Port Colborne Community Action Plan (PCCAP)

Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

Revised – March 24, 2023

Contents

Key Guidance

- Copper (Cu) concentrations in soils in the vicinity of 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) at the suggestion of the Ontario Ministry of the Environment, Conservation and Parks (MECP). 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.
- The CBRA did not specifically address pets (dogs and cats), but elevated soil Cu in surface soils in the vicinity of the refinery should be considered, as there has been an apparent increase in copper-overload (Cu-associated hepatopathy (CAH)) in North American dog breeds in recent years.
- Cu-sensitive dog breeds include the Bedlington, West Highland White, and Skye terriers, Labrador retrievers, Doberman Pinschers, and Dalmatians which require specific management of Cu intake from their diet. Owners of these breeds should be aware of the potential for elevated exposure in the vicinity of the refinery from the historical contamination. Cu overload appears to be rare among cats.
- Symptoms of copper overload can include lethargy, vomiting, diarrhea, and jaundice.
- Copper in pet food (added as the highly bioavailable form of copper sulphate) is the largest source of Cu to pets. Copper water lines in homes can also be a source of ingested Cu via water supply. The copper in Port Colborne soils is largely present as less bioavailable forms (oxides, slags, and metallics) and likely contributes very little Cu to the diet of dogs.
- If your pet displays soil-eating behaviour and displays symptoms of CAH, contact your veterinary care team.
- The Vale Port Colborne information helpline is available by telephone (289-478-8253) or email (Ontario.questions@vale.com) to have questions answered.

About this Document

This document has been prepared to support the residents of Port Colborne in light of the historical soil contamination from the former Inco Nickel Refinery. Vale has developed the guidance to address Ministry of the Environment, Conservation, and Parks (MECP) concerns for Cu-sensitive pet breeds, given the elevated copper in soil near the former Ni refinery. A draft of this guidance has been reviewed by MECP. Ministry comments and Vale's responses are appended to this document. Some Ministry comments are reflected directly in this Revised – March 24, 2023 guidance, and others are reflected indirectly by the reorganization of the guidance, including a table of contents and the addition of this "About this Document" section.

Comments on the document are always welcome.

The 'Supporting Information' section is technical in nature and is provided for the purposes of transparency, presenting the calculations used to support the Key Guidance and providing some explanation of those calculations.

Supporting Information

During the CBRA, community members asked whether their pets were safe, given the soil contamination, particularly with respect to copper, since there are several known copper-sensitive dog breeds. The "human influenced environment" was not included in the CBRA. Pets, as part of the human influenced environment, were therefore not assessed during the CBRA. This guidance has been developed to provide information on this issue, by addressing the safety of Cu-sensitive pets where soil Cu is elevated.

Copper (Cu) is an essential trace element/micronutrient for mammals. However, some species are known to be susceptible to copper poisoning, including several dog breeds (Bedlington, West Highland White, and Skye terriers, Labrador retrievers, Doberman Pinschers, and Dalmatians), all of which should receive specific management of Cu intake from their diet.

As a result of the historical contamination of soils from the Inco Nickel Refinery in Port Colborne between 1918 and 1984, the issue of potential elevated risk of Cu in soil on these common pet breeds should be assessed for the community near the refinery.

What is Copper Sensitivity in Dogs?

Copper is an essential micronutrient in mammals, with the homeostatic regulation of Cu in tissues and organs being centered in the liver (Strickland et al., 2018). When Cu overload occurs, excretory pathways become saturated and Cu accumulates in the liver. Cumulative hepatic Cu accumulation can lead to cirrhosis and potentially death – a syndrome referred to as Cu-associated hepatopathy/hepatitis (CAH) (Strickland et al., 2018; Center et al., 2021). Symptoms of CAH include loss of appetite, vomiting, diarrhea, lethargy, and jaundice (Hoffmann, 2008).

An increase in CAH has been documented in the United States in the past 20 years, the onset of which closely matches changes in guidelines for the Cu content of commercial dog foods (Strickland et al., 2018; Center et al., 2021). In 1997, the AAFCO (Association of American Feed Control Officials) changed the Cu supplementation guidelines for commercial pet feed to recommend supplementation with copper sulphate or Cu-amino acid complexes (Cu proteinate) (Center et al., 2021). Cu sulphate is significantly more bioavailable than copper oxide, the previously recommended Cu supplementation source, and the trend of increasing hepatic liver Cu concentrations coincides approximately with the change in pet feed Cu supplementation recommendations (Fig. 1).

