Valentine Gold Project: Federal Information Requirements

Round Three Information Requirements – Response to IR(3)-54

Marathon Gold Corporation
36 Lombard Street, Suite 600
Toronto, ON M5C 2X3

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RESPONSE TO IR(3)-54

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IR 1 Reference #:	IR(2)-54
EIS Reference:	EIS Appendix 7A, Table D-5, pdf 129 Valentine Gold Project: Responses toround two Federal information requests,pages 47-55.
Context and Rationale:	The Proponent completed an avian risk assessment in response to Federal IR(2)-54. As part of this assessment, the Proponent provided information about the water intake rate of different avian receptor species (e.g., duck (black duck & mallard duck), common merganser, great blue heron, and Canada goose) that is used to characterize the degree to which avian species are exposed to contaminants that are predicted to be potentially present in TMF water. There are no peer reviewed studies provided to verify the accuracy of these water intake estimates; the accuracy of these intake values provides the foundation of the avian exposure/risk assessment. The proponent used toxic reference values (TRVs) available for various metals and water intake to calculate maximum acceptable water concentrations (MACs) for birds. MAC values were then compared to predicted worst-case scenario surface water concentrations for the tailings management facility (TMF). In order to be conservative, the Proponent recalculated MAC values based on the assumption that drinking water for birds accounts for 1% of their daily exposure to metals and it was thus concluded that the MAC values would be reduced by 100-fold. While the Proponent has provided sample calculations used to calculate MAC values, it is not clear how MAC values were derived using the assumption that the daily exposure of metals through drinking water in birds represents 1%. Given that this approach shifted MAC values 100-fold relative to the previous assessment using intake rate values, it is important to understand how these values were calculated, and whether the assumption of 1% daily exposure associated with drinking water is a scientifically defensible methodology. In the EIS Appendix 7A, Table D-5: The highest value of the monthly mean and 95th percentile for each project phase in the TMF pond. However, these values do not correspond to the upper bound predicted values in Table IR(2)-54.4. For example, for arsenic the upper 95th percentile TMF concentration is 21 ug/L, but table 54.4 has it as 11 ug/L . For Cyanide, 95th % TMF estimates are 6700 ug/L for total and 230 ug/L for Weak Acid

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	Dissociable, but table 54.4 has a value of 87 ug/L for Weak Acid Dissociable. The avian risk assessment evaluates the potential toxicity of individual metals and cyanide exposure by making comparisons to well-established toxicity reference values (TRVs); however, no TRV was provided for aluminum or cyanide. It is noted that, in general, risk assessment of chemicals is predicated on the toxicity of individual chemicals and not of environmentally relevant chemical mixtures. Furthermore, the potential for metal-cyanide complexes may be present in TMF water. The proponent used TRVs available for various metals and water intake to calculate maximum acceptable water concentrations (MACs) for birds. MAC values were then compared to predicted worst-case scenario surface water concentrations for the tailings management facility (TMF). There are numerous discrepancies between the TRVs in Table IR(2)-54.2 and the values in the cited references. For example, the mallard NOAEL for arsenic in Sample et al., 1996 is 5.1 mg/kg/d, but the Proponents uses a value of 4.3 mg/kg/d. Granted , in this instance, this value is more conservative but it is not clear why it was used. For mercury, it is not clear why the selected TRV was based on a single study using Japanese quail, when more relevant toxicity values are available for waterbird species, like those that the proponent identified as having a greater likelihood to be exposed to the TMF. Lastly, for TRVs based on multiple test species, it is not clear how the TRVs were established and selected for the risk assessment. Pending additional clarification and detail, the expectation from the Proponent is that metals and cyanide present in TMF water are not at sufficiently high enough concentrations to elicit toxicological effects to avian species (e.x. duck (black duck & mallard duck), common merganser, great blue heron, and Canada goose) that may come into contact with, and ingest TMF water. Two different scenarios are used to calculate MAC values, however predicted worst-case scenario water concentrations are used as the starting point for both of these risk assessment scenarios/calculations. Additional details are requested to verify the accuracy of these modelled values.
Information Request:	a. Provide references for the water intake rate values used to estimate exposure of contaminants present in TMF water forspecies included in Table IR(2)-54.1 b. Provide clarification, including references, on how the MAC valuewould change using water intake rate versus the estimated 1% ofdaily metal intake attributed to drinking TMF water.

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	c. Provide clarification on the discrepancy between the water quality values presented in Appendix 7A, Table D-5 and Table IR(2)-54.4. Describe how this discrepancy affects the conclusions drawn from the avian risk assessment. d. Describe how aluminum, cyanide and metal-cyanide complexeswere accounted for in the risk assessment. e. Explain how the TRVs were chosen for the avian risk assessment. f. Describe the mitigations to protect waterfowl if water qualityexceeds predicted worse case values.
Response:	a. The response provided to IR(2)-54 (response to federal Information Requirements (IRs) submitted to the Impact Assessment Agency of Canada on September 22, 2021) relied on receptor characteristics from the USEPA (1993) and evaluated the risk to avifauna with exposure to the upper bound (95th percentile) predicted contaminant concentrations for the worst-case (Fair Weather) water quality predictions for the tailings management facility (TMF). In response to this IR, additional assessment has been completed using federal guidance for ecological risk assessment (Federal Contaminated Sites Assessment Program, FCSAP) and the water quality values (95th percentile) presented in Appendix 7A, Table D-5 of the EIS. Further information on the differences in the water quality values presented in Appendix 7A, Table D-5 and Table IR(2)-54.4 is provided in response to part c) of this IR response, below. Note that the conclusions of the additional assessment provided below are consistent with those presented in IR(2)-54. As indicated above, receptor-specific characteristics have been updated to reflect Environment Canada's FCSAP (2012) guidance and are provided in Table IR(3)-54a.1. For the mallard duck, common merganser, and great blue heron, both body weight (BW, expressed in kg) and water intake rate values (in L/kg BW-day) were obtained directly from FCSAP (2012). For the Canada goose (a species not listed in FCSAP 2012 guidance), body weight and water intake rate (IR_{water}) were obtained following FCSAP (2012) guidance for determining receptor-specific characteristics. Specifically, the average BW for the great blue heron was obtained from the USEPA Wildlife Exposure Factors Handbook (USEPA 1993). The water intake rate (in L/kg BW-day) was based on the allometric equation (Calder and Braun 1983 in USEPA 1993) for total water intake for all birds (L/day; ($0.059*BW^{0.67}$) divided by BW.

