INDEPENDENT CONSULTANT REVIEW OF THE ECOLOGICAL RISK ASSSESSMENT REPORT ON THE NATURAL ENVIRONMENT OF PORT COLBORNE

CITY OF PORT COLBORNE COMMUNITY BASED RISK ASSESSMENT

WATTERS ENVIRONMENTAL GROUP INC.

CONFIDENTIAL

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CITY OF PORT COLBORNE COMMUNITY BASED RISK ASSESSMENT

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EXECUTIVE SUMMARY

Jacques Whitford (JW), as a consultant to Vale Inco (Inco), issued a final Ecological Risk Assessment report concerning the impacts of emissions from a former Inco nickel refinery on the natural environment within the City of Port Colborne, Ontario (the City). This five-volume report is entitled, "*Community Based Risk Assessment Port Colborne, Ontario; Ecological Risk Assessment Natural Environment*" and dated September 2004 (the Natural Environment Report), and is one component of a Community Based Risk Assessment (CBRA) that is attempting to address potential impacts from former Inco emissions on agricultural crops, the natural environment, and human health within the City of Port Colborne. The Natural Environment Report relates to Sections 2.1.3 and 3.1 of the *Technical Scope of Work* (TSOW) document, which was prepared by JW in November, 2000 (i.e., at the outset of the CBRA).

The objective of the ERA - Natural Environment was to determine if emissions from the Inco metal refinery present an unacceptable risk to the natural environment found in the Port Colborne area. The Ontario Ministry of the Environment (MOE) defines an "unacceptable risk" as a soil chemical concentration above a specific generic standard provided in its regulation. For nickel, that value is 200 micrograms per gram (ug/g) (or parts per million ["ppm"]).

The Chemicals of Concern (CoCs) for the CBRA currently are nickel, copper, cobalt and arsenic. Although not included as a CoC for the CBRA, there is ongoing debate about whether lead should be added to this list.

The study objective for the CBRA as described in the Technical Scope of Work (TSOW) was to produce, "*an empirical model that predicts safe concentrations of CoC's based on relevant soil parameters, such as texture, pH and organic content, for Port Colborne soils*". However, the Natural Environment "Final Report" also describes a primary objective (Final Report, page vi), "*to determine if CoCs in soils, as a result of* [Inco] *Refinery emissions, present a potentially unacceptable risk to the natural environment found in the Port Colborne area. For the ERA, an unacceptable risk is defined as an estimated risk linked to the occurrence of soil concentrations of CoCs that prevents sustainable population(s) of flora and fauna, or prevents a sustainable level of ecological functioning, within the defined Study Area*." The reason for this change in objective is not explained in the report.

The assessment involved data collection and field investigations in 2001 and 2002. The ERA-NE involved studies and assessments of selected Valued Ecosystem Components (VECs),

including decomposers (earthworms, woodlot litter), amphibians (frogs; tadpoles and adults and Fowler's Toad), plants (maples and woodlots), mammals (Meadow Voles, Raccoon, Red Fox and White-tailed Deer), and birds (Red-tailed Hawk, American Woodcock, American Robin, and Red-eyed Vireo). Following technical review of previous "drafts" of the report, JW produced and released a "Draft" report for public and agency review in July of 2003. That "Draft" document was the subject of community and agency input, and was also reviewed by Inco's external (peer) review consultant (CH2MHill). The "Final" report (2004), which is the subject of this review, was produced with the objective of attempting to address the concerns and comments raised by the public, agency, peer and Independent Consultant with the "Draft" report (2003).

In response to matters raised by the community and the Independent Consultants after release of the "Final" report in 2004, JW produced an "addendum" to the Natural Environment Report dated March 2005. The "Final" Report (2004) and "addendum" report (2005) formed the basis of the submission from Inco to the Ministry of Environment (MOE) in early 2005.

Watters Environmental Group Inc. (Watters Environmental) is the current Independent Consultant to the City of Port Colborne and the Public Liaison Committee (PLC) for the CBRA. In this capacity, Watters Environmental was requested to review the Final Natural Environment Report to provide an opinion on whether the conclusions in the report are supported by the data and its analysis and interpretation in the report. Based on the technical review undertaken, and on issues raised by members of the Port Colborne community, this report represents the opinions of Watters Environmental with regards to the Natural Environment Report.

The Natural Environment Risk Assessment Study Process comprised:

- a baseline inventory of plants and animals in the Port Colborne Area,
- identification of VECs and components of the natural environment considered to be most sensitive to CoCs,
- identification of specific pathways (and organisms) for study (considering both the aquatic and terrestrial ecosystems), and
- conducting studies for CoCs to determine the levels that cause impairment to the most sensitive plants and animals; in other words to determine the "safe" level(s) of CoCs for protection of Port Colborne's natural environment.

The Independent Consultants' Findings

Based on the technical review undertaken, and on issues raised by members of the Port Colborne community, it is the view of Watters Environmental that the data collected and analyses undertaken by JW do not support the conclusions in the Natural Environment Report.