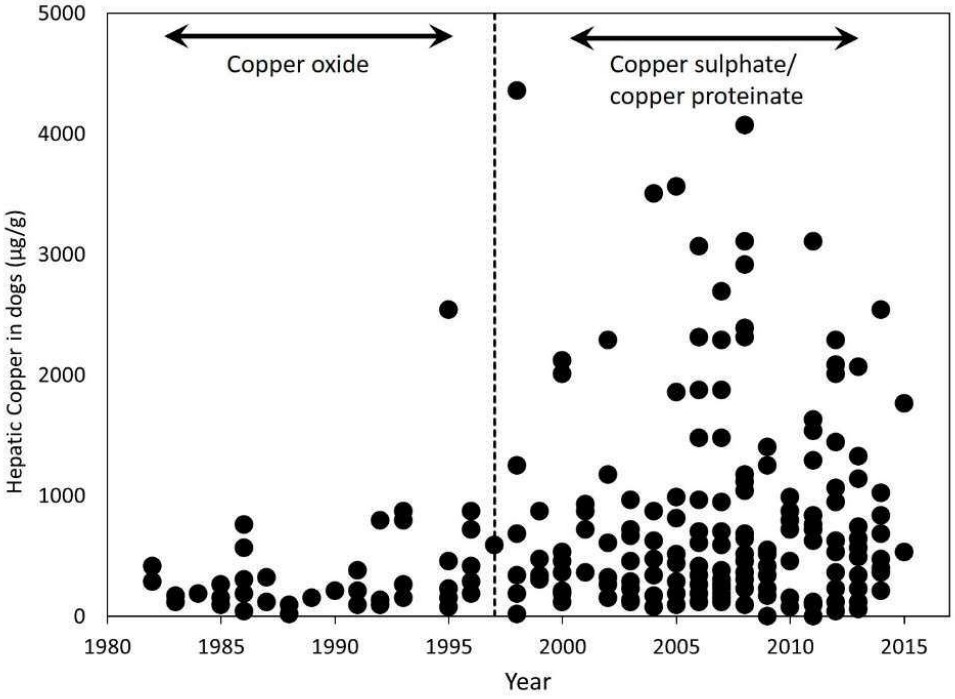

Fig. 1. Trends in hepatic copper concentrations in dogs in relation to changes in copper supplementation in commercial dog food. (After Strickland et al., 2018).

Potential Copper Exposure from Commercially Available Dog Food

The AAFCO Cu supplementation recommendations have been adopted in Canada. Two samples of dry dog food available in Southern Ontario were analyzed for Cu content (Table 1).

Dog food #1 is supplemented with copper sulphate and contained 20.7 ppm (mg/kg) Cu (analysis by hand-held portable XRF). Dog food #2 is formulated specifically for Labrador retrievers (a Cu-sensitive breed) was found to have a Cu content of 5 ppm (5 mg/kg). In the latter brand, the Cu content would be from the components of the feed, including organ meats such as liver, known to contain Cu (i.e., natural Cu). Not only is dog food #1 supplemented with a highly bioavailable form of Cu (copper sulphate), but in addition, it exceeds the AAFCO recommendation for Cu supplementation in dog food (1.83 mg Cu/1000 kcal). Dog food #2 did not contain added Cu in a mineral form and did not exceed the minimum recommended level of daily Cu intake (Table 1).

Table 1. Dietary copper ingestion rates for two commercially available dry dog foods. For comparison, recommended minimum and maximum intakes (mg/kg in dry food or mg/1000 kcal of metabolizable energy (ME) from the Association of American Food Control Officials (AAFCO)) are provided. In addition, an oral toxicity threshold of 16.3 mg Cu/kg body weight is provided for further context.

Data Source	Metabolizable energy (ME) (kcal/g)	Amount of food needed (g) to provide 1000 kcal	[Cu] in food (mg/kg)	Amount of Cu in 1,000 kcal of food (mg)	Daily Cu intake from Food (mg Cu/kg body weight/day)
Dog food #1	4.65	215	20.7	4.45	**0.247**
Dog food #2	3.48	287	5	1.44	**0.080**
AAFCO minimum Cu requirement in food for growth and reproduction	3.5	286	7.3[1]	2.09	0.116
AAFCO minimum Cu requirement for adult maintenance	3.5	286	7.3[1]	2.09	0.116
AAFCO maximum Cu allowance in food for adult maintenance	3.5	286	250[1]	714.57	39.698
Toxicity threshold for oral Cu ingestion (Taylor et al. 2020)	-	-	-	-	16.300

[1]The AAFCO recommended values assume an energy intensity of food to be 3.5 kcal/g of dry food. Dog foods with different energy density will result in a different amount of food required. Foods with higher ME require less food to be eaten to meet daily energy needs. This will also reduce the amount of Cu ingested. The reverse holds for foods with lower ME. (Source of AAFCO recommended values: Merck, 2023).

