Valentine Gold Project: Federal Information Requirements

Response to IR-59 to IR-76

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RESPONSE TO IR-59

ID:	**IR-59**
Expert Department or Group:	FFA
Guideline Reference:	EIS Guidelines Section 7.1 and7.3.3.1
EIS Reference:	EIS - Baseline Study Appendix 2: Woodland Caribou (BSA 2)
Context and Rationale:	The EIS Guidelines state that the EIS will present information in sufficient detail to enable the identification of how the project could affect the VCs and the analysis of those effects. Specifically, the EIS Guidelines require an assessment of the potential adverse effects on caribou that could be caused by all project activities. There are significant gaps in information on caribou use of the project area as well as well as baseline information on population size as a whole and for Buchans caribou in particular. The Baseline Caribou Study (Appendix 2 of the EIS) needs to adequately: • Represent the extent of use of the project area by caribou and relate it to the degree of risk posed by project components. • Provide a comprehensive assessment of risk posed by the project as a whole to caribou migration and subsequently to caribou populations. For example, it needs to discuss implications for the Buchans caribou herd if they are unable to travel between calving and wintering grounds. • Provide standardized analyses and summaries of data collected for all baseline studies. Baseline data that meets scientific standards is needed to understand current conditions and to assess the potential significance of effects of the project on caribou.
Information Request:	Work with Newfoundland and Labrador Wildlife Division to provide an adequate description of caribou use of, and movement through, the project area and provide estimates for caribou populations potentially affected by the Project.
Response:	Marathon will continue to work with Wildlife Division to provide additional baseline information on caribou use, movement, and a population estimate for caribou herds potentially affected by the Project. Baseline information collected to date is detailed in the EIS (Section 11.2.2 and BSA.2), and additional baseline information will be collected in 2021. The 2021 additional baseline effort includes deployment of collars, the use of remote cameras, and an aerial population survey. A brief summary of each follows. The Wildlife Division is currently deploying 60 Global Positioning System collars on caribou belonging to the Buchans and Grey River herds to support future environmental effects monitoring. To date, 40 collars have

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	been deployed on caribou in the Buchans herd, noting that one of these collars was lost due to a suspected winter coyote kill on a pond (i.e., the collar sank in a pond and no longer transmits a signal) as investigated and reported by the Wildlife Division. Another 20 collars are to be deployed on caribou in the Grey River herd in May/June. The Wildlife Division has full and continuous access to the monitoring data from the deployed collars, and Marathon will analyze and report on the data collected. The data collected from the collaring program is expected to provide current information on caribou movement (Buchans herd) and caribou use (Buchans and Grey River herds) of the Project Area and surrounding areas. This information should help to inform whether caribou movement or use of the Project Area and surrounding area changes during construction and operation of the Project, and help to confirm the effectiveness of proposed mitigations or the need for adaptive measures. For 2021, the remote camera monitoring program, which is being used to monitor Buchans herd caribou migrating through and around the Project Area has been expanded to gather supplementary information on the timing and local concentration of travel during the spring and fall migration. In consultation with Wildlife Division, 15 additional cameras were deployed for the spring 2021 migration; further program refinements, including deployment for fall 2021 migration, are anticipated based on survey outcomes and continued discussion with Wildlife Division. Data from the remote camera monitoring program will be analyzed, and a report on the results will be provided to the Wildlife Division. It is expected that the monitoring program will be expanded to capture potential change in caribou movement and the use of alternate migration paths. Marathon will continue to consult with the Wildlife Division with regard to camera placement and results. Marathon will complete a post-calving and population survey of the Buchans caribou herd in June 2021 to provide baseline information and to address technical issues associated with the 2020 survey. Based on ongoing consultation with the Wildlife Division, Marathon's environmental consultant will submit a detailed plan for these surveys for review and approval prior to undertaking the survey. Further, Marathon and the Wildlife Division have agreed to have a representative from the Wildlife Division accompany the environmental consultant for the first day or two of the survey to observe the work and provide input on additional refinements to the program, if needed. Marathon will provide data and the final survey report to Wildlife Division for review once complete, and the results will serve as baseline information for comparison with future surveys.

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	The response to IR-60 provides additional information on the use of caribou baseline data, the extent of caribou use of the Project Area and the risk that the Project and Project components pose to caribou, and potential implications on caribou if their movement changes (including an inability to migrate).
Appendix:	None

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Expert Department or Group:	FFA
Guideline Reference:	EIS Guidelines 7.3.3.1
EIS Reference:	EIS – Chapter 11
Context and Rationale:	The EIS Guidelines require an assessment of the potential adverse effects on caribou that could be caused by all project activities. The analysis of migration patterns of Buchan's caribou through the project area presented in the EIS (Section 11.2.2.1 page 11.31, also figures 11-12, and 11-13) indicate that there was 'only one distinct population level path identified'. Similarly, the caribou component study indicates heavy use of the project area by migrating caribou during spring and fall. Residual impacts for Buchans caribou are considered to be of a 'high' magnitude. The EIS needs to present detailed or effective mitigations related to key project components for all affected caribou. The potential impacts on caribou population, if caribou are unable to migrate to their calving grounds, need to be considered, even though calf mortality may be substantial in this case. The assessment of (indirect) habitat loss is based on a very conservative level of anticipated avoidance (500 m) and will likely underestimate impacts on caribou during construction and operation phases of the development. The EIS needs to discuss the risks to caribou migration due to specific project components (pit, road, waste rock pile) based on caribou movement through the project area as well as effective mitigation measures for caribou, in particular migrating caribou, based on best practices and degree of obstruction posed by specific project components to migration during construction and operation. For example, the impact of the waste rock pile, directly in the path of a migratory corridor, is a major concern that needs to be evaluated or discussed. The EIS needs to include a discussion of combined project impacts from disturbance, habitat loss, mortality, and potential changes in migration stemming from project development caribou. The EIS only indirectly addresses the effects of noise, lights and dust on caribou. All aspects of human activity (noise and light) are key disturbance stimuli for caribou and should be considered together. Moderating mining activity during critical periods (e.g., migration) may be an important tool for mitigation of the mine's effects, and should be measured and quantified. This information is needed to assess the significance of potential effects and for follow-up and monitoring programs.
Information Request:	a. Provide a comprehensive assessment of potential effects of the project as a whole (i.e. all project components) on caribou migration, calving