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	Water intake rates in Table IR(3)-54a.1 were also expressed in L/day by multiplying the water intake rates expressed as L/kg BW-day by the BW (kg). Similarly, the toxicological reference values (TRVs) have been updated to reflect default FCSAP (2021) TRVs, where available, and are summarized in Table IR(3)-54a.2. For contaminants of potential concern (COPC) where there was no default FCSAP TRV, an explanation of how those TRVs were selected for the avian risk assessment are provided below in the response to part (e). **Exposure Estimates** These receptor characteristics, combined with the maximum predicted concentrations of the COPC, were used to develop a quantitative estimate of exposure to each COPC for each receptor. For birds, the rate of exposure to a COPC is estimated on a mg/kg-day basis (referred to as the average daily dose or ADD). For each receptor, the ADD from water (ADD_{water}) was calculated for each COPC using the following equation (based on CCME 1997): $ADD_{water} = IR_{water} \times f_{site} \times ABS \times EPC_{water}/BW$ **Equation 1** Where: ADD_{water} = Average daily dose from water ingestion (mg chemical/kg BW-day) IR_{water} = Ingestion rate of water (L contaminated water/day) f_{site} = Fraction of total ingestion of water from the site (unitless, and assumed to be 1) ABS = Absorption factor (default value of 1 for all COPCs) EPC_{water} = Exposure point concentration of water (mg contaminant/L water) BW = average body weight of receptor (kg) As noted in the response to IR(2)-54, receptors were conservatively assumed to obtain 100% of their total water ingestion from the site (i.e., f_{site} = 1). Further, it is assumed that 100% of the ingested dose is absorbed by the receptor (i.e., ABS = 1). To assess the potential risks to avifauna associated with exposure to water quality values presented in Appendix 7A, Table D-5, these values were used as the EPC_{water}.

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	For example, the average daily dose of arsenic to the mallard duck is calculated as: ADD_{water} = (0.072 L/day) x (1) x (1) x (0.021mg/L)/(1.2 kg) = 0.00126 mg/kg BW-day The ADD_{water} for each COPC, for each of the receptors are provided in Tables IR(3)-54a.3 to IR(3)-54a.6. **Hazard Quotients** Risk Characterization evaluates the evidence linking COPCs with adverse ecological effects by combining information from the exposure and toxicity assessments. The potential for adverse effects is quantified by comparing the amount of a substance that can be tolerated, below which adverse environmental effects are not expected (e.g., TRV or toxicity benchmarks), to the amount of a COPC an organism is expected to be exposed to or come into contact with on a daily basis. This is defined as the Hazard Quotient (HQ): HQ = ADD (mg/kg BW-d)/TRV (mg/kg BW-d) **Equation 2** The magnitude by which values differ from parity (e.g., TRV = daily dose, HQ = 1.0) is used to make inferences about the possibility of ecological risks. A HQ less than 1.0 indicates that the exposure concentration is less than the threshold of toxicity and there is a low probability that adverse environmental effects might occur. Given the conservative approach to ecological risk assessment, it is likely that no adverse environmental effects would occur at HQs less than 1.0. However, a HQ value of greater than 1.0 does not automatically indicate that there is an unacceptable level of risk, only that there is a possibility of adverse ecological effects. For example, the HQ for arsenic for the mallard duck is calculated as: HQ = (0.00126 mg/kg BW-d)/(4.4 mg/kg BW-d) = 0.00029 As this HQ is well below the threshold of 1.0, the risk to the mallard duck from ingestion of TMF water is negligible. The HQs for each COPC for each of the receptors are provided in Tables IR(3)-54a.3 to IR(3)-54a.6, and summarized for all four receptors in Table IR(3)-54a.7. As indicated in Table IR(3) 54a.7, the HQs range from 0.0000020 for the Canada goose ingesting cadmium to 0.0039 for the mallard duck ingesting copper. As all the calculated HQs

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	were orders of magnitude below 1.0, and the assumptions used in the assessment overestimate exposure (i.e., assumption that 100% of water ingestion is from Project Area, and that receptors ingest upper limit of concentrations from worst case water quality prediction for TMF), the risk to avifauna from ingestion of water from the Project Area is negligible. **Maximum Acceptable Concentrations** As per FCSAP (2021), TRVs can be transformed to obtain concentrations in some media to use as a cleanup value or maximum acceptable concentration (MAC). The MACs have been calculated using the revised receptor characteristics provided in Table IR(3)-54a.1 and revised TRVs provided in Table IR(3)-54a.2 using the following general equation: $MAC = TRV \times AF_{water} \times BW/IR_{water}$ **Equation 3** Where MAC = Maximum acceptable concentration (mg /L) TRV = Toxicity reference value (mg/kg BW-day) AF_{water} = Allocation factor for water, which is the fraction of the maximum daily exposure limit that comes from water (unitless) IR_{water} = Ingestion rate of water (L contaminated water/day) BW = average body weight of receptor (kg) Birds and other ecological receptors are exposed to chemicals by consuming both food and water and through incidental ingestion of sediment and soil. The TRVs represent maximum daily exposure limits for all exposure media and pathways. When the total daily exposure (from food, water, and sediment/soil) to a given chemical is less than the TRV for that chemical, exposure to that chemical is considered to represent a negligible health risk for a given ecological receptor. For birds, TRVs are typically expressed as daily exposure doses in mg of chemical/kg body weight per day (mg/kg BW-day). A MAC for any given environmental medium represents the maximum concentration of chemical that can be present in that medium before the total exposure experienced by a given receptor would be predicted to exceed the TRV for that chemical.