Dietary Cu restriction is likely the most effective way to prevent CAH (Hoffmann et al., 2009). Dietary Cu restriction requires the avoidance of foods supplemented with soluble Cu. Dog foods without any added Cu provide adequate Cu intake, even for breeds that are not Cu-sensitive (Center et al. 2021).

Potential Copper Exposure from Port Colborne Soil

Does the elevated soil Cu in the vicinity of the Port Colborne refinery pose a risk to Cu-sensitive breeds? Risk is dependent on several factors, including not only the concentration, but also the chemical form (speciation) of the Cu in the soil.

Soil ingestion by dogs has been considered for city soils, soil from the CBRA zones B, C, D, and woodlot soil (Table 2). The sources of the soil Cu data are provided in Table 2.

The form of the Cu affects its solubility and bioavailability, which in turn affect exposure and toxicity. Cu in typical dietary items in a western (human) diet is believed to be 30-40% bioavailable, the cationic Cu^{2+} ion being bound to plant and animal proteins in food items (Wapnir, 1998). Copper salts such as copper sulphate are thought to be similarly bioavailable, as the Cu^{2+} ion is released into aqueous solutions in a pH-dependent manner as the Cu salt dissolves in water. Copper sulphate would be expected to completely dissolve in stomach acid. In contrast, the Cu in the Port Colborne soils from the historical contamination is present largely as poorly soluble oxides of Cu (Vale, 2014), and are much less bioavailable than the Cu in copper sulphate. To estimate the meaningful amount of Cu exposure associated with Port Colborne soil Cu ingestion, CBRA oral bioaccessibility data (the 95%UCL (37.7%) of all 32 soil samples from Table 2 of Dutton et al., 2019) was adjusted relative to the bioaccessibility of soluble copper sulphate (99.95% (Delbeke et al., 2020)) to give a bioavailability adjustment factor of 0.38 for Cu in Port Colborne soil (i.e., 37.7÷99.95=0.38).

This assessment found that a medium-sized dog ingesting city soil with elevated Cu would not exceed the recommended Cu intake levels for dogs (Table 2). Ingestion of the woodlot soils from Vale-owned lands east of Reuter Road does exceed the recommended minimum Cu intake values, but is well below the recommended maximum dietary Cu allowance from the AAFCO (39.698 mg Cu/kg body weight/day) or the toxicity threshold of 16.3 mg Cu/kg body weight/day (Taylor et al., 2020) (Table 2). This holds true for the combined intake of soil and food as well.

Table 2. Incidental oral copper ingestion by dogs from Port Colborne soil. For context, AAFCO recommended minimum and maximum intakes (mg Cu/kg body weight/day) and an oral toxicity threshold of 16.3 mg Cu/kg body weight are provided.

Source of Information	[Cu] in soil (mg/kg)	Daily Cu intake from soil (mg Cu/kg body weight/day)[6]	Daily Cu intake from soil and food (mg Cu/kg body weight/day)[7]
Cu in city soil (95% UCLM[1])	300	0.092	0.339/0.172
Cu in CBRA Zone B garden soil[2]	228	0.070	0.317/0.150
Cu in CBRA Zone C garden soil[3]	93	0.029	0.276/0.109
Cu in CBRA Zone D garden soil[4]	81	0.025	0.272/0.105
Cu in woodlot soil (95% UCLM)[5]	3,035	0.935	1.182/1.015
AAFCO **minimum** Cu requirement for growth and reproduction		0.116	
AAFCO **minimum** Cu requirement for adult maintenance		0.116	
AAFCO **maximum** Cu allowance for adult maintenance		39.698	
Toxicity threshold for oral Cu ingestion (Taylor et al. 2020)		16.300	

[1]City soil Cu concentration represented by the largest 95%UCLM value for the 0-5, 5-10, and 10-15 cm soil depth increments from Table 14 of the 2002 Rodney Street Risk Assessment. Part A - Soil Investigation: Tables (MOE, 2002).

