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KAVAMATKOT APIKHOIYIT
DEPARTMENT OF JUSTICE
MINISTÈRE DE LA JUSTICE

June 19th, 2003

Mr. Philippe Di Pizzo
Executive Director
P.O. Box 119
Gjoa Haven, NU
X0B 1J0

BY FAX 1 867 360 6369

Dear Mr. Di Pizzo:

Re: Licence NWB1NAN0208 – HHERA and Phase 2 ESA - GN Report (H&SS) and Comments

This is the Government of Nunavut's fourth letter responding, to the HHERA and Phase 2 ESA Reports submitted by Canzinco/ Breakwater Resources Ltd. pursuant to License NWB1NAN0208.

As requested by NWB in a letter dated June 2nd, 2003, we are enclosing for consideration at the upcoming teleconference of regulators, the Review Report prepared for Nunavut Health and Social Services, by Drs. Bob Rogers and Brian Zelt. The GN will also make every effort to ensure that these experts are available during the Regulators' teleconference, to respond to questions raised by other parties or experts attending.

On behalf of affected Government of Nunavut regulators and other interests, I also take this opportunity to restate the concerns identified in our correspondence to the Board of April 25th and May 21st, 2003. Once again, we reiterate that the HHERA in particular, is not a sound basis for decision-making as presently drafted, and that the defenses filed by CanZinco Ltd, on June 16th 2003 and previously, do not provide a sufficient answers to the concerns that we have raised.

It is a point common to all peer reviewers of these technical reports, that the reliance on 1985 soil geochemistry to provide background data for the risk assessment and the development of SQRO's has been inappropriate. The gravity of these deficiencies in terms of the scope and accuracy of background data, and of the possibility for inappropriately permissive outcomes, are among the concerns re-emphasized in the attached Review Report.

In addition, the Review Report filed herewith goes well beyond those shared concerns, to reflect a variety of important additional corrective input, given from a qualified human health perspective, which has not been seen in previous peer reviews. This perspective brings into clearer focus the nuances of toxicology and health risk analysis, which other experts have tended to overlook, or approach merely as fixed "formula" components.

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On behalf of the GN it is submitted:

- The HHERA, proposed SQRO's and relevant portions of the Phase 2 ESA should be treated as a first iteration only, requiring further dialogue and revision in accordance with the Review Report, before NWB approval is given; and

- Wider soil sampling to establish reliable background data be ordered, and performed by the Mine as soon as feasible, and that upcoming Technical meetings or teleconferences should include the discussion in advance, of the proposed control site, included metals, and other aspects of sampling program that the Mine proposes to use to obtain this needed background data.

Thank you for the opportunity to provide these comments.

Sincerely,

Susan Hardy,
Legal Counsel

NWB Senior Technical Advisor

From: "Hardy, Susan" <SHardy@GOV.NU.CA>
To: "'Patrick Duxbury'" <nunavutwaterboard@nt.sympatico.ca>
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Sent: June 19, 2003 1:40 PM
Attach: 2003 06 19 - FINAL - Nanivisik HHERA Review.pdf; 2003 05 03 - BRCV long.doc; 2003 05 03 - Zelt-Brief.v1.pdf; 2003 05 03 - Zelt Experience-FtMcMurray-SAGD.v1.pdf; 2003 06 19 - GN Medical Health Review Report - Cover Ltr.doc
Subject: RE: GN Report

Please find enclosed a Review Report obtained by the Nunavut Department of Health and Social Services the Technical Review of the Nanisivik HHERA and Phase 2 ESA, togther with a GN Covering letter and copies of expert CV's.

These documents will also be forwarded to the Board by fax.

Susan L. Hardy, Legal Counsel
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Review Comments on:

Human Health and Ecological Risk Assessment
Nanisivik Mine,
(for CanZinco Ltd.,
by Jacques Whitford Environmenal Limited,
January, 2003)

Submitted to

Bruce Trotter
Environmental Health Specialist
Health and Social Services
Government of Nunavut
Box 1000 Stn. 1000
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19 June 2003

Prepared by

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1 INTRODUCTION

Toxcon Health Sciences Research Centre Inc. (Toxcon) was contracted by the Government of Nunavut to carry out a review of the Human Health Risk Assessment portion of the Jacques Whitford Environment Limited (January, 2003) report to CanZinco Ltd. Entitled "Human Health and Ecological Risk Assessment Nanisivik Mine, Nunavut". This review was performed by Dr. Bob Rogers, President, Toxcon HSRC Inc. (Edmonton) and Dr. Brian Zelt, President, Zelt PSI (Calgary).