An immediate difficulty in assessing whether the conclusions reached in the Natural Environment Report are supportable is that there are actually two, quite different, conclusions presented in the Report:

1. In the Executive Summary of the Report, a very clear and strong statement is made that:

   "*Following a number of lines of evidence to assess potential risk caused by soil CoCs, no unacceptable risk to elements of the natural environment in the Study Area as a whole was identified. As a result of these findings, no immediate need to mitigate or manage risk to the natural environment has been identified*."

2. However, the conclusions in Section 9 (Conclusions) are quite different, stating that:

   "*Based on the results of the general field observations undertaken for this study, it is evident that existing CoC concentrations in the soil or other environmental media do not represent a toxicity level that is lethal to local flora and fauna. Quantitative assessment of the potential risks to VECs in the natural environment undertaken in this study support these qualitative observations*"

Lethality is quite different from "unacceptable risk" but, in fact, even the conclusion in the executive summary that there is no unacceptable risk is not supported by the evidence presented in the report. The conclusion is concerning in two regards:

i. The objective of the Natural Environment studies was to determine if sustainable populations exist within the Port Colborne area and whether the ecosystems within the study area are functioning sustainably – NOT whether lethal concentrations exist, and

ii. The objective of the Natural Environment Study as outlined in the TSOW was to develop an empirical model that predicts safe concentrations of CoCs for Port Colborne soils. The intent was to use the quotient method to calculate risk to various populations and to validate the empirically-derived results with observations of the natural environment.

However, the conclusions in the Natural Environment Report are largely based on general field observations and qualitative assessment.

The reason for this important shift in emphasis and the consequences of the change are not satisfactorily explained in the Natural Environment Report.

The data in the Natural Environment Report do not support either of the alternative conclusions presented. The manner in which the data were analyzed and interpreted introduces significant uncertainties into the findings, and our own interpretation of the data presented leads us, in many instances, to come to conclusions opposite to those presented by JW. For example, while the JW Report asserts there is no adverse effect on frogs and toads in the aquatic environment, we conclude, based on the same information presented in the Report that there is evidence of adverse impacts on the amphibia populations. This is demonstrated in both the empirical modeling and the observational studies. Further, sufficient scientific justification or rationale is not provided to support the contention that there is no unacceptable risk to the Natural Environment of Port Colborne. Some of the more important concerns with the study are as follows:

- The Study Area(s) originally included a "Primary Study Area", a "Secondary Study Area" and a "Reference Area" based on reported soil levels of CoCs, with intent to characterize exposure and risk in each. However, JW's Final Report merged the data from the Primary and Secondary areas into one area, which significantly increases uncertainty in the study results. In simple terms, merging the study areas "averages away" potential risks by blending the data over a large area resulting in standard deviations for the data sets that often exceed the reported mean values,

- Within the Study Area(s), there are gaps in the general distribution of sampling points that exclude large areas of potentially important habitat (such as the wetland and wooded areas on Inco lands to the west of Reuter Road),

- The sample size for several of the VECs studied was insufficient to be able to draw any reasonable conclusions on these components of the natural environment,

- The Study Area excluded the "urban" (residential) areas of Port Colborne, which contains important elements of the environment both in terms of flora and fauna. As a result of this exclusion, the impact of CoCs on domestic animals and other "urban" elements of the Natural Environment have not been fully addressed,

- There is no attempt to identify species that would be expected to be present in the habitats found in the Study area that are missing or are present in reduced numbers and which could provide an indicator of ecological stress,

- Seemingly arbitrary choices are made in selecting or rejecting lines of evidence for assessing risks, and there is selective weighting given to various study components when drawing conclusions,

- The impact of arsenic on the Natural Environment has not been assessed.

- As the study progressed, the risk quotients used for certain VECs were changed without adequate justification, and

- Notwithstanding the important sources of uncertainty described above, the "uncertainty analysis" contained in the Report does not provide sufficient analysis to address the concerns.

The combined result of the above issues, and particularly the blending of the data, is that the standard deviation for data sets is often greater than the mean value. The risks are most probably underestimated, particularly for species that are not mobile or which do not range widely.

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1.0 INTRODUCTION

Vale Inco (Inco) operated a nickel refinery in the City of Port Colborne from 1918 to 1985. During that time, the refinery emitted large amounts of several chemicals into the environment, including nickel, copper, cobalt, arsenic and lead. To assess the extent of the impact that these emissions have had on the natural environment, crops and human health within the City of Port Colborne, and to determine the nature and extent of cleanup (if required), Inco undertook a Community Based Risk Assessment (CBRA). The CBRA comprises a Human Health Risk Assessment (HHRA), and an Ecological Risk Assessment (ERA) that consists of an assessment of the impact of the chemicals of concern (CoCs) on the natural environment (ERA-NE) and their impact on crops grown in the Port Colborne area. This Report relates to Sections 2.1.3 and 3.1 of the *Technical Scope of Work* document, which was prepared by JW in November, 2000 (i.e., at the outset of the CBRA).

The CBRA currently address impacts from four chemicals, namely nickel, copper, cobalt and arsenic. Although not included as a CoC for the CBRA, there is ongoing debate about whether lead should be added to this list.