[2]The 95%UCLM value for soil [Cu] from CBRA HHRA "Zone B" garden soil samples (n=25) from Table 2 of Appendix 17 of Vol. V: Input Data - Soil, Water and Food of the CBRA Human Health Risk Assessment (JWEL, 2007) (pdf p. 209/1045).

[3]The 95%UCLM value for soil [Cu] from CBRA HHRA "Zone C" garden soil samples (n=104) from Table 3 of Appendix 17 of Vol. V: Input Data - Soil, Water and Food of the CBRA Human Health Risk Assessment (JWEL, 2007) (pdf p. 210/1045).

[4]The 95%UCLM value for soil [Cu] from CBRA HHRA "Zone D" garden soil samples (n=113) from Table 4 of Appendix 17 of Vol. V: Input Data - Soil, Water and Food of the CBRA Human Health Risk Assessment (JWEL, 2007) (pdf p. 211/1045).

[5]The 95UCLM value for soil [Cu] from the CBRA in woodlots, as provided by MECP comments.

[6]Calculated as follows: The soil Cu concentration is multiplied by the bioavailability adjustment factor (0.38) and by the assumed daily soil ingestion rate of 0.0146 kg (14.6 g) and divided by the assumed dog body weight (18 kg) (i.e. 300×0.38× 0.0146÷18=0.092 mg Cu/kg body weight/day for city soil and 3,035×0.38× 0.0146÷18=0.935 mg Cu/kg body weight/day for woodlot soil.

[7]The value to the left of the forward slash is the combined food and soil intake for medium-sized dogs eating dog food #1. The value to the right of the forward slash is the equivalent value for dog food #2.

Cu from Drinking Water

The Cu concentration from well water (household tap sources only) used in this assessment is the upper 95% confidence limit of the combined well water data sets from the CBRA (74.1 µg/L Table 3). An 18 kg dog would drink approximately 1.2 L of water per day. Water containing 74.1 µg Cu/L would therefore contribute 0.005 mg of Cu per kg of body weight per day, which is a very minor exposure source. However, pet owners should be aware that drinking water could be an important exposure source for Cu-sensitive dog breeds due to copper piping in houses.

Table 3. Combined (meta-analyzed) Cu concentrations in well water from the CBRA. Meta-analysis was via the ESCI statistical software (Cumming, 2012).

CBRA Data Source	Arith. Mean [Cu] (mg/L)	Std. Dev. (mg Cu/L)	Variance	Sample size (n)	Conf. Interval	Data Source Weighting (%)	95% Confidence Limits
Zone E[1]	0.053	0.051	0.00087	3	0.1267	20.9	[-0.0737, 0.1797]
Drilled Wells[2]	0.059	0.14	0.00019	101	0.0276	36.2	[0.0314, 0.0866]
Dug Wells[3]	0.014	0.019	0.000052	7	0.0176	42.9	[-0.0036, 0.0314]
Meta-analyzed joint values	0.038	-	0.00033	111	0.0357	-	[0.0027, ***0.0741***[4]]

1. Zone E data is for 3 wells from Table 6 (pdf p. 55/1045) in Appendix 15 (Domestic Drinking Water Sampling Program) from the CBRA Human Health Risk Assessment Volume V: Input Data - Soil, Water and Food. December, 2007. (JWEL, 2007).

2. Drilled well water collected at the tap from Table 8 (pdf p. 56/1045) in Appendix 15 (Domestic Drinking Water Sampling Program) from the CBRA Human Health Risk Assessment Volume V: Input Data - Soil, Water and Food. December, 2007. (JWEL, 2007).

3. Dug well water collected at the tap from Table 11 (pdf p. 59/1045) in Appendix 15 (Domestic Drinking Water Sampling Program) from the CBRA Human Health Risk Assessment Volume V: Input Data - Soil, Water and Food. December, 2007. (JWEL, 2007).

4. The upper 95% confidence limit for the combined (meta-analyzed) Cu concentration in tap water is 0.0741 mg/L (74.1 µg/L)

Summary

The highest (worst case) exposure to Cu would be expected from dogs eating the dog food #1 coupled with incidental soil ingestion of the 95%UCL soil Cu value of 3,035 ppm from Vale-owned woodlots. For that case, the estimated total daily Cu ingestion exposure rate of 1.182 mg/kg body weight/day is 14 times lower than the toxicity based exposure threshold of 16.3 mg/kg body weight/day and 34 times lower than the AAFCO maximum recommended value for adult dog maintenance (Table 2). Other exposures would be lower, and for brevity have not been presented here.