1.1 OBJECTIVES

The review is limited to the human health risk assessment portion of the HHERA as prepared by Jacques Whitford Environment Limited (JWEL).

Specifically, the authors were to conduct an evaluation of the:

- conclusions;
- potential adverse health effects of site-related lead levels on pregnant women and in particular, the developing foetus;
- Phase 2 ESA with conclusions and recommendations as it relates to the human health; and
- site being considered for use as a training centre (short-term use on a long term basis) with permanent residents, possibly with families, living on-site, and undertaking activities related to reclamation.

1.2 BACKGROUND RESOURCES AVAILABLE

The technical documents available during the review that provided background information included:

- *Human Health and Ecological Risk Assessment Nanisivik Mine,* for CanZinco Ltd., by Jacques Whitford Environmenal Limited, January, 2003.

- *2002 Phase II Environmental Site Assessment,* Nanisivik Mine, Nunavut, for CanZinco Ltd. by Gartner Lee Limited, January, 2003.

- *Review of JWEL HHERA for Metals Contamination at Nanisivik Mine and Townsite, Nunavut*, for EBA Engineering Consultants Ltd., by BC Research Inc., March 2003.

- 2003 04 25 - FSC Report - Environmental Section 6, by FSC Architects and Engineers.

- *Re: Licence NWB1NAN0208-HHERA, Phase 2 ESA and Emergency Response Reports - GN Comments,* Letter to Mr. Di Pizzo, May 5,2003, from Nunavut, Department of Justice, Susan Harding.

- *Preliminary Comments: On the compassion between Nanisivik and Polaris Mine Closures*, 2003 05 12 - JWEL Response Polaris Nanisivik Discrepancy.doc

- *Comparison of HHERA's Done for Nanisivik and Polaris Mine Closures*, Prepared for EBA Engineering Consultants Ltd. by BC Research Inc., May, 2003.

HHERA (Human Health and Environmental Risk Assessment) and the Report refer to *Human Health and Ecological Risk Assessment Nanisivik Mine,* for CanZinco Ltd., by Jacques Whitford Environmenal Limited, January, 2003.

2 Results and Discussion

2.1 BACKGROUND CONCENTRATIONS

One of the principal initial steps in the assessment of a contaminated site is a clear understanding of background concentrations for the area affected. This is a difficult issue when the site is large, multi-segmented and contamination has occurred over many years.

CCME Guidelines state that a background concentration is:

> "...a representative ambient level for a contaminant in soil or water. ... Background concentrations should be determined from an area at the site under investigation, or at a nearby site, sufficiently removed from the source of contamination to be safely presumed to have been unaffected by contaminant release" (March 1996: Guidance Manual for Developing Site Specific Soil...).

The current Human Health Risk Assessment (HHRA) under review has made use of a 1985 data set for the Nanisivik mine as being representative of background concentrations. Neither the data nor the documentation of that data set was available for this review. However, based on limited information available from the HHRA, the 1985 data set appears to have significant issues associated with its use:

- It is presumed that the 1985 data set was selected to represent pre-development conditions, however, the site development history dates back more than ten years before 1985. Therefore, the 1985 data could be affected by developments or undisclosed environmental practices from that era. The ESA Phase II demonstrated that mine activities have had a cumulative effect on the soil by direct deposit, spill, indirect (traffic) and by deposition;

- There was no information presented regarding where the 1985 samples were taken. The 1985 data set was not provided in an appendix. No statistical information regarding the data set was provided (sample sizes, distributions, standard deviations).

- The 1985 data set appears to only contain information on Cu, Pb and Zn.

An important objective of the remediation plan is to determine level of clean up required. In the Nanisivik development study area, the soils reflect high levels of natural mineralization. A good understanding of the region's

natural levels of the minerals is required before cleanup remediation options can be assessed. The natural mineralization of soils is likely to reveal isolated 'hotspots' due to the sparse soils distribution. It is therefore necessary to describe the distribution of concentrations that are natural for the area.

A statistical comparison of the distribution of background concentrations to the distribution of mine development influenced soils concentrations will assist in determining the scope of the remediation assessment. 'Hot-spots' specific to mine development disturbed areas will require individual attention to relate concentrations to background and environmental due diligence.