A Public Liaison Committee (PLC) was established to oversee the CBRA process and to help facilitate community consultation. Watters Environmental Group Inc. (Watters Environmental) is the current technical consultant to the PLC and City of Port Colborne.

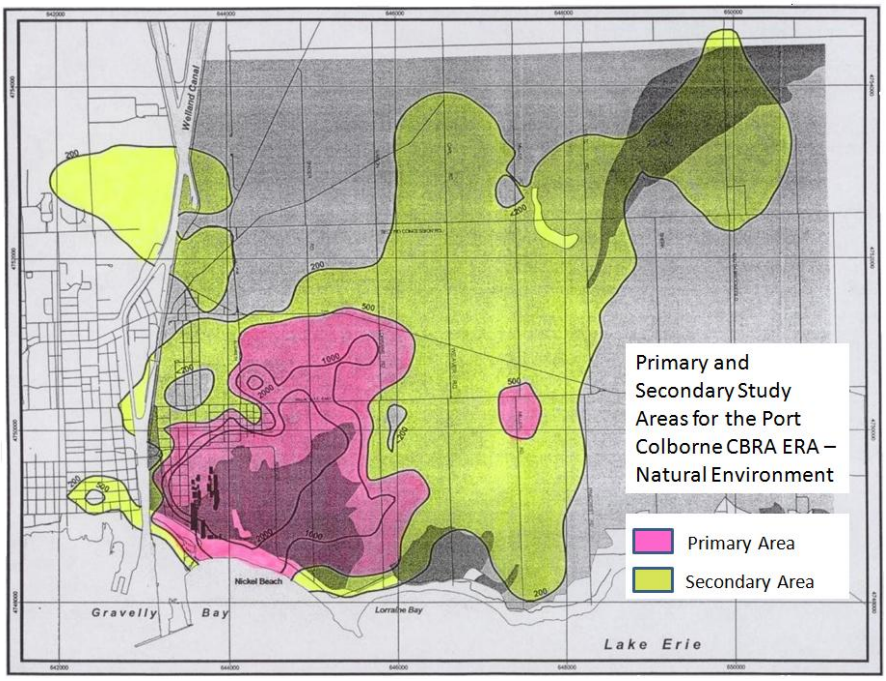
This document was prepared by Watters Environmental to outline current residual comments and technical concerns (from community members and Watters Environmental) on the final technical report prepared by Inco's consultants, Jacques Whitford (JW) to address impacts to the Natural Environment of Port Colborne.

2.0 BACKGROUND

The whole of Port Colborne has been highly influenced by human activity over the past two centuries of settlement with extensive agricultural cultivation, deforestation and woodlot management, disturbed sand dunes, and the introduction of artificial structures as drainage channels. In effect, there is no part of the Port Colborne area that can be regarded as "natural" although the usual populations of animals and plants typical of urban/agricultural areas in Southern Ontario should be expected to be found thriving in the study area if there is no undue, adverse effect by emissions from the Inco Refinery.

The original study plan for assessment of the Natural Environment involved characterizing exposure and risk across the following three areas:

- Primary Study Area (105 hectares),
- Secondary Study Area (462 hectares), and
- Reference Area.



Within each of these areas, Valued Ecosystem Components were studied, which were: earthworms, frogs (including tadpoles), Fowlers' toad, American woodcock, American robin, Red-eyed vireo, Red-tailed hawk, Meadow vole, White-tailed deer, Raccoon, Red fox, and as a measure of woodlot health, soft maples, woodlots and leaf litter. Subsequently, the common shrew was also added to the study. Household pets were specifically excluded from study by Inco, which was an enduring concern of the community and one that was steadfastly resisted by the proponent.

2.1 LINE OF EVIDENCE APPROACH

A line-of-evidence approach was used in evaluating potential impacts on the natural environment. This took into account data from three approaches: experiments to determine the dose-response of exposure, calculation of risks (by comparing estimated total exposures with values known to cause impact published in the scientific literature), and field observations.

A Site Specific Risk Assessment or, in this case, a Community Based Risk Assessment entails a detailed quantitative assessment of the threat posed to the effective ecological functioning of the area being studied. A simple survey based on observation of the environment by trained naturalists is not sufficient. The field observations carried out as part of the CBRA studies were only intended to provide corroborative information to "test" the calculated risks. An important concern with the CBRA is that this principle was abandoned during the conduct of the assessment. Consequently, much greater reliance was placed on observational studies than was intended. This was particularly the case with frogs, where risk assessment indicated that there was quantifiable risk to frog populations and "frog calling surveys" were used in a [largely unsuccessful] attempt to refute this. That this was done when other, more rigorous approaches, suggested that there might be a problem affects the perceived integrity of the study.

3.0 TECHNICAL ISSUES

The following sections describe specific technical issues with the Natural Environment Report relevant to assessing whether the proposed soil nickel levels are as protective as the MOE's generic standards.

