rock, and what are the true economic benefits of the project? Based on the fact the EIA report is incomplete, our experts' findings that many of the project's adverse environmental effects are significant, and the application of the precautionary principle, it is CCNB Action's position that the adverse environmental effects of the project must be accepted as being significant. Given all of this, it is clear that at present the obvious risks posed to the environment by the proposed mine, such as the release of air contaminants, the physical destruction of valuable fish habitat, and metal leaching and acid rock drainage, substantially outweigh the unsubstantiated need for or benefits of the project. For this reason, it is the position of CCNB Action the project should not receive the approval of decision-makers until such time as fundamental errors and oversights in the EIA report are adequately addressed. It is only after the EIA report is properly completed that the public and regulators can return to the question of whether the project should receive approval.

Following from the above, we will be requesting that the Minister use her authority under s. 23(2) of the old *CEAA* and/or the CEA Agency use its authority under s. 23(2) of *CEAA 2012* to require the proponent, Northcliff Resources Inc., to redo and revise the EIA report so that the information gaps in it identified by CCNB Action's experts are filled. We will also ask that the current public comment period not be ended and that it be extended for 45 days following the submission of a revised EIA report by the proponent. If these revisions are not made, then CCNB Action will stand by its position that the adverse environmental effects of the Sisson Project must be deemed to be significant and because of the unsubstantiated need for the project, that these effects cannot be justified. As such, we will ask the CEA Agency to conclude in its comprehensive study report (CSR) for the project, "That even with the implementation of mitigation measures, the Sisson Project is likely to cause significant adverse environmental effects and that these effects cannot be justified."

2. Experts' Reports

2.1 Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Component: Atmospheric Environment
Subject Area: Air Quality
EIA Report Section: 8.2
Date: September 30, 2013

Inka Milewski
Conservation Council of New Brunswick
and
Lawrence Wuest
Consultant in Quantitative Ecology

1. Summary

This review examined EIA Report (EIAR) Section 8.2 Atmospheric Environment, EIA Report Section 7.1 Summary of Key Predictive Studies (Air Quality Monitoring), and the Baseline Ambient Air Quality Technical Report (AQTR). In addition, information from portions of the Metal Leaching and Acid Mine Drainage Characterization Report (ML/ARD Report) and the Canadian National Instrument 43-101 Technical Report (Samuel Engr. 2013) were accessed.

Overall, the study's conclusion that air quality will not be significantly impacted by the project is not credible and cannot be supported by the proponent's dispersion and deposition modeling which used inaccurate estimates of particulate and trace metal emissions and site-specific meteorological data. Once operational, the project will release an estimated 1563.8 metric tonnes (mt) of total particulate matter (dust of all particle sizes) into the atmosphere annually (EIAR). The large quantity of particulate matter (PM) generated by the project will not meet the nation-wide goal of "keeping clean areas clean" as defined for PM by the Canadian Council of Ministers of the Environment. The project will emit nearly 3 times the particulate matter of any existing industrial project in the province.

The key issues identified in this review are:

- discrepancies and inconsistencies in the meteorological data used in the air dispersion model;
- the improper location of the meteorological station at the proposed project site;
- a lack of data on background ambient air concentrations for PM_{10};
- missing and inaccurate emission estimates for some project sources;
- missing geo-referenced data required to validate the concentration and spatial distribution of trace metals at the project site;
- higher average arsenic concentration in all pathways (except topsoil) than the arsenic value used in the dispersion and deposition model;
- emission estimates from the APT plant are not supported by available data or calculations;
- the spatial domain for the air quality model is too small; and
- no environmental monitoring for future air quality is proposed for the project.

The accuracy of emission estimates and the reproducibility of air dispersion modeling results are central components in the assessment of the project's impact on ecological and human health. Deficiencies in the air quality assessment for this project need to be remedied in order for regulators and reviewers to have any confidence in the predictions generated by the EIA report. A detailed review of the deficiencies and recommendations to remedy them are presented below.

2. Review of methods and results used by the proponent to study existing conditions (EIA Report: Section 8.2.2 and Baseline Ambient Air Quality Technical Report)

The proponent's study of existing ambient air quality reviewed data from existing provincial monitoring networks, compared and assessed existing climate and meteorological data and examined meteorological data and dustfall data previously collected by RESCAN for the Sisson Project. The study identified several gaps in earlier efforts to collect baseline air quality data, resulting in an incomplete, six-month collection of baseline ambient air quality monitoring data at a single monitoring station located in Napadogan, approximately 10 km east of the project.

2.1 Meteorological Data

The study compiled data from a meteorological station operated by Northcliff Resources at the site of the Sisson Project site from "spring 2011 to winter 2012" (EIAR). The study is unclear whether this constitutes a full year of data collection. The study concluded that winds at the project site were dominant from the southwest direction (AQTR page14). RESCAN-Geodex operated a meteorological station at the site of the Sisson Project from 2007-2011 (AQTR page 14). In a summary of the period Nov. 2007 to Mar., 2008, RESCAN reported dominant winds were from the northwest (RESCAN 2008, page 3-23). In Figure 1, we compare the study's wind rose (EIAR Figure 8.2.3) to that reported by RESCAN (Rescan 2008, Figure 3.2-10) and illustrates the discrepancies between the two sets of data.

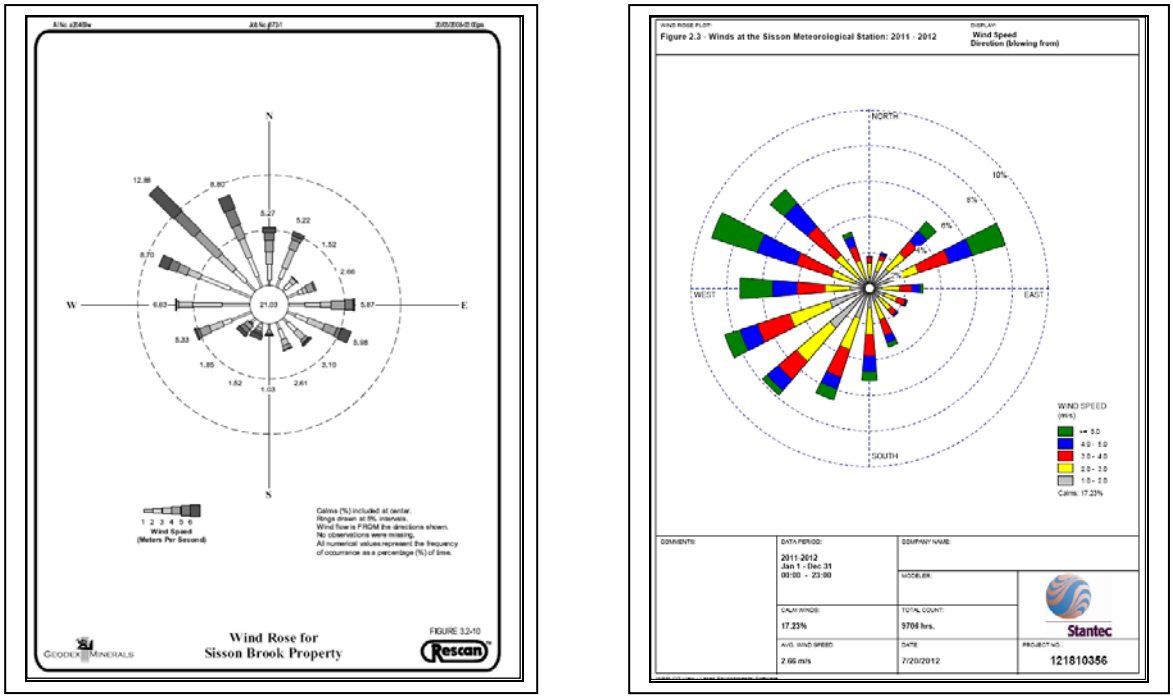

Figure 1. Wind rose from Rescan (2008) on the left and the study wind rose (EIAR) on the right. The meteorological station was in the same location for both recordings.

The study referred to "uncertainties" in the quality of the meteorological wind data collected and reported by Rescan (2008) at the open-pit site (AQTR page 14, Sec. 2.3.1). The study suggested that a lack of evidence of station maintenance and quality assurance precluded the use of the RESCAN data (EIAR page 8-14). The study did not elaborate or provide any further discussion as to why the RESCAN data would not be used.

There appears to be a lack of precision (reproducibility) in the meteorological data and considerable uncertainty as to exactly what is being measured. For example, 5 year summaries in two different wind rose plots for the Fredericton Airport, 60 km south of the project area, are presented in the study. One appears on page 8-15 of the EIA report and the other on page 9 of the Baseline Ambient Air Quality Technical Report (Figure 2).The study has suggested that the climate conditions at the project site are comparable to climate conditions in Fredericton. However, neither Fredericton airport 5 year wind rose matched the RESCAN wind rose or the EIA report wind rose for the project site.

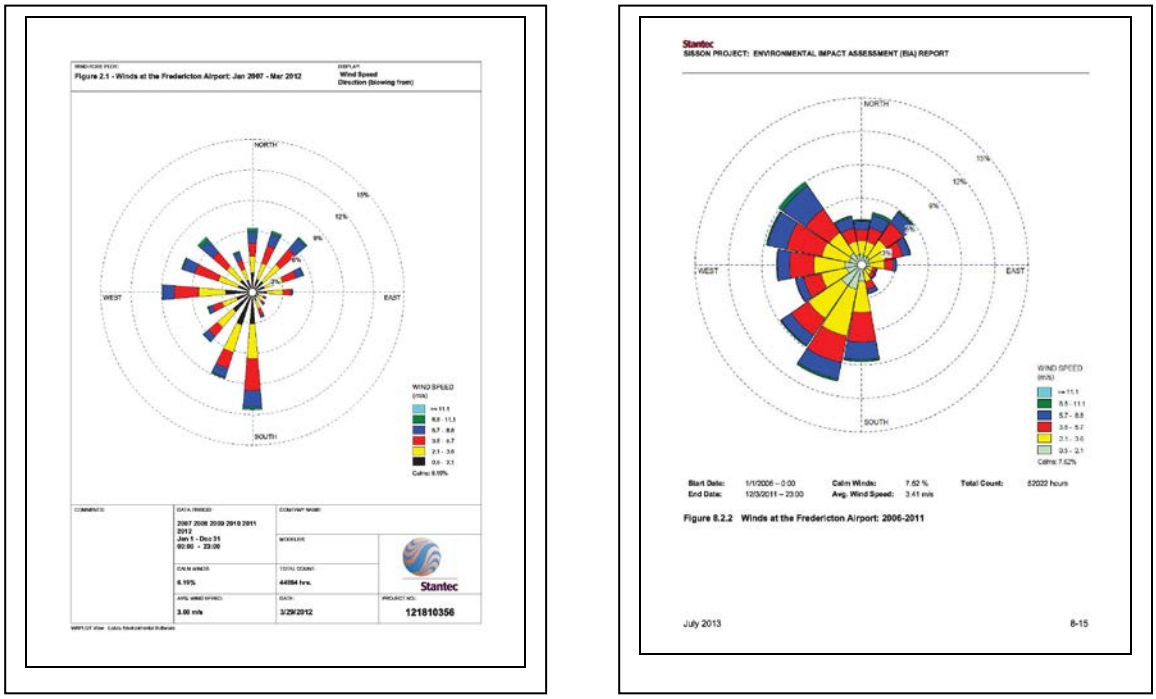

Figure 2. Wind rose for Fredericton Airport Jan 2007 – Mar 2012 on the left and for 2006-2011 on the right.

In Figure 3, we present 5-year summary wind rose plots for Saint Leonard and Edmunston (New Brunswick), communities in the central and northern regions of New Brunswick. Wind direction and speed for St. Leonard and Edmundston are more consistent with the RESCAN plot than the proponent's plot, suggesting the regional trend appears to be contradictory to the Fredericton data used in the study.

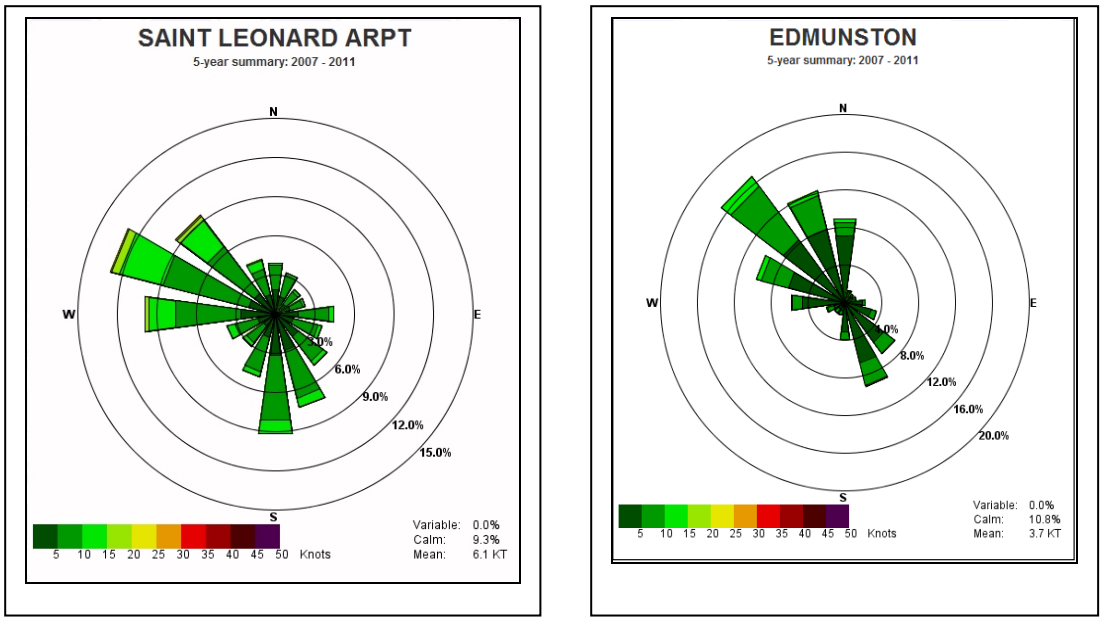

Figure 3. Five-year wind rose summary for Saint Leonard and Edmundston, New Brunswick. Data Source: NOAA's National Climatic Data Center (NCDC) 2013, http://cdo.ncdc.noaa.gov/pls/plclimprod/poemain.accessrouter?datasetabbv=DS3505

The meteorological station monitored by both RESCAN and Northcliff Resources for the EIAR was located at the most southerly end of the proposed open-pit at Sisson (AQTR page 15). This location is roughly positioned at 305m above mean sea level. The processing plant, Tailings Storage Facility (TSF), quarry and ammonium paratungstate (APT) plant are located at elevations 385m-400m, an 80 metre differential. Looking at a topographical map, it is clear the meteorological station was located in a localized basin surrounded on three sides by upland terrain. A large fraction of dust emissions from the project will emanate from sources above the open-pit, e.g. the TSF, quarry, processing plant and APT plant. Placing the meteorological station in a relatively sheltered location and below the maximum sources of emissions fails to capture the wind conditions that are critical to assessing the predictions of contaminant dispersion from the project.

Accurate characterization of wind patterns is central to producing valid and reasonable estimates of contaminant dispersion and deposition. Wind erosion is the most important factor influencing dust emissions and deposition which, in turn, have important environmental consequences (Csavina *et al*. 2012).

The discrepancy and uncertainty of wind patterns reported by Rescan (2008) and the EIA report, and the rationale for locating the meteorological station below the maximum sources of dust emission must be properly explained. The proponent must examine the implications for modeling resulting from the use of uncertain and incomplete site meteorological wind data. The proponent must also defend the use of Fredericton airport wind data as opposed to the Saint Leonard and/or Edmundston wind data, and speak to the uncertainties in emission patterns resulting from that choice. The proponent should also be required to re-measure over an appropriate period of time, site meteorological data at project sites appropriate to individual project emission sources. These measures are required before recompiling model dispersion and deposition patterns of mine emissions. Adequately representative wind pattern

data are essential to making informed assessments of ecological and human health risks associated with project contaminants.

2.2 Ambient baseline air quality monitoring

The study collected ambient air quality data for a six-month period (August 2011 - February 2012) at a monitoring station located in Napadogan, approximately 10 km northeast of the project area. The rationale for placing the monitoring station in Napadogan is reasonable, (e.g., close to residential area, open and away from building, distance from heavy industry and traffic, etc.).

The baseline ambient air quality monitoring results indicate that air quality in the vicinity of Napadogan is representative of that found in a rural, sparsely populated area with no significant source of industrial emissions (AQTR page 38). This is a reasonable conclusion.

Ambient baseline air quality monitoring did not include monitoring for particulate matter (PM) less than 10 microns (PM_{10}) except $PM_{2.5}$. No explanation was provided as to why PM_{10} were not monitored. Sources of PM_{10} are dust from roads, quarries and to a lesser extent diesel exhaust and NOx and SO_2 emissions (NB DELG 2013). These sources of particulates have been identified and associated with the construction and operational phases of the Sisson Project.

The potential for the project to release large quantities of PM_{10}, as well as PM and $PM_{2.5}$, is significant as fugitive dust emissions are the largest source of air contaminants from open pit mining projects (Huertas *et al.* 2012; Silvester *et al*. 2009; Lowndes *et al.* 2008). The potential for the project plus the background levels of PM_{10} to exceed air quality objectives, guidelines or standards are not quantified or assessed because data for background levels were not collected by the proponent.

Given the known health impacts of PM_{10} as well as $PM_{2.5}$, the absence of background PM_{10} data creates gaps and uncertainties in the results of air dispersion and deposition modeling. It also compromises any health risk assessment and provides a low level of confidence in the predictions generated by the models as presented in the EIA report.

3. Review of Potential Project-VEC Interactions (Atmospheric Environment) EIA Report Section 8.2.3)

The Air Quality Predictive Study (EIAR Sec. 7.1) acknowledged that changes to the atmospheric environment could occur due to emissions from the project's construction, operation, decommissioning, reclamation and closure. According to the study's emissions inventory, one of the major air contaminants from the project will be dust emissions in the form of PM, PM_{10} and $PM_{2.5}$. The study predicted that the project effects on the atmospheric environment would not be significant and confidence in the prediction was high (EIAR pages 8-24 to 8-25).

The conclusions of the air quality study were based on estimates of air contaminants from the construction (EIAR pages 3-94 to 3-101) and operation (EIAR pages 3-127 to 3-134) phases of the project. Emission inventories were developed based on information provided by the proponent. No emissions were predicted from the decommissioning, reclamation and closure of the project.

A dispersion model (AEROMOD) was used to estimate the dispersion and deposition of selected air contaminants from the project. Key model inputs were estimates of project emissions, meteorological data from the Fredericton airport and receptor grid and terrain data.

3.1 Air Emissions Inventories

Open pit mining operations present special challenges in measuring air emissions and determining emission factors, particularly for particulate (dust) emissions (Huertas *et al.* 2012a; Huertas *et al*. 2012b; Lowdnes *et al.* 2008). These challenges include estimating appropriate emission factors for non-point sources such as loading and unloading of material, topsoil and overburden handling and drilling. The Sisson Project EIA report did not acknowledge these challenges and, as a result, did not identify or address uncertainties in emission estimates.

The EIA report referenced the US EPA Compilation of Air Pollutant Emission Factors as the source of the project's emission estimates. Each emission factor has a rating from A to E with A being the best to indicate the reliability and robustness of a factor. The Sisson Project EIA report did not rate the reliability of emission estimates from the various sources.

The following is a review of the key air contaminant emissions presented in Sec. 3.4.1.6 and Sec. 3.4.2.5.1 of the EIA report.

3.1.1 Particulate Emissions

Apart from carbon dioxide, particulate emissions (dust) will be the single largest criteria air contaminant (CAC) released from the project. Particulate releases will occur from mobile (vehicles), fixed (concrete plant, APT plant) and fugitive (top soil and overburden handling, loading and unloading ore, quarrying, drilling, blasting, haulage over unpaved roads, etc.) sources. A summary of these emissions does not appear in the EIA report but has been prepared by the reviewers (Table 1).

Table 1. Selected Criteria Air Contaminants (CAC) Emission for the Sisson Project[a]

	Total Particulates metric tonnes/year	**Particulate Matter (PM_{10})** metric tonnes/year	**Particulate Matter ($PM_{2.5}$)** metric tonnes/year
Project - Construction Phase			
On-site Fuel Combustion - Construction Equipment	5.54	-[b]	-[b]
Vehicle Fuel Combustion	0.05	0.05	0.03
Site Preparation	40.0	7.6	4.2
Quarry- blasting	0.02	-[b]	-[b]
Unpaved roads	851.0	226.0	22.6
Topsoil and overburden piles	-[c]	-[c]	-[c]
Material Transfer	-[c]	-[c]	-[c]
Concrete plant	3.3	0.98	-[b]
Sub total	**899.91**	**234.6**	**26.83**
Project - Operation Phase			
Fuel Combustion in mining and support equipment	20.2	20.2	20.2
Vehicle Fuel Combustion	0.07	0.07	0.04
Primary Crusher	32.0	3.20	0.48
Ore Concentrator Plant	-[c]	-[c]	-[c]
APT Plant	-[d]	-[d]	-[d]
Package Boiler	1.0	1.0	0.65
Drilling	-[c]	-[c]	-[c]
Blasting	3.96	2.06	0.12
Material Handling and Transfer	19.9	8.02	1.21
Unpaved roads	1397.0	370.0	37.0
Crushed Ore Stockpile	0.013	0.12	0.002
Beaches	89.7	0.000135	0.0000202
Sub-total	**1563.84**	**404.67**	**59.7**

Notes:
[a] Data source: EIAR pages 3-94 to 3-98 and pages 3-127 to 3-134.
[b] No data provide in report
[c] Assumed negligible
[d] Identified but no data provided

As indicated in Table 1, data for some sources were simply assumed by the proponent to be negligible (topsoil and overburden stockpiling, drilling, the ore concentrator and the APT plant). Published emission factors are available for these sources and should have been applied to generate estimates of particulate emissions. Any emission control measures identified by the proponent could have been accounted for by applying percentage emission reduction efficiencies in the calculation of emissions (US EPA 1995; Environment Canada 2013).

Unpaved roads can include site access (SSA) roads, forest roads and internal site (PDA) roads. The emissions from SSA and PDA have different maintenance standards, different emission factors and different dust suppression capabilities, all factors affecting the level of emissions. The proponent has failed to itemize roads to an acceptable level of differentiation for validation of the reported emissions.

The EIA report's analysis, characterization and reporting of particulate emissions from the Sisson Project are inadequate and incomplete. The likelihood that particulate emissions are underestimated is high because the details of emission source estimates are missing and there is a lack of reproducibility of the emissions data.

3.1.2 Metals Emissions

The proponent reports that 304 drill cores were collected at Sisson from 1979 to 2011 (Table 10.1, Samuel Engr. 2013). The spatial distribution of these drill cores is shown in Figure 10-1 of Samuel Engr. (2013)

For the EIA report, estimates of trace metal content of fugitive dust emissions were determined from assays of 61 trace elements in 184 samples at various depths from 39 of the 304 drill cores as selected by SRK Consulting for ML/ARD studies. The location of the samples in the project area are shown graphically in Figure 5 of SRK (2013).The samples were primarily selected on the basis of sulfur content (SRK 2013 Sec.3.3.5).

The assay results were used to estimate trace metal content of Particulate Matter resulting from truck loading at the crusher, the primary, secondary and tertiary crusher operations, material transfer onto the conveyor, material transfer onto the crushed ore stock pile, haul road emissions, and stock pile wind erosion(EIAR page 3-134, Table 3.4.31). No rationale is given for using the results of trace element analyses of samples selected on the basis of sulfur content, nor is there any discussion of the possible bias injected into the trace element results due to non-random sampling of underlying rock strata (see "stratified random sampling"; SRK 2013 at Sec.3.2.1).

Emission rates for each trace metal by source (e.g., unpaved roads, primary crusher operation, overburden piles) were not provided. The study did not include trace metal emissions during the construction phase of the project or in the overall calculation of trace metal emission rates.

It bears repeating that the study's discussion of trace metal emissions from the project was restricted to the presentation of a table of average trace metal concentrations in samples classified as "ore" (EIAR page 3-134, Table 3.4.31). The only other location in the EIA report where these average trace element values appear is in Appendix E5 - Trace Metal Results for Tailings (ML/ARD report Appendix E5).

The trace metal values in Appendix E5 were drawn from the analysis of 184 drill core composite samples of barren rock (defined as waste rock and mid-grade ore) used to characterize element leaching potential from the project's waste rock (SRK 2013 page 12). According to the SRK ML/ARD report, mid-grade ore was used in the mine leaching/acid rock drainage experiments (ML/ARD report page 26 Sec. 4.2.3).

Average trace metal values in waste rock and mid-grade ore used to determine trace metal emissions to air are not representative of trace elements in the high-grade ore that will be processed in the APT plant and are not representative of the metal emissions from other potential emission pathways such as

overburden removal or waste rock storage. If, arsenic concentrations in ore were derived from the analysis of 184 drill core samples, then there is a discrepancy between the average concentration of arsenic in ore reported in the EIA report (41 mg/kg) and the actual value (64.8 mg/kg) calculated by the reviewers from available drill core data (SRK 2013 Appendix B2).

Table 2 provides a summary of arsenic concentrations measured in various potential pathways of metal releases to the atmosphere through the project's activities such as overburden removal, loading and dumping, crushing, haulage roads, and storage piles. The mean arsenic concentration in the overburden (143.3 mg/kg), which was not used in the study's calculation of trace metal emissions, is more than 250% higher than the concentration of arsenic identified for ore (41 mg/kg) which was used to calculate arsenic emission to air. In fact, arsenic concentrations are significantly higher in all emission pathways than the value used to estimate arsenic releases from the project.

Table 2. Arsenic concentrations in various project pathways

Statistical Value	**Baseline Surface Soil**[a] ppm (mg/kg)	**Overburden**[b] ppm (mg/kg)	**Sub-soil**[c] ppm (mg/kg)	**Pit Walls**[d] ppm (mg/kg)	**Waste-Rock/Mid-grade Ore**[e] ppm (mg/kg)	**Ore**[f] ppm (mg/kg)
Mean	**10.7**	**143.3**	**66.4**	**83.5**	**64.8**	**41**
Number of Samples	51	300	667	58	184	-[g]
Standard Deviation	17.0	612.7	113.3	349.7	287.1	-[g]
Margin of Error	-[g]	69.3	8.6	83.1	41.5	-[g]
95% Upper Confidence Limit	20.8	212.67	75	166.6	106.3	-[g]
95% Lower Confidence Limit	-[g]	74.0	57.8	0.5	23.3	-[g]
Maximum Value	103	10200.0	1470	2490	2917.6	-[g]
Minimum Value	1	6.8	10	0.9	<0.1	-[g]
No. of samples below detection limit	1	0	0	8	4	-[g]

Notes:

[a] Data Source: Baseline Metal in Soil Technical Report Table 3.1, page 17 and Appendix B -ProUCL Outputs for Samples from Key and Soil Sites. Baseline soil samples restricted to the top 30 cm of soil.

[b] Data Source: MRARD Report, Appendix G Overburden Results, G1:Overburden trace element data

[c] Data Source: 2008 Geodex Mineral Report No. 476311

[d] Data Source: ML/ARD Report, Appendix D Pit Wall Results, D2: Trace element analysis

[e] Data Source: ML/ARD report, Appendix B:Barren rock Static Test Results, B2: Trace element analysis results

[f] Data Source: Sisson Project EIA Report, Table 3.4.31, page 3-134. Value used to estimate project trace metal emissions

[g] Data not provided

During the construction phase of the project, an estimated 28 million cubic meters (74.5 million mt@specific gravity 2.66 [Rambøll Arup. 2011]) of overburden will be removed, transported, stored and subject to wind erosion until mitigation measures are put in place. The source of the overburden will be the pit area, the tailing storage facility (TSF) embankment foundations, and the on-site quarry. Clearly, arsenic from overburden removal during the construction phase will be a significant source of arsenic emissions to the atmosphere.

The SRK 2013 ML/ARD report acknowledged that arsenic concentrations in the project area, particularly in the overburden, were high and that it was unclear from the work done to date as to its source. According to the SRK ML/ARD report, further studies were being planned for the fall of 2013 to understand the source and mobility of arsenic in the overburden (SRK 2013 ML/ARD Report page 40).

Drill core and trace metal analyses performed by the previous proponent of the project and reported to New Brunswick Department of Energy and Mines also indicated high concentrations of arsenic and other trace metals in the project area (Geodex 2008 - Mineral Report of Work 476311).

Northcliff Resources has reported the existence of many more geo-referenced drill cores and mineral assays but those data were not part of the EIA report. The geo-location of all drill cores and accompanying mineral assays are necessary to properly assess and estimate trace metal emissions from the project. The EIA Report failed to provide the data necessary to estimate the concentration and spatial distribution of trace metals at the project site.

The study's analysis, characterization and reporting of trace metal emissions from the Sisson Project are incomplete. The likelihood that trace metal emissions, in particular arsenic, are underestimated is high because, as demonstrated, concentrations of arsenic are significantly higher in all potential pathways/sources than the value used in the EIA report to estimate arsenic emissions.

3.1.3 Hydrogen Sulphide

The Sisson Project will operate an ammonium paratungstate (APT) plant. The APT plant will operate year-round, with two 12-hour shifts per day, processing approximately 2 to 3 metric tonnes (mt) per hour of tungsten trioxide (WO_3) concentrate (EIAR page 3-116). The principle point source air emissions from the APT plant have been identified as hydrogen sulfide (H_2S), ammonia (NH_3), sulfur dioxide (SO_2), decane, ethylbenzene, naphthalene and tri-isoocytlamine (TIA) (EIAR page 3-131).

The study failed to provide an audit trail for estimates of APT plant emissions of hydrogen sulfide (H_2S), ammonia (NH_3) and sulfur dioxide (SO_2). The lack of an audit trail of these pollutants is a major deficiency in the EIA report. It presents problems for reviewers and regulators attempting to assess the potential impacts of this project because the estimates of these emissions directly impact the outcomes of the project's air quality modeling, water treatment design, air and aquatic impacts, and reclamation design and bonding.

In the absence of an audit trail detailing the calculations of emission rates and efficiencies, information on emissions from an APT facility operating in New York State was obtained by the reviewers. This information was used to estimate emissions at the Sisson Project APT Plant and compare them to the stated emissions in the Sisson Project EIA report.

In 2012, Niagara Refining LLC (NRL) applied for a permit to operate an APT plant in Depew (New York State). A copy of the permit application containing the calculations of emissions upon which the New York State Department of Environmental Conservation (NYSDEC) based their decision to issue a permit to operate the NRL plant was obtained by the reviewers from the NYSDEC. These calculations were provided to NYSDEC by Conestoga-Rovers & Associates (CRA), consultants to NRL (Appendix A; NRL, 2012). The Permit Conditions issued by the NYSDEC for the New York-based APT facility are shown in **Appendix F**: NYSDEC (2012) of this review. Relevant statements in the permit conditions on the NRL plant include:

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- "….captured ammonia emissions are controlled by 94 percent using a two stage sulfuric acid ammonia scrubbing system. "
- The ammonia scrubbing system reduces the projected potential ammonia emissions to less than 15 [Imperial] tons per year (tpy).
- The captured hydrogen sulfide emissions are controlled to 99 percent by utilizing a sodium hydroxide and sodium hypochlorite scrubbing system.
- The hydrogen sulfide scrubbing system reduces the projected potential hydrogen sulfide emissions to less than 10 tpy.

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- If the combined total production of APT and tungsten oxides exceeds 2,750 tons per year, you shall demonstrate the control equipment is designed to process the additional load.

Reporting of tungsten inputs to the NRL APT plant in New York and the Northcliff Sisson Project APT plant differ slightly. Inputs to the Sisson APT Plant are reported as Scheelite $CaWO_4$. The inputs to the New York-based facility are reported as pre-processed scheelite in the form of $(NH_4)_2WO_4$, obtained after crushing of the scheelite, ball milling, alkali digestion, dilution and filtration. The mass balance of the emissions of concern, hydrogen sulfide (H_2S), ammonia (NH_3) and sulfur dioxide (SO_2) are not affected by this difference.

Northcliff has provided estimates of the WO_3 resource in the EIA report and in NI 43-101 document (Samuel Engr. 2013). The average grade of the ore at Sisson is .067% (EIAR Sec. 3.1.3.3, page 3-7). The expected input to the Sisson Project APT plant is projected to be 15.5 mt per day of WO_3 based on 30000 mt per day of ore processed at 0.77 tungsten recovery.

At the Niagara Refining facility, the input of $(NH_4)_2WO_4$ is expected to be 8212 pounds (lb) per batch at 2.4 batches per day translating into 9.0 mt per day. The molecular weight of $(NH_4)_2WO_4$ is 284. The molecular weight of WO_3 is 232. The WO_3 input into the Niagara Refining APT plant is projected to be 232/284 x 9.0 mt per day or 7.3 mt per day.

Based on these calculations, the scale of operations at Sisson will be roughly twice that of the New York APT facility. It is expected that the emissions at the Sisson Project APT plant will scale similarly at twice the Niagara Refining facility emissions.

After APT processing, the scrubber inputs at the Niagara Refining plant include 40.1 imperial tons per year (imp.tpy) of H_sS, 316.5 imp.tpy of SO_2, and 157.0 imp.tpy of NH_3 (NRF 2012 attachment A2; Table 1.0). Scaling the scrubber inputs for the Sisson Project facility by a factor of 2, the scrubber inputs at Sisson can be projected to be 72.9 mt per year of H_sS, 575.4 mt per year of SO_2, and 285.4 mt per year of

NH_3. The scrubber efficiencies at the New York facility are projected to be 99% for H_2S, 94% for SO_2, and 94% for NH_3.

Table 3 presents calculations for the scrubber outputs at the Sisson Project APT facility based on estimated scrubber inputs, and assuming efficiencies similar to the Niagara Refining plant. The calculated emissions differ sharply with the projections provided in the EIA report for the Sisson Project APT facility (EIAR page 3-131 Table 3.4.22 Point Source Emissions – APT Plant – Operation). Air emissions are estimated to be one to two orders of magnitude higher than estimated in the Sisson EIA report. The magnitude of the underestimations of emissions has serious implications on the number of times air and odour quality standards will be exceeded on and off the project site.

Table 3. Calculation of Selected Point Source Emissions - Sisson Project APT Plant

Emission Type	**Calculated Emission Estimates**[a] metric tonnes per year (mtpy)	**EIAR Emission Estimates**[b] metric tonnes per year (mtpy)
Hydrogen Sulphide (H_sS)	**0.73**	**0.05**
Sulphur Dioxode (SO_2)	**34.5**	**0.00**
Ammonia ($NH_{3)}$	**17.1**	**0.2**
Notes: [a] Base on emission rate calculations and efficiencies for the Niagara Refining APT plant [b] As presented in Table 3.4.22 EIAR page 3-131		

The emission estimates from the APT plant identified in the EIA report are questionable and not supported by available data, calculations or references. Based on the calculations in this review, the likelihood that emissions from the APT plant are underestimated is high.

4.0 Characterization of Residual Project Environmental Effects (of a Change in Air Quality) (EIA Report Section 8.2.4.3)

The evaluation of changes to air quality resulting from the Sisson Project's emissions were based on estimates of air contaminants during the construction and operation phases of the project and the application of the AEROMOD dispersion and deposition model . The study did not acknowledge or discuss the special challenges of modeling dust emissions from open pit mining operations where the lack of emissions data is a main source of uncertainty (Huertas *et al*. 2012a).These challenges include estimating appropriate emission factors for non-point sources such as loading and unloading of quarry material, topsoil, and overburden and drilling.

There was also no discussion or evaluation of the relative pros and cons of using the AERMOD model versus other models such as CALPUFF which is believed to offer a better treatment of the dispersion and transformation of emissions than AERMOD (BC Department of Environment 2005). Gaussian plume (straight line) dispersion models like AERMOD are limited in their ability to account for the complex particle movement associated with large open pit operations (Lowndes *et al.* 2008). Alternative modeling of emissions from open pit mines use a combination of AERMOD and computation fluid dynamic (CFP) models (Huertas *et al.* 2012b).

The accuracy and precision of the dispersion and deposition model for the Sisson Project depend on the accuracy and precision of the meteorological, terrain and emission input data used in the model. As discussed in earlier sections of this review, there are discrepancies and inconsistencies in the

meteorological data used in the model. As also shown in this review, the emissions data for the project are incomplete and unreliable. As a result, the findings of dispersion and depositional modeling for the project lack accuracy and precision.

As summarized in Table 4 below from data in the EIA report, once operational, the Sisson Project will release 1563.8 mt of total particulate matter annually. In 2011, 33 New Brunswick industrial operations reported their emissions to the National Pollutant Release Inventory (Environment Canada 2013). Their cumulative emission of total particulate matter to air was 3,794 mt (Environment Canada 2013b). The Sisson Project will release ten times the particulates emitted by the Potash Corp. mining operation in Sussex and seven times the emissions of the Xstrata zinc mine (now closed) in Bathurst and four times the emissions of the largest oil refinery in Canada, JD Irving in Saint John (Table 4).

Table 4. Total Particulate Emissions Releases - Sisson Project[a] compared to Selected New Brunswick Industries[b]

Facility	Total Particulate Emissions (metric tonnes)	Stack Air Release (metric tonnes)	Fugitive (metric tonnes)	Road Dust (metric tonnes)	Storage and Handling (metric tonnes)	Other (metric tonnes)
Sisson Project Construction Phase	**899.77** (Estimate)	-	-	**851.0**	-	**48.77**
Operation Phase	**1563.84** (Estimate)	-	-	**1397.0**	**19.9**	**146.94**
Xstrata Mine (Bathurst)	**214.87**	115.87	-	99	-	-
Potash Corp (Sussex)	**151.88**	116.7	18.51	5.7		10.97
JD Irving Scierie Grand Riviere (Saint Leonard)	**553.9**	72.5	451.3	-	30.1	-
Irving Oil Refinery (Saint John)	**381.25**	381.25	-	-	-	-
Twin River Paper (Edmundston)	**128.69**	128.69	-	-	-	-
JD Irving/Russell and Swim Sawmill and White Pine Value-added (Doaktown)	**186.1**	49.2	132.1		4.8	

Notes:
[a] Data source: EIA Report pages 3-94 to 3-98 and pages 3-127 to 3-134. For a detailed summary see Table 1 of this review.
[b] Data source: 2011 National Pollutant Release Inventory (Environment Canada 2013).

Given the large quantity of particulate releases during both construction and operational phases, it is simply not credible that the annual average ground-level concentration of total particulates during the construction phase will be six times lower, and during the operation phase only slightly higher, than the annual average in the rural, sparsely populated village of Napadogan which has no significant source of industrial emissions (AQTR page 38) (See Table 5). If a five-week period of road construction in Napadogan could raise ground-level concentration of total suspended particulate matter above annual average baseline concentrations(AQTR page 38 and Table 3.3, page 32), the removal of an estimated

74.5 million mt of overburden, and the annual quarrying and mining of 23.7 million mt of material (Samuel Engr.2013 page 200, Table 16.12) will likely raise the ground-level concentration of particulate emissions significantly more than were raised during the resurfacing of one section of highway.

Table 5. Selected Dispersion Modeling Results for the Sisson Project[a]

Contaminant	Averaging Period	Background Concentration ($\mu g/m^3$)	Maximum Overall Predicted Ground-Level Concentration from the Project - **Construction Phase** ($\mu g/m^3$)	Maximum Overall Predicted Ground-Level Concentration from the Project - **Operation Phase** ($\mu g/m^3$)
SO_2	1-hour maximum	**5.5**	**0.16**	**0.12**
	24-hour maximum	**2.3**	**0.02**	**0.03**
	annual average	**1.1**	**0.002**	**0.01**
PM	24-hour maximum	**23**	**22.5**	**526**
	annual average	**11**	**1.82**	**14.9**
PM_{10}	24-hour maximum	**-**	**6.83**	**38.8**
$PM_{2.5}$	24-hour maximum	**6.1**	**1.01**	**6.05**
Notes: [a] Data Source: EIA Report Vol 1. Sec. 7. Table 7.18 page 7-13 and Table 7.1.10 page 7-16				

It is also not credible that the 1-hour, 24-hour and annual average concentrations of SO_2 during the operational phase of the project will be 45,76 and 110 times respectively lower than ambient levels given that the APT plant is estimated to release 34.5 mt of SO_2 annually (Table 5).

The study had an opportunity and should have evaluated the accuracy and precision of the AERMOD model results by using the dustfall data collected by Rescan (2008) to check the model's predictions of ground-level concentrations of particulates. The AQTR indicated dustfall data was available and reviewed but it was not presented in the AQTR (AQTR page 1).

The receptor grid for the air quality modeling covered the project's defined Local Assessment Area (LAA), a 25 km by 25 km domain area (EIAR page 8-7). The contour plots illustrating predictions of ground-level, 24-hour total and fine particulates ($PM_{2.5}$) and 1-hour NO_2 during the construction phase of the project (EIAR Sec. 7 Figures 7.1, 7.3 and 7.5) extend beyond the LAA but are not reported because they are constrained by the domain area set in the model. Similarly, the contour plots for 24-hour ground-level total PM and NO2 extend beyond the defined receptor grid (EIAR Sec. 7 Figures 7.1.6 and 7.1.7).

For a proper assessment of the environmental impacts of the project, air quality modeling should be re-done and the model domain set to cover an area of 50 km by 50 km. The larger domain area is justified given that transportation routes to and from the project area extend beyond 25 km, fugitive dust emissions along road and from mining operations are a widely acknowledged problem (Csavina *et al*. 2012; Petavratzi *et al*. 2005), and research indicates that fugitive emissions associated with mining operations can be measured at least 20+km from the source (Berryman *et a*l. 2009; Hasselbach *et al*. 2005).

5. Review of assessment of project related effects on air quality (EIA Report Section 8.2.4)

The EIA report has ranked the change in air quality as a result of the project's activities at N - "not significant" due to the proposed mitigation measure (e.g., idling reduction program, dust suppression using water, seeding and re-vegetating topsoil and over burden piles) (EIAR page 8-24). No evaluation of the efficacy of these mitigation measures was provided and no air quality or dust monitoring is proposed to validate claims of "not significant".

The EIA report acknowledged that, based on dispersion modeling, air quality within the project's LAA would change compared to pre-project background levels but because these changes were within various provincial and national standards, guidelines or objective, these changes were not significant.

The Canadian Council of Minister of the Environment (CCME) has produced a guidance document for jurisdictions to assist them in designing and implementing their Continuous Improvement/ Keeping Clean Areas Clean (CI/KCAC) programs as it pertains to the Canada-wide Standards (CWS) for PM and ozone. The CI/KCAC program was established for CWS relating to PM and ozone because it was acknowledged that current CWS numerical targets 'may not be fully protective' of human health and the environment and that these pollutants have no apparent lower threshold for adverse health effects

The CCME guidance document is clear - polluting "Up to a Limit" is not acceptable and has stated that" allowing PM and ozone ambient levels to increase up to the current numerical CWS targets is counter-productive, and unacceptable in light of the absence of any apparent lower threshold for adverse effects and the knowledge that the numerical CWS targets may not be fully protective" (CCME 2007 page 4). The CCME guidance document also states that proponents of development should not regard the current CWS numerical targets as a permissive maximum. The clear intent of CI/KCAC is to ensure air quality is not significantly degraded and to ensure improvement in air quality whenever feasible.

The assessment method used in the Sisson Project EIA report to determine the significance of the project's impacts on air quality is the same method of which the CCME is critical in their guidance document. The Sisson Project will not contribute to the nationally-supported goal of "keeping clean areas clean".

6. Mitigation of Project Environmental Effects (EIA Report Section 8.2.4.2)

The EIA report indicated the project will rely on water spraying to suppress dust on the site access road connecting the project site to the fire road as well as other onsite roads within the project area but not on the forest resource roads. The study does not indicate how much water will be required and whether the fresh water wells developed for the project will have sufficient capacity to meet all the project needs (drinking water, sanitary facilities, fire protection, ore processing as well as dust suppression) (EIAR Sec. 3.4.4.3.8). The freshwater system for the project will produce 21 m^3/hour (EIAR Sec. 3.2.5.4.2).

The proponent reports that the mill will require 14 m^3/hour (EIAR Sec. 7.6.2.2.1.6), leaving 7 m^3/hour for dust suppression, drinking water, sanitary facilities and fire protection. Based on findings in Cecala *et al.* (2012) and Howard and Cameron (1998), site roads will require approx 0.63 l/hour/m^2 of road surface to achieve the proponents 70% dust suppression target (EIAR Table 3.4.28) for 115 dry days. Assuming a 20m-wide right-of-way for site roads, a maximum of 1750m of haul road could be effectively watered if no other demands were being made on the freshwater supply (e.g., drinking and sanitary purposes, fire protection). The proponent has reported 1.2 km of haul roads from the pit to the TSF, 1.2 km of roads

from the quarry to the TSF (EIAR Vol. 1 Table 7.1.2), and an embankment crest length of 8.8 km (EIAR Sec. 3.2.4.3.2.1) requiring service roads. Fresh water dust suppression on this length of site roadways is not possible under the current fresh water system design.

The proponent should be required to file a revised haul road dust suppression plan, complete with detailed haul road usage and fresh water demands to confirm that the current design of the freshwater supply system is adequate to meet project objectives. This requirement is crucial because it has been noted by Cecala (2012) that *''water to be used for spray systems at most mineral processing operations is drawn from settling ponds''*. Given ML/ARD conditions, and given the reagents used in the processing plant and APT plant at the Sisson Project, the use of recycled water for dust suppression cannot be an option. The current fresh water system design and the current dust suppression plans put forward by the proponent are neither feasible nor credible.

7. Review of Follow-up and Monitoring (EIA Report Section 8.2.7)

The study has indicated that no follow-up monitoring will be done to verify the environmental effects predicted, or the effectiveness of mitigation measures with regard to the VEC – air quality. Given that the project will release particulate emissions four times higher than the largest oil refinery in Canada, and that predictions of trace metal emissions, many of which are toxic to human and environmental health, are largely unknown, a monitoring program must be put in place.

Environmental monitoring programs are a cornerstone of mining operations in Canada. These programs confirm whether pre-estimates of emissions were accurate, whether assumptions and predictions made by dispersion and deposition models rates were valid, whether the impact of contaminant deposition on vegetation (habitat), wildlife, water and air quality were accurately predicted and whether provincial and national standards/guidelines for air and water are being met.

The Rio Tinto Diavik Diamond Mine in the Northwest Territories serves as an example of the value of conducting environmental monitoring. According to the 2011 Diavik Mine Environment Agreement Annual Report, the overall amount of dust measured since 2001 (including 2011) had exceeded predictions (by 5 to 30 times depending on the year) made by initial depositional modeling, the zone of influence (area in which animals may be affected by mine activities) around the mine was larger than originally predicted, small changes in water chemistry (quality), sediment chemistry (quality) and benthic invertebrates were measured, and several seepage events were reported from collection ponds (Rio Tinto 2011).

Given the scale of the Sisson Project and the deficiencies and uncertainties in emissions and air quality model predictions identified by this review, it is essential that an environmental monitoring program be developed for the Sisson Project. Key elements of the monitoring program must include (but are not restricted to) the following:

- establishment of a more appropriately located meteorological station to confirm assumptions of, and validate predictions about wind speed and direction;
- establishment of no less than three air quality monitoring stations with the capability of monitoring total particulates, PM-10 and PM-2.5 as well as other criteria contaminants identified by the project;
- trace metal monitoring in dustfall;
- a baseline survey and monitoring program for lichen and moss metals levels; and

- an expanded vegetation survey to obtain more complete baseline information on plant communities in order to monitor the effects of dust on plant communities.

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9. CVs and Biographies of Reviewers

CV of Inka Milewski – see Appendix A.

Biography and Publications of Lawrence Wuest – See Appendix B.

Appendix F: Details of Niagara Refining LLC APT Plant (New York), NYSDEC *DEC ID: 9145200327:* Permit Application

See below.

2.2 Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Component: Public Health and Safety
Subject Area: Public Health
EIA Report Section: 8.9
Date: October 3, 2013

Inka Milewski
Conservation Council of New Brunswick

1. Summary

This review examined EIA Report (EIAR) Section 8.9 Public Health and Safety, EIA Report Section 7.7 Human Health and Ecological Risk Assessment, EIA Report Section 7.1 Air Quality Modeling, and the Baseline Ambient Air Quality Technical Report (AQTR). In addition, information from portions of the Metal Leaching and Acid Rock Drainage Characterization Report (SRK 2013 ML/ARD Report) and the Knight Piésold 2013 Predictive Water Quality Monitoring Report were accessed.

Overall, the study's conclusion that human health will not be significantly impacted by the project is not credible and cannot be supported by the proponent's human health risk assessment (HHRA). There are serious deficiencies in the methods and data used to estimate the project-related human health risks that compromise the validity and precision of the results generated from the HHRA. They are as follows:

- the HHRA modeling domain is too small and does not cover the entire project Local Assessment Area (LAA);
- emissions of particulate matter and metals during the construction phase of the project and the potential seepage of metals from overburden piles during the construction phase have been excluded from the assessment;
- the Project + Baseline assessment of maximum acute and chronic human health risks from inhaling PM_{10} emissions are incomplete and inaccurate;
- particulate emission estimates during the operational phases of the project are significantly underestimated;
- arsenic emission estimates during operational phases of the project are significantly underestimated;
- sulphur dioxide (and other) emission estimates from the Project's ammonium paratungstate (APT) facility are significantly underestimated;
- characterization of health risks for on-site workers are not reported or discussed; and
- public and occupational health follow-up or monitoring will not be done.

The most serious deficiency in the HHRA is that it did not evaluate the non-cancer health risk of the most common route of exposure to arsenic - ingestion of soil, water and food and dermal contact with soil. Non-cancer oral and dermal exposure limits for arsenic have been identified and are available. They have been used in previous heath risk assessments in New Brunswick and worldwide to evaluate non-cancer risks from ingestion of soil, water and food and dermal exposure to soil.

The HHRA stated that conservative assumptions were used in air and predictive water quality models and, therefore, risk estimates tend to overestimate rather than underestimate health risk. Given the significant uncertainties in the project's estimate of dust and arsenic emissions and the yet-to-be estimated seepage of arsenic from sources (e.g., overburden) other than the TSF, the Sisson HHRA should have conducted a sensitivity analysis to identify how variations in the model inputs influence the outputs of the model.

Lastly, the Canadian Handbook on Health Impact Assessment, a Report of the Federal/ Provincial/ Territorial Committee on Environmental and Occupational Health and published by Health Canada, is explicit regarding the need for follow-up monitoring for development projects such as Northcliff's Sisson Project. At the very least, the public and worker physical health and socio-cultural well-being indicators outlined in the Canadian Handbook on Health Impact Assessment should form the basis of a health monitoring program for the Sisson Project.

A detailed review of the deficiencies and recommendations to remedy them are presented in the following sections.

2. Review of methods used by the proponent to study existing conditions (EIA Report Section 8.9.2)

The method use by the proponent to examine the current public health and safety status from existing conditions relied on two approaches:

- reviewing current health and other data for residents in the Regional Assessment Area (RAA) which was spatially defined as the former Health Region 3; and
- predicting the health risks associated with human exposure to existing contaminants of potential concern (COPCs) in the environment within the project's Local Area Assessment (LAA).

2.1 Current Health Status (EIA Report Section 8.9.2.1)

The presentation of information on the current health status of Health Region 3 residents (EIAR Sec. 8, pages 8-443 to 8-448) and the description of the socio-economic setting for New Brunswick and York and Carlton Counties (EIAR Sec. 6, pages 6-43 to 6-49) has no statistical relevance in evaluating the potential health or socio-economic changes that may occur as a result of the project's activities for residents who live, work or spend leisure time around and within the LAA. The health information provided in the EIA report is not (and statistically cannot be) linked to any future monitoring or health assessment of the project's impacts.

A more appropriate approach to documenting current health status of residents in the LAA, but still not ideal, would have been to gather health and socio-economic data for the principal Statistics Canada census subdivision (CSD) that encompass the project's LAA (Stanley and Douglas Parishes) (Statistics Canada 2013). At a very minimum, this geographic area should be the basis for assessing changes to health and socio-economic status from the project's activities.

The presentation of statistics on general workplace injuries in New Brunswick and injuries in the construction, mining or quarrying sectors in Canada as a whole (EIAR Sec. 8, page 8-448) are also not useful or relevant to understanding the workplace health and safety issues associated with the Sisson project. The EIAR should have presented New Brunswick-specific information on workplace injuries and

illness reported in the construction, quarrying and mining industries. Presumably WorkSafe New Brunswick maintains a database on injuries and illness by industrial sector which should have been accessed for this information.

Numerous studies have statistically linked occupational exposure to arsenic and dust with a wide range of cancer and non-cancer diseases. A review of workplace diseases linked with arsenic and other metals associated with the molybdenum/tungsten mining industry would have been useful to regulators and the public. The review would have provided regulators and the project proponents with information on successful prevention measures and best practices that could improve workplace conditions.

- **2.2 Predicted Baseline Human Health Risks - Existing Environmental Contaminant Concentrations (EIA Report Section 8.9.2.2)**

There are deficiencies in the data used to characterize the baseline human health risks for the LAA that seriously compromise the validity and precision of the results generated from the human health risk assessment (HHRA) overall. They are as follows:

- Portions of the LAA are not covered by the Public Health and Safety assessment because the receptors defined for the HHRA cover a smaller spatial (20 by 20 km) (EIAR Sec. 8.9, page 8-439) than the area used to gather baseline line information (25 by 25 km) (EIAR Sec. 7.1, page 7-5). As a result, HHRA receptor locations in the community of Napadogan, and other locations at the edges of the LAA where people from Williamsburg, Currieburg, Boyds Corner, Fredericksburg and Stanley may spend recreation time, are not covered by the HHRA. No explanation is provided in the HHRA for the decision to use the smaller domain area. The spatial modeling domain of the HHRA should be expanded to cover, at the very least, the entire LAA area (25 by 25 km).

- Coarse particulate matter (PM_{10}) is identified as a COPC in the project HHRA but was not measured in the baseline air quality assessment (EIAR; AQTR page 19). No explanation is provided as to why baseline PM_{10} was not monitored. Numerous epidemiological studies have made a statistical link between the concentration of PM_{10} in ambient air and health effects. These effects include mortality, increased hospital admissions and emergency room treatment, increased incidence of pneumonia and exacerbation of chronic obstructive pulmonary disease, exacerbation of asthma attacks and broncho-dilator use, increased respiratory symptoms, such as coughs, and decreased lung function (UK Environmental Agency 2012).

