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Risk Management Approach for Cyanides

Environment and Climate Change Canada

Health Canada

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Canada

Summary of proposed risk management

This document outlines the proposed risk management actions for cyanides. In particular, the Government of Canada is proposing measures to reduce anthropogenic releases of cyanides to water from the following industrial sectors:

- Metal Mining: monitoring the effects of the lower maximum authorized concentrations of cyanide (came into force on June 1, 2021) in the *Metal and Diamond Mining Effluent Regulations* on reducing the risks to fish and fish habitat.
- Road Salts: working with the road salt mining sector and road salt importers and users to determine the feasibility of controlling the concentration of ferrocyanide salt in road salts or its release to the environment.
- Integrated Iron and Steel Manufacturing: working with industry and the Government of Ontario to gather additional information to determine whether there is a need to further limit total cyanide concentrations released from mill wastewater treatment effluent.

Moreover, because certain data gaps remain, the following information should be provided, (ideally on or before April 26, 2023), to the contact details identified in section 8 of this document to inform risk management decision-making:

- Metal Mining:
  - Weak Acid Dissociable Cyanides (CN_{WAD}) concentrations in effluent and exposure and reference areas in the receiving water bodies of metal mining facilities that use cyanides in their process.

- Road Salt:
  - Types of road salts used across Canada that contain cyanides;
  - Minimum concentration of ferrocyanides needed to prevent caking in various environmental conditions;
  - Technical and/or economic feasibility of anticaking alternatives to ferrocyanides;
  - Ferrocyanide controls in other jurisdictions;
  - Amounts and concentrations of ferrocyanides in imported and domestic road salt; and
  - Amount of road salts used by private organizations.

- Iron and Steel Manufacturing:
  - CN_{WAD} concentrations;
  - If available, free Cyanide (CN_{Free}) concentrations in effluent(s) reported to the Ontario Government;
  - Locations of sampling points for the different effluents; and
  - If available, CN_{WAD} and CN_T concentration data in the receiving water body downstream from the effluent(s) discharge point(s).

The risk management actions outlined in this risk management approach may evolve through consideration of assessments and risk management actions published for other Chemicals Management Plan substances to ensure effective, coordinated, and consistent risk management decision-making.

Note: The above summary is an abridged list of actions proposed to manage cyanides and to seek information on identified gaps. Refer to section 3 of this document for more complete details.

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1. Context

The *Canadian Environmental Protection Act, 1999* (CEPA) (Government of Canada, 1999) provides the authority for the Minister of the Environment and the Minister of Health (the Ministers) to conduct assessments to determine if substances are toxic to the environment and/or harmful to human health as set out in section 64 of CEPA[1,2], and if so to manage the associated risks.

Pursuant to the Act, the Minister of the Environment and the Minister of Health have conducted a screening assessment for Cyanides under the Government of Canada's Chemicals Management Plan (CMP; Canada 2023a). The ecological portion of the screening assessment used a moiety-based approach, which includes free (unbound) cyanide [hydrogen cyanide (HCN) and the cyanide anion (CN^-)] and precursors of free cyanide. The ecological moiety assessment includes the 10 substances which met categorization criteria under subsection 73(1) of CEPA and were identified as priorities for assessment. As the ecological assessment took a moiety approach, it is not limited to these 10 substances.

Free cyanide and precursors of free cyanide are referred to throughout this document as cyanides.

2. Issue

Environment and Climate Change Canada (ECCC) and Health Canada (HC) conducted a joint scientific assessment to evaluate cyanides in Canada under section 68 or 74 of CEPA. A notice summarizing the scientific considerations of the final screening assessment for these substances was published in the *Canada Gazette*, Part I, on February 25, 2023 (Canada 2023b). For further information, refer to the final Screening Assessment for the Cyanides Group.

[1] Section 64 [of CEPA]: *For the purposes of* [Parts 5 and 6 of CEPA]*, except where the expression "inherently toxic" appears, a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that*

- *(a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity;*
- *(b) constitute or may constitute a danger to the environment on which life depends; or*
- *(c) constitute or may constitute a danger in Canada to human life or health.*

[2] A determination of whether one or more of the criteria of section 64 are met is based upon an assessment of potential risks to the environment and/or to human health associated with exposures in the general environment. For humans, this includes, but is not limited to, exposures from ambient and indoor air, drinking water, foodstuffs, and the use of products available to consumers. A conclusion under CEPA is not relevant to, nor does it preclude, an assessment against the hazard criteria specified in the *Hazard Product Regulations* and the *Controlled Products Regulations*, which are a part of the regulatory framework for the Workplace Hazardous Materials Information System for products intended for workplace use. Similarly, a conclusion based on the criteria contained in section 64 of CEPA does not preclude actions being taken under other sections of CEPA or other Acts.