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	and subsequently to caribou populations for all phases of the project. Include at a minimum the effects of dust, noise and vibrations on caribou. This must include impacts resulting from stress as well as habitat degradation. b. Provide an assessment of effects and risks for predicted caribou avoidance zones using distances consistent with scientific literature. This must include an assessment of the amount of direct and indirect caribou habitat loss resulting from avoidance at an appropriate distance(s) consistent with scientific literature. c. Describe in detail proposed measures that will be used to mitigate for predicted effects on caribou. This is to include, but not be limited, to targeted mitigations which address permeability of the migratory pathway to caribou and is also to address how the effects of noise, light and particulate will be mitigated during the different phases of the project. Describe in detail any associated monitoring and follow-up and monitoring programs. d. Provide an assessment and discussion of combined project impacts from disturbance, habitat loss, mortality, and potential changes in migration stemming from project development (past, present and future) on affected caribou.
Response:	a. The environmental assessment methods used in the EIS rely on the systematic identification of both the activities that may occur in association with each phase of the Project and the potential effects of the Project, including Project components, on the valued component (VC). For caribou, potential effects identified included change in habitat (both direct and indirect changes), change in movement and change in morality risk. Table 11.12 (Section 11.3.4 of the EIS) identifies each Project activity with potential to contribute to environmental effects on caribou. The identified interactions in Table 11.12 informed the assessment of residual Project effects, ensuring the assessment provided in Section 11.5 of the EIS considered the potential effects resulting from all Project components and phases. With specific respect to change in movement for the Buchans herd, the Project as a whole was assessed as a barrier to caribou movement. This included the presence of the Marathon pit and waste rock pile that are aligned with the primary migration path of the Bucans herd (Section 11.5.2.2). In determining the significance of residual effects of the Project on caribou habitat, movement, and mortality risk as provided in Section 11.6, all Project

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	phases (i.e., construction, operation, and decommissioning) and activities were considered and a potential significant residual effect was predicted for caribou based on uncertainty in how the movement of caribou will be affected, how effective mitigation will be at reducing adverse effects on movement, and what effect a change in movement may have on the Buchans herd population. The following information is provided for additional context and does not change the prediction of a significant residual effect on caribou. **Sensory Disturbance and Stress Response** Sensory disturbances (including noise, light, dust, vibrations, and visible human activity) are key disturbance stimuli for caribou and can decrease habitat quality (habitat degradation). As stated in Section 11.5.1.1 “Noise and vibration disturbance generated through equipment and activities such as rock breakers, blasting and heavy equipment operations have the potential to indirectly affect caribou habitat adjacent to the Project Area and may cause reduced use or avoidance by caribou.” Traffic and maintenance activities on the access road may also indirectly affect caribou habitat through dust deposition in adjacent areas (e.g., caribou may avoid consuming dust covered plants or changes in soil alkalinity may affect the availability of forage plants). Potential avoidance of the Project due to sensory disturbance is discussed in Section 11.5.1.2, with relevant literature summarized in Table 11.14, and Section 11.5.2.2 includes a discussion of caribou avoidance of anthropogenic disturbances and the impacts on (and resulting from) a change in migratory movements. Sensory disturbance can result in short-term behavioral and physiological responses by caribou, including a startle response, elevated heart rate, and increased hormone production (e.g., glucocorticoids) (ECCC 2019); the latter of which may indicate a physiological response to stress (MacDougall-Shackleton et al. 2019). While levels of stress hormones in caribou have been shown to increase with exposure to anthropogenic disturbance (e.g., Freeman 2008; Wasser et al. 2011; Renaud 2012; Ewacha et al. 2017; Plante et al. 2020), the evidence is somewhat inconsistent. Potential effects from increased stress include: • reduced fitness (Bonier et al. 2009). • poor body condition and potentially lower survival and reproductive rates (Escribano-Avila et al. 2013).

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	• reduced immune function and increased parasite load or susceptibility to disease (Hughes et al. 2009, Hing et al. 2016). Project-related physiological stress on caribou has the potential to affect caribou health and, ultimately, population demographics. Potential long-term effects of the Project on caribou (e.g., reduced calving rates) are discussed in Section 11.5.2.2. Mitigation measures to reduce sensory disturbance from noise, light, and dust are provided in Table 5.11 in Chapter 5 (mitigation related to Atmospheric Environment) and Table 11.13 (mitigation measures related to caribou); see also the response to part c) below. **Dust and Caribou Habitat** Sources of fugitive dust were assessed in Chapter 5 of the EIS. Dust will be generated during construction and operation activities, including from blasting, material handling and processing, and wind erosion of stockpiles and tailings beach surfaces. The EIS concluded that emissions during construction are anticipated to be low in magnitude and generally confined to the area (i.e., within 1 to 2 km) surrounding the mine site. An atmospheric dispersion model was used to predict maximum ground level concentrations of particulate matter during normal operation of the Project at receptor locations within a 40 km by 40 km area centered around the mine site. Results of the analysis indicate that the highest predicted concentrations of fugitive dust are expected to occur within 1 to 2 km of the mine site (refer to Figure 5.2 in the EIS) and that generally the predicted concentrations reach background levels within 10 to 15 km of the mine site. Section 5.10.1.2 of the EIS states that air contaminant releases associated with vehicle traffic on the access road were not quantified or included in the dispersion modelling because releases are expected to be localized (confined to a 500 m buffer surrounding the access road) and transient in nature. Given the large distance between the mine site and most of the access road, air contaminant releases from the road are generally not expected to overlap with those from the mine site. Section 11.5.1.1 of the EIS states that dust may reduce caribou habitat suitability by altering vegetation communities and functionally reducing caribou forage. Chen et al. (2017) reported significant increases in the amount of dust and soil pH levels, corresponding with reductions in the percent cover of vascular plants and lichen, associated with the Misery Haul Road at the Ekati Diamond Mine. Specifically, the zone of increased dust on leaves was observed within 1 km of the road,