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	When chemical exposure is limited to a single environmental medium (e.g., water), then MACs can be calculated assuming that 100% of the maximum daily exposure limit (TRV) comes from that medium (i.e., AF = 1). If 100% of the maximum daily exposure limit is allocated to water (AF_{water} = 1), then the Equation 3 is identical to the equation indicated in the initial response to IR(2)-54. For example, the MAC for arsenic for the mallard duck when 100% of the maximum daily exposure limit is allocated to water (AF_{water} =1) is calculated as: MAC = (4.4 mg/kg BW-d) x (1) x (1.2 kg)/(0.072 L/d) = 73 mg/L Where exposures to a chemical can occur through contact with multiple media (e.g., water, food, sediment/soil), MACs can be calculated for each medium (albeit with different units) based on the relative proportion of the maximum daily exposure limit of that chemical that comes from each medium. These calculations are conducted by apportioning the maximum daily exposure limit between the environmental media as shown in Equation 3, where AF_{water} represents the fraction of the maximum daily exposure limit that comes from water. The use of allocation factors for soil and water guideline development is consistent with CCME (2006). The response to IR(2)-54 included MACs that were calculated based on an assumption that the portion of the maximum daily exposure limit of metals that would come from the TMF water was limited to 1%. These MACs were simply a recalculation of the MACs using Equation 3 but with an AF_{water} of 0.01. Although the selection of an AF_{water} of 1% is somewhat arbitrary, it is considered very protective as it allows for the remaining 99% of the maximum daily exposure limit to be reserved for other media such as food, sediment/soil. For example, the MAC for arsenic for the mallard duck when 1% of the maximum daily exposure limit is allocated to water (AF_{water} =1) is calculated as: MAC = (4.4 mg/kg BW-d) x (0.01) x (1.2 kg)/(0.072 L/d) = 0.73 mg/L The MAC for each COPC for each of the receptors is provided in Tables IR(3)-54a.8 to IR(3)-54a.11. Calculations were made using AF_{water} values of 1 and 0.01. The lowest of the MAC values (i.e., mallard duck) are summarized in Table IR(3)-54a.12. The predicted

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	contaminant concentrations for the TMF from Table D-5, Appendix 7A of the EIS are also provided in Table IR(3)-54a.12 for comparison. The MACs provided in Table IR(3)-54a.12 are higher than the predicted worst-case contaminant concentrations in water in the TMF. Based on these results, it is reasonable to conclude that the worst-case predicted metal concentrations in TMF water represent a negligible risk to avifauna. It should also be noted that the MACs do not represent pollute-up-to numbers and are not protective of other aquatic receptors (e.g., fish). Rather, they have been calculated to provide a means of comparing TMF water quality with chemical concentrations that could pose an unacceptable health risk for avifauna. b. Please see additional clarification that has been incorporated in the response to part (a). c. The differences between TMF pond water quality predictions presented in Appendix 7A, Table D-5 of the EIS and Table IR(2)-54.4 are readily explained. The water quality predictions presented in Appendix 7A, Table D-5 of the EIS are based on the modeled wet year, dry year, and climate normal years resolved at a monthly time scale. The predictions of average and 95th percentile concentrations are derived from these climate conditions. While the average value would be extracted from monthly climate normal conditions, the 95th percentile (a poor water quality case) is a combination of dry conditions and worse water quality inputs (e.g., seepage, process water). Of the climate conditions assessed, precipitation on the TMF as well as runoff to the TMF are at their lowest during a dry year incident. As a result, there is minimal rainwater, snowmelt, or runoff to assimilate or improve the concentration of mine water cycling through the process plant as reclaim and returning as tailings slurry water. Table IR(2)-54.4, on the other hand, was based on the water level and storage condition in the TMF pond immediately preceding the onset of the Environmental Design Flood (1:100 year event) and/or the Inflow Design Flood (Probable Maximum Flood). The Canadian Dam Association provides guidance to the antecedent condition indicating that it should be the normal high-water level in the TMF pond. The normal high-water level is the highest water level anticipated under normal conditions throughout the year. This antecedent normal high-water level includes a substantially higher TMF pond water level and storage volume, including increased incident rainfall, snowmelt, and runoff. The differences between the 95th percentile water quality

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	predictions in Appendix 7A, Table D-5 and the water quality predictions in Table IR(2)-54.4, which used water quality predictions for Fair Weather conditions, are derived from those climatic and water level condition factors. With respect to differences in the effect these two scenarios would have on the conclusions of the avifauna risk assessment, a comparison between the lowest calculated MACs (mallard duck) (assuming a AF_{water} of 1 and a AF_{water} of 0.01) and the worst-case predictions for TMF water (95th percentile water quality predictions from the Operations phase of Table D5 from Appendix 7a) is provided in Table IR(3)-54a.12. The 95th percentile water quality results represent predicted water in the TMF under dry conditions when the TMF water values do not include precipitation and/or runoff water, and thus represent the lowest volumes of TMF water and highest concentrations of metals in the water. In both cases (AF_{water} = 1 and AF_{water} = 0.01), the MACs for the most sensitive of the four avian species (mallard duck) are higher than the worst-case predicted water quality for the TMF. The MACs were calculated based on the unrealistic assumptions that the birds would spend 365 days per year on the TMF, and that the TMF water would be the only drinking water source these birds would use, which exaggerates potential exposures. Further, the worst-case water quality conditions are based on drier than average conditions, when the surface area of water in the TMF would be at its lowest. These conditions would not be expected to persist over a long period (i.e., would not persist for 365 days as assumed in the assessment). There is also an abundance of waterbodies in the immediate vicinity of the site with more suitable habitat and with food sources that would be more attractive to avian species. Therefore, it is unlikely that waterfowl would spend much, if any, time on water in the TMF, which will provide neither food nor suitable habitat. Based on this, it is reasonable to conclude that, even under worst-case conditions, water in the TMF would represent a negligible health risk for avifauna. d. Although the toxicity of aluminum has been studied extensively in fish, as indicated Table IR(3)-54a.2, a TRV for aluminum that is suitable for use in birds has not been identified in the literature, and thus a quantitative assessment of the potential health risks for avifauna could not be conducted for aluminum. What has been reported is that concentrations greater than 1000 mg/kg in food may be toxic to young birds (Sparling et al. 1997); however, as the tailings and sedimentation ponds will not contain fish, and the continuous deposition of tailings (in

