Government of Canada   Gouvernement du Canada

Risk Management Scope for Zinc and Soluble Zinc Compounds under the Zinc and its Compounds grouping

Environment and Climate Change Canada

Health Canada

June 2019

Canada

Summary of proposed risk management

This document outlines the risk management options under consideration for zinc and soluble zinc compounds , which have been proposed to be harmful to the environment.

In particular, the Government of Canada is considering reducing anthropogenic releases of zinc to water from the following sectors or activities:

1. **Metal mining:** by applying the updated zinc effluent limits (amended in 2018) in the *Metal and Diamond Mining Effluent Regulations* (MDMER), and reviewing information received from regulated mines in response to environmental effects monitoring requirements under these regulations to determine if additional regulatory or non-regulatory risk management is appropriate.

2. **Base metals smelting and refining:** by addressing facilities that are subject to the MDMER through the action proposed above for metal mining. Base metals smelting and refining facilities that are not subject to the MDMER are not proposed for risk management action.

Interested stakeholders are invited to provide the following information to help in refining ECCC's risk analysis:

- Dissolved or total concentrations of zinc in effluents, receiving environments, and reference areas for surface waters.
- Measurements of dissolved organic carbon (DOC), pH, and hardness related to these dissolved concentrations of zinc.

This information should be provided on or before August 28, 2019, to the contact identified in Section 8 of this document.

Under phase 3 of the Chemicals Management Plan (CMP3), ECCC and HC are conducting assessments of a variety of metals that may also identify metal mines and base metals smelting and refining facilities as sources of risk. ECCC is considering the risk management actions for zinc and soluble zinc compounds as part of a more comprehensive strategy to manage the metals assessed as toxic under CMP3. Implementation of this strategy would begin in 2023, when all risk assessments and risk management approaches for these metals will have been completed and published. This strategy will be focused on effluents rather than on single metals and will reduce the administrative burden on implicated sectors that would otherwise result from implementing multiple risk management approaches (e.g. repeated amendments to the MDMER) over a five year period, for metals assessed and found to be toxic.

Note: The above summary is an abridged list of options under consideration to manage these substances and to seek information on identified gaps. Refer to section 3 of this document for more details in this regard. It should be noted that the proposed risk management options may evolve through consideration of additional information obtained from the public comment period, literature, and other sources.

Table of Contents

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.

As part of the third phase of the Chemicals Management Plan, the Ministers plan to assess and manage, where appropriate, the potential health and ecological risks associated with approximately 1550 substances (Government of Canada, 2016).

The Minister of the Environment and the Minister of Health have conducted a screening assessment of zinc and its compounds . The 75 substances, listed in Annex A are included in the zinc and its compounds grouping of the Chemicals Management Plan (Government of Canada, 2017) and the Revised In Commerce List (Government of Canada, 2010) (Health Canada, 2017). Sixty-four substances in this group were identified as priorities for assessment as they met categorization criteria under subsection 73(1) of CEPA. Eleven additional substances were identified for further consideration following prioritization of the Revised In Commerce List (R-ICL). The draft screening assessment focuses on the zinc moiety and therefore considers zinc in its elemental form, zinc-containing substances, and zinc released in dissolved, solid or particulate form. As such, it is not limited to consideration of the 76 substances listed in Annex A.

2. Issue

Environment and Climate Change Canada (ECCC) and Health Canada conducted a joint scientific assessment to evaluate zinc and its compounds in Canada. A notice summarizing the scientific considerations of the draft Screening Assessment Report for these substances was published in the *Canada Gazette*, Part I, on June 29, 2019 (ECCC and Health Canada, 2019). For further information on the draft Screening Assessment Report for Zinc and its Compounds, refer to the draft screening assessment.

2.1 Draft screening assessment report conclusion

On the basis of the information available, the draft Screening Assessment Report proposes that zinc and soluble zinc compounds are toxic under section 64*(a)* of CEPA because they are or may be entering the environment in a quantity or concentration or under conditions that have or may

[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 products used by 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*, which are a part of the regulatory framework for the Workplace Hazardous Materials Information System for products intended for workplace use. Similarly, a conclusion on the basis of the criteria contained in section 64 of CEPA does not preclude actions being taken under other sections of CEPA or other Acts.

have an immediate or long-term harmful effect on the environment or its biological diversity (ECCC and Health Canada, 2019).

The draft Screening Assessment Report also proposes that zinc and soluble zinc compounds meet the criteria for persistence, but do not meet the criteria for bioaccumulation, as defined in the *Persistence and Bioaccumulation Regulations* made under CEPA (Government of Canada, 2000).

The risks of concern, identified in the draft Screening Assessment Report, are based on the release of zinc from metal mining and some base metals smelting and refining. As such, this document will focus on these activities and exposure sources of concern (refer to section 5.2).

2.2 Proposed recommendation under CEPA

On the basis of the findings of the draft screening assessment conducted as per CEPA, the Ministers propose to recommend that zinc and soluble zinc compounds be added to the List of Toxic Substances in Schedule 1 of the Act[3].

The Ministers will take into consideration comments made by stakeholders during the 60-day public comment period on the draft Screening Assessment Report and Risk Management Scope document. If the Ministers finalize the recommendation to add zinc and soluble zinc compounds to Schedule 1, a risk management instrument must be proposed and finalized within a set period of time, as outlined in sections 91 and 92 of CEPA (refer to section 8 for publication timelines applicable to this group of substances).

3. Proposed risk management

3.1 Proposed environmental objective

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

For this substance grouping, the proposed objective is focused on addressing the exposure sources of concern from the sectors outlined in section 5 of this document. As such, the proposed environmental objective for zinc and soluble zinc compounds is to reduce anthropogenic releases of zinc and soluble zinc compounds to water so as not to 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.

In this case, the proposed risk management objective for zinc and soluble zinc compounds is to achieve the lowest level of releases of zinc and soluble zinc compounds to water that is technically

[3] 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 substances, 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.

and economically feasible, taking into consideration socio-economic factors and natural background concentrations.

Such objectives will be refined on the basis of consultation with stakeholders, the proposed risk management options, consideration of further information received, the outcome of the final Screening Assessment Report, and socio-economic and technical considerations (such as may be outlined in section 6 of this document).

Revised environmental and/or human health and risk management objectives should next be presented in the Risk Management Approach document that will be published concurrently with the final Screening Assessment Report for these substances, or in subsequent risk management documents (e.g. consultation document on proposed instrument), as the case may be.