2.2 RISK BASED REMEDIATION

A risk-based framework is an iterative process, whereby successive levels of data, analysis and risk characterization are applied. The CCME guidelines reflect this iterative approach. Important elements in the risk assessment process are: the description of model; statement of uncertainty (both in the data and in the modelling analysis and how that uncertainty affects the conclusions); and, assumptions made and limitations of the assumptions. In the risk characterization step of the assessment, these limitations are reviewed with respect to the assessment objectives to determine whether additional iterations are required. Proper management of risk (decisions) cannot be conducted without this transparency. The lack of transparency appears to be a major fault in the HHRA. An element of transparency in an assessment report are the appendices where data used in the report are listed and qualified, calculations are well documented, toxicological endpoints are well researched and referenced.

The CCME Guidelines (1996a) for risk based contaminated site remediation are based on estimating exposure in a two-part model. The Tolerable Daily Intake (TDI) of a toxic chemical is divided into a component influenced by the soils on the contaminated site (an Estimated Daily Intake, EDI_s) and background exposure through all media not influenced by the site (EDI_b). The simplified site-specific remediation framework presented by CCME (1996a) over-simplifies the exposures if the site poses multi-media or multi-segmented exposures. In this latter case, a more detailed exposure scenario and back-calculation or site-specific remedial soil concentrations would be required.

The simplified CCME approach recognises that a site can potentially impact other exposure routes and therefore limits the portion of the EDI_s/TDI to 20%. Although the HHRA used this approach for some metals, it claimed to represent all pathways for Pb and Cd, thereby using 100% of the residual TDI. This assumption can be argued.

2.3 HAZARD SCREENING GUIDELINES

Many of the human health generic soil guidelines for screening appear to be incorrectly stated in their Table 6.1 (also in Table 7.1 for the ecological health). Most of the values reported in their Table 6.1 appear to be grossly over-stated, thereby screening out metals possibly inappropriately. In Table 2.1 and Table 2.2 below, the screening guidelines are compared and the conclusions compared using the corrected numbers.

Table 2-1: Town Area-Residential/Parkland (Adapted from CanZinco 2003, Table 6.1)

Metal	Applicable Guideline (CanZinco 2003, Table 6.1)	Ref (CanZinco 2003, Table 6.1)	Applicable Guideline	Ref	Carried Forward (CanZinco 2003, Table 6.1	Carried Forward
Ag	98	MOEE	20 (20)	CCME (MOEE)	N	N
As	12	CCME	12	CCME	Y	Y
B	7000	USEPA Reg 3 *	2	CCME	No data	No data
Cd	14	CCME	10	CCME	Y	Y
Co	2700	MOEE	50 (40)	CCME (MOEE)	N	**Y**
Cu	1100	CCME	63	CCME	N	**Y**
Ni	310	MOEE	50 (150)	CCME (MOEE)	N	**Y**
Pb	140	CCME	140	CCME	Y	Y
Tl	1	CCME	1	CCME	Y	Y
Zn	1600	MOEE	200	CCME	Y	Y

* Region III was referenced instead of perhaps, the more appropriate Region IX-Alaska

Table 2-2: Dock Area-Industrial (Adapted from CanZinco 2003, Table 6.1)

Metal	Applicable Guideline (CanZinco 2003, Table 6.1)	Ref (CanZinco 2003, Table 6.1)	Applicable Guideline	Ref	Carried Forward (CanZinco 2003, Table 6.1	Carried Forward
Ag	240	MOEE	40 (40)	CCME (MOEE)	N	N
As	12	CCME	12	CCME	N	N
B	180,000	USEPA Reg 3 *	92,000	USEPA Reg III	N-(n=1)	N
Cd	2,090	CCME	22	CCME	N	**Y**
Co	7,200	MOEE	300 (80)	CCME (MOEE)	N	N
Cu	20,000	CCME	91	CCME	N	**Y**
Ni	710	MOEE	50 (150)	CCME (MOEE)	N	N
Pb	8,200	CCME	600	CCME	N	**Y**
Tl	32	MOEE	1	CCME	N	**Y**
Zn	100,000	MOEE	360	CCME	N	**Y**

* Region III was referenced instead of perhaps, the more appropriate Region IX-Alaska

The HHRA screened-out the soil concentration for Boron, which was justified because there was only a single soil sample. In risk analysis, however, all available information should be considered and its quality assessed. Should Boron have been identified as a potential contaminant, with n=1, then a data gap should have been identified and a weight of evidence argument formulated to characterize the risk.