  The baseline health risks associated with exposure to PM_{10} from the project were not examined or assessed (EIAR Sec. 7.1, page 7-153). As a result, the Project + Baseline assessment of maximum acute and chronic inhalation human health risk is not only inaccurate as it only reflects the project's contribution to risk but it underestimates the overall health risks from PM_{10} emissions (EIAR Sec. 7.1, page 7-153). Ambient baseline monitoring for PM_{10} must be undertaken and, once completed, the estimated health risks associated with PM_{10} re-calculated.

- The HHRA has incorrectly assumed that the health risks related to ingesting or inhaling arsenic are cancer-related only and that there are no toxicological reference values for non-cancer health effects via the oral or dermal route for adults or toddlers (EIAR Sec. 7.7, pages 7-148, 7-149). As a result, the baseline (and project-related) human health risk assessment via ingestion of soil, water and food and dermal contact with soil has not been assessed for arsenic (EIAR Sec. 7.7, page 7-156). This is a serious omission in the HHRA and must be remedied.

Oral and dermal exposure limits for arsenic are available and the non-cancer health endpoints for arsenic via the oral route are hyperpigmentation, keratosis and vascular complications (CalEPA OEHHA 2000; US EPA 1998). Heath risk assessments in New Brunswick (Cantox Environmental Inc. *et al.* 2006; New Brunswick Department of Health 2005; Jacques Whitford 2003), Ontario (SARA Group 2008) and worldwide (Kar *et al*. 2011; Ordóñez *et al.* 2011; De Miguel *et al.* 2007; Obiri *et al.* 2006) have evaluated the non-cancer health risks from ingesting arsenic in soil, water and food as well as from dermal contact.

3. Review of Potential Project-VEC Interactions re: Public Health (EIA Report Section 8.9.3.1)

The HHRA has indicated that during the Construction and Decommissioning, Reclamation and Closure phases the mine would not be producing, processing or handling ore and hence there would be no atmospheric deposition of ore dust (EIAR Sec. 7.7, page 7-129). The EIAR has stated that during construction, there would be no mining activity and thus no seepage or surplus water from the tailing storage facility (TSF) (EIAR Sec. 8, page 8-453). As a result, the HHRA concluded that a Change in Public Health during these phases of the project are rated as not significant and are not part of the HHRA. This conclusion is inaccurate and not supported by the available evidence in the EIA report.

- **Particulate emissions during the <u>construction phase</u> are significant**

During the construction phase of the project, an estimated 28 million cubic meters or 74.5 million mt (at a specific gravity of 2.66 [Rambøll Arup. 2011]) of overburden will be removed, transported, stored and subject to wind erosion until mitigation measures are put in place. The sources of overburden material will be the pit area, the tailing storage facility (TSF) embankment foundations, and the on-site quarry (EIAR; SRK 2013 ML/ARD page 11). A summary of these emissions does not appear in the EIA report but has been prepared by reviewers (Table 1).

Table 1. Selected Criteria Air Contaminants (CAC) Emissions during the Construction Phase of the Sisson Project[a]

	Total Particulates metric tonnes/year	**Particulate Matter (PM_{10})** metric tonnes/year	**Particulate Matter ($PM_{2.5}$)** metric tonnes/year
Project - Construction Phase			
On-site Fuel Combustion - Construction Equipment	5.54	-[b]	-[b]
Vehicle Fuel Combustion	0.05	0.05	0.03
Site Preparation	40.0	7.6	4.2
Quarry- blasting	0.02	-[b]	-[b]
Unpaved roads	851.0	226.0	22.6
Topsoil and overburden piles	-[c]	-[c]	-[c]
Material Transfer	-[c]	-[c]	-[c]
Concrete plant	3.3	0.98	-[b]
Sub total	**899.77**	**234.6**	**26.83**

Notes:
[a] Data source: EIAR pages 3-94 to 3-98.
[b] No data provide in report
[c] Assumed negligible
[d] Identified but no data provided

As indicated in Table 1, data for some sources were simply assumed to be negligible (topsoil and overburden stockpiling and material handling). Research indicates that PM_{10} emissions from construction operations involving earth-moving (scraping operations) are up to an order of magnitude greater than US AP-42 generic equation factors because these factors under-predict the emissions from loading, unloading and transporting (Muleski *et al*. 2005). PM_{10} emissions from material handling are reported to be 10% of the amount generated from transportation on unpaved roads and the efficiency of watering to suppress dust begins to decrease by 3-14% per hour (Muleski *et al.* 2005). If this relationship between emissions from transportation and material handling was applied to the Sisson Project, PM_{10} emissions for material transfer would be 85 mt and not "negligible" as suggested in the EIAR (EIAR Sec. 3, page 3-98).

Given that the EIA report referenced the same US AP-42 equation factors to predict emissions during construction and operation phases of the Sisson Project (EIAR Sec. 3, pages 3-94 to 3-98 and pages 3-127 to 3-134) and that these factors have been found to under-predict emissions by a factor of 10, particulate emissions from the construction phase of the project have likely been significantly underestimated.

- **Arsenic emissions and deposition modeling estimates during the project's <u>construction phase</u> are missing**

An estimated 28 million cubic meters of overburden will be scraped, moved and stored in the project area during the construction phase of the project. The EIA report failed to characterized the concentration, volume, dispersion and deposition of metals, in particular arsenic, emissions from loading, transporting and unloading overburden from the pit area, the tailing storage facility (TSF) embankment foundations, and the on-site quarry.

SRK Consulting analyzed 300 overburden samples for mine leaching/acid rock drainage (ML/ARD) studies for the EIA Report (SRK 2013 MR/ARD Report Appendix G). Based on data in Appendix G1 of the MR/ARD report, the mean arsenic concentration in the overburden was calculated by the reviewer to be 143.3 mg/kg (95% upper confidence limit = 212.7 mg/kg.). Arsenic concentrations in overburden were more than 250% higher than the value of arsenic in ore (41 mg/kg) used to calculate arsenic emission to air (EIAR Sec 3, page 3-134). Failure to incorporate arsenic emissions, which are likely to be significant, from overburden removal and handling will result in under-predictions of arsenic deposition and, subsequently, under-predictions of the human health risks associated with arsenic.

- **Arsenic seepage from topsoil/overburden piles during the construction and operational phases are unknown**

The SRK 2013 ML/ARD report acknowledged that arsenic concentrations in the overburden were high and that it was unclear from the work done to date as to its source (SRK 2013 ML/ARD page 40). According to the SRK 2013 ML/ARD report, further studies were being planned for the fall of 2013 to understand the source and mobility of arsenic in the overburden and it's metal leaching potential (SRK 2013 ML/ARD page 40).

The EIA report indicated that overburden would be stockpiled and used during reclamation and closure and that stockpiles would not be located within 30 m of a watercourse or wetland to minimize environmental effects through erosion and sedimentation (EIAR Sec 3.4.1.2.4, page 3-85) However, management of seepage from the stockpiles is not outlined in the EIA report other than suggesting that

water contacting this material could easily be collected and directed to the water treatment plant if required (SRK 2013 ML/ARD Sec. 5.4, page 46).

The Knight Piésold Predictive Water Quality Modelling (PWQM) study, completed in July 2013, could not account for the contribution of arsenic from overburden to water seepage because the data were not available at the time of their study. The PWQM for the Sisson project will need to be redone once this data is available. Any changes in the outputs of the PWQM will have implications for the HHERA model outputs.

The emissions of dust and metals during the **construction phase of the project** and the potential seepage of metals from overburden piles during the construction and operational phases should have been included in the HHRA.

4. Review of environmental effects assessment re: Characterization of Residual Project Environmental Effects (of a Change in Public Health) (EIA Report Section 8.9.4.3)

The project HHRA used predicted or measured levels of COPCs provided in other studies conducted for the project's EIA report to estimate, describe and evaluate the health risks associated with the project (EIAR Sec 7.7, page 7-140). These studies included project-related emissions and waste estimates (EIAR Sec. 3.4.1.6), baseline soil and biota sampling (EIAR Baseline Reports), deposition modeling (EIAR Sec. 7.1), water quality modelling (EIAR; Knight Piesold 2013, WQMR) and metal analyses in the metal leaching/acid release drainage (SRK 2013 ML/ARD). The HHRA has assumed the estimate of emissions and predictions of releases and deposition provided by these studies were complete and accurate.

The HHRA has concluded that, overall, the projects activities are not expected to affect the health risk for long-term inhalation exposures, exposure to soil, or ingestion of water. The project will affect the future concentrations of arsenic, boron, cobalt and thalium in fish and increase cancer-related health risks for people who consume those fish (EIAR Sec 8, page 8-462). The HHRA views this risk to be low or moderate due to the degree of conservatism in the assessment (EIAR Sec 8, page 8-462).

There are serious deficiencies in the methods and data used to estimate the human health risks associated with the project's COPCs that compromise the validity and precision of the predictions generated from the HHRA. They are as follows:

- **The HHRA modeling domain does not cover the entire LAA**

As previously discussed in section 2.2 of this review, sections of the LAA are not covered by the Public Health and Safety assessment because the receptors defined for the HHRA cover a smaller spatial (20 by 20 km) (EIAR Sec. 8, page 8-448) than the area used to gather baseline line information (25 by 25 km) (EIAR Sec. 7.1, page 7-5). As a result, HHRA receptor locations in the community of Napadogan and other locations at the edges of the LAA where people from Williamsburg, Currieburg, Boyds Corner, Stanley, and Fredericksburg may spend recreational time are not covered by the HHRA. No explanation is provided in the EIA report for the decision to use the smaller domain area. The spatial area of the HHRA must be expanded to cover, at the very least, the entire LAA area (25 by 25 km).

- **Particulate emissions and deposition from the operational phase of the project are underestimated**

Apart from carbon dioxide, particulate emissions (dust) will be the single largest criteria air contaminants (CACs) released from the project during the operational phase. A summary of these emissions does not appear in the study but has been prepared by this reviewer (Table 2).

Table 2. Selected Criteria Air Contaminants (CAC) Emission from the Operation Phase of the Sisson Project[a]

	Total Particulates metric tonnes/year	**Particulate Matter (PM_{10})** metric tonnes/year	**Particulate Matter ($PM_{2.5}$)** metric tonnes/year
Project - Operation Phase			
Fuel Combustion in mining and support equipment	20.2	20.2	20.2
Vehicle Fuel Combustion	0.07	0.07	0.04
Primary Crusher	32.0	3.20	0.48
Ore Concentrator Plant	-[b]	-[b]	-[b]
APT Plant	-[c]	-[c]	-[c]
Package Boiler	1.0	1.0	0.65
Drilling	-[b]	-[b]	-[b]
Blasting	3.96	2.06	0.12
Material Handling and Transfer	19.9	8.02	1.21
Unpaved roads	1397.0	370.0	37.0
Crushed Ore Stockpile	0.013	0.12	0.002
Beaches	89.7	0.000135	0.0000202
Sub-total	**1563.843**	**404.67**	**59.7**

Notes:
[a] Data source: EIAR 2013 pages 3-127 to 3-134.
[b] Assumed negligible
[c] Identified but no data provided

As indicated in Table 2, particulate emissions data for some sources were simply assumed by the proponent to be negligible (drilling, the ore concentrator and the APT plant). Published emission factors are available for these sources and should have been applied to generate estimates of particulate emissions. Any emission control measures identified by the proponent could have been accounted for by applying percentage emission reduction efficiencies in the calculation of emissions (US EPA 1995; Environment Canada 2013).

Unpaved roads can include site access (SSA) roads, forest roads and internal site (PDA) roads. The emissions from SSA and PDA have different maintenance standards, different emission factors and different dust suppression capabilities, all factors affecting the level of emissions. The proponent has failed to itemize roads to an acceptable level of differentiation for validation of the reported emissions.

In addition, research has shown that the US AP-42 generic equation factors used to calculate material handling and transfer significantly under-predict the emissions from loading, unloading and transporting

of material (Muleski *et al.* 2005). PM_{10} emissions from material handling are reported to be 10% of the amount generated from transportation on unpaved roads and the efficiency of watering to suppress dust begins to decrease by 3-14% per hour (Muleski *et al.* 2005).

It is instructive to note that predictions of dust emissions from at least one open pit mine in Canada were found to be five to 30 times higher (depending on the year) than estimates made by initial depositional modeling for the mine (Rio Tinto 2011).

The EIA report's analysis, characterization and reporting of particulate emissions from the Sisson Project lack transparency in how emissions were calculated and the emission inventory is incomplete. The likelihood that particulate emissions are underestimated is high because the details of emission source estimates are missing and there is a lack of reproducibility of the emissions data. As a result, human health risks associated with exposure to particulate matter are likely underestimated.

- **The Baseline + Project assessment of maximum acute and chronic human health risks from inhaling PM_{10} emissions are inaccurate**

As previous discussed in section 2.2 of this review, the baseline health risks associate with exposure to PM_{10} from the project were not examined or assessed (EIAR Sec. 7.1, page 7-153) because baseline PM_{10} was not monitored. Consequently, the combined Baseline + Project health risks from inhaling PM_{10} are inaccurate and the risks, as presented in the HHRA, are underestimated.

- **The project's sulphur dioxide emissions are underestimated**

The estimated emissions of sulphur dioxide (SO_2) from the Sisson Project's ammonium paratungstate (APT) plant were re-calculated as part of the review of the project's impact on air quality. These calculations indicated that SO_2 emissions would be 34.5 metric tonnes per year. The EIA report stated there would be no SO_2 emissions from the plant (EIAR Sec. 3, page 3-131).

The EIA report failed to provide an audit trail for estimates of APT plant emissions of hydrogen sulfide (H_2S), ammonia (NH_3) and sulfur dioxide (SO_2). The lack of an audit trail of these pollutants is a major deficiency in the EIA report. The emission estimates from the APT plant are questionable and not supported by available data, calculations or references. The likelihood that emissions from the APT plant were underestimated is high and, therefore, the likelihood that the project's inhalation human health risks for SO_2 were underestimated is also high.

- **Arsenic emissions and deposition during the construction phase of the project are underestimated**

The HHRA has assumed that arsenic and other metals in ore dust are correctly characterized and that dust from ore represents the only source of arsenic and other metal emissions from the project (EIAR Sec. 7.7, page 7-129). No deposition concentration contours for arsenic (or other metals) were presented in the air quality modeling study (EIAR Sec 7.1)

There is no explanation in either the EIA report's air quality modeling study or in the HHRA to indicate how and where the value for arsenic in ore (41 mg/kg) were obtained. The only reference to this value, other than a table of average trace metal concentrations in samples classified as "ore" (EIAR Sec 3., page

3-134, Table 3.4.31), is in Appendix E5 - Trace Metal Results for Tailings (SRK 2013 ML/ARD report Appendix E5).

The trace metal values in SRK 2013 Appendix E5 were drawn from the analysis of 184 drill core composite samples of barren rock (defined as waste rock and mid-grade ore) used to characterize element leaching potential from the project's waste rock (SRK 2013 page 12). According to the SRK 2013 ML/ARD report, mid-grade ore was used in the mine leaching/acid rock drainage experiments (SRK 2013 ML/ARD Sec. 4.2.3, page 26).

Average trace metal values in waste rock and mid-grade ore used to determine trace metal emissions to air are not representative of trace elements in the high-grade ore that will be processed in the APT plant and are not representative of the metal emissions from other potential emission pathways such as overburden removal or waste rock storage. If arsenic concentrations in ore were derived from the analysis of 184 drill core samples, then there is a discrepancy between the average concentration of arsenic in ore reported in the EIA report (41 mg/kg) and the actual value (64.8 mg/kg) calculated by reviewers from available drill core data (EIAR Appendix B2).

- **The non-cancer human health risks associated with arsenic via ingestion of soil, water and food and dermal contact with soil are missing**

The HHRA did not evaluate either the baseline or project-related human health risk for arsenic via ingestion of soil, water and food and dermal contact with soil (EIAR Sec. 7.7, page 7-156). This is a serious omission in the HHRA and must be explained and remedied.

As indicated in section 2.2 of this review, non-cancer oral and dermal exposure limits for arsenic have been identified and are available (CalEPA OEHHA 2000; US EPA 1998). They have been used in previous heath risk assessments in New Brunswick (Cantox Environmental Inc. *et al.* 2006; New Brunswick Health Department 2005; Jacques Whitford 2003) and Ontario (SARA Group 2008) to evaluate non-cancer risks from ingestion of soil, water and food and dermal exposure to soil.

- **Characterization of health risks for on-site workers are not reported or discussed**

The EIA report has indicated that the project will generate direct employment for up to 300 workers during the operation phase of the project, generally split between two 12-hour shifts per day (EIAR Sec 3.4, page 3-138). At any one time, there will be approximately 150 workers on site who will be working primarily in an area between the quarry and the mine pit. Four HHRA receptors (HHERA 21, 23, 25 and 43) were identified in this area (EIAR Sec 7.7; page 7-119). This area was also identified by depositional modeling to be the area of highest ground level concentration of NO_2 , total PM, PM_{10} and $PM_{2.5}$ (EIAR Section 7.1, Figures 7.1.2 to 7.1.8).

The HHRA reported that the 24-hour Project + Baseline health risk (CR = 7.0) associated with inhaling PM exceeded the Concentration Ratio (CR) benchmark (CR= 1.0) by seven times at the maximum ground level concentration for PM (EIAR Section 7.7, page 7-153). The Project-related risk (CR = 6.81) accounted for almost all of the risk.

The HHRA downplayed or dismissed this risk by stating there were no HHRA receptors at that location, an area at the edge of the quarry and the TSF area. In fact, a receptor location (HHERA25) was located less than 500 metres from the maximum ground level concentration point. It is simply not credible to

suggest that people working less than 500 meters from the precise point where air quality model predicted maximum concentrations of PM would not be affected by high concentrations of PM. Air quality modeling results predict maximum ground level concentrations of NO_2, total PM, PM_{10} and $PM_{2.5}$ encompass larger areas than just a single point of maximum concentration (EIAR Section 7.1, figures 7.1.2 to 7.1.8).

The HHRA also downplayed all the inhalation risks where aluminum, arsenic, cadmium and manganese exceeded CR benchmarks by stating that the location of the maximum ground level concentration was not at any of the HHRA receptor locations (EAIR Section 7.7., page 155). Air quality modeling results for metals were not provided in the EIA report's air quality modeling study (EIAR Sec. 7.1). Again, it is not credible that the area of maximum deposition is restricted to a single point.

Health risk values (CR, Health Quotients, and Lifetime or Incremental Cancer) were not reported for any individual HHRA receptor locations directly at the project site. No explanation is provided for this omission. This information would be useful to New Brunswick's occupational health and safety agency in ensuring that the correct and highest occupational health standards are imposed on the project to protect the health and well-being of workers. Specifically, occupational health and safety regulators will need to ensure that monitoring for tungsten metal and insoluble tungsten compounds are enforced in areas of the project where inhalation health risks for tungsten will be the greatest (e.g., the crusher areas, the APT plant). The current National Institute for Occupational Safety and Health (NIOSH) recommended exposure level (REL) and the American Conference of Industrial Hygienists (ACGIH) threshold limit value (TLV) 8-h time weighted average (TWA) are 1 mg tungsten/m^3 for soluble tungsten compounds and 5 mg tungsten/m^3 (Jackson *et al.* 2013).

The **Canadian Handbook on Health Impact Assessment**, a Report of the Federal/Provincial/Territorial Committee on Environmental and Occupational Health, makes the following case for worker health to be part of health risk assessments of development projects:

> "*In the past, workers have unintentionally played the role of the "mining canary," with their negative health outcomes serving as a warning for the rest of society. It behooves us to give prominent consideration to these individuals, who not only are responsible for societal productivity, but are most at risk by virtue of the dose response relationship that is fundamental to toxicology*." (Health Canada 2004c. Volume 3, Chapter 7, page 7-1)

- **A sensitivity analysis of the HHRA results has not been done**

The EIA report acknowledges that human health risk assessments are inherently uncertain and has indicated it has adopted conservative assumptions to account for these uncertainties (EIAR Section 7.7, page 7-164).

Risk assessments rely on at least 50 different assumptions regarding exposure, dose-responses, ingestion rates, bioavailability and toxicological reference values (TRV) (Raffensperger and Tichner 1999). Statistical sensitivity analyses are usually preformed to understand how risk estimates are dependent on variability and uncertainty in the factors contributing to risk.

This type of sensitivity analysis was performed for the Sudbury Area Risk Assessment (SARA) study (2008) to assess how variations in the soil risk management level were influenced by uncertainties in the health human risk assessment input variables. The sensitivity analysis revealed that by altering soil

ingestion rate, soil to dust ratio, food consumption rate, bioavailability of lead in soil and dust and the TRV, soil risk management levels varied substantially (-41% to +2200%) (SARA 2008 Vol II, Chapter 5, pages 5-40 to 5-41).

Given the significant uncertainties in the project's estimate of dust and arsenic emissions and the yet-to-be estimated seepage of arsenic from sources (e.g., overburden) other than the TSF, the Sisson HHERA should have conducted a sensitivity analysis to identify how variations in the model inputs influence the outputs of the model.

5. Review of Follow-up and Monitoring (EIA Report Section 8.9.7)

The HHRA study has indicated that no follow-up monitoring of either the general public or workers will be done to verify the effectiveness of mitigation for Public Health and Safety (EIAR Sec 8.9, page 8-465). This decision is unacceptable and unsupported by a 2004 report from a Canadian Federal/ Provincial/Territorial Committee on Environmental and Occupational Health.

The **Canadian Handbook on Health Impact Assessment**, a Report of the Federal/Provincial/Territorial Committee on Environmental and Occupational Health is explicit regarding the need for follow-up monitoring:

> "*Monitoring and follow-up are perhaps the most crucial steps to advance our understanding of the effects of development projects on our physical and social well-being. If we are to understand the health implications for future development projects, we must rely on an accurate depiction of health effects from similar previous development projects. This can only be obtained through follow-up monitoring*." (Health Canada 2004b, Volume 1, page 2-14)

Health Canada's Handbook on Health Impact Assessment provides guidance for public and occupational health monitoring. It states that the need for occupational health monitoring cannot be overemphasized because occupational levels of exposure are generally higher than environment levels (Health Canada 2004c), as the results of the Sisson Project HHRA have demonstrated (see review above).

At the very least, the public and worker physical health and socio-cultural well-being indicators outlined in Table 3.1 (Volume1, Chapter 3, page 3.2) of the Canadian Handbook on Health Impact Assessment should be monitored. For the public, these would include health indicators such as respiratory effects, noise, and cancer and socio-cultural well-being indicators such as crime rates and drug and substance abuse. Health monitoring of workers would include indicators such as respiratory effects, effects on skin and fertility, and cancer incidence. Socio-culture well-being indicators could include necessity for relocation or stress-related conditions.

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7. CV of Reviewer

CV of Inka Milewski – see Appendix A.

2.3 Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Components: Water Resources
Subject Areas: Ecological Water Availability
EIA Report Sections: 8.4
Date: September 26, 2013

André St.-Hilaire, PhD.
INRS-ETE (Institut national de la recherche scientifique), University of Québec

1. Summary

What did I review?
Baseline Hydrogeology Report, Baseline Hydrometeorolgy Report, EIA report section 8.4 Water Resources, EIA report section 7.6 Predictive Study, re: water quality modeling

What are the highlights of my review?
Hydrometeorology
Overall, the methods used by the proponent to gather data for regarding water resources in the project development area were correct, albeit not the most up to date approaches in the case of regional frequency analysis. Local frequency analysis appeared to be done without respecting the initial verifications on time series and only one statistical distribution was tested. The proponent's work in this area would have been improved by comparing the goodness of fit of more than one distribution. As a result; any extreme value analysis and return period estimated in the report should be treated as an order of magnitude to be partially validated with goodness of fit criteria on the selected distribution.
Hydrogeology
I am less familiar with hydrogeology methods than with surface hydrology. However, I noted that the proponent's consultant claims to want to use the hydrological model results to validate some of the hydrogeology settings to be used subsequently (Baseline Hydrogeology Report page A1 of 43). Later on, the consultant mentions that the model can assist in identifying long term trends from changing climate. I did not find any conclusions related to those two points.

2. Review of methods used by the proponent to study existing conditions (EIA Report section 8.4.2)

Were proper sampling methods used?

- Meteorological data used to perform frequency analysis may be insufficient.
- We do not know what type of water level gauge was used and the precision of the instrument is not mentioned.
- The baseline hydrogeology report recommends (at page 8) that given the uncertainty with the high groundwater take tests, there needs to be recognition of "the implications of potentially high hydraulic conductivity values within the deposit area on engineering and environmental studies until additional testing is completed to gain a better understanding of the hydraulic conductivity values."
  It is unclear if this was ever done or accounted for in the EIA report?

Timing of sampling, e.g., appropriate season
Stream gauging in the spring and in the winter is challenging. Given the relatively short period of the study, it should be made clearer in the report if the sampling period covers years that are more or less typical hydrologically for the region.

A large proportion of the synthetic flows (for Station B-2 (Bird Brook at Napadogan Brook) as discussed in Appendix A1, Baseline Hydrogeology report) generated for the period of April and May is in the extrapolation range of the rating curve. Is this a problem?

Is the sampling science/methodology up-to-date (Baseline Hydrometeorology Report)
There are more updated methods for regional frequency analysis (estimation of return periods) for precipitation and flow. It is not clear in the Baseline Hydrometeorology Report if the hypotheses of stationarity, independence and homogeneity were tested before completing the frequency analysis. In Table 2.14 (Baseline Hydrometeorology Report), it is stated: "Return period rainfall amounts computed assuming an Extreme Value Distribution." What specific distribution was used? Does the author mean the Generalized Extreme Value (GEV) distribution? What fitting method was used? I assumed it is L-moments, mentioned earlier in the report. If so, the authors should warn the reader that it is based on order statistics and thus attenuates the relative importance of very high values in the frequency analysis. The approach could be improved by comparing the goodness of fit of more than one distribution.

The Herschfield Equation for PMP (probable maximum precipitation) has been criticized in the past. For instance, Koutsoyiannis (1999) states that there is no published data to support the notion of an upper physical limit to PMP and that a probabilistic framework is more appropriate.

The low flow frequency analysis was done using LFA software (Table 3.10). If I am not mistaken, two distributions can be used in LFA: the Weibull and the LN III. Which one was used? How does this choice affect quantile estimations? Also, regression based generation of synthetic flows without variance inflation may in some cases decrease the variability of synthetic flows compared to natural flows. Is it the case here?

The report states that the consultant has not modified quantitative predictions presented in this report to account for climate change (at page 14). This may be problematic. Minimally, a trend analysis could be performed to see if precipitations and flows are increasing or decreasing in the area. Note that if a trend is present, than no stationary frequency analysis can be performed. Additionally, the consultant could at least look at some of the most pessimistic and optimistic climate change scenarios in regional or even global climate model outputs for the region and provide more information on climate change impact.

At the end of the peak flow estimate section, it is stated: "Return period flood estimates for basins larger than 10 km^2 should be separately assessed on the basis of available regional data" (at page 12). I gathered this has not been done, in spite of the fact that some gauging stations have drainage basin larger than 10 km^2?

Are appropriate references used,
Some of the references are quite old (Hogg and Carr, 1985; Herschfield, 1961).

Are references properly interpreted/reported/used,
For the Baseline Hydrometeorology Report: Yes, from what I can see.

For the Hydrogeology report, Section 3.2.2. It is stated: "These high flow rates indicate the potential for relatively high hydraulic conductivity values but were not conclusively supported by other available drilling information such as drill circulation losses and observations of the core." Are there other references that could have been used to compare these high flow rates with typical values?

Are proper models used
See my comments on Frequency analysis.

Are models used correctly
See my comments on Frequency analysis.

3. Review of results of studies of existing conditions

Based on the methods used, are the results accurate
Hydrometeorology: See my comments on frequency analysis and climate change
Hydrogeology: Results of the hydrological model reflect the difficulty of transferring precipitation information from a regional station and also the (unexplained) potential difficulty in transferring the parameters of the model from a large basin to a smaller one.

Are conclusions/statements made regarding existing conditions (results of studies) accurate
See my comments on Frequency analysis and climate change.

Are the results in keeping with your knowledge or experience from other studies
Regional Frequency analysis on small drainage basins is tricky because there are very few gauged basins of small size. Results for small basins have usually more uncertainty than with larger ones. One way to partially assess the regionalization technique is to proceed with a leave-one-out cross validation on gauged basins.

Are other data sources properly interpreted/reported/used
See my question on synthetic flows.

4. Review of Potential Project-VEC Interactions re: water quantity (EIA Report section 8.4.3)

Are there other interactions that have not been identified?
The interaction between groundwater and wetlands is discussed, but not truly quantified.

5. Review of assessment of project related environmental effects re: water quantity (EIA Report section 8.4.4)

5.1 Review of environmental effects assessment re: Potential Project Environmental Effects Mechanisms (EIA Report section 8.4.4.1)

- **For the environmental effects identified in the EIA Report, are they discussed/described accurately**

The issues included are well described in this section

- **Are there other possible environmental effects that have not been identified**

At this stage of the EIA report, it appears that the only potential impact of the lowering of the water table is related to drinking water. The EIA report stats on page 8-111 that the project "may affect groundwater availability within the PDA and possibly the LAA". Possible impacts on baseflow are mentioned in the context of local water users only. Impacts on stream biota are not discussed (maybe in another report?). The potential impact of water table lowering on wetlands is not mentioned.

5.2 Review of described mitigation measures (EIA Report section 8.4.4.2)

- **Are the suggested mitigation measures feasible?**

In this section, the mitigation measures are described succinctly. The list is quite exhaustive but somewhat lacking in details. For instance, I am not clear on what will be done for sediment mitigation during construction.

- **Are there other measures that should be taken?**

Monitoring of groundwater levels in adjacent wetlands may be useful.

5.3 Review of environmental effects assessment re: Characterization of Residual Project Environmental Effects (EIA Report section 8.4.4.3)

In this section, potential impact of the permanent loss of Sisson Brook is focusing on human water consumption, which is clearly not the main issue. Aquatic life is the main issue. It is discussed briefly in other sections.

Also, on EIAR page 8-123, it is stated: "The Construction activities (Years -2 and -1) will result in retention of Bird Brook water within the PDA which will permanently reduce the stream flows to 16% of MAF. The diversion of a portion of flow of Sisson Brook to McBean Brook, and the installation of a starter dam and WMP, will reduce the flow in Sisson Brook to 42% of MAF, while increasing the flow in McBean Brook to 102% of MAF. The combined effect of stream flow reductions from Bird and Sisson brooks will reduce the flow in Napadogan Brook to 76% of MAF below the confluence with Sisson Brook, and to 91% of MAF at the confluence of Napadogan Brook with the Nashwaak River." Reductions as a percentage of MAF are useful, but can the proponent's consultant provide information about the impact of timing of these reductions within the annual hydrograph?

Post closure stream flows in Sisson Brook will rise to 213% of MAF. What might that increase do to stream geomorphology and riparian flooding?

Sediment loading mitigation will be done by locating structures more than 30 m from watercourses, and use of silt fencing. Maintenance of silt fences should be mentioned. Will there be a need for small settling ponds?

- **Matter of indirect loss of wetlands at p. 8-421.**

In this section, fen hydrology is discussed and it is stated: "These fens all have a high degree of groundwater input as evidenced by the number of springs found during field work…. Because of the

location of these wetlands within large wetland complexes and the high input from groundwater, the hydrology tends to be very stable."

It is unclear to me if the post-closure differences in MAF may have impacts on adjacent fens and bogs and if water table fluctuations may also have an impact.

It is further on p. 8-421: "The relative ratio of groundwater to surface water inputs to the headwaters of McBean Brook cannot be accurately determined." Water temperature can be a good and cheap tracer for hydrograph separation in groundwater and surface runoff. Conductivity can also be used.

- **Matter of the <u>spatial boundaries</u> used by the proponent in the assessment, in particular the defined "Local Assessment Area" (LAA) (see EIAR 8-61).**

On page 8-61, it is stated that '"he LAA is the maximum anticipated area within which Project-related environmental effects are expected to be discernible. For Water Resources, the LAA includes the McBean and Napadogan Brook sub-watersheds (Figure 8.4.1). Spatial boundaries for surface water flows and hydrology will be considered for watercourses draining to and away from Project components and facilities, with a particular emphasis on those watercourses downstream of the Project to determine the potential for flow reductions as a result of the Project."

What about the aquifer? Drainage basin boundaries do not necessarily coincide with aquifer boundaries.

6. Summary of Water Quality and Water Balance Modelling (EIA Report section 7.6).

Was a proper model used
It is here at last that we find out that the proponent's consult is using Monte Carlo simulations produced using the Gold Sim software. Form the limited reading I could do of references related to this model, it seems adequate.

The stochastic component of rainfall is modeled using a gamma distribution. It would be nice to see if it is adequate, at least graphically (p.7-78).

On p. 7-80, it is stated that "The TSF pond is predicted to be in a net surplus condition for the entire operating life of the mine, indicating that the system (including the TSF and contributing catchments) is able to supply more than enough water to meet the mill process water requirements, even under dry conditions." What does dry mean? Are we looking at extreme dry spells? Of which return period?

On p. 7-86, it is stated that 77 parameters were modeled using mass balance. Are they all conservative? I am not a chemist, but it seems to me that e.g., carbon requires a more sophisticated model?

7. Have the project's residual environmental effects by properly characterized?

Has the analysis for the environmental effect been done correctly and is it environmentally realistic,
There may be room for Improvement, but I think that generally speaking, the methodology is correct.

Based on the models used, are the results accurate
See my previous comments on the results of the model. The claim that the TSF will be in net surplus all the time needs to be quantified in a probalistic framework, in my opinion.

8. Review of Determination of Significance (EIA Report section 8.4.6)

Are proponent's conclusions regarding the environmental effects of the project on water resources being "not significant" accurate?

It is difficult to discuss accuracy of the findings because they are predictions based on models. Georges Box's famous quote comes to mind: "Remember that all models are wrong; the practical question is how wrong do they have to be to not be useful."' I think that, given the information provided, the statement that there is minimal risk to health related to water resources is plausible. The risk of local impacts on aquatic fauna and wetlands is difficult to assess from the sections that I read.

9. Review of Follow-up and Monitoring (EIA Report section 8.4.7)

The proposed monitoring is feasible, but information is missing. Frequency of water quality monitoring should be proposed and some information about the timing of sampling with respect to hydrological events or extremes should be provided. Rating curves for hydrometric stations would benefit from high flow measurements, where feasible.

10. Discussion of uncertainties and inappropriate reliance on adaptive management

Relies on future monitoring to verify or confirm predictions

Potential changes in water quality and quantity will be verified with ongoing monitoring. This is feasible.

Relies on future adaptive management or an ambiguous environmental protection plan to address possible environmental impacts of the project

I did not find ambiguities.

11. Conclusion and recommendations

In my opinion, in spite of the fact that the analyses could benefit from some potential methodological improvements and specifications mentioned above, the assessments provided appear to be technically and scientifically sound. Some (probably small) risks associated with local, perhaps short term, changes in the hydrological budget and water routing for wetlands and aquatic life are scarcely treated.

12. References cited by Reviewer

Koutsoyiannis, D. 1999. A probabilistic view of Hershfield's method for estimating probable maximum precipitation. Water Resources Research 35(4):1313-1322.

13. Biography of Reviewer

Dr. St.-Hilaire's biography can be found at: http://www.inrs.ca/english/andre-st-hilaire.

2.4 Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Components:
1) General comments on Executive Summary, Project Description, Summary of Key Predictive Studies
2) VEC – Water Resources
3) VEC – Aquatic Environment
4) VEC – Accidents, Malfunctions and Unplanned Events
Subject Areas: Water Quality, Fish and Fish Habitat
EIA Report Sections: Exec. Summary, 3.0, 7.0, 8.4, 8.5, 8.17
Date: October 1, 2013

Allen Curry, PhD.
Canadian Rivers Institute
University of New Brunswick

NOTE: Dr. Curry's review begins on the next page. Dr. Curry's biography can be found at: http://www.unb.ca/research/institutes/cri/people/sciencedirectors/curry/index.html.

Canadian Rivers Institute
10 Bailey Drive Fredericton, NB E3B 5A3

1 October 2013

Mr. Scott Kidd
c/o Conservation Council of NB

RE: Sisson Brook Mine EIA Report Review

Dear Scott:

Please find enclosed my report on the issues that arise in this EIA Report. I will present the major concerns that are more project-wide in nature. The final component will be a detailed description of issues that were inadequately addressed in this EIA report beginning with the Water Treatment Plant (WTP), and including my original letter to HDI/Northcliff in 2012 describing the short-comings.

Some highlights of the topics most serious:

1. WTP – Poorly described and what is described is inadequate. It is designed to deal with arsenic and antimony only, not other of the many chemicals in the TSF. This is the core of the water management plan, yet it wasn't presented to the proponent until after the EIA release date (6 August 2013). Ad hoc at best.
2. TSF Liner – Why isn't it lined? We are talking about a massive water body with no guaranteed containment of seepage. To suggest the settling of tailings will create a liner is at best a shot in the dark; how can you present this operation without a risk assessment for full containment of seepage?
3. TSF Plan – Repeatedly, plans for the TSF are described differently including their maps/figures with some in-site features not described except in the technical documents (i.e., ferric sulphate sludge holding).
4. Modeling Natural Variability – Such is not incorporated into their models. The proponent uses averages where it has some information, yet the proponent knows and discusses variability in several places. The biological data has so few data that confidence limits are best estimated to be +- 100% of the average.
5. Atlantic salmon – Soon to be an Endangered Species and the Nashwaak River is officially recognized as the critical river for their survival, yet there is no planning for the risk of loss if any/some/all of their plans fail.
6. Water Releases to Sisson Brook – It is nearly non-existent for the first years then it becomes what the proponent estimates to be all WTP water forever thereafter (discharge to meet pre-construction levels). Massive assumptions, inadequate analyses, and no clear risk assessment for the aquatic environment of this planned management of all water leaving the site.
7. Water Pumping – WMP will collect and pump back to TSF any seepage or other surface water. How will this be managed (e.g., secure pumping when required, overflow conditions) and paid for as long as TSF water is below water quality standards (in perpetuity)?
8. Residual Water Features (post-operations) – TSF, pit lake, and channel between the two. These are massive bodies of potentially seriously, toxic water, yet there is no assessment of this risk into the future.

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9. Financing – There is no adequate proposal of environmental funding to deal with the water issues for such a massive landscape feature post-operations. $50M may clean up the site (it also appears to be a "best guess"), but will never come close to handling the volumes of water in perpetuity. These sites will never be restored by humans, yet the legacy has to be addressed to protect the rest of the environment of the Nashwaak River. And, this money needs to be put up-front, into an independent trust fund untouchable to government or industry.

Some general notes:
The EIA report is written as if the process was concluded and a decision was final to proceed with the project. I have read and critiqued a few EIA reports from across Canada and consistent among the reports is a "tone" of writing as well as selection of terms that detracts from an objective assessment of the potential impacts, their risks, and the options for mitigating risks. Perhaps that is what the law demands – I certainly hope not – we need objectivity to assess accurately. For example, there are repeated references to assessing the accuracy of their many models once the project is underway and using this testing against their predictions as useful in the current assessment. Stating that one goal of the future work is "to confirm results of models" presumes the models were correct. The issue is what to do about the problem if the models were incorrect (risk assessment). Dealing with incorrect models was totally lacking in this report, i.e., there is no risk assessment for assumptions and models. Testing post-hoc is not assessment of risk; it is hand waving, academic hypothesis and prediction testing.

One global issue is the complexity of the presentation. I appreciate it is a complex project, but a reviewer shouldn't have to have multiple documents open and continuously search word by word through documents to find the details of referenced components of the proposed work, especially given the short review time given to the public and government regulators. There are >5000 pages in the document set that need to be reviewed. Poor structure hinders the review process. I hope that proponents don't do this on purpose to keep reviewers (regulators and others) from understanding the actual project and therefore confusing mass of reporting (pages) for quality of an EIA report. I did the math on my time on this review, so this is specific to the complexity, missing pieces and/or mixed location of pieces. I could do about 16 pages per 8 hour day. That is 362 days to actually do it right. The cost would be about $120,000 based on consulting rates.

The EIA report speaks to potential outcomes, but gives no probability values of such as would be expected in an objective report on such an operation. Where risk is presented, e.g., Table 8.17.5, the risk is consolidated into just a few categories (three in this table). These are again the proponent's "judgment"; as a reviewer of the risk, it is imperative that probabilities (%) are presented. Even risk matrices would have been useful.

The objectivity of the EIA report is undermined by their repeated use of their own "expert knowledge and opinion" (e.g., page 8-130). Their job was to collect the data and do appropriate analyses. The public and government regulators require by law (that is my interpretation of the Canadian Environmental Assessment Act), reality not opinion. For example, their description of environmental issues if the

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WTP fails: *"Interaction may occur. However, **based on past experience and professional judgment**, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices."* Given that the proponent has not presented an adequately engineered WTP which is consistent with their engineers' opinion presented in this specific component of the report (see below), any opinion about the WTP and in my view, any opinion in this EIA report, is compromised.

One good example of the poor structure is the description of the Water Treatment Plant (WTP). In reading "Metal Leaching and Acid Rock Drainage Potential Characterization. Sisson Project. FINAL." dated 6 August 2013 (referred to as SRK 2013, e.g., EIAR page 7-88), I discovered buried in an Appendix what appears to be the only description of a Water Treatment Plant, although it is titled "Conceptual Design". This is the WTP from which all water exiting the site must pass, i.e., it is the critical piece in all their water management planning. Point 1: Why is this buried in an Appendix? Point 2: How can you submit an appropriate EIA if you are only seeing a finalized report at the time of the EIA's release to the government and public? (This might explain the many missing pieces, vague, and non-science assumptions the proponent uses in the aquatic resources sections related to water quality.)

Because of the significance of the WTP to the entire aquatic environment, I reviewed it in detail. My notes on the WTP (SRK 2013) are presented below.

Having critically reviewed a multitude of environmental science from around the world, I find it disturbingly unprofessional that environmental scientists would fill a serious assessment with assumptions and non-objective opinions that could have been easily overcome with more investment of time which presumably implies funding. I know the people who prepared this document and conducted many of the baseline studies for the proponent. I know they have the training and experience to understand and accept as legitimate all of the criticisms I and others will present. I can only conclude that had these people been given enough time and resources, they would not have rushed through the assessment process and presented what is without any doubt, a premature EIA report. If this report were a Master of Science thesis I was reviewing, I wouldn't fail the candidate at this time, but I would send her back to the field and laboratory to complete the work required to prepare a full report of value.

Sincerely,

R. Allen Curry
Science Director, CRI
Professor of Biology, Forestry and Environmental Management
University of New Brunswick

cc: Dr. Rick Butts, CRI Director

…/4

The Water Treatment Plant (SRK 2013 - Appendix I: Water Treatment Plant Conceptual Design)

a) *"SRK was directed to investigate water treatment processes for **removal of arsenic and antimony only**. No other elements were considered in the process described herein, although the treatment may result in other metals removal for a net water quality benefit."*

- The proponent assumes that these elements are the only issue, yet we know and the proponent reports a long list of other chemicals in this TSF water. If the proponent can't get the WTP right at the planning stage, how will it do it *ad-hoc* in the field? Here is a list of the actual chemicals the proponent will add to the TSF and not including the elements and compounds arising from the natural geologic by-products:

• sodium hydroxide
• sodium carbonate
• sodium silicate
• sodium hydrosulphide
• quebracho (tannins?)
• fatty acids
• sulphuric acid
• ferric sulphate
• anhydrous ammonia
• lime
• Fuel oil (probable kerosene-type reagents)
• pine oil
• organic exchange media
• potassium alkyl xanthate (PAX)
• methyl-isobutyl-carbinol (MIBC)
• copper sulphate
• sodium cyanide (possibly)
• sodium oleate
• Magnesium Chloride
• Amine
• Frothers (xanthates, dithiophosphates and thionocarbamates)

b) *During operations, the TSF average flowrate will be approximately 700 m^3/hr with peaks up to 2,200 m^3/hr. The mill reclaim (lime and CO_2) water treatment facility is sized to meet the peak mill water demand of 2,200 m^3/hr. However, to meet discharge demands, **we have sized the ferric co-precipitation facility to meet the average flowrate only**, as the TSF may be used for water storage and flow equalization.*

- So what are the efficiencies at flow rates greater than average? Greater than average over long periods? This is the critical process, yet it is not modeled beyond one and only the average scenario.

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c) *Post-closure, the TSF/open pit will discharge an average of 1,280 m3/hr, with seasonal peaks of up to 4,200 m3/hr. This memo assumes that the TSF and open pit may be used for water storage and flow equalization, and that a combination of* ***in-pit ferric iron addition*** *(for arsenic and antimony co-precipitation) and the* ***existing retrofitted mill reclaim water treatment facility*** *will be sufficient for the average post-closure flow rates. However, if the 4,200 m3/hr peak flows must be treated, then* ***a duplicate lime treatment facility*** *must be implemented at closure.*

- Here the proponent introduces several concepts I can't find elsewhere and which should be fully explained, i.e., modeled and planned for appropriately: in-pit ferric iron addition; retrofitted WTF; second lime treatment facility.

d) *The water treatment process described herein is based on an evaluation of general capabilities of water treatment technologies. Performance of water treatment technologies is dependent on site specific factors.* ***Bench and pilot scale tests are required in order to verify the efficacy*** *of the proposed water treatment process.*

- The proponent is guessing based on past experience, but it doesn't know for sure how it will work. So where is the plan (models, financing, etc.) for failure of their assumptions?

e) *The balance of ferric sludge will be* ***pumped for disposal to a holding cell within the TSF****.*

- This is the toxic ferric sulphate and sulphuric acid mix. Where is this holding cell – it is not on any diagrams, it is not discussed, and thus it is not planned for. This sludge must remain stable otherwise it creates a different set of water quality problems, also unplanned for. Where are the EIA statements about this issue?

f) *The treated effluent will report to Sisson Brook and from there to Napadogan Brook.* ***Water treatment will be limited to the open water season****.*

- What are the plans for the released water in winter? No water will be released in winter? If a release becomes necessary, e.g., an emergency, flooding, then will Sisson Brook be only untreated, TSF water? If so, where is the planning and risk assessment of that event?

g) *In-pit water treatment for arsenic and antimony will be implemented after the spring melt each year. Pit water will be pumped to a mixing tank on shore where ferric sulphate will be added from a reagent stock tank. After reacting with ferric sulphate, the process water* ***will flow to a section the pit lake that is enclosed with an open-bottom floating baffle curtain made of impermeable liner material.*** *The enclosed section of the pit lake will allow ferric solids to settle to the bottom of the pit for permanent disposal. Arsenic and antimony will tend to adsorb and precipitate with the ferric solids, which will leave the clarified water depleted in arsenic.*

- Where is this facility/structure in the EIA report? Where is the plan? What will happen in winter? This is serious toxic materials not discussed.

h) ***In the event that water treatment for sodium or fluoride is required or if effluent metal concentrations must be lower than those achievable by ferric and lime treatment then the water treatment process proposed here will not be adequate.***

- As the proponent admits, it is presenting a WTP that is inadequate beyond its restrictive assumptions. Is the entire water management plan based on this inadequate model? It appears so.

…/6

i) *The post-closure metal hydroxide sludge will also be disposed of in a* ***dedicated holding cell within the TSF.*** *This cell can be constructed by placing berms around an appropriately sized area within the TSF. The top of the berms should be above the ultimate water level of the TSF and constructed with a spill-way that connects the holding cell to the rest of the TSF. It is envisioned that sludge will be pumped to – and allowed to settle within – the area behind the berm. Excess water will flow through the spillway to the TMF. Thus, the area behind the berm will act as a settling pond or lagoon for sludge from the water treatment plant.*

- This feature/component is not on any diagrams or discussed elsewhere. Where is the plan for this? Where are the implications for the TSF? What if the berm fails?

The EIA Report - Summary Points:

Page	Issue
EIA Report Executive Summary	
E-2	*$50M to reclaim the site.* a) That may be the case for the construction on site, but the proponent gives no figures to describe these costs. Where are the engineering details for site reclamation? b) Where are the costs described to fix an "unplanned event"? The proponent lists many of these, but gives no cost or the financial plan to address these events. c) Where is the cost to pump water from the WCPs to the TSF, and the other pumping the proponent discusses? It is mentioned no place. Spencer *et al.* estimated the pumping costs could be $200M alone.
EIA Report Sec. 3.2 Description of Major Project Components and Facilities	
3-17, 18	*3.2.3.1 Concentrator Process Facilities* a) The process is described: (W)aste is first and then the same stream flows to Tu. This means that PAG materials are ***not*** fully removed from BSF stream and are in the NPAG stream, i.e., they become part of the presumed NPAG. So, how much is PAG in this stream? And over the life time? b) The PAG stream is still first, so how much of first process (W) "waste" (not sequestered) is going on to second (Mo) is PAG?
3-21, 25, 26, 27	*3.2.4.3 Tailings Storage Facility (TSF)* The facility is inadequately described. Here are the examples I have found: i) Liner – None - Really – for a massive water body that is toxic? ii) PAG will be "*encapsulated by NPAG*". This is appears to be a best guess that it will work – how could you possible engineer and control this to insure it will work over this broad an area? Where is the risk assessment that you will be successful? iii) Another attempt at a pseudo-liner: What determines when native overburden will be compacted? Is this an onsite decision by operators? Rules? Why not do all of it to insure safety of the seepage water? iv) *3.2.4.3.2.5* – "*Waste rock will be placed in the TSF by mine trucks*". Where is there any description of this process? The composition of this rock? The PAG assessment?
3-21, 25, 26, 27 (con't)	v) *Storm Events* - Capacity yes, but what about stress on embankment at this load? What about seepage at load? There are no analyses of such situations. Given recent weather history, why didn't the proponent do these analyses? vi) *Stability Analysis* - What about under load of high tailing pond volumes?
3-25	**Recognition of the TSF as a significant risk** to the aquatic environment downstream. The one and only time this is mentioned. See also Page 8-686
3-37	*Process Water* – Where is the analysis to prove this is enough water? We need to know that rainfall, groundwater, plus impoundment seepage (lack thereof) will be adequate, first, and then we need to know what is the plan for capturing this

	required water for processing if their plan doesn't work, e.g., pumped from Nashwaak River?
3-37	*Fresh Water* – Required is 21 m^3/hour. Average household well is 1 m^3/hour. Their own estimates for area are <1L/s (Page 6-27). Does that mean there will be >20 some wells on site? Where are these to be located? Impact?
EIA Report Sec. 3.3 Alternative Means of Carrying out the Project	
3-79	*Removal of Lower Lake Dam* – The local experts have already told the proponent this is not an option for fish habitat compensation, so why the EIA report recommends it is unclear.
EIA Report Sec. 3.4 Description of Project Phases and Activities	
3-118	*"lined containment pond"* in the TSF – The only time this component is mentioned (3-119, 3-121, 3-136). It is not on the map (Fig. 3.4.5.) So, where and how does this work? Why just this process water?
3-123	*"acceptable pond levels"* – And what happens if you can't meet this target level, i.e., it floods after a rain event? Where are the plans for your WTF to sustain this increased capacity before discharging downstream? If it can't meet that volume of water treatment before discharge – what is the plan? What happens during winter, temperature impacts, ice cover?
3-125	*"an intermediary WMP"* – Where is this located, i.e., it is not shown in Fig. 3.4.9 Schematic of Mine Operational Water Balance? What is its capacity? What are its risks of escaped water?
3-142	***TSF Water Quality*** – Two statements that demonstrate the proponent knows the TSF water quality will not meet any provincial or federal standards.
3-143	*Pit Lake* – a) *"A groundwater sink"*. Pumping water in or out to achieve this requires a perpetual activity, unless the proponent gets "lucky". Where are the numbers that show the probability the proponent won't have to pump in perpetuity? Where are the numbers to show during of pumping and costs? b) *Water quality of pit*: Similarly, where are the numbers to show how much needs to be treated each year for how many years and then what are the costs? c) What if blasting creates fractures and all pit water flows via groundwater to Napadogan? Where is this described and assessed for risk?
EIA Report Sec. 7.4 Key Predictive Study – Fish Habitat Loss and Compensation	
7-35, 7-41	The proponent describes direct loss (site construction) and indirect loss as loss due to flow. Where are the analyses of loss due to process water in the Sisson and Napadogan rivers, i.e., water quality? Where are the blasting effects on fish and/or their eggs and larva?
7-36, 7-39	*Beaver ponds* - Excluded based on statement that these are "ephemeral water features". Beaver ponds ***are*** fish habitat as the proponent's biologists know and the scientific literature well demonstrates. The proponent then says fish were observed in these ponds on page 7-39.
7-45	*Assumed no discharge to Sisson Brook for the models.* Yes it is conservative to

	do this, but it also neglects that there will in fact be discharge water from the TSF/WTP to Sisson Brook. Why weren't those analyses done?
7-52	Why isn't the Fish Passage Issue addressed at this point?
7-58, 7-61, 8-136	*Lower Lake Dam Removal* – Repeatedly, local experts as well as NB DNR have told the proponent that this is not a barrier to fish movement. If the proponent wants to present this as a "barrier" then the proponent should provide some empirical proof that it is a barrier. The proponent had opportunities to do that; it chose not to do that study. To suggest it is a "*viable potential opportunity*" suggests the biologists and scientists truly don't understand this system and specifically the fish in this system. To present it as such is a direct challenge of their professionalism, i.e., it is (again) the easiest and cheapest way forward for the proponent.
EIA Report Sec. 7.5 Key Predictive Study – Geochemical Characterization of Waste Materials	
7-65, 69	*Quarry Rock (Borrow)* – Only two (2) samples tested? This is the rock that will make up the bulk of the dam material, i.e., it is the source chemistry for water seeping through and downstream. Inadequate sampling to confirm NAPG or PAG.
EIA Report Sec. 7.6 Key Predictive Study – Water Quality and Water Balance Modelling	
7-73	*Site Water Management* – Collected in channels and routed to WMPs. So where are these channels on the diagrams and which WMPs are the collector sites? Where is the plan for their failure, i.e., How will these ponds perform in extreme events, winter, site accidents that put metal/chemical TSF/Process water into them?
7-75	*Pit Water (post-operations)* – There is a channel that is mentioned. This is a major water feature that transfers untreated TSF water to the Pit. Where is the plan?
7-75	*Pit Water Levels* – A major operation moving water and treating water. Where is the plan? How much water at what discharge rate? How much money?
7-78	*TSF Embankment Drainage and Seepage Collection*- Seepage through the embankment will occur. Some will be captured. Where is the plan – how much is captured, are the WSP large enough? What is the water chemistry of seepage water? How much will by-pass treatment? Impacts on downstream?
7-79	*Why are the units of measure repeatedly changed? m^3/a, L/s, m^3/hour*
7-79	*6M m^3/a* – This translates to 6B L of water processed in the plant each year and this is released downstream into Sisson Brook. It works out to be 190 L/s, which matches the current discharge pre-operations (200 L/s). Just an FYI.
7-79	*Groundwater inflows to pit are assumed to max-out at 40L/s* – This is equivalent to about 144 household wells (not under Artesian pressure). It seems to be a significant under-calculation. I'm not expert enough in this field to assess the numbers, but it these are wrong, then their fresh water budgets are wrong.
7-83	*Water Management Ponds (downstream of TSF dam walls)* – a) I can't find the calculations to show these are of adequate size/volume? b) Water will not be stored in these WMP, yet the proponent will continuously

	pump, i.e., there is ponded water to pump. There are many questions unanswered about these WMP. Are they of adequate size to take seepage and precipitation/overland flow? If they fail and/or water breaches top of berm, what happens to the untreated water, etc? How do they work in winter?
7-85	*A brief reference to the WTP operations* – It incorrectly describes the "*ferric sulphate batch treatment"* sic. (in fact there is no reference to 'batch treatment' – I'm not sure what the proponent is referring to, it is not in SKR 2013). This begins at the time of operation and discharge of TSF water to Sisson Brook, i.e., Year 7-8.
7-88	*Description of Water Treatment Plant* – This statement doesn't reference SRK 2013 and I would assess from the statement that the writer has not read SRK 2013, or they read it hastily in some draft form (it wasn't released until 6 August 2013).
7-90	*TSF seepage rates are lower in Closure and Post-Closure than during Operation* – Hydrogeologically (near) impossible. The TSF water levels are highest during closure and post-closure and therefore the hydraulic head is maximized and with no changes in hydraulic conductivity, groundwater flow will occur. Categorically wrong.
7-92	*Baseline Water Quality Calibration Model* – a) In every case, elements are elevated once operations begin and well after closed - these are base estimates not including high precipitation or associated events. b) Where is the discussion of the Sisson Brook water quality node? It is the source of all treated water - it is nothing but treated water, i.e., it is all coming from the WTP. It will be the most potentially toxic system, so where is it?
EIA Report Sec. 7.7 Key Predictive Study – Human Health and Ecological Risk Assessment	
7-113	Again, the models are based on everything working perfectly – where is the reality, i.e., a true risk assessment?
7-122	*7.7.2.1.4 COPC Screening Based on Water Quality Guidelines* – Why is anything screened out if this is a full EIA?
EIA Report Sec. 8.4 WATER RESOURCES	
8-57	*"…the environmental effects of the Project on Water Resources will not be significant because…"* – What about the legacy of water features on the landscape. These are not assessed in any manner so how can this be complete and therefore "not significant"?
8-105	*"water quality…is predicted to be of sufficient quality to meet the GCDWQ at some point during the Post-Closure period"* – At some point in time? Correct in about 1000+ years it should be fine. This is not professional assessment quality.
EIA Report Sec. 8.4.4 WATER RESOURCES – Assessment of Project-Related Environmental Effects	
8-106	*"not significant" "not considered further"* – How do you dismiss 2 and possible 3 water features (the channel between the TSF and pit to be constructed) one of

	which will be the largest tailings pond in NB and requiring water treatment for an impossible to estimate number of years.
8-107	*Monitoring* – Great. But, where are the statements of potential problems/risk (follow-up) and the plans to fix including the cost estimates and who pays?
8-110	*Magnitude of Effect* - Here you recognize need to understand natural variability, yet you don't establish baseline of "normal". It needs to be defined upfront for legal purposes.
8-117	*TSF description,* a) Figure 8.4.10 - This diagram is inaccurate. TSF is incorrect in size. It doesn't match Figure 3.4.6. Also, the pit doesn't match Figure 3.4.6. So which one is correct?? b) Starter dams – There are only 2 tests that prove it is NAP. (Pages 7-65, 7-69) c) Groundwater not predicted to be affected – A water body of this size does by the laws of physics these engineers know well, affect groundwater flow and chemistry downstream of the TSF. Unacceptable from a qualified engineer.
8-121	*Fresh Water Supply* – Wells - Where? How Many? It is nice to say you are going to do it right, but this is an EIA and we are assess the water needs.
8-121	*Effects on Stream Flow* - These figures show a 10 to 20% reduction in MAF - that does not jive with HECRAS models? There needs to be an explanation.
8-126	*Water Quality Modeling* – Only under normal conditions. Assumes the system is functioning at 100% efficiency 100% of the time. Where are the extremes? What happens when WTP is not functioning, how many times will that happen, what is the power supply emergency plan, etc.
8-131	*"Water quality monitoring will continue post-closure until such time that the water quality* ***is acceptable****"* – And how is "acceptable" defined? It is not defined in this document – what level, how many occurrences, etc. This is an assessment so how can we know from such statements what we can apply in the future?
EIA Report Sec. 8.4.6 WATER RESOURCES – Determination of Significance	
8-132	*Changes in Water Resources – "…not significant…moderate level of confidence"* – Given that there are no empirical evaluations of risk, this is just an "opinion". It would be better to have a table showing the impacts as probabilities: 90% chance of 25% impact, 50% chance of 20% impacts, etc. This is a risk assessment. A risk assessment is not the proponent making the conclusions - that is not their decision (it is their opinion) and we can't decide if we don't know all the probabilities.
EIA Report Sec. 8.4.7 WATER RESOURCES – Follow-up or Monitoring	
8-133	*Follow-up* – What are the follow-up mitigation activities?
EIA Report Sec. 8.5 AQUATIC ENVIRONMENT	
8-136	*An adaptive management strategy and mitigation plan will be applied in the event that follow-up and monitoring identifies that seepage or treated surplus water releases lead to concentrations of metals in surface waters that pose a risk to ecological or fish health.* – Not good enough – we have stated this repeatedly – identify and describe the risks empirically and then allow us to assess them.