3.3 Proposed risk management options under consideration

To achieve the proposed risk management objective and to work towards achieving the proposed environmental objective, the risk management options under consideration for zinc and soluble zinc compounds will focus on reducing releases of zinc and soluble zinc compounds to water from the sectors of concern identified in the draft Screening Assessment – metal mining and base metals smelting and refining facilities that combine their effluent with metal mines. These proposed actions are described below.

Note that the proposed risk management options, described in this document, are preliminary and subject to change. Following the publication of this document and publication of other metal assessments, 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[4], if required. The risk management options outlined in this document may also evolve through consideration of assessments and risk management options published for other CMP substances to ensure effective, coordinated, and consistent risk management decision-making.

3.3.1 Metal mining

The existing risk management instrument for zinc in effluents discharged from the metal mining sector is the *Metal and Diamond Mining Effluent Regulations* (MDMER) under the *Fisheries Act* (Government of Canada, 2018).

The MDMER prescribe effluent concentration limits for a list of harmful substances including for zinc at 0.50 mg/L for existing mines after June 1, 2018, and a lower limit of 0.40 mg/L for any new mines after June 1, 2021.

Under phase 3 of the Chemicals Management Plan (CMP3), ECCC and HC are conducting assessments of a variety of metals that may also identify metal mines as sources of risk. Following publication of these metal assessments, ECCC will review the information received from regulated mines in response to environmental effects monitoring requirements under MDMER to determine if additional regulatory or non-regulatory risk management of effluents from metal mines is appropriate for one or more assessed metals.

[4] The proposed risk management regulation(s), instrument(s) or tool(s) will be 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 2012a), the Red Tape Reduction Action Plan (TBS 2012b), and in the case of a regulation the *Red Tape Reduction Act* (Canada, 2015).

ECCC is considering the RM actions for zinc and soluble zinc compounds as part of a more comprehensive strategy to manage the metals assessed as toxic under CMP3. Implementation would begin in 2023, when all risk assessments and risk management approaches for these metals will have been completed and published. Risk management is focused on effluents, rather than on single metals. The strategy will reduce the administrative burden on metal mines that would otherwise result from implementing multiple risk management approaches (e.g. repeated amendments to the MDMER) over a five year period, for metals assessed and found to be toxic.

3.3.2 Base metals smelting and refining

Base metal and smelting facilities vary significantly in terms of their processes and products, and are therefore expected to have varying levels of zinc in their effluent, ranging from insignificant to high enough to be a source of concern. The MDMER apply to 6 out of 12 existing smelters and refineries that combine their effluent with that of a metal mine effluent. ECCC would apply the same RM approach as described for metal mining.

For the remaining 6 facilities that do not combine their effluents with metal mines, no risk management is proposed.

3.4 Risk management information gaps

For the purpose of risk characterization, measured zinc concentration (dissolved and total) and toxicity modifying factors (TMF), hardness, pH and dissolved organic carbon (DOC) values reported under Environmental Effects Monitoring (EEM) and MDMER were used to calculate the Predicted No Effect Concentration where available. In exceptional cases where these values were unavailable, central tendencies of TMFs were developed for the ecozones and certain Great Lakes. Ecozone geometric means for total hardness and DOC, and average pH were used in substitution.

Interested stakeholders are invited to provide further information, as outlined below, to help in refining ECCC’s risk analysis:

- Dissolved concentrations of zinc in effluents, receiving environments, and reference areas for surface waters.
- Measurements of dissolved organic carbon (DOC), pH, and hardness related to these dissolved concentrations of zinc.

Should stakeholders have further information to help address these gaps, they should provide it ideally on or before August 28, 2019 to the contact identified in section 8 of this document.

4. Background

4.1 General information on zinc and its compounds

Zinc occurs naturally in the terrestrial crust as five stable elemental (metallic) forms. Zinc compounds considered in the draft Screening Assessment belong to various categories or subgroups including elemental zinc, inorganic compounds, organic-metal salts, organometallic compounds, and compounds of “unknown or variable composition, complex reaction products, or biological materials”.

Most of the zinc compounds on the Domestic Substances List may dissociate or degrade to release zinc. Metallic zinc is insoluble, whereas the solubilities of different zinc compounds range from insoluble (for oxides, carbonates, phosphates, and silicates) to soluble (for sulphates and chlorides) (CCME, 1999)

Sphalerite containing zinc sulphide is the most important zinc ore - over 95% of the world's zinc is produced from this mineral (IZA, 2018). Zinc concentrate is produced from zinc ore, but it is also a by-product/co-product in the mining and production of other metals, including precious metals and lead (NRCan, 2018a).

4.2 Current uses and identified sectors

Zinc and its compounds have a wide array of industrial and domestic applications.

The main use of refined zinc (i.e., 50% of the global production) is for galvanizing iron and steel products (e.g., pipes, wires, etc.) to prevent corrosion and rust (NRCan, 2018a). The remaining global consumption of zinc is approximately 25% in the transportation sector and 23% for consumer goods (IZA, 2018), including electronics, electrical appliances, sunscreen, dry cell batteries, and tires. It is also used with copper to make brass. Zinc oxide (ZnO, CAS RN1314-13-2) is the compound most commonly used in industrial applications (ECCC, 2009) (ECCC, 2013).

Uses of zinc compounds and the sectors where use occurs in Canada were also identified from the Domestic Substances List Inventory Update Phase 1 and Phase 2 surveys for 2008 and 2011, respectively ((ECCC, 2009); (ECCC, 2013) and from the National Pollutant Release Inventory (NPRI), which provides public information on zinc release in the environment (ECCC, 2016). The results indicate that major uses of zinc in Canada involve activities of the following sectors: iron and steel mills and ferro-alloy manufacturing; medical, health products and veterinary; hardware manufacturing; pulp, paper and paperboard mills; animal food manufacturing and crop production; metal products manufacturing and foundries; and chemical manufacturing.

In Canada, other sources of anthropogenic releases of zinc to the environment include electroplating, road surface runoff, corrosion of zinc alloys and galvanized surfaces, and erosion of agricultural soil (Weatherly, Lakes, & Rogers, 1980) (Mirenda, 1986). Zinc is also dispersed from corroded galvanized electrical transmission towers for at least 10 km by runoff and by wind-driven spray and water droplets from the towers (Jones & Burgess, 1984).

4.2.1 Metal mining

Canada is one of the larger producers of zinc concentrate globally, but China represents almost half the world production (NRCan, 2018a). In terms of zinc ore reserves, Canada represents about 3% of the world with Australia having the greatest abundance at 29% and China in second at 18% (NRCan, 2018a).