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	the TMF pond) and routine maintenance of the sedimentation ponds (i.e., clearing out sediment build-up) will limit the likelihood that invertebrates will be present within the TMF or sedimentation ponds, food ingestion is not a significant exposure pathway for avifauna in the Project Area. Based on this qualitative assessment of exposure, the predicted aluminum concentrations in water within the TMF are expected to represent a negligible health risk for avifauna. The total cyanide and weak acid dissociable (WAD) concentrations under the worst-case conditions for TMF water (95^{th} percentile water quality predictions from the Operations phase) were predicted as 6.7 mg/L (6700 µg/L) and 0.23 mg/l (230 µg/L), respectively (Table D5 of Appendix 7a of the EIS). Based on this, the strong acid dissociable (SAD) would be 6.47 mg/L (SAD = total – WAD). Geochemical modelling of TMF water quality (Appendix 7a of the EIS) indicates that SAD would be predominantly ferric ferrocyanide complexes which generally have low toxicity and low bioavailability (Government of Canada 2018) and thus, would not represent a substantial potential health risk for avifauna. In addition, as indicated in Table D5 of Appendix 7a of the EIS, under worst-case conditions, WAD is predicted to be 0.23 mg/L, which is below the International Cyanide Code guideline for WAD for the protection of birds and wildlife. Based on this, it is reasonable to conclude that cyanide and cyanide-metal complexes in TMF water represent a negligible health risk for avifauna. e. The focus of the avian risk assessment conducted as part of the response to IR(2)-54's specific question "a. Provide an avian risk assessment based on a comparison of modelled contaminant values to toxicity reference guidelines for birds for all project surface-water components", was to assess potential risk for a selected group of receptors at the population level. Where available, the TRVs were obtained from FCSAP (2021), which was prepared by Environment and Climate Change Canada. Supporting rationale for the FCSAP (2021) TRV selections is provided in Appendix A of that document. No FCSAP default TRVs are available for boron, molybdenum, selenium, silver, thallium and uranium. TRVs for these chemicals were sourced from the scientific literature, with origins primarily from the USEPA Ecological Soil Screening Levels Documents specific to each metal (USEPA various dates) and from Sample et al. (1996). These TRVs were based on dose-response studies, typically conducted with laboratory animals where, for example, the lowest observable adverse

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	effects level (LOAEL) or no observable adverse effects level (NOAEL) have been quantified. These TRVs are discussed individually below. The application of TRVs derived from LOAELs is preferred in the calculation of risk as the LOAELs are based on long-term growth or survival, or sub-lethal reproductive outcomes determined from chronic exposure studies. As such, these endpoints are relevant to the maintenance of wildlife populations. However, in some cases, suitable chronic LOAELs were not identified. In those cases, TRVs may be based on other endpoints and uncertainty factors may be applied as deemed necessary. The uncertainty factor scheme that was used is based on guidance provided by Ohio EPA (2018), USEPA (2002), Sample and Arenal (1999) and the professional judgment of the study team. If the TRV was based on an acute lethal dose (LD50, the amount of an ingested substance that kills 50 percent of a test sample), then it was adjusted by a factor of 100 to make it comparable to a chronic LOAEL. If the TRV was based on a subchronic LOAEL or NOAEL, then it was adjusted by 3 to make it comparable to a chronic LOAEL. **Boron** The boron TRV selected for this assessment is based on the chronic LOAEL determined from studies performed by Smith and Anders (1989), cited in Sample et al. (1996). The study was based on oral exposure of mallard ducks to boric acid in their diet. The study endpoint was reproductive. While ducks exposed to doses of 1000 ppm boric acid exhibited reduced egg fertility and duckling growth, increased duckling mortality and embryo mortality, no adverse reproductive effects were observed at other dose levels. Because the study considered exposure throughout reproduction, the 1000 ppm dose (100 mg/kg/day) was considered to be a chronic LOAEL, while 288 ppm (28.8 mg/kg/day) was considered a chronic NOAEL. The LOAEL of 100 mg/kg/day was selected for use as the TRV for bird species for this model. **Manganese** In their assessment, the USEPA conducted an in-depth review of the toxicological literature pertaining to the effects of manganese on birds (USEPA 2007). Of the 3,618 studies examined, 21 addressed effects on birds and were considered in the selection of a TRV for manganese. Using the 21 studies addressing effects on birds, the USEPA (2007) applied the geometric mean of NOAELs from those studies which

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	monitored growth or reproductive endpoints as the Eco-SSL TRV. This value (179 mg/kg/day) is lower than any LOAEL for studies monitoring growth, reproductive, or survival endpoints in the USEPA database, and is used as the TRV for effects of manganese on bird species in the ecological model. The collection of toxicological literature from which this geometric mean was calculated contained studies using multiple bird species as test animals (e.g., chicken, Japanese quail), and primarily acute or subchronic exposures, but included several of reproductive endpoints that had higher NOAEL values than the geometric mean NOAEL value. Therefore, the geometric mean NOAEL value can be used as the TRV for a variety of avian species without additional uncertainty factors being applied. As the TRV for manganese is based on the geometric mean of NOAEL values, additional factors are not used, and the TRV is set at 179 mg/kg-bw/day. **Molybdenum** The molybdenum TRV selected for this assessment of avian species is based on a LOAEL determined from studies performed by Lepore and Miller (1965), cited in Sample et al. (1996). The study was based on exposure of chickens to molybdenum in the diet. The study endpoint was reproduction. Chickens were exposed to molybdenum as sodium molybdate at concentrations of 500, 1000, or 2000 ppm molybdenum in diet over a period of 21 days. Adverse reproductive effects (reduced embryonic viability) were observed at all concentrations tested. Therefore, the lowest concentration (500 ppm) is considered the LOAEL. The LOAEL diet was converted to a daily dose rate of 35.3 mg/kg-bw/day based on estimated body weight and food ingestion rate. Although exposure in this study was less than 90 days in duration (i.e., subchronic), it is considered chronic because it was administered during a critical life stage (i.e., gestation). **Selenium** The selenium TRV selected for this assessment of avian species is based on the chronic LOAEL determined from a study performed by Heinz et al. (1987), cited in Sample et al. (1996). The study was based on oral exposure of mallards to sodium selenite in diet. The study endpoint was reproduction. Mallards were exposed to sodium selenite at 1, 5, 10, 25, and 100 mg/kg selenium in diet over a period of 78 days. Mallards exposed to 100 mg/kg selenium showed reduced adult survival; exposure to 10 and 25 mg/kg selenium resulted in a significantly increased frequency of lethally deformed embryos; exposure to 5 mg/kg selenium resulted in no significant adverse effects.