	Simply using current terminology doesn't make reality go away.
8-137	Again, no recognition of what is normal. The proponent only modeled for average. How will the proponent detect the state and therefore define "undesirable change".
8-138	*Water Temperature/Dissolved Oxygen* – Change from baseline is actually not relevant. It is absolute change that would invoke exceedence of temperature and/or oxygen limits. Not acceptable level of interpretation for professional biologists.
8-138	*pH* – Again, assumes the modeling is correct and everything is normal. That is never and will never be the case, so where is the modeling to explain these risks?
8-138	*Benthic Community* – The proponent identified metals in sediment as an issue and then don't address it here?
8-138	*Fish Passage* - Napadogan predicted reduction by 10-20% of MAF. How does this translate to 1 cm drop? This issue needs to be addressed and explained.
EIA Report Sec. 8.5.1 AQUATIC ENVIRONMENT – Scope of Assessment	
8-139	*Approval to Operate and the federal MMER* – The MMER don't meet the same standards set by NB for Water Quality (see Table 8.5.2)
8-140	*"…the potential environmental effects of a failure of water management facilities, including the TSF, on fish and fish habitat* – Here perhaps the most important issue of concern is raised only to be dismissed later.
8-141	*Benthic Macroinvertebrate Community Structure* – What is the metric? There are many options.
8-151	*Water Classification – "Neither the Nashwaak River nor any of its tributaries have been formally classified by the Minister to date, and thus the Regulation has no relevance to the Project at this time and is thus not discussed further in relation to this VEC."* – Northcliff/HDI and Geodex were asked repeatedly by community members and organizations to respect the work they did to have the Nashwaak watershed classified. This dismissal is exactly what I mean when I have said the propenent is doing just what it has to, rather than truly engaging and listening to the community.
8-152	*"…effects…upon which **model predictions** are based are difficult to simulate numerically. Thus, **interpretation and use of the results generally rely substantially upon the professional judgment** of the study team. As with any model, there is also some **inherent uncertainty in the results as models** are simplified or idealized representations of what are complex physical phenomena. The source term estimates and modelling results are nonetheless conservative."* – This is exactly why you do the empirical work *a priori* – so you can define the parameters as best as possible. That you didn't invest in the field work or the time of the analysts to overcome these exact issues doesn't make your models therefore correct. Again, this is unacceptable science, and actually something I expect to hear from first year undergraduates handing in a report they did the night before.

EIA Report Sec. 8.5.2 AQUATIC ENVIRONMENT – Existing Conditions	
8-154	*8.5.2.2 Methods for the Characterization of Baseline Conditions* – See my original letter of December 7, 2012 to HDI/Northcliff about the inadequacy of their sampling, both spatially and temporally (see **Appendix 1** below at the end of Dr. Curry's report). There is no way to know when a location along Sisson, Napadogon, or the Nashwaak is affected in the future. The confidence limits on their data, if they could actually produce such, are best estimated to be ±100%. That plays well to the proponent winning a legal battle in the future trying to determine when something is affected or not, because there is no way to know with the current data. Furthermore, the proponent could have overcome this issue by stating what it defines as outside normal for the record and had that written into any operational agreement. The proponent didn't because it knows it can't define it and therefore in the future the proponent is legally protected.
8-164	*HSI = habitat suitability index* – In this exercise, different sites had different parameters applied, different seasons (i.e., Napadogan Brook), and then the proponent compared all the sites. Not a scientifically defendable method. Late spring was the Napadogan sampling period – this is not a stress period so these results are irrelevant for this analysis.
8-189	*Although the field surveys were carried out as discrete "onetime" sampling events, a* ***technical limitation of the baseline information****, the species that were not observed are* ***generally sedentary in nature and would likely have been found if present*** *at the time of the surveys.* – Simply unacceptable as a science work. That you didn't sample enough doesn't make your results immune for the harshest of criticisms especially given that you were told, repeatedly, you weren't sampling enough. Again, minimal investment of time and money.
EIA Report Sec. 8.5.4 AQUATIC ENVIRONMENT – Assessment of Project Related Env. Effects	
8-194	*Table 8.5.8 Summary of Residual Project-Related Environmental Effects* - Even this 'qualitative" assessment of risk has *prediction confidence* of 'Moderate', not minimum or zero.
8-200	*Primary Environmental Effects Operations* – Where is unplanned point-source events? To simply not include it suggests there will never be a failure, which even this report recognizes and assessed as a potential, i.e., the 12h event for the WTP to stop working (see EIAR page 8-719).
8-202	*Cold Water Plume at W. Napadogan* – A recognized issue, but where is the analysis of this? Is it critical habitat for coldwater species? How will it change?
8-207	*Mine Waste and Water Management – "Prior to Construction,* ***further*** *geotechnical and hydrogeological investigations will be undertaken in the TSF area to support basic engineering and detailed design studies for the TSF embankments and associated seepage and water management systems."* – And what if it proves too unsuitable for any of a thousand reasons – then what? That is why we are planning now. Again, the proponent is not ready to do this.
8-209	*Residual Project Environmental Effects - "…the results indicate that standalone*

	and seasonal brook trout habitat is abundant in the West Branch Napadogan Brook watershed, in a few tributaries of East Branch Napadogan Brook, and in Manzer Brook, ensuring that brook trout populations will be maintained in the Napadogan Brook watershed overall". Not all assumed habitat is actual habitat. Which of these assumed habitats are "critical", e.g., what if brook trout can only spawn in Sisson Brook? Again, more sampling is required to understand the impact. This analysis was done as a desktop exercise and biology (as these authors stated before) is near impossible to model. The community asked for a better effort.
8-210	*"not significant effect…and particularly in consideration of the compensation measures as mitigation for the direct loss of fish habitat"* – As this "compensation" has already been deemed irrelevant (the removal of the Lower Lake Dam), hanging your hat on this as your major evidence of non-effect is quite a stretch of imagination.
8-212	*Environmental Effects to Water Quality* – The proponent modeled perfect conditions; this is not acceptable.
8-221	*Water Quality (Temperature)* – The paper cited doesn't address the issue of small, spatially disjoint habitats as is in the Napadogan system (as the proponent's biologists writing the EIA report know well). These biologists know that salmonids move long distance to find thermal habitats. This could have been investigated if the proponent made the investment.
8-222	*Thermal Habitats for Brook Trout* – New data and analyses we have not seen before. Is there a scientific reference for this analysis? If there are brook trout there then it must be habitat and conditions will be warmer longer, then it suggests a loss of habitat. Just because there are fewer brook trout doesn't mean the modeled habitat loss won't be "not significant" for these fish. This presentation of findings would be rejected if peer reviewed (by me at least).
EIA Report Sec. 8.17 ACCIDENTS, MALFUNCTIONS and UNPLANNED EVENTS	
8-698 (see 8-702)	*A loss of containment from a TSF is defined as a significant failure of a TSF embankment leading to the release of large quantities of mine contact water and/or tailings into the receiving environment. As considered by Knight Piésold as experts in mine design, geotechnical engineering, and mine waste and water management, this scenario was not considered to be credible in consideration of the design basis* – I respect that the engineers can design a well-built dam that has a low probability of failure under normal operating conditions. However, the statistics on TSFs are indisputable – the proponent will fail to contain their water. As Larry Wuest points out, "…assuming a mine life of 27 years and the current empirical rate of 1 [failure sic.] in 2000 per dam year, the TSF dam at Sisson would have a 98.65% chance of surviving 27 years without a failure, or a 1 in 74 risk of at least one failure over 27 years…". NB has 5 larger TSFs discussed by Roy Parker (see Section 2.10 below): 1. Heath Steel Mine – 2.3 km long by 2.6 km wide = 598 hectares 2. Brunswick 12 – 2.2 km long by 2.0 km wide = 440 hectares

	3. Nigadoo Mine – 0.76 km long by 0.55 km wide = 42 hectares 4. Mt. Pleasant Tungsten/Tin mine – 1.9 km long by 0.61 km wide = 112 hectares 5. Caribou mine – 1.57 km long by 0.8 km wide = 126 hectares The Mt. Pleasant TSF failed in 1998 ("Tin mine tailing pond breached by flood." Tue Mar 17 1998, Byline: LISA HRABLUK, The Telegraph Journal). That could be interpreted as 1 in 5 large, TSFs in NB have failed to date, i.e., a 20% failure rate in NB. The less dramatic interpretation is also the obvious – TSF failure includes unplanned events that may or may not result in a physical failure of the Embankment structure. As Rico *et al*. point out, we will have failures and in their study area (Europe), "…The major percentage of incidents is related to meteorological causes (26% to unusual rainfall and 3% to snow)…". Given that the Mt. Pleasant TSF failure was due to a precipitation event and which are becoming more common in our region, that such understanding of failures was not incorporated into this analyses and planned for is totally unacceptable. Rico, M., G. Benito, A.R. Salgueiro, A. Díez-Herrero, H.G. Pereira. 2008. Reported tailings dam failures. A review of the European incidents in the worldwide context. Journal of Hazardous Materials 152:846–852.
8-702	*"A release of off-specification effluent could adversely affect downstream surface waters (i.e., Napadogan Brook and eventually the Nashwaak River) and associated fish and fish habitat. This could result in the short-term ingestion/uptake of contaminants by fish, wildlife, the public or First Nations. Downstream groundwater, soil, or wetlands could also be adversely affected.* – The proponent recognizes the implications of a TSF failure or release, but then where is the discussion of the risk? This statement is in conflict with its opinion expressed in 8-698.
8-719	*"Release of Off-Specification Effluent from Water Treatment Plant"* – This entire section is to be rejected. 1. The proponent modeled one (1) fixed amount for one (1) fixed period. It is possible that scenario could be real, but so could an infinite number of other scenarios. Their attempt to negate this risk, *"…any release of off-specification effluent would be detected within a 12-hour period, and corrective action would be initiated such that the release of off specification effluent for a longer period of time is not believed to be a credible scenario."*, demonstrates exactly why their "scenario" is not "credible" = probability of happening is 1 of ∞ (~zero). It is very blatant circular reasoning.
8-720	*"…in the unlikely event of a release of off-specification effluent…This release is not expected to interact with downstream groundwater, but could interact with downstream wetlands and vegetation."* – First, the proponent just argued that release of effluent was NOT a credible scenario. Then to compound its excruciatingly, painful logic and failure of basic physics and hydrogeology, the proponent states that surface water in the brook won't interact with groundwater but it will make it to wetlands (perhaps via the proverbial 'ducks feet'?). The only time no groundwater recharge could occur is in an engineered flowing water

	environment, e.g., an impenetrable culvert or perhaps a massive, flash flood. If the proponent can't get this simple work right, then how can we trust the rest of the documented claims?
8-721	*"Potential Interactions between VECs and Release of Off-Specification Effluent from Water Treatment Plant – Note 1- Interaction may occur. However,* ***based on past experience and professional judgment****, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices."* – Had the proponent done the appropriate empirical studies, then it wouldn't need to "guess".
8-721	*"Table 8.17.5. Under* ***normal*** *watercourse flow conditions, an off-specification release is not likely to impinge on…"* – Define normal? How often does it occur? We get that the proponent can plan for normal – we want to know what happens the rest of time?
8-721	*"Under normal watercourse flow conditions, an off-specification release is* ***not*** *likely to impinge on riparian wetlands* ***as contaminants will likely flush downstream*** *and be quickly diluted such that contaminant uptake in wetlands will be limited in extent and duration."* If there is nothing but untreated water in Sisson Brook, then what would be the "likely" mechanism of dilution and especially if it were a large volume of water released? We already know from the proponent's plans that the 'new' Sisson Brook will be almost entirely discharge from the WTP (Page 7-79). What about the accumulation of these metals and other chemicals even if diluted along the system – where is that modeled?
8-721	*"…off-specification discharge would move rapidly downstream…"* – Perhaps this may/might be true in its 12hr model, but that was already proven to be 1 of an infinite scenarios.
8-722	*"Based on the mitigation and response mechanisms and procedures, the potential environmental effects of a Release of Off-Specification Effluent from the Water Treatment Plant on the VECs … rated not significant, with a high level of confidence."* – I'm not sure if this is a lack of engineering training, naïve inexperience, or some combination of both. It is a 'true' statement for the failed model the proponent presented; in reality, it is >99% certain not to occur as the proponent described it.
And the rest…	It goes on from here, but I've lost the energy to detail any more challenges in this EIA report.

Appendix 1 to the Comments of Dr. Curry

December 7, 2012

RE: Meeting of December 6, 2012 at Northcliffe Offices, Fredericton, NB

Hello John and the Northcliffe Team:

We went long and late last night, so I wanted to make sure you understood the message we were delivering. I'm following up today to provide you with our concerns from my perspective in writing.

From the very beginning of the project, I and many others have indicated that we are interested in engaging in a dialogue about the potential benefits of the Sisson Brook Mine (SBM). We have made only one fundamental requirement: create and build the best operation the world has ever seen and in doing so, we will be comfortable in supporting you. In response, you and your team over the years have said you were going to do exactly that, build the best.

For those of us engaged on the environment component, we laid out for you our definition of the minimum standards that had to be met to qualify to be the best.

1. We asked you to define what is the current state of the environment for the watershed.
2. We explained that this measure of state includes its inherent variability because this is the fundamental nature of hydrology and biology.
3. When you showed us your 2011 results, we explained that you had not sampled enough of the environment to establish its condition. A) You had not sampled enough of the fish and benthos within the affected area and across the watershed to establish the standard conditions. We explained why – you hadn't sampled all the various habitats for these organisms. B) You had not sampled enough years to establish the variability over time for these species. We explained why – biological systems are regulated by the dynamic components of the physical environment, i.e., seasonal; and annual water levels and temperature.
4. We had asked you match the provincial standards for sampling techniques, i.e., so that your results could be used by the province and the local watershed associations to better understand this river and all our provincial waters. You did follow their standards for fish habitat assessment and electrofishing. You didn't for benthos.
5. We had asked you to use your biological surveys and habitat modelling to tell us the significance of the affected area for the fish and benthos in the Nashwaak River watershed, e.g., what is the production of juvenile salmon and other species in the area, what proportion of spawning for salmon and other species occurs in the affected area, what rare or special species occur in the affected area and is this a significant portion of their populations.

We asked these questions so that you would understand what we consider to be the minimum standard of information we need to enter into a discussion and possible agreement to support the SBM.
We explained why these questions are so critical.

1. We need to know what is the current state, so that in our partnership with you can establish what we will define as "not normal", i.e., when has the system changed its state. We explained that the inherent variability of hydrology and biology across space and time demands an appropriate

sampling regime and we described this in detail. We indicated this is our minimum standard of acceptance.

2. We need to know the significance of the affected areas for the species so we can assess the risk to the ecosystem and discuss and decide if they are acceptable to us. For example, can we (the community) accept the loss of X % of salmon spawning habitat in the Nashwaak River watershed, in terms of the entire Saint John River population, and what are the modeled scenarios for various catastrophic losses of stream habitats (e.g., uncontrolled leaching of toxics, dam breaching).

Your assessment to date hasn't provided the information we asked for as our minimum standard for the best operations. Instead, you appear to be content with achieving the minimum standard for the regulators which we have explained repeatedly is not good enough for our community.

Our goal has always been to establish a partnership with the company that makes us comfortable. We have to live with this undertaking of a major disruption of our natural environment and then we have to live with the legacy long after you and your shareholders are gone. Your industry doesn't have a track record that makes us comfortable and therefore we can't accept any verbal assurance from you and your team (don't take it personally). We can't depend on the regulators because they are governed by politics not the people; therefore our community needs a very well defined partnership agreement in writing.

1. We need to agree on what is the current state of the environment. That has to include a good understanding of the natural variability in this system.
   → You expressed concerns that this will take too much money to cover the necessary area and too many years to sample. As partners, we could have and can come to an agreement on what is mutually acceptable for the sampling regime, i.e., where to sample and for how many years.
2. We need to agree on what will be considered "not normal", i.e., what are the indicators that tell us the system has changed.
   → We don't want to be in a future situation where we may have to argue, including in a court of law, that the system is changed. We want "change" to be articulated in an agreement before you start impacting the environment. This is why understanding the variability is absolutely required. For example, we need to agree in writing upfront to statements such as, "The Lower Napadogan is deemed to have changed its state for brook trout when the average density is less than 2 standard deviations below the pre-activity average, at X number of sites, for Y number of years."
3. We need to agree on the actions to be taken by Northcliffe if your monitoring shows the system has changed.

These are our minimum standards we asked you to meet. You are proceeding to the final EIA report in February 2013 without having started to approach our standards. I think you can understand why we are very unhappy with your performance so far.

Respectfully,

Allen Curry

2.5 Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Components:
1) Comments on Project Description (particularly water management and the design of the tailings storage facility
2) Summary of Key Predictive Study – Geochemical Characterization of Waste Materials
3) VEC – Aquatic Environment
4) VEC – Accidents, Malfunctions and Unplanned Events
5) Follow-Up and Monitoring Program, and
6) Conceptual Decommissioning, Closure, and Reclamation Plan
Subject Areas: Mine design and planning, Water Quality
EIA Report Sections: Exec. Summary, 3.0, 7.5, 8.5, 8.17, 9.0, Other documents: Conceptual Decommissioning, Closure, and Reclamation Plan
Date: October 1, 2013

Dr. David Chambers and Mr. Stu Levit, M.S., J.D.
Center for Science in Public Participation (CSP2)

NOTE: Dr. Chambers and Mr. Levit's review begins on the next page. There biographies can be found at: http://www.csp2.org/expertise.

CENTER for SCIENCE in PUBLIC PARTICIPATION

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"Technical Support for Grassroots Public Interest Groups"

October 7, 2013

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Re: Comments on Sisson Brook Environmental Impact Assessment

The Center for Science in Public Participation provides technical advice to public interest groups, non-governmental organizations, regulatory agencies, mining companies, and indigenous communities on the environmental impacts of mining. CSP2 specializes in hard rock mining, especially with those issues related to water quality impacts and reclamation bonding.

SPECIFIC SECTION COMMENTS

3.0 PROJECT DESCRIPTION

3.2.4.3 Tailings Storage Facility (TSF)

3.2.4.3.1 Overview

It is noted that:

> "The TSF will be located in the area formerly covered by Bird Brook and its various tributaries, and will cover an area of approximately 751 ha at its ultimate extent at the end of mine life."
>
> "The base of the TSF embankments will be native overburden, compacted as required to minimize seepage." (p. 3-21)

Seepage under Ring-Dike impoundments is common. Leaving native overburden usually enhances seepage under the tailings dam. The EIA does not expand on when, or how, it will be determined if the 'native overburden' needs compaction, even though this could be critical in controlling seepage.

Recommendation: *A more sound approach in terms of controlling seepage would be to remove the native soils for use in reclamation, and to compact the remaining material to a specified density.*

3.2.4.3.2.1 Embankments

Starter Embankments (Stage 1):

> "The liner will be anchored into a trench keyed into the lower permeability bedrock on the upstream side of the embankment." (p. 3-24)

It seems there might be a possibility that portions of the 8.8 km starter dam cannot be keyed into competent bedrock.

It is noted in the Knight Piesold Baseline Hydrogeology Report that:

"● Till: Surficial geology mapping has identified basal and ablation tills up to about 10 m in the project area. The till is comprised of varying composition of sand, silt, gravel and clay. The ablation till may be more permeable than the basal till.

● Shallow, weathered bedrock: The presence of this zone in the upper 10 m to 20 m of rock is based on regional mapping as well as drilling in the project area."[1]

With up to 10 m of till, potentially on top of fractured bedrock that could be an additional 20 m in depth, the likelihood of seepage under the starter (and fully constructed) tailings dam seems probable in some locations.

The tailings, and co-disposed waste rock, are apparently to be placed on native overburden, like the main raised portion of the tailings dams. One potential approach to minimizing the amount of seepage that will escape under the tailings dams would be to place a drain system underneath the tailings on top of the Zone S fill material that will key the dam into base rock. This would provide several benefits, including: relieving pressure on seepage that would go under the starter dam; dewatering the tailings above the starter dam, which would provide more stability in the event of an earthquake; and, lowering the phreatic surface on the dam face itself.

A tailings drainage system could consist of a series of trenches filled with rock (and perhaps a perforated drainage pipe) placed under the tailings to be deposited at the base of the dam. This seepage could drain to a common sump to be pumped as necessary. This would not be prohibitively expensive, and could more than pay for itself in decreased seepage collection costs, especially post-closure.

3.2.4.3.3.2 Earthquakes

Design Earthquake

It is noted:

> "Consistent with the current design philosophy for geotechnical structures such as dams, two levels of design earthquake have been considered: the Operating Basis Earthquake (OBE) for normal operations, and the Maximum Design Earthquake (MDE) for extreme conditions (ICOLD 1995)." (p. 3-26)

However, it should also be noted that ICOLD has subsequently recommend: "According to the current ICOLD guidelines, large dams have to be able to withstand the effects of the so-called Maximum Credible Earthquake (MCE). This is the strongest ground motion that could occur at a dam site. In practice, the MCE is considered to have a return period of several thousand years (typically 10,000 years in countries of moderate to low seismicity)."[2]

In order to conform with the most recent recommendations from the International Commission on Large Dams (ICOLD), and in recognition that tailings dam must be designed to last in perpetuity, the Maximum Design Earthquake should be equivalent to the Maximum Credible Earthquake.

In this section it is also stated:

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[1] Northcliff Resources Ltd. Sisson Project, Baseline Hydrogeology Report VA101-447/2-8, Knight Piesold, January 2, 2012, p. 11.

[2] Earthquake Safety of Existing Dams for Irrigation and Water Supply in Rural Areas, ICOLD, Martin Wieland, December, 2001

"... the MDE selected for the TSF is the 1-in-5,000-year earthquake which has an estimated mean average maximum acceleration of 0.37g." (p. 3-27)

The MDE should be the 1-in-10,000 year event – the MCE earthquake as recommended by ICOLD.

However, it was also reported in the EIA that the MCE is a magnitude 7.0 event (6.3.1.3.1 Seismicity). If a magnitude 7.0 event is the MCE, as described in Section 6.3.1.3.1 Seismicity, then apparently the MCE was used as the MDE. It should be clarified that the MDE is also the MCE.

Stability Analysis

"The seismic analyses indicate that any embankment deformations during earthquake loading from the OBE or MDE will be minor and will not have a significant impact on embankment freeboard or result in any loss of embankment integrity." (p. 3-27)

It is not clear from the description above if dynamic (numerical) modeling was completed using the MDE/MCE event, or if pseudo-static modeling was used. It is especially important that dynamic modeling be performed since the dam design has incorporated a modified centerline-type construction (which has an upstream-type component built on seismically unstable tailings). Today, few US regulatory agencies accept pseudostatic methods for seismic design of new dam projects. Seismic loading need not be considered for most new dams if the maximum credible earthquake produces a peak ground acceleration of less than 0.1 g at the site.[3]

More detail on the type of modeling used, and the results of that modeling, are warranted.

Recommendation: *If pseudo-static modeling was used to test for seismic stability, then a numerical model should be used to test the dam under seismic loading.*

3.3.4.2 Thickened (Paste) Tailings Disposal

"...the advantage of employing thickened tailings is improved conservation of water..." (p. 3-61)

The primary advantages of paste tailings are: (1) it allows tailings disposal on hillside areas instead of in high value stream valleys; and, (2) it does not require the same impoundment design (starter dams instead of full tailings dams). Conservation of water is an advantage, but is a major factor largely in arid areas.

3.3.4.3 Filtered Dry Stack Tailings Disposal

"… the advantages of filtered tailings are that they allow improved water conservation, and they are denser and thus require slightly less land area for storage …" (p. 3-62)

The primary advantages of dry stack tailings are: (1) it allows tailings disposal on uplands instead of in high value stream valleys; and, (2) it does not require the same impoundment design (starter dams instead of full tailings dams).

It would be more appropriate if the EIA better represented the advantages of paste and dry stack tailings technology.

3.3.5 Alternative TSF Embankment Designs

"Knight Piésold further undertook a trade-off study in 2012 to compare the use of cycloned NPAG tailings sand vs. quarried rock fill as construction material alternatives for the TSF embankments. Both methods are technically feasible, though cycloned sand construction is rather more challenging..." (p. 3-63)

[3] From http://www.meadhunt.com/documents/newsletters/persp_water3.pdf, downloaded on 14Jan10

The EIA does not explain whether the use of cycloned tailings for dam construction, which would probably require downstream-type construction, would provide better seismic stability than for the modified centerline design chosen as the preferred alternative.

Recommendation: *It would be appropriate to have a full explanation of why a modified-centerline rockfill dam is better than a downstream dam constructed of tailings.*

3.4.2.5.4 Mining Waste Disposal

> "Six separate storage cells will be constructed over the mine life to manage the APT residues within the TSF footprint. Each cell will be lined, and equipped with a leak detection and recovery system, to prevent comingling of the APT residues and the TSF water and thus avoid additional treatment of the TSF water for reuse in the process. Fences or other suitable means will be used to limit access to the ponds and deter wildlife entry. The cells will be progressively closed and encapsulated with tailings and barren rock as the TSF fills." (p. 3-137)

The basic construction design of the cells is sound, but the location is problematic. Cell liners can be subject to differential or seismic-induced settling if built on the tailings pond.

Recommendation: *It would be safer to construct the storage cells outside the impoundment (perhaps in the quarry if there is room).*

3.4.1.1.5 Removal and Stockpiling of Topsoil and Overburden

There is very little discussion of the overburden in the EIA. However, in the ML-ARD Potential Characterization Study it was noted:

> "At the time of reporting, acid-base accounting data was not available."[4]

There are a number of examples of overburden containing sulfide material, sometimes related to biologic activity. Failing to sample the overburden for sulfur is a significant technical deficiency.

Recommendation: *The overburden should be sampled for sulfur and carbonate to insure that no acid drainage will emanate from the overburden.*

3.4.2.2.5 Reagents

Each reagent should be evaluated for its stand-alone toxicity and for its ability to react with or alter (or be altered) by other contaminants in the TSF waste stream. The EIA should evaluate the potential for action and interaction individually and between chemical compounds, especially reagents. Monitoring will be critical before, during, and after mining to characterize the waste flows and TSF water quality.

Copper has already been identified as a waste water problem and is known to be toxic to fish and aquatic life, so removing copper sulfate would be a useful goal. Where appropriate, regulators should require removal or treatment of flows into the TSF to reduce interaction between compounds, reduce copper, and thereby overall TSF hazards.

Recommendation: *Reagents and other chemicals added or produced at the mine site should be characterized to determine their potential impacts alone and in combination with the dozens of other compounds at the mine site that will flow into the TSF. This analysis should make a threshold determination of potential impacts to human health or the environment and then those compounds that could cause harm (alone or in combination) should be analyzed for treatment and removal.*

[4] Metal Leaching and Acid Rock Drainage Potential Characterization, Sisson Project, SRK Consulting, August 2013, p. 40

Recommendation: *Monitoring and characterization of both the waste stream into the TSF and in the TSF itself should be sufficient in time, location, and breadth to ensure that the waste stream(s) at the mine are appropriately understood and regulated and where appropriate - specially treated.*

3.4.2.3.4 Water Management in the TSF

There is a discrepancy between a figure quoted in this section, and the prediction for the same figure later in the EIA:

"● The TSF will have approximately 2 million m^3/year of surplus water starting at about Year 8." (p. 3-123)

and;

"Approximately 6 million m^3/year of TSF pond water will be pumped to the WTP during Operation starting in Year 8 under average conditions." (p. 7-80)

This is a discrepancy of 4 million m^3/year.

3.4.3 Decommissioning, Reclamation and Closure

"Once the pit is completely full (at approximately Year 40), Post-Closure begins and water (treated, if necessary, until it meets regulatory requirements) will discharge to the former Sisson Brook channel." (p. 3-139)

The EIA is noncommittal on whether water treatment will be required after mine closure at Year 40. Water treatment has more impact on the amount of financial assurance required and any other facet of the mine. Water treatment, especially for the volumes possible at Sisson Brook could require a financial surety in the $100's millions.

Because the public is ultimately the guarantor of water treatment (not the regulatory agency) or alternatively would bear the effects of the untreated contamination, the public should be involved in the analysis and setting of the amount for the financial surety.

By failing to declare, whether through lack of information or analysis, it must be assumed that a financial surety for water treatment in perpetuity needs to be established. However, the financial analysis of this outcome is also not addressed in the EIA.

Because of the financial risk it places on the public, this is a major omission in the EIA.

Recommendation: *An analysis of a financial surety that includes water treatment in perpetuity should be included in the EIA.*

7.0 SUMMARY OF KEY PREDICTIVE STUDIES

7.5.2.3 Mid-Grade Ore Characterization

"Placement of the mid-grade ore within the TSF area for eventual sub-aqueous storage, if it is unused, should effectively inhibit potential generation of acid and metal leaching." (p. 7-68, 69)

However, it is also noted in the ML-ARD Potential Characterization Study:

"Processing of mid-grade ore is currently uncertain in the project plan and it is possible that it may sit exposed for longer than two years. In the event that ARD is produced, the project plan includes placement of this material on the edge of the TSF so that any contact water flows into the TSF and is

> contained, and as a result, collection of contact water and treatment (if required) would be easily facilitated."[5]

Typically there is only limited room around the edge of a dyke-type impoundment to place rock. There is no discussion of how much room would be required to store 17 Mt of mid-grade ore, and whether all of this material could be placed in a manner to assure it would drain into the tailing pond.

Recommendation: *More discussion of the temporary storage of the mid-grade ore in the EIA is warranted.*

7.5.3 Drainage Chemistry Predictions

> "For tailings, the scaling factor was 0.2 as test material and full-scale material was assumed to have the same particle size." (p. 7-70)

There are several scaling factors applied to convert the laboratory-calculated weathering rates to field conditions weathering rates. These scaling factors include a Temperature Scaling Factor, Particle Size Factor, and Contact Factor. These scaling factors are all 1.0 or less, and are multiplied together to calculate a Bulk Factor, which is applied to reduce the laboratory-calculated weathering rates.[6]

The values for most of the scaling factors (temperature, particle size, contact factor) are based of best professional judgment. Combining that with the fact they are multiplied together means there could be significant uncertainty in the weathering rates assumed for field conditions used in the water quality modeling.

> "After the pit is filled, only a small hanging wall (e.g., average height estimated at 22 m) will remain exposed." (p. 7-70)

It is also noted in the ML-ARD Potential Characterization Study:

> "Monitoring of pit sump water chemistry and pit wall oxidation during operations will help refine this prediction and better inform closure options as required."[7]
>
> and;
>
> "The pit high wall had an average NPR of 0.71 and ranged from 0.7 to 1.7 (5^{th} to 95^{th} percentile, respectively)."[8]

This is clearly Potentially Acid Generating material. For the purposes of establishing a financial surety, it should be assumed that a cover will be placed on exposed PAG pit walls. This is only prudent, and it doesn't mean that the money needs to be spent until the data referenced in the ML-ARD Potential Characterization Study has been collected – but the financial surety needs to be in place when the pit is opened.

Recommendation: *The reclamation plan should assume that a cover will be placed in exposed PAG pit walls until data collection can prove otherwise.*

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[5] IBID, p. 44
[6] IBID, p. 54
[7] IBID, p. 46
[8] IBID. p. 34

8.5 AQUATIC ENVIRONMENT

8.5.6.1 Residual Project Environmental Effects

"… the Project will necessarily need to comply with the discharge limits of MMER and those of the provincial Approval to Operate. Specifically with respect to total dissolved copper levels, the water quality model has predicted that copper concentrations in downstream watercourses will exceed both CCME and USEPA guidelines throughout most of the Operation and Decommissioning, Reclamation and Closure phases." (p. 8-243)

and;

"The parameters that are predicted to exceed at least one guideline at any of the downstream Napadogan Brook model nodes are sodium (Na), manganese (Mn), fluoride (F), aluminum (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), selenium (Se), and lead (Pb). All of the key parameter concentration changes are affected by seepage." (Metal Leaching and Acid Rock Drainage Potential Characterization, Sisson Project, SRK Consulting, August 2013, p. II)

Recommendation: *These statements strongly suggest that water treatment will be required throughout the project, and for as far in time as the water quality predictive modeling was performed. This is further confirmation that long term water treatment should be part of the financial surety for the mine – until it can be demonstrated that treatment will not be necessary.*

8.17 ACCIDENTS, MALFUNCTIONS AND UNPLANNED EVENTS

8.17.2.1.1 Loss of Containment from Tailings Storage Facility (TSF)

"With the application of these standards and rigorous construction methods to ensure the structural integrity of the TSF embankments and components, the implementation of adaptive management measures as necessary over the life of the mine, and the legislated regulatory oversight, the possibility of a structural failure of a TSF embankment is so unlikely that it cannot reasonably be considered a credible accident or malfunction, and is thus not considered further in this EIA Report." (p. 8-698, emphasis added)

This is the first time I have seen this glaringly overconfident statement made in an EIS/EIA.

In the 10 years since the ICOLD 2001[9] report the failure rate of tailings dams has remained at roughly one failure every 8 months (i.e. three failures every two years).[10] These dam failures are not limited to old technology or to countries with scant regulation. Previous research pointed out that most tailings dam failures occur at operating mines, and that 39% of the tailings dam failures worldwide occur in the United States, significantly more than in any other country.[11]

Tailings dam failure is a low probability event, but also an event with high consequences. These consequences have never been ignored in any other EIS/EIA I have reviewed. To in essence assert that 'my engineering' could not possibly fail, in light of existing statistics, is arrogantly assuming that it is always the other guy (or gal) that will make a mistake – but not me. This is exactly the attitude that leads to accidents – as has been proven many times in the aviation world.

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[9] Tailings Dams, Risk of Dangerous Occurrences, Lessons Learnt from Practical Experiences, Bulletin 121, International Commission on Large Dams, 2001

[10] Data from http://www.wise-uranium.org/mdaf.html "Chronology of major tailings dam failures" as of March 22, 2011

[11] Reported tailings dam failures, A review of the European incidents in the worldwide context, M. Rico, G. Benito, A.R. Salgueiro, A. D´ıez-Herrero, H.G. Pereira, Journal of Hazardous Materials 152 (2008) p. 848

9.0 FOLLOW-UP AND MONITORING PROGRAM

9.3.4 Adaptive Management

> "As part of the ESMS and adaptive management plan Northcliff will have in place for this Project, the Follow-up and Monitoring Program will be periodically evaluated for effectiveness and appropriateness of the elements of the Program and the parameters being measured and reported. This evaluation will be done in consultation with the appropriate regulatory agencies and as the results of the Program are analyzed." (p. 9-7)

A consultation limited to the regulatory agencies leaves the public, and any of their concerns, out of the adaptive management process.

As noted in: 9.3.3 Community/Stakeholder/Aboriginal Involvement

> "Communication of the results of follow-up or monitoring initiatives to the general public, stakeholders, and First Nations is an essential component of the Follow-up and Monitoring Program to be implemented by Northcliff. Not only does this maintain communication with all parties and keeps them informed of the Project activities and their associated environmental effects, but it also offers the opportunity to incorporate public, stakeholder and First Nation input into the design of these programs and any consequential adaptive management, as applicable." (p. 9-7)

Recommendation: *The public should be explicitly included in the adaptive management process.*

9.4.3.2.1 Surface Water

> "The concentrations of aluminum, ammonia, arsenic, boron, cadmium, copper, iron, lead, mercury (contingent on MMER, Schedule 5, Section 4(3)); molybdenum, nickel, nitrate, radium-226 (contingent on MMER Section 13(2)); and selenium, thallium, total suspended solids and zinc will be determined." (p. 9-15)

It is not clear if these are the only constituents being monitored as a part of the regular monitoring plan. If this is the case, then in addition to the metals and anions mentioned as substances to be monitored in this section, several others should be added.

Recommendation: *Sulfate is an excellent early indicator of ARD/ML problems. Silver, uranium, and antimony ("... molybdenum, lead, silver, arsenic, uranium, thorium, cadmium, antimony, bismuth, phosphorus, and tungsten have ML potential." Metal Leaching and Acid Rock Drainage Potential Characterization, Sisson Project, SRK Consulting, August 2013, p. 40) should be at least monitored until it is demonstrated that they are not potential contaminants.*

Table 9.4.1 Proposed Water Quality Stations for Long-Term Monitoring

Quarterly monitoring is proposed for several surface water reference locations and other sites. Quarterly monitoring is not adequate to capture surface water variations. Weekly sampling is typical at most mines.

Recommendation: *Monthly sampling is a minimum interval for surface water, especially at potentially mineralized sites where diurnal variations and other natural and anthropomorphic-related causal factors could be involved.*

Recommendation: *If there is a discharge of treated effluent, then monitoring for the discharge site and downstream monitoring locations should be done at least weekly.*

9.4.3.2.2 Groundwater

No groundwater sampling interval is specified/discussed.

Recommendation: *Groundwater monitoring wells should be sampled at least quarterly during mine operation, and at least semi-annually after closure to insure high flow (usually spring) and low flow (usually fall or winter) recharge events are captured.*

9.4.5 Follow-up or Monitoring during Decommissioning, Reclamation and Closure

"The water quality will be sampled twice a year at all sampling stations and the analysis will include the same parameters monitored during Operation." (p. 9-27)

Recommendation: *As previously noted, monthly sampling is a minimum interval for surface water to establish proper background, and similarly semi-annual groundwater sampling.*

CONCEPTUAL DECOMMISSIONING, RECLAMATION AND CLOSURE PLAN

The Conceptual Decommissioning, Reclamation and Closure Plan (the Plan) is an important part of the EIA for two primary reasons: (1) it demonstrates that the mine can be safely closed and restored to a usable land use using existing reclamation techniques in a cost effective manner; and, (2) that a financial surety necessary to accomplish the reclamation and closure tasks can be established to protect the public from financial liability in the event of an unplanned closure/bankruptcy of the mine.

The Plan should ensure that there is sufficient detail and data for regulators and the public to reasonably ascertain the likely water quality and long term treatment needs at the site. The idea of a "living document" is appropriate but it must begin its life with detailed information sufficient to assess long-term impacts, costs, and liabilities.

The Plan should sufficiently describe certain important environmental and other aspects that should be reasonably determined prior to mine permitting. It states that:

> "The Plan described in this document has been prepared to meet one of the requirements for the Environmental Impact Assessment of the Project, and to support the eventual preparation of a Mining and Reclamation Plan required by the *Mining Act* of the Province of New Brunswick." (Plan, page ii – *see also* Section 4.0).

Although the reclamation plan should be a "living document" it should also be sufficiently detailed at the mine-proposal stage to estimate the reclamation and long-term water treatment costs, since these represent major financial and environmental liabilities to the public. A reasonably detailed and accurate mining and reclamation plan is further essential for the public and government to understand and evaluate the true long-term ramifications of the mine. This is particularly important because the facility is proposed for Crown Land (see Section 2.1) meaning that the public and government will be permanently left with the mine's post-closure consequences. Once started, many if not most mining impacts cannot be simply "turned-off" - they tend to last forever.

Recommendation: *The Plan should be completed at the mine-proposal stage, and certainly prior to permitting, to a sufficient degree to reasonably determine water treatment costs, reclamation costs, and assess the short and long term social, health, and economic impacts from the mine (including post-closure).*

Long Term Water Treatment

Post-mine planning documents should explicitly identify what post-mine treatment will be necessary at the site. This includes temporary treatment and treatment into perpetuity. The Plan states that:

> "Within about 10 years following this initial work, the open pit will be flooded. This begins the Post-Closure period and most active reclamation will be complete. Some Project facilities will be nearing their target end land uses. **Work will focus on treating discharge water from the open pit as necessary** to protect the integrity of downstream watercourses, monitoring the stability of the Site, encouraging the development of diverse and sustainable plant communities that are similar to those that were present prior to Project development, and Site maintenance. Some Site infrastructure will remain to support this work" [Emphasis added]. (Plan, Page i.)

It is important to reasonably predict and disclose what long term and permanent water treatment is reasonably probable. The information should be predicted based on water quality, geologic, and other data that is already available. The cost to the government and public of the company's failure to adequately predict long-term water quality is too great to not demand the information before permits are issued.

The Plan appears to acknowledge that the mine site will require treatment into perpetuity. It states:

> "When the open pit has been filled, about 10 years later, the water treatment facilities will be re-furbished as required to treat surplus pit water before it is discharged to Sisson Brook." (Plan, page 38.)

If there is surplus pit water that will require treatment it is reasonable to anticipate that this treatment will be required in perpetuity - forever. That presents clear long-term liabilities and costs to the Crown, Province, and public. These liabilities and costs should be fully evaluated and discussed - and alternatives developed to reduce impacts or the need for permanent treatment.

Recommendation. *Prior to permitting the company should identify what long term and permanent water quality treatment may be necessary at the mine site. This includes but not be limited to discharges from the pit (including from pit walls that will not be submerged and pit discharges to groundwater).*

Recommendation: *Permanent treatment should be avoided. The Plan should more fully evaluate this and identify alternatives to perpetual treatment.*

Water Quality Protection

The Plan strives to protect water quality to meet required permitted water quality requirements (*see e.g.* Plan section 3.6.4) but should strive for even greater water quality protection. While the Plan asserts that the mine will seek to protect water quality, it often does not include specific or clear criteria that it will meet (aside from obvious permit and/or regulatory requirements). Meeting water quality standards and/or permit requirements should be a starting point - not final goal - to water quality protection.

The Plan should seek to not degrade existing quality - even if the current quality is above water quality standards and there is "room" to degrade water quality and also not violate the standards.

Monitoring

The Plan generally describes broad monitoring goals that will be developed in the final plan. (*See* section 4.5.3.1 (surface water) and Plan section 4.5.3.2 (ground water). The plan fails to commit to ensuring that monitoring is representative, accurate, and complete and geographically encompass all disturbed lands (and not just the TSF).

Commitment to Reporting

It is important that the public be able to participate in all phases of mine permitting, operations, closure, and post-closure activities. To support this need, monitoring and discharge reports, including reporting on contamination of surface and ground water, should be made publicly available in a timely manner.

The mine should immediately notify the public of leaks, contamination, etc., and develop a system for such timely notification in a way that is broadly accessible to all affected parties. This is essential for trust and to develop a working relationship with the public, especially affected communities. Adequate monitoring is the only way to determine spills and their impacts. Unknown leaks, or leaks that employees fail to report or attempt to hide will remain undiscovered and their contamination will continue or disperse unless monitoring is in place to detect them. Adequate monitoring before, during, and following mining also protects the company, because it allows all involved to determine what is caused by the mine versus other sources/causes.

Recommendation. *Contaminant release and incident reporting structures should require that the company provide environmental data and reports to the public. There should be full transparency and the company should commit to informing the public and government about any unplanned or unpermitted releases as soon as it becomes known - not just during the regular document/reporting cycle. Annual or even quarterly reports do not adequately address the public's right to know about problems at the mine. This promotes good operating procedures and public trust.*

Tailings Storage Facility

There is little protection to groundwater if the tailings storage facility (TSF) is not lined. Without a liner the TSF could transmit leaks to soils and/or groundwater (and arguably surface water).

Either a compacted liner or a full synthetic liner would be appropriate for the TSF, given that it will contain materials that are expected to produce and leach acid (or chemicals, such as residual milling and processing materials).

Lining the tailings impoundment would increase the cost, but would significantly protect water resources. Moreover, if seepage does occur on a larger scale than predicted, the overall cost will be significantly less than had the pond been lined in the first place.

Finally, monitoring should include leak detection. A leak detection system not only could identify how much and where a liner is leaking, but the leak detection system provides a significant barrier to groundwater infiltration even absent a competent liner.

Open Pit

The Plan states:

> "...the open pit will not be reclaimed other than to allow it to fill with water and to monitor and treat water quality, as required." (Plan, page 29.)

This is proposed because of possible safety or difficulty issues with reclaiming the pit's steep slopes. The Plan states that:

> "Reclaiming these areas [the upper pit slopes] will be difficult not only due to the challenging terrain, but also because of safety concerns." (Plan, page 29.)

This summary disposition of upper-pit reclamation alternatives appears to ignore possible lessening of pit slopes or variable treatments. This may include reducing all or some upper walls and slopes to establish benches or larger areas that could be capped and revegetated.

Recommendation: *The Plan should evaluate actual reclamation alternatives for the upper pit showing a range of alternatives for the above-flood zone and the variable flood-dry interface.*

Because the Plan does not consider in detail the ramifications of chemical and acid leaching from the pit's walls that are above the water level of the flooded pit. The pit's exposed walls could be a considerable source of acid formation and thus acid mine drainage that could alter the predicted chemistry of the flooded pit.

Recommendation: *The Plan should predict the acid mine drainage or other chemical leaching that could occur at the pit slopes/walls and develop a proposal to deal with the predicted outcome.*

The Plan estimates that it could take decades for the pit to fill to its predicted flooded elevation. There is some probability that the pit lake could become acidic by solubilizing/leaching metals from submerged waste rock and/or exposed pit wall rock.

Recommendation: *There should be modeling to predict pit water quality during the pit flooding phase and after the pit is flooded. That will allow the Plan and mine to commit to specific treatment goals and considerations.*

Recommendation: *The Plan should anticipate how to prevent wildlife and bird use of pit waters. This may include the use of nets, hazing, and other demonstrated wildlife mitigation measures.*

Long Term Maintenance

Prior to permitting the mine should develop a detailed long-term monitoring program to provide appropriate remote surveillance and retrieval of field monitoring data and replacement of the remote monitoring equipment.

Recommendation: *The Plan should evaluate the reasonable costs for long term routine maintenance.*

Reclamation Costs

Neither the Plan nor the reference (Samuel Engineering 2013) contains any detail on how the $50 million was estimated. The Samuel Engineering reference, which is an NI 43-101 technical report, contains only two short paragraphs that discuss reclamation.

There is also no discussion of whether the closure cost estimate includes water treatment. $50 million might be a reasonable "ball park" estimate of dirt-moving closure costs for a mine of this size, but if the closure estimate included both dirt-moving and water treatment, the cost estimate is likely too low.

Not having enough money to assume closure obligations, including water treatment in perpetuity, is a major potential financial and environmental impact on the public. This information should be carefully calculated and disclosed as a part of the EIA process. The currently available information is perilously lacking.

Recommendation: *The Plan and environmental impact analysis process should identify implementable reclamation practices and costs in a detailed reclamation plan. This is essential prior to permitting to ensure that regulatory agencies and the public are aware of the potential results that can be achieved, and costs posed in reclaiming the site.*

If a company becomes financially insolvent at any point and there is not sufficient bond available, the public would be responsible for the difference between available funds and the money required to complete site reclamation and other tasks (maintenance, monitoring, etc.). As described in the Plan, the Provincial policy for reclamation costing it is intended to provide 'reasonable assurance' that government funds will not be used for mine reclamation. Therefore it is important in calculating costs to ensure that the calculations represent the actual costs, including indirect costs, for the government to complete reclamation.

Recommendation: *The reclamation financial surety should reflect the third party costs for the remaining reclamation, including indirect costs, and should be adjusted downward as the company completes those tasks.*

At all times during mine activities, the company should be required to maintain a financial surety sufficient to reclaim and restore lands from all mine disturbances that occur over the life of the mine and after closure. Mines incur much/most of their reclamation liability in the first years after opening the mine (pit, tailings pond and dam, and waste rock piles - but before they may produce substantial or any income). If the mine closes or goes bankrupt before mining and reclamation is complete then there probably won't be enough money to close/reclaim the mine. Similarly, if the mine temporarily suspends activities there would need to be funds to maintain operations and activities that protect human health and the environment, such as pumpback operations, water treatment, monitoring, etc.

The cost to an agency to perform reclamation at a mine site is usually 30-50 percent higher than the cost to the original operator. This is because of costs for mobilization, overhead (regulators issuing contracts), contractor profit, etc. The most commonly underestimated portion of these estimates is that of calculating the indirect cost, i.e. the costs to third parties (government and contractors) in performing the reclamation work should the mining operator not be able to do so because of financial insolvency.

The Center for Science in Public Participation (CSP2) has done a number of studies on reclamation costing and the calculation of financial sureties. CSP2 has developed the following recommendation for computing indirect costs, and in the table below the CSP2 recommendations are compared to indirect cost recommendations of the US Forest Service.

Recommendation: *Indirect cost estimates used for reclamation bond calculations should be disclosed to the public and carefully reviewed*

INDIRECT COST GUIDELINES

CSP2* Recommended Percentage of contract costs		USFS** Recommended Percentage of contract costs			
			Minimum	Maximum	
Contingency	10%	Contingencies:	6%	20%	- Scope Contingency
			10%	20%	- Bid Contingency
Mobilization / Demobilization	10%	Mobilization and Demobilization	0%	10%	
Engineering Redesign	3%	Engineering Redesign	2%	10%	
Engineering, Procurement & Construction Management	5%	--			
Contractor Overhead	15%	Contractor's Costs:	3%	3%	- Performance & Payment Bonds:
			0%	5%	- Estimated Sales Tax:
Contractor Profit	10%		15%	30%	- Profit & Overhead:
Agency Administration	10%	Agency Project Management	2%	7%	
Inflation	3%	Inflation	0%	3%	
TOTAL	66%		38%	108%	

References:

* Hardrock Reclamation Bonding Practices in the Western United States, James R. Kuipers, PE, Center for Science in Public Participation, February 2000.

** Training Guide for Reclamation Bond Estimation and Administration, For Mineral Plans of Operation Authorized and Administered Under 36 CFR 228A, USDA Forest Service, Minerals and Geology Management, April 2004.