Canadian mines produced 272 000 tonnes of zinc concentrate in 2015 and increased production to 322 000 tonnes in 2016 (NRCan, 2018a). However, production has generally decreased since 2008 and the increase in 2016 represents only about half the quantity produced in 2008 (NRCan, 2018a). In 2015, zinc was produced from mines located in British Columbia, Manitoba, Ontario, Quebec, Yukon, New Brunswick and Newfoundland and Labrador (ECCC, 2017)

Zinc ore may be extracted from underground or above ground mines in Canada. The processing of ore during extraction and concentration generates dust that may escape and be deposited nearby, and produces effluent which may be stored in tailings ponds or treated and released to surface water. The generated dusts, potential leachates from tailings ponds, and effluent releases to surface water are all pathways from which zinc may be released into the surrounding environment.

Mines and mills, even if they do not produce zinc, may release zinc to the environment, given that this metal is present in a variety of ores.

4.2.2 Base metals smelting and refining

In 2016, Canada was the third largest producer of refined zinc (from both mined and recycled sources) with a production of 686 000 tonnes from refineries located in British Columbia, Manitoba, and Quebec (NRCan, 2018a).

Canadian smelters imported 414 000 tonnes of zinc in concentrates in 2016, compared to 532 000 tonnes in 2015 (NRCan, 2018a). In 2016, 94% of zinc metal was exported to the United States (NRCan, 2018a).

Base metals smelting and refining facilities produce one or more metals, such as copper, lead, nickel, and cobalt, from feed material that primarily comes from ores. They also produce intermediate and compound products and other saleable metals, such as precious metals.

The smelting process uses heat and chemical reduction to extract the metal from mined ores. Traces of zinc are found in many mined ores, but primarily ores with copper or lead deposits. Zinc may be intermediate products, residues or main products from the smelting or refining process.

4.2.3 Iron and steel manufacturing

In 2016, Canada was the eighth largest producer of iron ore in the world representing 2% of the global production. The primary use of iron ore, at 98%, is to make steel. Canada’s estimated crude steel production for 2016 was 12.6 million tonnes (NRCan, 2018b).

Zinc is used in the iron and steel manufacturing process, at the end, as a coating that is applied to iron and steel products to prevent corrosion and rust. This process is called galvanizing and represents almost 50% of the global use of zinc.

There are currently 8 facilities equipped with a galvanizing processing step, four of which are located in Ontario, two in Quebec, one in Manitoba and one in Saskatchewan. In 2015, the Canadian steel industry exported 6 million tonnes, but imported 8 million tonnes, of semi-finished and finished steel products (NRCan, 2018b).

4.2.4 Publicly owned wastewater treatment systems

Effluent from wastewater treatment systems (WWTS) may contain zinc despite wastewater treatment. The source of zinc in WWTS effluent originates from consumer, commercial, or industrial uses upstream of the plant.

4.2.5 Other uses and sectors

Zinc and soluble zinc compounds are used or found incidentally, due to their natural occurrence, in a variety of other sectors; however, the draft Screening Assessment Report did not identify risks from these uses or releases associated with these activities.

The sectors or exposure scenarios, which were evaluated, but not described in detail in the draft Screening Assessment Report, include oil sands, pulp and paper, alternatives to lead wheel weights, and rubber wear from tires.

5. Exposure Sources and Identified Risk

5.1 Natural Sources

Natural sources of zinc in the environment include the weathering of zinc-enriched rocks, soils and sediments by wind and water (Clement Associates, 1989). Erosion of soils naturally enriched with zinc particularly accounts for a large input of zinc into water (CCME, 2006). Additional sources include forest fires, volcanic activity, and aerosol formation above seas (Singh, 2005). Globally, the largest source of natural emissions of zinc to the atmosphere is sea salt spray (Richardson, Garrett, Mitchell, Mah-Paulson, & Hackbarth, 2001).Mean predicted natural emission rates from the various natural sources are 4.6x106 kg/year for Canada, 3.8x107 kg/year for North America, and 5.9x109 kg/year globally (Richardson, Garrett, Mitchell, Mah-Paulson, & Hackbarth, 2001).

Naturally occurring background levels of zinc were identified in the draft Screening Assessment Report and were taken into consideration when estimating the exposure of ecological receptors to zinc-containing substances.

5.2 Anthropogenic releases to the environment

Anthropogenic releases of zinc to the environment have been identified in the draft Screening Assessment Report as posing a risk in some sectors, which are identified below, particularly when released directly to the aquatic environment.

5.2.1 Metal mining

In 2016, 79 mining facilities in Canada reported releases, disposal and/or off-site recycling of zinc and its compounds to the National Pollutant Release Inventory (ECCC, 2016). These facilities reported on-site releases of 32 tonnes to air, 49 tonnes to water and 6 tonnes to land, while on-site disposal amounted to 48 559 tonnes and off-site disposal was 42 tonnes (ECCC, 2016). It should be noted that "disposal" includes information on the disposal of tailings and waste rock, which tend to be disposed of on-site.

Data presented in the draft Screening Assessment Report, pulled from provincial environmental monitoring databases and data submitted under the Environmental Effects Monitoring requirements, indicate that zinc releases from this sector are likely the cause of the elevated zinc levels found near these sites.

For this sector, dissolved zinc concentrations in water bodies and total zinc concentrations in sediment and soils near sources of releases may exceed estimated no-effect levels for aquatic organisms, and sediment-dwelling organisms.

5.2.2 Base metals smelting and refining

In 2016, 12 smelters and refineries reported zinc and its compounds to the National Pollutant Release Inventory (ECCC, 2016). These facilities reported on-site releases of 94 tonnes to air, 241 kg to water and 0 to land, while on-site disposal amounted to 355 kg, off-site disposal was 53 tonnes and off-site recycling was 6051 tonnes (ECCC, 2016).

While the focus of risk management will be the release of zinc and soluble zinc compounds to water, the draft Screening Assessment Report also identifies the release of zinc to air from the base metals smelting and refining sector as a potentially significant contributor to zinc levels in environmental media.

Releases varied significantly among facilities, as expected, due to their different processes and products. Modelled data of releases to water and measured data in water, sediment and soil indicate that releases from this industrial activity may contribute to the elevated levels of zinc found near the facilities that combine their effluent with metal mines.

5.2.3 Iron and steel

In 2016, 26 iron and steel facilities reported zinc and its compounds to the NPRI. This includes all iron and steel facilities and not just those that have galvanizing. These facilities reported on-site releases of 77 tonnes to air, 9.7 tonnes to water and 5 kg to land, while on-site disposal amounted to 5 389 tonnes, off-site disposal was 9 135 tonnes and off-site recycling was 14 523 tonnes (ECCC, 2016).