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	Therefore the 10 mg/kg and the 5 mg/kg diets are considered to represent a chronic LOAEL and NOAEL, respectively. The chronic LOAEL of 10 mg/kg in diet was converted to a dose rate of 1.0 mg/kg-bw/day based on the body weight and food ingestion rate and is selected for use as the TRV. **Silver** In their assessment, the USEPA conducted an in-depth review of the toxicological literature pertaining to the effects of silver on birds (USEPA 2006). Seven studies addressing effects on birds were identified and considered in the selection of a TRV for silver. Of the seven studies identified by the USEPA for avian studies involving silver, none identified a NOAEL for growth, reproduction, or survival endpoints; the study with the lowest LOAEL for growth, reproduction, and survival performed by Jensen et al. (1974), was selected for use in deriving an avian TRV for this assessment. This TRV, a LOAEL of 20.2 mg/kg-day, is based on growth effects (change in body weight) of juvenile turkeys (male and female) sub-chronically exposed to silver acetate (100% silver) via diet at doses of 0, 300, or 900 mg/kg. An uncertainty factor of 3 (to account for a subchronic LOAEL compared to a chronic LOAEL) is applied to the silver subchronic LOAEL of 20.2 mg/kg-bw/day, yielding a TRV of 6.73 mg/kg-bw/day. **Thallium** The thallium TRV selected for this ERA model for avian species is based on an acute LD50 (34.6 mg/kg) value cited in Schafer et al. (1972), cited in Schafer et al. (1983). The study was based on oral exposure of starlings to thallium sulphate administered in propylene glycol via gavage. The study endpoint was mortality. Because the study considered only acute exposures, the 34.6 mg/kg dose is assigned an uncertainty factor of 100 for the conversion from an acute LD50 to a chronic LOAEL, resulting in a chronic LOAEL of 0.353 mg/kg-bw/day used in this model for avian species. **Uranium** The uranium reference dose selected for bird species is based on the subchronic NOAEL determined from studies performed by Haseltine and Sileo (1983), cited in Sample et al. (1996). The study was based on oral exposure of black ducks to metallic depleted uranium in diet. The study endpoints considered were mortality, body weight, blood chemistry, or liver or kidney effects. Ducks were exposed to depleted

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	metallic uranium at doses of 25, 100, 400, and 1,600 ppm U in diet over a period of 6 weeks. No adverse effects were observed at any dose. Because this study took place over a period of less than 10 weeks that did not include a critical life stage, the subchronic NOAEL 160 mg/kg-bw/day was modified by an uncertainty factor of 3 (to account for a subchronic NOAEL compared to a chronic NOAEL), resulting in a chronic NOAEL of 53 mg/kg-bw/day. f. As noted in the response to part d), the lowest MAC values calculated for avifauna (mallard duck) are 10-fold higher than the worst-case metal concentrations predicted for TMF water under drier than normal conditions. Thus, it is unlikely that TMF water quality would exceed the calculated MAC values. Marathon will monitor water quality in the TMF during active discharge and treatment in order to accurately and efficiently treat effluent to regulatory criteria and adjust reclaim processing water quality. This is generally during the ice-free season. During the non-discharge season, the TMF is expected to be ice-covered and monitoring will continue for reclaim/process water. The proactive mitigation measures described in the EIS (Section 10.4) and the original response to IR-54 (e.g., maintaining embankments of the TMF and polishing pond free of vegetation, limiting the attraction of waterfowl and/or wildlife to these ponds for foraging or breeding) will be implemented irrespective of results of water quality monitoring. In the event that TMF water quality exceeds the MAC values, appropriate measures will be taken to limit waterfowl contact with TMF water. Should avifauna use of the TMF and/or polishing pond become a concern due to TMF water quality and despite the implementation of proactive mitigation measures, Marathon will notify Canadian Wildlife Service (CWS) and consult with CWS regarding the implementation of additional adaptive mitigation measures, such as those identified in the original response to IR-54 (e.g., potential deterrents and exclusionary measures). **References:** Calder, W. A., and E .J. Braun. 1983. Scaling of osmotic regulation in mammals and birds. American Journal of Physiology 224:R601-R606. Cited in USEPA (1993). Canadian Council of Ministers of the Environment (CCME). 1997. A Framework for Ecological Risk Assessment (Technical Appendices).

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Appendix:	None

Table IR(3)-54a.1 Receptor Characteristics

Species	Body Weight [1] BW	Water Intake Rate [2] IR_{water}	
	(kg)	(L/kg-BW/day)	(L/day)
	(A)	(B)	(C = A*B)
Duck (Mallard)	1.2	0.06	0.072
Common Merganser	1.5	0.05	0.075
Great Blue Heron	2.3	0.04	0.092
Canada Goose [3]	3.7	0.04	0.14

Notes:
1. Average body weight in kg as reported in FCSAP (2012), except as noted
2. Water ingestion rate in L per kg BW per day as reported in FCSAP (2012), except as noted
3. Canada goose body weight from (USEPA 1993); intake rate calculated using allometric equation (see text)

Table IR(3)-54a.2 Toxicity Reference Values for Metals

Parameter	Bird			
	Endpoint	Effect	Toxicity Reference Value (mg/kg BW-day)	Reference
Aluminum	No suitable study identified			
Antimony	No suitable study identified			
Arsenic	EC20	growth, reproduction, mortality	4.4	FCSAP (2021)
Barium	mortality	mortality	51.3	FCSAP (2021)
Boron	chronic LOAEL	reproduction	100	Smith & Anders (1989) in Sample et al. (1996)
Cadmium	EC20	growth, reproduction, mortality	2.1	FCSAP (2021)
Chromium (Total)	geometric mean of NOAEL	growth, reproduction	2.66	FCSAP (2021)
Copper	EC20	reproduction	4.5	FCSAP (2021)
Lead	highest bound NOAEL	growth, reproduction, survival	1.63	FCSAP (2021)
Manganese	geometric mean of NOAEL	growth, reproduction	179	USEPA Eco-SSL (2007)
Mercury	EC20	mortality	0.8	FCSAP (2021)
Molybdenum	chronic LOAEL	reproduction	35	Lepore and Miller (1965) in Sample et al. (1996)
Nickel	geometric mean of NOAEL	growth, reproduction	6.71	FCSAP (2021)
Selenium	chronic LOAEL	reproduction	1	Heinz et al. (1987) in Sample et al. (1996)
Silver	subchronic LOAEL	growth	6.73	Jensen et al. (1974) in USEPA Eco-SSL (2006)
Thallium	acute LD50	mortality	0.353	Schafer (1972) in Schafer et al. (1983)
Uranium	subchronic NOAEL	various, including mortality	53	Haseltine and Sileo (1983) in Sample et al. (1996)
Zinc	geometric mean of NOAEL	growth, reproduction	66.1	FCSAP (2021)