2.1 Final screening assessment conclusion

The ecological portion of the screening assessment uses a moiety-based approach[3] that focuses on free cyanide (CN_{Free}), and precursors of free cyanide as the forms of primary ecotoxicological significance. Free cyanide, consisting of the cyanide anion (CN^-) and molecular hydrogen cyanide (HCN), is considered the moiety of concern for this screening assessment. Precursors to free cyanide are substances, such as cyanide salts and cyanide complexes, that contain the cyanide moiety and that can degrade to free cyanide through various transformation pathways (e.g., hydrolytic, redox, or metabolic) at environmentally, industrially or physiologically relevant conditions. Based on the information available, the final screening assessment concludes that free cyanide and precursors of free cyanide are toxic under paragraph 64(*a*) of CEPA because they are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. It is concluded that free cyanide and precursors of free cyanide do not meet the criteria under paragraph 64(*b*) of CEPA as they are not entering the environment in a quantity or concentration or under conditions that constitute or may constitute a danger to the environment on which life depends.

The final screening assessment also concludes that free cyanide and precursors of free cyanide meet the persistence criteria but not the bioaccumulation criteria as set out in the *Persistence and Bioaccumulation Regulations* of CEPA (Government of Canada, 2000). Specifically, HCN is considered persistent in air, ferrocyanides are considered persistent in soils and sediments, and free cyanide and its precursors are not considered bioaccumulative.

The ecological assessment focused on CN_{Free} and CN_{WAD} data where available, as these are the most relevant measures for ecological effects. Measurements of total cyanides (CN_T), which represents the sum of cyanide compounds in a sample (including strong acid dissociable cyanide (CN_{SAD})), were also a line of evidence considered in the screening assessment. The ecological concern identified in the final screening assessment is based on the potential release of free cyanide from some facilities within the metal mining sector, use of ferrocyanide-containing road salts, and some facilities within the iron and steel manufacturing sector. As such, this document will focus on these activities and exposure sources of potential concern (refer to section 5.2).

For the assessment of risk to human health, it is concluded that the 10 cyanides which were identified as priorities for assessment, do not meet the criteria under paragraph 64(*c*) of CEPA as they are not entering the environment in a quantity

[3] For the purpose of this document, “moiety” signifies a part of a molecule. A moiety is a discrete chemical entity, identified from a parent compound, or its transformation products, that is expected to have toxicological significance.

or concentration or under conditions that constitute or may constitute a danger in Canada to human life or health.

2.2 Recommendation under CEPA

On the basis of the findings of the final screening assessment, the Ministers recommend that free cyanide, cyanide salts, and cyanide complexes be added to the *List of Toxic Substances* in Schedule 1 of the Act[4].

The Ministers have taken into consideration comments made and information provided by stakeholders during the 60-day public comment period on the draft screening assessment for cyanides and its associated risk management scope.

As the Ministers finalize the recommendation to add free cyanide, cyanide salts and cyanide complexes to Schedule 1 of CEPA, a risk management instrument must be proposed within 24 months from the date on which the Ministers recommend that free cyanide, cyanide salts and cyanide complexes be added to Schedule 1 of CEPA and finalized within 18 months from the date on which the risk management instruments are proposed, as outlined in sections 91 and 92 of CEPA (refer to section 8 for publication timelines applicable to this group of substances). For cyanides, a risk management instrument has already been proposed and finalized with the publication of the *Metal and Diamond Mining Effluent Regulations* (MDMER) on May 30, 2018, with some amendments that came into force on June 1, 2021, including new cyanide limits in effluent.

2.3 Public comment period on the risk management scope

The risk management scope for cyanides, which summarized the proposed risk management options under consideration at that time, was published on February 10, 2018. Industry and other interested stakeholders were invited to submit comments on the risk management scope during a 60-day comment period.