3.1 DEFINITION OF THE STUDY AREA

Defining the Study Area by the 200 µg/g Isopleth

An important remaining concern with the ERA is that the definition of the study area is based on a 200 µg/g nickel isopleth that was developed using the initial MOE soil quality data, despite the fact that there is now a significant volume of additional data that could have been used to better define this isopleth. The pattern of nickel distribution using the more recent data does not correlate with the distribution using only the original MOE data. The differences in the patterns of distribution need to be reconciled and explained, because this new data may change the boundaries of the study area and possibly affect the conclusions and interpretations of the ERA-NE findings.

Excluding Residential Areas

Animals within the urban areas of Port Colborne, such as squirrels and domestic animals, have not been included in the risk assessment. That the impact of CoCs on these animals has not been addressed under the CBRA has been a long-standing and consistently expressed concern of the community. In our opinion, this is a gap in the NE-ERA. The potential CoC exposure for cattle in Port Colborne is also not assessed. Grazing on grass growing on contaminated soil in the summer and feeding in the winter on forage grown on contaminated soil could give a potentially large, but still unknown, exposure to CoCs.

Irregular Distribution of Sampling Stations

Related to the general concern over the definition of the study area is a concern regarding the irregularity or "patchiness" of the distribution of the sampling stations. It is understood that some amount of unevenness is inevitable to properly address sites of special interest, such as woodlots. Although we recognize that an irregular distribution doesn't necessarily imply that inferior data will be produced, it is no guarantee that it won't.

If the irregularity does produce anomalous data that require follow-up, or it produces meaningful trends, either will be lost when all of the individual station data is averaged.

3.2 AVERAGING AWAY THE RISKS

Perhaps the biggest and most central concern with the ERA-NE Report is the decision made to merge the separate study areas into one combined area. The study area for the ERA-NE originally consisted of two general areas for the purpose of data collection: a Primary Study Area (105 hectares) and a Secondary Study Area (462 ha). A Reference Area, consisting of woodlands, wetlands and conservation areas primarily to the west of the Welland Canal, was also sampled.

The Primary and Secondary Study Areas were selected based on soil sampling conducted by the MOE in order to direct data collection efforts into areas where soil COC concentrations are high to moderate (i.e., they were established for the purpose of ensuring representative sample collection, **not** with the intent of combining all the data into one average number representative of the whole of the Port Colborne Area for each variable studied).

Within the Secondary and Primary Study Areas, sampling sites were sampled for a broad range of biota representing valued ecosystem components and capable of establishing food chain relationships. The analytical results show significant differences (sometimes two orders of magnitude difference) from one sampling location to another for CoCs in the environment and various biota/tissue samples. While samples from the Primary Study Area generally show higher levels of CoCs than those from the Secondary Study Area, there are instances where even the control (reference) area results are higher in CoC levels than in the Study Area. Rather than seeking explanations for local variability, the Natural Environment study simply combines and averages the data.

The original drafts of the ERA-NE Report followed the original study plan laid out in the Technical Scope of Work (November 30, 2000) and provided the CoC data for the Primary Study Area, the Secondary Study Area, and the Reference Area.

In the draft of the ERA-NE Report issued in January 2003, the individual data points from the Primary Area and the Secondary Area were combined to provide just one average number for each biota/tissue type and CoC within the Primary Area and the Secondary Area. This “representative” number was then used in the assessment of risk to the VECs.

This approach, carried out over such a large geographic area, has the effect of "averaging out" meaningful data that could have demonstrated variability in the values within the Primary and Secondary Study Areas.

The 2004 Report goes even further and collapses much of the data for various Port Colborne VECs into **just one** data set for the entire "Study Area". This one combined data set is now referred to as "Primary and Secondary Areas" (Tables 6.3 and 6.13 of the report), or simply as the "Study Area" i.e., one combined study area comprising the previous Primary Study Area and the Secondary Area (Tables 6.4, 6.5, 6.6, 6.7, 6.9, 6.10 and 6.12). All of the study area data for each parameter is treated as a single data point. The mean values, sometimes consisting of 50 or so samples, comprising wide ranging values, taken from High and Moderate Exposure Areas are now used to typify an area of 567 hectares.

Much of the risk assessment data for the ERA-NE comes from samples of amphibians, worms, insects and other biota living on, in, and around the soil. The variability in these types of natural system is enormous and largely unpredictable. Within the "Study Area", the difference between the maximum CoC value and the minimum CoC value is often as much as 100-fold (and higher) for various amphibian and other tissue results. The use of "mean" values minimizes the significance of the individual site data sets to the point where they have virtually no usefulness and thereby renders the large ERA-NE field data-set nugatory.

The considerable effort that went into the sample-gathering exercise in 2001was done with the clearly stated intention of using measured values instead of reference values, so as to "reflect the actual conditions present in Port Colborne" (CBRA ERA–Natural Environment, September 2004). As discussed, the benefits of sampling and analyzing the various organisms and associated soils or sediments from diverse locations within the Primary Study Area and the Secondary Study Area are lost through the process of the averaging of the entire Study Area data set for each type of organism sampled.