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	elevated pH levels and reduced vascular plants were observed within 10 m of the road, and reduced lichen cover was observed within 1 km of the road. Measures in place to reduce dust emissions (Section 5.4 of the EIS), including progressive rehabilitation and application of water to roads during dry periods will serve to reduce potential effects of dust on caribou. Additional details on mitigation measures related to caribou are provided in part c). **Noise** Noise was assessed in Chapter 5 (Atmospheric Environment) of the EIS. As stated in Section 5.3.1.1 of the EIS, a conservative approach was used to assess Project effects on the acoustic environment, which included the following assumptions related to noise: i. Worst-case conditions were incorporated into the acoustic modelling. For example, the maximum equipment operation at the mine site and the maximum hauling activities are anticipated to occur at different stages of the mine life. For the acoustics assessment, it was assumed that these activity levels occur simultaneously. ii. The noise assessment assumed that all equipment was running simultaneously. iii. Noise propagation from mining activities was exaggerated by assuming that the ground near the Project will reflect more sound waves than is actually anticipated. Based on acoustic modelling, sound pressure levels related to construction are predicted to be 35 dBA (background levels) at approximately 5 km from the mine site, and at 25 dBA at approximately 8 km from the mine site (Chapter 5). Sound pressure levels related to the access road are predicted to be 25 dBA at approximately 1 km from the access road during rotation changes. During operation, sound pressure levels are predicted to be 35 dBA at approximately 5 km from the mine, and 25 dBA at approximately 10 km from the mine. Sound pressure levels related to the access road are predicted to be 25 dBA at approximately 1 km during rotation changes. Within the mine site, predicted sound pressure levels could reach approximately 80 dBA (e.g., rock breaker: 80 dBA at 100 m distance; processing plant: 67 dBA at 100 m; edge of Marathon Pit: 52 dBA at 100 m; edge of Leprechaun Pit: 55-60 dBA at 100 m). Blasting activities were considered within the acoustic assessment by assuming one blast per day lasting approximately one-minute in duration.

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	Studies have shown that effects of acoustic emissions on wildlife have the potential to occur above 40 dBA (Shannon et al. 2016). Bradshaw et al. (1997) found that caribou exposed to simulated noise levels between 90 and 110 dB had an increased rate of movement following exposure. Maier et al. (1998) found that caribou responded to noise levels of 46 dB to 127 dB associated with low-level jet aircraft overflights in Alberta by either interrupting resting bouts (late winter), increasing activity (during the insect season), or by increasing activity and moving farther from the disturbance (post-calving). Mitigation measures to reduce the amount of noise produced during construction and operation are provided in Table 5.11 (Chapter 5 – Atmospheric Environment) and Table 11.13 (mitigation measures related to caribou). Additional details on mitigation measures related to caribou are provided in part c). **Vibrations** Vibrations were modelled in the Blast Impact Assessment completed for the Project (BSA.1, Attachment 1-C) and blasting was included in the assessment of change in air quality and sound quality presented in Sections 5.5.1 and 5.5.2 of the Atmospheric Environment VC. Blasting during Project construction and operation is impulsive and provides a low frequency air blast and ground vibration. Air blast is low frequency sound generated by energy waves transferred through the air and is measured in dB. Vibration is energy waves transferred through the ground and measured by particle velocity. The type of geology and the blast configuration greatly influence how the energy of the blast is released into the atmosphere. During a blast, the majority of the energy generated is consumed in fragmenting the desired portion of rock with the remaining energy released as air blast and ground vibration. During Project operation, blasting will alternate between pits (Marathon and Leprechaun) such that a blast is expected to occur at a given pit every second day, overall averaging one blast per day for both pits combined or approximately 350 total blasts per year. Blasting at mines routinely follows best management practices, namely the Blasters Handbook (ISEE 2016) and the Environmental Code of Practice for Metal Mines (ECCC 2009). These guides include recommended threshold values for blasting and mitigation options to reduce air blast related noise and vibration during blasting events, and the recommended methods and thresholds will be incorporated into the blasting design for the Project (Section 5.5.3.1 in the EIS). Relative to blasting for other types of mining (e.g., iron ore), blasting for gold

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	mining generally requires smaller and more precise blasting effort, thereby resulting in less air blast -related noise and vibration. It is expected that noise and vibration emissions from blasting during Project construction and operation will conform to the recommended thresholds outlined in these best-practice guides. A recent study by Eftestol et al. (2019) found no difference in avoidance behavior of reindeer between workdays with and without blasting, suggesting that sensory disturbance associated with high levels of activity at the mine site have greater effects on caribou than the blasting itself. Mitigation measures to reduce sensory disturbance to caribou include visual surveys for caribou prior to any blasting whereby, if caribou are observed within a 500 m blasting radius, blasting will be delayed until the caribou have left the area (Table 11.13 of the EIS). Activities in the Marathon pit area that may result in sensory disturbance to migrating caribou (e.g., blasting, loading, hauling) will also be reduced or ceased while caribou are migrating within a set distance from the site (e.g., 10 km north or south) and through the corridor at the site. Additional details on mitigation measures related to caribou are provided in part c). **Residual Effects on Change in Movement** As described in Section 11.6, due to the overlap between the Project and the migration corridor used by more than half of the Buchans herd, Project-related residual effects were considered and a potential significant residual effect was predicted for caribou based on uncertainty in how the movement of caribou will be affected, how effective mitigation will be at reducing adverse effects on movement, and what effect a change in movement may have on the Buchans herd population. As caribou movements will be altered by the Project, there is uncertainty in how the Buchans herd will respond and the resulting effects this may have on their population. Given the potential significance of this residual effect, an analysis of potential alternate caribou migration routes was completed to address the assumed impermeability of the migratory corridor through the mine site. This GIS-based analysis is supported by literature relating to caribou avoidance of disturbances, the presence of physical barriers, energetic costs, predation risk, and the use of existing migration routes outside of the identified primary migration corridor which are used by some caribou from the Buchans herd. A summary of the analysis is provided below, with full details found in the Caribou Alternate Migration Pathway Analysis (Appendix IR-60.A). The additional information provided here and in Appendix IR-60. A does not change the prediction of a significant