Comments received on the risk management scope were taken into consideration in the development of this document, where appropriate. Refer to the summary of responses to public comments received for further information.

3. Proposed risk management

3.1 Proposed environmental objective

[4] When a substance is found to meet one or more of the criteria under section 64 of CEPA, the Ministers can propose to take no further action with respect to the substance, add the substance to the *Priority Substances List* for further assessment, or recommend the addition of the substance to the *List of Toxic Substances* in Schedule 1 of the Act.

Proposed environmental objectives are quantitative or qualitative statements of what should be achieved to address environmental concerns.

For these substances, the proposed objective is focused on addressing the exposure sources of concern from the sectors identified in the final screening assessment, as outlined in section 5 of this document. As such, the proposed environmental objective for cyanides is to reduce anthropogenic releases of free cyanide and precursors of free cyanide to water, so that concentrations in receiving environments do not exceed levels observed to cause adverse effects to aquatic organisms.

3.2 Proposed risk management objective

Proposed risk management objectives set quantitative or qualitative targets to be achieved by the implementation of risk management regulations, instrument(s), and/or tool(s) for a given substance or substances.

The proposed risk management objective for cyanides is to achieve the lowest level of releases of free cyanide and precursors of free cyanide to water that is technically and economically feasible, taking into consideration socio-economic factors, including roadway safety.

3.3 Proposed risk management actions

To achieve the proposed risk management objective and to work towards achieving the proposed environmental objective, the proposed risk management actions being considered for cyanides include the implementation of regulatory and non-regulatory controls to minimize releases of cyanides to the Canadian environment. These proposed actions are described below.

Note that the proposed risk management actions described in this document are preliminary and subject to change. Following the publication of this document, additional information obtained from the public comment period and from other sources will be considered, along with the information presented in this document, in further instrument selection and development processes[5], if required. The risk management actions outlined in this document may also evolve through consideration of assessments and proposed risk management actions published for other CMP substances to ensure effective, coordinated, and consistent risk management decision-making.

[5] The proposed risk management regulation(s), instrument(s) or tool(s) are selected using a thorough, consistent and efficient approach and take into consideration available information in line with the Government of Canada's Cabinet Directive on Regulatory Management (TBS, 2018) , the Red Tape Reduction Action Plan (TBS, 2012b), and in the case of a regulation the *Red Tape Reduction Act* (Canada, 2015).

[6] Performance measurement can be performed at two levels:

3.3.1 Metal mining

There are currently existing instruments to reduce anthropogenic releases of cyanides into the environment from the metal mining sector. The MDMER under the *Fisheries Act* prescribes limits on the concentration of total cyanide in effluent (Government of Canada, 2002). This is the primary risk management instrument currently used to reduce releases of cyanides into the environment from the metal mining sector. The Environmental Effects Monitoring (EEM) provisions in the MDMER require the monitoring of effects on fish and other organisms. In addition, testing of effluent for acute lethality is required within the regulations.

The MDMER were recently amended (May 30, 2018) and the Government of Canada lowered several of the effluent limits, including the limits for total cyanide. On June 1, 2021, the monthly mean limit for total cyanide was lowered to 0.5 mg/L and this is expected to result in lower levels of cyanides released from metal mines. In the years following the coming into force of these amendments, ECCC will continue to monitor to assess the effectiveness of the MDMER and these new limits in managing the risks associated with cyanides.

Additionally, an existing *Environmental Code of Practice for Metal Mines* published pursuant to subsection 54(4) of CEPA includes recommendations for the management of cyanides (ECCC, 2009). This risk management instrument is complementary to the MDMER and could potentially be considered for an update to further improve the management of cyanides if additional recommended management practices are identified.

3.3.2 Road salts

ECCC published a *Code of Practice for the Environmental Management of Road Salts* in 2004 (ECCC, 2004). Under this Code, municipalities and provinces that use more than 500 tonnes of road salts per year or have a vulnerable area in their territory are encouraged to develop salt management plans addressing salt storage, application and snow disposal, and report annually to ECCC on the implementation of these plans. The Code applies to the environmental management of road salts that contain inorganic chloride salts with or without ferrocyanide salts. As such, any reductions in releases of inorganic chloride salts to the environment resulting from the Code should have a co-benefit of reducing releases of ferrocyanide salts to the environment.