We plotted the relationships between tissue nickel concentrations and Study Area to illustrate the concern with not using separate Secondary and Primary Area data. Figures 1 to 4 provide bar charts illustrating the difference in CoC concentrations for several organisms sampled in the Reference, Secondary and Primary Areas. Many other similar relationships may exist for other data sets.

[Data in Figures 1 – 4 are derived from Tables 6.3, 6.4 and 6.8 in the 2004 Natural Environment Report and Table 6.13 in the July 2003 Report.]

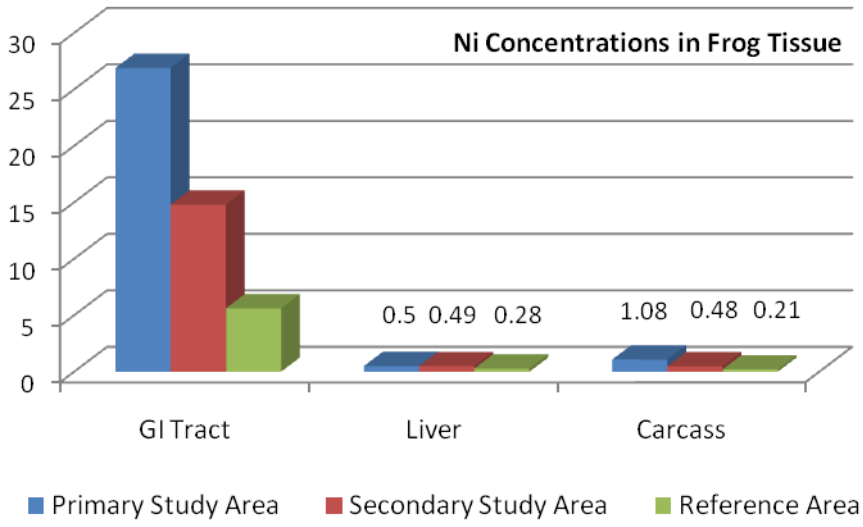


Figure 1. Nickel Concentrations in Frog Tissue.

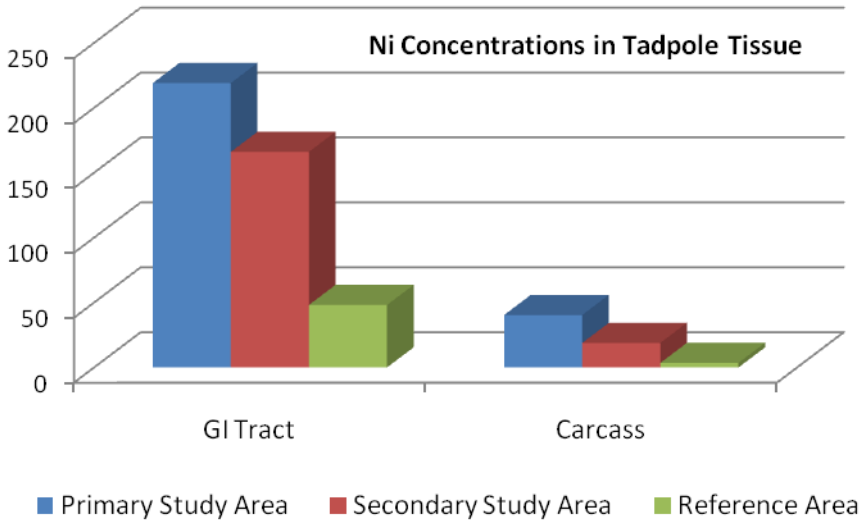


Figure 2. Nickel Concentrations in Tadpole Tissue.

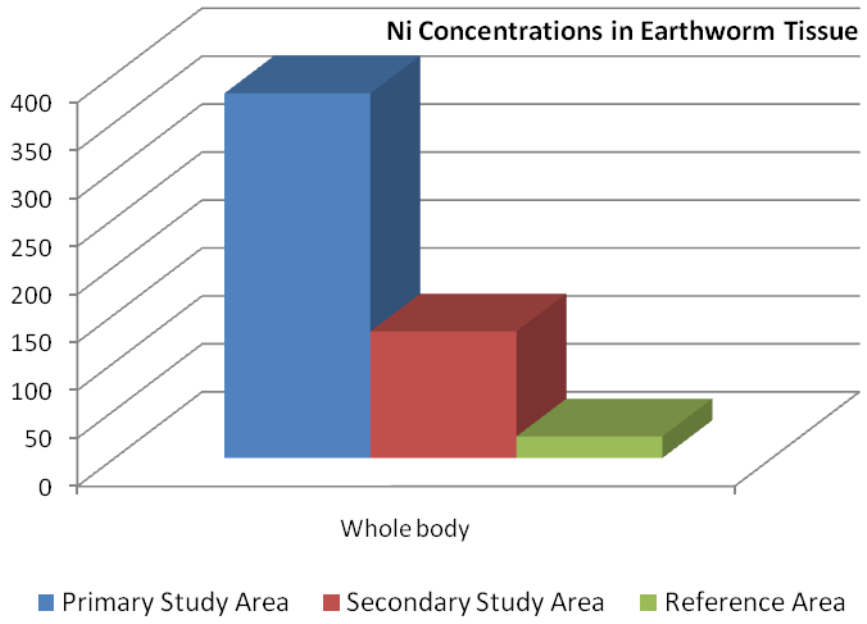


Figure 3. Nickel Concentrations in Earthworm Tissue.