This sector was identified as a source of zinc, but not as a risk.

5.2.4 Publicly owned wastewater treatment systems (WWTS)

In 2016, 20 wastewater treatment facilities in Canada reported releases, disposal and/or off-site recycling of zinc and its compounds to the NPRI. A total of 125 tonnes were released to water (from 15 facilities) and 1.2 tonnes to air. Off-site disposal, which includes off-site treatment prior to disposal, was 231 tonnes, and a total of 35 tonnes were recycled off-site.

However, based on a risk characterization conducted for 21 WWTS facilities across Canada, this sector was identified as a source of zinc, but not as a risk.

6. Risk management considerations

6.1 Alternatives and alternate technologies

For sectors of concern identified in the draft Screening Assessment Report, it is not expected that chemical alternatives or alternate process technologies would be a practical approach to minimizing releases of zinc.

Additional effluent control technologies (e.g., additional on-site or off-site effluent treatment), process optimization, and recovery of waste metals at the end of the process may be effective approaches for most sectors, as appropriate and economically feasible.

6.2 Socio-economic and technical considerations

Socio-economic factors will be considered in the selection process for a regulation or instrument respecting preventive or control actions, and in the development of the risk management objective(s). Socio-economic factors will also be considered in the development of regulations, instrument(s) or tool(s) as identified in the *Cabinet Directive on Regulatory Management* (TBS, 2012) and the guidance provided in the Treasury Board document *Assessing, Selecting, and Implementing Instruments for Government Action* (TBS, 2007).

7. Overview of existing risk management

7.1 Related Canadian risk management context

7.1.1 Metals mines

The existing risk management instrument for zinc in effluent discharged from the metal mining sector is the *Metal and Diamond Mining Effluent Regulations* (MDMER) under the *Fisheries Act* (Government of Canada, 2018)

The MDMER prescribe maximum concentration limits in effluent for certain harmful substances including for total zinc at 0.50 mg/L (monthly mean) for existing mines and a lower limit of 0.40 mg/L (monthly mean) for any new mines after June 1, 2021. MDMER also require environmental effects monitoring (EEM) to identify potential effects caused by effluents on fish, fish habitat and use by humans of fish. EEM is a science-based performance measurement tool used to evaluate the adequacy of effluent regulation. EEM studies include: water quality monitoring; effluent chemical characterization; effluent sublethal toxicity testing; and, biological monitoring in the receiving environment.

For complete details on the MDMER refer to: (Government of Canada, 2018) http://laws-lois.justice.gc.ca/eng/regulations/SOR-2002-222/index.html

In 2009, Environment Canada published the *Environmental Code of Practice for Metal Mines*, according to subsection 54(4) of CEPA, to support the previous *Metal Mining Effluent Regulations* (MMER) and to include other subjects that are not dealt with in the MMER, which 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 (ECCC, 2009).

7.1.2 Base metal smelting and refining

Atmospheric emissions from smelters and refineries were assessed under the Priority Substances List and concluded to be toxic under CEPA (EC, HC, 2001).

Base metals smelting and refining facilities were subject to a Pollution Prevention Planning Notice published in 2006. The Notice includes release targets for particulate matter, which contains most of the metals emitted to air, including zinc. The Notice requires facilities to take into consideration a number of factors including the *Environmental Code of Practice for Base Metals Smelters and Refineries*, which recommends particulate matter emission limits to air and effluent limits for chemical parameters and certain metals including zinc. The Code of Practice lists an effluent limit for zinc at a maximum monthly mean concentration of 0.50 mg /L. In addition, the Code of Practice recommends that each facility design and operate effluent discharge systems, taking local conditions into account to obtain a maximum ambient water quality objective of 30 µg/L for total zinc (ECCC, 2006).

The base metals smelting and refining facilities subject to the notice reduced particulate matter releases by a total of 50% between 2005 and 2015.

As a result of the implementation of the Base-Level Industrial Emission Requirements (BLIERs), it is expected that particulate matter emissions will be further reduced from that of 2015 levels. Since most metals from these facilities are discharged to the atmosphere as particulate matter emissions, it is anticipated that emissions of metals, including zinc, would also be reduced as a co-benefit of particulate matter emission reductions. While zinc is not specifically monitored in the emissions or in the environment as part of the BLIERs program, it is expected that zinc reductions will be reflected in the annual emissions data reported by smelters and refineries to the National Pollutant Release Inventory (NPRI).

7.1.3 Iron and steel

Ontario Regulation 214/95: Effluent Monitoring and Effluent Limits - Iron and Steel Manufacturing Sector monitors and controls 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 report zinc loadings for process effluent, once-through-cooling-water effluent and combined effluent (Government of Ontario, 2016) to the ministry via the Ministry of the Environment Wastewater System (MEWS) web application.

7.1.4 Publicly-owned wastewater treatment systems (WWTS)

The *Wastewater Systems Effluent Regulations*, established under the *Fisheries Act*, include mandatory minimum effluent quality standards that can be achieved through secondary wastewater treatment (Government of Canada, 2012). Although the Regulations do not directly target zinc, the requirement for at least secondary treatment, where there is currently no or primary treatment, is expected to generate co-benefits for industrial sectors that send their effluent to a publicly owned WWTS, as secondary treatment has been shown to reduce the quantities of zinc released (ECCC and Health Canada, 2019)

7.1.5 National water quality guidelines

Canadian Council of Ministers of the Environment (CCME) published a revised Zinc Canadian Water Quality Guideline for the Protection of Aquatic Life ($CWQG_{PAL}$) for fresh water in September 2018. ECCC contributed to the revised zinc $CWQG_{PAL}$ for CCME and it is based on dissolved concentrations. It includes equations for both short-term and long-term exposure that account for relevant toxicity modifying factors, including water hardness, pH and dissolved organic carbon. The dSAR for zinc uses the $CWQG_{PAL}$ in calculation of PNEC values.

7.1.6 Municipalities

The largest cities in Canada all have limits in place for zinc. Toronto's by-law limits the concentration of total zinc that can be discharged to the wastewater collection system to 2000 µg/L, and the concentration of total zinc in discharges to storm sewers to 40 µg/L (City of Toronto, 2010). In Montreal, the total extractable zinc level must be below 10 000 µg/L for discharge into the wastewater collection system and below 1000 µg/L for discharge into storm sewers or natural waterways (Communauté Métropolitaine de Montréal, 2012). In Vancouver any wastewater with more than 3000 µg/L of zinc needs a permit for discharging into a wastewater collection system (Metro Vancouver, 2007). Vancouver also has water quality objectives for the Burrard inlet. The maximum concentration objective is 95 µg/L, while the average concentration objective is 86 µg/L (Phippen, 2001). The regional municipality of Halifax sets a maximum total zinc concentration of

2000 µg/L in effluent discharged to wastewater collection or treatment systems (Halifax Regional Municipality, 2001). Halifax has a Harbour Water Quality Monitoring program that uses a guideline of 86 µg/L (AMEC Earth & Environmental, 2011).