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	adverse residual effect on caribou, as the analysis of potential alternate migration routes cannot predict the likelihood the caribou will use the alternate routes or the subsequent long-term effects on caribou. *Overview of the Caribou Alternate Migration Pathway Analysis* A least-cost path (LCP) analysis was undertaken to predict potential alternate migratory pathways that may be used by the Buchans herd during spring and fall migrations during Project activities, identify the habitat types within alternate migratory routes, and estimate changes in energetic costs based on distance travelled. This analysis modelled the relative energetic cost for an animal to move between locations, assuming complete avoidance of Zones of Influence (ZOIs) around the mine site of 1 km, 5 km, 10 km and 15 km, and under frozen and unfrozen scenarios. A 'baseline' movement pathway was predicted by running the LCP analysis with no ZOI to serve as a comparable baseline for alternate pathways. Generally, the baseline LCP migration route and the Dynamic Brownian bridge movement models (dBBMM) results presented in the EIS (Section 11.2) had a high degree of congruence, suggesting the caribou are currently migrating along the shortest, LCP, and that additional LCP analyses could be reasonable predictors of potential alternate migration pathways. The analysis predicted that caribou could travel between 0 km and 13 km farther than the estimated baseline LCP during frozen conditions, and between 6 km and 30 km farther than the estimated baseline LCP during unfrozen conditions (spring and fall migration combined). The associated energetic costs of these alternative pathways range from 1.01 to 1.41 times greater than baseline. Baseline and alternate pathways traverse primarily open habitats (coniferous forest, low shrub, and wetland-shrub types), with amounts of open coniferous habitats decreasing with increasing ZOI distance, suggesting that alternate pathways contain habitats that would be more energetically demanding during migration. *Potential Risk to Caribou Populations* Maintaining connectivity between seasonal ranges is vital to sustaining viable populations of migratory ungulates (Monteith et al. 2018). The Caribou Alternate Migration Pathway Analysis illustrates the relative cost of identified alternate spring and fall migration pathways that are outside of the preferred migration corridor for each of the ZOIs examined. While it is unlikely that migration to calving grounds cannot be completed, the reduction in suitable migration habitat and potential changes to the timing, movement rate, or use of stopover sites during

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	migration may have effects on caribou recruitment and survival. Effect pathways include increased energetic costs, decreased forage availability, or increased mortality risk (e.g., if predators prefer habitat types that caribou would typically avoid), described as follows: • Reduced forage availability can lead to smaller calves and subsequent increased vulnerability to predation. High- and moderate-value caribou habitat comprises approximately 80 to 90 percent of habitats available within potential ZOIs up to 15 km from the mine site, suggesting that the availability of preferred forage is likely similar within these zones. • The effects of increased energetic demands during migration are discussed in Section 11.5.2.2 of the EIS. Potential long-term effects include decreased body condition, pregnancy rates, calving success, and caribou recruitment. • A decrease in body condition as a direct result of a change in movement can increase mortality risk to caribou (Section 11.5.3 of the EIS). • The presence of predators can be particularly detrimental to caribou populations where primary prey, such as moose, are also abundant to support high predator densities (Section 11.5.3.1 – Indirect Mortality Risk). Both coyote (*Canis lantrans*) and black bear (*Ursus americanus*) – primary predators of caribou calves on the Island of Newfoundland – were confirmed near the mine site (Chapter 12 of the EIS) and have the potential to occur in suitable habitat elsewhere in the Regional Assessment Area (RAA) for the Project. Moose (*Alces alces*) have also been confirmed near the mine site, with more than 140 photographed during the remote camera program in 2019 and 2020 (Chapter 12 of the EIS), and similarly are expected to occur in suitable habitat throughout the RAA. As such, the predation risk to caribou is likely to be similar within potential ZOIs up to 15 km from the mine site. The potential risks from a change in movement (described above) includes a potential increased risk of adverse effects on the population (size and trend) of caribou from the Buchans herd. b. An assessment of residual effects and risks related to predicted caribou avoidance zones and the amount of direct and indirect caribou habitat loss resulting from avoidance is provided in Section 11.5.1 of the EIS. Additional discussion regarding potential avoidance distances, based on available scientific literature, is provided below.

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	Sensory disturbances (e.g., noise, visual, vibration, dust, and human activities) are anticipated to be more substantial within than outside the 500 m buffer, based on proximity, propagation, and attenuation of sensory disturbance related to Project activities. Therefore, habitat within the 500 m buffer is expected to have reduced value for, and hence reduced use by, caribou through all Project phases. The use of a 500 m sensory disturbance buffer for caribou is aligned with the federal Scientific Assessment to inform the Identification of Critical Habitat for Woodland Caribou in Canada (Environment Canada 2011), which uses a 500 m buffer on anthropogenic disturbances to define disturbed habitat as a correlate of population decline. Direct and indirect effects on caribou habitat were quantified in the EIS based on habitat loss due to vegetation clearing in the Project Area and habitat alteration due to sensory disturbance, respectively, and were considered in the context of habitat availability within the 1,830.6 km^2 Ecological Land Classification Area (ELCA). Table 11.15 in the EIS estimates that the amount of high and moderate-value caribou habitat that will be directly affected is 28.5 km^2 and the amount indirectly affected is 57.3 km^2, which (combined) represents 5.5% of the high and moderate value habitat available in the ELCA. Because the ELCA is small relative to the population ranges of the four caribou herds assessed (6.4% of 28,809 km^2), the estimated proportion of habitat affected by the Project is larger than if compared to caribou range use and is therefore a conservative estimate. Predicted effects on caribou habitat are expected to extend beyond the 500 m buffer, as indicated in Section 11.5.1.3. These effects, however, are expected to decrease with increasing distance from the Project Area. For example, while Rudolph et al. (2012) detected avoidance of roads by woodland caribou at distances greater than 2 km, the analysis showed that avoidance dissipated exponentially with increasing distance. At distances of 500 m and 1,000 m from roads, the relative probability of caribou occurrence was approximately 60% and 80%, respectively, of the estimated maximum caribou occurrence (see Figure 13 in Rudolph et al. 2012). This suggests that while caribou may avoid habitats beyond the footprint of the Project, those habitats would not be lost to all caribou. The area in the vicinity of a development project where avoidance by caribou and other wildlife is observed is known as the ZOI. As indicated in Table 11.14 in the EIS, the ZOI for caribou is highly variable in the literature. Recent analyses by Boulanger et al. (2021) identified the ZOI