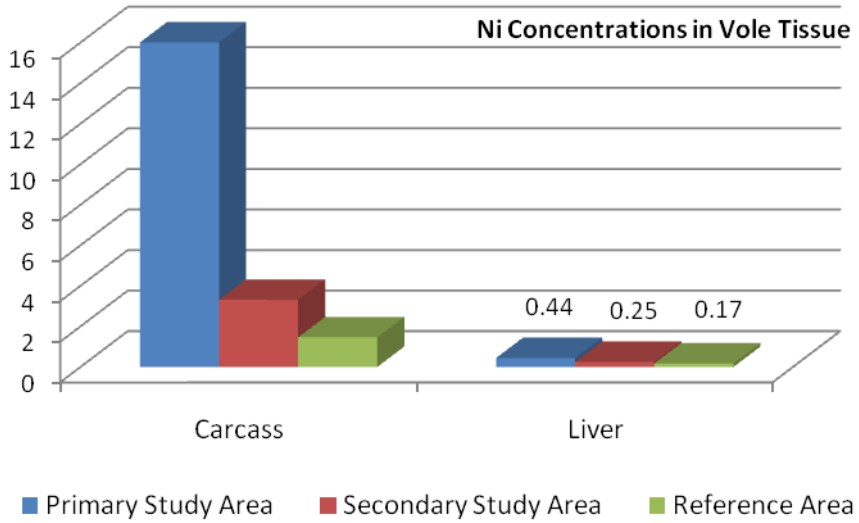


Figure 4. Nickel Concentrations in Vole Tissue.

The bar charts demonstrate that nickel concentrations follow a pattern where lowest CoC levels are found in samples from the Reference Area, highest levels are found in Primary Area samples, and Secondary Area concentrations are in the middle range. This pattern, showing higher

concentrations closer to the refinery, follows the intuitive expectation for the data. While the correlation between Reference, Secondary and Primary CoC concentrations does not necessarily mean that risks were increased for the study organisms, the data shows that organisms in the area of Port Colborne with the highest soil levels of nickel concentrations have themselves accumulated higher concentrations of those COCs than have organisms from other, less polluted areas of the City.

The graphs indicate the value of examining data at a smaller geographic scale than the whole of Port Colborne. Because this was not done, there was no opportunity to even notice local, smaller area data trends, yet alone understand their significance.

It is understood that such a large data base needs to be broken down, and averaging within carefully established geographic limits is certainly a way to provide a sense of the degree to which a soil or an organism living in a given soil may be contaminated. However, the use of a mean value spread out over such a large study area becomes a way of obscuring or obliterating any local variations, whether high or low. In this case, it is a mechanism virtually guaranteed to obfuscate potentially meaningful data trends within the study areas.

A key purpose of the CBRA is to provide suggestions for remediation if and where warranted. In the Natural Environment component of the CBRA the areas where recommendations for remediation might be required are indiscernible due to the averaging across the area.

This averaging represents the biggest and most important shortcoming in the Natural Environment Report. It effectively makes it not possible to draw any meaningful conclusions regarding the impact of contamination on the natural environment in the Port Colborne area.

3.3 POTENTIALLY MISSING SPECIES

A part of a review of the natural environment would logically include identifying species that should be present based on habitat and ecological factors but which are absent or are present in lower than expected numbers. This has not been pursued in the ERA-NE study.

Concerns were raised in reviews of earlier drafts of the report that missing species had not been addressed. The response was:

> "*Given all the potential confounding factors, and time constraints for completing this study, detailed analysis of this type was not considered appropriate for the CBRA - ERA.*"

Particularly given the shift in emphasis away from a risk assessment to an observational study, this cannot be regarded as a satisfactory response. It leaves the question, "Are there species or populations that would be expected to be present and thriving in Port Colborne that are absent or stressed because they are exposed to CoCs?"

3.4 WEIGHTING OF VARIOUS STUDIES IN DETERMINING OVERALL FINDINGS

The Natural Environment Report would benefit from a better description of the process for determining the relevance of each of the studies, limitations on them, the weight that each should be accorded, and the process that was followed for selecting studies and developing conclusions from them is needed. Concerns with specific studies making up the ERA-NE are as follows:

Leaf Litter Study

The protocol for the Leaf Litter Study states (page 1), "*In cases where the decomposition process is decreased, the amount of materials being formed and returned to the system (i.e., leaf litter fall) is greater than the amount being broken down or decomposing. Under conditions of decreased decomposition the amount of litter on the ground may start to accumulate and nutrients would not be available to the vegetation (i.e., trees) in that area. If the disruption continued over a long period of time, the tree's growth might decrease accordingly*".