2.4 SPECIFIC ISSUES IDENTIFIED IN THE NANISIVIK MINE HHRA

The following table was constructed in an attempt to address what we felt were significant issues within the HHRA. We have provided where possible references to specific sections/pages. Note that we have attempted to be constructive in our review and recognize that the science of risk assessment is quite diverse. Thus, we acknowledge at the outset that the manner in which two risk assessors approach a contaminated site will vary. Also note that this table should not be construed as reporting all of the deficiencies in the HHRA.

Table 2-3: List of Issues identified with HHRAA

	ISSUE	DESCRIPTION	CONSEQUENCE
1	Arbitrary rejection of data/information	pg.15 - arbitrary criteria for limited data, therefore no health assessment was performed for noxious chemicals where. n<5, rather than using a weight of evidence approach. A sample of n=1 is sufficient for a risk assessment, especially if the concentrations indicate levels above guidelines.	Boron was screened out of the assessment whereas the concentrations presented indicated a potential for concern. Boron should have been included in the risk-based assessment with a note that further data may be required
2	The mean background soil concentration was used instead of the 95-percentile.	pg.15 - Exposure Point Concentration (EPC) was determined based on the 95%-UCL of the log-transformed data. This EPC is an estimate of the mean of the data and not of the range of observed data.	In this simplified or screening level assessment, assumptions made through the modelling process should err on the conservative-side. This approach produces an estimate of risk that greater than expected but represents a reasonable-maximum exposure. Using the mean value (or the UCL on the mean) does not represent a reasonable maximum exposure
3	Incomplete assessment of risk due to exposure to noxious chemicals discovered on the site.	The ESA Phase II noted several areas where petroleum hydrocarbons exceeded screening levels, resulting in potential areas of concern. However, the HHRA has concentrated only on the metals.	The assessment is not complete.

4	Poor land use description	The reclamation closure plan, alluded to in the ESA Phase II document, was not made available for this review, nor where the details of the closure plan reviewed for the HHRA. Therefore land use scenarios are only generically defined.	An important part of the risk assessment is the description of what the risks are estimated for (i.e., clearly defined future land use). Even though future land use may be not be well predicted, the conceptual model must be clearly defined so that limitations of the assessment may be cautioned to the risk manager.
5	Apparent errors in the selected soil screening concentrations.	Many of the human health generic soil guidelines for screening appear to be incorrectly stated in Table 6.1 (also in Table 7.1 for the ecological health). Most of the values reported in Table 6.1 appear to be grossly over-stated, thereby screening out metals possibly inappropriately.	It appears that Ag, Cu, Co, Ni, Zn have been screened out in some scenarios, inappropriately.
6	Background risk has not been appropriately characterized.	Whether the CCME guideline or a more inclusive assessment were to be performed, the background risk to residents and users of the area needs to be assessed appropriately using relevant exposure information for the region. The HHERA used inappropriate: air concentrations, potable water concentrations, and dust concentrations.	Background risk, especially for trace metals such as lead, must be properly and conservatively estimated for exposures in the region. An improper or low bias in the background risk may lead to higher than acceptable soil remediation criteria.
7	Undefined potable water concentrations.	Wind-blown fugitive dust was identified as significant mechanism of dispersal of potentially noxious chemicals in the area. The quality of potable water has not been investigated nor the break in the link between dust exposures from West Twin area not reaching the potable water source.	An important exposure pathway has not been characterized. This affects both a background risk and potentially impacts from the remediated soils.
8	Inappropriate dust emission estimate	Dust emission rates were take generically from USEPA Region 3 (Atlanta) as being representative of the dust emission rates from the fugitive emission from the mine area. This was grossly erroneous.	Dust emission rates that are site specific allow the prediction of wind blown fugitive dust from soils to exposure areas. Impacts from fugitive emissions represent an important mechanism of exposure to wildlife and human health. This was not properly estimated.
9	Inappropriate air concentrations	Air concentrations for background risk exposures were taken from urban site studies rather than from measured site-specific concentrations or literature review for remote/polar locations. This was erroneous.	Concentrations of trace elements in air differ between urban and remote locations. A principal reason for this is the because combustion sources play an important role in trace element concentrations in the $PM_{2.5}$ range and fugitive dust plays an important role in the PM_{10} and TSP range.
10	Missing meteorological information	No on-site meteorological information presented, such as: actually precipitation intensities and frequencies; and, hourly statistics of wind direction and wind speed.	The assessment of future impacts from contaminated soils was not assessed, especially as it may relate to future soil contamination for the town site and to the potable water source.
11	Contamination and consumption of fish and game trivialized	The fish and game exposures to soils, vegetation and sediments have been simplistically characterized. Fish and marine mammals have not been characterized. The characterization of the concentrations in game does not appear to be appropriate, possibly a result of the simplified CCME guideline framework.	The impacts to regional wildlife appear to be trivialized and thereby the impacts to humans who may consume fish and game have been trivialized. Reasonable maximum exposures to fish and game have not been determined.