The screening-level calculations here indicate that there is little concern for copper exposure due to elevated copper in soil from the historical contamination from the Inco Port Colborne Nickel Refinery.

The choice of dog food will be an important consideration for owners of dogs from Cu-susceptible breeds. The use of pet food that is specifically developed for Cu-sensitive breeds (i.e., without added Cu in highly bioavailable forms such as copper sulphate or copper proteinate) will reduce the largest component of daily Cu ingestion.

CAH is unlikely to be an issue as a result of historical copper contamination on the impacted lands in the vicinity of the Port Colborne Refinery site.

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Appendix – MECP-Vale Comment-Response on Draft Version of this Guidance

Port Colborne Community-based Action Plan (PCCAP): Response to MECP Comments on Vale's Draft Document Entitled "Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery"

January 27, 2023

VALE

Overview

- Vale has developed a series of guidance documents for the community as a way to address a number of comments provided by the MECP over the duration of the CBRA. The guidance documents consist of simplified key guidance in point form and supporting information, which is technical in nature, indicating how the guidance was developed.

- Vale appreciates comments provided by MECP on these guidance documents and will take Ministry comments into consideration while revising the guidance documents. The content and flavour of the comments have provided Vale with context for finalizing these guidance documents.

- Not all MECP comments will necessarily be incorporated into revised guidance documents, but for purposes of transparency, responses are provided here.

- The Ministry comment memorandum is amended to this document following the final Vale slide. Only comments 1 (a general comment), and comments 9-14 are considered here, as they are the only comments relevant to the Cu-sensitive pet guidance.

VALE

Comment	Response
Re: "General Comments" 1. Given previous ministry comments on the Community Based Risk Assessment (CBRA), it is disconcerting that Vale continues to rely solely on their CBRA results without summarizing or recognizing ministry concerns or identifying that the CBRA results were never accepted by the ministry. We recommend that the "Key Guidance" sections of Vale's reports include the following edits (in red): "… The company accepted responsibility for the contamination and undertook the Port Colborne Community-Based Risk Assessment (CBRA). All CBRA documentation, including Ontario Ministry of the Environment, Conservation, and Parks (MECP) technical review comments, is available at http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx. The CBRA report was never accepted by MECP but some of the underlying science is relied upon to support the Port Colborne Action Plan.	• The guidance documents are intended to provide factual guidance to the community. • The dialogue that MECP has highlighted could be considered for the PCCAP final report, but is unproductive to include in the guidance documents. • New data is being generated under the PCCAP, but original CBRA data is also being used. The original CBRA data were generated by a qualified laboratory. They are good data. The use of these data should not be disconcerting. • The guidance documents have been provided to MECP for comment. Comments are received and will be taken under serious consideration. • The recommended wording will likely not be included in revisions.

Comments on Port Colborne Community Action Plan (PCCAP) Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

Comment	Response
9. Page 3 – Assessment of Risk of Cu Intake by Cu-Sensitive Dogs. Recommend a simple appendix that provides a full example calculation for determining total Cu exposure.	• The Supporting Information section provides the requested information. It will be revised for clarity in response to this comment.

VALE

Comments on Port Colborne Community Action Plan (PCCAP) Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

Comment	Response
10. Page 4. Cu from Drinking Water. Water intake should be included in the estimated Cu exposure. The CBRA update report provides information on Cu concentrations in wells at much higher concentrations than the average concentration of 22.4 ug/L reported here for municipal water in Niagara region. For example, the reasonable maximum exposure scenario for Cu in dug wells from Zone D, Residential, was 196 ug/L and the maximum concentration was 840 ug/L.	• Indeed, a single dug well in zone D had 840 µg Cu/L, but the sample was taken directly from the well, not from a tap in the house (all tap samples were low in Cu). Nickel and cobalt were very low in that sample, so the source of the Cu is unknown (presumably from Cu piping within the well), but it does not fit the profile of a refinery-impacted sample; the refinery is likely not the source of the Cu. • Additionally, the maximum value for dug well water collected at the tap was 56 µg Cu/L. • Vale will revise the document to provide a more accurate Cu in water concentration.