A review of the implementation of the Code was initiated in 2019. Data on cyanide use in road salts in Canada were requested in the risk management scope. Limited information was gathered through voluntary surveys and therefore ECCC is now planning additional information gathering activity on ferrocyanide in road salts in Canada.

ECCC will work with the road salt mining sector, as well as importers and users of road salts, to gather information required to determine the feasibility of controlling the concentration of ferrocyanide salts in road salts or their release to the environment.

Should it be determined that controls are necessary, revisions to the Road Salts Code of Practice could be considered to minimize the need for ferrocyanides or their release to the environment.

Other risk management options that could be considered, as necessary, are a CEPA section 56 Pollution Prevention Planning Notice, CEPA section 54 Guideline/Code of Practice, or an Environmental Performance Agreement with the Canadian salt mining industry and road salt importers.

3.3.3 Iron and steel manufacturing

Cyanides are produced incidentally in coke ovens and in the blast furnace of integrated iron and steel manufacturing plants. There are currently four integrated iron and steel manufacturing facilities in Canada, all located in Ontario. Individual Environmental Compliance Approvals (ECAs), which replaced the *Ontario Regulation 214/95: Effluent Monitoring and Effluent Limits - Iron and Steel Manufacturing Sector,* monitor and control the quality of effluent discharged from iron and steel plants in Ontario (Government of Ontario, 1995). Industrial facilities that discharge wastewater directly into Ontario's lakes and rivers must sample, analyze, and report the results, including total cyanide, to the ministry via the Ministry of the Environment Wastewater System (MEWS) web application. ECCC is proposing to work with the industry and the Government of Ontario to seek further understanding of cyanide releases from integrated mills and determine whether there is a need to further limit total cyanide concentrations released from integrated mill wastewater treatment plants.

3.4 Performance measurement and evaluation

Performance measurement evaluates the ongoing effectiveness and relevance of the actions taken to manage risks from toxic substances[6]. The aim is to determine whether human health and/or environmental objectives have been met and whether there is a need to revisit the risk management approach for that

[6] Performance measurement can be performed at two levels:

- Instrument-based performance measurement evaluates the effectiveness of an individual instrument in meeting the specific risk management objectives that were set out when the risk management tool was designed. The results of performance measurement will help determine if additional risk management or assessment is needed (i.e., evaluate whether risk management objectives have been met); and
- Substance-based performance measurement considers performance of all final risk management instruments applied to a chemical substance and relevant data or indicators of exposure to the environment or human health (i.e., evaluate whether human health and/or environmental objectives have been met).

substance. In evaluating progress and revisiting risk management, as warranted, these activities together will aim to manage risks effectively over time. To achieve this, the Government of Canada plans to review the effectiveness of the risk management actions for cyanides.

The Government of Canada plans to measure the effectiveness of the risk management actions by collecting and analyzing data submitted by metal mines, following the coming into force of amended cyanide requirements under MDMER, to measure progress towards meeting the risk management objective.

As part of performance measurement evaluation, new information (e.g., emerging concerns or new sources of exposure) will be taken into consideration to ensure long-term effectiveness of actions in place. ECCC may also consider monitoring and other data on cyanide emissions from other industrial sectors such as oil refining, aluminium manufacturing, and chemical manufacturing (such as the manufacture of carbon black) when measuring progress made towards meeting the environmental objectives. In addition, the Government of Canada plans to collect and analyze monitoring data , in order to establish a baseline environmental presence, and over time to measure progress towards meeting the environmental objective.

The results of performance measurement and evaluation will be used to inform whether further risk management action is warranted, and will also be made available to Canadians along with recommendations for further action, if applicable.

3.5 Risk management information gaps

Interested stakeholders can provide further information to inform risk management decision-making regarding cyanides, including:

- Metal Mining:
    - Weak Acid Dissociable Cyanides (CN_{WAD}) concentrations in effluent and exposure and reference areas in the receiving water bodies of metal mining facilities that use cyanides in their process.

- Road Salt:
    - Types of road salts used across Canada that contain cyanides;
    - Minimum concentration of ferrocyanides needed to prevent caking in various environmental conditions;
    - Technical and/or economic feasibility of anticaking alternatives to ferrocyanides;
    - Ferrocyanide controls in other jurisdictions;
    - Amounts and concentrations of ferrocyanides in imported and domestic road salt; and
    - Amount of road salts used by private organizations.