Table IR(3)-54a.3 Hazard Quotients for Mallard Duck

Parameter	Receptor Characteristics		Exposure Estimate		Risk Estimate	
	Body Weight, BW (kg)	IR_{water} (L/d)	EPC_{water} (mg/L)	Average Daily Dose, ADD_{water} (mg/kg BW-day)	Toxicity Reference Value, TRV (mg/kg BW-day)	Hazard Quotient, HQ
Arsenic	1.2	0.072	2.1E-02	1.26E-03	4.4	2.9E-04
Barium	1.2	0.072	5.9E-02	3.54E-03	51.3	6.9E-05
Boron	1.2	0.072	2.1E-01	1.26E-02	100	1.3E-04
Cadmium	1.2	0.072	1.1E-04	6.60E-06	2.1	3.1E-06
Chromium (Total)	1.2	0.072	3.3E-03	1.98E-04	2.66	7.4E-05
Copper	1.2	0.072	2.9E-01	1.74E-02	4.5	3.9E-03
Lead	1.2	0.072	4.0E-04	2.40E-05	1.63	1.5E-05
Manganese	1.2	0.072	4.8E-01	2.88E-02	179	1.6E-04
Mercury	1.2	0.072	6.3E-04	3.78E-05	0.8	4.7E-05
Molybdenum	1.2	0.072	1.5E-01	9.00E-03	35	2.6E-04
Nickel	1.2	0.072	6.7E-03	4.02E-04	6.71	6.0E-05
Selenium	1.2	0.072	5.6E-03	3.36E-04	1	3.4E-04
Silver	1.2	0.072	8.0E-04	4.80E-05	6.73	7.1E-06
Thallium	1.2	0.072	1.1E-04	6.60E-06	0.353	1.9E-05
Uranium	1.2	0.072	6.6E-03	3.96E-04	53	7.5E-06
Zinc	1.2	0.072	1.2E-02	7.20E-04	66.1	1.1E-05

Notes:

1. The TMF predicted worst-case predictions from Table D5 from Appendix 7a, EIS selected as EPC_{water}
2. ADD_{water} calculated using equation $ADD_{water} = IR_{water} \times f_{site} \times ABS \times EPC_{water}/BW$
3. Receptor assumed to obtain 100% of ingested water from Project Area (i.e., $f_{site} = 1$)
4. Assumed that 100% of the ingested dose is absorbed by the receptor (i.e., ABS = 1)
5. HQ less than 1.0 indicates that there is a low probability that adverse environmental effects might occur

Table IR(3)-54a.4 Hazard Quotients for Common Merganser

Parameter	Receptor Characteristics		Exposure Estimate		Risk Estimate	
	Body Weight, BW (kg)	IR_{water} (L/d)	EPC_{water} (mg/L)	Average Daily Dose, ADD_{water} (mg/kg BW-day)	Toxicity Reference Value, TRV (mg/kg BW-day)	Hazard Quotient, HQ
Arsenic	1.5	0.075	2.1E-02	1.05E-03	4.4	2.4E-04
Barium	1.5	0.075	5.9E-02	2.95E-03	51.3	5.8E-05
Boron	1.5	0.075	2.1E-01	1.05E-02	100	1.1E-04
Cadmium	1.5	0.075	1.1E-04	5.50E-06	2.1	2.6E-06
Chromium (Total)	1.5	0.075	3.3E-03	1.65E-04	2.66	6.2E-05
Copper	1.5	0.075	2.9E-01	1.45E-02	4.5	3.2E-03
Lead	1.5	0.075	4.0E-04	2.00E-05	1.63	1.2E-05
Manganese	1.5	0.075	4.8E-01	2.40E-02	179	1.3E-04
Mercury	1.5	0.075	6.3E-04	3.15E-05	0.8	3.9E-05
Molybdenum	1.5	0.075	1.5E-01	7.50E-03	35	2.1E-04
Nickel	1.5	0.075	6.7E-03	3.35E-04	6.71	5.0E-05
Selenium	1.5	0.075	5.6E-03	2.80E-04	1	2.8E-04
Silver	1.5	0.075	8.0E-04	4.00E-05	6.73	5.9E-06
Thallium	1.5	0.075	1.1E-04	5.50E-06	0.353	1.6E-05
Uranium	1.5	0.075	6.6E-03	3.30E-04	53	6.2E-06
Zinc	1.5	0.075	1.2E-02	6.00E-04	66.1	9.1E-06

Notes:

1. The TMF worst-case predictions from Table D5 from Appendix 7a, EIS selected as EPC_{water}
2. ADD_{water} calculated using equation $ADD_{water} = IR_{water} \times f_{site} \times ABS \times EPC_{water}/BW$
3. Receptor assumed to obtain 100% of ingested water from Project Area (i.e., $f_{site} = 1$)
4. Assumed that 100% of the ingested dose is absorbed by the receptor (i.e., ABS = 1)
5. HQ less than 1.0 indicates that there is a low probability that adverse environmental effects might occur

Table IR(3)-54a.5 Hazard Quotients for Great Blue Heron

Parameter	Receptor Characteristics		Exposure Estimate		Risk Estimate	
	Body Weight, BW (kg)	IR_{water} (L/d)	EPC_{water} (mg/L)	Average Daily Dose, ADD_{water} (mg/kg BW-day)	Toxicity Reference Value, TRV (mg/kg BW-day)	Hazard Quotient, HQ
Arsenic	2.3	0.092	2.1E-02	8.40E-04	4.4	1.9E-04
Barium	2.3	0.092	5.9E-02	2.36E-03	51.3	4.6E-05
Boron	2.3	0.092	2.1E-01	8.40E-03	100	8.4E-05
Cadmium	2.3	0.092	1.1E-04	4.40E-06	2.1	2.1E-06
Chromium (Total)	2.3	0.092	3.3E-03	1.32E-04	2.66	5.0E-05
Copper	2.3	0.092	2.9E-01	1.16E-02	4.5	2.6E-03
Lead	2.3	0.092	4.0E-04	1.60E-05	1.63	9.8E-06
Manganese	2.3	0.092	4.8E-01	1.92E-02	179	1.1E-04
Mercury	2.3	0.092	6.3E-04	2.52E-05	0.8	3.2E-05
Molybdenum	2.3	0.092	1.5E-01	6.00E-03	35	1.7E-04
Nickel	2.3	0.092	6.7E-03	2.68E-04	6.71	4.0E-05
Selenium	2.3	0.092	5.6E-03	2.24E-04	1	2.2E-04
Silver	2.3	0.092	8.0E-04	3.20E-05	6.73	4.8E-06
Thallium	2.3	0.092	1.1E-04	4.40E-06	0.353	1.2E-05
Uranium	2.3	0.092	6.6E-03	2.64E-04	53	5.0E-06
Zinc	2.3	0.092	1.2E-02	4.80E-04	66.1	7.3E-06

Notes:

1. The TMF worst-case predictions from Table D5 from Appendix 7a, EIS selected as EPC_{water}
2. ADD_{water} calculated using equation $ADD_{water} = IR_{water} \times f_{site} \times ABS \times EPC_{water}/BW$
3. Receptor assumed to obtain 100% of ingested water from Project Area (i.e., $f_{site} = 1$)
4. Assumed that 100% of the ingested dose is absorbed by the receptor (i.e., ABS = 1)
5. HQ less than 1.0 indicates that there is a low probability that adverse environmental effects might occur

Table IR(3)-54a.6 Hazard Quotients for Canada Goose

Parameter	Receptor Characteristics		Exposure Estimate		Risk Estimate	
	Body Weight, BW (kg)	IR_{water} (L/d)	EPC_{water} (mg/L)	Average Daily Dose, ADD_{water} (mg/kg BW-day)	Toxicity Reference Value, TRV (mg/kg BW-day)	Hazard Quotient, HQ
Arsenic	3.7	0.14	2.1E-02	8.05E-04	4.4	1.8E-04
Barium	3.7	0.14	5.9E-02	2.26E-03	51.3	4.4E-05
Boron	3.7	0.14	2.1E-01	8.05E-03	100	8.0E-05
Cadmium	3.7	0.14	1.1E-04	4.21E-06	2.1	2.0E-06
Chromium (Total)	3.7	0.14	3.3E-03	1.26E-04	2.66	4.8E-05
Copper	3.7	0.14	2.9E-01	1.11E-02	4.5	2.5E-03
Lead	3.7	0.14	4.0E-04	1.53E-05	1.63	9.4E-06
Manganese	3.7	0.14	4.8E-01	1.84E-02	179	1.0E-04
Mercury	3.7	0.14	6.3E-04	2.41E-05	0.8	3.0E-05
Molybdenum	3.7	0.14	1.5E-01	5.75E-03	35	1.6E-04
Nickel	3.7	0.14	6.7E-03	2.57E-04	6.71	3.8E-05
Selenium	3.7	0.14	5.6E-03	2.15E-04	1	2.1E-04
Silver	3.7	0.14	8.0E-04	3.07E-05	6.73	4.6E-06
Thallium	3.7	0.14	1.1E-04	4.21E-06	0.353	1.2E-05
Uranium	3.7	0.14	6.6E-03	2.53E-04	53	4.8E-06
Zinc	3.7	0.14	1.2E-02	4.60E-04	66.1	7.0E-06

Notes:

1. The TMF worst-case predictions from Table D5 from Appendix 7a, EIS selected as EPC_{water}
2. ADD_{water} calculated using equation $ADD_{water} = IR_{water} \times f_{site} \times ABS \times EPC_{water}/BW$
3. Receptor assumed to obtain 100% of ingested water from Project Area (i.e., $f_{site} = 1$)
4. Assumed that 100% of the ingested dose is absorbed by the receptor (i.e., ABS = 1)
5. HQ less than 1.0 indicates that there is a low probability that adverse environmental effects might occur

Table IR(3)-54a.7 Summary of Hazard Quotients

Parameter	Mallard Duck	Common Merganser	Great Blue Heron	Canada Goose
Arsenic	2.9E-04	2.4E-04	1.9E-04	1.8E-04
Barium	6.9E-05	5.8E-05	4.6E-05	4.4E-05
Boron	1.3E-04	1.1E-04	8.4E-05	8.0E-05
Cadmium	3.1E-06	2.6E-06	2.1E-06	2.0E-06
Chromium (Total)	7.4E-05	6.2E-05	5.0E-05	4.8E-05
Copper	3.9E-03	3.2E-03	2.6E-03	2.5E-03
Lead	1.5E-05	1.2E-05	9.8E-06	9.4E-06
Manganese	1.6E-04	1.3E-04	1.1E-04	1.0E-04
Mercury	4.7E-05	3.9E-05	3.2E-05	3.0E-05
Molybdenum	2.6E-04	2.1E-04	1.7E-04	1.6E-04
Nickel	6.0E-05	5.0E-05	4.0E-05	3.8E-05
Selenium	3.4E-04	2.8E-04	2.2E-04	2.1E-04
Silver	7.1E-06	5.9E-06	4.8E-06	4.6E-06
Thallium	1.9E-05	1.6E-05	1.2E-05	1.2E-05
Uranium	7.5E-06	6.2E-06	5.0E-06	4.8E-06
Zinc	1.1E-05	9.1E-06	7.3E-06	7.0E-06

Note:

1. HQ less than 1.0 indicates that there is a low probability that adverse environmental effects might occur

Table IR(3)-54a.8 Maximum Acceptable Concentrations for Mallard Duck

Parameter	Receptor Characteristics		Toxicity Reference Value	Maximum Acceptable Concentration, MAC (mg/L)	
	Body Weight, BW (kg)	IR_{water} (L/d)	TRV (mg/kg BW-day)	Allocation Factor, $AF_{water} = 1$	Allocation Factor, $AF_{water} = 0.01$
Arsenic	1.2	0.072	4.4	7.33E+01	7.33E-01
Barium	1.2	0.072	51.3	8.55E+02	8.55E+00
Boron	1.2	0.072	100	1.67E+03	1.67E+01
Cadmium	1.2	0.072	2.1	3.50E+01	3.50E-01
Chromium (Total)	1.2	0.072	2.66	4.43E+01	4.43E-01
Copper	1.2	0.072	4.5	7.50E+01	7.50E-01
Lead	1.2	0.072	1.63	2.72E+01	2.72E-01
Manganese	1.2	0.072	179	2.98E+03	2.98E+01
Mercury	1.2	0.072	0.8	1.33E+01	1.33E-01
Molybdenum	1.2	0.072	35	5.83E+02	5.83E+00
Nickel	1.2	0.072	6.71	1.12E+02	1.12E+00
Selenium	1.2	0.072	1	1.67E+01	1.67E-01
Silver	1.2	0.072	6.73	1.12E+02	1.12E+00
Thallium	1.2	0.072	0.353	5.88E+00	5.88E-02
Uranium	1.2	0.072	53	8.83E+02	8.83E+00
Zinc	1.2	0.072	66.1	1.10E+03	1.10E+01

Note:
MAC calculated using equation $MAC = TRV \times AF_{water} \times BW / IR_{water}$