The results presented in Figure 8-23, Volume 1 of the report show the mass of dry leaf litter plotted against the soil Ni concentrations. The range of values was high for woodlots in high Ni areas and in low Ni areas. The range of litter weights is from 63.2 to 536.9 g/m^2, i.e., an order of magnitude difference. Several types of forest were sampled (FOD 2, FOD 7, SWD 6 and MAS 3) as indicated by examining the location of Leaf Litter Sampling Locations in Maps 1, 2 and the ELC forest classifications on Map 3.

In the Report, the comment made by JW that the plotted data indicate, "*As soil nickel concentrations increase, dry weight of leaf litter increases (Figure 8-23), presumably indicating that decomposition is slower*". For data with such wide ranges in the amounts of litter collected per site, such conclusions are at the most tenuous. While the final conclusions that the woodlots appear to be healthy may actually be correct, the logic on which these conclusions are based is weak.

While the Leaf Litter Study appears to be been carried out diligently by the sub-contractor, the study design renders the relevance and usefulness of its findings questionable. The report on Leaf Litter states that, *"time constraints imposed by the current situation would not allow for a detailed investigation using the normal procedures. Instead a proxy method of assessing the rate of decomposition was used".* The value of the proxy method and how its findings would be expected to relate to those derived from "normal procedures" is not known.

Frogs and Toads

Two lines of evidence are pursued to assess the health of amphibian populations: (i) the quotient method for calculating risk and (ii) a survey of frog calling.

The report indicates that the quotient method determined that 80% of ponds and ditches put tadpoles at risk as a consequence of nickel exposure. However, the report dismisses this important and concerning finding and instead relies on the subjective spring calling survey to provide evidence that no unacceptable risk exists.

The scientific rationale for giving more weight to the frog calling compared with the quotient method is not clearly presented. The situation is confused even more by the selective weighting given to information provided by the calling survey. For example, the absence from many calling sites of the Northern Leopard Frog, generally common throughout Southern Ontario, and the lower than expected density of calling adult frogs than would be expected compared to other areas of Southern Ontario is not explained. Furthermore, site-specific CoC concentrations were not available for the frog survey stations and so nickel in the soil in the general vicinity of frog habitat was used as a surrogate for nickel concentrations in the water bodies. Given the extreme variability between sampling sites already discussed, this is problematic. This limitation of the analysis is acknowledged in the ERA-NE Report.

So, despite two lines of evidence leading to a concern that frog and toad populations are at risk, and admitted limitations on the value of the study, the report concludes: "*CoCs in surface water of the study area does not represent an unacceptable risk to the frog and toad populations*".

The quotient method is dismissed as being "*too conservative*" and the suggestion in the conclusion that the study area, "*supports high species diversity and typical abundance of adult frogs for the species present*" begs the question of what is happening with the species absent in many sites (e.g., Leopard Frog), and does not appear to be consistent with other observations made in the report.

Notwithstanding the dismissal of the Quotient Method for the assessment of general populations of amphibia when a problem is identified by the method, the method is deemed acceptable when a problem is not found, as is the case for Fowler's Toad.

The selective use of various lines of evidence and dismissal of others without scrupulous explanation of why this is done is troubling. At best it points to a lack of scientific rigour that undermines the faith that can be placed in the conclusions of the report.

Invertebrates

The arthropod data set was based on averaging the CoC values for spiders and various insects including grasshoppers, caterpillars, etc. Not surprisingly, when combining data from such a heterogeneous collection, the "plus or minus" values for the mean CoC concentrations are in the range of 70-90%. Differences in CoC concentrations between predatory and vegetarian arthropods were not possible to assess with this averaging approach. The result is that very little can be said about the effect of CoCs on arthropods or on the general health of invertebrate components of the natural environment in Port Colborne.

Maple Sap, Wood Cores

In assessing woodlot health, the results of studies of woodlot health, leaf litter decomposition and maple leaf health were considered but not all of the woodlot studies that were carried out such as maple sap and wood increment cores were included. The reason for the partial selection of studies is not clear, but it seems that considerable sampling, analytical and assessment time and effort resulted in no visible input to the ERA-NE.

3.5 THE LACK OF ARSENIC DATA

While the CoCs are generally dealt with in terms of their distribution in soil and in tissues, potentially useful information on arsenic has been omitted. Tables 2-8 and 2-9 describe the various means by which CoCs can be extracted from clay and organic soils for nickel, copper and cobalt, but provide no data for arsenic. Although this matter is commented on in the report, *("Data for arsenic were not obtained due to the limitations of these extraction methods with arsenic" p. 2-15),* the fact remains that the data are missing. This means that the four different soil extraction techniques were either not capable of extracting arsenic, and/or the studies failed to examine arsenic. In either case, the report lacks potentially useful information regarding the amount of arsenic that could be available in Port Colborne soils to have a harmful effect on organisms.

A conclusion following Tables 2-9 in the Report says: "*less than 1% of soil CoCs are removed, indicating that soils in the Study Area have a low leaching capacity under neutral water conditions*". This generalized conclusion, and others following it, cannot be made in the absence of data for one of the CoCs.