- Iron and Steel Manufacturing:
    - Weak Acid Dissociable Cyanides (CN_{WAD}) concentrations;
    - Free Cyanide (CN_{Free}) concentrations in effluent(s);
    - Locations of sampling points for the data provided; and
    - CN_{WAD} and CN_T concentration data in the receiving water body downstream from the effluent(s) discharge point(s).

Stakeholders that have such information should provide it to the address identified in section 8.

4. Background

4.1 General information on cyanides

Cyanides are a large family of chemical compounds that contain the cyano functional group (-CN), consisting of a carbon atom triple bonded to a nitrogen atom. See the final screening assessment for additional information on the chemistry of cyanides (Canada, 2023). Cyanides include some ferrocyanides that were discussed in the First Priority Substances List (PSL1) Road Salt Assessment (ECCC, HC, 2001).

4.2 Current uses and identified sectors

Cyanides are imported into Canada for use by many sectors for a wide variety of applications. In addition, cyanides are incidentally manufactured in Canada by a few sectors where high temperature and pressure processes are used. The information that was collected on these uses and sectors was reviewed and presented in detail in the final screening assessment. The sections below provide a summary of the uses and sectors where a potential risk was identified in the final screening assessment. Other sectors of activity (e.g., carbon black manufacturing, etc.) may also be sources of cyanides to the environment. However, based on preliminary exposure information available at the time of the screening assessment, deemed these sources to be either of lesser concern or lacking data.

4.2.1 Metal mining

Sodium cyanide (NaCN; CAS RN 143-33-9) is used mainly as an extraction agent for precious metals (e.g., gold, silver) and to a lesser degree for base metals, and as a result, free cyanide and precursors of free cyanide may be released in the effluent of metal mining facilities that use it. In 2016, 42 gold mines and 10 other metal mines used and/or reported releases of cyanides (ECCC, 2017). Note that at least five of these facilities were not operating in 2016, having already been closed for several years. It should also be noted that not all facilities which use cyanide in their processes have elevated levels of

cyanides in their effluents or receiving environments. According to information submitted in response to a CEPA section 71 survey, quantities of NaCN imported into Canada for use in 2011 by the metal mining sector ranged from 10 000 to 50 000 tonnes (Government of Canada, 2012).

4.2.2 Road salts

Tetrasodium ferrocyanide (CAS RN 13601-19-9) is used mainly as an anticaking agent in road salts and may be released to the environment by run-off from road and pavement de-icing applications. Information available at the time of the screening assessment indicates that ferrocyanides were added to road salt at the mine(s) where they are processed. Road salts containing ferrocyanides were used in Ontario, Quebec, and the Atlantic provinces. From Manitoba to the interior of British Columbia, a by-product salt from Saskatchewan potash mines that is used as road salt was not treated with ferrocyanides. On the west coast, imported rock salt was pre-treated with ferrocyanides prior to importation. Road salt is not effective in very cold climates and is typically not used in northern parts of Canada. In a study conducted for ECCC in 2003, approximately 300 to 350 tonnes of ferrocyanides per year were reported to be imported from European and Asian manufacturers for use as an anti-caking agent (JEGEL, 2003). Updated information on ferrocyanide use in road salts in Canada is not available.

4.2.3 Iron and steel manufacturing

Cyanides are incidentally manufactured during certain processes using high temperatures and pressures and may be found in gas and in wastewater from blast furnaces at integrated iron and steel manufacturing mills. The final screening assessment identified integrated iron and steel mills as a sector of concern since high total cyanide concentrations were found in the effluents of certain integrated steel mills in Canada, potentially resulting in high total cyanide concentrations in the receiving environment.

5. Exposure sources and identified risks

5.1 Natural sources

A number of cyanides are naturally occurring substances that may be produced in the environment by abiotic processes (e.g., combustion) and by biota (e.g., cyanogenic glycosides (CGs); produced as natural plant defense agents). Gaseous or particulate cyanide emissions from combustion may enter surface waters by deposition or surface runoff (Barber, et al., 2003). Biomass burning and forest fires are a source of HCN to the atmosphere (Li, et al., 2000; Simpson, et al., 2011) and may represent more than 90% of all natural or anthropogenic air emissions (ECETOC, 2007). Other potential sources may include volcanoes or lightning (Cicerone & Zellner, 1983).