7.2 Pertinent international risk management context

7.2.1 United States – Statutes

Over 717 zinc compounds are regulated in the USA under different statutes, with legal requirements ranging from reporting and notifications to restrictions. Of relevance to water releases is the Clean Water Act (CWA).

Under the CWA the discharge of oil or hazardous substances into or upon navigable waters as well as contiguous waters and areas of the United States is prohibited. Zinc acetate (CAS No. 557346), Zinc ammonium chloride (CAS No. 14639-97-5, 14639986, 52628-25-8), zinc borate (CAS No. 1332-07-6), zinc bromide (CAS No. 7699-45-8), zinc carbonate (CAS No. 3486-35-9), zinc chloride (CAS No. 7646-85-7), zinc cyanide (CAS No. 557-21-1), zinc fluoride (CAS No. 7783-49-5), zinc formate (CAS No. 557-41-5), zinc hydrosulfite (CAS No. 7779-86-4), zinc nitrate (CAS No. 7779-88-6), zinc phenolsulfonate (CAS No. 127-82-2), zinc phosphide (CAS No. 1314-84-7), zinc silicofluoride (CAS No. 16871-71-9), and zinc sulfate (CAS No. 7733-02-0) are all listed as hazardous substances under the CWA (US EPA, 2018a).

Considering that zinc and zinc compounds are listed on the Hazardous Substance List of Section 311 of the CWA, there are effluent guidelines in place in certain industries for their control (US EPA, 2018b). These industries include nonferrous metals forming and metal powders, electrical and electric components, battery manufacturing, metal molding and casting, coil coating, porcelain enameling, aluminum forming, copper forming, metal finishing, the centralized waste treatment, ore mining and dressing, transportation equipment cleaning, waste combustors, landfills, pesticide chemicals, iron and steel, non-ferrous metals manufacturing, steam electric power generating, rubber manufacturing, timber products processing and pulp, paper and paperboard point source categories (US EPA, 2018b).

Zinc and zinc containing substances are not on the 2014 TSCA Work Plan for Chemical Assessments and are therefore not being considered for further risk assessment by the agency (US EPA, 2014).

7.2.2 United States – Guidelines

Pursuant to Section 304(a) of the *Clean Water Act* (CWA), the *United States Environmental Protection Agency* (US EPA) publishes national recommended water criteria. The US EPA published an acute and chronic criterion of 120 µg/L for the protection of freshwater aquatic life. They established acute and chronic criteria of 90 µg/L and 81 µg/L, respectively, for the protection of saltwater life. Both the freshwater and marine criteria apply to a water hardness of 100 mg/L (US EPA, 2007). The US EPA also provides a human health consumption criterion of 7,400 µg/L for water and organisms and 26,000 µg/L for organisms only (US EPA, 2017). There is no maximum drinking water contaminant level for zinc in the *National Primary Drinking Water Regulations*, which are for contaminants that pose a risk for human health consumption and are legally enforceable. However, the *Secondary Drinking Water Standards*, which are to assist public water systems in managing their drinking water for aesthetic considerations and are not enforceable, has set a concentration limit of 5,000 µg/L for zinc (US EPA, 2012).

Some states have also published their own guidelines. For example, Minnesota has established a chronic standard of 106 µg/L and an acute standard of 117 µg/L in state waters based on a hardness of 100 mg/L (Minnesota Pollution Control Agency, 2016). New York uses equations based on water hardness as well to determine its state freshwater values, listing a chronic equation of $e^{0.85\ (\ln\ (\text{ppm hardness}))\ +\ 0.5}$ and an acute equation of $0.978e^{0.8473\ (\ln\ (\text{hardness}))\ +\ 0.8604}$. For saline environments, it has an acute value of 95 µg/L and a chronic value of 66 µg/L (New York State Department of Environmental Conservation, 2017). Washington State uses equations based on water hardness to provide criteria for zinc concentrations in state freshwaters as well with an acute criterion of $\leq 0.978e^{0.8473(\ln(\text{harness}))\ +\ 0.8604}$ and chronic criterion of $\leq 0.986e^{0.8473(\ln(\text{harness}))\ +\ 0.7614}$. Its acute (90 µg/L) and chronic (81 µg/L) marine criteria match those of the current US guidelines. Washington also provides a human health consumption criterion of 2,300 µg/L for water and organisms and 2,900 µg/L for organisms only. (Washington State, 2016)

7.2.3 European Union – Statutes

In the European Union, some form of risk management exists or is being recommended for 2 zinc-containing substances.

Pentazinc chromate octhydroxide (CAS No. 49663-84-5) and Potassium hydroxyoctaoxodizincatedichromate (CAS No. 11103-86-9) have been identified by the European Union as Substances of Very High Concern (SVHC) for their carcinogenicity. As a result, these substances have been listed on both the Candidate List and the Authorisation List of the regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (ECHA, 2018b; ECHA, 2018a). Being listed on the Candidate List may imply legal obligations for producers, importers, and suppliers of those substances, while being listed on the Authorization List means that these substances cannot be placed on the market or used after a given date unless an authorisation is granted for their specific use, or the use is exempted from authorisation (ECHA, 2018c).

Under REACH, some zinc substances are restricted. Restricted substances (on their own, in a mixture or in an article) are substances for which manufacture, placing on the market or use is limited or banned in the European Union. Gallium zinc triarsenide (CAS RN 98106-56-0); trizinc diarsenide (CAS RN 12006-40-5); zinc diarsenide (CAS RN 12044-55-2); zinc aresenate (CAS 13464-44-3); silicic acid (H4SiO4), zinc salt (1:2), arsenic and manganese-doped (CAS RN 68611-46-1); cadmium zinc sulfide yellow (CAS RN 8048-07-5); cadmium zinc sulfide (CAS RN 12442-27-2); cadmium zinc lithopone yellow (CAS RN 90604-89-0); leach residues, zinc ore-calcine, cadmium copper ppt. (insoluble material precipitated by hydrolysis during hydrometallurgical treatment of crude zinc sulfate solution, CAS RN 91053-46-2); leach residues, zinc refining flue dust, cadmium-thallium ppt. (sponge produced by leaching and precipitating cadmium and thallium fumes and flue dusts from lead/zinc smelting operations, CAS RN 92257-11-9); and zinc bis(pentachlorophenolate) (CAS RN 2917-32-0) are all restricted (ECHA, 2018d).