Arsenic should have been assessed as thoroughly as the other CoCs.

3.6 CHANGING THE RISK QUOTIENTS

The quotient method is a cornerstone line of evidence for many of the studies that comprise the ERA-NE. It is claimed to be a standardized method, although considerable changes in risk quotients are presented from the draft report to the final report. Most notably, the American Woodcock has a risk quotient (RQ) of 0.87 for nickel in woodlots in the July 2003 ERA-NE report, but a RQ of 0.24 in the September 2004 report. These changes are nowhere satisfactorily justified within the report and this is an important omission.

The method is claimed to be conservative, yet there are important aspects that demonstrate a lack of conservatism. For example, the method does not consider additive or synergistic interactions. This is an important weakness when considering metal toxicity, especially when the study area is impacted by additional heavy metals emitted from the refinery, such as lead. The inclusion of factors for bioavailability into the calculation of absorbed dose is also non-conservative.

The suggested conservatism of the method so often cited as a strength of the method, is the cause of its rejection as the major line of evidence, in favour of observational studies, in the case of amphibia, where the quotient method actually indicated a problem exists.

3.7 INADEQUATE UNCERTAINITY ANALYSIS

An "uncertainty analysis", absent in earlier drafts, is provided in the Final Report to provide a response to many concerns raised by reviewers and the public regarding approaches in the ERA-NE and assumptions in the previous report. However, this section is less of an analysis of uncertainty and more an expression of unsubstantiated opinion as to whether genuine concerns with the ERA-NE and identified shortcomings in the study approach are likely to underestimate or overstate the assessed risk.

4.0 CONCLUSIONS

Two concluding statements are made in the CBRA Environmental Risk Assessment – Natural Environment Report:

"*Following a number of lines of evidence to assess potential risk caused by soil CoCs, no unacceptable risk to elements of the natural environment in the Study Area as a whole was identified. As a result of these findings, no immediate need to mitigate or manage risk to the natural environment has been identified*."

"*Based on the results of the general field observations undertaken for this study, it is evident that existing CoC concentrations in the soil or other environmental media do not represent a toxicity level that is lethal to local flora and fauna. Quantitative assessment of the potential risks to VECs in the natural environment undertaken in this study support these qualitative observations*"

Neither of these conclusions is supportable because:

- There are elements of the study and the analysis and interpretation of results that lead to significant unacceptable uncertainties about the conclusions;
- The Study Area(s) originally included a "Primary Study Area", a "Secondary Study Area" and a "Reference Area" based on reported soil levels of CoCs, with intent to characterize exposure and risk in each. However, the Final Report merged the data from the Primary and Secondary areas, which significantly increases uncertainty in the study results. In simple terms, merging the study areas "averages away" potential risks by blending the data over a large area resulting in standard deviation for the data sets often exceeding the mean value;
- Within the Study Area(s), there are gaps in the general distribution of sampling points that exclude large areas of potentially important habitat (such as the wetland and wooded areas on Inco lands to the west of Reuter Road);
- There is insufficient sample size for several of the VECs studied to be able to draw any reasonable conclusions on these components of the natural environment;

- The Study Area excludes the "urban" (residential) areas of Port Colborne, which has important elements of the Natural Environment both in terms of flora and fauna. As a result of this exclusion, the impact of CoCs on domestic animals and other "urban" elements of the Natural Environment have not been fully addressed;

- The conclusions of the Study are clearly based primarily on the observations of biologists in the field. This was not the way the study was meant to be conducted but rather, the field observations were meant to provide a "reality check" on the calculated risks. The field observations were not conducted in a way that would provide sufficient scientific rigour to reach the conclusions attributable to them;

- An attempt was not made to identify missing or reduced populations of species that would be expected to be present in the habitats represented in the Study area;

- The observational studies were not sufficiently systematic to identify stress in communities. Where potential problems were flagged, such as the frog surveys, the concerns were not properly evaluated or sufficiently considered in drawing conclusions;

- The Study makes seemingly arbitrary (or at least unexplained) choices in selecting or rejecting lines of evidence for assessing risks and, uses selective weighting for study components when drawing conclusions;

- The Study did not attempt to assess the impact of arsenic, an accepted CoC on the Natural Environment and did not consider lead, a disputed CoC, which in any event could be expected to have an additive or synergistic effect and influence findings of metal toxicity;

- As the study progressed, the risk quotients used for certain VECs changed without adequate justification; and

- Notwithstanding the above, the "uncertainty analysis" contained in the Report does not provide anything like the depth and rigour of analysis required to justify the conclusions reached in the Report.

The combined result of the above issues, and particularly the blending of the data, is that the standard deviation for data sets is often greater than the mean value, and the risks are most probably underestimated, particularly for species that are not mobile or show limited range.

A problem certainly appears to exist for aquatic populations (typified by frogs and toads). Woodlots in high concentration areas are clearly stressed. For the rest, the averaging of data over the whole of the Port Colborne Study Area effectively renders it impossible to draw meaningful conclusions respecting the effect of CoCs on the natural environment.