Higher plants produce small amounts of HCN as part of certain metabolic processes (Lechtenberg & Nahrstedt, 1999) and CGs are known to be produced in at least 2000 plant species (Speijers, 1993). Many edible plant-based foods naturally contain CGs, which have the potential to release HCN. There are numerous types of CGs (e.g., linamarin, amygdalin, dhurrin) that exist and the degree to which a particular CG is present varies depending on the given plant (FSANZ, 2014). Examples of foods that contain CGs include lima beans, apple seeds, cassava, bamboo, stone fruit pits (e.g., apricot, peach, cherry), and flax seed. The leaching and subsequent hydrolysis of CGs from plant matter may release HCN to the environment (Bjarnholt et al., 2008). Aquatic microorganisms such as green algae (*Chlorella* sp.) and particularly the blue-green algae (*Anacystis nidulans*) can produce HCN (Gewitz et al., 1976; Pistorius et al., 1979). A review by NICNAS determined that cyanides may be produced by other microorganisms (i.e., bacteria and fungi), as well as a small number of invertebrates (e.g., arthropods) (AGDH, 2010).

5.2 Anthropogenic releases to the environment

Anthropogenic releases of cyanides to the environment have been identified in the final screening assessment as posing a risk in some sectors which are identified below, particularly when released directly to the aquatic environment.

5.2.1 Metal mining

CN^- is the main reagent used to extract gold and other precious metals efficiently from ore (Johnson, Leinz, Grimes, & Rye, 2002). Major steps in ore processing include grinding and crushing, chemical / physical separation and dewatering (ECCC, 2009). Cyanides (e.g., NaCN) may be added in the grinding circuit or during ore separation processes involving flotation, or during cyanide leaching which is the dominant process for the recovery of metallic gold or silver (ECCC, 2009). Mines that use cyanides often use treatment technologies to destroy the cyanide in effluent, though some operations rely solely on natural degradation of cyanide (Hatch, 2014). In Canada, common technologies used for the removal of cyanides from mining wastes (e.g., effluent and tailings) are the SO_2^-air process and the hydrogen peroxide process. Natural degradation is often used as a polishing step.

The final screening assessment looked at various sources of information for cyanides, which included reports, studies, and databases, including measured concentrations of cyanides included in reports submitted in response to EEM provisions under the MDMER. The information presented in the final screening assessment tends to show higher cyanide concentrations (CN_{Free}/CN_{WAD} and CN_T) in water samples receiving effluent from mining activities and in concentrations that suggest there is potential for ecological concern with releases of cyanides from certain facilities in this sector.

5.2.2 Road salts

Ferrocyanides are used as anti-caking agents in road salts to prevent clumping (EC + HC, 2001). While the ferrocyanide anion is stable and exhibits low toxicity to organisms, in solution it can fully dissociate via photolysis to produce free cyanide (HCN) (EC + HC, 2001; Exall et al., 2011). Road salts containing iron cyanides are applied as de-icing agents on roads and parking lots in some parts of Canada during the late fall, winter and early spring seasons (EC + HC, 2001; (Exall et al., 2013).

5.2.3 Iron and steel manufacturing

Free cyanide and other species may be found in gas and in wastewater from coke plants and blast furnaces at iron and steel manufacturing facilities (Luzin et al., 2012; Petelin et al., 2008; Yu X, 2016). Cyanides are produced by the reaction between carbon and nitrogen under reducing conditions and high temperature (>1000 ^{o}C); conditions that are found during coking and blast furnace operations (Wong-Chong et al., 2006c; Petelin, Yusfin, & Travyanov, 2008). Cyanides may be found in coke oven gas (COG) and blast furnace gas, in cooling water that has been in contact with COG, in flushing liquor from cleaning of COG, or in blast furnace gas scrubber effluent (Wong-Chong et al., 2006b; U.S. EPA, 2008).

The predicted environmental concentrations calculated from total cyanide concentrations reported in effluents from two integrated iron and steel manufacturing sites in Ontario were greater than the long-term predicted no-effect concentration value of 1.7 µg/L (Ontario, 2016).

6. Risk management considerations

6.1 Alternatives and alternate technologies

For sectors of concern identified in the final screening assessment, it is not expected that chemical alternatives or alternate process technologies would be a practical approach to minimizing releases of free cyanide.