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Soils Salvage Strategy

The Plan describes "soils" materials and breaks them into Categories for salvage purposes (*See e.g.* Plan section 2.5.1*)*. These descriptions are reasonable but should be applied in a more nuanced manner to maximize available growth media for revegetation and reclamation. The use of 'standardized' depths to plan salvage is inconsistent with the categorical depths/variations described and potentially ignores important materials and maintaining their value for reclamation.

The greater the depth/quantity of topsoil (soil growth media), the greater the chance of revegetation success. Long-term vegetation success will depend on greater soil depths compared to short-term vegetation success. Greater soil depth may not benefit revegetation success in the 5-year period of revegetation monitoring but greater soil depths will benefit longer-term revegetation success. It would be a waste, and potentially impair long-term revegetation success, to not use all topsoil resources. For the public increasing revegetation success is highly valuable, and it is the public that will ultimately be responsible for the site. Therefore, it is important to ensure that all soils materials are actually properly distributed at the site.

Recommendation: *All soil material should be accounted for and distributed to maximize revegetation potential.*

The Plan describes the use of quarried rock for capping and then covering that material with soil for revegetation. The lack of detail makes it difficult to assess from the Plan exactly what the size/fractionation is of these materials, but it is presumed to vary widely. Quarried or 'clean' overburden/waste rock can be very course compared to the other materials. If fine materials, such as topsoil are placed over course materials such that the material sizes are very different, the smaller materials placed on top of the larger materials can form a layer that appears stable but over time (ranging from weeks or months to many years) may form pipes (piping) or simply infiltrate (fall) into the larger material. For this reason, the Plan should ensure that operators and inspectors are aware of the problems associated with disparate size fractions when materials are being placed. This is particularly important for topsoil, which can be particularly susceptible to infiltrating/falling into spaces below it during storm events, snowmelt, and freeze/thaw cycles.

Recommendation: *The Plan should establish general criteria and guidance to ensure that materials placement where topsoil is replaced does not allow small size materials to be placed on materials that have much larger size particles. Where this could happen, an interlayer of mid-size materials should be placed between them.*

Recommendation: *The Plan and permit should require salvaging all topsoil and subsoil from areas disturbed by mining activities - regardless of location or volume. Post-mine plant growth and establishment benefit substantially from maximizing plant growth media (soils), particularly where agriculture is a proposed post-mine land use. The more soil, the better the post-mine revegetation success, particularly in the first five years.*

The best reclamation practice would be to salvage Category 1 soil materials in two lifts - the first being A and B horizons, then the lower horizons. These lower horizons should then be placed as the first step of replacing cover material, upon which the topsoil (A and B horizons) would be placed. The effect is more cover material that will better support plants and more quickly further develop soils than just the A and B horizons placed on top of sand, waste rock, liners, etc. Given the EIA's reclamation goals, ensuring the good growth environment provided by maximum salvage and replacement is essential.

The topsoil salvage piles will stand unused for years. As a result the soils quality will degrade during mine operations and the soil value will be reduced from when it was salvaged compared to when it is replaced.

Recommendation: *To preserve soil integrity (including organic materials, microbes such as mycorrhizae, promote aeration, reduce weed introduction, and reduce erosion, the EIA should identify specific steps that it commits to employ to establishing nurse crops on the topsoil salvage piles. These plants should be consistent with, and not compete, with the planned postmine revegetation, especially agricultural seeding/planting.*

The Plan should commit to characterizing stored topsoil resources (one or two years prior to starting reclamation) to identify basic physical and chemical characteristic. These results can then be used to modify the reclamation plan and determine what, if any, amendments are necessary and appropriate to enhance and ensure revegetation success. Criteria should include material size fractions, nutrients, pH, microbial condition, and organic content. Sampling should be done at the surface and deep in the piles. This will ensure that the replaced soil and subsoil materials/horizons are best able to support post-mine agricultural goals. By sampling and evaluating the materials before they are disturbed, the mine can mix-in organics and other amendments that may be necessary to ensure they are fully integrated into the replaced soils (as compared to simply added as top-dressing).

Recommendation: *The Plan should develop detailed topsoil salvage and storage plans to ensure that the maximum amount of materials is salvaged for reclamation. These materials should be stored to maximize soil health and reclamation efforts. Characterization of materials should be based on field observation and not on a 'standardized' depth measurement.*

Revegetation Plan

The General Plan for Re-Vegetation (Plan section 4.2.5) is obviously general but it fails to establish criteria to measure revegetation success. The Reclamation Monitoring (Plan section 4.5.2) establishes some goals but they remain deficient for this phase of mine planning and based on the need for information to promote public and agency review and consideration.

The Plan should establish specific goals for essential revegetation features and not just generalized, conceptual goals. There should be clear noxious weed criteria, based on basal and aerial cover, which should be used to trigger treatment and retreatment.

Vegetation cover goals should be established - and are suggested to be at least 50%. Further, the percentage cover should be required to persist for at least 5 consecutive years prior to bond release. Plant growth (germination and early growth) is not as important as long-term establishment. Section 4.5.2 discusses a 5-year goal but its details should be expanded.

Because post-mine land uses will not be homogenous, it will be important to establish criteria for both alpha and beta diversity. Such criteria should make clear both aerial and basal cover-percent and further identify criteria for success and failure for both alpha and beta diversity. Without these standards revegetation could achieve some goal or required percent coverage but not establish, or even provide a reasonable ecological basis for future establishment of the diverse vegetative cover that will be needed for post-mine land uses.

The post-mine land use standards should roughly mimic the pre-mine alpha and beta diversity numbers for the mine, broken down into appropriate sub-regions. The goal should be to ensure that both species numbers and richness are established - which is necessary to achieve post-mine land use goals.

The 5-year period described should re-start whenever revegetation activities are taken to enhance revegetation. The goal of the minimum period should be demonstrating that plants have established and are self-sustaining. If supplemental activities are taken (such as adding amendments, fixing erosion or subsidence, recontouring, reseeding, planting, weed control, etc.) then the clock should re-start to ensure

that vegetation is actually surviving on its own. The 5-year period should demonstrate the site's ability to sustain itself - not demonstrate that with various treatments the company can keep the site growing.

Recommendation: *Establish clear noxious weed criteria, including the lowest amount of weeds that will trigger treatment and the highest allowable percentage of noxious weeds that will be allowed for bond release.*

Recommendation: *Establish minimum percentage vegetative cover goals of at least 50% after three years and 80% for five years before determining "success" or allowing relevant bond release.*

Recommendation: *Establish clear alpha and beta diversity requirements for vegetative cover.*

Recommendation: *Revegetation success should be measured no sooner than five years after revegetation goals have been met - without additional treatments or activities. If additional treatments or activities are undertaken, the 5-year clock should restart to ensure that revegetation and long-term plant establishment has actually occurred.*

Weed Management

The Plan does not establish a detailed weed control plan, but weeds could significantly threaten the post-mine land uses. Weed problems can begin during the first stages of mining, particularly during topsoil salvage operations and establishing nurse crops, when weeds can begin to take hold.

Recommendation. *A weed-prevention program should be developed and implemented.*

At a minimum, this plan should include, but not necessarily be limited to:

(1) Certification of weed-free seed;

(2) Processes to prevent weed introduction (such as washing vehicles if there is a specified potential to distribute weeds, such as off-site equipment that will be brought on-site to hydroseed or otherwise cover a lot of ground on the site and could thereby distribute weed seeds across a large area);

(3) Weed-response plan identifying how weeds will be controlled if they do come to the site.

Thank you for the opportunity to comment on this EIA.

Sincerely:

David M. Chambers, Ph.D., P. Geop. Stuart M. Levit, M.S., J.D.

2.6(a) Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Component: Terrestrial Environment
Subject Area: Wildlife with a focus on Birds
EIA Report Section: Section 8.6 and Baseline Wildlife and Wildlife Habitat Technical Report (WTR)
Date: October 12, 2013

Antony W Diamond, Research Professor, Wildlife Ecology (speciality: bird ecology)
University of New Brunswick, Dept. of Biology and Faculty of Forestry & Environmental Management

1. Summary

- *I reviewed Ch.8.6, Terrestrial Environment, with particular attention to Sections 8.6.2 to 8.6.4, of the EIS Report, and the Baseline Wildlife & Wildlife Habitat Technical Report (WTR).*
- *Description of current conditions is appropriate for birds; survey methods used are up to professional standards, clearly described, and quantitative.*
- *Description of current conditions for other animal groups is inadequate; no quantitative information is given, merely general list of species detected by a variety of methods that are poorly or vaguely described – little better than a species list.*
- *Likely effects on populations of Species at Risk and Species of Conservation Concern (pp.8-313/314) are dismissed as negligible or zero because "habitat is available elsewhere". This is based on the statement (for each species) that "not all available habitats are typically occupied by [Canada Warbler] in the local area, and therefore it is expected that any individuals displaced from habitat as a result of the Project are likely to find suitable nesting habitat nearby." (The same statement is made for all 5 SARA species of bird). No source is given for this statement; it implies a rigorous definition (and modelling) of each species' habitat in the area, and mapping species-specific habitat models onto a habitat map of the area; there is no evidence that this has been done. There is no reference to such models having been developed – the statement is given as if it is a fact whereas it is evidently an opinion. The number of bird Species At Risk identified in the project area deserves much more serious attention with regard to both Significance and Mitigation.*

2. Review of methods used to study existing conditions (EIA Report section 8.6.2)

BASELINE WILDLIFE AND WILDLIFE HABITAT TECHNICAL REPORT
Methods (Section 3.1):
WTR 3.1.1 Wildlife. "collected baseline wildlife information by observing animals and animal sounds" (at p. 37) – *no mention of looking for sign (tracks, dung) or using camera traps for rare species. This sounds like casual observations rather than systematic quantified sampling. It is* ***clearly inadequate*** *for mammals (especially small and nocturnal species) and herptiles (reptiles & amphibia).*

WTR 2.3.1 Ungulates
Pellet count surveys were conducted June 11-12, 2008. Surveyors walked transects to visually identify the presence of scat or pellets from moose and deer. They observed evidence of moose and white-tailed deer during pellet count. No pellets from deer were observed; however a number of tracks were present along the transects. Signs of both moose and deer were noted incidentally throughout the wildlife field

program. *No data are presented; no information on number, length, duration of transects, or which habitat types were involved.*

WTR 2.3.2 Amphibians and Reptiles

Ground surveys for herpetile species (*i.e.*, amphibians and reptiles) were conducted between June 5-10, 2008 in conjunction with waterfowl and forest breeding bird surveys. Herpetile species were identified incidentally and in targeted potential habitats based on visual characteristics, and in the case of some frog species, auditory cues. *No data are presented; no information on number, length, duration or method of surveys, or which habitat types were involved.*

Forest Bird sampling however seems to have been carried out thoroughly and according to accepted standards, with the exception of surveys for owls and other nocturnal birds.

3.1.2 Early breeding birds – playback in old forest, early May 2011. OK but no actual breeding confirmed. (*Need to return later in season to find occupied nests – no mention of this having been done*)

3.1.3 Owl surveys – standard protocol (April 2011) – poor weather, only 1 Barred Owl detected! *Needed to be repeated in later years, 1 at least of which should have provided suitable weather*

Nightjars – US survey protocols, dusk, June 11-July 8 2011: 20 CONI at 14/61 stations; ***likely breeding***, all over clearcut or regeneration or transmission corridors. Common Nighthawk is a species at risk, threatened under SARA, as are Canada Warbler, Olive-sided Flycatcher and Rusty Blackbird. *Strong evidence of breeding (from behaviour) – as strong as you can get without finding nests (did they try?) – of a significant number of a Threatened Species.*

3.1.4 Forest birds – 208 point counts (10 min each), June 11-July 8 2011; *data seem thorough & reasonable*

Summary/conclusions

- *Overall, sampling for wildlife other than birds is clearly inadequate.*

3. Review of results of studies of existing conditions

Species At Risk

Canada Warbler: 31 males (territories) in study area: densities ca. 4.81 territories/100 ha within 500 m of the PDA, and 3.65 territories/100 ha in the remainder of the Study Area. Most commonly observed within riparian wetland and near freshwater marsh habitats, and all detections within forest point counts were within 250 m of watercourses and wetlands. *A significant number of probably-breeding birds of a Threatened Species.*

Olive-sided Flycatcher: 18 detected: typically at edge areas near watercourses or open water wetlands. *A significant number of probably-breeding birds of a Threatened Species.*

Rusty Blackbird: 9 recorded in all. Densities 0.46 territories/100 ha in the Study Area, comparable to the 0.39 territories/100 ha recorded overall during the 2008 5-minute point counts. All in or adjacent to riparian wetland areas and beaver ponds. *Likely-breeding birds of a Threatened Species.*

No attempt seems to have been made to establish whether or not waterfowl are breeding in the area (no brood counts referred to – waterfowl records are referred to as "incidental"), or to target rare species that might be expected in the freshwater swamps and wetlands (e.g. Marsh/Sedge Wren, rails, grebes).

Summary / conclusion

- *Forest birds were surveyed properly, and results more or less in line with what would be expected; Canada Warbler perhaps more abundant than would be expected.*
- *Results for other wildlife taxa, including waterfowl and marsh birds, are inadequate, being based on poorly-described methods with similarly nebulous results.*
- *Referencing throughout is to public sources or proponent's field data, with no peer-reviewed literature referred to.*

4. Review of described mitigation measures (EIA Report section 8.6.4.2)

- *The only mitigation referred to is to avoid cutting vegetation during the birds' breeding season. Since various bird species breed at any time between Jan/Feb and August, it is very much to be doubted that they will observe this*.

5. Review of Determination of Significance (EIA Report section 8.6.6)

5.1 Review of definition of "Residual Environmental Effects Significance Criteria"

- EIAR section 8.6.1.6 *(For rare or threatened species or SOCCs) the proponent has used criteria that very few projects would meet, including* "the likelihood of the long-term survival of these rare, uncommon and/or non-secure population(s) within New Brunswick is substantially reduced as a result;" *by requiring the entire provincial population to be substantially reduced the proponent essentially ensures that the criterion cannot be met. A more biologically relevant land area – instead of the entire province of New Brunswick! – would be the LAA.*
- For other wildlife the criterion is also much too broad in geographic scope: "*such that the populations will not be sustainable within the Madawaska Uplands portion of the Central Uplands Ecoregion and the Valley Lowlands Ecoregion*". *Again, the LAA would be a more appropriate area over which to assess significant population reduction.*

5.2 Determination of Significance

- *Having used an inappropriate criterion for significance, the conclusion that no significant effects on birds will result is a foregone conclusion.*

6. Review of Follow-up and Monitoring (EIA Report section 8.6.7)

- "No follow-up is recommended to verify the environmental effects prediction or the effectiveness of mitigation for the Terrestrial Environment. No monitoring programs are recommended for the Terrestrial Environment." (p.8-320, EIS Report)
- *Monitoring impacts on wildlife responses in the area surrounding the immediate project area (LAA) should have been proposed, to test the prediction that (especially) SARs and SOCCs would simply move into vacant habitat nearby*.

7. Conclusion and recommendations

- *In my opinion the report does a poor job of assessing effects on wildlife other than migratory birds, and the conclusion of no significant effects is premature without (a) much better data on all wildlife other than forest birds, (b) development of species-specific habitat models for SARs and SOCCs to justify the statement that unoccupied but suitable habitat is available "nearby".*
- *Allusion to an "Avifauna Management Plan (AMP) to be submitted to Canadian Wildlife Service to address incidental take" (EIS p.8-311) is inadequate without giving details of that plan.*

8. Biography of Reviewer

CV of Dr. Antony Diamond – see Appendix C (short version: full CV available on request).

2.6(b) Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Component: Terrestrial Environment
Subject Area: Rare Forests and Wildlife, excluding Birds
EIA Report Section: 8.6
Date: September 27, 2013

Tracy Glynn, PhD. Candidate, University of New Brunswick
Acadian Forest Campaign Director, CCNB Action Inc.

Sections of the EIA report for the Sisson Project (Tungsten and Molybdenum Mine) that deal with terrestrial environments and wildlife (excluding birds) (EIAR Sec. 8.6) are reviewed here.

1. Background to review

With reference to Conservation Forest in Sec. 8.6.2.2.1 (EIAR page 8-265), it is noted that there is 1,968 ha of Conservation Forest with a wildlife objective intersected by the LAA. Old Forest Wildlife Habitat make up 1,111 ha (53%) of this area, which is significant in a province that has reduced areas of Old Forest Wildlife Habitat. It is important to note that the province's Conservation Forest area was recently reduced, going against the recommendations of many wildlife biologists and forest ecologists. The amount of Crown forest set aside for Conservation Forest used to be 30 per cent but also has been reduced to 23 to 25 per cent. At the same time, the NB government has increased the amount of intensive forest practices. Plantations, for example, will go from 12 per cent now to a maximum of 28 per cent of the public forest in the next 50 years. These are significant changes to the public forest, which makes up 50% of the land base of the province. The loss of Conservation Forest in this area should be assessed in the larger context of a reduced Conservation Forest area in the province.

The LAA contains a total of 2,048 ha of managed wildlife habitats (EIAR page 8-266). It is noted that forestry operations have resulted in the loss of interior forests in and around the LAA. There are 72 interior forest stands within the LAA, eight of which are intersected by the mine site portion of the PDA. Seven of these eight stands intersected by the PDA range between 10.9 and 73.9 ha and are all or mostly within the PDA, the eighth is 179.2 ha with only a few ha within the PDA. The total area of the interior forest intersected by the LAA is 3,303 ha. There are 8 stands that intersect the PDA, totalling 374 ha.

For the last 20 years, forest management planning in New Brunswick has been based on maintaining minimum amounts of wildlife habitat; the Conservation Forest in the LAA are one of the last bits of old forest that certain animals, such as fisher and flying squirrels, must have in order to live and raise their young. Wildlife that need old spruce fir forest may not be able to tolerate the clearcutting, conversion, and plantations if there are not enough untouched stands of 375 ha with trees of a certain size and type (Forbes *et al.* 2009).

2. Review of proponent's discussion of existing conditions (EIA Report Section 8.6.2)

A total of 33 wildlife species (22 mammal, 11 herpetiles) and birds are noted in the LAA during field studies (EIAR Sec. 8.6.2.4, page 8-279). The reviewer notes that insects and other wildlife are not

mentioned here even though they play an important part of healthy forest ecosystems. There are rare butterfly species, including the rare early hairstreak, hoary elfin and hoary comma in the Buttermilk Ecodistrict that lies in Central New Brunswick and forms and elongated transitional zone between the Central Uplands Ecoregion and the Eastern Lowlands Ecoregion, the Ecoregions where the project's footprint covers, according to *Our Landscape Heritage* classification (NB DNR 2007).

The EIA notes that Myotis is one of two species that are not common or widespread in the area but that are potentially present (see page 8-282). Myotis are mouse-eared bats. The common name for Myotis should be included. The status of both Myotis species found in New Brunswick, the little brown bat and the northern long-eared myotis, are not mentioned in the EIA but both species are listed as endangered on the Department of Natural Resources website. Pertinent information about the species and status of the species is missing from Sec. 8.6.2.4 Wildlife (EIAR pages 8-266-299). A national recovery strategy is being prepared for mouse-eared bats by the federal government in consultation with the New Brunswick government. How the project will affect the national recovery strategy is not mentioned but should be included.

The proponent's work on the terrestrial section would have been improved by adding details about the eco-regions and eco-districts as outlined in the 2007 NB Department of Natural Resources document, *Our Landscape Heritage: The Story of Ecological Land Classification in New Brunswick*.

3. Review of environmental effects assessment re: Characterization of Residual Project Environmental Effects (EIA Report Section 8.6.4.3)

The impacts of habitat fragmentation are downplayed in the EIA report, especially when one considers the cumulative impacts of human activity in that area, the overall health of the Acadian forest type in New Brunswick, and the largely vegetated area that the project is impacting: "The majority of land-cover types identified for direct disturbance by the project (i.e., that which is within the PDA) are upland forests and wetlands" (EIAR page 8-312). In addition, the EIA report does not provide numbers of individuals for certain species. Without this information, the proponent can only assume regional wildlife populations are "healthy" (EIAR page 8-316). Reliance on these assumptions versus actual data makes the EIA report's conclusion that the project will not have a significant impact on wildlife suspect.

As an example of the above, Sec. 8.6.4.3.2 on wildlife (EIAR page 8-315) argues that Canada lynx will easily find habitat elsewhere. Canada lynx prefers habitat that are beneficial to snowshoe hare, usually in forests with dense vegetation and shrubbery. Numerous studies have shown that lynx populations are influenced by that of the snowshoe hare. As hare populations become larger or smaller, so do the lynx populations. The EIA notes that snowshoe hare were the most frequently recorded species in both transects. The reviewer disagrees that degradation of habitat for the snowshoe hare and the Canada lynx with this project will be unlikely to affect the regional population of this species. Inter-species competition is not addressed where Canada lynx with home ranges that overlap with the PDA could be forced into areas and therefore in competition with other Canada lynx, bobcat, and competition with and predation by fisher and coyote. As well, the EIA report infers at page 8-315 that there is unoccupied lynx habitat just waiting for lynx displaced by the project to move to. There are two problems with this position. First, if the lynx population is healthy, as the EIA report suggests, then it is ecologically unlikely there is unoccupied lynx habitat. On the other hand, if there is unoccupied lynx habitat near the project, then this suggests the lynx population is not as robust in the RAA as the EIA concludes. Finally, changes to forested landscape and access brought about by forest management, road development and mining may threaten lynx recovery.

Given the above, it is clear the project will impact lynx populations in the region. However, the EIA report does not provide data about the number of lynx in New Brunswick, which is not surprising as, “The population size and trends for the lynx population in New Brunswick is poorly understood” (NB DNR undated). Without this data, and contrary to the blithe conclusions of the EIA report, the significance of the loss of one, two, or more individual lynx to a population of an unknown size cannot be determined.

Affected herpetile species in the RAA are also said to be common with secure status in the province (EIAR page 8-315). However, on EIA report page 8-286, wood turtles are recorded as found just outside the LAA. Wood turtles are listed as at risk species by the New Brunswick Department of Natural Resources and listed as threatened by COSEWIC. Furthermore, how the proponent's project will affect species' national and provincial recovery strategies for both the Canada lynx and wood turtle are not outlined but should be.

The above also highlights one of the proponent’s efforts to downplay the impacts of the project on wildlife and wildlife habitat. The EIA uses a very small LAA (1.5 km perimeter around the PDA), thereby keeping the number of individuals of a species that could be impacted by the project to a small a number. Then it uses a very large RAA to support its contention that the project will not have significant impacts on these species. While disingenuous, it also ignores the fact that different species have different ranges, mobility, etc. Finally, the reviewer notes that the LAA for the acoustic environment has a 10 km perimeter, which is “the maximum anticipated area within which Project-related environmental effects are expected” (EIAR page 8-35). It is unclear to me, and not explained in the EIA report, why humans can hear and be disturbed by noise from the project up to 10 kilometres away and wildlife will only suffer these same effects only up to 1.5 kilometres away.

4. Review of cumulative environmental effects assessment (EIA Report Section 8.6.5)

The reviewer disagrees with the proponent's assessment that "forest harvesting and other activities on Crown land are strictly managed by NBDNR through provincial objectives and standards that are revisited and updated every five years (NBDNR 2005) for many variables including vegetation communities, fish and wildlife habitat, timber and wood supply, and recreation and aesthetics." New Brunswick's forestry operations on Crown land are criticized for ever-expanding intensive forestry practices that include clearcuts and herbicide spraying that wipe out swaths of forest and wildlife habitat, reduce biodiversity, and cause run off into rivers and streams. Only fragments of intact forest remain in New Brunswick. Maps produced by Global Forest Watch Canada in 2000 revealed that no remaining large intact forests (500 square kilometres or more) exist in New Brunswick. The remaining 299-500 square kilometre blocks of forest in New Brunswick disappeared between 2000 and 2006, according to data from Global Forest Watch. Two disturbing observations stand out in these maps: 1) There are no large blocks of ecologically intact, undisturbed natural forests in the province of New Brunswick outside of protected areas, which cover only 3 % of the province; and 2) None of our major watersheds have more than 25 per cent intact forest cover (Global Forest Watch 2010). Global Forest Watch Canada used medium-resolution satellite imagery as well as some medium-resolution Landsat data and ground and aerial photography verification to generate the maps.

The Acadian forest type has been listed as one of six endangered forests in North America in a study by the World Wildlife Fund (Davis *et al.* 2001). New Brunswick makes up a large portion of the Acadian forest. Ensuring that the Acadian forest is properly managed here in New Brunswick is key to

maintaining this unique forest region. The EIA fails to acknowledge that the project will contribute to deforestation and forest degradation at a time when the diversity of the Acadian forest should be restored.

It is further noted that the EIA fails to describe the potential effects of ecosystems and changes in the biota of terrestrial and freshwater ecosystems as a result of climate change in the future. One report that the EIA should reference is the 2013 study, *Potential Effects of Climate Change on New Brunswick Freshwater and Terrestrial Ecosystems* by Arielle DeMerchant, Dr. Tom Beckley and Dr. Shawn Dalton. The report describes the views and opinions of leading scholars, researchers, and managers regarding potential macro-level ecosystem effects and changes in the biota of terrestrial and freshwater ecosystems as a result of climate change. The clearing of forest for the forestry industry and large industrial projects like mining can no longer be justified but rather larger tracts of the Acadian forest of New Brunswick must be conserved and restored so that the forest is resilient in a future of climate change. Forests also trap and store carbon dioxide and therefore play a major role in mitigating climate change.

5. Review of Determination of Significance (EIA Report Section 8.6.6)

The reviewer disagrees with the proponent's assessment that the environmental effects of the project on the terrestrial environment and wildlife are not significant. While the impacts of different aspects of the project on a variety of wildlife are summarized on pages 8-308-309 of the EIA report, the reviewer feels that the proponent fails to adequately address the local loss of habitat for a variety of species including Canada lynx and wood turtle, species being pushed to the brink of extirpation in this province. The proponent argues that "wildlife habitat types within the LAA are common and found throughout Central New Brunswick." However, how the project accompanied by planned forestry operations both within and outside the LAA and RAA will contribute to the further loss of old forest stands and mature forest stands, habitat for a variety of wildlife, is not mentioned or assessed by reviewing future forest management plans, which are also subject to change. It is assumed that Canada lynx and other wildlife will find similar suitable habitat outside the RAA but this does not take into account future planned activities and habitat destruction in these outside areas, which includes potential shale gas exploration and development (page 8-319). How climate change will affect the project's residual and cumulative impacts on wildlife is also missing, which should be included when assessing residual project and cumulative environmental effects.

6. Review of Mitigation, Follow-up, and Monitoring

The reviewer disagrees that mitigation measures, including the management of forestry activities by NBDNR for the protection of wildlife will minimize the environmental effects to wildlife populations such that they are not substantive. As mentioned above, the provincial government's management of public lands has and continues to be criticized by a number of the province's biologists and forest ecologists for failing to protect wildlife populations.

The reviewer disagrees with the proponent's recommendation to not to do any follow-up or monitoring to verify the predicted environmental effects of the project on the terrestrial environment (EIAR page 8-320). Given the uncertainty of effects of habitat loss on wildlife, some of them currently threatened species, requires follow-up and monitoring.

7. Conclusion

In a time of climate change, we should be conserving and restoring our Acadian forests and terrestrial environments so that they are resilient in the future. While the project does not occupy a large spatial area, any loss of very ecologically important and ever diminishing Acadian and old forests and wildlife habitat in New Brunswick should be treated as significant. Also, the proponent's treatment of the project on New Brunswick's forests in combination with other projects is disingenuous. It first relies on its position that New Brunswick is home to large tracts of old or mature forest and as such the project will not have a significant effect on the terrestrial environment and wildlife. Relying on this forest on one hand, the proponent then does not properly describe the decline and state of the forest and its potential effect on wildlife outside the project area.

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9. CV of Reviewer

CV of Tracy Glynn – see Appendix C.

2.6(c) Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Component: Terrestrial Environment
Subject Area: Protected Natural Areas
EIA Report Section: 8.6
Date: October 5, 2013

Lawrence Wuest
Consultant in Quantitative Ecology

EIA Report Section 8.6.2.2.3 Protected Natural Areas (PNAs)

The proponent fails to develop a systematic approach to documenting project LAA overlap with, and consequent impact on, candidate PNAs (CPNA). The reasons for the areal extent of the LAAs applied to individual VECs are never adequately defended by reference to peer reviewed science. The proponent only examines the overlap of existing and candidate PNAs with a single LAA from a single VEC. This is totally inadequate given the scope of the project and leaves the EIA report incomplete.

The reviewer notes that in EIA report 8.6.2.2.3, the proponent incorrectly assumes that undeveloped mineral claims and petroleum licenses to explore constitute "resource use". The proponent states: "Another [candidate] PNA (PNA #325) overlaps the southwest corner of Northcliff's mineral claim boundary, apparently in contradiction of the stated PNA objective to avoid areas for resource use." The candidate PNAs that do overlap the LAAs of interest for the Sisson Project do not include any current "resource use" by mineral or petroleum interests, e.g., an actual working mine, and thus PNAs have every right to compete with the proponent for the use of the land base in this area.

Although clearly an oversight, the proponent has not examined, nor did the final terms of reference for the Sisson Project EIA require the proponent to examine:
1) the overlap of all VEC LAAs with existing and candidate PNAs.
2) the economic benefits of candidate PNAs as economic alternatives to the project.
3) the impact of PNAs as part of the environment's impact on the project.

Addressing 1) above, the proponent has confined LAA overlap with existing and candidate PNAs to the LAA of the Terrestrial Environment VEC (EIAR Sec. 8.6.2.2.3). In Sec. 8.6 the proponent states "Managed conservation areas including interior forest, deer wintering areas, old forest wildlife habitat, protected natural areas (existing and proposed) will not be affected substantially by the Construction and subsequent Operation of the Project" (at EIAR p.8-247). The EIA report fails to provide evidence in support of this contention.

The proponent has assumed a 1.5 km buffer about project facilities, the PDA, as the extent of the LAA for wildlife habitat, and for the terrestrial Environment VEC as a whole. This is a highly questionable assumption given that the proponent's LAA for the Atmospheric Environment VEC is 25 km by 25 km. The assumption also flies in the face of published research on mine emissions and their areal extent. The 1.5 km buffer is contradicted by recent peer reviewed studies of the occurrence of heavy metals from mining activities in biota 20 km to 30 km from the source (Hasselbach *et al.* 2004; Aznar *et al.* 2008; Pilgrim and Schroeder 1997). The proponent has failed to consider this research and to incorporate the

findings into its modeling of dust and water emissions. The proponent's conclusions about impacts of the project on candidate PNAs are compromised by this oversight and require revision. The proponent's current conclusions regarding PNAs are not credible.

Based on the available mapping of VEC LAAs in Sections 8.2 to 8.17 of the EIA report, the reviewer has analyzed the overlap of candidate PNAs with the LAA of the Atmospheric Environment VEC. This VEC LAA overlaps with 5 candidate PNAs as illustrated in Figure A1 below adapted from EIA report Figure 8.2.1. Without exact geo-location of Figure 8.2.1, the calculation of LAA overlap is approximate only, but some statistics are exact.

- Atmospheric Environment LAA overlap with CPNA #183 is 712 ha
- Atmospheric Environment LAA overlap with CPNA #325 is 551 ha
- Atmospheric Environment LAA overlap with CPNA #240 is 494 ha
- Atmospheric Environment LAA overlap with CPNA #150 is approximately 3100 to 3200 ha

In addition to the above, there might be a small overlap with CPNA #311 at the boundary of the LAA. Total project LAA overlap with CPNAs is estimated to be 4944 ha. This is several orders of magnitude higher than the figures reported by the proponent for the Terrestrial Environment LAA (EIAR Sec. 8.6.2.2.3). There is no rationale given for the lack of consideration of the overlap of the LAA for Atmospheric Environment. There will be pollutant pathways into PNAs emanating from the project. As Milewski and Wuest (2013; CCNB Action Report Section 2.1 above) have shown earlier in this review of the EIA report for the project (see CCNB Report Section 2.1above), elevated levels of pollutants in air and snowmelt will be exhibited throughout the LAA for the Atmospheric Environment, and as a result they will find their way into the candidate PNAs. The pollutants will include PM containing higher than acceptable levels of arsenic and other trace metals, as well as hydrogen sulfide gas, sulfur dioxide gas, and ammonia.

Pursuant to the point of using an LAA larger than the terrestrial Environment LAA chosen by the proponent for PNA interaction, it has been observed by Gurd *et al* (2001) that mammalian population survival decreases below 270,000 ha of connected protected habitat. The Canadian Parks and Wilderness Society: New Brunswick Chapter has quoted some scientific literature suggesting a minimum PNA size of 25,000 ha (CPAWS 2013). Given that agglomerations of connected habitat like that in the LAA in the Upper Nashwaak are disappearing quickly in New Brunswick, it is important that the connections of these PNA clusters be protected from the deleterious effects of industrial emissions. The proponent has not addressed this issue as part of the environment's impact on the project.

Addressing 2) and 3) above, given the proponent's unsubstantiated and incomplete conclusions regarding candidate PNAS, the proponent has subsequently failed to consider the loss of economic potential of the affected PNAs resulting from mine operations at Sisson. The proponent has not shown evidence that it has considered current literature on the economic value of PNAs (e.g. Wilson *et al*. 2010) in assessing the interaction of the project with the environment.

The proponent has failed to properly evaluate the economic potential of the proposed PNAs as an alternative to the project, a project whose emissions will destroy the economic and ecological potential of the PNA areas. The proponent has also failed to consider the PNAs as part of the environment's impact on the project as discussed in EIA report Sec. 8.16.

Finally, the proponent has failed to appreciate the increased risk to PNA #150 from a tailing dam disaster. The proponent has described the risk of dam failure as not credible. The risk of a dam failure may not be high but it is a credible risk, with approximately 3 tailing dam failures every two years in the world. The impact of a failure on the ecological and economic value of the candidate PNAs must be considered as part of the bonding of this project.

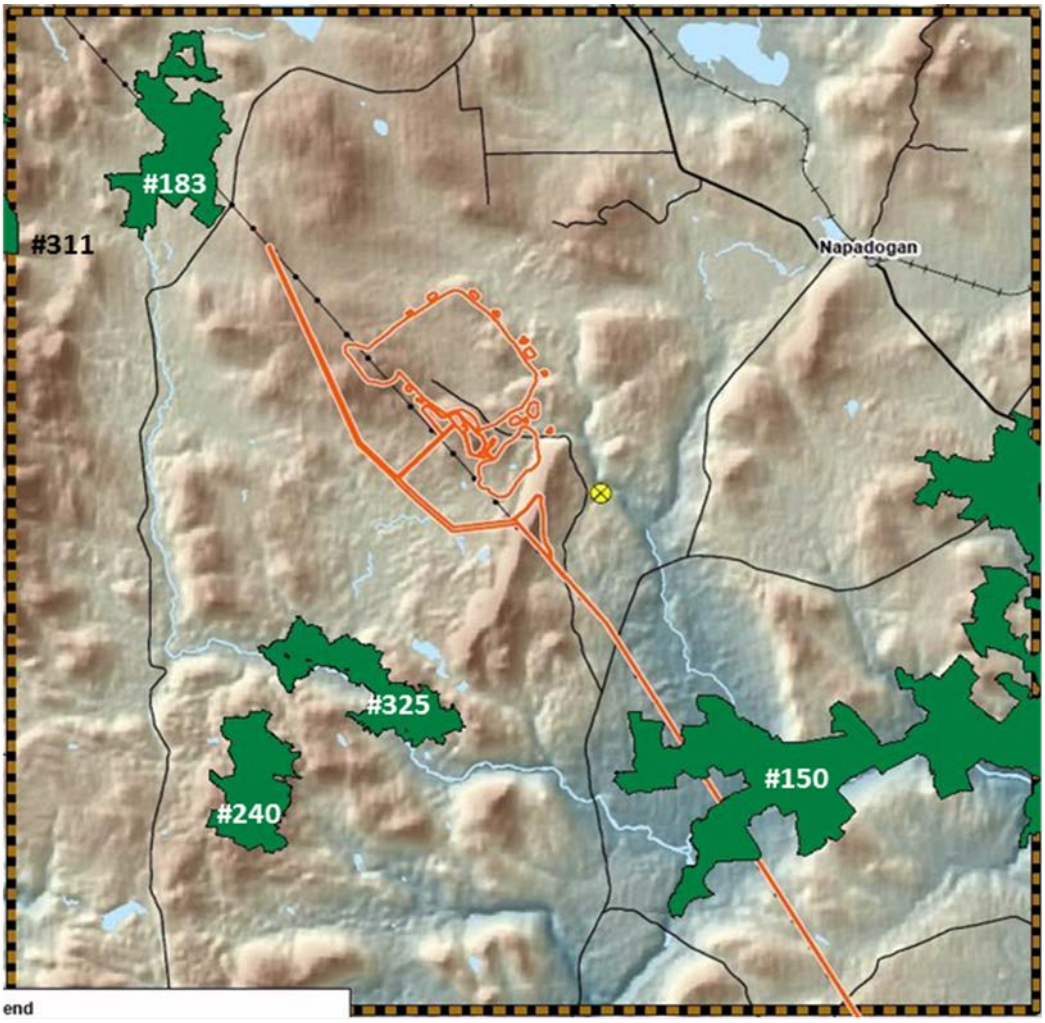

Figure A1. Sisson Project: Atmospheric Environment LAA Overlap with Candidate Protected Natural Areas ■ *Adapted from Stantec(2013) EIA Report: Figure 8.2.1*

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Publications of Reviewer

Biography and Publications of Lawrence Wuest – See Appendix B.

2.7 Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Component: Vegetated Environment
Subject Area: Rare Vegetation Communities
EIA Report Section: 8.7
Date: September 27, 2013

Tracy Glynn, PhD. Candidate, University of New Brunswick
Acadian Forest Campaign Director, CCNB Action Inc.

Sections of the EIA report for the Sisson Project (Tungsten and Molybdenum Mine) that deal with Species at Risk and rare vegetation communities (EIAR Sec. 8.7) are reviewed here. In addition, many of the reviewers comments on the project's impacts on those sections of the EIA report for the project that deal with the VEC Terrestrial Environment (EIAR Sec. 8.6) are applicable to this review.

1. Comments

The PDA and LAA cross several Old Forest Communities as identified by NB DNR in their Standards and Guidelines for Identification of the 2012 Old Forest Community and Old Forest Wildlife Habitat Land Base (EIAR page 8-363). The reviewer feels that the importance of the Old Forest Communities is understated in the EIA. The importance of conserving Old Forest Communities was highlighted ten years ago in the province's 2004 forest inventory. The forest inventory noted that the area of mature forest (average tree age of 80 years) had been reduced by approximately 35% from its historic levels in New Brunswick and old growth forest (average dominant tree age of 150 years) had been reduced from 50% of the forested land base to less than 5% of the current land base (Mosseler *et al.* 2003. The most recent cycle of forest inventory is in preparation (Dick 2013). The Acadian forest type has been listed as one of six endangered forests in North America in a study by the World Wildlife Fund (Davis *et al.* 2001). New Brunswick makes up a large portion of the Acadian forest. Ensuring that the Acadian forest is properly managed here in New Brunswick is key to maintaining this unique forest region. The EIA fails to acknowledge that the project will contribute to deforestation and forest degradation at a time when the diversity of the Acadian forest should be restored.

It is noted that Nodding ladies'-tresses, a Species of Conservation Concern (SOCC) plant, was observed at one location within the LAA (EIAR page 8-364). How the project will affect recovery strategies for that species is not mentioned. Furthermore, it should be noted that researchers are finding that reduced diversity of forest stands is reducing the diversity of herbaceous plants (Ramovs and Roberts 2003) and bryophytes in New Brunswick (Ross-Davis and Frego 2002).

With regards to the assessment of cumulative environmental effects, industrial land use is mentioned but is not described and does not include potential shale gas exploration and development in the RAA. SWN Resources currently holds a license to explore for shale gas in the area. The reviewer disagrees with the statement that "past, present and future industrial land use within the RAA is limited and not predicted to act cumulatively with the project on the Vegetated Environment" (EIAR page 8-365) because it does not adequately address future industrial activity including shale gas exploration or development. The EIA fails to acknowledge the full extent that the project will contribute to deforestation and degradation of forests and vegetated environments at a time when the diversity of

the Acadian forest and vegetated environments should be restored, considering the current overall health of the Acadian forest.

Further on the issue of the cumulative impacts of the project on forests, forest scientists have noted that the Department of Natural Resources has favoured softwood communities in forest management to the detriment of hardwood species and vegetation communities. Mixedwood communities with less than 50 percent hardwood component have been replaced by softwood communities or plantations (Coon *et al.* 2005). Replacing mixedwood and hardwood forest communities with softwood forest communities has made the Acadian forest a less resilient forest. Resilience refers to the ability of an ecosystem to absorb external influences and remain intact (Holling 1973). Vegetation communities are a major biological component of forests and directly influences, or is influenced by, several other ecological attributes of forest ecosystems including "stand structure, forest growth and productivity, epiphytic bryophyte and lichen composition, and soil properties including faunal community" (Banner *et al.* 2008). The project will contribute to loss of and degraded vegetated environments and will also affect the previously mentioned ecological attributes of forest ecosystems.

Another failing of the EIA report is that it fails to describe the potential effects of climate change on the vegetated environments in the future. One report that the EIA should reference is the 2013 study, Potential Effects of Climate Change on New Brunswick Freshwater and Terrestrial Ecosystems by Arielle DeMerchant, Dr. Tom Beckley and Dr. Shawn Dalton. The report describes "the views and opinions of leading scholars, researchers, and managers regarding potential macro-level ecosystem effects and changes in the biota of terrestrial and freshwater ecosystems as a result of climate change." In a time of climate change, we should be conserving and restoring our Acadian forests and vegetated environments so that they are resilient in the future.

The reviewer disagrees with the proponent's recommendation not to do any follow-up to verify the predicted environmental effects of the project on vegetated environments (EIAR page 8-370). Given the uncertainty of effects of the project on vegetated environments, including Nodding ladies'-tresses, a SOCC, requires follow-up and monitoring beyond five years.

Finally, the proponent’s work on the vegetated environment section of the EIA report would have been improved by adding more specific details about the eco-regions and eco-districts as outlined in the 2007 NB Department of Natural Resources document, Our Landscape Heritage: The Story of Ecological Land Classification in New Brunswick.

2. Conclusion

In a time of climate change, we should be conserving and restoring our Acadian forests and vegetated environments so that they are resilient in the future

While the project does not occupy a large spatial area, any loss of very ecologically important and ever diminishing Acadian and old forests in NB should be treated as significant. Also, the proponent’s treatment of the project on NB’s forests in combination with other projects is disingenuous. It first relies on its position that there is lots of forest in NB and as such the project will not have a significant effect on the vegetated environment. Relying on this forest on one hand, the proponent then does not properly describe the decline and state of the forest outside the project area.

3. References cited by Reviewer

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4. CV of Reviewer

CV of Tracy Glynn – see Appendix C.

2.8 Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Component: Wetland Environment
Subject Area: Wetland Protection
EIA Report Section: 8.8
Date: September 30, 2013

Stephanie Merrill, MSc.F.
Director Freshwater Protection Program,
CCNB Action Inc.

1. Summary

I reviewed Section 8.8 - Wetlands Environment of the EIA report, with a particular focus on the cumulative impacts of the Sisson Project on wetlands in the PDA and LAA. In summary, there is an over reliance on adhering strictly to the current provincial wetlands management policy which (as the proponent clearly states) does not regulate a large proportion of wetlands in the PDA, LAA, and RAA. This leads to an underestimation of impacts due to a lack of requirements for compensation for this loss and an underestimation of the cumulative impacts, particularly when considered with future forestry activity which has the most impact on the unregulated wetlands (forested wetlands).

2. Review of assessment of project related environmental effects re: Wetland preservation (EIA Report Section 8.8.4)

2.1 Review of described mitigation measures (EIA Report Section 8.8.4.2)

It is my position that the proponent's mitigation plans to lessen the impacts of the project on surrounding wetlands are not described in enough detail in the EIA report for the public and decision makers to truly gauge whether they will be effective. For example:

- The proponent does not go into detail about their proposed wetland compensation approach for mitigating the loss of wetlands functions of government regulated wetlands.
- The proponent identifies that there could be "positive" environmental effects by compensating for lost wetlands; however the proponent does not detail what these might be. Furthermore, the proponent does not define "positive" effects; re-creating the wetland function lost does not necessarily provide a net positive effect but only neutralizes the lost incurred by the project.
- The proponent relies heavily on future work to identify compensation measures. With a lack of detail it is impossible to comment on such things as watershed thresholds for wetland function loss and appropriate compensation to reflect the watersheds thresholds. This modeling should be undertaken.

Given the above lack of specificity about the possible mitigation of the project's impacts on wetlands, i.e., is it clear they actually work?, it is premature of the proponent to determine that the project will not have significant effects on the wetland environment.

2.2 Review of environmental effects assessment re: Characterization of Residual Project Environmental Effects (EIA Report Section 8.8.4.3)

After reading the EIA report, it is my view that not all of the project's residual environmental effects on the wetland environment have been properly characterized. For example:

- The proponent indicates that there is an 'unknown' extent of indirect loss of wetlands due to the drawdown effect of the open pit. This unknown impact, combined with the fact that unmapped wetlands are not considered for 'avoidance, mitigation and compensation' strategies by the NB provincial government (and therefore not the proponent), results in the potential for a compounding wetland function loss without documentation.
- There is no modeling of hydrological changes and the proponent relies heavily on adaptive management to determine the impact on regulated wetlands, but not unregulated wetlands.
- The proponent argues that the loss of wetlands that provide hydrological function to the receiving watercourses that will themselves be lost is not a significant environmental impact. The loss of the relationship between the two should indeed be characterized as significant for their inherent value and not dismissed because they are not utilized or consumed by humans.
- The proponent indicates that "… treated surplus water will be released from the Project to the former Sisson Brook channel and may present an opportunity for positive environmental effects on wetlands …" (EIAR page 8-422) without detailing how this could be. Furthermore, the proponent does not acknowledge or identify any impacts (or not) from releasing surplus water potentially contaminated with heavy metals and reagents from the processing plant and the APT plant. Dissolved oxygen may also be an important factor to consider in assessing the impacts of releasing surplus water.
- The proponent justifies the lack of regulation and the subsequent impacts on unmapped wetlands to the fact that they are forested wetlands and do not have the relative ecological function or values as other wetland types. It is my position that the proponent, as is reflected in the EIA report, under-appreciates the long term absorption capacity and vernal pool habitat for important invertebrates that forested wetlands provide.

3. Review of cumulative environmental effects assessment (EIA Report Section 8.8.5)

The EIA report's treatment of the cumulative environmental effects of the project on the wetland environment is deficient for several reasons.

- The EIA report does not mention potential oil and gas activities, including shale gas and pipelines that are identified in economic development plans and by exploration licences given in the LAA.
- The proponent inaccurately relies on the provincial regulations managing wetlands when speaking of the cumulative effects of current and future forest activity. The majority of wetlands that would be impacted by forestry activity are not regulated under the *Watercourse and Wetland Alteration Regulation* as per the current operating procedure (forested wetlands) and therefore the EIA report does not accurately describe potential cumulative impacts to wetlands. The potential cumulative impacts on all wetlands are greater than stated. This is compounded by the fact that it seems the proponent is only predicting the cumulative impacts of the project over the current 5-year forest management plan and not the entirety of the project.
- The proponent does not mention the potential cumulative impacts that might occur in changing climatic conditions, specifically higher precipitation rates. How is the increasing flow rates reflected in the loss of wetland function (in addition to other lost water features)?

4. Review of Determination of Significance (EIA Report Section 8.8.6)

The proponent's determination that the residual cumulative environmental effects of the project on the wetland environment will not be significant needs to be revisited. For example, the proponent relies on future work to determine this cumulative impact particularly on wetlands outside the PDA. No modeling was attempted to be done at this stage. As a result, the proponent states they are moderately confident in the significance of the impact. It is recommended that modeling be undertaken to increase the confidence level. This is especially important because there is no regulated compensation requirement for unmapped wetlands (which are mostly forested wetlands) and therefore there is potential for a net loss of wetland function.

5. Review of Follow-up and Monitoring (EIA Report Section 8.8.7)

- Given a potential underestimation of the cumulative impacts on all wetlands, particularly in the LAA, the recommended follow up or monitoring may be understated. Currently no recommendations are made in the EIA report.
- Modeling may show an increased cumulative impact on all wetlands in the LAA and therefore it would be appropriate to implement follow up and monitoring. And, given that the cumulative impacts on all wetlands are stated as unknown it would seem reasonable that follow up and monitoring would be needed.

6. Conclusion and recommendations

In summary, there is an over reliance on adhering strictly to the current provincial wetlands management policy which (as the proponent clearly states) does not regulate a large proportion of wetlands in the PDA, LAA, and RAA. This leads to an underestimation of impacts due to a lack of requirements for compensation for this loss and an underestimation of the cumulative impacts, particularly when considered with future forestry activity which has the most impact on the unregulated wetlands (forested wetlands). Some more appropriate hydrological modeling that includes the changes to the unmapped forested wetlands would give a better sense of the residual environmental impacts, not just for mapped wetlands, the significance of these impacts, and the need for mitigation measures.

7. Resume of Reviewer

Resume of Stephanie Merrill – see Appendix D.

2.9(a) Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Valued Environmental Component: Labour and Economy
EIA Report Section: 8.10
Date: October 3, 2013

Rob Moir, PhD.
UNB Saint John, Dept. of Social Sciences (Economics)

1. Summary

I have reviewed *Sisson Project: Environmental Impact Assessment Report* (CEAR #11-03-63169), Section 8.10 concerning the Valued Environmental Component: Labour and Economy filed in July 2013. For the purposes of this review, I shall refer to this document as EIAR. In reviewing the EIAR it is necessary for me to review and refer to three other filed documents – the *Baseline Socioeconomic Technical Report* filed 1 June 2012 (referred to as BSTR), *Economic Benefits Arising From the Construction and Operation of the Sisson Project* produced in February 2013 by the consulting firm EcoTec (referred to as EcoTec), and the *Conceptual Decommissioning, Reclamation and Closure Plan* (referred to as CDRCP). To help further understand the economics of the project, I also have reviewed the Canadian National Instrument 43-101 Technical Report on the Sisson Project, effective date January 22, 2013. The review of the National Instrument follows this review of EIA report Sec. 8.10.

I make a number of recommendations based upon my review of the EIAR and supporting documents. Highlights of these recommendations include:

- The proponent should use cost-benefit analysis instead of economic impact modeling to analyze the economics of this project.
- To ensure that economic benefits accrue to the Province, the proponent should voluntarily and explicitly limit access to the temporary foreign workers program.
- The proponent should explicitly identify how the $50 million financial security used to fund decommissioning and reclamation will be funded.
- Given that Northcliff Resources Inc. owns Sisson Brook as its only project, the company should be required to have a financial surety or insurance against catastrophic failure. It may be possible to link the size of this surety to risks of catastrophic events occurring.

2. Review of methods used by the proponent to study existing conditions (EIA Report Section 8.10.2)

The existing socioeconomic conditions are outlined in EIAR section 8.10.2 pages 8-468 through 8-480 which are essentially a summary of the BSTR. Data has been gathered using traditional methods; through reference to publicly available census data and contact with local officials. I believe the methodology used here is reasonable, but have a few recommendations.

Recommendations

1. Given the later-than-expected filing of the EIAR, it would be reasonable to expect that this baseline data could be updated using the 2011 Census.
2. Provide baseline data on population health (unless gathered elsewhere) both for areas local to the project and for areas likely to provide labour to the project. The BSTR only lists access to health facilities and programs and availability of resources (pp. 48-56).
3. Provide baseline data on local housing prices and rental rates in the EIAR. These data are available in the BSTR (pp. 40-45) but they do not make it to the EIAR. Moreover, the BSTR provides these data for 2006 and this should be updated.
4. Provide baseline data on well-water quality for local properties (unless reported elsewhere).
5. Provide baseline data on local alternative land/resource uses (specifically forestry, hunting, fishing, and other recreational use). These data are glossed over in the BSTR (p. 63).

Reasoning: If the goal of this section of the EIAR is to provide a baseline for existing economic conditions then it should address the productive capacity of individuals (health – recommendation 2), stored wealth (property values – recommendations 3 and 4), and alternative uses of the land which might be crowded-out by the project (recommendation 5).

Overall the methods used in Section 8.10.2 of the EIAR are reasonable but I recommend the updating of data and the reporting of additional data to provide a complete baseline before the project begins.

3. Review of results of studies of existing conditions

Section 8.10.2 of the EIA amounts to recording and reporting baseline data. In Section 2 of this review, I have made specific recommendations for the updating of the data reported in this section of the EIAR and the reporting of additional data. The data should be updated as soon as new data becomes available – typically a year or two after the Census – with these data made publicly available, both in print and through electronic access.

Recommendations

1. Update expanded baseline data on a regular basis.
2. Make the data publicly available, both in print and through electronic access.

4. Review of Potential Project-VEC Interactions (EIA Report Section 8.10.3)

As an economist, I find it odd that labour and the economy are considered to be valued environmental components (VECs). I also consider it odd that for a project with considerable negative economic externalities (social costs in excess of private costs), I am not directly commenting on any of these issues. I will return to this in Sections 5 through 7 and 10 of this review.

That said, I now turn to the issue as presented in the EIA report. Rather than consider the individual impacts of activities during the construction, operation and decommissioning phases of the mine, the proponent gathers all of the employment and expenditures associated with these activities and lists them as a category for each phase in the mine's life (see EIAR Table 8.10.4 pp. 8-480 to 8-481). This seems reasonable as the employment and expense associated with any single activity is likely to have a very small effect on either labour or the economy but in combination during any phase, might have a non-trivial effect. The proponent rates the effect upon labour as a 1 in all phases and the effect upon the economy as a 2 in all phases.

I would expect, and believe that the proponent demonstrates by virtue of space devoted to making their case, that in terms of the effect upon labour a rating of 2 should be given during the construction and decommissioning phases.

Specifically during the construction phase there is the potential to suddenly increase demand in construction-related markets (labour, materials, equipment, etc.). While the proponent dismisses this as a concern right now due to current unemployment rates, should this project proceed it may do so at a time when the market is much tighter. This could very well occur if the Energy East Pipeline Project proceeds, if the re-purposing of the Canaport LNG Plant as a production facility proceeds, if the province proceeds with shale gas development, if other major mining projects occur on the East Coast, or if the Province decides to proceed with refurbishment of the Mactaquac dam.