7.2.4 European Union – Guidelines

In 2008, the European Union published Directive 2008/105/EC on Environmental Quality Standards. Annex I of the directive establishes limits on concentrations of certain pollutants in surface waters. Annex II lists the priority substances in the field of water policy. None of the targeted pollutants are zinc containing substances (European Commission, 2008). A proposal submitted in January 2012 to amend Directives 2000/60/EC and 2008/105/EC with regards to priority substances in the field of water policy does not include any zinc containing substances either (European Commission, 2012).

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 Scope or other information that would help to inform decision-making (such as outlined in sections 3.2 or 3.3). Please submit additional information and comments prior to August 28, 2019. The Risk Management Approach document, which will outline and seek input on the proposed risk management instrument(s), will be published at the same time as the final Screening Assessment Report. At that time, there will be further opportunity for consultation.

Comments and information submissions on the Risk Management Scope should be submitted to the address provided below:

Program Development and Engagement Division
Environment and Climate Change Canada
Gatineau, Québec K1A 0H3
Telephone: 1-800-567-1999 (in Canada) or 819-938-3232
Fax: 819-938-5212
Email: eccc.substances.eccc@canada.ca

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

8.2 Timing of actions

Electronic consultation on the draft Screening Assessment Report and Risk Management Scope: June 29, 2019 to August 28, 2019.

Submission of public comments, additional studies and/or information on zinc and its compounds: on or before August 28, 2019.

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

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

9. References

AMEC Earth & Environmental. (2011, April). *Halifax Harbour Water Quality Monitoring Program Final Summary Report [PDF].* Retrieved June 2018, from Halifax.ca Legacy Content.

CCME. (1999). *Canadian soil quality Guidelines for the Protection of Environmental and Human Health - Zinc [PDF].* Retrieved 2018, from Canadian Council of Ministers of the Environment.

CCME. (2006). A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines [PDF]. Retrieved 2018, from Candian Council of Ministers of the Environment.

City of Toronto. (2010, July 8). *By-Law No. 868-2010 [PDF].* Retrieved 2018, from City of Toronto-Toronto City Council and Committees - By-laws and Municipal Code.

Clement Associates. (1989). *Toxicological Profile for Zinc.* Atlanta (Ga): Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.

Communauté Métropolitaine de Montréal. (2012, January 1). *Règlement Numéro 2008-47 sur l'assainissement des eaux.* Retrieved June 2, 2017, from Ville de Montréal - Réglement des rejets. (available in French only)

EC, HC. (2001, March). *Priority Substances List Assessment Report for Releases from Primary and Secondary Copper Smelters and Refineries; Releases from Primary and Secondary Zinc Smelters and Zinc Refineries*. Retrieved 2018, from Canada.ca.

ECCC. (2006, March). *Environmental Code of Practice for Base Metals Smelters and Refineries*. Retrieved 2018, from Environment and Climate Change Canada.

ECCC. (2009 , 10 3). *Domestic Substances List Inventory Update Phase 1 (DSL IU1): Update on Approximately 500 Inanimate Substances (Chemicals) on the Domestic Substances List- Published in Canada Gazette on October 3, 2009*. Retrieved 06 2018, from Environment Canada.

ECCC. (2009). *Environmental Code of Practice for Metal Mines [PDF]*. Retrieved 2018, from Environment and Climate Change Canada.

ECCC. (2013, June 16). *List of Substances in Phase 2 of the DSL IU.* Retrieved 2018, from Environment and Climate Change Canada - DSL IU2.

ECCC. (2016). *NPRI Data Search - 2016*. Retrieved 2018, from National Pollutant Release Inventory.

ECCC. (2017, January). *Status Report on the Performance of Metal Mines subject to the Metal Mining Effluent Regulations in 2015*. Retrieved June 2018, from Government of Canada Publications.

ECCC and Health Canada. (2019). *Draft Screening Assessment Zinc and its Compounds.* Retrieved 2019, from Environment and Climate Change Canada.

ECHA. (2018a, June). *Authorisation List*. Retrieved June 2018, from European Chemicals Agency.

ECHA. (2018b). *Candidate List of Substances of very high concern for Authorisation*. Retrieved June 2018, from European Chemicals Agency.

ECHA. (2018c). *Summary of obligations resulting from inclusion in the Candidate List of Substances of Very High Concern for authorisation*. Retrieved August 4, 2015, from European Chemicals Agency.

ECHA. (2018d). *Substances restricted under REACH.* Retrieved June 2018, from European Chemicals Agency.

European Commission. (2008, December). *Directive 2008/105/EC - Environmental quality standards in the field of water policy*. Retrieved June 2018, from EUR-Lex - Access to European Union Law.

European Commission. (2012, January 31). *Proposal for a Directive of the European Parliament and of the Councuk amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.* Retrieved June 2018, from EUR-Lex: Access to Europoean Union Law.

Government of Canada. (1999). *Canadian Environmental Protection Act, 1999. S.C., 1999, ch. 33 [PDF].* Retrieved November 2013, from Canada Gazette, Part III, Vol. 22, No. 3.

Government of Canada. (2000). *Canadian Environmental Protection Act, 1999: Persistence and Bioaccumulation Regulations [PDF]*. Retrieved from Canada Gazette, Part II, P.C. 2000-348, SOR/2000-107

Government of Canada. (2010). *Notice of Intent on the In-Commerce Substances List (ICL) Nomination Process*. Retrieved April 2018, from Canada Gazette, Part I: Vol. 144, No. 36.

Government of Canada. (2012). *Wastewater Systems Effluent Regulations (SOR/2012-139)*. Retrieved 2018, from Justice Laws Website.

Government of Canada. (2016). *Canadian Environmental Protection Act, 1999: Announcement of planned actions to assess and manage, where warranted, the risks posed by certain substances to the health of Cadadians and the environment*. Retrieved 2018, from Canada Gazette Part I, Vol. 150, No. 25.

Government of Canada. (2017). *List of substances in the third phase of CMP (2016-2020): December 2017 update*. Retrieved April 2018, from Chemical Substances.

Government of Canada. (2018, 06). *Metal and Diamond Mining Effluent Regulatons.* Retrieved 2018, from Justice Laws Website.

Government of Ontario. (1995). *O.Reg. 214/95: Effluent Monitoring and Effluent Limits - Iron and Steel Manufacturing Sector.* Retrieved 2017, from Government of Ontario.