While there are cyanide-free gold extraction technologies currently being developed, the extent of their application is not well known. In addition, gold and silver extraction processes using mercury are discouraged globally due to the adverse impacts of mercury to the environment and human health.
Although alternatives to road salts are available, these have not been proven to be cost effective or efficient for wide-spread use. Municipal and provincial authorities are best qualified to determine which de-icing chemicals are suitable for use considering their local environmental sensitivities and road conditions to ensure road safety. Alternatives to road salts should therefore not be considered as an overall risk management option for ferrocyanides.

In a study conducted for ECCC in 2003, no effective alternatives to ferrocyanides as an anti-caking agent in road salts were found (JEGEL, 2003).

In the case of integrated iron and steel manufacturing, additional effluent control technologies could likely be an effective approach, as appropriate and economically feasible.

6.2 Socio-economic and technical considerations

Socio-economic factors have been considered in the selection process for a regulation respecting preventive or control actions, and in the development of the risk management objective as per the guidance provided in the Treasury Board document *Assessing, Selecting, and Implementing Instruments for Government Action* (TBS, 2007). In addition, socio-economic factors will be considered in the development of the regulations, instrument(s) or tool(s), to address risk management objective(s), as identified in the Cabinet Directive on Regulation (TBS 2018), Red Tape Reduction Action Plan (TBS, 2012) Amendments and the *Red Tape Reduction Act* (Government of Canada, 2015).

7. Overview of existing risk management

7.1 Related Canadian risk management context

The Canadian water quality guidelines developed by the Canadian Council of Ministers of the Environment recommend a maximum value of 5 µg/L for free cyanide in fresh water to protect the aquatic life (CCME, 1997).

7.1.1 Metal mining

The MDMER, under the *Fisheries Act*, authorizes the deposit of deleterious substances[7] into natural fish-bearing waters. Schedule 4 of these regulations prescribes concentration limits in effluent for certain parameters including a maximum authorized monthly mean concentration for total cyanide. This monthly mean concentration limit was lowered from 1 mg/L to 0.5 mg/L total cyanide in amendments that came into force on June 1, 2021. Facilities are also required to conduct EEM where water quality monitoring, including the monitoring of total cyanide if it is used as a process reagent at the mine, must be completed in the exposure area surrounding the point of entry of effluent into water from each discharge point and from the related reference areas.

[7] A deleterious substance is defined by the *Fisheries Act* as any substance that, if added to water, makes the water deleterious to fish or fish habitat or any water containing a substance in such quantity or concentration or has been changed by heat or other means, that if added to water makes that water deleterious to fish or fish habitat.

The *Environmental Code of Practice for Metal Mines*, published according to subsection 54(4) of CEPA, is designed to support the MDMER and includes other subjects that are not dealt with in the MDMER and may have an influence on the environmental impact of mining operations. The objective of the Code is to identify and promote recommended best practices to facilitate and encourage continual improvement in the environmental performance of mining facilities throughout the mine life cycle. It includes recommendations for the management of cyanides and refers to the International Cyanide Management Code (see section 7.2.1).

All provinces and territories have established effluent limits for metal mines, either by regulations, permits, licenses, or certificates of approval. The limits are generally the same as those in the MDMER, or more stringent to address site-specific or jurisdiction-specific circumstances.

7.1.2 Road salts

ECCC developed a *Code of Practice for the Environmental Management of Road Salts* in 2004 (ECCC, 2004). Under this Code, municipalities and provinces that use more than 500 tonnes of road salts per year or that have a vulnerable area in their territory are encouraged to develop salt management plans addressing salt storage, application and snow disposal and report annually to ECCC on the implementation of these plans. The Code is intended to be used in conjunction with the *Salt Management Guide* and *Syntheses of Best Practices* developed by the Transportation Association of Canada (TAC, 2013), as well as any other federal, provincial, territorial or municipal maintenance standards. Releases of ferrocyanide to the environment are indirectly controlled through the best management practices that are included in individual salt management plans developed to address the Code.

7.1.3 Iron and steel manufacturing

ECCC published *an Environmental Code of Practice for Integrated Steel Mills* in 2001 (ECCC, 2013). The Code lists environmental performance standards for atmospheric emissions, water and wastewater, wastes, and environmental management practices for new integrated steel mills. The Code also provides a set of environmental performance goals that existing mills can strive to achieve through continual improvement over time.