VALE

Comments on Port Colborne Community Action Plan (PCCAP) Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

Comment	Response
11. Page 4. Ingestion of Cu due to Incidental Soil Ingestion in Dogs. Calabrese and Stanek (1995) reported soil ingestion of between 10 and 20 g of soil based on limited data for a single dog over 3 days of observation. Please provide additional rationale to support the soil ingestion rate of 14.6 g/day. More current soil ingestion data may be available from the veterinary scientific literature and should be used if available.	• Calabrese and Stanek (1995) appears to be the entire literature on this subject. Vale has already searched the literature.

VALE

Comments on Port Colborne Community Action Plan (PCCAP) Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

Comment	Response
12. The assessment relies on the average and 90 percentile of Cu in soil (246 mg/kg and 471 mg/kg respectively) from the 2002 Rodney Street CBRA conducted by the MOE. This assessment should also include residential areas outside of the Rodney Street area where Cu concentration in soil can be much higher. For example, the CBRA Update report calculated the 95% UCLM as the exposure point concentrations for Cu of 3035 mg/kg in woodlots and 379 mg/kg in fields (Table 4-5). The 90 percentile data is not provided but the maximum Cu concentration was 3930 mg/kg in woodlots and 577 mg/kg in fields (Tables B-1 and B-2).	• The woodlots having the highest soil Cu concentrations are posted as Vale property with no trespassing warnings. It is likely that the exposure pathway for Cu-sensitive pets is therefore non-existent. Nevertheless, Vale will revise the exposure-point concentration used in the guidance.

VALE

Comments on Port Colborne Community Action Plan (PCCAP) Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

Comment	Response
13. Page 4, Exposure Limit. The citation to Taylor et al., 2019 should be Taylor et al., 2020. The NOEAL of 16.3 mg/kg/d from Taylor et al., 2020 derived from a study with rats should be reconsidered as the toxicological benchmark to use in this assessment given the current guidelines for Cu reduced therapeutic diets for dogs. For example, much lower Cu intake rates are provided in Center et al., 2021. Vale reports the fact that the current AAFCO recommendation for minimum daily copper intake for maintenance adult canine diets is 1.83 mg/1,000 kcal but fails to mention that the authors also note that is equivalent to a copper intake of approximately 0.067 mg/kg/day. Center et al., 2021, also notes that copper-restricted diets have copper intake ranging from 0.04 to 0.07 mg/kg/d. These recommended Cu doses are significantly less than the proposed exposure limit of 16.3 mg/kg/d.	• The AAFCO value is a recommended minimum intake, it is a nutritional rather than a toxicologically-based value. • Center et al. (2021) merely stated that a Cu-restricted diet providing 0.04-0.07 mg/kg/d did not seem to cause symptoms of Cu deficiency in normal dogs, not that that range of exposure should be considered a toxicological reference value. • The revised guidance will provide additional AAFCO intake recommendations and intakes will be provided on a per kg body weight basis.

VALE

Comments on Port Colborne Community Action Plan (PCCAP) Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

Comment	Response
14. Page 4, Findings. The estimated exposure of 1.1 mg/kg body weight/day exceeds the amount of Cu recommended in Cu restricted diets of between 0.4 to 0.7 mg/kg/day.	• Dietary Cu restriction in dogs is a preventative measure for Cu-sensitive (i.e., Cu–accumulating) dog breeds. The copper restricted diets are intended to prevent hepatic Cu accumulation in the susceptible breeds, it is not a toxicological value, specifically. • The exposure limit used provides an expression of exposures that might cause overt toxicity. The 16.3 mg/kg/d value is an appropriate benchmark for toxicity. • Vale will revise the guidance to reflect the two issues of toxicity and accumulation.

VALE

For a world with new values.

Ministry of the Environment, Conservation and Parks

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Ontario

June 6, 2022

MEMORANDUM

To: Greg Washuta, District Engineer, Niagara District Office, DWECD

From: Paul Welsh, Brownfield Program Coordinator, TASDB

CC: Andrew McDonough, Terrestrial Effects Scientist, EMRB

RE: Review of Various Guidance Documents prepared by Vale in Support of the Port Colborne Community-Based Action Plan

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As requested, the purpose of this memorandum is to provide technical comments on the following reports prepared by Vale in Support of the Port Colborne Community-Based Action Plan (PCCAP):

- Guidance for Growing Ornamental Plants in the Vicinity of the Port Colborne Refinery
- Guidance Regarding Chronic Copper Poisoning (CCP) in Sheep in the Vicinity of the Port Colborne Refinery
- Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