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	associated with two operational gold mines in the Northwest Territories to range from 6.1 to 18.7 km with a standardized average ZOI of 7.2 km over a 15-year period. The authors noted a high degree of annual variation in the estimates of ZOI size due to several factors including environmental conditions (e.g., forage quality, drought), perceived level of disturbance (e.g., vehicles, blasting, etc.), herd size, and seasonal range size and location (Boulanger et al. 2021). Other researchers have estimated seasonal ZOIs of mine sites ranging from 0.25 km to up to 23 km (e.g., Boulanger et al. 2012; Plante et al. 2018; Polfus et al. 2011). In Newfoundland, caribou showed avoidance of the Hope Brook Gold Mine at distances of up to 6 km during construction, and most caribou avoided the mine site within 4 km during the construction and operation phases (Weir et al. 2007). While much of the research on caribou ZOIs reflects different landscapes, topography, habitats, and caribou behaviours (e.g., migratory vs. sedentary) compared to Newfoundland, findings suggest that the ZOI for caribou in Newfoundland would also vary among years and herds. The mechanisms that cause caribou to avoid mines and other types of anthropogenic disturbances are unclear but may include visual and other sensory disturbances, such as noise and dust (Boulanger et al. 2012 and 2021), in addition to changes in habitat resulting from construction activities. Avoidance behaviours can result in a change in movement patterns, with potential implications on energetic demand, body condition, pregnancy rates, and predation risk (Section 11.5.3.2 of the EIS; refer also to part a) for a discussion of sensory disturbance to caribou and part c) regarding mitigation). Supplementary to information presented in Table 11.15 of the EIS, Table IR-60.1 provides additional information on low, moderate, and high-value caribou habitat located within a range of ZOIs extending up to 15 km from the mine site. This distance was selected as the greatest distance that predicted effects are likely to extend based on information in the scientific literature (e.g., Boulanger et al. 2011) and knowledge of the Project and surrounding landscape. The area within the mine site includes habitats that will be directly affected by the Project, through vegetation clearing during construction and subsequent mine operations. Habitats within potential ZOIs may have reduced use or seasonal avoidance by caribou but are anticipated to be recoverable at post-closure of the Project. As noted, mechanisms that may cause caribou to avoid mines and other anthropogenic disturbances are not well understood and there is a high degree of variation in the effect of differently sized ZOIs on

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	caribou. Responses by caribou are also variable but can include a shift in individual home ranges to avoid overlap with the disturbed area (e.g., MacNearney et al. 2016), seasonal avoidance (e.g., Boulanger et al. 2012), alteration of behaviors and group sizes in the vicinity of the disturbance (e.g., Weir et al. 2007), and a change in the timing and direction of migration (e.g., Mahoney and Schaefer 2002). To investigate potential alternate migration routes for caribou from the Buchans herd, Marathon has undertaken a LCP analysis (Appendix IR-60.A) to predict potential alternate migratory pathways that may be used by the Buchans herd during spring and fall migrations during Project activities, identify the habitat types within alternate migratory routes, and estimate changes in energetic costs based on distance travelled. Please see the response to part b) for the results of the analysis. c. Project planning and the application of proven mitigation measures will be used to reduce adverse residual effects on caribou. Specific mitigation is presented in Chapter 2 (Section 2.11 – Project Description) and in Chapter 11 (Caribou) of the EIS. A complete summary of mitigation measures for the Project is provided in Table 23.4 of the EIS. The following information provides additional context regarding mitigation measures that were considered for the Project in general (e.g., reduce the size of the footprint) and for individual Project components (e.g., diversion fencing around the crest of pits), and the rationale, as applicable, to support their inclusion or exclusion in the EIS. To limit potential adverse effects on caribou, a mitigation hierarchy was used to systematically evaluate mitigation opportunities for each component and phase of the Project. The mitigation hierarchy is: Avoid, Reduce, Restore, Offset, and has been applied elsewhere for caribou (e.g., Alberta; British Columbia). As is standard practice, Marathon focused on avoiding and reducing potential Project effects on caribou to the extent feasible, and to address remaining residual Project effects through restoration and possibly offsetting. Appendix IR-60.B outlines the mitigation measures that Marathon has evaluated for the Project including measures that have been committed to in the EIS and measures to be further reviewed and discussed with the Newfoundland and Labrador Department of Fisheries, Forestry and Agriculture (NLDFFA)-Wildlife Division. The proposed mitigation measures are based on industry best practices and guidelines and have been used and accepted by provincial regulators for other mine projects that overlap with caribou herd ranges. The table in Appendix IR-60.B includes measures to reduce effects related to:

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	i. Permeability of the migratory pathway for caribou ii. Noise emissions iii. Dust emissions iv. Light emissions The Project will have full-time On-Site Environmental Monitors (OSEMs) who will inspect worksites and activities for conformance with the EPP, Contract-Specific Environmental Protection Plans and government regulations and permits, to effectively implement and monitor mitigation measures. The OSEMs will also be notified if caribou are observed within 500 m of Project activities and appropriate mitigation will be implemented in accordance with outcomes of consultations with regulators. Marathon has been and will continue to consult with NLDFFA-Wildlife Division to evaluate strategies to facilitate caribou migration (through and adjacent to the site) and reduce potential adverse effects on caribou. As indicated in Section 11.9 of the EIS, Marathon is committed to working with regulators, Indigenous groups, and stakeholders to develop and implement robust monitoring programs that consider migration patterns and populations of the Buchans and Grey River herds. Marathon is currently engaging with the NLDFFA-Wildlife Division with respect to ongoing monitoring programs, and it is anticipated that these monitoring programs will adapt as required over the life of the Project (including closure and post-closure monitoring) to reflect updated knowledge of caribou in the Project Area. The following programs have been initiated or are scheduled to occur in 2021: • Deployment of 60 telemetry collars on caribou in the vicinity of the Project (partially complete) • Assessment of the effects of the Project on caribou migration (alternate migration route analysis) • Aerial post-calving surveys of caribou from the Buchans herd • Expansion of remote cameras program to gather supplementary information on the timing of spring and fall migration in the Project Area and caribou use of the Project Area. In consultation with NLDFFA-Wildlife Division, 15 additional cameras are currently deployed in spring 2021, with future program refinements anticipated based on survey outcomes and continued discussion with NLDFFA-Wildlife Division. In addition, and as indicated in Section 5.9 of the EIS, the following would be included within the Air Quality Management Plan:

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	• An ambient air quality (total suspended particulate matter [TSP], respirable particulate matter with an aerodynamic diameter less than 10 µm [PM_{10}] and fine particulate matter with an aerodynamic diameter less than 2.5 µm [$PM_{2.5}$] concentrations) monitoring program to be implemented and used to assess the effectiveness of dust mitigation • Sound pressure level monitoring programs, as required, to be conducted near the most affected receptor locations In response to regulatory feedback, monitoring for light levels will also be added to the Air Quality Management Plan. The results of these monitoring programs would be available to inform Project effects on caribou and the potential need for additional mitigation measures. d. The EIS Guidelines for the Project indicate the requirement for a comprehensive analysis of the Project's predicted effects on the environment. In the approach to the assessment, effect pathways for Project and cumulative effects for caribou were change in habitat, change in movement, and change in mortality risk (Section 11.5). Within the EIS, effect pathways for caribou are first considered separately to demonstrate that the full range of potential effects of the Project has been assessed and characterized. Within the assessment of individual effect pathways, linkages between pathways are also identified and discussed (e.g., change in habitat or movement may affect mortality risk, as discussed in Section 11.5.3.2 - indirect Mortality Risk). The determination of the significance of residual effects of the Project considers the combined effects of all identified pathways and provides an overall prediction of the potential risk posed by the Project for caribou. As indicated in Section 11.5.1.3 of the EIS, residual effects on change in caribou habitat are predicted to be neutral to adverse, long term in duration and low in magnitude for all assessed herds for most Project phases. Adverse effects on habitat are expected to extend beyond the Local Assessment Area (LAA), with caribou showing various degrees of avoidance beyond the 500 m buffer (e.g., depending on season, location, and nature of Project activities). Change in habitat, either directly or indirectly, may also affect movement and mortality risk of caribou. As indicated in Table 11.14, caribou often respond adversely to sensory disturbances (i.e., indirect habitat changes), with avoidance of mine sites reported up to 19-23 km (Plante et al. 2018). The avoidance of the mine site can result in altered migration routes with potential implications on energetic demand, body

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	condition, pregnancy rates, and predation risk. A change in habitat can also affect predator-prey dynamics through the creation of habitat ideal for predator movements or their hunting success (Section 11.5.3.2). Part a) of IR-60 provides the results of a Caribou Alternate Migration Pathway Analysis completed by Marathon and a discussion of potential implications. As indicated in Section 11.5.2.3, residual effects on change in caribou movement is predicted to be negligible for the Gaff Topsails and La Poile herds because of the limited overlap between those herds and the Project. Change in movement for the Grey River herd is predicted to be adverse but low in magnitude, given the limited overlap of their summer range with the Project. Project-related effects on movement of the Buchans herd, however, are expected to be high in magnitude because of the overlap of the Project with a well-defined and well-used migration corridor. The effect on the Buchans herd is expected to be long term and irreversible and will extend beyond the LAA. As indicated in Section 11.5.3.3 of the EIS, residual effects on change in caribou mortality risk will be adverse, low in magnitude, and medium term in duration. The risk of increased predation is expected to extend beyond the LAA and will affect all assessed caribou herds, however a change in mortality risk is likely to be greatest for caribou from the Buchans and Grey River herds as their ranges (or part thereof) overlap the Project in at least one season. The overall significance of Project effects on change in habitat, change in movement, and change in mortality risk are summarized in Section 11.6 of the EIS (Determination of Significance). The adverse residual effects of the Project on caribou from the Gaff Topsails, Grey River, and La Poile herds are expected to be low in magnitude and not significant. Adverse residual effects on caribou from the Buchans herd are expected to be high in magnitude and significant. While the determination of a significant residual adverse effect on caribou is largely attributed to the overlap between the Project and a primary migration path of the Buchans herd, the conclusion is also linked to other effect pathways, including, for example, direct effects on a change in habitat (i.e., habitat will be lost along the migration route) and indirect effects on mortality risk (e.g., altered migration routes may increase mortality through changes in predation or body condition). The implications of a significant change in movement could also result in changes to the timing of or movement rate during migration, ultimately resulting in changes in caribou recruitment and/or survival.

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	Project effects on change in caribou habitat, movement, and mortality risk will act cumulatively with similar residual effects resulting from past, present, and reasonably foreseeable projects and activities (Chapter 20 – Cumulative Effects Assessment). As stated in Table 20.14 (Section 20.8), cumulative effects resulting from the Project and reasonably foreseeable future activities are predicted to be high in magnitude, based on the following: i. While a small amount of caribou habitat will be lost, suitable habitat remains abundant and widespread throughout the cumulative effects RAA. ii. The Project may contribute to a small change in caribou mortality risk; however, it is not anticipated to affect the viability of caribou in the RAA. iii. Project-related contributions to cumulative effects on change in movement have the potential to disrupt the preferred migration path of the Buchans herd. Future activities combined with potential Project effects, specifically changes in movement, may measurably affect the abundance or sustainability of caribou (i.e., the Buchans herd) in the cumulative effects RAA. As stated in Table 20.14 (Section 20.8), with mitigation, the cumulative effects from the Project and reasonably foreseeable future activities are expected to be significant. References: Bonier, F., P.R. Martin, I.T. Moore, and J.C. Wingfield. 2009. Do baseline glucocorticoids predict fitness? Trends in Ecology and Evolution 24: 634-642. Boulanger, J., K.G. Poole, A. Gunn and J. Wierzchowski. 2012. Estimating the zone of influence of industrial development on wildlife: a migratory caribou *Rangifer tarandus gorenlandicus* and diamond mine case study. Wildlife Biology 18: 164-179. Boulanger, J., Poole, K.G., Gunn, A., Adamczewski, J. and J. Wierzchowski. 2021. Estimation of trends in zone of influence of mine sites on baren-ground caribou populations in the Northwest Territories, Canada, using new methods. Wildlife Biology, 2021(1). Available online at: https://doi.org/10.2981/wlb.00719 Last accessed 2 March 2021. Dyer, S.J., J.P. O'Neill, S.M. Wasel and S. Boutin. 2001. Avoidance of Industrial Development by Woodland Caribou. Journal of Wildlife Management 65: 531-542.