Individual ECAs, which replaced the Ontario *Regulation 214/95: Effluent Monitoring and Effluent Limits - Iron and Steel Manufacturing Sector* (Government of Ontario, 1995) which falls under the Ontario *Environmental Protection Act*, monitor and control the quality of effluent discharged from iron and steel plants in Ontario. The requirements are that all industrial wastewater facilities must have an environmental compliance approval to establish, use, operate, or modify a facility. The environmental compliance approval normally

imposes site-specific effluent limits and monitoring and reporting requirements for the operation of the facility. Industrial facilities that discharge effluent directly into Ontario's lakes and rivers must sample, analyze and report the results to the ministry via the MEWS web application.

7.2 Pertinent international risk management context

7.2.1 Metal mines

Heap leaching is an industrial mining process used to extract precious metals and other compounds from ore using a series of chemical reactions that absorb specific minerals and re-separate them after their division from other earth materials. Cyanide is utilized in heap leaching facilities for gold/silver extraction, and as flotation reagents in surface operations which are typically called the mills or concentrators. Internationally, several countries have restricted cyanide leach technology in mining. In the United States, Montana restricted new heap leaching facilities, but existing leaching facilities are permitted (implemented November 6, 1998) (MEIC, 1998). Counties in the state of Colorado have the authority to restrict the use of cyanides in gold mining (implemented March 22, 2007) (Associated Press, 2007). The Czech Republic, Germany, Costa Rica, and some provinces in Argentina have also restricted the technology (Rodriguez, 2009).

In the European Union, Directive 2006/21/EC sets out cyanide limits for tailing ponds, where CN_{WAD} is to be reduced to the lowest possible levels. As well, mines started after May 1, 2008, may not discharge waste that contains more than 10 ppm CN_{WAD}. Those built or permitted before that date, were to meet that level by 2018.

In addition, the *International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide in the Production of Gold* (Cyanide Code) was developed by a multi-stakeholder Steering Committee under the guidance of the United Nations Environmental Program and the then-International Council on Metals and the Environment (ICMI, 2015).

The Cyanide Code is a voluntary industry program for gold and silver mining companies. It considers the best practices regarding cyanides from codes and regulations of various jurisdictions. It focuses exclusively on the safe management of cyanides and cyanidation mill tailings and leach solutions. Companies that adopt the Cyanide Code must have their mining operations that use cyanides to recover gold or silver audited by an independent third party to determine the status of Cyanide Code implementation. Those operations that meet the Cyanide Code requirements can be certified. In 2018, five Canadian mines were certified and several others were in the process of obtaining certification. A unique trademark symbol can then be utilized by the certified operation. Audit results are made public to inform stakeholders of the status of cyanides management practices at the certified operation.

The objective of the Cyanide Code is to improve the management of cyanides used in gold and silver mining and assist in the protection of human health and the reduction of environmental impacts.

8. Next steps

8.1 Public comment period

Industry and other interested stakeholders are invited to submit comments on the content of this risk management approach or other information that would help to inform decision-making (such as outlined in section 3.3). Please submit additional information and comments prior to April 26, 2023.

Comments and information submissions on the risk management should be submitted to the address provided below:

Environment and Climate Change Canada
Chemicals Management Division
Gatineau Quebec K1A 0H3
Tel: 1-800-567-1999 | 819- 938-3232
Fax: 819-938-3231
Email: substances@ec.gc.ca

Companies who have a business interest in cyanides are encouraged to identify themselves as stakeholders. Stakeholders will be informed of future decisions regarding cyanides and may be contacted for further information.

Following the public comment period on the risk management approach, the Government of Canada will further work on addressing the risks posed by cyanides where necessary, and comments received on the risk management approach will be taken into consideration.

8.2 Timing of actions

Electronic consultation on the risk management approach: February 25, 2023 to April 26, 2023

Submission of additional studies or information on cyanides: on or before April 26, 2023

Publication of responses to public comments on the risk management approach: Concurrent to the publication of the proposed instrument(s)

Publication of the proposed instrument(s), if required: at the latest, 24-months from the publication of the final screening assessment

Consultation on the proposed instrument(s), if required: 60-day public comment period starting upon publication of each proposed instrument(s)

Publication of the final instrument(s), if required: at the latest, 18-months from the publication of each proposed instrument(s).

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