General Comments

1. Given previous ministry comments on the Community Based Risk Assessment (CBRA), it is disconcerting that Vale continues to rely solely on their CBRA results without summarizing or recognizing ministry concerns or identifying that the CBRA results were never accepted by the ministry. We recommend that the "Key Guidance" sections of Vale's reports include the following edits (in red):

   > "… The company accepted responsibility for the contamination and undertook the Port Colborne Community-Based Risk Assessment (CBRA). All CBRA documentation, including Ontario Ministry of the Environment, Conservation, and Parks (MECP) technical review comments, is available at http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx. The CBRA report was never accepted by MECP but some of the underlying science is relied upon to support the Port Colborne Action Plan.

Comments on Port Colborne Community Action Plan (PCCAP) Guidance for Growing Ornamental Plants in the Vicinity of the Port Colborne Refinery

1. Page 2, 1st paragraph. Recommend adding text to note that these symptoms of toxicity have also been observed in several site-specific studies conducted outside of the CBRA.

2. Page 2. The figure of contour lines for Ni has no context to it. Although ornamental plants were not explicitly considered in the CBRA, the ministry has previously suggested that the crops toxicity information could be used to develop site-specific benchmarks for the natural environment (see Attachment #2, and #3 of ministry comments on the 2017 draft PCCAP (dated August 10, 2018). These are also appropriate for ornamental plants and would range from 1,200 to 2,400 mg/kg Ni in soil. Several areas in the Port Colborne area fall within or exceed these concentrations. Recommend adding text to note that some residential soils may exceed these benchmarks.

3. Page 3, last paragraph. Potential impacts to ornamental plants from exposure to elevated COCs in soil may occur; but it is not appropriate to refer to potentially elevated COCs. It has already been established that levels of COCs in Port Colborne soils are elevated due to historic emissions from the refinery. The last sentence should be revised accordingly.

Comments on Port Colborne Community Action Plan (PCCAP) Guidance Regarding Chronic Copper Poisoning (CCP) in Sheep in the Vicinity of the Port Colborne Refinery.

Overall, reviewer notes that Vale has included requested information from previous ministry comments. However, this assessment is incomplete as it doesn't incorporate information on copper to molybdenum ratios in plant tissue – information that is critical to understanding the potential risk of CCP to sheep in the Port Colborne area. The assessment would also benefit from site-specific data published in the literature from studies conducted outside of Vale's CBRA.

4. Page 2, 3rd paragraph. In addition to the OVR circular noting that copper in diet is considered high at 10-20 ppm dry weight and toxic above 20 ppm, they also provide information on the importance of the ratio between copper (Cu) to molybdenum (Mo). This ratio is also discussed in the OMAFRA circular. In fact, OMAFRA notes of a case where CCP was diagnosed where Cu concentrations were only 8 ppm but where molybdenum was 0.5 ppm. The OVR circular indicates that the "goal is to keep Cu:Mo ratios approximately 6:1". The analysis provided by Vale indicates an overall average of total Cu in plant tissue of 9.3 ppm from the greenhouse and field plot studies and from 6.85 to 13.1 ppm in goldenrod depending on soil type. This analysis should be expanded to also other site-specific information from the literature (see comment #3) as well as consider the ratio between Cu and Mo concentrations (see comment #4).

5. Page 2, last paragraph. This analysis should also include results from site-specific information from literature published on the Port Colborne area. These studies are readily available from the work done on the CBRA update report of site-specific crop studies and are summarized in Attachment #2 (Suggested Ministry Approach to Derive SSTLs for the Crops ERA and the Natural Environment ERA) in ministry comments provided on the 2017 draft PCCAP (dated August 10, 2018). For example:

    a. Temple and Bisessar (1981) measured Cu concentrations ranging between 7 and 10 ppm in celery and onions stalks/bulb and leaf but 48 ppm in lettuce leaf in organic muck soil containing 800 ppm Cu.

b. Frank et al., (1982) measured Cu concentrations between 19 and 32 ppm in tops of beetroot, between 6 and 20 ppm in cabbage, and 8 to 18 ppm in radish in soils with total Cu ranging from 250 to 820 ppm.
c. Bisessar (1991) measured Cu concentrations between 5 and 9 ppm in organic soils and between 6 and 10 ppm in mineral soils from the Davison property; Cu concentrations in organic soil ranged from 105 to 180 ppm and in mineral soil from 60 to 140 ppm.
d. Everhart et al., (2006) measured Cu in plants from various metal contaminated soils (some with lime application). They observed Cu concentrations in Aventa sativa shoots of between 15 and 31.9 ppm in loam soil and between 11.5 and 28.4 ppm in muck soil and Cu concentrations in Alyssum murale shoots of between 6.5 and 23.9 ppm in loam soil but between 2.8 and 3.9 in organic soils.