12	Lead exposures do not make use of current modelling methods.	There has been much concern over exposures to infants, the foetus and adults (particularly mothers of child-bearing age) to lead. Because of these concerns and the range of lead exposures, models exist that are particular to lead that account for bioavailability and kinetics to developing infants and their blood lead levels. These models may be readily applied to the Nanisivik area but are dependent on proper estimating methodology and interpretation of results.	Lead exposures may have been trivialized, especially for residents who may be exposed to high levels of lead in their homes and to multi-site outdoor soil and dust concentrations. Although surface soils may be snow covered for much of the year, land-use scenarios (i.e., construction or below grade exposures) may result in soil/dust exposures atypical for the region. Careful consideration of land-use and soil/dust exposure scenarios is warranted. Screening level application of the IEUBK lead exposure model (USEPA 2002; USEPA 2001) for this review suggests that the combined dust/soil concentrations have the potential to reduce lead remediation levels significantly.
13	The HHRA states that it meets CCME, Health Canada and U.S. EPA guidelines	It appears that the entire HHRA is driven more by CCME and Health Canada guidelines than those of the U.S. EPA. This gives the reader a false sense of acceptability of the overall HHRA across a broad regulatory sector. This is not necessarily true.	The U.S. EPA recently published two revised guidelines that should have been at least reviewed for this HHRA (USEPA 2003a; USEPA 2003b).
14	The HHRA makes numerous references to "adverse (health) effects" in humans and yet fails to define for each chemical what constitutes an "adverse health effect".	In Section 1.1, the report states that the basic purpose of the study was to develop SQROs in surface soil "..below which no adverse health effects would be expected". This is a probabilistic concept that is based on the existing site conditions, characteristics of the exposed human receptors at Nanisivik, and what is known about each chemical in the current open scientific literature. For example, TDI's or NOAEL's reported in the literature are often limited in terms of their applicability to broader human populations. While the HHRA acknowledges the limitation of the CCME guidelines, it also fails to focus the reader on the specific adverse effect that is being protected against and why Nanisivik receptors would not be impacted.	The reader is left to believe that if a SQRO is less than a specific value, then no adverse health effects of any type will occur at this site for any human receptor under any exposure condition at any time. Unfortunately, blanket assumptions such as this are usually invalid. The report should discuss very clearly the limitations of its report.
15	No clear definition of the human receptors at the Nanisivik mine site.	The HHRA states (Section 2.1.2, p.8) that the "…purpose of the HHERA was to identify the most sensitive human …receptors.." and yet on p.20 states that "…the human receptor is characterized as an adult or child with no extreme sensitivities." Furthermore, the HHRA reveals that a limited community consultation was undertaken (see Section 4.0, p.14). Copies of the High Arctic Community Questionnaire were not available to Toxcon/Zelt PSI. The short description of the method of interviewing local residents leads to a number of unanswered questions.	The HHRA fails to deal adequately with more susceptible human receptor health conditions (e.g. pregnancy, early childhood development, asthma, COPD, etc.). It also provides no information on important socio-demographic parameters such as community age/gender structure, typical activities, number of children living in the townsite, smoking/drinking/drug use histories; food consumption rates and patterns etc. Without a thorough community exposure profile, the validity of the SQRO's are questionable. This is a major data gap.