Table IR(3)-54a.9 Maximum Acceptable Concentrations for Common Merganser

Parameter	Receptor Characteristics		Toxicity Reference Value TRV (mg/kg BW-day)	Maximum Acceptable Concentration, MAC (mg/L)	
	Body Weight, BW (kg)	IR_{water} (L/d)		Allocation Factor, $AF_{water} = 1$	Allocation Factor, $AF_{water} = 0.01$
Arsenic	1.5	0.075	4.4	8.80E+01	8.80E-01
Barium	1.5	0.075	51.3	1.03E+03	1.03E+01
Boron	1.5	0.075	100	2.00E+03	2.00E+01
Cadmium	1.5	0.075	2.1	4.20E+01	4.20E-01
Chromium (Total)	1.5	0.075	2.66	5.32E+01	5.32E-01
Copper	1.5	0.075	4.5	9.00E+01	9.00E-01
Lead	1.5	0.075	1.63	3.26E+01	3.26E-01
Manganese	1.5	0.075	179	3.58E+03	3.58E+01
Mercury	1.5	0.075	0.8	1.60E+01	1.60E-01
Molybdenum	1.5	0.075	35	7.00E+02	7.00E+00
Nickel	1.5	0.075	6.71	1.34E+02	1.34E+00
Selenium	1.5	0.075	1	2.00E+01	2.00E-01
Silver	1.5	0.075	6.73	1.35E+02	1.35E+00
Thallium	1.5	0.075	0.353	7.06E+00	7.06E-02
Uranium	1.5	0.075	53	1.06E+03	1.06E+01
Zinc	1.5	0.075	66.1	1.32E+03	1.32E+01

Note:
MAC calculated using equation $MAC = TRV \times AF_{water} \times BW/IR_{water}$

Table IR(3)-54a.10 Maximum Acceptable Concentrations for Great Blue Heron

Parameter	Receptor Characteristics		Toxicity Reference Value TRV (mg/kg BW-day)	Maximum Acceptable Concentration, MAC (mg/L)	
	Body Weight, BW (kg)	IR_{water} (L/d)		Allocation Factor, $AF_{water} = 1$	Allocation Factor, $AF_{water} = 0.01$
Arsenic	2.3	0.092	4.4	1.10E+02	1.10E+00
Barium	2.3	0.092	51.3	1.28E+03	1.28E+01
Boron	2.3	0.092	100	2.50E+03	2.50E+01
Cadmium	2.3	0.092	2.1	5.25E+01	5.25E-01
Chromium (Total)	2.3	0.092	2.66	6.65E+01	6.65E-01
Copper	2.3	0.092	4.5	1.13E+02	1.13E+00
Lead	2.3	0.092	1.63	4.08E+01	4.08E-01
Manganese	2.3	0.092	179	4.48E+03	4.48E+01
Mercury	2.3	0.092	0.8	2.00E+01	2.00E-01
Molybdenum	2.3	0.092	35	8.75E+02	8.75E+00
Nickel	2.3	0.092	6.71	1.68E+02	1.68E+00
Selenium	2.3	0.092	1	2.50E+01	2.50E-01
Silver	2.3	0.092	6.73	1.68E+02	1.68E+00
Thallium	2.3	0.092	0.353	8.83E+00	8.83E-02
Uranium	2.3	0.092	53	1.33E+03	1.33E+01
Zinc	2.3	0.092	66.1	1.65E+03	1.65E+01

Note:
MAC calculated using equation $MAC = TRV \times AF_{water} \times BW/IR_{water}$

Table IR(3)-54a.11 Maximum Acceptable Concentrations for Canada Goose

Parameter	Receptor Characteristics		Toxicity Reference Value TRV (mg/kg BW-day)	Maximum Acceptable Concentration, MAC (mg/L)	
	Body Weight, BW (kg)	IR_{water} (L/d)		Allocation Factor, $AF_{water} = 1$	Allocation Factor, $AF_{water} = 0.01$
Arsenic	3.7	0.14	4.4	1.15E+02	1.15E+00
Barium	3.7	0.14	51.3	1.34E+03	1.34E+01
Boron	3.7	0.14	100	2.61E+03	2.61E+01
Cadmium	3.7	0.14	2.1	5.48E+01	5.48E-01
Chromium (Total)	3.7	0.14	2.66	6.94E+01	6.94E-01
Copper	3.7	0.14	4.5	1.17E+02	1.17E+00
Lead	3.7	0.14	1.63	4.25E+01	4.25E-01
Manganese	3.7	0.14	179	4.67E+03	4.67E+01
Mercury	3.7	0.14	0.8	2.09E+01	2.09E-01
Molybdenum	3.7	0.14	35	9.14E+02	9.14E+00
Nickel	3.7	0.14	6.71	1.75E+02	1.75E+00
Selenium	3.7	0.14	1	2.61E+01	2.61E-01
Silver	3.7	0.14	6.73	1.76E+02	1.76E+00
Thallium	3.7	0.14	0.353	9.21E+00	9.21E-02
Uranium	3.7	0.14	53	1.38E+03	1.38E+01
Zinc	3.7	0.14	66.1	1.73E+03	1.73E+01

Note:

MAC calculated using equation $MAC = TRV \times AF_{water} \times BW/IR_{water}$

Table IR(2)-54a.12 Lowest Maximum Acceptable Concentrations Compared to Predicted Water Quality (from Table D5, Appendix 7a, EIS)

Parameter	Lowest Maximum Acceptable Concentration, MAC (mg/L)		TMF Predicted Worst Case Water Quality (mg/L)
	Allocation Factor, AF_{water} = 1	Allocation Factor, AF_{water} = 0.01	
Arsenic	7.33E+01	7.33E-01	2.1E-02
Barium	8.55E+02	8.55E+00	5.9E-02
Boron	1.67E+03	1.67E+01	2.1E-01
Cadmium	3.50E+01	3.50E-01	1.1E-04
Chromium (Total)	4.43E+01	4.43E-01	3.3E-03
Copper	7.50E+01	7.50E-01	2.9E-01
Lead	2.72E+01	2.72E-01	4.0E-04
Manganese	2.98E+03	2.98E+01	4.8E-01
Mercury	1.33E+01	1.33E-01	6.3E-04
Molybdenum	5.83E+02	5.83E+00	1.5E-01
Nickel	1.12E+02	1.12E+00	6.7E-03
Selenium	1.67E+01	1.67E-01	5.6E-03
Silver	1.12E+02	1.12E+00	8.0E-04
Thallium	5.88E+00	5.88E-02	1.1E-04
Uranium	8.83E+02	8.83E+00	6.6E-03
Zinc	1.10E+03	1.10E+01	1.2E-02

Note:
1. Lowest MAC based on Mallard Duck the Operations phase of Table D5 from Appendix 7a, EIS