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Appendix:	Appendix IR-60.A, Appendix IR-60.B

Table IR-60.1 Amount of High-, Moderate-, and Low-value Caribou Habitat within the Project Area, Potential Zones of Influence, and the ELCA

Habitat Value Ranking[1]	PA[2]		Project Area + 500 m buffer		Potential ZOI (distance from Mine Site)[3,4]								Area in ELCA2[2,4]	
					2 km		5 km		10 km		15 km			
	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%
High	18.7	53.9	52.5	41.3	42.6	44.5	117.9	49.4	308.7	52.2	481.7	50.3	849.1	46.4
Moderate	9.8	28.1	46.5	36.6	43.6	45.5	102.8	43.1	235.5	39.9	381.5	39.8	718.5	39.2
Low	6.2	18.0	28.0	22.1	9.6	10.0	17.8	7.5	47.2	8.0	94.5	9.9	263.0	14.4
Total	**34.7**	**100.0**	**127.0**	**100.0**	**95.8**	**100.0**	**238.6**	**100.0**	**591.5**	**100.0**	**957.7**	**100.0**	**1,830.6**	**100.0**

NOTES:

1 Habitat value rankings for caribou are provided in Table 11.8 of the EIS. Existing anthropogenic areas are included in the rankings as low-quality habitat.

2 PA = Project Area and includes the mine site plus haul road and 20m buffer; ELCA = Ecological Land Classification Area and indicates the areal extent of detailed habitat information for the Project. Habitat availability in the PA, PA+500 m buffer and ELCA are also found in Table 11.9 of the EIS.

3 ELC coverage of the 10 km and 15 km ZOIs is 98% and 85%, respectively; coverage is 100% in all other areas.

4 Percent of habitat represents the area covered by the ELCA only and does not infer habitat distribution for those areas where there are gaps in the ELCA.

RESPONSE TO IR-61

ID:	**IR-61**
Expert Department or Group:	MFN
Guideline Reference:	Part 2, Section 5 and Section 7.3.4.
EIS Reference:	3.4.2 Indigenous Engagement: Methodology and Approach3.4.4.4 Land and Resource Use Information Exchange 17.2.1 Existing Conditions for Indigenous Groups - Methods17.2.3.3 MFN Current Use of Lands and Resources for Traditional Purposes 17.9 Follow up and m
Context and Rationale:	The EIS Guidelines direct the proponent to engage with Qalipu First Nation and Miawpukek First Nation (MFN) to obtain their views on, among other things, “physical and cultural heritage, including any structure, site or thing that is of historical, archaeological, paleontological or architectural significance. […] pursuant to paragraph 5(1)(c) of CEAA 2012.” The EIS Guidelines requires baseline information of current use of lands and resources for traditional purposes, and specific aspects should be considered. Additionally, the EIS guidelines also require the assessment of impacts to Indigenous people’s health based on effects of changes to the environment. The EIS states “Marathon Gold invited each group to share Indigenous Knowledge […]and has taken into account relevant Indigenous knowledge”. The Agency understands that MFN has not provided Indigenous Knowledge to date. MFN has indicated there is land and resource use in the Project Area. The Agency understands that the proponent is working with MFN to determine their land use in the Project Area. The EIS indicates that the proponent is prepared to support a land and resource use study to enhance an understanding of Indigenous land and resource use in the Project Area and relevant Indigenous knowledge. Should this study proceed, results will be used to inform the development of monitoring and follow-up programs and to guide proponent’s future engagement. The documentation and incorporation of Indigenous Knowledge is critical in the development and evaluation of all components of the EIS, as well as in the proper assessment of the impacts the Project may have on Indigenous interests and health.
Information Request:	Describe the process that the proponent will undertake to gather and incorporate MFN’s Indigenous Knowledge, including current use of lands and resources in the Project Area. Describe how this information would be used by the proponent to mitigate potential effects, if applicable and to develop follow-up and monitoring programs. If there is a determination of MFN use of the area, provide an assessment of how the project might impact Indigenous peoples’ health and the measures proposed to mitigate them.

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Response:	Marathon has engaged with the Miawpukek First Nation (MFN) since early 2019. While MFN did not undertake an Indigenous Knowledge study prior to submission of the EIS, as described in EIS Chapter 3 (Engagement) and Chapter 17 (Indigenous Groups) information respecting the group's Indigenous Knowledge and current land and resource use was provided by MFN during engagement and, together with secondary sources, was taken into consideration by Marathon in both the description of the baseline and the effects assessment. Within the EIS, a conservative approach was used to address uncertainty in the effects assessment, which increases confidence in the final determination of significance by reducing the risk of understating potential Project effects. While MFN indicated that its use of the Project Area has declined in recent years, the assessment on Indigenous peoples' health assumed that there was the potential for Indigenous groups to use the area for traditional purposes, including for harvesting country foods. With this conservative assumption, it was predicted that the overall residual effects from the Project on a change in Indigenous health conditions are anticipated to be negligible to low in magnitude, based on the low potential for air emissions and water discharges to affect the quality of country foods. In response to regulatory review of the EIS, a quantitative human health risk assessment (HHRA) has subsequently been completed for Indigenous and non-Indigenous receptors within the Local Assessment Area (LAA), which confirms predictions made in the EIS. The LAA for the HHRA corresponds with the LAA for the Atmospheric Environment and Surface Water Resources Valued Components. The assessment considered the potential changes in environmental quality for air, soil, surface water, terrestrial country food, and fish between Baseline Case and Future Case conditions. The results of the HHRA are provided in the Valentine Gold Human Health Risk Assessment (Appendix IR-61.A). The HHRA assumed that both Indigenous and non-indigenous receptors spent 100% of their time in the LAA and that 100% of country food and fish were harvested from within the LAA. Country food consumption rates for Indigenous receptors were based on the 95th percentile grams of traditional food per day reported in the First Nations Food, Nutrition and Environment Study – Atlantic Region Results 2014 (Chan et al. 2017). The results demonstrated that the predicted changes in inhalation exposure, direct contact exposures to soil and surface water, and ingestion exposures from the consumption of country foods represent a negligible change in human health risk for the Indigenous and non-Indigenous receptors. Ongoing monitoring related to country foods will be employed and, should the need