In the decommissioning phase, both the public and the proponent have pointed out the worry that this could be a "boom and bust" situation with respect to labour (EIAR p. 8-486). The proponent seems to dismiss this rather cavalierly. Indeed, it is notable that in Section 8.10.3 the proponent considers current unemployment to be a positive, noting that, "[t]he Project is not likely to create a highly competitive labour market that would cause greater wage increases …," (EIAR p. 8-482) during the construction phase. However, in the decommissioning phase as people are released from employment and re-enter the workforce, thereby increasing unemployment, this is too viewed as a positive: "minor positive environmental effects to a Change in Labour as skilled workers return to the available work force, resulting in greater availability of skilled labour for other Projects and economic sectors" (EIAR pp. 8-482 to 8-483). While it is true that released workers will perhaps have a greater (and potentially in-demand) skill set, the benefit in both phases accrues to potential employers as wages aren't predicted to rise. This seems a bit biased and is symptomatic of a benefits analysis.

For the above stated reasons, I would recommend the Change in Labour be rated as 2 in Table 8.10.4 of the EIAR (pp. 8-480 to 8-481) for the construction and decommissioning phases. I would like to see the proponent be more explicit in how they propose to mitigate these potential impacts. I would also like to see a statement by the proponent that it will not quickly turn to the Temporary Foreign Workers program in any phase of the mine's history. This seems to happen somewhat frequently in the Canadian mining sector and is a method of artificially reducing the wage bill which would decrease economic activity in the Province.

Recommendations

1. Rate potential project environmental effects to VEC-Labour as a 2 in both the Construction and Decommissioning phases of the mine. Adjust the EIAR accordingly.
2. The proponent should explicitly state that they would limit access to the Temporary Foreign Workers program until all other avenues of hiring have been documented to lead to production shortfalls. An independent board should scrutinize all such documentation.

5. Review of assessment of project-related environmental effects (EIA Report Section 8.10.4)

The proponent's list of project-related environmental effects is limited to Change in the Economy because of Employment and Expenditure activities (see Table 8.10.5, EIAR pp. 8-484 to 8-485). The proponent limits analysis to this single VEC because they rated all potential project effects on Labour as a 1. As I argue in Section 4 above, I believe this is incorrect. A careful examination of the mitigation

measures in Table 8.10.5 reveals that the first 2 of the 6 in-total measures are specifically aimed at Labour (hiring and training, EIAR p. 8-484). The second 2 measures are really backhanded mitigations amounting to "we will help local businesses and business groups to enhance their ability to capitalize on the many benefits we will bring to them." While this is laudable and an issue I will expand upon later, this seems to be a bit like marketing. In subsequent sections, I will delineate a different methodology that would more appropriately identify interactions.

At this point, I have to depart somewhat from the format used by the proponent in section 8.10 of the EIA report and the format suggested by the review coordinator. In Section 5.1 of my review, I will provide a general description of economic impact modeling used by EcoTec to draw general predictions in EIAR section 8.10.4.1. In Section 5.2 of this review I will then describe the shortcomings of this modeling technique and relate it to the predicted residual effects in EIAR section 8.10.4.3. In Section 5.3 I will then address the proponent's mitigation strategies for predicted residual effects, and make my own recommendations.

5.1 Review of environmental effects assessment re: Potential Project Environmental Effects Mechanisms (EIA Report Section 8.10.4.1)

In EIA report Sec. 8.10.4, the proponent makes reference to the EcoTec Report. In EIA report Sec. 8.10.4.1, the EcoTec Report is not directly mentioned, but elements of the basic model used by EcoTec are alluded to in the summary. For that reason, I will attempt to highlight the key features used in the EcoTec model.

The EcoTec report is generated using internal expense figures generated by Northcliff Resources, baseline data mostly from Statistics Canada (see BSTR for example), an economic impact model developed and owned by EcoTec which was peer-reviewed by Wade Locke Economic Consulting.

At this point, I will provide a general overview of economic impact models (EIMs). In Canada, EIMs are typically calibrated using Statistics Canada Input/Output tables and adjusted for local relationships and the particulars of a project. Key to the functioning of the model is the concept of an expense multiplier. Simply put, new spending in a region either through a project or through government spending turns into income for other parts of an economy. This income sometimes goes to individuals who themselves have a propensity to consume and can also generate new hires which leads to additional income for individuals who have a propensity to consume.

Key to EIMs are assumptions about how additional sales might affect hiring and the fraction of a new dollar received by an individual that actually goes to new spending in the time-period it was received and in the province it was received.

EcoTec's EIM does ***not*** make the assumption that sales-employment elasticity is fixed at 1 – i.e., they do ***not*** assume that a 1% increase in sales leads to a 1% increase in employment. This is a sensible correction. It seems that they permit sales elasticities to vary (e.g., be less than 1), but the specifics of this variation are not identified (EcoTec p. 21). I would expect that the elasticities are permitted to vary across industrial classification and perhaps across provinces, but not across companies within an industrial classification, and likely not as a function of sales (e.g., I suspect all construction heavy-equipment companies in New Brunswick have a sales-employment elasticity of, say, 0.68 and while this may vary according to province of location, it does not vary across companies and it is the same whether sales increase by 1% or 8%).

Likewise, the marginal propensity to consume (mpc) – the fraction of a new dollar that is spent in the manner delineated above – has been adjusted to a value less than 1. According to EcoTec (p. 22) downward adjustments are made to account for taxes ("[s]ubtracting both federal and provincial income tax from earned income …") and payroll taxes ("employee contributions to Employment Insurance, pension funds and RRSP, etc."). Suppose the mpc is 0.8. The multiplier works in the following way: the government hires me and pays me $100 of which I spend $80 (i.e., 0.8 x $100) which you receive and spend $64 (i.e., 0.8 x $80) which another person receives and spends $51.20, etc., etc. until the $100 in newly injected spending turns into a total increase of $500 – the direct increase of $100 and an additional $400 of induced spending. In other words, in this example, the multiplier is 5. The formula for this type of multiplier is M=[1/(1-mpc)]. It is simple to verify that the closer the mpc is to 1, the higher the multiplier. Thus EcoTec's stated adjustments (p. 22) serve to lower the mpc, consequently lowering the multiplier "[i]n order to ensure that induced impacts are not overestimated …" (p. 22).

At this point, I remind the reader that the devil is in the details. In the body of EcoTec's report, the marginal propensity to consume (and hence the multiplier) is implied to have been downwardly adjusted for, "leakages such as imports, taxes and savings …" (p. 10). However, in EcoTec's direct statement of the EIM's assumptions (see p. 22), no mention is made of adjusting for imports (both international and out-of-province-but-within-Canada) nor are personal savings mentioned. Moreover, no mention is made for the timing of spending (does it happen within the same fiscal year as the income was earned?), whether the mpc adjusts according to the size of the change in income, or whether the mpc is dependent upon people's assessment of their income change as a windfall gain (for which the mpc is typically lower – see Kinnaman (2011, p. 1243 referencing Thaler (1990)) or a more permanent increase to an income stream.

Before making my recommendations, I note that it can be rare as a reviewer to receive internal reports such as EcoTec's from proponents such as Northcliff. I do not know if obtaining the report was difficult, but I think it is imperative for reviewers to have access to such reports in order to do their jobs as assumptions matter. I thank Northcliff for its cooperation.

Recommendations

1. Assuming the Board of Northcliff receiving this EIA (and associated comments) and the proponent continues with economic impact assessments (see comments in Section 5.2 of this review), then consultants using the EIM should be much more explicit about the assumptions used in calculating both the sales-employment elasticity and the marginal propensity to consume.
2. Inasmuch as EcoTec cares about the accuracy of its EIM and improvements that might be made to it, Northcliff and EcoTec should monitor data on employment creation and business expansion.

5.2 Review of environmental effects assessment re: Characterization of Residual Project Environmental Effects (EIA Report Section 8.10.4.3)

In this section of my review I will highlight the problems associated with EIMs. I draw heavily upon peer-reviewed and published research produced by Kinnaman (2011) used to dispute the EIMs used in non-peer-reviewed publications to promote shale gas development in the United States. However, there are additional concerns.

First, the results of the EIM are critically dependent upon the mpc used. As described above, it is not clear that EcoTec adjusted for consumers' propensity to import, their propensity to use personal savings, or the timing of their spending (see Kinnaman throughout but especially p. 1244 for implications). **This means that despite EcoTec's attempts, the multiplier is likely overstated thus overstating the economic benefits of the Sisson Project.** Second, while the sales-employment elasticity has been adjusted in a sensible manner, as described in Section 5.1 of my review, it quite likely has not been adjusted enough, again contributing to an overestimation of economic impacts.

Third, there is ongoing theoretical discussion about the long-term effects of expenditure multipliers. Multipliers are expected to work in a Keynesian world of significant under-employment. However, as an economy nears full-employment, expenditure by one entity (industry/government) crowds-out expenditure made by other entities (see Kannaman, p. 1247). EcoTec (pp. 2-3), BSTR (pp. 22-30), and EIAR (8-467, 8-477 to 8-483) all attempt to convince us that there is no scarcity in New Brunswick's labour market. This permits the proponent to claim that virtually all employment created by this project is brand new employment. Suppose a new job paying $65,000 is created by this project. This employed person adds to GDP, spends money which has multiplied effects through the economy, and pays taxes. However if this new job hires a person away from her forestry job (paying $58,000) then the real benefit generated by the project is the $7,000 in extra salary.

Fourth – and this might be because of the combined effects of the above three problems – a "theoretical weakness of this method of measuring impact is the lack of economy-wide logical consistency" (Kinnaman, p. 1247). If an EIM was conducted today for each industry in the New Brunswick economy, we would estimate more economic activity in the economy than is actually taking place.

Consequently the impacts arising from an EIM are very likely to be overstated. Essentially, EIMs go looking for benefits and find them. A new mine is a benefit. Paying people is a benefit. Buying/leasing equipment is a benefit. Decommissioning a mine is a benefit. A catastrophic release of tailings would be a benefit as it would add to spending in the province. Indeed, the very title of the EcoTec report, *Economic Benefits Arising …*, speaks to this bias. Perhaps this is just a misfortunate title choice, but a very simple textual analysis of section 8.10 of the EIAR reveals that variants upon the word "benefit" appear 46 times compared to "cost" appearing twice ("adverse" appears 24 times, but this is still significantly less than 46 for "benefit"); "positive" appears 22 times while "negative" does not appear at all. Indeed, this makes the EcoTec report and section 8.10 of the EIAR sound more like a marketing document than a review.

As it is, the claims in the EIAR section 8.10.4.3 regarding predicted effects (which are often classified as "benefits") on VECs are seriously questionable and subject to overestimation. That said, one could conclude that if adjustments were made, EIM would be redeemed: "Sure, we can accept that the benefits are a bit overstated, but they are very large, so even if they are reduced a little bit, they are still large." However, there are serious questions as to whether EIM does the job required from an economic sense. First, EIM is designed to study small (marginal) changes but is typically applied to large changes (Kinnaman, p. 1244) as it is in this instance if one is to believe news coverage and government excitement over the Sisson Brook Project. The problem is that large changes can alter input-output relationships, in the sales-employment elasticity and in the marginal propensity to consume, and these dynamics are difficult if not impossible to model. Second, we have at our disposal much better methods of analysis. For instance, one could turn to social and economic impact analysis (see Esteves, Barclay,

and Brereton 2011) or better yet, traditional cost-benefit analysis as performed by an environmental economist used to dealing with environmental externalities (see Kinnaman, pp. 1247-1248). To see the potential for bias, consider the study by Taks *et al.* (2011). A direct comparison was made between an economic impact assessment and cost-benefit analysis of the 2005 Pan-American Junior Athletic Championships in Windsor, Ontario. The EIM suggested a net increase of economic activity in Windsor of $5.6 million while the cost-benefit analysis indicated a ***negative*** net benefit of $2.4 million.

This is not to say that the EIM is a useless methodology. Indeed, the use of input-output tables to highlight where changes may take place is quite useful. It is especially useful to examine direct and indirect effects of expenditures on GDP and identify potential leakages. *Nevertheless, economic analysis of a project should be conducted using the proven method of cost-benefit analysis.*

Recommendation

1. Use cost-benefit analysis to analyze this project.

5.3 Review of described mitigation measures (EIA Report Section 8.10.4.2)

The above recommendation, if implemented, would significantly alter the effects and potential mitigation strategies. Rather than reject the mitigation recommendations outright, I here seek to suggest changes to the recommendations as they appear in EIAR section 8.10.4.2.

First, as mentioned previously, I would like to see the proponent formally and explicitly limit its recourse to the temporary foreign workers program. This would augment the first and second bullet points (EIAR p. 8-487). Second, I would recommend that the proponent visit with local and provincial businesses to jointly identify potential supply chains which could be strengthened. The visits should have already begun to allow business to consider infrastructure investment. This would augment the third bullet point (EIAR p. 8-487). Finally, using the EIM already conducted it is clear from a comparison of Tables 7 and 12 in EcoTec (pp. 5 and 9) that the input-output tables predict significant leakages of expenditures from the New Brunswick economy in the construction phase. I would recommend that the proponent identify the potential sources of these leakages in the supply chain and work with companies and the province to see if these leakage points might be stoppered.

Recommendations

1. Formally and explicitly limit recourse to the temporary foreign workers program.
2. Meet with the government and potential members of the supply chain to identify links and shortcomings in the supply chain. Such meetings should not simply take place with existing potential supply chain members, but also seek to identify where local businesses could be expanded or new industries created which would enhance the local supply chain and limit leakages.

6. Review of cumulative environmental effects assessment (EIA Report Section 8.10.5)

It would be nice in this section of the EIAR to see the proponent explicitly make the links that they tabulate in Table 8.10.12 (p. 8-492). I think the directionality is wrong. In its current form it seems to suggest how other projects impact upon the VECs whereas it should be how the changes in VECs potentially impact other uses.

When I look at this section and try to understand what might be meant, I recall my comments made in Section 2 of this review. Specifically I refer to the need to record and monitor housing prices, well-water quality, and alternative land use (industrial, forestry, and recreational use). This Project, if it proceeds, will have an impact on the VECs of Labour and the Economy. If these VECs change then there is potential to affect alternative land uses – you can't build a house where a mine pit is dug; you can't fish in an acidified stream.

The current land and resource use are sparsely presented in the BSTR (pp. 63-64). I am not qualified and cannot speak to uses past, present or future of the land and resources by Aboriginal Persons; evidently this is true even for the authors of the BSTR (p. 64). I can accept that there is no current industrial land use at the proposed site (but I have not travelled the area). The BSTR claims there are rental cabins in the area which may see less use if a mine moves in and limits recreational use. Nearby stores and restaurants might see an expansion of business if the project proceeds. It does not look like the mine will directly affect the community of Napadogan (i.e., cause houses to move), but there may be indirect effects including increased housing construction (necessitating infrastructure construction), damage to water supplies, increased traffic, etc.. The proponent already accepts that there is ongoing recreational land and resource use and these will be negatively affected if a mine opens up because of noise, traffic, land space devoted to the mine, and the potential for degraded water quality which might last decades beyond the life of the mine.

Future use in all categories, with the exception of Aboriginal Persons as mentioned earlier, is likely to be permanently affected, although it is possible that some of the negative effects might be mitigated. Where there is an open pit mine, there cannot be a forest or a community, etc.. Likewise for a tailings storage facility, especially if it might leak.

Recommendations

1. I believe that Table 8.10.12 (EIAR p. 8-492) should be re-coded as below:

Other Projects	VEC – Change in Labour	VEC – Change in Economy
Past / Present		
Industrial	1	1
Forestry/Agriculture	~~1~~ 2	~~1~~ 2
Traditional Aboriginal Persons	~~0~~ ?	~~0~~ ?
Recreational	~~1~~ 2	~~1~~ 2
Residential	~~1~~ 2	~~1~~ 2
Future		
Industrial	~~1~~ 2	~~1~~ 2
Forestry/Agriculture	~~1~~ 2	~~1~~ 2
Traditional Aboriginal Persons	~~0~~ ?	~~0~~ ?
Recreational	~~1~~ 2	~~1~~ 2
Residential	~~1~~ 2	~~1~~ 2

The proponent should then be required to plan appropriate mitigation techniques.

2. As for mitigation efforts, one might want to explore the following strategies which are in no sense meant to be considered exhaustive.

Present

a) Meet with the community (leaders, business owners, and the general public) in Napadogan to discuss changes that might occur in their community with the construction of this mine. These meetings should be public and operated as a meeting, not as a drop-in information session.
b) Meet with cabin owners to discuss how the mine might affect their business.
c) Meet with local foresters to discuss how the mine might affect their activities

I suspect that through meetings, people will suggest effective mitigation strategies.

d) As mentioned earlier, the BSTR should get more complete data on current use; these data should be updated regularly and made publicly available for analysis.

Future

a) Design all on-site industrial and support buildings and associated infrastructure so that they can be adapted for re-use by a new company post-closure if a suitable owner can be found. I note that this recommendation would augment plans described in CDRCP (p. 26) and is not meant to replace them.
b) The current plan for a TSF (CDRCP p. 31) leaves the company and the Province with a legacy which must be managed for decades if not centuries. Alternatively both the company and the province might want to explore high density thickened tailings (HDTT) storage (http://www.tailings.info/disposal/thickened.htm). As I understand it, such storage might be reclaimed as usable land post closure. This land could eventually be used for industry, residences, forestry, parkland, hunting, etc.. Moreover, the low leaching potential for HDTT storage post-closure would minimize future impact on recreational fisheries. Furthermore, HDTT storage would reduce the risk of catastrophic release of tailings into the watershed during the operational phase of the mine.
c) The company and the province might also want to research alternative uses of the tungsten and molybdenum tailings perhaps as a substitution material for cement (see Choi *et al*. 2009). If this is possible it would decrease the remaining tailings, become a salable byproduct of production, and increase production within the province.

7. Review of Determination of Significance (EIA Report Section 8.10.6)

7.1 Review of definition of "Residual Environmental Effects Significance Criteria"

At no point does the proponent define significance. Within section 8.10.6 of the EIAR (pp. 8-493 to 8-494), variants of the word "significant" appear 7 times (one of which is in the section title). When the proponent deems a project effect to be positive, the effects are deemed to be significant in two of three cases. In all three instances where the proponent deems a project effect to be negative, the effects are classified as not significant.

I believe the reason for this classification is twofold. First, it is a byproduct of using an EIM framework that goes looking for benefits. Costs are simply not considered. Second, perhaps by virtue of the environmental assessment itself or perhaps because of the use of the EIM, the "environment" was not

really considered at all in section 8.10 of the EIAR. Anything that a regular person would typically identify as part of the environment (air/water quality, wildlife, plants, human health, etc.) is ignored. Consequently, I have not discussed the proponent's financing of the decommissioning bond, valuing impacts upon the environment, the need for a financial surety/insurance to cover catastrophic tailings-water release, etc..

7.2 Determination of Significance

Staying within the definition of VECs as used in this EIAR, I have argued that there are potentially significant effects to Labour in the Construction and Decommissioning phases (see EIAR Table 8.10.4, pp. 8-480 to 8-481, and Table 10.5, pp. 8-484 to 8-485; see my comments in Sections 4 and 5 of this review). Likewise, I have argued that interactions identified in Table 8.10.12 (EIAR p. 8-492) should be rated as significant (see Section 6 of this review). I have also argued that many of the positive effects as identified by the proponent through the use of an EIM are in fact overstated (see Section 5 of this review) and may not be as significant as the proponent believes.

8. Review of Follow-up and Monitoring (EIA Report Section 8.10.7)

The proponent suggests no follow-up and no monitoring. I have suggested a great deal of recommendations throughout this review. My recommendations will be re-listed in the conclusion. Most germane to this sub-section would be my recommendations regarding updating and expanding the data collected in the BSTR, collecting this data on a regular basis, and making this data publicly available for analysis and for calibration of the EIM.

9. Conclusion and recommendations

I have made recommendations throughout this report. I gather them below. Then I add a few additional considerations that do not seem to fit elsewhere.

RECOMMENDATIONS

From Section 2 of this review

1. Given the later-than-expected filing of the EIAR, it would be reasonable to expect that this baseline data could be updated using the 2011 Census.
2. Provide baseline data on population health (unless gathered elsewhere) both for areas local to the project and for areas likely to provide labour to the project. The BSTR only lists access to health facilities and programs and availability of resources (pp. 48-56).
3. Provide baseline data on local housing prices and rental rates in the EIAR. These data are available in the BSTR (pp. 40-45) but they do not make it to the EIAR. Moreover, the BSTR provides these data for 2006 and this should be updated.
4. Provide baseline data on well-water quality for local properties (unless reported elsewhere).
5. Provide baseline data on local alternative land/resource uses (specifically forestry, hunting, fishing, and other recreational use). These data are glossed over in the BSTR (p. 63).

From Section 3 of this review

1. Update expanded baseline data on a regular basis.

2. Make the data publicly available, both in print and through electronic access.

From Section 4 of this review

1. Rate potential project environmental effects to VEC-Labour as a 2 in both the Construction and Decommissioning phases of the mine. Adjust the EIAR accordingly.
2. The proponent should explicitly state that they would limit access to the Temporary Foreign Workers program until all other avenues of hiring have been documented to lead to production shortfalls. An independent board should scrutinize all such documentation.

From Section 5.1 of this review

1. Assuming the Board receiving this EIA (and associated comments) and the proponent continue with economic impact assessments (see comments in Section 5.2 of this review), then consultants using the EIM should be much more explicit about the assumptions used in calculating both the sales-employment elasticity and the marginal propensity to consume.
2. Inasmuch as EcoTec cares about the accuracy of its EIM and improvements that might be made to it, Northcliff and EcoTec should monitor data on employment creation and business expansion.

From Section 5.2 of this review

1. Use cost-benefit analysis to analyze this project.

From Section 5.3 of this review

1. Formally and explicitly limit recourse to the Temporary Foreign Workers program.
2. Meet with the government and potential members of the supply chain to identify links and shortcomings in the supply chain. Such meetings should not simply take place with existing potential supply chain members, but also seek to identify where local businesses could be expanded or new industries created which would enhance the local supply chain and limit leakages.

From Section 6 of this review

1. I believe that Table 8.10.12 (EIAR p. 8-492) should be re-coded as below:

Other Projects	VEC – Change in Labour	VEC – Change in Economy
Past / Present		
Industrial	1	1
Forestry/Agriculture	~~1~~ 2	~~1~~ 2
Traditional Aboriginal Persons	~~0~~ ?	~~0~~ ?
Recreational	~~1~~ 2	~~1~~ 2
Residential	~~1~~ 2	~~1~~ 2
Future		
Industrial	~~1~~ 2	~~1~~ 2
Forestry/Agriculture	~~1~~ 2	~~1~~ 2

Traditional Aboriginal Persons	~~0~~ ?	~~0~~ ?
Recreational	~~1~~ 2	~~1~~ 2
Residential	~~1~~ 2	~~1~~ 2

The proponent should then be made to develop appropriate mitigation techniques.

2. As for mitigation efforts, one might want to explore the following strategies which are in no sense meant to be considered exhaustive.

Present

a) Meet with the community (leaders, business owners, and the general public) in Napadogan to discuss changes that might occur in their community with the construction of this mine. These meetings should be public and operated as a meeting, not as a drop-in information session.
b) Meet with cabin owners to discuss how the mine might affect their business.
c) Meet with local foresters to discuss how the mine might affect their activities

I suspect that through meetings, people will suggest effective mitigation strategies.

d) As mentioned earlier, the BSTR should get more complete data on current use; these data should be updated regularly and made publicly available for analysis.

Future

a) Design all on-site industrial and support buildings and associated infrastructure so that it can be adapted for re-use by a new company post-closure if a suitable owner can be found. I note that this recommendation would augment plans described in CDRCP (p. 26) and is not meant to replace them.
b) The current plan for a TSF (CDRCP p. 31) leaves the company and the Province with a legacy which must be managed for decades if not centuries. Alternatively both the company and the province might want to explore high density thickened tailings (HDTT) storage (http://www.tailings.info/disposal/thickened.htm). As I understand it, such storage might be reclaimed as usable land post closure. This land could eventually be used for industry, residences, forestry, parkland, hunting, etc.. Moreover, the low leaching potential for HDTT storage post-closure would minimize future impact on recreational fisheries. Furthermore, HDTT storage would reduce the risk of catastrophic release of tailings into the watershed during the operational phase of the mine.
c) The company and the province might also want to research alternative uses of the tungsten and molybdenum tailings perhaps as a substitution material for cement (see Choi *et al*. 2009). If this is possible it would decrease the remaining tailings, become a salable byproduct of production, and increase production within the province.

In addition to these recommendations, I include a few points for consideration.

a) The proponent has never really addressed environmental issues in section 8.10 of the EIAR. If you did a poll and asked people, “Are labour and the economy part of the environment?” I suspect the majority of the respondents would say “No.” Likewise, if you asked them, “What do

you think about when you think about the environment?" virtually no one would say labour/jobs and the economy.

b) Neither in the National Instrument (*Canadian National Instrument 43-101 Technical Report on the Sisson Project*) nor in the EIAR section 8.10 is any mechanism described for funding the $50M financial security for reclamation. The greatest detail on this financial security within the many documents associated with the EIA is provided in two paragraphs and one graph in the CDRCP (p. 39). The CDRCP (p. 39) suggests that the fund will begin "one year before mine-start-up" and states that there will be enough money in the account to deal with "decommissioning, reclamation, and closure" but does not detail the initial injection of funds, the real expected rate of return on those funds, nor the expected costs of decommissioning, reclamation, and closure at any point in the mine's operations. Indeed, it is odd to see that the graph (CDRCP Figure 6.1, p. 39) is non-monotonic in shape, even falling in some years. It is important to note that the CDRCP and the $50 million financial security do not account for any costs associated with catastrophic damages.

c) There is no mention of a financial surety or insurance in the case of a catastrophic outcome (e.g., an unexpected release from the TSF) at the mine. Even renters are required to provide landlords with a damage deposit. The need for such a surety is enhanced by the fact that the relationship between Hunter Dickinson Inc. (HDI) and Northcliff Resources Inc., is not straightforward ownership. Northcliff is a "discrete public company" (http://www.hdimining.com/s/HDICompanies.asp) for which HDI, "a private mining group," provides "management and technical services" (http://www.hdimining.com/s/AboutHDI.asp). Northcliff "wholly-own[s]" the Sisson Project (http://www.northcliffresources.com/s/Home.asp) and does not have any other holdings beyond Sisson Brook. If something goes wrong at Sisson Brook, Northcliff might declare bankruptcy and leave the Province (and the environment) with the bill; this happened with the Montreal, Maine and Atlantic Railway in the *Lac-Mégantic rail* disaster. A sensible surety/insurance policy would be linked to level of risk of catastrophic failure (e.g., it would be tied to the level of risk associated with various tailings management technologies).

10. References cited by Reviewer (I do not include references to documents used in the EIA report.)

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Esteves, A. M., Barclay, M., & Brereton, M. (2011). Integrating social and economic impact assessment into local procurement strategy. *First International Seminar on Social Responsibility in Mining (SR Mining 2011)*.

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Taks, M., Kesenne, S., Chalip, L., & Green, C. B. (2011). Economic Impact Analysis versus Cost Benefit Analysis: The Case of a Medium-Sized Sport Event. *Int. Journal of Sport Finance*, *6*(3), 187-203.

11. Biography of Reviewer – Rob Moir

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2.9(b) Comments on Canadian National Instrument 43-101 Technical Report
Effective Date: 22 Jan. 2013

Valued Environmental Component: N/A
Factor/Subject Area: Overall Economics of the Project
Date: August 19, 2013

Rob Moir, Associate Professor of Economics
University of New Brunswick – Saint John, Dept. of Social Sciences

1. Executive Summary

As an academic economist, I have reviewed the Canadian National Instrument 43-101 Technical Report on the Sisson Project, effective date January 22, 2013 (hereafter referred to as NI; unattributed page references are from NI). I did not limit my role to simply the business aspects of the project as the project may also have external costs and benefits accruing to those not directly involved in the mine. For the most part, it is in the company's best interest to correctly state the business case and to emphasize the potential external benefits as this strengthens the case for the project. Consequently, I will highlight some potential external costs which may not be as apparent. Overall, while there seems to be a solid business case put forward for the mine, there are economic concerns which should be addressed.

2. Basic Economics of the Project

Most companies are interested in making a profit, and I suspect Northcliff Resources Inc., fits into this category. Consequently, barring any attempts to willfully misguide investors such as artificially inflating stock prices, it is in the best interest of the company to build a relatively truthful business case for a project.

The Sisson Project involves building an open pit mine, tailings storage facility (TSF), associated treatment facilities and an APT plant (used to process tungsten to ammonium paratungstate or APT) to extract and to varying degrees process molybdenum (Mo) and tungsten (WO_3). Located in the Nashwaaksis watershed, Northcliff Resources Inc. estimates a net present value (NPV) of $714 M (before tax) and $418 M after-tax – this is after paying for all costs (which includes capital, operating, and clean-up/site secure). They project this value over an expected 27 years of operation. Using these figures, Northcliff calculates an internal rate of return (IRR) of 20.4% (pre-tax) and 16.3% (post-tax), both of which exceed the assumed discount rate of 8%. **In other words, this is more profitable than their next best investment.** The discount rate might be thought of as an outside alternative investment for the money used to purchase the capital. (*Aside:* The lower the discount rate, the higher the NPV as future revenues are counted more closely equal to current expenses. While this makes mega-projects more desirable, it also means that future environmental damage and other costs weigh more equally in the equation. As it stands, Northcliff has not seemed to put much weight on environmental and social costs.) Finally, the payback time is estimated to be 4.1 years (4.5 post-tax); Northcliff is stating that for the remaining 22.9 years (22.5 post-tax) of the expected mine's life, the initial investment and past and future operating costs have been paid off and they are making money.

The above is the business case Northcliff Resources has filed. I would cautiously suggest that the business case is reasonably solid. That said, in seeking investors a company will necessarily attempt to

put an optimistic spin on the figures. The worry with a project like this is that there is potential for serious environmental, and to a lesser degree social, impact. If production results are less than expected, if ore prices fall, or if operating costs increase, then in order to meet investor agreements shortfalls must somehow be accounted for. It often seems to be the case that these shortfalls are made up by cost-cutting those factors of production that have little voice in operations – local workers might be replaced by temporary foreign workers, and cuts to environmental maintenance and/or remediation efforts are "easy" as the "environment" (a resource owned by us all) does not have a seat at the negotiating table.

I now turn to specific issues that I think need greater exploration. In section three, I identify some discrepancies in the document that stood out upon an initial reading. I then turn to some of the economic assumptions made in the document with the hope that we might seek greater clarification. Finally, I present additional considerations that I think may affect the social and environmental impact of this project and make some recommendations for further study and discussion. These are areas which I believe need addressing and deserve careful scrutiny in the environmental impact assessment.

3. Discrepancies in the Document

I had some difficulty in reconciling Tables 1.2 and 1.3. For instance in Table 1.2, WO_3 % is listed as 0.072 for the "Measured" while in Table 1.3 it is listed as 0.069 for the "Proven." Likewise in Table 1.2, WO_3 % is listed as 0.067 for the "Measured+Indicated" while in Table 1.3 it is listed as 0.066 for the "Total." Perhaps this is due to difference in the meanings of the two tables, but it seems odd that other percentages align themselves exactly. Similarly, why is a net smelter return cut-off grade of $US9/t used in Table 1.2 yet it is $8.83/t in Table 1.3? Is this just a different exchange rate (i.e., $1 CDN = $1.0193 US) or perhaps rounding? I note that electricity prices are estimated at $0.065/kWh on page 22 but are $0.066/kWh on page 227. Mineral prices assumptions are listed for WO_3 in some places (pp. 24, 271) but it is clearly stated that the price for APT is actually what is meant (pp. 249-251). **While none of these discrepancies are likely important on their own, it suggests some carelessness and may play a role in sensitivity analysis.**

4. Economic Assumptions

On page 262 of the submitted NI, Northcliff lists a series of *General Risk Factors* and follows with the statement, "No allowance has been made in the capital cost for any of the potential risk items discussed" (p. 263). Where possible, I will link my comments below to specific risk factors (RF) as identified by Northcliff (these will be highlighted by the use of italics).

4.1 Labour and Capital Costs

Labour and capital costs are, insofar as I can judge, reasonable. I note that the capital cost of $579M has a contingency allowance of approximately 15% (p. 33) which suggests that Northcliff is preparing for cost overruns. Indeed, New Brunswick has very recently seen a very significant cost overrun in the Point Lepreau Nuclear Power Station retro-fit – well in excess of 15%. It is unlikely that such a significant cost overrun will occur in the development of a new open pit mine but cost overruns are quite possible. Sources of potential cost overruns in the near future include increasing fuel prices (as a general trend that will increase when some form of carbon pricing comes in – *RF: Global inflation*), higher than expected electricity costs (see below), the start-up of mega-projects such as an East-West bitumen pipeline or a new refinery which would increase both labour and capital costs (*RF: Escalation of local*

materials and labour), and the potential for higher interest rates in the future (*RF: Global inflation*). Likewise, with lower-than-national-average literacy, there may be a shortage of skilled labour in that part of New Brunswick (*RF: Shortage of skilled labour*). A tighter-than-normal market for physical capital may also play a role; this is the Irving influence on local construction equipment rental prices (*RF: Escalation of local materials and labour*).

I find the sentence, "No provision has been included in the capital cost to offset future escalation" (p. 259) to be worrying. I am not sure what they mean by "future escalation." Might this been an escalation of mining activities or could it be future increases in capital prices?

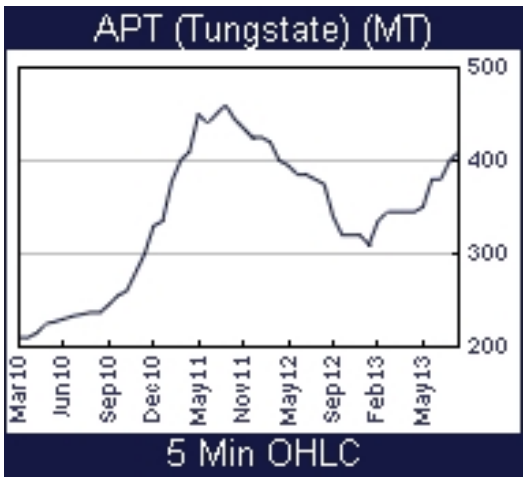
4.2 Electricity Prices

The Sisson Project will become a large industrial user of power according to NB Power. In consultation with an academic familiar with electricity pricing we found that under current rules, the mine could not operate as a small industrial user and expect to achieve average electricity rates of $0.066/kWh. As a large industrial user, the average price would be $0.064/kWh in year 1 assuming the new load incentive rate is applied. Without the incentive rate, the average price would be $0.0711/kWh. Assuming the rate book rules are followed, the price would start at $0.064/kWh in year 1 and rise to the higher price in year 6. Moreover, given the very significant cost overruns and time delays associated with the Lepreau retro-fit and the likely shift of generating facilities in New Brunswick toward higher-cost renewable energy generation, these electricity charges may in fact increase (*RF: Escalation of local materials (energy prices?) and labour*). Any increase in electricity rates will affect the operating costs of the mine and lower the NPV presented in the submitted NI document.

4.3 Mineral Prices

Core to the economic analysis of the project are the minerals themselves – molybdenum (Mo forecast to be $US15/lb) and tungsten ($WO_3$ and its upgraded product APT forecast to be $US350/mtu). Of the two, tungsten is expected to be found in greater quantity at this site.

As noted earlier, there is some confusion in the submitted NI document over whether it is WO_3 or APT prices used. This confusion seems to exist in the market too with WO_3 and APT used somewhat interchangeably. However, it is eventually made clear that Northcliff means APT prices. While the current price (14 August 2013) of $430 is above the $350 used in the analysis, historical prices have not always been this close (see http://www.northernminer.com/investing/metalcharts.aspx). Nominal prices exceeded $350 from early-2011 until the summer of 2012. It dipped below $350 until early-spring of 2013. However, prior to 2011, prices were significantly lower than $350. Chinese tungsten production accounted for nearly 85% of worldwide amounts in 2012 (http://minerals.usgs.gov/minerals/pubs/mcs/2013/mcs2013.pdf) and for nearly 60% of reserves. China is also the largest tungsten consumer. The Chinese government seems to use its market power to shift prices in its favour. It should be noted that the ramp-up of production at the Mactung mine in the Yukon and the Sisson Brook facilities might put downward pressure on APT prices (*RF: Commodity price volatility*).



(*Source:* http://www.northernminer.com/investing/metalcharts.aspx accessed 19 August 2013)

The current price of Mo is $9.34 (16 August 2013, http://www.infomine.com/investment/metal-prices/molybdenum-oxide/5-year/). This is well-below the low range (-25% or $11.25) of Mo prices used in the sensitivity analysis. While the price used to be over $40 in 2005, prices in the last year have not exceeded $14.29 and have been trending lower (*RF: Commodity price volatility*). While molybdenum production is concentrated in China (42% in 2012 along with a 39% share of reserves – http://minerals.usgs.gov/minerals/pubs/mcs/2013/mcs2013.pdf), the market is fairly competitive. The addition of production from the Sisson Brook project will not likely affect prices.

(*Source:* http://www.infomine.com/investment/metal-prices/molybdenum-oxide/5-year/ accessed 19 August 2013)

Mineral prices are posted in US dollars. Assuming a constant mineral price, an appreciation of the Canadian dollar against the US dollar will necessarily decrease revenues. Capital imported from the US will become cheaper with an appreciation of the Canadian dollar, but ongoing capital costs are significantly lower than revenues from mineral production so profits would be negatively affected.

While there are a number of factors affecting the exchange rate between the Canadian and US dollars, there is also a fairly strong link between the price of a barrel of oil and the strength of the Canadian dollar. This is not surprising given Canada's resource production, especially oil, and our export of energy products to the United States. Northcliff's assumption of a depreciating Canadian dollar (Table 22.3, p. 271) in the face of ever-increasing oil prices is questionable (*RF: Global inflation*, *RF: Currency exchange rate swings*). We continue to go through a protracted worldwide recession which started with the financial crisis of 2008 and there is continued uncertainty in global recovery, yet, with the exception of an initial price drop, the price of a barrel of oil has steadily risen. Continuing in this vein, the slow and very uncertain economic recovery from the 2008 financial crisis would cause one to wonder if the prediction of strong mineral demands will continue into the future (*RF: Commodity price volatility*).

4.4 Environmental Costs

An open pit mine in a relatively undisturbed watershed will have environmental impact. These environmental impacts have very real associated costs. It may be the case that society as a whole bears these costs, but this does not diminish their impact and their importance in assessing the project. I find it disconcerting that in a 300+ page document, there are only 4 pages associated with environmental impacts and associated costs. It is clear that Northcliff is worried about the potential effects on fish and fish habitat and damage from acid-generating rock and metal leaching (p. 254). In some cases, acid generation is expected to continue for several decades – well beyond the life of the mine (p. 254).

Tracking environmental expenses in the NI is, to say the least, difficult. For instance, a category of "Environmental Monitoring" is included as part of Owner Cost in the Capital Costs estimates (mine start-up costs). Trying to track costs for the "TSF & Environmental" from table 21.1 (p. 258) to Table 21.2 (p. 252) is extremely difficult. Likewise, the statement that, "Environmental facilities contractor indirects … are estimated to be 8% of the direct costs" (p. 260) does not make it clear exactly how much is being spent on environmental monitoring and protection. I note too that in this section, reclamation bond funding has been specifically excluded (p. 259).

Ongoing environmental costs must be incurred for monitoring and water treatment – "[d]uring operations, any surplus water from the TSF and open pit will be discharged to the environment, treated if necessary …" (p. 255). These costs are not always clearly identified. For instance, Waste and Water Management Operating Costs seems to include mining as part of its costs (Table 2.16, p. 267) and costs for the Environmental staff (no mention of the number of staff or their responsibilities) is embedded within General and Administrative Costs (p. 268)

A financial security, estimated to be $50M at the time of mine closing, is to be created and used to close the mine and begin reclamation. As noted earlier, it is not clear how funding for this financial security is being accounted for (p. 259). **Moreover, while the security will be used for funding mine closure and reclamation, there is potential for very long-term costs for water treatment as waste and barren rock in the TSF and the pit walls have delayed acid-generating potential lasting several decades (p. 254).** In the submitted NI, Northcliff states, "… post-closure, any necessary treatment of surplus water discharged to the environment will be continued until water quality meets discharge standards" (p. 255). This could very well double the expected cost of the $50M financial security. For instance, using the costing data in Table 21.6 (p. 267) and assuming water treatment at the TSF and water-filled pit lasts as long as the life of the mine – not unreasonable given the acid-generating potential of several decades – this cost would be an additional $57.1M. More importantly, these costs will come at a time long after the mine has stopped generating revenues. At this point, owners and shareholders will have an

incentive to avoid costs or might use these costs as a method of profit reduction and tax avoidance in future projects.

4.5 Sensitivity Analysis

I was glad to see a sensitivity analysis included in the NI. Looking at Figures 22.3 and 22.4 (p. 278) we see that the project's business case is negatively affected by (in order of most sensitive to least sensitive):

- lower recoveries
- appreciation of the Canadian dollar relative to the US dollar
- lower tungsten (APT) prices
- higher operating costs
- higher capital (start-up) costs
- lower molybdenum (Mo) prices

It should be noted that the current price of Mo ($US9.34/lb) is 37.7% below the assumed price of $15, putting us off the edge of the graphs in the two figures. While I appreciate the inclusion of the sensitivity analysis, I note that the events are treated as independent. Tables 22.11 and 22.12 (p. 279) attempt to correct for this by examining co-movements in mineral pricing. Neither of these tables includes the current price of Mo as part of its range. Extrapolating from Table 22.12, and forecasting at current mineral prices (Mo=9.34 and APT=$430), the post-tax NPV is approximately $593M as compared to the base projection of $418M. However, when I looked at these prices on 9 May 2013 (Mo = $11.50 and APT=$355) the extrapolated post-tax NPV was $347M. Mineral price movements, especially in the price of APT, will have a significant effect on the viability of this project.

It is beyond the scope of this review to look for all possible correlations in key variables in this project, but it could be very important. Consider the following scenario. Current fuel price trends along with the possibility of carbon pricing suggest higher fuel prices in the future. At the same time the increase in fuel prices has kept the Canadian dollar strong relative to its US counterpart. The ongoing fuel price increase has occurred despite global economic uncertainty and a very slow and tenuous recovery. This recovery has largely been fueled through monetary stimulus and historically low interest rates during which consumer and government debt has risen considerably. Eventually interest rates will rise if for no other reason than to rationalize debt holdings and to curb inflation stemming from fuel price increases. Rising fuel costs also contribute to slow growth in aggregate demand, depressing demand for minerals. In this pessimistic (but not unrealistic) scenario higher fuels prices and increasing interest rates will decrease NPV as will the appreciation of the Canadian dollar and lower mineral prices. None of these effects have to be large on their own, but the combined effect would negatively affect the business case for the project. [To see that this is a possibility, see the *Telegraph Journal*'s Business section from 9 July 2013 (included)].

5. Additional Considerations/Recommendations

5.1 Labour

While not included in this NI submission, mega-projects like these are often locally marketed based on perceived social benefits. Typically this means mentioning jobs created, income tax paid, and corporate/mineral taxes gathered. Here I will focus on the creation of jobs.

Project proponents often count all jobs at the project as new jobs. This is incorrect if the so-called new jobs simple shift employed individuals from one job to another. A Target store opening where a Zellers used to be creates no new employment or income if all the old Zellers workers are hired by Target and paid their old wages. Given New Brunswick's high unemployment rate, it is not likely the case for this project. That said, if the proponents fail to train or otherwise improve skillsets and employ New Brunswick residents then the local gains are significantly diminished. Recently we have seen a number of news reports on the (ab)use of the Temporary Foreign Workers (TFW) program. The first reported case was the hiring of Chinese miners for a B.C. mining project. Inasmuch as possible, Northcliff should be required to invest in local labour training, especially in identified chronically unemployed groups. Likewise, the company should be required to limit or perhaps even eliminate access to the TFW for this project.

5.2 Toxicity and Health Effects

I note that there is research suggesting molybdenum dust is toxic (see footnotes 66, 79, and 80 at http://en.wikipedia.org/wiki/Molybdenum). This issue should be addressed, not only for on-site workers, but also for residents near the mine. Similarly, the effects of molybdenum mining on local wildlife should be mitigated. Tungsten might be an irritant (http://www.clean.cise.columbia.edu/msds/tungsten.pdf) but toxicological effects seem to be rare. It seems that tungsten decreases bacteria in soil and can enter the food chain. I would recommend additional research on this topic and study of this process (see Strigul et al., 2005).

5.3 Environmental Issues

I think it is important to once again comment upon the brevity of environmental management plans listed in the NI document – the entire 300+ page document contains about 4 pages devoted to environmental issues. Society has come to realize that business activity often has environmental (and social) impact. This does not mean that business activity has to cease but it is important to account for these impacts. While I realize that Northcliff will be submitting a full environmental impact assessment, the minimal information contained in the NI and the difficulty of tracing the accounting for environmental expenses is cause for worry.

For instance, consider the financial security held to pay for reclamation and mine closure. It is estimated to be $50M, but does not seem to be accounted for in the financial analysis (p.259). As noted earlier, the cost of reclamation and closure could quite easily double once post-closure water monitoring and treatment is factored in. Indeed, according to Diamond (2005), "The actual and indirect costs of cleanup and restoration have typically proved to be 1.5 to 2 times mining industry walkaway estimates for mines without acid drainage, and *10 times those estimates for mines with acid drainage*" (italics added; p.455). This raises a number of questions regarding the security. How will it be funded? Will Northcliff be required to set aside funding at the beginning of the project? Will the necessary funds be subject to market forces (i.e., swings in stock valuation)? Will these funds be accessible to the proponent in the way that pension plans can sometimes be skimmed? It is often the case that security bonds of these types go underfunded and at the time of closure, reclamation and/or decommissioning is scaled back. I would like to see greater detail on the valuation of the closure and reclamation security and on its funding and management in a future document.

Over the last 100 years, tailings dams failure rates are "more than two orders of magnitude higher than the failure rate of conventional water retention dams" (Azam and Li, 2010: p.50). This may be because a TSF represents a cost to a mining company rather than an asset to a community in the case of a water retention dam. "Unusual rain" is often identified as a cause in these failures (Azam and Li, 2010: p.51). In this regard, it would be useful to note in the NI how the average climactic change was calculated and over what time-period (pp.241-242). Has the proponent tested for a moving average? When failures occur (see for example, a large number of cases reported in peer-reviewed and other sources at http://www.infomine.com/conferences/online/tailingsdamfailures/ and at http://www.wise-uranium.org/mdaf.html) some companies go bankrupt and even transfer assets to corporations owned by the same individuals (see Diamond, 2005, pp. 455-457). In some instances, of tailings storage facility failures and subsequent bankruptcy, "cleanup costs have proved to be up to 100 times the mining company estimates" (p.457).[6] This is especially of concern as the only mining project in which Northcliff Resources Ltd. is involved is Sisson Brook – a major environmental incident or a collapse of either tungsten or molybdenum prices could quite easily drive the company to bankruptcy.

Azam and Li further note that the majority of failures have occurred in TSF of the upstream variety up to 30m high (2005: p.53). While the modified centerline construction identified by the proponent is an improvement (p.253), it seems that "high density tailings" or "high density thickened tailings (HDTT) storage" might mitigate much of the risk associated with leakage from a traditional TSF (Fourie, 2009; also http:// www.tailings.info/disposal/thickened.htm). Consequently, the New Brunswick government might want to explore the use of a financial surety, distinct from the financial security for reclamation and closure, to guard against catastrophic environmental failure and/or bankruptcy-before-expected-closure given the proponent's limited explanation of the funding of the financial security for reclamation and closure (as a start, see Miller, 1998, http://www.abandoned-mines.org/pdfs/PolicyFrameworkCanforMinClosureandMgmtLiabilities.pdf, and more generally http://www.abandoned-mines.org/publications-e.htm for discussion).

It is beyond the scope of this review to suggest the size of this financial surety. However, it might make sense to make the size and funding of this surety contingent upon the proponent's tailings storage mechanism. Ideally a formula could be constructed to take into account the probability and potential impact of failure. Then a company could compare the costs of various environmental protection strategies of both mining and tailings storage to the cost of surety funding. Such a surety in the case of HDDT storage would likely be cheaper than if an upstream TSF was used, the storage and surety decision would ultimately be at the proponent's discretion based upon its perceived costs.

5.4 Sensitivity Analysis

Mineral pricing data is expensive as are research costs. As it is in Northcliff's and its prospective investors' best interest, I recommend that a more robust sensitivity analysis be completed that considers correlated movements in key variables.

[6] While the concept of declaring bankruptcy following a disaster seems distasteful if not dishonest, it is an issue currently under scrutiny. Following the Lac-Mégantic rail disaster of July 2013, Montreal, Maine & Atlantic Railway filed for bankruptcy in Maine and Québec.

6. Conclusion

I have conducted an expanded economic analysis of the NI submission for the Sisson Brook Project submitted by Northcliff. It is generally in the company's interest to submit a truthful but also an optimistic document so as to encourage investment without willfully misguiding investors. My ability to analyze claims is limited as much of the data is industry-specific and provided by the company. I cautiously suggest that the business case is reasonably solid but I would like to see a more robust sensitivity analysis. As an economist, I worry about social benefits through job creation and environmental and health effects. I would like to see a plan developed that enhances skills of New Brunswick labour and limits or eliminates access to the temporary foreign worker program. I would also like to see how Northcliff intends to deal with the potential effects of molybdenum dust and a study of the potential environmental effects of tungsten. Finally, the company should be required to file carefully valued financial security plans for both site closure and reclamation and in the event of a catastrophic event.

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8. Biography of Reviewer

Rob Moir

B. Arts&Sci (Hons. Economics), McMaster; MA (Economics), Queen's; PhD (Economics), McMaster.

Associate Professor of Economics, UNB Saint John (initial appointment, January 1996) and Chair of Social Sciences.

2.10 Review of EIA Report for the Sisson Project (Tungsten and Molybdenum Mine) - New Brunswick, CEAR #11-03-63169

Subject Area: Comparing water management plans for Sisson mine to those of other mines in NB
Date: September 29, 2013

Roy Parker, MSc.

General Comments/Overview

Given my past experience with mines in New Brunswick, I was asked to review the EIA report for the purpose of determining whether it had an "air of reality", particularly with regard to how the report addressed several potential accidents and the possible impacts of the project on water quality. From the parts that I read, it is my view that overall, the EIA report was very thorough and quite well done. The writers examined the major components of this large mining project and their assessment looked at most of the important issues and the potential for impacts in the ecosystem. Their assessment methods followed standard protocols and looked at the valued ecosystem components identified for the area of the mine development. However, I did identify a few issues that were not thoroughly addressed or that the proponent determined would not have a significant impact.

Tailings Pond

This proposed mine will have a huge Tailings Storage Facility (TSF) by the time the project is completed and the project moves to the Reclamation Phase after 27 years of operation. The footprint of the completed TSF will be 786 hectares (about 4.3 km. long and 3.3 km. wide). This will make the TSF at the Sisson Project the largest tailings pond in the province by the end of the operational phase. By comparison, the tailings storage facilities at the Brunswick 12 Mine and at the Heath Steele Mine each cover about 500 hectares. As well, the highest dam wall will be approximately 90 metres high (Table 3.4.2). This is roughly 50 metres higher than the Mactaquac Hydroelectric Dam on the St. John River. While not a failing of the project, the TSF's large size requires it be diligently planned, constructed, operated, and maintained.

Seepage

Almost all dams constructed of earth and rock leak; water seeps through the pores and usually exits at the toe of the outside wall. Seepage rates depend on the type of material used for construction and the diligence of the construction workers in placing and compacting the material. The Sisson project proposes a series of seepage collection ponds (Water Management Ponds, WMP) along the outside perimeter of the dam walls. These ponds will also collect surface runoff water from the outside faces of the dams. If the water collected in these ponds is of acceptable quality, it will be discharged to the environment. If the water is contaminated, it will be pumped back into the TSF. That is the correct approach but the mine operators must have contingency plans in place for the operation of these ponds to deal with:

1. Pumps failures.
2. Disruption in electrical service.
3. Heavy rainfall or large snow melt events that could exceed the capacity of the pumps and result in the WMP overflowing.

The Clover Hill Potash Mine near Sussex was equipped with collection ponds and pumps to intercept seepage water and any overflow water from the tailings pond. During a heavy rainfall event in late 1980's, the tailings pond overflowed but the pumps failed to operate and brine contaminated water escaped from the site causing the death of hundreds of juvenile salmon and trout in the nearby stream, a tributary of the Hammond River.

As large precipitation events, i.e., storms, and power failures often go hand in hand, the above is a very possible accident for the Sisson Project. Given this, it is surprising that the EIA report or the Environmental and Social Management System (EIAR Appendix D) do not provide more details about how this scenario will be addressed other than a brief mention of "replacement pumps" and "emergency generators" (EIAR pages 8-724 and 8-725). A condition for allowing the project to proceed should be the requirement of a *detailed* plan to deal with such an emergency.

Dam Failure

The Sisson Project will construct the TSF following the Canadian Dam Association Guidelines. These guidelines are based on many years of dam building experience in Canada. However, dams can and do fail. In March, 1998, heavy rainfall in southern New Brunswick resulted in the failure of the tailings dam at the Mt. Pleasant Tungsten Mine. The overflow spillway from the dam was washed away and the water level in the tailings pond dropped several metres. A new, concrete spillway was designed and constructed to withstand excess inflows of precipitation and surface run-off into the tailings pond. As well, an emergency spillway was constructed in the wall of the dam in case the main spillway could not handle the excess flow of water into the pond. The EIA report does not provide a description of the spillway on the TSF or describe the design criteria for that spillway.

Water Management

The EIA report describes the water management plan for all phases of the project from construction to post-closure. In Section 3.2.4.2, it states that "the pumps and pipelines will be sized to remove the inflow volume resulting from the 1 in 10-year design flood event within 10 days." In New Brunswick, the frequency of extreme rainfall events is expected to increase. For example, in 2008, Fredericton had 4 rainfall events that exceeded 50mm (New Brunswick Government Website). It is not clear from the EIA report whether all of the water management components (WMP, pumps, pipes, and spillways) are designed to deal with these types of extreme rainfall events.

Dam Inspections

The EIA states that – "A dam safety review will be conducted every five years by a qualified geotechnical engineer." This does not seem adequate for a structure as large as the TSF. Annual or at a minimum biannual inspections should be carried out to ensure the integrity of the dams surrounding the TSF.

Closure Scenario

The conceptual closure plan for the project appears to be sound and based on best available practices. The EIA states that "It will not be possible to reclaim the open pit other than as an open-water landscape feature..." (EIAR page 3-141). It should be noted that mined-out open pits do get filled in. It is technically possible and has been completed in New Brunswick at two sites, the Murray Brook Mine (2002) and the Stratabound CNE Open Pit Mine (1992). Both of these mines were much smaller than the

proposed Sisson Project. It may not be practical or economically feasible to fill in an open pit the size of the one proposed for the Sisson Project, but it can be done.