Government of Ontario. (2016). *Industrial wastewater discharges*. Retrieved 2018, from Government of Ontario.

Halifax Regional Municipality. (2001, June). *By-Law w-101 Respecting Discharge into Public Sewers [PDF].* Retrieved 2018, from Municipal Government of Halifax - Legislation and By-Laws.

Health Canada. (2017). *Table of prioritization results of substances on the Revised In Commerce List*. Retrieved April 2018, from Health Canada: Initiatives of the Chemicals Management Plan.

IZA. (2018). *Zinc Basics*. Retrieved 2018, from International Zinc Association.
Jones, R., & Burgess, M. (1984). Zinc and cadmium in soils and plants near electrical transmission (hydro). *Environmental Science and Technology*, 18(10): 731-734.

Metro Vancouver. (2007, May 25). *Greater Vancouver Sewerage and Drainage District Sewer Use Bylaw No. 299, 2007 Consolidated [PDF].* Retrieved 2018, from Metro Vancouver.

Minnesota Pollution Control Agency. (2016, December 9). *Chapter 7050, Waters of the States - Water Quality Standards for the Protection of Waters of the States.* Retrieved June 2018, from The Office of the Revisor of the Statutes - Minnesota Administrative Rules.

Mirenda, R. (1986). Acute toxicity and accumulation of zinc in the crayfish, Orconectes virilis (Hagen). *Bulletin of Environmental Contamination and Toxicology, Vol 37*, pp. Vol 37: pp 387-394.

New York State Department of Environmental Conservation. (2017, May 31). *Part 703 Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations.* Retrieved June 2018, from New York Codes, Rules and Regulations - Water Quality Standards and Classifications.

NRCan. (2018a, April). *Zinc Facts.* Retrieved 2018, from Natural Resources Canada.

NRCan. (2018b). *Iron ore facts*. Retrieved 2018, from Natural Resouces Canada.

Phippen, B. (2001, December). *Assessment of Burrard Inlet Water and Sediment Quality 2000 [PDF]*. Retrieved June 2018, from Government of British Columbia.

Richardson, G., Garrett, R., Mitchell, I., Mah-Paulson, M., & Hackbarth, T. (2001). *Critical review on natural global and regional emissions of six trace metals to the atmosphere.* Ottawa (ON): Risklogic Scientific Services Inc.

Singh, V. (2005). *Metal toxicity and tolerance in plants and animals.* New Delhi: Sarup & Sons.

TBS. (2007). *Assessing, Selecting, and Implementing Instruments for Government Action [PDF]*. Retrieved 2018, from Government of Canada Publications - Treasury Board of Canada Secretariat .

TBS. (2012). *Cabinet Directive on Regulatory Management*. Retrieved 2018, from Government of Canada Publications - Treasury Board of Canada Secretariat.

US EPA. (2007). *National Recommended Water Quality Criteria - Aquatic Life Criteria Table*. Retrieved June 2018, from United States Environmental Protection Agency.

US EPA. (2012, July 1). *Secondary Drinking Water Standards: Guidance for Nuisance Chemicals.* Retrieved June 2018, from United States Environmental Protection Agency - Drinking Water Contaminants - Standards and Regulations.

US EPA. (2014). *TSCA Work Plan for Chemical Assessments : 2014 Update.* Retrieved June 2018, from United States Environmental Protection Agency.

US EPA. (2017). *National Recommended Water Quality Criteria - Human Health Criteria Table.* Retrieved 2018, from United States Environmental Protection Agency - Office of Water.

US EPA. (2018a). *CWA - HS - Clean Water Act List of Hazardous Substances.* Retrieved June 2018, from United States Environmental Protection Agency - Substance Registry Services.
US EPA. (2018b). *Industrial Effluent Guidelines.* Retrieved June 2018, from United States Environemntal Protection Agency - Effluent Guidelines.

Washington State. (2016, August 1). *Washington Administrative Code 173-201A-240 Toxic Substances*. Retrieved June 2018, from Washington State Legislature.

Weatherly, A., Lakes, P., & Rogers, S. (1980). Zinc pollution and the ecology of the freshwater environment. In J. N. (Ed), *Zinc in the environment. Part I. Ecological cycling* (pp. 337-418). New York (N Y): Wiley-Interscience.

Annex A. List of zinc-containing substances that were identified for further action during categorization

CAS RN*	DSL or R-ICL Chemical Name	Substance Category	Inventory
127-82-2	Benzenesulfonic acid, 4-hydroxy-, zinc salt (2:1)	Organic-metal salt	DSL
136-23-2	Zinc, bis(dibutylcarbamodithioato-S,S')-, (T-4)-	Organometallics	DSL
136-53-8	Hexanoic acid, 2-ethyl-, zinc salt	Organic-metal salt	DSL
155-04-4	2(3H)-Benzothiazolethione, zinc salt	Organic-metal salt	DSL
546-46-3	1,2,3-Propanetricarboxylic acid, 2-hydroxy-, zinc salt (2:3)		R-ICL
556-38-7	Pentanoic acid, zinc salt (2:1)		R-ICL
557-05-1	Octadecanoic acid, zinc salt	Organic-metal salt	DSL
557-07-3	9-Octadecenoic acid (Z)-, zinc salt	Organic-metal salt	DSL
557-08-4	10-Undecenoic acid, zinc salt	Organic-metal salt	DSL
557-34-6	Acetic acid, zinc salt	Organic-metal salt	DSL
1314-13-2	Zinc oxide (ZnO)	Inorganics	DSL
1314-22-3	Zinc peroxide (Zn(O2))	Inorganics	DSL
1314-84-7	Zinc phosphide (Zn3P2)		R-ICL
1314-98-3	Zinc sulfide (ZnS)	Inorganics	DSL
1345-05-7	C.I. Pigment White 5	UVCBs-inorganic	DSL
1405-89-6	Bacitracin Zinc		R-ICL
1434719-44-4	Protein hydrolyzates, saccharomyces cerevisiae zinc complexes		NFC
2452-01-9	Dodecanoic acid, zinc salt	Organic-metal salt	DSL
3486-35-9	Carbonic acid, zinc salt (1:1)	Inorganics	DSL
36393-20-1	Zincate(2-), bis[L-aspartato(2-)-.kappa.N,.kappa.O1]-, dihydrogen, (T-4)-		NFC
4259-15-8	Zinc, bis[O,O-bis(2-ethylhexyl) phosphorodithioato-S,S']-, (T-4)-	Organometallics	DSL
4468-02-4	Zinc, bis(D-gluconato-O1,O2)-	Organometallics	DSL
5970-45-6	Acetic acid, zinc salt, dihydrate	Organic-metal salt	DSL
7446-19-7	Sulfuric acid, zinc salt (1:1), monohydrate	Inorganics	DSL
7446-20-0	Sulfuric acid, zinc salt (1:1), heptahydrate	Inorganics	DSL
7446-26-6	Diphosphoric acid, zinc salt (1:2)	Inorganics	DSL
7646-85-7	Zinc chloride (ZnCl2)	Inorganics	DSL
7733-02-0	Sulfuric acid, zinc salt (1:1)	Inorganics	DSL
7779-88-6	Nitric acid, zinc salt	Inorganics	DSL
7779-90-0	Phosphoric acid, zinc salt (2:3)	Inorganics	DSL
8011-96-9	Calamine (pharmaceutical preparation)	UVCBs-inorganic	DSL
8048-07-5	C.I. Pigment Yellow 35	UVCBs-inorganic	DSL
10139-47-6	Zinc iodide (ZnI2)		R-ICL