16	No clear understanding of the current health status of Nanisivik residents/workers.	Following from the previous point, the HHRA does not report anywhere the existing health status of any of the residents or workers. This would be invaluable information in making the risk assessment more relevant to Nanisivik. For example, given the high lead levels in the area, it is logical to assume that residents/workers may already have elevated blood lead levels. If this is so , then the calculated SQRO may be too high.	By not gathering any health status data, the HHRA fails to address an important issue, i.e. the degree of protection (i.e. margin of safety) that can be expected at the calculated SQRO's for individuals who might already have compromised health.
17	Focus of HHRA only on surface soils may be inadequate.	The HHRA indicates that only the first 10 – 15 cm of surface soil was considered for the calculation of SQROs. While the Report indicated that subsurface concentrations of key metals were lower, the HHRA does not examine the potential exposures in the future if surface and subsurface soils are disturbed through new building/facilities construction activities.	While key contaminants of concern appear currently to be in the surface soil layer, the Report needs to address potential health risks for future site uses in which considerable soil disturbance occurs. This could affect town/mine site exposures.
18	Young child (i.e. 6 mos.-4 yr old toddler) used as "most sensitive recptor" for all risk calculations and conclusions.	Throughout the HHRA the toddler is used as the most sensitive receptor. The Report did not provide clear evidence from the literature that this is a valid assumption for each chemical of concern. Furthermore, this should be done for all metals, not just those that are below a CCME guideline.	The Report acknowledges that biological end-points and mechanisms of action for each metal are different without demonstrating this clearly for the toddler. There are many health conditions that may make other receptors more sensitive (e.g. kidney disease in an adult; immunosuppression in an older adult). This is an important data gap.
19	Exposure definitions too qualitative.	In Table 6.2, the Report provides a number of exposure definitions that makes reference to a "qualitative method" and includes the concept of "likelihood". This information is then used to develop Table 6.3 from which the final conceptual risk characterization model is developed (Figure 5).	This approach implies that a standardized method was used. If so, then it should be referenced. If not, then the reader should not be misled. The use of terms such as "not expected", "probably not occur", "might be expected", and "is expected" are meaningless without some quantitative discussion of "likelihood".
20	Potential exposure scenarios incomplete	Table 6.3 does not consider all routes of exposure (e.g. inhalation of dust) and downplays others (e.g. dermal contact with soil – possible). This information is ultimately used in deriving the TDI for the town and mine sites suggesting that this calculation may be erroneous. Furthermore, combined U.S. FDA and Health Canada survey data is used without any field validation in Nansivik to calculate an EDI. Again, for drinking water, it appears that data from Ontario was relied upon as opposed to collecting and analyzing water from Nanisivik for the chemicals of concern.	It is surprising that the main routes of exposure for lead are food and household dust. Given that the EDI for food was not validated in the field, it is questionable whether this value has any merit in Nanisivik. This is a significant data gap. The same applies for lead in drinking water

21	Literature cited not most recent.	The Report states in Table 6.12 that the most current toxicity information available from Health Canada, U.S. EPA's IRIS database and the WHO was employed. While this may be true, an extensive and current literature search should have been conducted on each chemical of concern. Failure to do this undermines the validity of the HHRA. It should reflect both site-specific conditions as well as current scientific knowledge.	A review of the lead toxicity profile does not make use of the most recent references, e.g., lead (USEPA 2001, USEPA 2002, ATSDR 2001). The HHRA should also be revised to take into account more recent articles such as Canfield et al (2003). The carcinogenicity classification of lead and the implications of the classification would have to be considered more thoroughly with respect to the proposed land-use. The objective is to ensure the SQRO's will be protective for as many health end-points as possible.
22	Form of lead/zinc exposure not described appropriately.	On p.13 of the ESA Phase II Report (GLL), it indicates that lead in the Nanisivik area occurs in the galena (lead sulphide) form. Zinc also occurs predominantly in the sulphide form. JWEL does not include a full discussion of the form of lead/zinc to which human receptors would be exposed in Nanisivik and hence overlooks the possibility that lead/zinc in these forms may be more/less toxic than TDI's reported in the literature. Furthermore, the HHRA should discuss	In the most recent 2003 ATSDR review of lead, numerous regulations and guidelines applicable to lead are reported. Several of these recognize the differences between various forms of lead. It is also recognized that the gastrointestinal bioavailability of lead can be influenced by its physical and chemical nature as well as the type of soil, the presence of other contaminants, the degree of "aging" etc. The same should be addressed for zinc.
23	Key terms not defined well.	The HHRA does not read well due to a lack of explanation of key terms. Examples: acceptable/unacceptable risk, dust, vs. particulates/particulate matter; cancer slope factor etc.	The Report assumes that all readers of the HHRA will be equally conversant with risk assessment terminology. This is highly unlikely and could be helped by inclusion of a glossary in the report.
24	Uncertainty analysis section poorly supported.	This section (6.6, pp.43-48) provides a variety of general statements without clearly indicating how these were addressed in the HHRA. Table 6.12 provides a variety assumptions and why they are "acceptable" without providing the reader with sufficient evidence to support these assumptions. For example, no explanation of how a factor is "Neutral" in its effect on risk estimates is given. Were calculations performed to demonstrate this? If so, these should have been provided.	The list of factors/assumptions provided by in the Report in Table 6.12 does not clearly demonstrate that these are the only ones that are relevant to the final results of the HHRA. The Report should provide an exhaustive list of all assumptions used.