The EIA predicts that eventually, the water in the flooded open pit will achieve acceptable water quality, and if all of the EIA predictions hold true and everything works out as planned, acceptable water quality could result. Given my knowledge of the legacy of the continuing contamination of mine waste water in New Brunswick many years after these mines have closed, I have reservations about the proponent's contingency plan if this acceptable water quality is not achieved? While the proponent commits to treating overflow water from the flooded open pit "for as long as is necessary" (EIAR page 3-143), it is my experience that what is necessary is required for a much longer period of time than typically anticipated. Also, will the $50 million proposed to be set aside be sufficient funding to pay for "as long as is necessary"? For example, the Caribou Mine in northern New Brunswick has operated on and off since the 1960's. In the early years of lead-zinc production, acid generating tailings were deposited in a tailings pond adjacent to the mine site. This pond was filled nearly to the top of the dams and was built on sloping ground and contaminated water leaked through the walls of the tailings dam as well as through the bottom of the pond. This water percolated through the aquifer and the contaminated groundwater entered Forty-Mile Brook which flowed through the mine site. The pH of the brook was lowered for several kilometres downstream of the mine and concentrations of lead, zinc and copper were all elevated. Forty-Mile Brook is a tributary of the Nepisiguit River, an important trout and salmon stream in NB. Water samples collected 5 kilometres downstream on the mile were routinely acutely lethal to rainbow trout in standard laboratory tests. When the mine resumed production in the 1980's, a new tailings facility with an effluent treatment system was constructed and was operated in effective manner. Attempts were made to seal the original tailings pond and to intercept the contaminated groundwater seeping from it, but for the most part, these measures were ineffective and Forty-Mile Brook remained contaminated.

The EIA states that, "TSF embankments and beaches will be undergoing re-vegetation with suitable species to provide forested, wetland, and open water habitats suitable for wildlife" (EIAR page 3-139). Vegetation does not grow well on tailings, even tailings that are not acid generating and do not contain elevated concentrations of minerals. Tailings are nutrient deprived, low in organic content and do not hold moisture well. There are many abandoned tailings ponds in the Maritime Provinces that have been sitting unattended for decades and there is no natural vegetation established on them (e.g., Nigadoo Mine in northern NB and the Stirling Mine in Cape Breton). In order to get the vegetation to establish, tailings are normally covered with a layer of soil and supplied with quantities of nutrient in the form of fertilizer or manure. The Sisson Project proposes to stockpile topsoil material as it clears the site for construction but it will take a large amount of soil to cover the exposed tailings beaches in the TSF. It is not clear from reviewing the EIA report that the proponent has calculated the soil requirements for re-vegetation and they will have enough material available when the reclamation begins.

Water Treatment

Although the EIA refers to waste water treatment, no specifics are ever provided about the predicted contaminants or how they will be removed from the effluent before discharge. Will they be required to treat for elevated suspended solids, elevated concentrations of metals, depressed pH or all of the above? Some detail should be provided about the type and efficacy of the proposed waste water treatment processes that will be employed. In Section 7.6.3.3.2, there is a reference to batch treatment of the water in the open pit with ferric sulphate. What is the purpose of this procedure? Most water

treatment plants create precipitate containing the contaminants, generally referred as sludge. What plans are there for sludge disposal?

Follow Up Monitoring

In Section 7.6.3.6.3.3, the EIA predicts that fluoride will exceed the CCME FAL guidelines (for the protection of aquatic life) at all model nodes throughout the life of the project. In Section 8.5.4.3.2.2, it states that, "The follow-up and monitoring program for water quality in all metals, including fluoride, is provided in Section 9, and includes metal concentrations in groundwater, surface water, and fish tissue." However in Section 9.4.3.1.5 Fish Tissue Analysis, fluoride is not listed among the parameters to be measured. As fluoride is known to accumulate in bones, the fish tissue analysis for fluoride should include fish bones. Similarly, in Section 9.4.3.2.1 Surface Water, fluoride is not listed.

Acid Rock Drainage

The proponent has conducted humidity cell testing, acid-base accounting tests, and field kinetic tests to predict the potential for waste material from the mining operation to generate acid rock drainage. These tests represent the best available methods for predicting the acid generating potential of geological material. However, these tests are only predictive and what actually happens during the operation and closure phase of the mine could be quite different. At the East Kemptville Tin Mine in Nova Scotia, the EIA did not predict that the waste rock and tailings would be acid generating. As it turned out, after the mine began operation in 1985, acid rock drainage became an issue and a water treatment plant and a total reconfiguration of the tailings pond system was required to deal with the problem. The mine closed in 1992 and the surface run-off from the site is still being treated, some 21 years after operations ceased.

Operational Interruptions

Very few mines commence operation and run uninterrupted for the predicted full operational life of the mine. Metal prices, technical problems and labour disputes can all result in temporary or premature closure of a mine. This issue is not discussed in the EIA. Should an interruption in production occur, how will that affect the water management plan, the operation of the TSF and the treatment of the waste water?

Biography of Reviewer

I earned a B.Sc. (Biology) and a Masters of Environmental Studies from Dalhousie University. I worked for 34 years as an aquatic biologist with Environment Canada in Dartmouth and Fredericton. I worked in, and then managed an aquatic testing laboratory for Environment Canada for 15 years. In 1985, I became responsible for pollution abatement, pollution prevention and environmental assessment for all mines in the four Atlantic Provinces. Starting in 1992, I became a member of the Environmental Effects Monitoring (EEM) National Team with Environment Canada and worked on the development of EEM regulations for the pulp and paper and the mining industries. I was the Atlantic Regional Coordinator for the implementation of the EEM programs under the revised federal effluent regulations. In 1999, I was assigned to Environment Canada's Fredericton office and focused primarily on assessing the environmental impacts of open-pen salmon farming in the Bay of Fundy and working with other government departments (provincial and federal) and the aquaculture industry to reduce and eliminate adverse effects of salmon farming on the aquatic ecosystem adjacent to the farms.

3. Comments on the EIA Report not in relation to VECs (Valued Environmental Components), such as matters of Sustainable Development and Need for the Project

Commentary provided to CCNB Action by Ramsey Hart, M.Sc., MiningWatch Canada.

3.1 EIA Report Section 1.3.5 Sustainable Development and the Precautionary Approach

The Sisson Project Terms of Reference require the proponent to address the project's contribution to sustainable development as follows:

"In planning the Project and compiling information for the EIA REPORT Report, the Proponent should demonstrate how the proposed Project, including the alternative means of carrying out the Project, takes into account the relations and interactions among the various components of the ecosystems, including the extent to which biological diversity may be affected by the Project, and how it meets the needs of the present as well as future populations."

Northcliff's makes commitments to sustainable development and explains its approach in Section 1.3 of the EIA REPORT. In this section the proponent does not provide any references to recent efforts to assess and address the challenges inherent in "sustainable" mining such as the Mining, Minerals and Sustainable Development initiative, Mining Association of Canada's Towards Sustainable Mining, or the International Council of Metals and Mining's Sustainable Development Framework. While these initiatives have their weaknesses they do go beyond Northcliff's approach providing more detailed guidance for promoting sustainable development and represent the industry's leading practices. It is disappointing that Northcliff, has not provided a more thorough review of how it proposes to address the spectrum of inherent challenges in "sustainable mining".

In the EIA report, Northcliff's emphasis for addressing sustainable development is on mitigating environmental effects and conventional approaches to economic development. There is little in the EIA report that addresses other key aspects of sustainable development that go beyond these conventional approaches to address, for example, the distribution of costs and benefits and inter-generational equity.

The specific examples provided by the proponent of how it has addressed questions of sustainable development (EIAR Sec. 1.3.5) include only one that is relevant to socio-economic impacts of the project- additional value-added processing of tungsten. While we agree that this is an added economic benefit, it is important to also consider the distribution of all costs and benefits within and between generations. As noted by the economic review of Dr. Moir (Section 2.9 above), the EIA report lacks a balanced presentation of costs and benefits for the near term. We also find it lacking in the context of distribution of these costs and benefits.

In its Labour and Economy and Community Services and Infrastructure sections and associated background documents, the proponent has provided only general statistics on the regional and provincial economy but has done little to correlate the actual demands for labour and economic impacts to the local communities. There is no substantiation provided for the proponent's claim that the existing NB labour pool would provide the labour necessary for the construction and operation of the mine. Without an assessment of the existing skills and their relevance to work in the project it is not clear how this assertion can be substantiated. The proponent's proposed mitigation measure of informing local

educational institutions about potential needs is a valid approach but at this stage of the project development should be further elaborated and developed with concrete measures that are needed, a review of existing programs, identification of gaps etc.

Substantiation of the proponent's estimation of taxes that would be paid are lacking and seem unrealistic in light of the potential for the proponent to apply tax credits for exploration and development expenses. The amount of taxes likely to be paid should be re-evaluated with tax credits, the effective tax rate and the actually taxes paid by other mining operations in NB.

The EIA report also down-plays potential costs associated with project-related effects on the local housing market. It assumes adequate capacity exists within the local area but this assumes an even spread of workers, without consideration of travel routes and access to the mine site favouring specific communities. The EIA report does not address the potential impact on those needing low-cost housing who are most likely to be in competition with transient workers that will make up the bulk of the construction workforce and could make up a significant number of workers during the operations phase. The Baseline Socio-economic Report indicates a serious issue with affordable housing, with demand greatly exceeding capacity. The EIA report does nothing to reconcile this reality with potential competition for temporary and low-cost housing with mine workers. This represents a significant cost to a segment of society that is already vulnerable and unlikely to be able to participate in the benefits of the mine through employment or business development.

The inter-generational impacts of mining include the exploitation of a non-renewable resource, the creation of environmental liabilities and the potential boom and bust cycles associated with the opening and inevitable closure of a mine (which is tied into the inherent instability of mineral commodity prices).

The conventional compensation to society for the extraction of a non-renewable resource is the payment of royalties or taxes on the production minerals. Given the uncertainty related to the proponent's estimates of taxes to be paid to governments, we do not feel this element of sustainable development can be evaluated with the information provided.

While beyond the responsibility of the proponent – the New Brunswick Government should consider the potential for mineral revenues to be invested with a long-term vision rather than simply expended on immediate needs. Without such a strategy it is hard to imagine how a project like this can be considered sustainable from an economic perspective.

From a socio-economic perspective the EIA does little to address the challenges of mine closure and simply assumes other industrial projects will be ready and waiting to absorb the workforce from the mine. This is an oversimplification and does not provide adequate consideration for the sustainability of local communities. There is no discussion about the impacts of the loss of revenues to governments and the implications for inter-generational equity.

This project has the potential to create significant future environmental liabilities that will remain the responsibility of future generations to manage. Even if we accept that the proponent's water quality mitigation measures are adequate and reliable, there is no way of getting around the imposition of a considerable future environmental and financial liability. We have found that these plans are not adequately described and there is no substantive plan of how they would be managed post-closure. We are also concerned that some of the key aspects of the proponent's mitigation plan will need to be implemented decades after production and revenue generation cease. Given this project is the

proponent's only substantial asset we are concerned that the company may not survive long enough to fulfil the closure and post-closure commitments. Our reviewers have clearly indicated that the estimated closure bond of $50-million will not be adequate for these long-term measures. We would draw the Agency's attention to the Kemess North Review Panel's final report which noted that such costs were "a high price for future generations to pay" and expressed concern about whether "adequate oversight would remain in place to ensure implementation of site management obligations for as far into the future as this is necessary". (Kemess North Joint-Review Panel 2007)

3.2 EIA Report Section 1.3.6 Benefits to Canadians

With respect to the issue of the benefits to Canadians, the Final Terms of Reference (TOR) for the Sisson Project required to proponent to do as follows (at TOR p. 26):

> **2.2.2.10 Benefits to Canadians**
> The Proponent should describe how Canadians benefit from the project planning and information gathering process undertaken by the Proponent as part of the environmental assessment. Factors to be considered may include the following.
> - Maximized environmental benefits: Describe the environmental benefits created as a result of the project going through the EA process.
> - Contribution of the EA to support sustainable development: Describe how the EA process for the Project contributed to the concept of sustainable development for a healthy environment and economy.
> - Public Participation: Describe how public participation in the EA influenced the Project design and the environmental effects analysis.
> - Technological innovations: Identify any new technologies that were developed to address environmental effects that could be used for other projects.
> - Increases in scientific knowledge: Describe any new scientific information collected through the EA that could benefit the assessment of other projects.
> - Community and social benefits: Describe any changes in Project design that resulted in indirect benefits to communities and/or social benefits (e.g., enhanced access to wilderness areas for recreation).

The EIA report's treatment of this requirement is superficial at best. This EIA section, one page in length, is cursory and references only general and generic benefits. For example, no specific or concrete examples of modifications, input from Aboriginal peoples, local communities or stakeholders are given. No specifics about any meaningful contributions to scientific knowledge are given. If more detail is provided elsewhere in the EIA report about how the proponent's project planning has benefited Canadians, such as EIA sections discussing consultation for example, then this should be made clear in Sec. 1.3.6. Concrete examples of how the preparation of an EIA report can modify a project can be found in the Comprehensive Study Report for the Kitsault Mine Project, e.g., "The NLG and Aboriginal groups identified that the current decline of the moose population in the Nass Area could potentially be affected by the Project. Because moose are of high value ecologically, culturally and economically, the proponent, with input from the NLG and Aboriginal groups, developed mitigation measures to address the potential effects on moose along the Nass FSR." (CEAA 2013 at p. 105)

3.3 EIA Report Section 2.1 About Northcliff Resources (the proponent)

A proponent is responsible for a project and the qualities of a proponent play an important role in how it will manage that project. For example, a proponent that is financially or organizationally unsound, or has a record of environmental violations, is likely to be a poor manager of a project. Poor management of large resource projects will result in harm to the environment. As such, assessing the "character" of a proponent is an important part of any EIA process. Simply put, the public and decision makers needs to have confidence that a proponent can and is going to fulfill the commitments it makes in an EIA report, such as completing mitigation measures.

Taking a closer look at the proponent of this project, Northcliff Resources Inc., the EIA report clearly states that it is Northcliff that is fully responsible for project governance (EIAR Sec. 1.3.3) yet Northcliff relies on the track record of HDI to boost their own reputation. The use of multiple corporate structures is a common industry practice that creates serious challenges for transparency and accountability. The relationship between HDI and Northcliff is a puzzling one and all the more so as it is not the standard subsidiary relationship. In the end, who will be truly managing this project is unclear.

HDI is currently involved in two of North America's most contested mining projects, the Prosperity Project (now New Prosperity) in BC and the Pebble Mine Project in Alaska. Despite the individual proponents' repeated assertions that the projects would not have significant adverse effects, technical reviews by government experts, and experts contracted by Indigenous groups and stakeholders, have found the projects to be highly problematic and to create unacceptable levels of risk.

After the Prosperity Project was soundly rebuked by a federal review panel (Prosperity Project Review Panel 2010) and rejected by the Minister of the Environment the proponent re-submitted a mine plan that it had previously claimed was more environmentally damaging than its favoured (and rejected) alternative. The new submission has just finished a set of hearings including detailed technical reviews. Major uncertainties and risks were identified through this process and there was little confidence that the proposed mitigation measures would be adequate to meet the company's claims of protecting the environment. The technical responses to the resubmitted project are captured well by a Vancouver Sun posting from earlier this year (Vancouver Sun 2013). Both the previous and current submission of the project were staunchly opposed by affected First Nations backed by their regional and national organizations but the company has continued to aggressively push it forward.

The ambiguous corporate relationship between the proponent and HDI should raise questions with the public and decision makers about which entity will be managing this project should it proceed. (As an aside, the proposed "Environmental and Social Management System" for the project is on HDI letterhead (EIAR Appendix D)). As well, the shortcomings of other HDI led EIA reports reinforces the concerns many of CCNB Action Inc.'s experts have about the soundness of the plans for the Sisson Project and the quality of the EIA report.

3.4 EIA Report Section 2.2.1 About Tungsten

The EIA report assumes a considerable and likely unrealistic growth in demand for tungsten in the short term – almost 30% by 2014. Figure 2.2.2 and Table 2.2.1 confirm that these projections are unrealistic. Production seems to have decreased since 2010 when the graph was produced compared to 2012 when the figures in the table are from. It's also worth noting that the graph indicates a surplus of tungsten and though there has been a sharp rise in both production and demand this is only a correction returning us

to levels from 2006.

The control of China over the market suggests that the price is artificially inflated. Should China's control weaken (for example through increased production outside of China) their influence on price would also weaken and there could well be a correction in price. Similar concerns emerged recently with potash when assumed collusion between corporate producers of the fertilizer ingredient broke down (Thomson Reuters 2013). *A downward price correction for tungsten could bring this project's viability into question, a risk confirmed by the sensitivity analysis in the proponent's National Instrument technical report.*

The section on tungsten should include a review of projects coming online in the short to medium term that could affect supply and price for the minerals. Without such context it is impossible to assess both the need for THIS project and the risks of price shifts that could affect the project's viability. The National Instrument technical report notes that this may be a significant issue (p. 249):

> "From 2012, primary production of tungsten is likely to grow relatively strongly as a number of tungsten projects are at later stages of feasibility, construction and/or financing. However, not all of the potential new primary tungsten supply will be commissioned in the short-term and may be delayed until market demand increases."

Other projects are delaying their start up due to a soft market – what makes the Sisson Project any different from these? While there aspects of the Sisson Project that make it distinct from these others, this should be explained in the EIA report. The National Instrument technical report further indicates that a "pessimistic", some might say realistic or conservative, scenario has the current supply of tungsten meeting demand through to 2025 (p. 250).[7]

3.5 EIA Report Section 2.3 Need for the Project

Given the market issues flagged above and the lack of information provided about this project's relative advantages over other tungsten projects (currently on hold until market conditions improve) the proponent has failed to demonstrate a clear need for the project in its basic purpose – supplying tungsten.

The extent to which there is uncertainty about demand for the production introduces a considerable degree of uncertainty in the ability of the project to meet the other identified needs of shareholder benefits and contributions to the local and provincial economies.

3.5.1 Why do we assess the need for a project?

Assessing the need for a project allows decision makers and the public to balance or weigh the need for a project vs. the environmental harm it may cause. The CEA Agency defines "need for" a project as, "The problem or opportunity that the proposed project is intending to solve or satisfy." (from: http://www.ceaa.gc.ca/.) Looking at the need for a project helps fulfill the two main purposes of environmental assessment, being 1) to minimize or avoid adverse environmental effects before they occur, and 2) incorporate environmental factors into decision making. The greater the need for a project the more environmental harm we are generally prepared to accept. For example, in an emergency like a

[7] Dr. Moir raises these same concerns in his formal review of the National Instrument technical report (see CCNB Action Report Section 2.9(b) above at pp. 127 and 130).

flood, no environmental assessment is required. *At the same time, significant or potentially significant environmental damage is not justified if the need is trivial or minor.*

3.6 EIA Report Section 2.5 Project Alternatives

Section 2.5.1 does not meet the requirements of the terms of reference nor the CEAA guidance on providing information on project alternatives (CEAA 2007). The proponent should assess other potential sources of tungsten and molybdenum including primary production and recycling in a general way and other investment options for their shareholders.

The single sentence that responds to the Terms of Reference requirement to consider the "do nothing" scenario is also woefully inadequate and provides no information to reviewers and regulators to judge the relative importance of this project and the contextualized significance of its effects (positive and negative).

3.7 EIA Report Section 9.0 Monitoring, Auditing, Reporting and Follow-Up

Sustainable development approaches for the mining sector such as those noted above place a strong emphasis on transparency, monitoring, auditing, reporting and follow up. Given this we were surprised to read that the proponent concluded that "No follow-up or monitoring to verify the environmental effects prediction or the effectiveness of mitigation with respect to Labour and Economy is required." (EIAR page 8-494) We fundamentally disagree and believe that socio-economic monitoring must be included in monitoring and follow up plans. With regard to environmental monitoring we have found commitments to be vague and in need of much greater detail (see comments from technical reviewers).

The proponent has not proposed best-practices in terms of community engagement and transparency (*see comments on the Environmental and Social Management System below*), nor have they made a commitment to independent audits of their commitments as is required by participants in the Towards Sustainable Mining Initiative.

3.8 EIA Report Appendix D Environmental and Social Management System

The ESMS is fundamentally flawed in that its verification is done primarily and potentially exclusively by self-assessment (ESMS p. 2-1). As well, the "system" is really no more than a series of vague commitments to have plans and programs for various things. There is not sufficient detail involved, no reference to other operations with parallel systems, or any indication at all how the commitments will be operationalised. The communications section is emblematic of this:

> Northcliff will also ***have procedures*** for receiving, documenting and responding to relevant communication from external interested parties (ESMS page 2-8).

The Employment and Training Plan (ESMS Sec. 3.3) suggests a commitment to addressing barriers for locals and other NB residents to access employment at the mine. At this stage, however, and in order to assess the likelihood that this plan can be effective Northcliff should already have undertaken the background work to understand the principle barriers and be proposing how, specifically, it plans to address them.

A further example of the poor quality of the ESMS can be seen in Sec. 3.5.6. There are no plans for off-

site air quality monitoring so how will Northcliff know if their mitigation measures are adequate?

Finally, regarding "Public, Stakeholder and First Nations Engagement" (ESMS Sec. 3.6), if Northcliff were to apply industry best practices, they would go beyond establishing a liason committee and would establish an independent community monitoring agency. Following the example of mines in the NWT it would have an independent and secure source of funding, an independent governance system, be able to commission external expert consultants, and publish its own findings on the performance of the mine operations. Leading practices for independent monitoring have been outlined by Affolder *et al.* (2012).

3.9 References used by Reviewer

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Vancouver Sun. 2013. Government experts raised red flags on proposal to build mine: summary of concerns. Vancouver Sun Sept. 6: www.vancouversun.com/business/2035/Government+experts+raised+flags+proposal+build+mine+summary+concerns/8880799/story.html.

4. About CCNB Action Inc. and its Participation in the Review of the EIA for the Sisson Project

Since 1969, CCNB Action Inc.'s sister organization, the Conservation Council of New Brunswick, has worked for the protection of the environment in New Brunswick, Canada, and globally. Today, CCNB Action Inc. works to conserve our natural resources, air, land and water through education, networking, publishing, and collaboration with all sectors of civil society. We feel the proposed Project will impact local and regional air, soil, water quality, and wildlife habitats. Given CCNB Action Inc.'s mandate and purposes, we are greatly concerned about these potential impacts. We are interested in this environmental assessment because we believe the EIA process and report, if done properly, will help further sustainability in New Brunswick, which will in turn assist CCNB Action Inc. in fulfilling its mandate.

The Conservation Council of New Brunswick is a membership-based charitable organization that has been at the forefront of environmental action in New Brunswick. Its work and that of CCNB Action Inc. is carried out by a small staff and volunteers under the direction of a Board of Directors drawn from all regions of the province. Over the years, the two organizations' work has led to the clean-up of the St. John River, the wholesale removal of leaking underground gasoline storage tanks, the environmental regulation of drinking water supplies and salmon aquaculture, the legal protection of salt marshes and action on environmental clean-ups, acid rain, climate change, energy efficiency, and sustainable resource management such as forestry and mining. In 1991, the Conservation Council of New Brunswick was appointed to the Global 500 Honour Roll by the United Nations Environmental Programme.

Appendix A – CV of Inka Milewski

Inka A. Milewski
Science Advisor and Director of Health Watch
Conservation Council of New Brunswick
(Miramichi Office)
254 Douglasfield Road
Miramichi, New Brunswick
E1N 4S5
Phone: (506) 622-0314
E-mail: milewski@nbnet.nb.ca

Positions:

2000 -	Science Advisor and Director of Health Watch Conservation Council of New Brunswick
1996-2000	Atlantic Coordinator, Marine Protected Areas Program World Wildlife Fund Canada
1993 - 1996	Free-lance researcher, St. Andrews, New Brunswick
1992	Quebec-Labrador Foundation, Montreal, Quebec Policy Analyst, Community Development Project
1991	Science Council of Canada, Ottawa Research Associate
1983-1990	Huntsman Marine Science Centre, St. Andrews, New Brunswick Director of Public Education and Development
1981	Fisheries and Oceans Canada, Halifax, Nova Scotia Research Assistant
1979-1980	Bedford Institute of Oceanography, Dartmouth, Nova Scotia Research Assistant
1977-1978	Pathology Department, Ontario Veterinary College University of Guelph, Ontario Research Assistant
1976	Biology Department, Dalhousie University, Halifax, Nova Scotia Research Assistant

Teaching

2012	Guest Lecturer, Biology Department, Dalhousie University (Halifax)
2007 - 2008	Guest lecturer, School of Journalism, St. Thomas University (Fredericton)

2007	Guest lecturer, Law School, University of Moncton (Moncton)
2006 - 2007	Guest lecturer, Biology Department, University of New Brunswick (Fredericton)
1999	Guest lecturer, Resource Management, St. Mary's University (Halifax)
1997	Guest Lecturer, School for Resource Management, Dalhousie University (Halifax)
1983 - 1990	Field and laboratory classes in marine biology and ecology to undergraduate students, secondary and elementary students and the public at the Huntsman Marine Science Centre, St. Andrews, New Brunswick

Other Professional Activities

2012	Featured speaker, 2012 Rachel Carson Lecture Series Marine Environmental Research Institute, Blue Hill, Maine
2011	Testified before the House of Commons Standing Committee on Fisheries and Oceans - Closed Containment for Aquaculture
2006	Testified before the House of Commons Standing Committee on Fisheries and Oceans - Bennett Environmental Toxic Waste Incinerator in Belledune, NB
2006	Invited to participate in the DFO National Science Peer Review on Aquaculture-Environment Interactions: Shellfish Aquaculture in the Marine Environment (Moncton, NB)
2006	Testified as an expert witness on behalf of Belledune Citizens Committee before the New Brunswick Assessment and Planning Appeal Board
2006	Testify before the House of Commons Standing Committee on Environment and Sustainable Development - *Canadian Environmental Protection Act* and Vulnerable Ecosystems and Vulnerable Populations
2005	Invited to participate in the DFO National Science Peer Review on Aquaculture-Environment Interactions: Effects of Finfish Cage Aquaculture on the Marine Environment (Sydney, BC)
2003	Testified as an expert witness before the State of Maine Board of Environmental Protection on proposed regulations for aquaculture
2002	Testified before the State of Maine Board of Environmental Protection on a proposed aquaculture site in Loring Cove, Maine.
2001	Testified before the Senate Standing Committee on Fisheries and Oceans - Aquaculture

2000	Testified before the House of Commons Standing Committee on Fisheries and Oceans - Aquaculture
1999	Testified before the House of Commons Standing Committee on Environment and Sustainable Development - Aquaculture and nutrient regulations under the *Canadian Environmental Protection Act*

Voluntary Service

1999 – present	Science advisor to community, environmental and conservation groups in New Brunswick (e.g., Association of the Preservation of the Bouctouche Watershed, Belledune Citizen's Committee), Nova Scotia (e.g., Stewards of St. Ann's Harbour; Friends of Port Mouton Bay; Friends of Shelburne Harbour), Prince Edward Island (e.g., Mill River Wildlife Federation), Quebec (e.g., Coalition Retour à l'expéditeur), Ontario (e.g., Concerned Citizens of Port Colborne, Sudbury Committee for Human and Environmental Health) and Maine (e.g., Concerned Citizens of Passamaquoddy Bay)
1995 - 1998	Conservation Council of New Brunswick, President
1996 - 2001	Fundy Community Foundation, St. Andrews, New Brunswick Advisor to the Board of Directors
1993 - 1996	Fundy Community Foundation, St. Andrews, New Brunswick co-founder, first voluntary executive director and member of the Board
1992 - 1995	Conservation Council of New Brunswick, Fredericton, New Brunswick Board of Directors, Vice - President, Policy
1991	National Capital Aquarium Education Committee, Member, Ottawa
1986 - 1988	Educators of Atlantic Science Teachers Vice - President, Board of Directors
1986 - 1988	Conservation Council of New Brunswick, Fredericton, New Brunswick Member, Board of Directors
1986 - 1987	Sunbury Shores Art and Nature Centre, St. Andrews, New Brunswick Member, Board of Directors
1984 - 1986	Gulf of Maine Marine Education Association, Maine Member, Board of Directors

Appointments

2001	Delegate - Government of Canada UN Conference on The Global Programme of Action on Action for the Protection of the Marine Environment from Land-based Activities, Montreal

1999	Environmental Coordinating Committee Canada-Nova Scotia Offshore Petroleum Board, Halifax
1994	Public Advisory Committee Environment Canada State of the Environment Report, Ottawa
1993	Delegate - Ocean Caucus of the Canadian Environmental Network UN Conference on High Seas Fishing, New York
1992	Delegate - Government of Canada UN preparatory meeting for the Conference on Biodiversity, Costa Rica

Publications

Milewski I. 2012 Identifying at-risk communities for action on cancer prevention: a case study in New Brunswick (Canada) Communities. ***New Solutions*** 22(1):79-107.

Milewski, I. and Liu, L. 2010. *Cancer in New Brunswick: investigating the environmental connection. Part 2. 14 urban and rural areas (1989-2005).* Conservation Council of New Brunswick, Fredericton, New Brunswick. 90 p.

Milewski, I and Liu, L. 2009. *Cancer in New Brunswick: investigating the environmental connection. Part 1. Moncton, Saint John and Fredericton (1991-2005).* Conservation Council of New Brunswick, Fredericton, New Brunswick. 40 p.

Harvey, J. and I. Milewski. 2008. *Salmon Aquaculture in the Bay of Fundy: An unsustainable industry*. Conservation Council of New Brunswick. Fredericton, New Brunswick. 65 p.

Milewski, I. 2006. *Dying for Development: the legacy of lead in Belledune*. Conservation Council of New Brunswick. Fredericton, New Brunswick. 93 p.

Lotze, H.K and I. Milewski. 2004.Two centuries of multiple human impacts and successive changes in a coastal North Atlantic food web. ***Ecological Applications*** 14(5):1428-1447.

Milewski, I. and H.K. Lotze. 2004. Two hundred years of ecosystem change in the outer Bay of Fundy, Part II – A history of contaminants: sources and potential impacts. In Wells PG, Daborn GR, Percy JA, Harvey J, Rolston SJ (eds) Health of the Bay of Fundy: assessing key issues. Proceedings of the 5th Bay of Fundy Science Workshop, Wolfville, NS, Canada, May 13-16, 2002, ***Environment Canada – Atlantic Region, Occasional Report*** 21: 327-333.

Lotze, H.K., I. Milewski, B. Worm, and Z. Koller *2003. Nutrient Pollution: Eutrophication assessment of eelgrass beds in estuaries and coastal bays in northern and eastern New Brunswick*. Conservation Council of New Brunswick. Fredericton, New Brunswick. 60 p.

Lotze H.K. and I. Milewski. 2002. *Two Hundred Years of Ecosystem and Food Web Changes in the Quoddy Region, Outer Bay of Fundy*. Conservation Council of New Brunswick. Fredericton, New Brunswick.188 p.

Lotze H.K. and I. Milewski. 2002. Environmental history of a unique marine oasis in the Maritimes. New Brunswick Environmental Network, *Elements*, available at http://www.elements.nb.ca/theme/fisheries/heikeinka/overview.htm

Milewski, I. and A.S. Chapman. 2002. Oysters in New Brunswick: More than a harvestable resource. Conservation Council of New Brunswick, Fredericton, New Brunswick. 58 p.

Milewski, I. 2001 Impact of Salmon Aquaculture on the Coastal Environment: A review, pp. 166-197.In Tlusty, M.F., D.A. Bengston, H.O. Halvorson, S.D. Oktay, J.B. Pearce, and R.B. Rheault, Jr. (eds.) *Marine Aquaculture and the Environment: A meeting for Stakeholders in the Northeast*, Cape Cod Press, Falmouth, Massachusetts. 324 p.

Milewski, I. and J. Harvey. 2000. *Shifting Sands: The State of the North and Eastern Coast of New Brunswick*. Conservation Council of New Brunswick, Fredericton, New Brunswick, 144 p.

Milewski, I, J. Harvey and B. Buerkle. 1997. *After the Gold Rush: The Status and Future of Salmon Aquaculture in New Brunswick*. Conservation Council of New Brunswick. Fredericton, New Brunswick. 59 p.

Milewski, I. and G. Peabody. 1994. *Strengthening Environmental Organizations: An Environmentalists' Tool Kit*. New Brunswick Environmental Network. Sussex, New Brunswick. 110 p.

Milewski, I. 1994. Marine Biodiversity: Shaping a Policy Framework, ***Natural Areas Journal***, 15(1) 61-67.

Milewski, I. 1993. *State of the Bay: A bibliography of the environmental characteristics and resource management and development issues of the Bay of Fundy*. Conservation Council of New Brunswick. Fredericton, New Brunswick, 440 p.

Milewski, I. 1993. Local Commitment to Local Resources. ***Policy Options***, Vol.14(9), pp 40-43.

Milewski, I. 1992. *Education, Training, and Literacy* in Science Council of Canada's National Report (1991): Reaching for Tomorrow, pp. 34-48.

Milewski, I. and J.T. Morrisey 1987. *New Brunswick Elementary Science Survey*, Huntsman Marine Science. St. Andrews, New Brunswick. 40 p.

Milewski, I. 1986. *Education for a Sustainable Future*. Proceedings Globescope II, Tufts University, MA.

Milewski, I. 1985. *The need for a philosophical foundation for the teaching of science*. Proc. North American Association of Environmental Education. Maryland.

Appendix B – Biography and Publications of Mr. Larry Wuest

Lawrence Wuest is a sculptor and forest ecologist specializing in Quantitative Ecology and Spatial Analysis. He has a B.S. in Physics from Washington University. He has been a researcher in environmental issues since 1975, and has contributed to research in high energy physics, cancer diagnostics, fire science, aquatic microbiology, geographic analysis and forest ecology. He has lived in the Upper Nashwaak for 35 years, and has a passion for the Acadian Forest of the Nashwaak Watershed. He was a participant in the New Brunswick Ecological Land Classification Working Group 1994-2004. He is also the designer and creator of the sculpture symbolic of the New Brunswick Human Rights Award.

Wuest, L, and Betts, M.G. 2010. Quantitative tracking of the vegetative integrity and distinctness of forested ecological communities: A case study of plantation impacts. Can. J. For. R. 40: 330-346.

Betts, M, Diamond, A.W., Forbes, G.J., Frego, K., Loo, J., Matson, B., Roberts, M., Villard, M.A., Wissink, R. Wuest, L. 2005. A comment on the plantations and biodiversity debate in New Brunswick. The Forestry Chronicle 81(2):265-269.

Wuest, L.J., Mureika, R.A. and Nickerson, B.G. 2003. Information Entropy of Non-probabilistic Processes. Geographical Analysis. Vol. 35 No. 3. 215-248.

Roberts, M.R. and Wuest, L.J. 1999. Plant communities of New Brunswick in relation to environmental variation. Journal of Vegetation Science. 10:321-334.

Wuest, L.J. 1997. Landscape pattern from an information entropy perspective. Presentation to the Joint Annual Meeting of the Atlantic Society of Fish and Wildlife Biologists and Atlantic Cooperative Wildlife Ecology Research Network. Alma, NB Canada .

Wuest, L.J. 1997. An examination of mesoscale climate in UTM 21H. Report to the New Brunswick Fundy Model Forest Committee. Sussex, NB Canada.

Zundel, P.E., Hovingh, A.J., Wuest, L., MacElveney, D. and Needham, T.D. 1996. Silviculture systems for the production of energy biomass in conventional operations in Atlantic Canada. Report of UNB Applied Stand Dynamics and Management Group to The International Energy Agency.

Wuest, L.J. 1996. Statistical Analysis of Tree Species Communities, Vegetational Structure and Marten Track Occurrence in North Central New Brunswick. Report to NBDNRE Fish and Wildlife Branch.

Roberts, M. R. & Wuest, L. J. 1994. Vegetation communities and their relation to environmental factors in New Brunswick. Report to New Brunswick Dept. Of Natural Resources.

Holder-Franklin, M. A., Thorpe, A. & Wuest, L. J. 1992 Evaluation of tests employed in the numerical taxonomy of river bacteria. J. Microbiol. Methods 15, 263-277.

Holder-Franklin, M. A., & Wuest, L. J. 1983. Factor Analysis as an Analytical Method in Microbiology. In M. Bazin, (Ed.) Mathematics in Microbiology (pp. 139-169). London: Academic Press

Holder-Franklin, M. A., & Wuest, L. J. 1983. Population Dynamics of Aquatic Bacteria in Relation to Environmental Change. Journal of Microbiological Methods. 1 209-227.

Holder-Franklin, M. A.,& Wuest, L. J. 1978. Factor Analysis in Ecological Research. Am. Soc.Microbiol. Abstr. Annu. Meet. 178, 94.

Holder-Franklin, M. A., Franklin, M., Cashion, P., Cormier, C. & Wuest, L. 1978. Population Shifts in Heterotrophic Bacteria in a Tributary of the Saint John River as Measured by Taxometrics. In M. W. Loutit & J. A. R. Miles (Eds.), Microbial Ecology (pp. 44-50). Berlin: Springer-Verlag.

Steward, F. R., Wuest, L., & Waibel, R. T. 1977. Some Characteristics of Fires Within Uniform Fuel Matrices. AIChE-ASME Heat Transfer Conference, ASME 77-HT-71, Salt Lake City, Utah.

Miller, R., Wuest, L., & Cowan, D. 1972. Volume Analysis of Human Red Blood Cells I - General Procedures. Series Haematologica Vol. V,2 105-127.

Miller, R., & Wuest, L. 1972. Volume Analysis of Human Red Blood Cells II - Nature of the Residue. Series Haematologica Vol. V,2 128-141.

Appendix C – Biography of Dr. Antony Diamond

Education:

- B.A. Zoology, Queens' College Cambridge 1966.
- M.Sc. Ecology, Aberdeen, 1968.
- Ph.D. Zoology, Aberdeen, 1971.
- Post-Doc Research Fellowship, Oxford University (D. Lack, F.R.S.) and University of West Indies, Jamaica, 1970-73.

Employment:

- Scientific Administrator, Cousin Island Seychelles, 1973-75.
- Lecturer/Senior Lecturer, Zoology Department, University of Nairobi, Kenya, 1976-80.
- Research Consultant, Oxford & Ottawa, 1980-87.
- Coordinator, Acid Rain Program, Canadian Wildlife Service, Ottawa, 1987-88.
- Officer-in-Charge, Prairie & Northern Wildlife Research Centre, Canadian Wildlife Service, Saskatoon, 1988-94.
- Adjunct Professor, Biology Dept., University of Saskatchewan, 1988-96.
- Research Professor, University of New Brunswick, and Director, Atlantic Cooperative Wildlife Ecology Research Network (1994-2009) and Atlantic Laboratory for Avian Research (2009-present), 1994-present.

Related Activities:

- Member Royal Society of London Expeditions to Aldabra Atoll, Indian Ocean, 1967-69, and Cayman Islands, 1975.
- Member NSERC Grant Selection Committee 18, 1990-1993
- Member Doctoral Prizes Committee, NSERC, 1997-99
- Member ad-hoc committee, Ecological Field Stations, Major Facilities Access Grant Program, NSERC, 1996, 1998.
- Panel Reviewer, Estuarine Indicators program, U.S. Environmental Protection Agency, July 2000.
- Member of Science & Technology Advisory Board, Environment Canada, 2000-2005.
- Member of federal Council of Science and Technology Advisors, 2000-2002.
- President, Society of Canadian Ornithologists, 1998-2000.
- Elective Member (1990), Fellow (2010), American Ornithologists' Union.
- Member and Vice-Chair, Scientific Advisory Committee on Protected Natural Areas, New Brunswick, to 2013.
- 130+ peer-reviewed papers published or in press; editor/co-editor 4 books, co-author 1 book (14 national editions, 9 languages).
- >40 graduate students supervised to date.

Research Interests:
Evolutionary ecology of birds, especially in relation to conservation, roles in ecosystems, and as indicators of ecosystem health.

Appendix D – CV of Tracy Glynn

488 Charlotte St., Apt. 5, Fredericton, NB E3B 1L8 Canada
Tel: 506 440-5922
Email: tracy.a.glynn@gmail.com

PROFESSIONAL EXPERIENCE

2006 - current	**Acadian Forest Campaign Director** Conservation Council of New Brunswick/CCNB Action Implementing a province-wide campaign to protect the Acadian forest, including research, public and school-based outreach, media work, lobbying and interventions.
2008 - current	**Lecturer, Environmental Praxis** Environmental and Society Program, St. Thomas University The course deepens students' understanding of environmental praxis through critical texts and collective practice.
2010 - 2012	**Lecturer** Department of Social Work, St. Thomas University Courses discussed social action, social movements and how institutions and policies affect peoples' lives in New Brunswick, in Canada and around the world.
2011	**Lecturer, Environmental Perspectives** Environmental and Society Program, St. Thomas University The course explored how society has attempted to understand and act on different forms of environmental degradation.
2009 - 2010	**2009/2010 Gordon Global Fellow** Walter and Duncan Gordon Foundation Examined through a gender lens the situation of indigenous women in Guatemala, Indonesia and Canada affected by mining. Drafted policy recommendations aimed at addressing problems of gender inequality and lack of empowerment of women in mine affected communities.
2003 - 2005	**Teaching Assistant** Memorial University of Newfoundland, Department of Biology Taught lab component of first and third year biology courses.
2003	**Resource Development Coordinator** Canadian Crossroads International - Atlantic Regional Office, Halifax, NS Researched and wrote country handbooks for overseas volunteers. Archived photographs/materials.
2000-2002	**International Campaigner** CUSO placement at Mining Advocacy Network (JATAM), Jakarta, Indonesia Developed international campaign for national network of NGOs, community groups. Organized the International Mining Workshop at the UN PrepComm IV in Bali. Acted as project officer for the English newsletter and website. Responded to field developments through producing action alerts and media releases. Lobbied governments at all levels inside and outside of Indonesia. Networked with NGOs, indigenous communities, academics and journalists. Organized press briefings and special events. Managed program budgets and wrote funding proposals and financial reports.

EDUCATION

2011-2015	PhD Student, Interdisciplinary Studies, University of New Brunswick
January 2006	Masters of Science (Environmental Science), Memorial University of Newfoundland
2002-2003	Environmental Studies at Dalhousie's School of Resources and Environmental Studies
1999	BSc., Advanced Major Biology, St. Francis Xavier University

LANGUAGES

- Bahasa Indonesia
- French (Reading/Aural comprehension)
- Spanish (Basic/Learning)

ACTIVITIES

- Founder, Editor and Contributor, NB Media Co-op
- Board of Director, Mining Watch Canada
- Chair, Fredericton Committee for the New Brunswick Coalition for Pay Equity
- Founder, Chair, Fredericton Chapter, Conservation Council of New Brunswick
- Founder and Organizer, Cinema Politica Fredericton
- Organizer, 2006 N.B. Social Forum
- Steering Committee Member, Crown Lands Network
- Founder and Organizer, Fredericton Peace Coalition
- Organizer, Maritimes-Guatemala Breaking the Silence Network
- Organizer, Atlantic Regional Solidarity Network
- Chair, Mining Caucus, New Brunswick Environment Network, 2011-2012
- Supporting Body Member, Mining Advocacy Network (based in Indonesia)
- Editor, Mines and Communities website, minesandcommunities.org
- Board Member, *The Dominion,* an independent magazine of Media Co-op, 2009-11
- Founding Advisor, Small Change Fund, 2010-2011
- Opinion Columnist, *The Current* and *The Muse*, 2006
- Steering Committee, Newfoundland/Labrador Environment Network, 2004-5
- Chair, MUN Project Green Action Committee, 2004-5
- VP/Member At Large, Teaching Assistants' Union of Memorial University, 2004-5
- Returned Volunteer Representative/Volunteer, CUSO Atlantic Area Council, 2004-5
- Member, Trading Options Coalition, Halifax, 2003
- Member, Energy Issues Committee, Ecology Action Centre, Halifax, 2003
- Volunteer, L'ARCHE, 1995-99, community-based organization providing integrated daytime activities for adults with intellectual/physical handicaps.
- Volunteer, X-Project, 1997-98, peer mentoring at-risk children.
- Organizer, Action for Equity, 1995-1997, student society promoting gender equity.

AWARDS

- Gordon Global Fellowship, 2009-10
- New Brunswick Environmental Network award for environmental justice, 2009
- CIDA/AUCC CanadaCorps Scholarship, 2005
- Province of Newfoundland and Labrador Environmental Award, 2005
- Graduate Student Union Award for Excellence in Community Service, 2005

PUBLICATIONS

Books, magazines, non-referred journals

Glynn, T (2013). It's bigger than bling-bling and the banks: Invoking an anti-capitalist praxis in feminist activism at mining sites. *Women and Environments International Magazine.* Toronto: York University.

Co-authored chapter in *The People Behind Colombian Coal: Mining, Multinationals and Human Rights* (2007). Edited by Aviva Chomsky, Garry Leech and Steve Striffler.

Mining Advocacy Network (2004). Mining in the New Millennium. Jakarta: JATAM.

Papers in conference proceedings

Siti Maimunah, Hasanuddin, Aminuddin Kirom, Glynn, T. (2002) *Rio+10: Pertambangan dan Penghancuran Berkelanjutan.* Jakarta: JATAM.

Mining Watch Canada, Project Underground. (2002) Indonesia Case Studies: Minahasa & Nusa Tenggara. *Submarine Tailings Disposal Toolkit.* Berkeley: Project Underground.

Global Mining Campaign. (2002) Poboya-Paneki Forest Park, Indonesia. *Digging Deep.* Washington D.C.: Mineral Policy Center.

CONFERENCES

Presenter, Women's Worlds Congress, University of Ottawa, Ottawa, ON. July 2011.

Speaker, St. Thomas University Human Rights Week, Fredericton, NB. October 2008.

Speaker, New Brunswick Social Forum, Fredericton, NB. September 2008.

Presenter, Atlantic Provinces Council for the Sciences (APICS) Environmental Studies Conference, St. Francis Xavier University, Antigonish, NS. March 2008.

Organizer, Acadian Forest Science Conference, Fredericton, NB. October 2007.

Poster Presenter, Joint Meeting of the Geological Association of Canada, the Mineralogical Association of Canada, the Canadian Society of Petroleum Geologists and the Canadian Society of Soil Sciences, Halifax, NS. May 2005.

Speaker, "Mining and Sustainable Development -Two Apparently Contradictory Concepts: Challenges for the WSSD." Hosted by Third World Network. PrepComm IV, World Summit for Sustainable Development, Bali, Indonesia. June 2002.

Speaker, Drafter, Steering/Organizing Committee, International Mining Workshop (on the occasion of Fourth Preparatory Committee of the World Summit for Sustainable Development). Hosted by Mining Advocacy Network (JATAM). Bali, Indonesia. May 2002.

Participant, Building A Global Mining Campaign, International Meeting of NGOs, Activists, and Community Leaders. Hosted by Mineral Policy Center. Virginia, US, December 2001.

Organizer, International Conference on Submarine Tailings Disposal/Drafter, Manado Declaration on Submarine Tailings Disposal. Hosted by Mining Advocacy Network (JATAM). Manado, Sulawesi, Indonesia. May 1, 2001.

APPENDIX E – Resume of Stephanie Merrill

Stephanie E. Merrill, MSc.F
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Fredericton NB
E3A 1J7

506.458.8747
water@ccnbaction.ca

1. Academic Degrees

MSc.F	University of New Brunswick	2009	Forestry & Environmental Management
BSc.	University of New Brunswick	2004	Biology (Aquatic Ecology)

2. Work Experience

2010-Current Director, Freshwater Protection Program, Conservation Council of New Brunswick / CCNB Action, Fredericton, New Brunswick.

Research, writing, community campaigning and advocating for improved protection policies for freshwater in New Brunswick. Work to date has included extensive understanding and work on issues and impacts to water resources and NB water policy. Focus on networking and facilitating community organizations; social media, web communications, community engagement on St. John River watershed management and governance.

2009-2010 Research Associate, Rural and Small Town Programme, Mount Allison University, New Brunswick

Primary and secondary applied research on issues related to sustainability of rural communities and small towns, in partnership with communities and their organizations. This research combined the theory of traditional academic research with the experiences and realities of particular rural communities. Projects included an Integrated Community Sustainability Plan, municipal climate change adaptation survey, youth housing in PEI feasibility study, and a literature review of factors associated with successful post-secondary education to workforce transitions for Aboriginal youth.

2009-2010 Research Assistant, Université de Moncton, Faculty of Forestry, Edmundston, New Brunswick

Contracted research on forest management in Labrador, Newfoundland. This project involved a content analysis of Forest Management Plans in order to evaluate the

effectiveness of incorporating ecosystem-based management principles to forest planning. The project was especially focused on determining the evolution of including Aboriginal and non-Aboriginal cultural values and participation into forest management. This work culminated with a peer reviewed publication in the Canadian Journal of Forest Research.

2007-2008 Research Assistant, Landcare Research Ltd., Nelson, New Zealand

Canadian Water Network/UBC Internship in the Motueka River Integrated Catchment Management Programme. The various research topics included environmental farm planning, river substrate characterization, aerial photography digitizing, GIS/theolodite surveying, social network analysis, environmental (stream monitoring/riparian structure & function/native vegetation) education.

2007-2008 Canadian Water Policy Fellow, Walter and Duncan Gordon Foundation, Ontario

Awarded one of four annual (first ever in Atlantic Canada) Water Policy Fellowships under the Foundation's Fresh Water Resources Protection Programme. Developed and carried out a research project on private riparian land stewardship in partnership with the Canaan-Washademoak Watershed Association, including proposal writing, budgeting, scientific study design, data collection and analysis, interpretation and report writing.

2006-2007 Research Assistant, Canadian Water Network Knowledge Translation Project

Development and administration of surveys, interviews, Delphi methods and workshops with key informants in the Water Resource sector (Regional, National and International) in order to identify information gaps in knowledge translation between scientists / agencies / professionals and community groups.

2001-2009 Research Assistant, Environment and Sustainable Development Research Centre, University of New Brunswick

Research support for the activities of the Centre, including two community-based watershed groups. Responsibilities included administration duties (meeting and event organization, management committees), biophysical monitoring of urban and rural streams (water quality monitoring, fish populations and habitat assessment) and coordinating community engagement opportunities (urban stream awareness activities).

2. Publications

Merrill, S. and Hendricks, L. 2012. Making Connections on the St. John River: A river tour series connecting the "State of the St. John" to local community priorities for action. Fredericton, NB: CCNB Action, WWF-Canada and Canadian Rivers Institute. 18 pgs.

Wyatt, S., Merrill, S., and Natcher, D.C. 2011. Ecosystem Management and Forestry Planning in Labrador: Does Aboriginal Involvement Make a Difference? *Canadian Journal of Forest Research* Vol. 41: 2247-2258.

Merrill, S. 2010. Shale Gas Exploration in New Brunswick: What you need to know. Fredericton, NB: Conservation Council of New Brunswick. 14pgs.

Merrill, S., Bruce, D. and Marlin, A. 2010. Considerations for successful transitions from post-secondary education to the work-force for Aboriginal youth. Sackville NB: Rural and Small Town Programme.

Bruce, D. and Merrill, S. 2010. Youth housing options for 16-18 year olds in Charlottetown and Summerside, PEI. Sackville, NB: Rural and Small Town Programme.

Merrill, S., Zwicker, G., and Bruce, D. 2010. Cumberland County Integrated Community Sustainability Plan. Amherst, NS: Municipality of the County of Cumberland and Rural and Small Town Programme.

Merrill, S. and Zwicker, G. 2010. Capacity for climate change adaptation in New Brunswick municipalities. Sackville NB: Rural and Small Town Programme.

Merrill, S. 2009. An Exploration of Private Riparian Landowners in the Canaan-Washademoak Watershed: Ownership patterns, values and attitudes, and perceived and actual stewardship of different land tenure types. Masters Thesis. Faculty of Forestry and Environmental Management, University of New Brunswick. Fredericton, New Brunswick.

Snowdon, E. and Merrill, S. 2009. Fredericton's urban forest: A Fredericton Area Watersheds Association report on the structure and function of Fredericton's urban forest. Fredericton Area Watersheds Association. University of New Brunswick: Fredericton.

Merrill, S. 2008. The perceived and actual riparian zone management on recreational and residential lands along Washademoak Lake, New Brunswick. Toronto: Walter and Duncan Gordon Foundation.

Merrill, S. 2007. A characterization of the private riparian landowners in the Canaan-Washademoak Watershed. In: Valuing the contribution of private woodlots to society: a focus on riparian areas in a New Brunswick watershed. Report to the Canadian Model Forest Network.

4. Professional Associations and Volunteer Organizations

Nashwaak Watershed Association Inc.
Board of Directors, volunteer
2012-Present

Canadian Water Resources Association, NB Branch

Treasurer
2011-Present

New Brunswick Media Co-op
Volunteer contributor and Environmental Justice Advisor
2010- Present

Waterlution – A Water Learning Experience
Atlantic Associate
2010-Present
*includes formal facilitation training (Banff Centre) and workshop delivery

Appendix F – Article from Vancouver Sun, September 6, 2013

Government experts raised red flags on proposal to build mine: summary of concerns

(Available at: http://www.vancouversun.com/business/2035/Government+experts+raised+flags+proposal+build+mine+summary+concerns/8880799/story.html.)

The following is a summary of the concerns raised by federal and provincial government experts during the Canadian Environmental Assessment Agency review of Taseko Mines' New Prosperity Mine proposal.

1. Deteriorating Fish Lake Water Quality & Unproven "Aquarium" Lake Recirculation

Environment Canada

"The Proponent's modelling suggests water quality in Fish Lake may be marginal for the protection of aquatic life." (EC Panel Submission, July 25, 2013, CEAR #738, p. 10).

"There are few, if any, examples of lake recirculation at the scale proposed by the Proponent" (EC Panel Submission, July 25, 2013, CEAR #738, p. 11).

"Environment Canada is concerned that the recirculation mitigation measure proposed to manage water quality and the biological productivity of Fish Lake is unproven at this scale … the high level of uncertainty regarding the Proponent's recirculation scheme is a particular concern given the stated goal of preserving Fish Lake." (EC Panel Submission, July 25, 2013, CEAR #738, p. 12).

Natural Resources Canada

"The Proponent has estimated from the base of the TSF [Tailings Storage Facility] during the post-closure period at 760 m3/day. NRCan considers this value to be unrealistically low for a 12 km3 impoundment … NRCan estimated seepage through the base of the TSF to be approximately 8250 m3/day or 11 times the value estimated by the proponent". (NRCan Panel Submission, July 4, 2013, CEAR #587, p. 27, confirmed in NRCan's closing remarks, CEAR #1123, August 21, 2013).