6. Reviewer is not aware of plant tissue data for Mo from the Port Colborne area. However, both Cu and Mo concentrations in soil is available from MOE 1999 (Phytotoxicology Soil Investigation: INCO – Port Colborne (1998) - see Appendix A3 for Cu and Appendix A14 for Mo). Concentrations of Mo in soil are almost always less than 1 ppm while concentrations of Cu are much higher due to releases from the refinery. Given the levels of Mo in soil, it is possible that Mo levels in forage may also be low. Information on levels of Mo in forage is needed to properly assess the potential risk of CCP in sheep for the Port Colborne Action Plan.

7. Page 4, second last paragraph. This paragraph suggests that potential risk from CCP is limited only to those areas with extremely high Cu concentrations (more than 500 ppm). Additional information on the relationship between total Cu and Mo in soil to Cu and Mo concentrations in plant tissue is needed to determine areas that may be at risk from CCP.

8. Page 4, last paragraph. Summary information should be provided to support the statement that "plant tissue CU concentrations in some regions not being dissimilar from those measured in the CBRA crop studies". Note that reviewer was unable to open the URL for the Ontario forage copper report.

<u>Comments on Port Colborne Community Action Plan (PCCAP) Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery.</u>

Overall, this guidance focuses on exposure to pets that may occur with the Rodney Street community only. It does not include other residential areas in rural areas. Additional analysis is warranted to more comprehensively assess this pathway/potential risk.

9. Page 3 – Assessment of Risk of Cu Intake by Cu-Sensitive Dogs. Recommend a simple appendix that provides a full example calculation for determining total Cu exposure.

10. Page 4. Cu from Drinking Water. Water intake should be included in the estimated Cu exposure. The CBRA update report provides information on Cu concentrations in wells at much higher concentrations than the average concentration of 22.4 ug/L reported here for municipal water in Niagara region. For example, the reasonable maximum exposure scenario for Cu in dug wells from Zone D, Residential, was 196 ug/L and the maximum concentration was 840 ug/L.

11. Page 4. Ingestion of Cu due to Incidental Soil Ingestion in Dogs. Calabrese and Stanek (1995) reported soil ingestion of between 10 and 20 g of soil based on limited data for a single dog over 3 days of observation. Please provide additional rationale to support the

soil ingestion rate of 14.6 g/day. More current soil ingestion data may be available from the veterinary scientific literature and should be used if available.

12. The assessment relies on the average and 90th percentile of Cu in soil (246 mg/kg and 471 mg/kg respectively) from the 2002 Rodney Street CBRA conducted by the MOE. This assessment should also include residential areas outside of the Rodney Street area where Cu concentration in soil can be much higher. For example, the CBRA Update report calculated the 95% UCLM as the exposure point concentrations for Cu of 3035 mg/kg in woodlots and 379 mg/kg in fields (Table 4-5). The 90th percentile data is not provided but the maximum Cu concentration was 3930 mg/kg in woodlots and 577 mg/kg in fields (Tables B-1 and B-2).

13. Page 4, Exposure Limit. The citation to Taylor et al., 2019 should be Taylor et al., 2020. The NOEAL of 16.3 mg/kg/d from Taylor et al., 2020 derived from a study with rats should be reconsidered as the toxicological benchmark to use in this assessment given the current guidelines for Cu reduced therapeutic diets for dogs. For example, much lower Cu intake rates are provided in Center et al., 2021. Vale reports the fact that the current AAFCO recommendation for minimum daily copper intake for maintenance adult canine diets is 1.83 mg/1,000 kcal but fails to mention that the authors also note that is equivalent to a copper intake of approximately 0.067 mg/kg/day. Center et al., 2021, also notes that copper-restricted diets have copper intake ranging from 0.04 to 0.07 mg/kg/d. These recommended Cu doses are significantly less than the proposed exposure limit of 16.3 mg/kg/d.

14. Page 4, Findings. The estimated exposure of 1.1 mg/kg body weight/day exceeds the amount of Cu recommended in Cu restricted diets of between 0.4 to 0.7 mg/kg/day.