3 Conclusions

Following our review of the January (2003) HHRA presented in *Human Health and Ecological Risk Assessment Nanisivik Mine, Nunavut* (Jacques Whitford Environmenal Limited) for CanZinco Ltd., we conclude the following:

- There is reasonable doubt in the soil remediation levels, for lead alone, before final remediation decisions are adopted. Further, there is reasonable doubt in the risk assessment processes that excluded petroleum hydrocarbons and inappropriately screened out potential noxious chemicals.

- The Human Health Risk Assessment (HHRA) could be improved through better explanations of key concepts (e.g., most sensitive receptor, acceptable versus unacceptable risk, adverse health effects, etc.).

- There are numerous data gaps that should have been addressed prior to conducting the HHRA (e.g., drinking water lead concentrations and consumption rates in Nanisivik; lead content in household dust in Nanisivik; lead content in ambient air in Nanisivik; proportion of lead in the $PM_{2.5}$ and PM_{10} fractions in ambient air in Nanisivik etc.). The report has relied on non-site-specific data/assumptions in deriving SQRO's for Nanisivik town and mine sites.

- The data gaps and incompleteness of the HHRA make formal Risk Characterization (the final step in Risk Assessment) associated with the town site being used for a regional training centre difficult. In part, a better Receptor Characterization or scenario description would assist in this process.

- Because of the high concentrations of lead found at and near the townsite, the HHRA should use current risk analysis exposure methods or models to assess the health risks to pregnant female and the developing foetus from exposure to lead.

We recognize that the Human Health and Ecological Risk Assessment (HHERA) presented is an important first step in the assessment of exposures and risk, however, it is apparent that the HHERA represents only a first iteration in the assessment of risks and that many data and modelling gaps have been identified. These gaps must be reasonably addressed before site-remediation objectives can be properly addressed and risk-management decisions made.

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Career Objective

To provide a diverse range of expertise in general, consumer product, occupational and environmental toxicology and health to organizations concerned with occupational and environmental health, environmental contaminant control, site remediation, biocide impacts and environmental/occupational risk management.

Career Summary

Over twenty-five years involvement in the areas of general, occupational and environmental health and toxicology at the field, management and research levels. Participated in the resolution of numerous occupational and environmental and consumer products problems, as well as in the development of exposure standards for both provincial and federal government agencies. As a specialist in toxicology, has served on numerous committees as an expert advisor. As an educator, has developed and delivered post-secondary courses in biology and environmental science as well as specialty courses in biology, toxicology and hazardous waste and risk management. As a consultant, has undertaken numerous projects in which all aspects of applied toxicology/environmental health have been utilized.

Experience

August 1984 - Present

Toxcon Health Sciences Research Centre Inc Edmonton, Canada

President / CEO

- Responsible for the overall development and management of the company.
- Developed and implemented GLP/GCP-compliant operating systems.
- Identifies and develops potential markets.
- Responsible for the hiring and supervision of all staff and sub-consultants.
- Sole responsibility for the preparation and submission of proposals.
- Analyses needs of clients and develops specific project work plans. This includes interaction with the media on client's behalf.
- Responsible for project management.
- Performs critical analysis of scientific literature and writes reports.
- Develops and delivers educational training programs.

August 1984 – 1988

Concordia University College Edmonton, Canada

Assistant Professor of Biology and Environmental Science