Department of Fisheries and Oceans

"The Proponent's mitigation and adaptive management plan to preserve the functioning of Fish Lake using a recirculated closed system uses unprecedented and untested technology … DFO is

not aware of any examples of wilderness lakes or watersheds that have been subject to a recirculation program." (DFO Panel Submission, July 23, 2013, p. 14, CEAR #691).

"The New Prosperity Mine configuration was modified by from the original plan to prevent the immediate destruction of Fish Lake to create a tailings pond. In the New Prosperity Mine configuration, the Fish Lake watershed could be extensively altered, requiring intensive engineering efforts to maintain flows and lake levels. While Fish Lake itself would not be directly destroyed, as noted by the Proponent in the 2012 EIS, the lake is predicted to experience eutrophication and contamination with development of the mine." (Supplemental DFO Panel Submission, August 4, 2013, CEAR #886, p. 15).

Ministry of Energy and Mines

"MEM believes that in the context of preserving Fish Lake and its tributaries there remain uncertainties around the ability to limit and collect the expected volumes of seepage from the TSF, and the ability to effectively treat water to maintain water quality in Fish Lake and its tributaries. This leads MEM to conclude that, as detailed in the EIS and supporting documents, the ability to prevent adverse effects to Fish Lake and its tributaries from a water quality perspective is uncertain." (MEM Panel Submission, August 6, 2013, CEAR #873, p. 3).

"Taseko has proposed relying on adaptive management including water treatment to mitigate adverse effects to Fish Lake water quality and to conclude no significant adverse effects to Fish Lake. Since the effectiveness of the proposed treatment processes to decrease metal concentrations to the design specifications has not been fully provided, MEM believes that Taseko's conclusion of their ability to prevent adverse effects to Fish Lake is also uncertain." (MEM Panel Submission, August 6, 2013, CEAR #873, p. 2).

"Recirculation of Fish Lake flows in an effort to preserve the ecological values of Fish Lake and its tributaries is a very significant commitment. Fresh water diversion and flow augmentation through pumping and piping are sometimes applied at BC minesites, however not typically at this scale or for this length of time." (MEM Panel Submission, July 19, 2013, CEAR #655, p. 16).

"The predicted average model results indicate BC fresh water aquatic life water quality guidelines will be exceeded in Fish Lake, Upper Fish Creek, and Tributary 1 for aluminum, cadmium, iron, lithium, selenium, silver and thallium. Predicted average pit lake concentrations also exceed guidelines for antimony, arsenic, cobalt, mercury and zinc." (MEM Panel Submission, July 19, 2013, CEAR #655, p. 20).

"MEM notes that the proposed membrane water treatment, sulphide reduction, and ion exchange water treatment technologies are not widely used in mining applications, and none are currently in use at British Columbia minesites. The information provided on water treatment in the supplemental response provides very high level concepts but does not provide design level information that demonstrates that target objectives can be met. Water treatment is a primary mitigation strategy for this project and it should be demonstrated to be feasible at the EA phase, especially since it is key to conclusions on project related effects." (MEM Comment on

Adequacy of June 5, 2013 Supplemental Information, Submitted June 14, 2013, CEAR #541, p. 2).

"Seepage from the TSF is a very significant management issue for the Prosperity project, given the directive to protect the integrity of Fish Lake. There is large uncertainty regarding the spatial extent and hydraulic conductivity of the TSF till foundation materials and the current assumptions of its effectiveness to limit seepage have not been justified are considered potentially not conservative. Sensitivity analyses show that significantly higher seepage rates than used in the water quality loading models could occur." (MEM Panel Submission, July 19, 2013, CEAR #655, pp 14-15).

Ministry of Environment (Forests, Lands and Natural Resource Operations)

"Concerns have been raised … over the possibility of deteriorating water quality in the Fish Lake system. This could result in the loss or reduction of the productive capacity of the lake and unsuitable water quality for other uses including wildlife habitat use. These concerns stem from the high degree of uncertainty surrounding the capability and feasibility of the water quality mitigation measures (i.e. mixed levels of success for treatment and the lack of previous experience combining treatments on a lake) to treat water so as to avert irreversible impacts to water quality and aquatic life. Should such a scenario play out, there is a substantially greater risk of irreversibly damage to the Fish Lake ecosystem and the wildlife use of the system either directly by exposure to algal bloom toxins or indirectly by avoidance of the area due to poor water quality." (BC Environmental Assessment Office Panel Submission, July 19, 2013, p. 16/56 of PDF, CEAR 654).

2. Long-term Liabilities to Taxpayers & Questionable Economics of the Project

Ministry of Energy and Mines

"While detailed costing is reviewed at the Mines Act permitting stage when setting the financial security requirements, the full costs of treatment should be fully evaluated by the Proponent at the EA stage as it has the potential to affect the economics of a project. MEM expects that the amount of financial security that could be required to fund this scale of long-term liability would be very high and are likely unprecedented in the province." (MEM Panel Submission, July 30, 2013, CEAR #787, p. 5).

"In addition to the requirements for Fish Lake water treatment, the open pit lake may require water treatment before spilling at Year 48. The potential additional treatment requirements and costs associated with it have not been scoped in the EA or in these review comments." (MEM Panel Submission, July 30, 2013, CEAR #787, p. 5).

"An assessment of the potential effects to predicted water quality in Fish Lake, Fish Lake Tributaries, and the pit lake are documented in the Impact Assessment starting on pages 761, 764, and 769, respectively. The summary water quality effects assessment for Fish Lake, Fish Lake tributaries, adjacent streams and rivers and adjacent lakes all conclude that water quality

conditions could become significantly adverse (pages 793-796) if left unmitigated." (MEM Panel Submission, July 19, 2013, CEAR #655, p. 21).

"MEM concludes it is reasonable to assume that TSF water will need to be relayed to the open pit in the long term and Fish Lake may require re-circulation for at least 100 years, and perhaps in-perpetuity." (MEM Panel Submission, July 19, 2013, CEAR #655, p. 21).

"Based on preliminary cost information submitted for project configuration T2 (IR#4a), it appears that the costs for water treatment and for some aspects of water management, may not have been fully factored into the project. Water treatment is a significant undertaking, and the current proposed water treatment systems are known to be very expensive. The proponent should consider the full costs of these environmental protection requirements, as they have the potential to significantly affect the economics of the project." (MEM Panel Submission, July 19, 2013, CEAR #655, p. 27).

3. Risks to Taseko River & Other Nearby Lakes

Environment Canada

"Environment Canada is concerned that the Proponent may have underestimated the potential impacts of the Project on water quality in Wasp Lake, Little Onion Lake and Big Onion Lake. Given that these lakes drain to the Taseko River, Environment Canada is also concerned that the Proponent may have underestimated impacts on water quality in the Taseko River." (EC Panel Submission, July 25, 2013, p. 19, CEAR #738).

Department of Fisheries and Oceans

"Natural Resources Canada recently expressed concern that Taseko's seepage rate estimates for the TSF [Tailings Storage Facility] may be 11 times higher than those modelled in the EIS [Environmental Impact Statement] … as a result, groundwater seepage estimates that were modelled in the EIS may be underestimated. If actual baseline groundwater seepage contributions into Taseko River are significantly higher than those modelled, then development of the Project could result in impacts to Taseko River that have not been considered by the Proponent." (DFO Panel Submission, July 23, 2013, p. 13, CEAR #691).

B.C. Ministry of Environment

"There are concerns regarding the modelling of groundwater movement and the lack of on-site monitoring wells. Furthermore the mitigation method of recycling the water back from intercepting wells downslope may not be effective because the pathways for groundwater movement are not completely understood. There exists the potential for the movement of contaminated groundwater from the mine site into other surrounding watersheds downslope including the Taseko River" (BC Environmental Assessment Office Panel Submission, page 7/56 of PDF, CEAR 654).

"Water from the seepage ponds are to be discharged to Big Onion Lake and Wasp Lake. These lakes are expected to see deteriorating water quality. Creeks leading from these lakes go to Beece Creek and Taseko River, highly valuable fish streams. Pit Water is expected to be discharged to Fish Creek long after the mining is completed. This water will receive little dilution in Fish Creek before it enters Taseko River" (BC Environmental Assessment Office Panel Submission, page 35/56 of PDF, CEAR 654).

*NOTE: This document does not try to provide a comprehensive list of comments on impacts to Tsilhqot'in culture, rights and use.

Read more:
http://www.vancouversun.com/business/2035/Government+experts+raised+flags+proposal+build+mine+summary+concerns/8880799/story.html#ixzz2hjpkxf1q

<u>Appendix G</u> - Details of Niagara Refining LLC APT Plant (New York), NYSDEC *DEC ID: 9145200327:* Permit Application

See next page

PERMIT
Under the Environmental Conservation Law (ECL)

IDENTIFICATION INFORMATION

Permit Type: Air State Facility
Permit ID: 9-1452-00327/00001
Effective Date: 09/10/2012 Expiration Date: No expiration date

Permit Issued To:NIAGARA REFINING LLC
5661 TRANSIT RD
DEPEW, NY 14043

Facility: NIAGARA REFINING LLC
5661 TRANSIT RD|(IN THE INDUSTRIAL PARK)
DEPEW, NY 14043

Contact: MICHAEL W LINDAMAN
NIAGARA REFINING LLC
5661 TRANSIT RD
DEPEW, NY 14043
(716) 683-9170

Description:

1. Niagara Refining, LLC is the owner and operator of an ammonium paratungstate and tungsten oxide production facility. The facility is located at 5661 Transit Road in the Village of Depew, Erie County, New York.
2. This new facility includes the processing of concentrated scheelite ore to produce a sodium tungstate solution by crushing, ball milling, alkali digestion, dilution and filtration. The sodium tungstate solution generated from the concentrated ore undergoes additional processing which includes purification, filtration, solution pH adjustment, ion exchange, vaporization/crystallization, and ammonium paratungstate drying.
3. The main emissions from the new facility include ammonia, hydrogen sulfide and particulates. The ammonia emissions are reused using an ammonia recovery system that utilizes purified water for absorption. In addition, captured ammonia emissions are controlled by 94 percent using a two stage sulfuric acid ammonia scrubbing system. The ammonia scrubbing system reduces the projected potential ammonia emissions to less than 15 tons per year (tpy). The captured hydrogen sulfide emissions are controlled to 99 percent by utilizing a sodium hydroxide and sodium hypochlorite scrubbing system. The hydrogen sulfide scrubbing system reduces the projected potential hydrogen sulfide emissions to less than 10 tpy. Particulate emissions are controlled using baghouses, filter cartridges and best management practices.

4. A performance test to demonstrate compliance with the required 99 percent control efficiency of hydrogen sulfide (H2S) emissions across the gas scrubber system must be completed within 60 days after achieving the maximum production rate but not later than 180 days after initial start-up.
5. A performance test to demonstrate compliance with the required 94 percent control efficiency of ammonia emissions across the ammonia gas scrubber system and the ammonia recovery system must be completed within 60 days after achieving the maximum production rate but not later than 180 days after initial start-up.
6. On-going compliance monitoring of the control equipment and established operating limits must be completed to ensure proper operation and maintenance practices are used to minimize the impact of excess emissions on ambient air quality, the environment and human health.
7. Best management practices shall be implemented to reduce the potential for fugitive dust emissions.
8. This project was evaluated using Screen3 procedures for comparison to the hydrogen sulfide NAAQS standard of 14 ug/m3 and the DAR-1 limits for hydrogen sulfide and ammonia. The results indicated the maximum impact from this source is not expected to exceed the SGC and AGC guidance limits for hydrogen sulfide and ammonia.

By acceptance of this permit, the permittee agrees that the permit is contingent upon strict compliance with the ECL, all applicable regulations, the General Conditions specified and any Special Conditions included as part of this permit.

Permit Administrator: DOUGLAS E BORSCHEL
270 MICHIGAN AVE
BUFFALO, NY 14203-2915

Authorized Signature: _____ Date: ___ / ___ / _____

Notification of Other State Permittee Obligations

Item A: Permittee Accepts Legal Responsibility and Agrees to Indemnification

The permittee expressly agrees to indemnify and hold harmless the Department of Environmental Conservation of the State of New York, its representatives, employees and agents ("DEC") for all claims, suits, actions, and damages, to the extent attributable to the permittee's acts or omissions in connection with the compliance permittee's undertaking of activities in connection with, or operation and maintenance of, the facility or facilities authorized by the permit whether in compliance or not in any compliance with the terms and conditions of the permit. This indemnification does not extend to any claims, suits, actions, or damages to the extent attributable to DEC's own negligent or intentional acts or omissions, or to any claims, suits, or actions naming the DEC and arising under article 78 of the New York Civil Practice Laws and Rules or any citizen suit or civil rights provision under federal or state laws.

Item B: Permittee's Contractors to Comply with Permit

The permittee is responsible for informing its independent contractors, employees, agents and assigns of their responsibility to comply with this permit, including all special conditions while acting as the permittee's agent with respect to the permitted activities, and such persons shall be subject to the same sanctions for violations of the Environmental Conservation Law as those prescribed for the permittee.

Item C: Permittee Responsible for Obtaining Other Required Permits

The permittee is responsible for obtaining any other permits, approvals, lands, easements and rights-of-way that may be required to carry out the activities that are authorized by this permit.

Item D: No Right to Trespass or Interfere with Riparian Rights

This permit does not convey to the permittee any right to trespass upon the lands or interfere with the riparian rights of others in order to perform the permitted work nor does it authorize the impairment of any rights, title, or interest in real or personal property held or vested in a person not a party to the permit.

LIST OF CONDITIONS

DEC GENERAL CONDITIONS

General Provisions

Facility Inspection by the Department

Relationship of this Permit to Other Department Orders and Determinations

Applications for permit renewals, modifications and transfers

Permit modifications, suspensions or revocations by the Department

Facility Level

Submission of application for permit modification or renewal-REGION 9 HEADQUARTERS

DEC GENERAL CONDITIONS
****** General Provisions ******
GENERAL CONDITIONS - Apply to ALL Authorized Permits.

Condition 1: Facility Inspection by the Department
Applicable State Requirement: ECL 19-0305

Item 1.1:
The permitted site or facility, including relevant records, is subject to inspection at reasonable hours and intervals by an authorized representative of the Department of Environmental Conservation (the Department) to determine whether the permittee is complying with this permit and the ECL. Such representative may order the work suspended pursuant to ECL 71-0301 and SAPA 401(3).

Item 1.2:
The permittee shall provide a person to accompany the Department's representative during an inspection to the permit area when requested by the Department.

Item 1.3:
A copy of this permit, including all referenced maps, drawings and special conditions, must be available for inspection by the Department at all times at the project site or facility. Failure to produce a copy of the permit upon request by a Department representative is a violation of this permit.

Condition 2: Relationship of this Permit to Other Department Orders and Determinations
Applicable State Requirement: ECL 3-0301 (2) (m)

Item 2.1:
Unless expressly provided for by the Department, issuance of this permit does not modify, supersede or rescind any order or determination previously issued by the Department or any of the terms, conditions or requirements contained in such order or determination.

Condition 3: Applications for permit renewals, modifications and transfers
Applicable State Requirement: 6 NYCRR 621.11

Item 3.1:
The permittee must submit a separate written application to the Department for renewal, modification or transfer of this permit. Such application must include any forms or supplemental information the Department requires. Any renewal, modification or transfer granted by the Department must be in writing.

Item 3.2:
The permittee must submit a renewal application at least 180 days before expiration of permits for Title V Facility Permits, or at least 30 days before expiration of permits for State Facility Permits.

Item 3.3:
Permits are transferrable with the approval of the department unless specifically prohibited by the statute, regulation or another permit condition. Applications for permit transfer should be submitted prior to actual transfer of ownership.

Applicable State Requirement: 6 NYCRR 621.13

Item 4.1:
The Department reserves the right to exercise all available authority to modify, suspend, or revoke this permit in accordance with 6NYCRR Part 621. The grounds for modification, suspension or revocation include:

a) materially false or inaccurate statements in the permit application or supporting papers;
b) failure by the permittee to comply with any terms or conditions of the permit;
c) exceeding the scope of the project as described in the permit application;
d) newly discovered material information or a material change in environmental conditions, relevant technology or applicable law or regulations since the issuance of the existing permit;
e) noncompliance with previously issued permit conditions, orders of the commissioner, any provisions of the Environmental Conservation Law or regulations of the Department related to the permitted activity.

****** Facility Level ******

Condition 5: Submission of application for permit modification or renewal-REGION 9 HEADQUARTERS
Applicable State Requirement: 6 NYCRR 621.6 (a)

Item 5.1:
Submission of applications for permit modification or renewal are to be submitted to:
NYSDEC Regional Permit Administrator
Region 9 Headquarters
Division of Environmental Permits
270 Michigan Avenue
Buffalo, NY 14203-2915
(716) 851-7165

Permit Under the Environmental Conservation Law (ECL)

ARTICLE 19: AIR POLLUTION CONTROL - AIR STATE FACILITY PERMIT

IDENTIFICATION INFORMATION

Permit Issued To:NIAGARA REFINING LLC
5661 TRANSIT RD
DEPEW, NY 14043

Facility: NIAGARA REFINING LLC
5661 TRANSIT RD|(IN THE INDUSTRIAL PARK)
DEPEW, NY 14043

Authorized Activity By Standard Industrial Classification Code:
3399 - PRIMARY METAL PRODUCTS, NEC

Permit Effective Date: 09/10/2012 Permit Expiration Date: No expiration date.

LIST OF CONDITIONS

FEDERALLY ENFORCEABLE CONDITIONS
Facility Level
2 6 NYCRR 202-1.1: Required Emissions Tests
1 6 NYCRR 201-6.5 (g): Non Applicable requirements
3 6 NYCRR 211.1: Air pollution prohibited
Emission Unit Level

EU=U-00APT
4 6 NYCRR Part 211: Compliance Demonstration
5 6 NYCRR 212.4 (c): Compliance Demonstration
6 6 NYCRR 212.6 (a): Compliance Demonstration
7 6 NYCRR Subpart 257-10: Compliance Demonstration

EU=U-00APT,EP=00001

8 6 NYCRR 212.4 (a): Compliance Demonstration
9 6 NYCRR 212.4 (a): Compliance Demonstration

EU=U-00APT,EP=00002

10 6 NYCRR 212.4 (a): Compliance Demonstration
11 6 NYCRR 212.4 (a): Compliance Demonstration

STATE ONLY ENFORCEABLE CONDITIONS
Facility Level
12 ECL 19-0301: Contaminant List
13 6 NYCRR 201-1.4: Unavoidable noncompliance and violations
14 6 NYCRR Subpart 201-5: Emission Unit Definition
15 6 NYCRR 211.2: Visible Emissions Limited
Emission Unit Level
16 6 NYCRR Subpart 201-5: Emission Point Definition By Emission Unit
17 6 NYCRR Subpart 201-5: Process Definition By Emission Unit

FEDERALLY ENFORCEABLE CONDITIONS
****** Facility Level ******

NOTIFICATION OF GENERAL PERMITTEE OBLIGATIONS
This section contains terms and conditions which are federally enforceable. Permittees may also have other obligations under regulations of general applicability

Item A: **Sealing - 6 NYCRR 200.5**

The Commissioner may seal an air contamination source to prevent its operation if compliance with 6 NYCRR Chapter III is not met within the time provided by an order of the Commissioner issued in the case of the violation. Sealing means labeling or tagging a source to notify any person that operation of the source is prohibited, and also includes physical means of preventing the operation of an air contamination source without resulting in destruction of any equipment associated with such source, and includes, but is not limited to, bolting, chaining or wiring shut control panels, apertures or conduits associated with such source.

No person shall operate any air contamination source sealed by the Commissioner in accordance with this section unless a modification has been made which enables such source to comply with all requirements applicable to such modification.

Unless authorized by the Commissioner, no person shall remove or alter any seal affixed to any contamination source in accordance with this section.

Item B: **Acceptable Ambient Air Quality - 6 NYCRR 200.6**

Notwithstanding the provisions of 6 NYCRR Chapter III, Subchapter A, no person shall allow or permit any air contamination source to emit air contaminants in quantities which alone or in combination with emissions from other air contamination sources would contravene any applicable ambient air quality standard and/or cause air pollution. In such cases where contravention occurs or may occur, the Commissioner shall specify the degree and/or method of emission control required.

Item C: **Maintenance of Equipment - 6 NYCRR 200.7**

Any person who owns or operates an air contamination source which is equipped with an emission control device shall operate such device and keep it in a satisfactory state of maintenance and repair in accordance with ordinary and necessary practices, standards and procedures, inclusive of manufacturer's specifications,

required to operate such device effectively.

Item D: **Unpermitted Emission Sources - 6 NYCRR 201-1.2**

If an existing emission source was subject to the permitting requirements of 6 NYCRR Part 201 at the time of construction or modification, and the owner and/or operator failed to apply for a permit for such emission source then the following provisions apply:

(a) The owner and/or operator must apply for a permit for such emission source or register the facility in accordance with the provisions of Part 201.

(b) The emission source or facility is subject to all regulations that were applicable to it at the time of construction or modification and any subsequent requirements applicable to existing sources or facilities.

Item E: **Emergency Defense - 6 NYCRR 201-1.5**

An emergency constitutes an affirmative defense to an action brought for noncompliance with emissions limitations or permit conditions for all facilities in New York State.

(a) The affirmative defense of emergency shall be demonstrated through properly signed, contemporaneous operating logs, or other relevant evidence that:

(1) An emergency occurred and that the facility owner and/or operator can identify the cause(s) of the emergency;

(2) The equipment at the permitted facility causing the emergency was at the time being properly operated;

(3) During the period of the emergency the facility owner and/or operator took all reasonable steps to minimize levels of emissions that exceeded the emission standards, or other requirements in the permit; and

(4) The facility owner and/or operator notified the Department within two working days after the event occurred. This notice must contain a description of the emergency, any steps taken to mitigate emissions, and corrective actions taken.

(b) In any enforcement proceeding, the facility owner and/or operator seeking to establish the occurrence of an emergency has the burden of proof.

(c) This provision is in addition to any emergency or upset provision contained in any applicable requirement.

Item F: **Recycling and Salvage - 6 NYCRR 201-1.7**

Where practical, any person who owns or operates an air contamination source shall recycle or salvage air contaminants collected in an air cleaning device according to the requirements of 6 NYCRR.

Item G: **Prohibition of Reintroduction of Collected Contaminants to the Air - 6 NYCRR 201-1.8**

No person shall unnecessarily remove, handle, or cause to be handled, collected air contaminants from an air cleaning device for recycling, salvage or disposal in a manner that would reintroduce them to the outdoor atmosphere.

Item H: **Proof of Eligibility for Sources Defined as Exempt Activities - 6 NYCRR 201-3.2 (a)**

The owner and/or operator of an emission source or unit that is eligible to be exempt, may be required to certify that it operates within the specific criteria described in 6 NYCRR Subpart 201-3. The owner or operator of any such emission source must maintain all required records on-site for a period of five years and make them available to representatives of the Department upon request. Department representatives must be granted access to any facility which contains emission sources or units subject to 6 NYCRR Subpart 201-3, during normal operating hours, for the purpose of determining compliance with this and any other state and federal air pollution control requirements, regulations, or law.

Item I: **Proof of Eligibility for Sources Defined as Trivial Activities - 6 NYCRR 201-3.3 (a)**

The owner and/or operator of an emission source or unit that is listed as being trivial in 6 NYCRR Part 201 may be required to certify that it operates within the specific criteria described in 6 NYCRR Subpart 201-3. The owner or operator of any such emission source must maintain all required records on-site for a period of five years and make them available to representatives of the Department upon request. Department representatives must be granted access to any facility which contains emission sources or units subject to 6 NYCRR Subpart 201-3, during normal operating hours, for the purpose of determining compliance with this and any other state and federal air pollution control requirements, regulations, or law.

Item J: **Required Emission Tests - 6 NYCRR 202-1.1**

An acceptable report of measured emissions shall be submitted, as may be required by the Commissioner, to ascertain compliance or noncompliance with any air pollution code, rule, or regulation. Failure to submit a report acceptable to the Commissioner within the time stated shall be sufficient reason for the Commissioner to suspend or deny an operating permit. Notification and acceptable procedures are specified in 6 NYCRR Subpart 202-1.

Item K: **Open Fires Prohibitions - 6 NYCRR 215.2**
Except as allowed by section 215.3 of 6 NYCRR Part 215, no person shall burn, cause, suffer, allowor permit the burning of any materials in an open fire.

Item L: **Permit Exclusion - ECL 19-0305**
The issuance of this permit by the Department and the receipt thereof by the Applicant does not and shall not be construed as barring, diminishing, adjudicating or in any way affecting any legal, administrative or equitable rights or claims, actions, suits, causes of action or demands whatsoever that the Department may have against the Applicant for violations based on facts and circumstances alleged to have occurred or existed prior to the effective date of this permit, including, but not limited to, any enforcement action authorized pursuant to the provisions of applicable federal law, the Environmental Conservation Law of the State of New York (ECL) and Chapter III of the Official Compilation of the Codes, Rules and Regulations of the State of New York (NYCRR). The issuance of this permit also shall not in any way affect pending or future enforcement actions under the Clean Air Act brought by the United States or any person.

Item M: **Federally Enforceable Requirements - 40 CFR 70.6 (b)**
All terms and conditions in this permit required by the Act or any applicable requirement, including any provisions designed to limit a facility's potential to emit, are enforceable by the Administrator and citizens under the Act. The Department has, in this permit, specifically designated any terms and conditions that are not required under the Act or under any of its applicable requirements as being enforceable under only state regulations.

FEDERAL APPLICABLE REQUIREMENTS
The following conditions are federally enforceable.

Condition 2: **Required Emissions Tests**

Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 202-1.1

Item 2.1:
For the purpose of ascertaining compliance or non-compliance with any air pollution control code, rule or regulation, the commissioner may require the person who owns such air contamination source to submit an acceptable report of measured emissions within a stated time.

Condition 1: Non Applicable requirements
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 201-6.5 (g)

Item 1.1:
This section contains a summary of those requirements that have been specifically identified as being not applicable to this facility and/or emission units, emission points, processes and/or emission sources within this facility. The summary also includes a justification for classifying any such requirements as non-applicable.

40 CFR 60.380
Reason: 40 CFR 60 Subpart LL, New Source Performance Standards for Metallic Mineral Processing Plants, is applicable to facilities that process metallic mineral concentrates from ore. Niagara Refining reports Subpart LL is not applicable to this facility because the ammonium paratungstate is produced from metallic mineral concentrates that have been concentrated to approximately 50 percent prior to arrival on-site.

Condition 3: Air pollution prohibited
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 211.1

Item 3.1:
No person shall cause or allow emissions of air contaminants to the outdoor atmosphere of such quantity, characteristic or duration which are injurious to human, plant or animal life or to property, or which unreasonably interfere with the comfortable enjoyment of life or property. Notwithstanding the existence of specific air quality standards or emission limits, this prohibition applies, but is not limited to, any particulate, fume, gas, mist, odor, smoke, vapor, pollen, toxic or deleterious emission, either alone or in combination with others.

****** Emission Unit Level ******

Condition 4: Compliance Demonstration
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR Part 211

Item 4.1:
The Compliance Demonstration activity will be performed for:

Emission Unit: U-00APT

Regulated Contaminant(s):
CAS No: 0NY075-00-0 PARTICULATES

Item 4.2:
Compliance Demonstration shall include the following monitoring:

Monitoring Type: RECORD KEEPING/MAINTENANCE PROCEDURES
Monitoring Description:
Uncontrolled particulate emissions from truck traffic, storage piles, transfer of materials, or other facility operations cannot create a nuisance or exceed ambient air quality standards. Niagara Refining shall implement best management practices to reduce the potential impact of fugitive dust emissions on ambient air quality, the environment and human health. Such measures may include, but are not limited to, paving dirt roadways, installing a tire wash for trucks traveling on dirt roads, sweeping and cleaning paved areas, and installation of windrows.

Monitoring Frequency: AS REQUIRED - SEE PERMIT MONITORING DESCRIPTION
Reporting Requirements: AS REQUIRED - SEE MONITORING DESCRIPTION

Condition 5: Compliance Demonstration
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 212.4 (c)

Item 5.1:
The Compliance Demonstration activity will be performed for:

Emission Unit: U-00APT

Regulated Contaminant(s):
CAS No: 0NY075-00-0 PARTICULATES

Item 5.2:
Compliance Demonstration shall include the following monitoring:

Monitoring Type: MONITORING OF PROCESS OR CONTROL DEVICE PARAMETERS AS SURROGATE
Monitoring Description:
(1) No person will cause or allow emissions of solid particulates that exceed 0.050 grains of particulates per cubic foot of exhaust gas, expressed at standard

conditions on a dry gas basis.

(2) On-going compliance monitoring of the particulate emission limit for each particulate emission source, including but not limited to baghouses and particulate filter cartridges, shall be monitored as stated below. A particulate emission source shall include any equipment which emits particulate emissions to the outdoor atmosphere through any conduit, chimney, duct, vent, flue, stack, or opening of any kind. The identified sources at Niagara Refining include emission sources #00087, #08151, #08152, and several filter cartridges.

(a) Each baghouse and particulate filter cartridge must be operated and maintained according to manufacturer specifications. Within 180 days of startup, Niagara Refining shall submit to the Department a preventative maintenance plan designed such that the equipment is operated and maintained to limit particulate emissions or fall-out of material.

(b) Weekly inspection of any fall-out from the baghouses and filter cartridges shall be completed whenever a process is in operation.

(c) Weekly differential pressure measurements of each baghouse which vent to the outside atmosphere shall be completed whenever a process is in normal operation.

(d) Differential pressure shall be measured between the inlet and outlet to the dust collector. The dust collectors shall be operated within the differential pressure range specified by the manufacturer.

(e) The differential pressure transducer shall be calibrated annually or as required by the manufacturer.

(f) If any visible emissions, particulate fall-out or pressure measurement is recorded outside the manufacturer range, then Niagara Refining shall inspect the source, initiate corrective action, and restore operation of the dust collector and associated capture system to its normal operation as expeditiously as practicable.

(4) Records shall be maintained to include: (i) a daily log documenting whether any visible emissions or fall-out were observed, (ii) a log of the weekly pressure drop measurements with reference to the manufacturer differential pressure range, (iii) the date and time of

the observation or measurement, (iv) corrective action taken (if any), and (v) the cause of any visible emissions, fall-out or pressure measurements outside the manufacturer range (if known). The records shall be kept on-site and be made available to the Department upon request.

(5) At the discretion of the Department, an EPA Method 5 compliance test may be required to demonstrate compliance with the 0.05 grains/dscf emission limit.

Parameter Monitored: PARTICULATES
Upper Permit Limit: 0.05 grains per dscf
Reference Test Method: EPA Method 5
Monitoring Frequency: AS REQUIRED - SEE PERMIT MONITORING DESCRIPTION
Averaging Method: MAXIMUM - NOT TO EXCEED STATED VALUE - SEE MONITORING DESCRIPTION
Reporting Requirements: AS REQUIRED - SEE MONITORING DESCRIPTION

Condition 6: Compliance Demonstration
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 212.6 (a)

Item 6.1:
The Compliance Demonstration activity will be performed for:

Emission Unit: U-00APT

Regulated Contaminant(s):

CAS No: 007664-41-7	AMMONIA
CAS No: 007664-93-9	SULFURIC ACID
CAS No: 0NY075-00-0	PARTICULATES

Item 6.2:
Compliance Demonstration shall include the following monitoring:

Monitoring Type: MONITORING OF PROCESS OR CONTROL DEVICE PARAMETERS AS SURROGATE
Monitoring Description:

(1) No person will cause or allow emissions having an average opacity during any six consecutive minutes of 20 percent or greater from any process emission source, except only the emission of uncombined water.

(2) On-going compliance monitoring with this requirement shall be determined by the facility owner/operator conducting a daily survey of visible emissions whenever a process is in operation. A process shall include any equipment which emits air contaminants to the outdoor atmosphere through any conduit, chimney, duct, vent, flue,

stack, doorway or opening of any kind. The specific locations at Niagara Refining include emission points #00001, #00002, #0003A, #0003B, #00004, #00005, #00006, #00007, #00008, #00009 and any other general room ventilation exhaust or building opening through which air contaminants are emitted to the outdoor atmosphere.

(3) The daily survey does not require the determination of opacity levels. Rather the survey is used to document the presence or non-presence of visible emissions, excluding water vapor. Visible emission observations shall be performed, as best as possible, at a location to obtain the proper sun angle, background, and line of sight. The observer must be knowledgeable regarding the effects on the visibility of emissions caused by background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor).

(4) Upon detecting visible emissions, Niagara Refining shall inspect the source and restore operation of the emission unit (including the control devise, if any, and the associated capture system) to its normal operation as expeditiously as practicable.

(5) Records of the visible emission survey shall be maintained to include: (1) a check list of whether visible emissions were observed or not, (2) the date and time of the visible emission observation, (3) the corrective action taken (if any). The records shall be kept on-site and made available to the Department upon request.

(6) The Department reserves the right to perform or require the performance of a Method 9 or Method 22 opacity evaluation from any process emission source.

Parameter Monitored: OPACITY
Upper Permit Limit: 20 percent
Reference Test Method: EPA Method 9 and 22
Monitoring Frequency: AS REQUIRED - SEE PERMIT MONITORING DESCRIPTION
Averaging Method: MAXIMUM - NOT TO EXCEED STATED VALUE - SEE MONITORING DESCRIPTION
Reporting Requirements: AS REQUIRED - SEE MONITORING DESCRIPTION

Condition 7: Compliance Demonstration
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR Subpart 257-10

Item 7.1:

The Compliance Demonstration activity will be performed for:

Emission Unit: U-00APT

Regulated Contaminant(s):
CAS No: 007783-06-4 HYDROGEN SULFIDE

Item 7.2:
Compliance Demonstration shall include the following monitoring:

Monitoring Type: AMBIENT AIR MONITORING
Monitoring Description:
A Screen3 impact analysis was completed using hydrogen sulfide emissions controlled to a 99 percent control efficiency. The modeling results demonstrated the impact of captured hydrogen sulfide emissions are less than the standard concentration of 14 ug/m3. If hydrogen sulfide odors are detected near the facility, the Department will require Niagara Refining to complete a program of assessment and remediation to correct the potential impacts. Niagara Refining will be required to complete ambient air quality monitoring using methods specified by the Department and install appropriate control measures.

§257-10.1 Definition

Hydrogen sulfide (H2S) is a colorless gas having a characteristic, disagreeable odor often described as that of rotten eggs. For the purpose of this Subpart the term hydrogen sulfide will include hydrogen sulfide and other sulfides as measured by the acceptable analytical method.

§257-10.2 Objective

Hydrogen sulfide can cause odors which unreasonably interfere with the comfortable enjoyment of life and property. Although tarnishing of metals and discoloring of paint may occur at higher ambient air concentrations the primary objective of this standard is to prevent disagreeable odors.

§257-10.3 Standard

Applicable in all levels. In any one-hour period, the average concentration of hydrogen sulfide shall not exceed 0.01 ppm (14 μg/m3).

§257-10.4 Measurement

(a) Hydrogen sulfide is determined by the Cadmium Hydroxide-Methylene Blue method and expressed as parts of hydrogen sulfide per million parts of ambient air (ppm) by volume.
(b) All measurements are corrected to a reference temperature of 25 degrees Centigrade and to a reference pressure of 760 millimeters of mercury.

Parameter Monitored: HYDROGEN SULFIDE
Upper Permit Limit: 14 micrograms per cubic meter
Reference Test Method: Cadmium Hydroxide-Methylene Blue method
Monitoring Frequency: AS REQUIRED - SEE PERMIT MONITORING DESCRIPTION
Averaging Method: MAXIMUM - NOT TO EXCEED STATED VALUE - SEE MONITORING DESCRIPTION
Reporting Requirements: AS REQUIRED - SEE MONITORING DESCRIPTION

Condition 8: Compliance Demonstration
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 212.4 (a)

Item 8.1:
The Compliance Demonstration activity will be performed for:

Emission Unit: U-00APT Emission Point: 00001

Regulated Contaminant(s):
CAS No: 007783-06-4 HYDROGEN SULFIDE

Item 8.2:
Compliance Demonstration shall include the following monitoring:

Monitoring Type: INTERMITTENT EMISSION TESTING
Monitoring Description:
ROUTINE HYDROGEN SULFIDE PERFORMANCE TESTING AND ESTABLISH OPERATING LIMITS

(1) A performance test to demonstrate compliance with the required 99 percent control efficiency of hydrogen sulfide (H2S) emissions across the gas scrubber system must be completed within 60 days after achieving the maximum production rate but not later than 180 days after initial start-up.

(2) The performance test must be conducted at the maximum normal operating process load.

(3) You must establish the control parameters including: (1) the scrubber effluent pH, (2) oxidation reduction potential (ORP), (3) scrubber liquid flowrate, and (4) pressure drop as your operating limits during the

three-run performance test.

(4) You must collect pH, ORP, pressure drop, and liquid flow-rate data every 15 minutes during the entire period of the performance tests.

(5) You must determine the average pH, ORP, pressure drop, and liquid flow-rate for each individual test run in the three-run performance test by computing the average of all the 15-minute readings taken during each test run. The hourly averages shall be used to establish the operating limits.

(6) The method used to measure H2S shall include EPA Method 15 from 40CFR60, Appendix A or another reference method approved by the Department.

(7) A performance test protocol shall be submitted to the Department for approval at least 60 days prior to completion of the test. The Department must be notified 10 days prior to the scheduled test date so a Department representative may be present during the test.

(8) The results of the performance test shall be submitted to the Department within 60 days following completion of the performance test.

(9) A permit modification application shall be submitted no later than 90 days upon receiving approval of the performance test report. The application shall contain the proposed compliance certification conditions for the established operating limits for the scrubber effluent pH, ORP, scrubber liquid flowrate and pressure drop.

(10) Subsequent performance test requirements will be at the discretion of the Department based on design, operation and maintenance practices used to minimize the impact of excess emissions on ambient air quality, the environment and human health.

Parameter Monitored: HYDROGEN SULFIDE
Lower Permit Limit: 99 percent degree of air cleaning or greater
Reference Test Method: EPA Method 15 or other approved method
Monitoring Frequency: AS REQUIRED - SEE PERMIT MONITORING DESCRIPTION
Averaging Method: MINIMUM - NOT TO FALL BELOW STATED VALUE AT ANY TIME
Reporting Requirements: AS REQUIRED - SEE MONITORING DESCRIPTION

Condition 9: Compliance Demonstration
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 212.4 (a)

Item 9.1:
The Compliance Demonstration activity will be performed for:

Emission Unit: U-00APT Emission Point: 00001

Regulated Contaminant(s):
CAS No: 007783-06-4 HYDROGEN SULFIDE

Item 9.2:
Compliance Demonstration shall include the following monitoring:

Monitoring Type: RECORD KEEPING/MAINTENANCE PROCEDURES
Monitoring Description:
DEMONSTRATING CONTINUOUS COMPLIANCE
HYDROGEN SULFIDE SCRUBBER SYSTEM

(1) You must install, operate, and maintain a flow, pressure, ORP and pH measurement device for the hydrogen sulfide wet scrubber system.

(2) The monitoring equipment must complete a minimum of one cycle of operation for each successive 15-minute period. You must have a minimum of four successive cycles of operation to have a valid hour of data.

(3) You must monitor and collect data at all required intervals at all times that the affected source is operating, except for malfunctions, associated repairs, and required quality assurance or control activities (including, as applicable, calibration checks and required zero and span adjustments).

(4) You must determine the 12-hour block average of all recorded readings, except as provided as follows. For purposes of calculating data averages, you must not use data recorded during monitoring malfunctions, associated repairs, out of control periods, or required quality assurance or control activities. You must use all the data collected during all other periods in assessing compliance. Any period for which the monitoring system is out-of-control and data are not available for a required calculation constitutes a deviation from the monitoring requirements.

(5) You must maintain the 12-hour average pressure drop, liquid flow-rate, ORP and pH within the operating limits established during the performance test.

(6) Operation not within the established operating limits

shall indicate a deviation from normal conditions. You must immediately complete an investigation of the source, determine and document the cause of the deviation and complete corrective action, if necessary.

(7) You must monitor and maintain records of the total combined production of ammonium paratungstate (APT) and tungsten oxide on a rolling 12-month total basis. If the combined total production of APT and tungsten oxides exceeds 2,750 tons per year, you shall demonstrate the control equipment is designed to process the additional load. In addition, you shall complete an air screening analysis to demonstrate any increase in hydrogen sulfide emissions do not exceed the impact levels.

(8) You must keep the records of all inspection and monitoring data. Your records must be in a form suitable and readily available for expeditious review. You must keep records of the occurrence and duration of each malfunction of the associated air pollution control and monitoring equipment. You must keep records of actions taken during periods of malfunction to minimize emissions, including corrective actions to restore the malfunctioning air pollution control, or monitoring equipment to its normal or usual manner of operation. You must keep each record for 5 years following the date of each recorded action.

Monitoring Frequency: AS REQUIRED - SEE PERMIT MONITORING DESCRIPTION
Reporting Requirements: AS REQUIRED - SEE MONITORING DESCRIPTION

Condition 10: Compliance Demonstration
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 212.4 (a)

Item 10.1:
The Compliance Demonstration activity will be performed for:

Emission Unit: U-00APT Emission Point: 00002

Regulated Contaminant(s):
CAS No: 007664-41-7 AMMONIA

Item 10.2:
Compliance Demonstration shall include the following monitoring:

Monitoring Type: RECORD KEEPING/MAINTENANCE PROCEDURES
Monitoring Description:
DEMONSTRATING CONTINUOUS COMPLIANCE
AMMONIA SCRUBBER SYSTEM

(1) You must install, operate, and maintain a flow, pressure and pH measurement device for the ammonia wet scrubber system and the ammonia recovery system.

(2) The monitoring equipment must complete a minimum of one cycle of operation for each successive 15-minute period. You must have a minimum of four successive cycles of operation to have a valid hour of data.

(3) You must monitor and collect data at all required intervals at all times that the affected source is operating, except for malfunctions, associated repairs, and required quality assurance or control activities (including, as applicable, calibration checks and required zero and span adjustments).

(4) You must determine the 12-hour block average of all recorded readings, except as provided as follows. For purposes of calculating data averages, you must not use data recorded during monitoring malfunctions, associated repairs, out of control periods, or required quality assurance or control activities. You must use all the data collected during all other periods in assessing compliance. Any period for which the monitoring system is out-of-control and data are not available for a required calculation constitutes a deviation from the monitoring requirements.

(5) You must maintain the 12-hour average pressure drop, liquid flow-rate and pH within the operating limits established during the performance test.

(6) Operation not within the established operating limits shall indicate a deviation from normal conditions. You must immediately complete an investigation of the source, determine and document the cause of the deviation and complete corrective action, if necessary.

(7) You must monitor and maintain records of the total combined production of ammonium paratungstate (APT) and tungsten oxide on a rolling 12-month total basis. If the combined total production of APT and tungsten oxides exceeds 2,750 tons per year, you shall demonstrate the control equipment is designed to process the additional load. In addition, you shall complete an air screening analysis to demonstrate any increase in ammonia emissions do not exceed the impact levels.

(8) You must maintain the two stage scrubbing system in accordance with manufacturer specifications.

(9) You must keep the records of all inspection and monitoring data. Your records must be in a form suitable and readily available for expeditious review. You must keep records of the occurrence and duration of each malfunction of the associated air pollution control and monitoring equipment. You must keep records of actions taken during periods of malfunction to minimize emissions, including corrective actions to restore the malfunctioning air pollution control, or monitoring equipment to its normal or usual manner of operation. You must keep each record for 5 years following the date of each recorded action.

Monitoring Frequency: AS REQUIRED - SEE PERMIT MONITORING DESCRIPTION
Reporting Requirements: AS REQUIRED - SEE MONITORING DESCRIPTION

Condition 11: Compliance Demonstration
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable Federal Requirement:6 NYCRR 212.4 (a)

Item 11.1:
The Compliance Demonstration activity will be performed for:

Emission Unit: U-00APT Emission Point: 00002

Regulated Contaminant(s):
CAS No: 007664-41-7 AMMONIA

Item 11.2:
Compliance Demonstration shall include the following monitoring:

Monitoring Type: INTERMITTENT EMISSION TESTING
Monitoring Description:
ROUTINE AMMONIA PERFORMANCE TESTING AND ESTABLISH OPERATING LIMITS

(1) A performance test to demonstrate compliance with the required 94 percent control efficiency of ammonia emissions across the ammonia gas scrubber system and the ammonia recovery system must be completed within 60 days after achieving the maximum production rate but not later than 180 days after initial start-up.

(2) The performance test must be conducted at the maximum normal operating process load.

(3) You must establish the control parameters including: (1) the scrubber effluent pH, (2) scrubber liquid flowrate, and (3) pressure drop as your operating limits during the three-run performance test.

(4) You must collect pH, pressure drop, and liquid flow-rate data every 15 minutes during the entire period of the performance tests.

(5) You must determine the average pH, pressure drop, and liquid flow-rate for each individual test run in the three-run performance test by computing the average of all the 15-minute readings taken during each test run. The hourly averages shall be used to establish the operating limits.

(6) The method used to measure ammonia shall be approved by the Department.

(7) A performance test protocol shall be submitted to the Department for approval at least 60 days prior to completion of the test. The Department must be notified 10 days prior to the scheduled test date so a Department representative may be present during the test.

(8) The results of the performance test shall be submitted to the Department within 60 days following completion of the performance test.

(9) A permit modification application shall be submitted no later than 90 days upon receiving approval of the performance test report. The application shall contain the proposed compliance certification conditions for the established operating limits for the scrubber effluent pH, scrubber liquid flowrate and pressure drop.

(10) Subsequent performance test requirements will be at the discretion of the Department based on design, operation and maintenance practices used to minimize the impact of excess emissions on ambient air quality, the environment and human health.

Parameter Monitored: AMMONIA
Lower Permit Limit: 94 percent degree of air cleaning or greater
Reference Test Method: Department approved method
Monitoring Frequency: AS REQUIRED - SEE PERMIT MONITORING DESCRIPTION
Averaging Method: RANGE - NOT TO FALL OUTSIDE OF STATED RANGE AT ANY TIME
Reporting Requirements: AS REQUIRED - SEE MONITORING DESCRIPTION

STATE ONLY ENFORCEABLE CONDITIONS
****** Facility Level ******

NOTIFICATION OF GENERAL PERMITTEE OBLIGATIONS
This section contains terms and conditions which are not federally enforceable. Permittees may also have other obligations under regulations of general applicability

Item A: **Public Access to Recordkeeping for Facilities With State Facility Permits - 6 NYCRR 201-1.10 (a)**
Where emission source owners and/or operators keep records pursuant to compliance with the operational flexibility requirements of 6 NYCRR Subpart 201-5.4(b)(1) , and/or the emission capping requirements of 6 NYCRR Subparts 201-7.2(d), 201-7.3(f), 201-7.3(g), 201-7.3(h)(5), 201-7.3(i) and 201-7.3(j), the Department will make such records available to the public upon request in accordance with 6 NYCRR Part 616 - Public Access to Records. Emission source owners and/or operators must submit the records required to comply with the request within sixty working days of written notification by the Department of receipt of the request.

Item B: **General Provisions for State Enforceable Permit Terms and Condition - 6 NYCRR Part 201-5**
Any person who owns and/or operates stationary sources shall operate and maintain all emission units and any required emission control devices in compliance with all applicable Parts of this Chapter and existing laws, and shall operate the facility in accordance with all criteria, emission limits, terms, conditions, and standards in this permit. Failure of such person to properly operate and maintain the effectiveness of such emission units and emission control devices may be sufficient reason for the Department to revoke or deny a permit.

The owner or operator of the permitted facility must maintain all required records on-site for a period of five years and make them available to representatives of the Department upon request. Department representatives must be granted access to any facility regulated by this Subpart, during normal operating hours, for the purpose of determining compliance with this and any other state and federal air pollution control requirements, regulations or law.

STATE ONLY APPLICABLE REQUIREMENTS
The following conditions are state only enforceable.

Condition 12: Contaminant List
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable State Requirement:ECL 19-0301

Item 12.1:
Emissions of the following contaminants are subject to contaminant specific requirements in this permit(emission limits, control requirements or compliance monitoring conditions).

CAS No: 007664-41-7
Name: AMMONIA

CAS No: 007664-93-9
Name: SULFURIC ACID

CAS No: 007783-06-4
Name: HYDROGEN SULFIDE

CAS No: 0NY075-00-0
Name: PARTICULATES

Condition 13: Unavoidable noncompliance and violations
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable State Requirement:6 NYCRR 201-1.4

Item 13.1:
At the discretion of the commissioner a violation of any applicable emission standard for necessary scheduled equipment maintenance, start-up/shutdown conditions and malfunctions or upsets may be excused if such violations are unavoidable. The following actions and recordkeeping and reporting requirements must be adhered to in such circumstances.

(a) The facility owner and/or operator shall compile and maintain records of all equipment maintenance or start-up/shutdown activities when they can be expected to result in an exceedance of any applicable emission standard, and shall submit a report of such activities to the commissioner's representative when requested to do so in writing or when so required by a condition of a permit issued for the corresponding air contamination source except where conditions elsewhere in this permit which contain more stringent reporting and notification provisions for an applicable requirement, in which case they supercede those stated here. Such reports shall describe why the violation was unavoidable and shall include the time, frequency and duration of the maintenance and/or start-up/shutdown activities and the identification of air contaminants, and the estimated emission rates. If a facility owner and/or operator is subject to continuous stack monitoring and quarterly reporting requirements, he need not submit reports for equipment maintenance or start-up/shutdown for the facility to the commissioner's representative.

(b) In the event that emissions of air contaminants in excess of any emission standard in 6 NYCRR Chapter III Subchapter A occur due to a malfunction, the facility owner and/or operator shall report such malfunction by telephone to the commissioner's representative as soon as possible during normal working hours, but in any event not later than two working days after

becoming aware that the malfunction occurred. Within 30 days thereafter, when requested in writing by the commissioner's representative, the facility owner and/or operator shall submit a written report to the commissioner's representative describing the malfunction, the corrective action taken, identification of air contaminants, and an estimate of the emission rates. These reporting requirements are superceded by conditions elsewhere in this permit which contain reporting and notification provisions for applicable requirements more stringent than those above.

(c) The Department may also require the owner and/or operator to include in reports described under (a) and (b) above an estimate of the maximum ground level concentration of each air contaminant emitted and the effect of such emissions depending on the deviation of the malfunction and the air contaminants emitted.

(d) In the event of maintenance, start-up/shutdown or malfunction conditions which result in emissions exceeding any applicable emission standard, the facility owner and/or operator shall take appropriate action to prevent emissions which will result in contravention of any applicable ambient air quality standard. Reasonably available control technology, as determined by the commissioner, shall be applied during any maintenance, start-up/shutdown or malfunction condition subject to this paragraph.

(e) In order to have a violation of a federal regulation (such as a new source performance standard or national emissions standard for hazardous air pollutants) excused, the specific federal regulation must provide for an affirmative defense during start-up, shutdowns, malfunctions or upsets.

Condition 14: Emission Unit Definition
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable State Requirement:6 NYCRR Subpart 201-5

Item 14.1:
The facility is authorized to perform regulated processes under this permit for:
Emission Unit: U-00APT
Emission Unit Description:
Emission Unit U-00APT includes the processing of concentrated ore to produce sodium tungstate solution by crushing, ball milling, alkali digestion, dilution and filtration. The sodium tungstate solution generated from the concentrated ore undergoes additional processing which includes purification, filtration, solution pH adjustment, filtration, ion exchange, vaporization/crystallization, filtration and ammonium paratungstate drying.

Building(s): APT

Condition 15: Visible Emissions Limited
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable State Requirement:6 NYCRR 211.2

Item 15.1:
Except as permitted by a specific part of this Subchapter and for open fires for which a restricted

burning permit has been issued, no person shall cause or allow any air contamination source to emit any material having an opacity equal to or greater than 20 percent (six minute average) except for one continuous six-minute period per hour of not more than 57 percent opacity.

****** Emission Unit Level ******

Condition 16: Emission Point Definition By Emission Unit
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable State Requirement:6 NYCRR Subpart 201-5

Item 16.1:
The following emission points are included in this permit for the cited Emission Unit:

Emission Unit: U-00APT

Emission Point: 00001
Height (ft.): 100 Diameter (in.): 18
NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Emission Point: 00002
Height (ft.): 80 Diameter (in.): 6
NYTMN (km.): 4757.198 NYTME (km.): 198.494

Emission Point: 00004
Height (ft.): 58 Diameter (in.): 3
NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Emission Point: 00005
Height (ft.): 58 Diameter (in.): 6
NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Emission Point: 00006
Height (ft.): 58 Diameter (in.): 6
NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Emission Point: 00007
Height (ft.): 58 Diameter (in.): 6
NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Emission Point: 00008
Height (ft.): 58 Length (in.): 18 Width (in.): 12
NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Emission Point: 00009
Height (ft.): 58 Length (in.): 18 Width (in.): 12
NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Emission Point: 0003A
Height (ft.): 58 Diameter (in.): 2

NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Emission Point: 0003B
Height (ft.): 58 Diameter (in.): 2
NYTMN (km.): 4757.198 NYTME (km.): 198.494 Building: APT

Condition 17: Process Definition By Emission Unit
Effective between the dates of 09/10/2012 and Permit Expiration Date

Applicable State Requirement:6 NYCRR Subpart 201-5

Item 17.1:
This permit authorizes the following regulated processes for the cited Emission Unit:

Emission Unit: U-00APT
Process: 002
Process Description:

Process 002 includes a purification process. Sodium tungstate filtrate solution containing soluble impurities is transferred into purification tanks where chemicals including magnesium sulfate, sodium sulfide, 10% sulfuric acid and recycle liquor from the hydrogen sulfide scrubber are added. The pH of the solution remains slightly alkaline as silicone containing compounds are precipitated and then filtered out. Filtrate is collected and transferred to the pH adjustment tanks where dilution water and more 10% sulfuric acid are added. The key purpose of pH adjustment is to precipitate virtually all of the molybdenum present as the pH is lowered to approximately 3.0. At this pH a reaction takes place which results in the release of hydrogen sulfide and some sulfur oxide. These vapors discharge to a hydrogen sulfide scrubber.

The hydrogen sulfide scrubber system is designed to eliminate 99 percent of the hydrogen sulfide from the pH adjustment reaction. Hydrogen sulfide itself is acidic and will react with a base. The incoming hydrogen sulfide gas is scrubbed in a packed tower with a solution containing 20% sodium hydroxide (caustic soda) and 12.5% sodium hypochlorite. The tower is maintained at a pH of 8.0 via a pH probe, transmitter, controller and control valve. Sodium hypochlorite is added to the mix via an Oxidation Reduction Potential (ORP) probe, transmitter, controller and control valve. The probe will maintain a minimum of 600 millivolts of potential or approximately 8 mg/l of free chlorine to react with sodium sulfide. Sodium sulfate and sodium chloride salts are produced and discharged to the Buffalo Sewer Authority.

