Port Colborne Community Action Plan (PCCAP)

Guidance for “Soil-Pica” Behaviour in the Vicinity of the Port Colborne Refinery

Key Guidance

- Nickel, copper, cobalt, and arsenic (Ni, Cu, Co, and As) concentrations in soils around Vale Canada's Port Colborne Refinery are elevated due to historical emissions from the refinery. The company accepted responsibility for the contamination and undertook the Port Colborne Community-Based Risk Assessment (CBRA). All CBRA documentation is available at http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx
- The Port Colborne Community Action Plan (PCCAP) was initiated to address certain issues that arose from the CBRA.
- "Soil-pica" refers to the ingestion of unusually high amounts of soil (1,000-5,000 mg/day).
- Children under 6 years of age and developmentally delayed individuals are most likely to exhibit soil-pica behaviour.
- The CBRA addressed human health risk, including soil-pica behaviour, although soil-pica was not addressed quantitatively.
- Soil-pica can be a source of parasite exposure from wildlife and pet fecal matter in soil. The elevated metals in the soils in eastside Port Colborne could be an additional reason to intervene to prevent soil-pica behaviour.
- Soil-pica screening calculations predict an absence of elevated, unacceptable acute health risk due to soil-pica in the eastside community. (See supporting information.)
- If soil-pica behaviour is exhibited, parents/guardians should consult with their health care provider.
- The Vale Port Colborne information helpline is available by telephone (289-478-8253) or email (Ontario.questions@vale.com) to have questions answered.

Supporting Information

The Port Colborne Community-Based Risk Assessment (CBRA) studied the human health risk of the historically emitted elements Ni, Cu, Co, and As (chemicals of concern or CoCs) (JWEL, 2007; Stantec, 2014a). In the original CBRA Human Health Risk Assessment (HHRA) (JWEL, 2007), soil pica in toddlers was addressed only in terms of a sensitivity analysis, while the 2014 CBRA Update Report, an acute soil ingestion exposure scenario was not undertaken due to the lack of availability of an acute toxicity reference value (TRV) (Stantec, 2014a).

Some new guidance is available for assessing soil pica risk, which remains a difficult topic to address meaningfully in human health risk assessment. The U.S. EPA issued an update for chapter five (soil and dust ingestion) of the Exposure Factors Handbook (U.S. EPA, 2017), which recommends using an assumed soil ingestion rate of 1,000 mg/d (i.e., 1 gram per day) for addressing soil pica risk in toddlers.

In this document, soil pica is assessed as an acute risk issue. The chronic risk having been addressed in the CBRA HHRA (JWEL 2007, Stantec 2014a). Acute risk estimates are focused on Ni, the predominant metal contaminant (the approximate Ni:Cu, Ni:Co, and Ni:As ratios in soil being 9, 50, and 121, respectively (composite value approximated from JWEL (2007) and MOE (2002)). No TRVs for acute toxicity risk could be found in the open literature, which is one of the difficulties in addressing soil pica risk for the CoCs. Here, a TRV for Ni has been developed to address soil pica risk.

The Ni from the historical refinery emissions is present in soil predominantly as nickel oxide (Stantec (2014b). For Ni, an acute oral dose of 11,000 mg/kg was found to be a NOEL (no-observed-effect-level) for green nickel oxide (NiO – also called bunsenite) in rats (8,910 mg/kg as Ni) (Henderson et al., 2012). No mortality or other effects were found over the 14-day observation period following the test exposures, so this value represents a threshold – the nickel oxide test substance was so poorly bioavailable that no toxicity was observed.

An acute TRV for oral bunsenite (NiO) exposure was then developed by adjusting the NOEL value (8,910 mg/kg) downward by a total uncertainty factor (UF) of 1,000, resulting from:

UF=10 (animal-to-human extrapolation)
UF=10 (human variability in response)
UF=10 (database inadequacy (only one study used) (U.S. EPA, 2002))

Therefore, the TRV for NiO exposure is; 8,910 mg/kg / (10*10*10) = 8.91 mg/kg

Other variables relevant to the assessment of soil-pica oral risk include the following:

- The U.S. EPA recommends a soil ingestion rate of 1,000 mg per day for the soil ingestion rate for assessing soil-pica.
- No adjustment has been made for bioavailability. The acute TRV is based on oral nickel oxide (NiO/bunsenite) dosing. The expected form of the Ni in the soil is primarily nickel oxide, which is similar to NiO, so no bioavailability adjustment is warranted.
- The assumed body weight of a toddler is 16.5 kg (Stantec, 2014a).

The results of this screening level calculation for the eastside community indicate an absence of soil-pica risk for the exposure scenario (HQ=0.054) (detailed in Table 1). Several days of pica behaviour would not be expected to result in acute health risk from Ni, but residents who observe repeated soil pica behaviour among those in their care should consult with medical professionals as early as possible.

Table 1. Calculated acute Ni exposure Hazard Quotient (HQ) for a soil-pica scenario in the eastside community of Port Colborne.

Soil ingestion rate (g/d)	1
Soil Ni concentration[1] (µg/g)	8,000
Toddler body wt (kg)	16.5
Ni acute TRV (mg/kg/d)	8.9
Bioavailability adjustment	None
Exposure (mg/kg/d)	0.48
Acute HQ	0.054

Exposure calculation*:

$$\frac{1\ \text{g soil}}{\text{d}} \times \frac{8{,}000\ \text{µg Ni}}{\text{g soil}} \times \frac{}{16.5\ \text{kg body wt}} \times \frac{1\ \text{mg Ni}}{1{,}000\ \text{µg Ni}} = 0.48\ \text{mg Ni/kg body wt/d}$$

Footnotes

1. The exposure concentration of 8,000 µg/g was selected from MOE (2002).

* strike-throughs are used to indicate unit cancellation for the non-technical reader.

The exposure scenario has not been included as a component of the overall HHRA, but as a stand-alone scenario for an uncommon human receptor. HHRA is intended to assess risk for the general population, so this exposure scenario is considered separately from, but in parallel with the HHRA.

References

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