11103-86-9	Chromate(1-), hydroxyoctaoxodizincatedi-, potassium	Inorganics	DSL
12001-85-3	Naphthenic acids, zinc salts	UVCBs-organic-metal salts	DSL
12122-17-7	Hydrozincite (Zn5(CO3)2(OH)6)	Inorganics	DSL
12442-27-2	Cadmium zinc sulfide ((Cd,Zn)S)	Inorganics	DSL
13189-00-9	2-Propenoic acid, 2-methyl-, zinc salt	Organic-metal salt	DSL
13463-41-7	Zinc, bis(1-hydroxy-2(1H)-pyridinethionato-O,S)-, (T-4)-	Organometallics	DSL
13530-65-9	Chromic acid (H2CrO4), zinc salt (1:1)	Inorganics	DSL
13598-37-3	Phosphoric acid, zinc salt (2:1)	Inorganics	DSL
14324-55-1	Zinc, bis(diethylcarbamodithioato-S,S')-, (T-4)-	Organometallics	DSL
14476-25-6	Smithsonite (Zn(CO3))	UVCBs-inorganic	DSL
14726-36-4	Zinc, bis[bis(phenylmethyl)carbamodithioato-S,S']-, (T-4)-	Organometallics	DSL
15337-18-5	Zinc, bis(dipentylcarbamodithioato-S,S')-, (T-4)-	Organometallics	DSL
15454-75-8	Zinc, bis(5-oxo-L-prolinato-.kappa.N1,.kappa.O2)-, (T-4)-		R-ICL
16260-27-8	Tetradecanoic acid, zinc salt	Organic-metal salt	DSL
16283-36-6	Zinc, bis(2-hydroxybenzoato-O1,O2)-, (T-4)-	Organometallics	DSL
16871-71-9	Silicate(2-), hexafluoro-, zinc (1:1)	Inorganics	DSL
17949-65-4	Zinc, bis(2-pyridinecarboxylato-.kappa.N1,.kappa.O2-, (T-4)-		R-ICL
19210-06-1	Phosphorodithioic acid, zinc salt	Inorganics	DSL
20427-58-1	Zinc hydroxide (Zn(OH)2)	Inorganics	DSL
24308-84-7	Benzenesulfinic acid, zinc salt	Organic-metal salt	DSL
24887-06-7	Zinc, bis(hydroxymethanesulfinato-OS,O1)-, (T-4)-	Organometallics	DSL
27253-29-8	Neodecanoic acid, zinc salt	Organic-metal salt	DSL
28016-00-4	Naphthalenesulfonic acid, dinonyl-, zinc salt	Organic-metal salt	DSL
28629-66-5	Zinc, bis(O,O-diisooctyl phosphorodithioato-S,S')-	Organometallics	DSL
37300-23-5	C.I. Pigment Yellow 36	UVCBs-inorganic	DSL
38714-47-5	Zinc(2++), tetraammine-, (T-4)-, carbonate (1:1)	Inorganics	DSL
40861-29-8	Carbonic acid, ammonium zinc salt (2:2:1)	Inorganics	DSL
49663-84-5	Zinc chromate hydroxide (Zn5(CrO4)(OH)8)	Inorganics	DSL
50922-29-7	Chromium zinc oxide	UVCBs-inorganic	DSL
51810-70-9	Zinc phosphide		R-ICL
61617-00-3	2H-Benzimidazole-2-thione, 1,3-dihydro-4(or 5)-methyl-, zinc salt (2:1)	Organic-metal salt	DSL
68457-79-4	Phosphorodithioic acid, mixed O,O-bis(iso-Bu and pentyl) esters, zinc salts	UVCBs-organic-metal salts	DSL

68611-70-1	Zinc sulfide (ZnS), copper chloride-doped	UVCBs-inorganic	DSL
68649-42-3	Phosphorodithioic acid, O,O-di-C1-14-alkyl esters, zinc salts	UVCBs-organic-metal salts	DSL
68784-31-6	Phosphorodithioic acid, mixed O,O-bis(sec-Bu and 1,3-dimethylbutyl) esters, zinc salts	UVCBs-organic-metal salts	DSL
68918-69-4	Petrolatum (petroleum), oxidized, zinc salt	UVCBs-organic	DSL
68988-45-4	Phosphorodithioic acid, mixed O,O-bis(2-ethylhexyl and iso-Bu and pentyl) esters, zinc salts	UVCBs-organic-metal salts	DSL
73398-89-7	Xanthylium, 3,6-bis(diethylamino)-9-[2-(methoxycarbonyl)phenyl]-, (T-4)-tetrachlorozincate(2-) (2:1)	Organic-metal salt	DSL
84605-29-8	Phosphorodithioic acid, mixed O,O-bis(1,3-dimethylbutyl and iso-Pr) esters, zinc salts	UVCBs-organic-metal salts	DSL
85940-28-9	Phosphorodithioic acid, mixed O,O-bis(2-ethylhexyl and iso-Bu and iso-Pr) esters, zinc salts	UVCBs-organic-metal salts	DSL
102868-96-2	Zinc, bis[N-(acetyl-.kappa.O)-L-methioninato-.kappa.O]-, (T-4)-		R-ICL
113706-15-3	Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts	UVCBs-organic-metal salts	DSL

*CAS RN: Chemical Abstracts Service Registry Number. The Chemical Abstracts Service information is the property of the American Chemical Society and any use or redistribution, except as required in supporting regulatory requirements and/or for reports to the Government of Canada when the information and the reports are required by law or administrative policy, is not permitted without the prior, written permission of the American Chemical Society.