Emission Source/Control: 00017 - Control
Control Type: GAS SCRUBBER (GENERAL, NOT CLASSIFIED)

Emission Source/Control: 521VC - Control
Control Type: VENT CONDENSER

Emission Source/Control: 522VC - Control
Control Type: VENT CONDENSER

Emission Source/Control: 00056 - Process

Emission Source/Control: 00521 - Process

Emission Source/Control: 00522 - Process

Emission Source/Control: 00571 - Process

Emission Source/Control: 00572 - Process

Emission Source/Control: 00573 - Process

Emission Source/Control: 00621 - Process

Emission Source/Control: 00671 - Process

Emission Source/Control: 00672 - Process

Emission Source/Control: 00673 - Process

Emission Source/Control: IONEX - Process

Item 17.2:
This permit authorizes the following regulated processes for the cited Emission Unit:

Emission Unit: U-00APT
Process: 003
Process Description:
Process 003 includes the crystallization process. Aqueous ammonia tungstate solution, containing excess unreacted ammonium hydroxide, is fed to a batch operated evaporator-crystallizer system. Here ammonium paratungstate (APT) is precipitated and recovered as wet cake. The APT cake is then dried. All of the units are heated and vaporize the water and ammonia present. Some ammonia is released during the crystallization as ammonium tungstate converts to crystallized APT. Solution containing crystallized APT is filtered through a vacuum filter. Dewatered ammonium paratungstate crystals are then dried at 250 to 300 degrees Celcius in a furnace. Furthermore, at times, the facility plans to make tungsten oxide (WO3) instead of APT through additional heating in a calcining furnace. The production of WO3 drives off the combined ammonia and results in the liberation of additional ammonia. Ammonia from this process is vented

to a dilute ammonia recovery process.

Ammonia (NH3) Recovery Process Description

Ammonia is used at Niagara Refining to pull tungsten containing molecules off a resin bed, in the production process of tungsten oxide. When the ammonia has done its job, the excess free ammonia is “boiled” off in the crysallizer and recovered. During crystallization, as the free ammonia is boiled off, a chemical reaction occurs to form Ammonium Paratungstate or APT. During this reaction, ammonia is also formed. A subsequent process, in which crystalline APT is calcined to form tungsten oxide also forms ammonia.

These two sources of ammonia together with the free ammonia boiled off from the crystallizer are captured for reuse. The system that does this process is called the Ammonia Recovery System or ARS.

The ARS consists of a purified water spray, a heat recovering heat exchanger, a condenser and a scrubber. The ammonia from the crystallizer goes through a spray bank where purified water helps absorb the ammonia during the early stages of the crystallization. From there, the ammonia/water stream enters a heat recovery heat exchanger that helps cool the ammonia/water stream and heats the plant hot water system. The stream then combines with tha calciner ammonia, and then enters a large condenser. All the water condenses and most of the ammonia is absorbed in the water. This stream (now called aqua ammonia) is later strengthened back to its original strength with fresh commercial aqua ammonia.

Any ammonia that does not absorb into the water at the condenser is sent to a scrubber (packed tower) where it is absorbed by purified water. This weak stream of aqua ammonia is also reused in the process and can be strengthened back to usable strength with commercial aqua ammonia.

Emission Source/Control: 00015 - Control
Control Type: AMMONIA SCRUBBING

Emission Source/Control: 08101 - Control
Control Type: PARTICULATE TRAP

Emission Source/Control: 08102 - Control
Control Type: PARTICULATE TRAP

Emission Source/Control: 841ME - Control
Control Type: MIST ELIMINATOR

Emission Source/Control: 842ME - Control
Control Type: MIST ELIMINATOR

Emission Source/Control: 00841 - Process

Emission Source/Control: 00842 - Process

Emission Source/Control: 00851 - Process

Emission Source/Control: 00852 - Process

Emission Source/Control: 00891 - Process

Emission Source/Control: 00892 - Process

Emission Source/Control: 00ARS - Process

Item 17.3:
This permit authorizes the following regulated processes for the cited Emission Unit:

Emission Unit: U-00APT
Process: 004
Process Description:

Process 004 includes the gaseous ammonia scrubbing system. Niagara Refining's ammonium paratungstate production operation includes a two-stage scrubbing system to remove gaseous ammonia vented from various process tanks containing aqueous solutions. Most of the ammonia emissions occur during transfers of vessel contents.

The primary vent system consists of a common manifolded vent header purged with dilution air. Vents for three of the tanks, which normally contain liquors higher in ammonia content, are separately manifolded and padded with nitrogen to eliminate flammability potential. This manifold is also tied into the primary vent system.

Sulfuric acid is used as the scrubbing media. This is ideal since it reacts very rapidly with ammonia and exhibits no vapor pressure. Product formed is soluble ammonium sulfate. Pumps, one for each system, recirculate acidic liquor over a venturi eductor where the gas and liquid intimately contact.

The scrubber system utilizes venturi eductors not only to achieve vapor-liquid contacting but also to pull the dilution air and ammonia vapors through the common vent system. Gases exiting the first scrubber system are drawn into the second scrubber where further contacting takes

place. The second scrubber will always be richer in acid content then the first. When the first scrubber is spent, valves are switched to reverse the scrubbing order. The No.1 scrubber is pumped out, re-charged with dilute sulfuric acid to become the No.2 scrubber. The previous No.2 scrubber becomes No.1.

Vent pipes from the scrubber tanks, only one open at any given time, combine into a single vent pipe and direct dilution air containing moisture and small amounts of unneutralized ammonia to the atmosphere.

Emission Source/Control: 00018 - Control
Control Type: AMMONIA SCRUBBING

Emission Source/Control: 00491 - Process

Emission Source/Control: 00492 - Process

Emission Source/Control: 00711 - Process

Emission Source/Control: 00870 - Process

Emission Source/Control: 00925 - Process

Emission Source/Control: 00926 - Process

Emission Source/Control: 00927 - Process

Emission Source/Control: 07101 - Process

Emission Source/Control: 07141 - Process

Emission Source/Control: 09212 - Process

Emission Source/Control: 09214 - Process

Item 17.4:
This permit authorizes the following regulated processes for the cited Emission Unit:

Emission Unit: U-00APT
Process: 005
Process Description:
Process 005 includes tank vents not vented to the scrubber control systems. There are several chemical solution tanks that do not vent through the scrubber control systems. These include two NaOCl, NaOH, H2SO4, MgSO4, Na2S, NH3Cl and two IT feed tanks. Some of these tanks vent directly to the roof and others vent through filter cartridges to remove particulates before being vented inside the building. Particulates are generated from the addition of dry raw material used to create the

desired tank solution. Other particulate emissions are generated from the transfer of dry material to the Blue/Yellow Tungsten screeners. Particulates from these sources are controlled by a baghouse before being vented inside the building.

Emission Source/Control: 08151 - Control
Control Type: FABRIC FILTER

Emission Source/Control: 08152 - Control
Control Type: FABRIC FILTER

Emission Source/Control: 980FC - Control
Control Type: PARTICULATE TRAP

Emission Source/Control: 990FC - Control
Control Type: PARTICULATE TRAP

Emission Source/Control: 00674 - Process

Emission Source/Control: 00675 - Process

Emission Source/Control: 00716 - Process

Emission Source/Control: 00717 - Process

Emission Source/Control: 00781 - Process

Emission Source/Control: 00782 - Process

Emission Source/Control: 00783 - Process

Emission Source/Control: 00911 - Process

Emission Source/Control: 00941 - Process

Emission Source/Control: 00942 - Process

Emission Source/Control: 00951 - Process
Design Capacity: 5,000 gallons

Emission Source/Control: 00953 - Process
Design Capacity: 5,000 gallons

Emission Source/Control: 00980 - Process

Emission Source/Control: 00990 - Process

Emission Source/Control: 08121 - Process

Emission Source/Control: 08122 - Process

Emission Source/Control: 09141 - Process

Emission Source/Control: 09142 - Process

Item 17.5:
This permit authorizes the following regulated processes for the cited Emission Unit:

Emission Unit: U-00APT
Process: 01A
Process Description:
Process 01A includes the initial processing of ore concentrate. Scheelite or Wolframite is transferred from bulk super sacs and sent to a ball mill. The ore concentrate solution is mixed with sodium hydroxide to leach a sodium tungstate solution which is later purified. Particulate emissions are generated from the transfer of dry material to the Scheelite ore hoppers. Particulates from these sources are controlled by a baghouse before being vented inside the building.

Emission Source/Control: 00027 - Control
Control Type: FABRIC FILTER

Emission Source/Control: 422VC - Control
Control Type: VENT CONDENSER

Emission Source/Control: 00211 - Process

Emission Source/Control: 00212 - Process

Emission Source/Control: 00221 - Process

Emission Source/Control: 00222 - Process

Emission Source/Control: 00241 - Process

Emission Source/Control: 00242 - Process

Emission Source/Control: 00413 - Process

Emission Source/Control: 00414 - Process

Emission Source/Control: 00422 - Process

Emission Source/Control: 00442 - Process

ATTACHMENT A2

EMISSIONS CALCULATIONS

ATTACHMENT A2
TABLE 1.0

NIAGARA REFINING LLC
TOTAL AMMONIUM PARATUNGSTATE PROCESS EMISSIONS
JANUARY 2012

Parameter	*Emission Rate Potential (ERP)* [1]		*Controlled Emissions* [2]	
	(lbs/hr)	*(tons/yr)*	*(lbs/hr)*	*(tons/yr)*
Hydrogen sulfide (H_2S)	25.1	41.2	0.25	0.4
Sulfur dioxide[3] (SO_2)	192.8	316.5	11.6	19.0
Ammonia[3] (NH_3)	35.9	157.0	2.2	9.4
Sulfuric Acid (H_2SO_4)	0.04	0.2	Not Controlled	Not Controlled
Sodium Hypochlorite (NaOCl)	0.02	0.10	Not Controlled	Not Controlled
Particulate (PM)	0.2	0.7	0.002	0.01

Notes:

[1]Refer to Tables 1.1-1.5.

[2]Controlled Emissions (m-tons/yr) = ERP * (1-Removal Efficiency)

H_2S controlled by scrubbing with removal efficiency of: 99%

SO_2 controlled by scrubbing with removal efficiency of: 94%

NH_3 controlled by scrubbing with removal efficiency of: 94%

[3]See attachment titled Fugitive Emissions for additional H_2S, SO_2 and NH_3 emissions which are considered minimal as they would not impact the total emissions.

ATTACHMENT A2
TABLE 1.1

NIAGARA REFINING LLC (AMMONIUM PARATUNGSTATE PROCESS)
PROCESS HYDROGEN SULFIDE (H_2S) EMISSIONS DETERMINATION
JANUARY 2012

Maximum H_2S Emissions [1,2]		*H_2S Annual ERP*	
(lbs/hr)	*(lbs/day)*	*(lbs/yr)*	*(tons/yr)*
25.1	225.5	82,322	41.2

Notes:

[1]Refer to attachment A6 H_2S Scrubber for chemistry used in determining lbs/hr.

[2]Total H_2S emitted per batch * Maximum of nine batches per day.

ATTACHMENT A2
TABLE 1.2

NIAGARA REFINING LLC (AMMONIUM PARATUNGSTATE PROCESS)
PROCESS SULFUR DIOXIDE (SO_2) EMISSIONS DETERMINATION
JANUARY 2012

	Maximum SO_2 Emissions[1]			*SO_2 Annual ERP*	
	(lbs/batch)	*(lbs/hr)*	*(lbs/day)*	*(lbs/yr)*	*(tons/yr)*
Total from SO_2 Scrubber[2]:	573.5	191.2	1720.6	628,015	314.0
Total from H_2S Scrubber[3]:	1.54	1.54	13.86	5,059	2.5
Total SO_2:		*192.8*			*316.5*

Notes:

[1]Refer to attachment A6 H_2S and SO_2 scrubbers for chemistry used in determining lbs/hr.

[2]Total SO_2 emitted per batch * Maximum of three batches per day.

[3]Total SO_2 emitted per batch * Maximum of nine batches per day.

ATTACHMENT A2
TABLE 1.3

NIAGARA REFINING LLC (AMMONIUM PARATUNGSTATE PROCESS)
AMMONIA (NH_3) EMISSIONS DETERMINATION
JANUARY 2012

	Maximum NH_3 Emissions[1]		*NH_3 Annual ERP*	
	(lbs/hr)	*(lbs/day)*	*(lbs/yr)*	*(tons/yr)*
Total from NH_3 Recovery System Scrubber:	25.7	616.0	224,825	112.4
Total from NH_3 Header System:	10.19	244.6	89,264	44.6
Total NH_3:	*35.9*			*157.0*

Notes:
[1]Refer to attachment A6 NH3 Scrubber and Ammonia Header Design & Ammonia Scrubber for chemistry used in determining lbs/hr.

ATTACHMENT A2
TABLE 1.4

NIAGARA REFINING LLC (AMMONIUM PARATUNGSTATE PROCESS)
EMISSION SUMMAARY FOR STORAGE VESSELS GREATER THAN 10,000 GALLONS
JANUARY 2012

Tank Parameters	ph Adjustment Sol.	ph Adjustment Sol.	NaOH Sol.	H_2SO_4 Sol.[1]	NaOCl Storage Tank
Identification Number:	6.7.4	6.7.5	9.4.1	9.1.1	9.5.1
Storage Capacity (gal):	10,150	10,150	10,500	10,500	9,200
Diameter (ft):	12'	12'	11' 10"	11' 10"	
Height (ft):	12'	12'	14' 0.75"	14' 0.75"	
Annual Throughput (gal):	10,213,440	10,213,440	875,510	514,560	753,330
Chemical Makeup:	89.8% Water 3.0% Na6H2W12O40 6.1% Na2SO4 1.1% other non-volatiles	89.8% Water 3.0% Na6H2W12O40 6.1% Na2SO4 1.1% other non-volatiles	50% NaOH 50% H20	93.19% H2SO4 6.81% H20	86.5% H2O 0.5% NaOH 3% NaOH 10% NaOCl
Vapor Pressure (psi):	No Vapor Pressure	No Vapor Pressure	No Vapor Pressure	0.33	
Total (lbs/hr):	*NA*	*NA*	*NA*	***0.04***	***0.02***
Total (lbs/yr):	*NA*	*NA*	*NA*	***331.3***	***193.22***
Total (tons/yr):	*NA*	*NA*	*NA*	***0.17***	***0.10***

Notes:

[1] H_2SO_4 & NaOCl emissions were determined using EPA Tanks Software 4.0.9d (Refer to attachment A8).

*All other storage vessels are considered trivial or exempt per NYSDEC Subpart 201-3:
Exempt: (25) Storage tanks, with capacities under 10,000 gallons, except those subject to either Part 229 or Part 233 of this Title.
Trivial: (44) Storage vessels, tanks and containers with a capacity of less than 750 gallons.

ATTACHMENT A2
TABLE 1.5

NIAGARA REFINING LLC (AMMONIUM PARATUNGSTATE PROCESS)
PARTICULATE EMISSIONS DETERMINATION
JANUARY 2012

Dry Materials	*Scheelite Ore*	*Sodium Sulfate*	*Magnesium Sulfate*	*Sodium Sulfide*	*Ammonium Chloride*	*Blue/Yellow Tungsten Oxide*
Total Usage :						
lbs/year:	5,793,715	1,971,000	536,254	112,623	402,234	5,108,722
tons/year:	2,897	986	268	56	201	2,554
Em. Factors (lbs/ton)[1]:	0.12	0.12	0.12	0.12	0.12	0.12
No. of Transfer Locations[2]:	1	1	2	2	2	3
Particulate Em. Rates[3]:						
Uncontrolled lbs/yr:	*347.6*	*118.3*	*64.4*	*13.5*	*48.3*	*919.6*
Uncontrolled tons/yr:	*0.16*	*0.05*	*0.03*	*0.01*	*0.02*	*0.42*
Controlled lbs/yr:	*3.48*	*5.91*	*0.64*	*0.14*	*0.48*	*9.20*
Controlled tons/yr:	*0.0017*	*0.0030*	*0.0003*	*0.0001*	*0.0002*	*0.0046*
Other Parameters:						
Control Devices[2]:	Baghouse	Scrubber	Filter Cartridges	Filter Cartridges	Filter Cartridges	Baghouse
Removal Efficiency:	99	95	99	99	99	99
Container:	Super Sac	Super Sac	Super Sac	20 Kg bags	20 Kg bags	250 Kg Drums
Mode of Transfer:	Dumped into hopper	Dumped into smelter	Screw Conveyer to Dissolver	Screw Conveyer to Dissolver	Screw Conveyer to Dissolver	Screw Conveyer to Screener to Drum
Exhaust Location:	Inside Building	Atmosphere	Inside Building	Inside Building	Inside Building	Inside Building

Notes:

[1]Particulate emission factor was obtained from AP-42 Table 11.24.2 for material handling and transfer of low moisture ore.

[2]Only dry material transfers are used in determining particulate emissions. Throughout the process most transfers move wet material only.

[3]Uncontrolled Emissions = Total Usage (tons/yr) * Em. Factor (lbs/ton) * No. of Transfer Points

ATTACHMENT A6

SCRUBBER ESTIMATES

Scrubber Flowrates Estimate for NYSDEC Permit

SO2 Scrubber

Gas out of Smelter to Scrubber:
(per batch, pounds)

(Major Assumption: O2 needed = combustion O2 + 3 X reaction O2)

N2	11,759.47	72.2%
O2	1,176.22	7.2%
H2O	1,130.67	6.9%
CO2	1,647.11	10.1%
SO2	573.53	3.5%
	16,286.99	100.0%

Assumption #2: The batch is 4 hours in length, and double the SO2 emissions come off between ½ hours and 2½ hours as the other hours

Time Period	N2	O2	H2O	CO2	SO2	
0-0.5 hours	1,469.93	170.93	141.33	189.375	47.78	2,019.34
0.5-1 hour	1,469.93	123.13	141.33	222.402	95.61	2,052.41
1-1.5 hours	1,469.93	123.13	141.33	222.402	95.61	2,052.41
1.5-2 hours	1,469.93	123.13	141.33	222.402	95.61	2,052.41
2-2.5 hours	1,469.93	123.13	141.33	222.402	95.61	2,052.41
2.5-3 hours	1,469.93	170.93	141.33	189.375	47.78	2,019.34
3-3.5 hours	1,469.93	170.93	141.33	189.375	47.78	2,019.34
3.5-4 hours	1,469.93	170.93	141.33	189.375	47.78	2,019.34
	11,759.47	1,176.22	1,130.67	1,647.11	573.53	

Assumption #3, Scrubber is designed to be 94% efficient with SO2, and 20% efficient with CO2
Will use largest hourly rate:

SO2 Scrubber Chemistry

This is a MAXIMUM calculation

Vapor into Scrubber:

	lb/hr
N2	2,939.87
O2	246.26
CO2	444.80
SO2	191.21
H2O	282.67
Total	4,104.81

Vapor from Scrubber — Assumption: SO2 Scrubber runs at 50°C

	lb/hr	
N2	2,939.87	
O2	246.26	
CO2	355.84	Assumption: 20% of the CO2 reacts with NaOH in scrubbing liquor
SO2	11.47	Assumption: SO2 scrubber is 94% efficient
H2O	289.45	Assumption: Not all water from reaction goes out with vapor; some condenses.
Total	3,842.89	is the maxium hourly rate per batch, with 3 batches run per day

Reaction #1:

	SO2	+ 2 NaOH	---->	Na2SO3	+ H2O
Mass	179.742	224.474		353.671	50.545
Mole Wt	64.066	40.005		126.060	18.016
Moles	2.806	5.611		2.806	2.806

Delta = 0.000

Reaction #2:

	CO2	+ NaOH	---->	NaHCO3
Mass	71.169	64.692		135.861
Mole Wt	44.010	40.005		84.015
Moles	1.617	1.617		1.617

Delta = 0.000

Reaction #3:

	CO2	+ 2 NaOH	---->	Na2CO3	+ H2O
Mass	17.792	32.346		42.855	7.283
Mole Wt	44.010	40.005		106.004	18.016
Moles	0.404	0.809		0.404	0.404

Delta = 0.000

Reaction #1 a:

	SO2	+ NaOH	---->	NaHSO3
Mass	179.742	112.237		291.954
Mole Wt	64.066	40.005		104.062
Moles	2.806	2.806		2.806

Delta = 0.025

Reaction #1 b:

	NaHSO3	+ NaOH	---->	Na2SO3	+ H2O
Mass	291.954	112.237		353.671	50.545
Mole Wt	104.062	40.005		126.060	18.016
Moles	2.806	2.806		2.806	2.806

Delta = -0.025

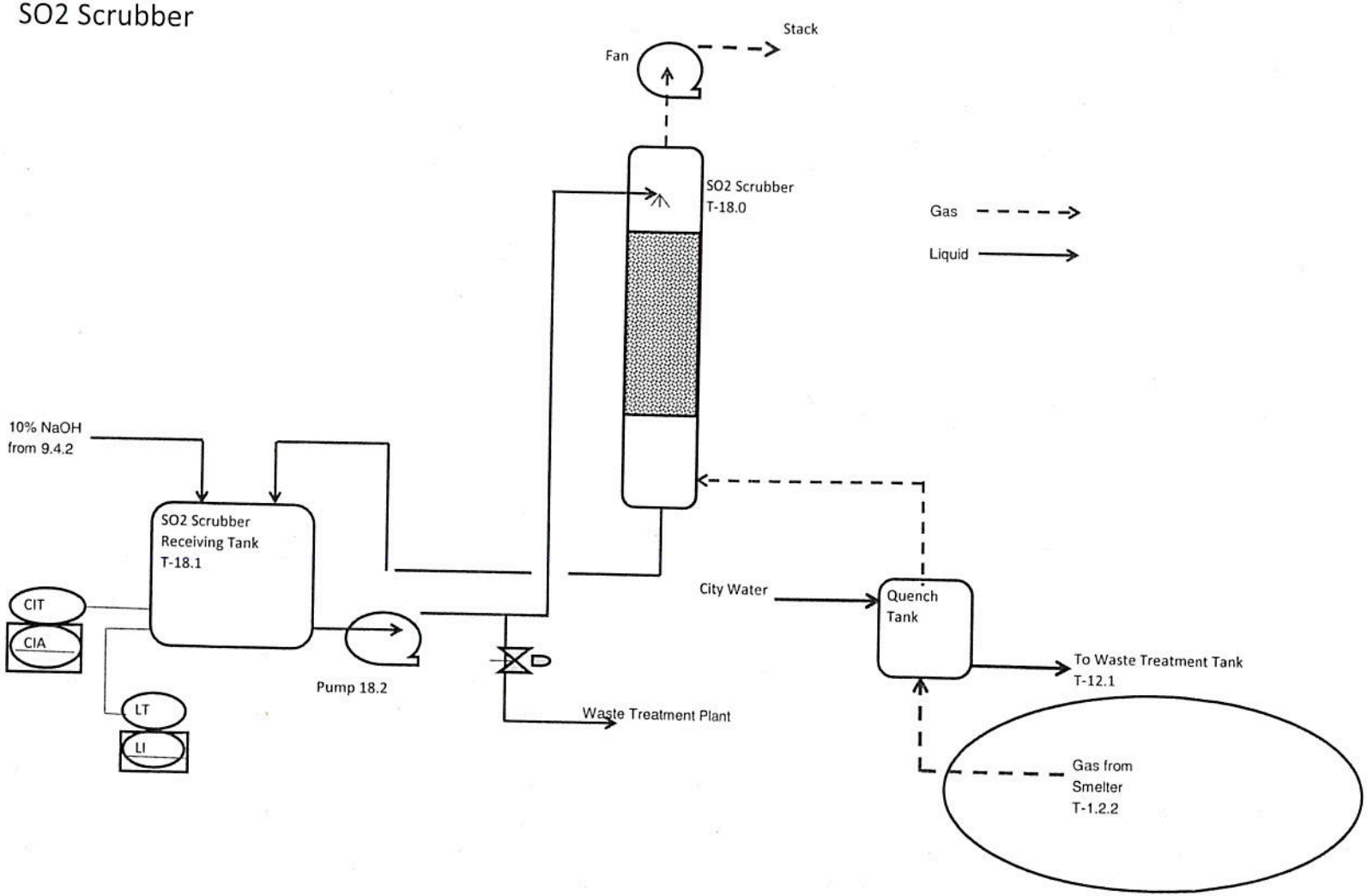
Vapor from Scrubber — Assumption: SO2 Scrubber runs at 50°C

This is an AVERAGE calulation for the entire day

	lb/day	
N2	35,278.40	
O2	3,528.67	
CO2	3,953.06	Assumption: 20% of the CO2 reacts with NaOH in scrubbing liquor
SO2	103.24	Assumption: SO2 scrubber is 94% efficient
H2O	3,473.38	Assumption: Not all water from reaction goes out with vapor; some condenses.
Total	46,336.76	

Physical Concept

SO2 Scrubber



Scrubber Flowrates Estimate for NYSDEC Permit

H2S Scrubber

Total Mass into pH 3 Reactors = 35,455.38 lbs.

Wt.% $Na_2S_2O_3$ =	0.011%	3.79 lbs.
Wt.% Na_2MoS_4 =	0.014%	4.81 lbs.
Wt.% Na_2S =	0.158%	56.02 lbs.

Reaction #1: (SO_2 Gas to Scrubber)

	$Na_2S_2O_3$ +	H_2SO_4	----->	Na_2SO_4 +	H_2O +	SO_2 +	S
Mass	3.79	2.35		3.41	0.43	1.54	0.77
MW	158.13	98.08		142.06	18.02	64.07	32.07
Moles	0.02	0.02		0.02	0.02	0.02	0.02

Delta = 0.00

Reaction #2: (Formation of Na_2S)

	Na_2MoS_4	----->	MoS_3 +	Na_2S
Mass	4.81		3.42	1.39
MW	270.21		192.15	78.06
Moles	0.02		0.02	0.02

Delta = 0.00

Reaction #3: (H_2S Gas to the Scrubber)

	Na_2S +	H_2SO_4	----->	H_2S +	Na_2SO_4
Mass	57.41	72.13		25.06	104.48
MW	78.06	98.08		34.08	142.06
Moles	0.74	0.74		0.74	0.74

Delta = 0.00

Assumption: #1: 1,000:1 dilution of the H_2S mass, for an air mix of 25,064.95 lbs. air per batch or
19,224.82 lbs. N_2 per batch and 5,840.13 lbs. O_2 per batch.

Gas out of pH3 Reactors to Scrubber:
(per batch, pounds)

N2	19,224.82
O2	5,840.13
H2S	25.06
SO2	1.54
H2O	30.17 Assumption: a ratio of 1.204 H2O:H2S goes out as vapor
	25,121.72

Assumption: It takes 30 minutes to add acid charge and make H2S
Assumption: The reaction is doubled in a 15 minute interval

Time Period	N2	O2	H2S	SO2	H2O
0-5 minutes	3,204.14	973.36	2.78	0.171	3.35
5-10 minutes	3,204.13	973.36	5.57	0.342	6.70
10-15 minutes	3,204.13	973.36	5.57	0.342	6.70
15-20 minutes	3,204.13	973.36	5.57	0.342	6.70
20-25 minutes	3,204.13	973.36	2.78	0.171	3.35
25-30 minutes	3,204.13	973.36	2.78	0.171	3.35
	19,224.81	5,840.13	25.06	1.54	30.17

H2S Scrubber Chemistry

This is a MAXIMUM calculation

Assumption: Scrubber runs at 20°C

Vapor into Scrubber:	lb/hr	Vapor from Scrubber:	lb/hr	
N2	19,224.81	N2	19,224.81	
O2	5,840.13	O2	5,840.13	
H2S	25.06	H2S	0.25	Assumption: Scrubber is 99% efficient
SO2	1.54	SO2	0.02	Assumption: Scrubber is 99% efficient
H2O	30.17	H2O	3.02	Assumption: Water comes out of scrubber at 10% of vapor inlet mass (most is condensed)
	25,121.71		25,068.22	is the maxium hourly rate per batch, and this is being emitted over a 15 minute period. There are 9 batches run per day

Note: the pounds per hour here are for a time period of 15 minutes for peak rate

Reaction #1:

	H2S +	2 NaOH	---->	Na2S +	2 H2O
Mass	24.809	58.242		56.822	26.229
Mole Wt	34.082	40.005		78.060	18.016
Moles	0.728	1.456		0.728	1.456

Delta = 0.000

Reaction #2:

	SO2 +	2 NaOH	---->	Na2SO3	+ H2O
Mass	1.525	1.904		3.000	0.429
Mole Wt	64.066	40.005		126.060	18.016
Moles	0.024	0.048		0.024	0.024

Delta = 0.000

Reaction #2 a:

	SO2 +	NaOH	---->	NaHSO3
Mass	1.525	0.952		2.476
Mole Wt	64.066	40.005		104.062
Moles	0.024	0.024		0.024

Delta = 0.000

Reaction #2 b:

	NaHSO3	+ NaOH	---->	Na2SO3	+ H2O
Mass	2.476	0.952		3.000	0.429
Mole Wt	104.062	40.005		126.060	18.016
Moles	0.024	0.024		0.024	0.024

Delta = -0.000214

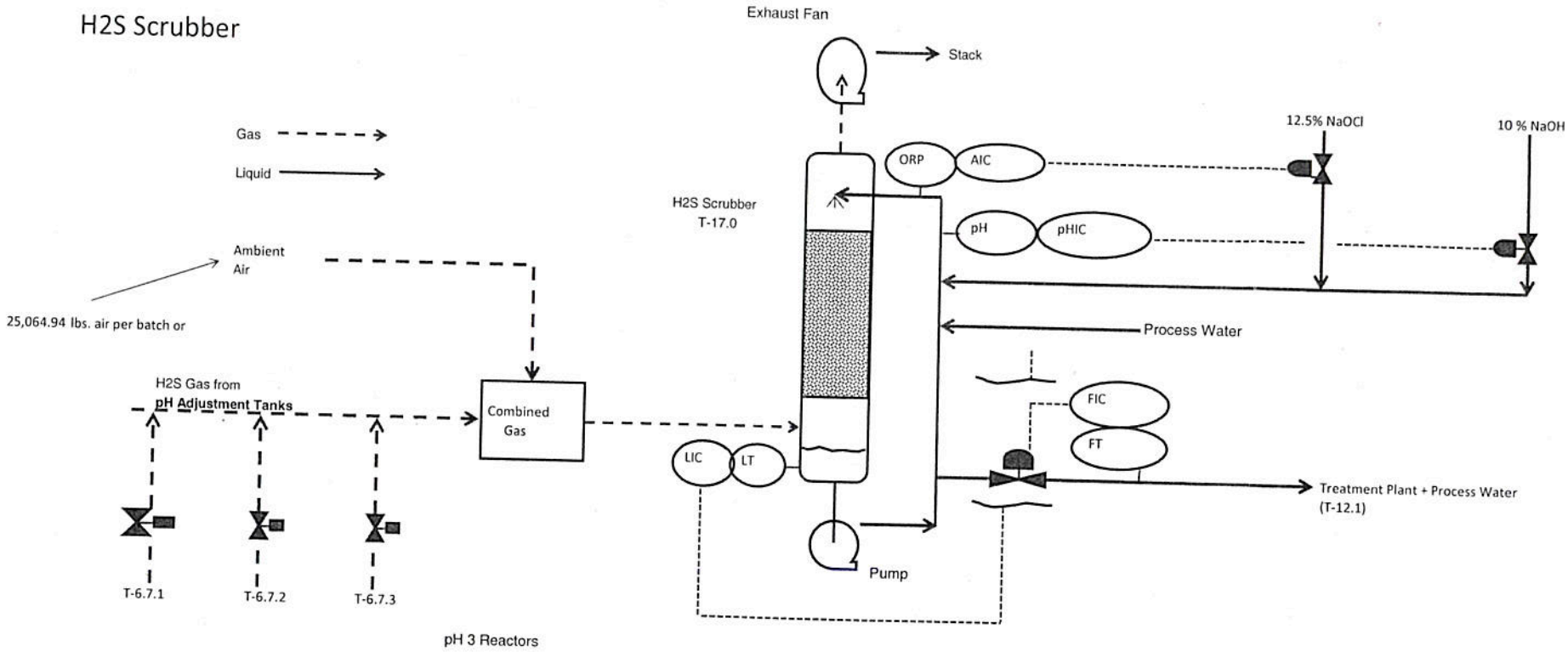
Vapor from Scrubber: Assumption: Scrubber runs at 20°C

This is an AVERAGE calculation for the entire day

	lb/day	
N2	173,023.27	
O2	52,561.18	
H2S	2.26	Assumption: Scrubber is 99% efficient
SO2	0.14	Assumption: Scrubber is 99% efficient
H2O	27.15	Assumption: Water comes out of scrubber at 10% of vapor inlet mass (most is condensed)
	225,613.99	

Physical Concept

H2S Scrubber



Scrubber Flowrates Estimate for NYSDEC Permit

NH3 Scrubber

NH3 & H2O Vapor Out of Crystallizers (per batch)

Batch Input to Crystallizer

Material

H2O	41,519.06
NH3	1,600.68
NH4Cl	488.70
(NH4)2WO4	8,212.21
(NH4)3VO4	64.31
Total	51,884.95

Assumption: 2.95 lbs. of ammonia remain in the crystals

NH3 Vapor:

1. "Free Ammonia" boiled off = 1,597.73 lbs

2 "Chemical Ammonia" = 574.585 lbs. 2,172.32 Total lbs. per batch
(Below)

Reaction:

	12 (NH4)2WO4	----->	(NH4)10W12O41.5H2O	+	14 NH3	+ 2 H2O
Mass	8,212.206		7,550.796		574.585	86.826
MW	284.000		3,133.520		17.032	18.016
Moles	28.916		2.410		33.736	4.819

Delta = 0.000

H2O Vapor:

H2O in charge :	41,519.06
H2O made in reaction:	86.83
H2O remaining in batch:	9,255.01
	32,350.87 Total lbs per batch

There will be 2.4 batches per day, so:

Vapor to Ammonia Recovery System (ARS):

	lb/day
NH3	5,213.56
H2O	77,642.10
	82,855.66

NH3 & H2O Vapor Out of Calciners

Ammonia/Water Vapor		X 24 hrs
N2	22.27 PPH	534.40 lbs.
NH3	39.42 PPH	946.04 lbs.
H2O	75.98 PPH	1,823.44 lbs.
	137.66 PPH	3,303.89 lbs.
	Steady Flow	

Total from both systems to the ARS:

	lbs./day
N2	534.40
NH3	6,159.60
H2O	79,465.54
	86,159.54

Ammonia to Scrubber:

	lbs./day	
NH3	615.96	Assumption: (90% of the NH3 dissolves in the condensate)

Off-Gas from Scrubber

This is an AVERAGE calculation for the entire day

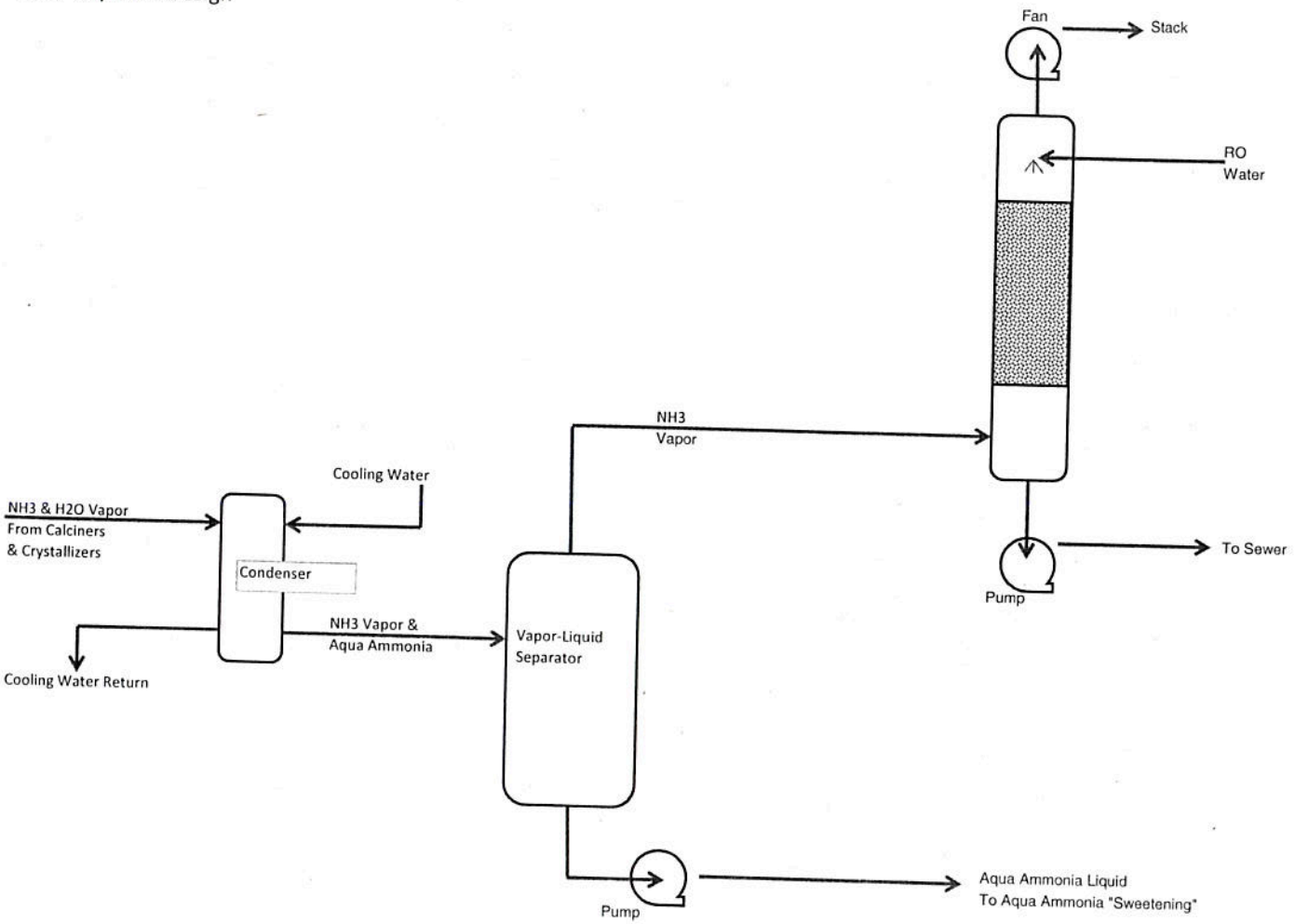
	lbs./day	
N2	534.40	
NH3	36.96	Assumption: the ARS is 94% efficient
H2O	38.19	Assumption: most of the H2O is condensed in the scrubber
	942.16	

NOTE: I do not have a maximum flow calculated, as this system is not designed yet.

Physical Concept

NH3 Recovery System

Ammonia Recovery System
Croll-Reynolds Design



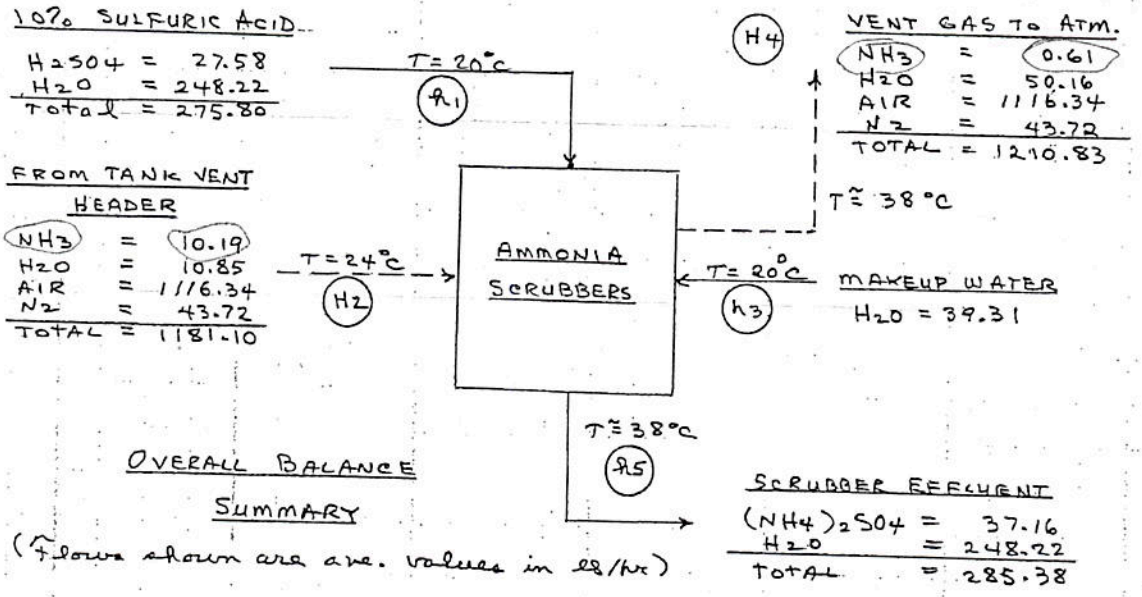
CONESTOGA-ROVERS & ASSOCIATES

PROJECT No.: 630770 60
PROJECT NAME: NIAGARA REFINING NH3 SCRUBBERS
DESIGNED BY: R.W. FOSTER

DATE: 1/12/12
CHECKED BY: RPM
PAGE 1 OF 3

NIAGARA REFINING NH3 VENT SCRUBBERS

MATERIAL & ENERGY BALANCES



OVERALL BALANCE SUMMARY

(Flows shown are ave. values in lb/hr)

This balance is based on the peak NH_3 flow venting during the simultaneous filling of three tanks containing aqua NH_3 in Niagara Refining's planned ammonium paratungstate (APT) production operations. See also separate Excel spreadsheet.

NH_3 Conversion = 94%

$$\underset{17.032}{2\,NH_3\,(g)} + \underset{98.082}{H_2SO_4\,(aq.)} \longrightarrow \underset{132.146}{(NH_4)_2SO_4\,(aq.)}$$

(9.58 lb NH_3; 27.58 lb H_2SO_4; 37.16 lb $(NH_4)_2SO_4$)

ΔH_{s0}: $2(-11.04)$ $\quad -216.90 \quad -283.34$

$$\Delta H_R = -283.34 + 2(11.04) + 216.9$$

$$\Delta H_R = -44.36 \text{ cal/gm mol } (NH_4)_2SO_4 \text{ or}$$

$$\Delta H_R = \frac{-44.36 \times 1800}{132.146} = -604.24 \text{ Btu / lb } (NH_4)_2SO_4$$

Total Reaction Heat = $604.24 \times 37.16 = 22\,454$ Btu/hr

Pump Heat Input

Two pumps will circulate scrubber liquor over the venturi scrubbers. Size for 60 gpm @ 200 ft each. Power Required ≅ 8 HP each.

Heat Equivalent = (2)(8)(42.44)(60) = 40742 Btu/hr

Conductive Heat Losses

Take as 10% of combined reaction + pump heat input.
This is 0.10 (22454 + 40742) = 6320 Btu/hr

Calculate Equilibrium Temperature & Water in Vent Gas

Use enthalpies & take h = 0 @ 20°C.
Therefore, h_1 & h_3 = 0.

(H2)

H_{NH3}	= (10.19)(0.52)(24-20)(1.8)	=	38
H_{H2O}	= (10.85)(1055.5) + 10.85(0.45)(24-20)(1.8)	=	11487
H_{air}	= (1116.34)(0.25)(24-20)(1.8)	=	2009
H_{N2}	= (43.72)(0.25)(24-20)(1.8)	=	79
Total	=	=	13613 Btu/hr

Determine Equilibrium Temperature by Trial & Error

Try T = 37.7 °C (final trial)
P'_{H2O} = 48.7 mm Hg (vapor pressure)
P_t = 1 atm = 750 mm Hg (WNY)

$$\frac{n_{H2O}}{n_{noncond}} = \frac{P'_{H2O}}{\bar{P}_{noncond}}$$

$$\frac{n_{H2O}}{\frac{1116.34}{29} + \frac{43.72}{28.02} + \frac{0.61}{17.032}} = \frac{48.7}{750 - 48.7}$$

n_{H2O} = 2.784 lb mol/hr

This equates to 50.16 lb/hr H_2O in vent gas.

Calculate H4 & h5 Using this Temperature & Water Flow

(H4)

H_{NH3}	=	$(0.61)(0.52)(37.7-20)(1.8)$	= 10
H_{H2O}	=	$(50.16)(1055.5) + (50.16)(0.45)(37.7-20)(1.8)$	= 53663
H_{air}	=	$(1116.34)(0.25)(37.7-20)(1.8)$	= 8892
H_{N2}	=	$(43.72)(0.25)(37.7-20)(1.8)$	= 348
Total	=		= 62913 Btu/hr

(h5)

$h_5 = (285.38)(0.86)(37.7-20)(1.8) = 7819$ Btu/hr

Heat Balance Check

$h_1 + H_2 + h_3 + \Delta HR + Q_{pump} = H_4 + h_5 + Q_L$

$0 + 13613 + 0 + 22454 + 40742 = 62913 + 7819 + 6320$

$76809 \neq 77052$ (?)

Very Close

Complete overall balance schematic on P-1.

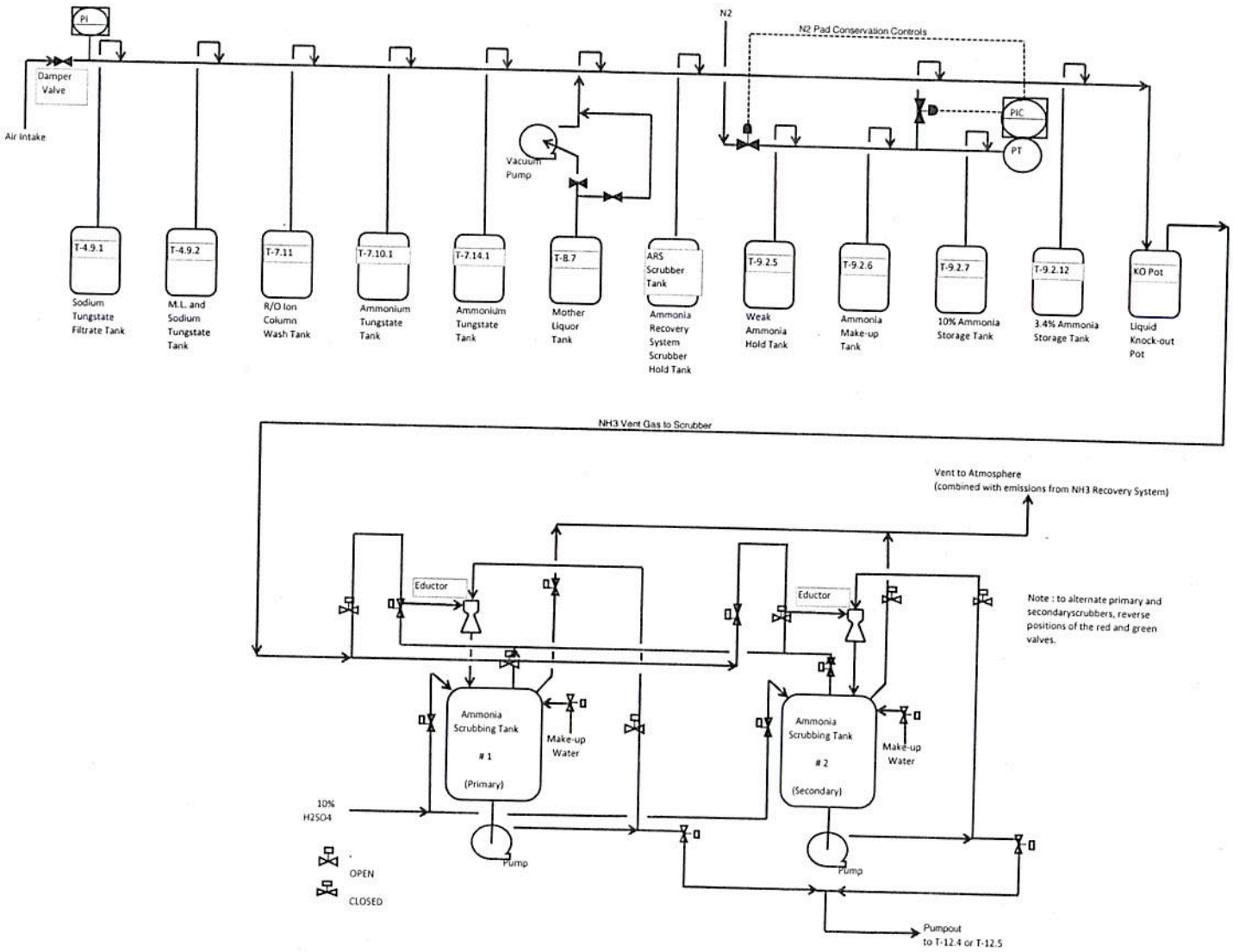
Volumetric Flow: Vent Gas to Atmosphere

$$\text{Mol/Hr} = \frac{0.61}{17.032} + \frac{50.16}{18.016} + \frac{1116.34}{29} + \frac{43.72}{28.02} = 42.875$$

$$\text{ACFM} = \frac{(42.875)(10.73)(37.7+273.2)(1.8)}{\left(\frac{750}{760}\right)(14.7)(60)} = 295.8$$

$$\text{Average M.W.} = \frac{1210.83}{42.875} = 28.241$$

Ammonia Header Schematic & Ammonia Scrubbers



ATTACHMENT A7

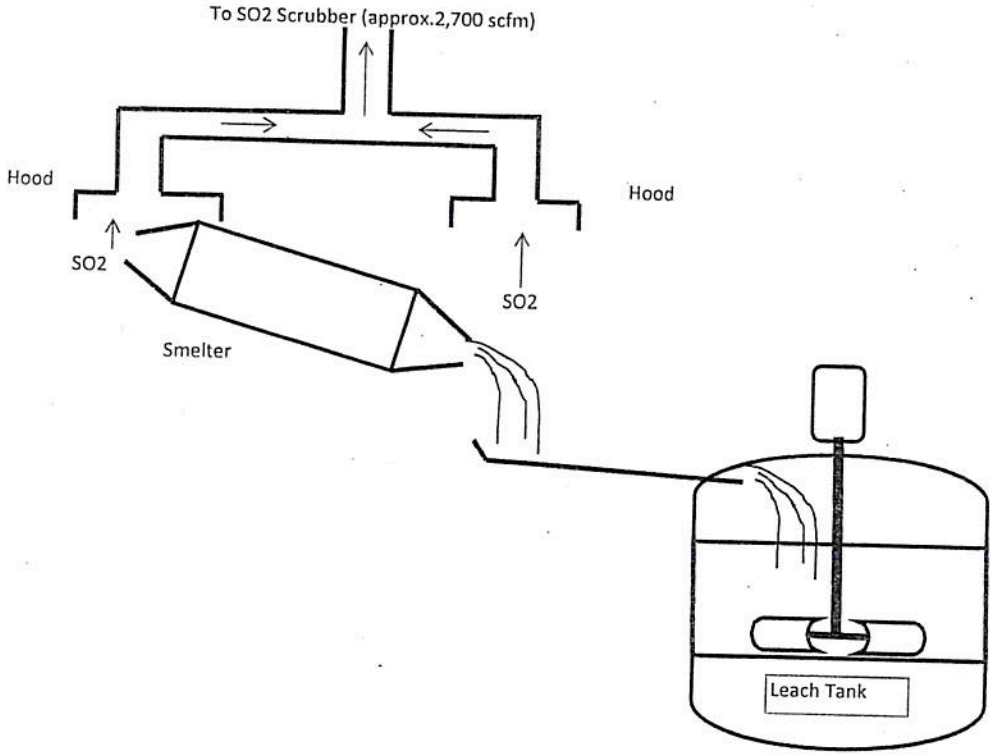
FUGITIVE EMISSIONS

Fugitive Emissions

H2S

None, there is no opening in the system

SO2



Assumption: SO2 generation from the reaction stops when the burner to the smelter is turned off
Assumption: There is approximately 10 ppm/sec. SO2 emitting from the molten Sodium Tungstate, which is SO2 "stuck" in the mas:
Assumption: The hood is 80% efficient, so it captures 80% of the SO2 (8 ppm)
Assumption: 2 ppm/sec. is lost to the atmosphere as "fugitive emissions.'

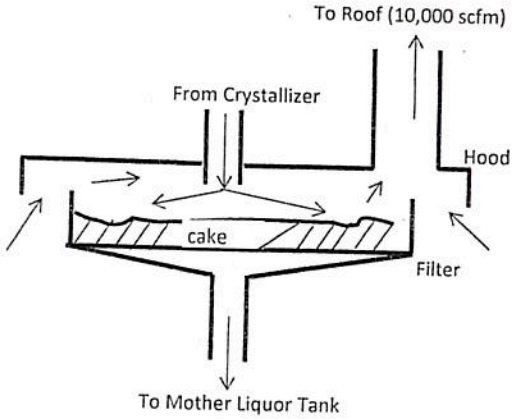
Assumption: This lasts for 15 minutes during a "dump" and 1 hour while charging scrap/Na2SO4
With three batches per day, the amount of SO2 that is lost is the following

2 ppm = 0.000002 lbs

Time = 1.25 hrs X 60 min/hr X 60 sec/min X 3 batches per day
= 13,500 seconds/day

Fugitive Mass Emitted = 0.027 lbs per day
= 8.91 lbs per year (based on a 330 day year, or 90% operating factor)

NH3



Assumption: There is approximately 20 ppm/sec. NH3 emitting from the filter cake
Assumption: The hood is 80% efficient, so it captures 80% of the NH3 (16 ppm
Assumption: 4 ppm/sec. is lost to the atmosphere as "fugitive emissions."

Assumption: This lasts approximately 1 hour for the filtration, and the washing
Assumption: After the washing, the NH3 is washed into the mother liquor; there is no more NH3 emission

24 ppm = 0.000024 lbs.
6 ppm = 0.000006 lbs.

Time = 1.0 hrs X 60 min/hr X 60 sec/min X 2.4 batches per day
= 8,640 seconds/day

Fugitive Mass Emitted = 0.207 lbs per day to the roof
= 68.429 lbs per year (based on a 330 day year, or 90% operating factor

Fugitive Mass Emitted = 0.052 lbs per day to the plant atmosphere
= 17.107 lbs per year (based on a 330 day year, or 90% operating factor

Fugitive Mass Emitted = 0.259 lbs per day total
= 85.536 lbs per year (based on a 330 day year, or 90% operating factor

Airflow = 10,000 cfm
= 26.385 lb moles/min
= 764.380 lbs./min

Concentration of NH3 in air up the stack = Non Detectable