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	for further mitigation measures be identified, these would be developed in collaboration with Indigenous groups and other stakeholders. Following the submission of the EIS, Marathon has continued to actively engage with MFN through correspondence and virtual meetings. Ongoing engagement has been directed at the conclusion of a Memorandum of Understanding which would include the undertaking of a traditional knowledge and land and resource use study. The results of this study will be used to enhance Marathon's understanding of MFN's land and resource use and, if necessary, to adjust mitigation and monitoring measures to avoid or mitigate adverse impacts upon Indigenous interests. Specifically, any Indigenous Knowledge or land and resource use information provided by MFN post-EIS submission will be taken into account in the development of monitoring programs, including monitoring of air and water quality and potential impacts upon country foods. Marathon has invited MFN to participate in monitoring measures and intends to work in a spirit of cooperation with MFN as the Project progresses. In addition to the mitigation measures and monitoring programs implemented by Marathon, Marathon will develop a grievance mechanism which will afford a process to address grievances on the part of Indigenous groups or Indigenous persons resulting from the effects of the Project on land and resource use, health, socio-economic conditions and heritage resources. References: Chan, L., O. Receveur, M. Batal, W. David, H. Schwartz, A. Ing, K. Fediuk, and C. Tikhonov. 2017. First Nations Food, Nutrition and Environment Study (FNFNES): Results from the Atlantic Region 2014. Ottawa: University of Ottawa, 2017. Print. Available at: http://www.fnfnes.ca/docs/Atlantic_Regional_Report_Eng_Jan_25.pdf (Accessed February 2021)
Appendix:	Appendix IR-61.A

RESPONSE TO IR-62

ID:	**IR-62**
Expert Department or Group:	ECCC-26
Guideline Reference:	Section 7.6.1
EIS Reference:	EIS Section 21.5.1.2 and BSA.1, Attachment 1-A, BSA.3, Attachment 3-C
Context and Rationale:	The EIS guidelines state the plausible worst-case scenario and their effects should be identified and evaluated. Section 21.5.1.2 of the EIS gives a lower value for an extreme rain estimate than used elsewhere in the EIS. It states: “The EDF [Environmental Design Flood] is defined as the most severe flood (i.e., largest design runoff event) that can be stored and does not result in an unscheduled discharge of water to the environment (Golder 2020; BSA.1. Attachment 1-A). The 100-year, 24-hour event (75 mm of rain) was selected as the EDF, which is on top of the 25-year return period wet hydrological conditions (Golder 2020b).”The above-mentioned 75 mm value is much lower than extreme values from Intensity-Duration-Frequency (IDF) data presented elsewhere in the EIS, including 130 mm from Stephenville (Attachment 3-C of Baseline Study Appendix 3: Water Resources).This information is needed for assessing the effects of an accident or malfunction and determining significance.
Information Request:	Update the effects analysis for surface water quantity taking into account the Environmental Design Flood values for a 100-year, 6-hour, 12-hour, and 24- hour or provide the rationale for using the 75 mm as the Environmental Design Flood value when the Intensity Duration Frequency values for a 100- year, 6-hour, 12-hour, and 24-hour event are above 75 mm.
Response:	The meteorological data used for the Tailings Management Facility (TMF) design has been reviewed and updated in consideration of a more conservative Environmental Design Flood (EDF). Although the 25-year return period wet hydrological conditions are still used to determine the maximum operating conditions in the TMF pond, the EDF value has been updated to be the larger of the 30-day, 100-year rainfall plus snowmelt event (occurring during the freshet) or the 7-day, 100-year rainfall event (during the non-winter months). Data for the Buchans station was used, and for each stage of deposition and dam raising, the 7-day, 100-year rainfall occurring over the maximum operating water level was found to be the critical EDF event (190 mm over 7 days). As noted, the update to the EDF does not affect the normal or maximum operating levels within the TMF. In turn, there is no change in the overall water balance for the TMF and associated infrastructure. These updates do

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	not affect the effects assessment or conclusions related to surface water quantity as provided in Surface Water Resources (Chapter 7 of the EIS). The increase in the EDF is considered in the accidental events assessment, as further described in the response to IR-63.
Appendix:	None

RESPONSE TO IR-63

ID:	IR-63
Expert Department or Group:	ECCC-27
Guideline Reference:	Section 7.6.1
EIS Reference:	EIS 21.5.1.4 and BSA.1, Attachment 1-A
Context and Rationale:	The EIS guidelines state the plausible worst-case scenario and their effects should be identified and evaluated. Section 21.5.1.4. identified two scenarios for the dam breach and inundation assessment that involve flood-induced conditions of the tailing management facility dams by piping and overtopping failure modes, with the probable maximum flood level, obtained by routing the probable maximum precipitation (PMP).Baseline Study Appendix (BSA) 1, 1-A, 4.2.2 Breach Outflow Modelling states that: “24-hr Probable Maximum Precipitation (PMP) depth used for the Stephenville Environment and Climate Change Canada (ECCC) meteorological station (ID: 8403800) is 309 mm (Golder 2020b)”.That PMP value is based on relatively few years of older data and is lower than updated PMP estimates available from the ECCC Engineering Climate Datasets (described in Annex C) at the same location and nearby the Project Area. This includes Stephenville: 377 mm, Burnt Pond: 354 mm, and Buchans: 450 mm. Accurate PMP values are essential for assessing the effects of an accident or malfunction and determining significance.
Information Request:	In consideration of the available data, update the effects assessment by using PMP estimates based on updated/longer periods of record, including for stations closer to the project site or provide a rationale for using the older data that is lower than updated PMP estimates.
Response:	The response below includes updated dam breach assessment (DBA) results that have been completed incorporating several design refinements to the Tailings Management Facility (TMF). These refinements have been applied based on further engineering design review and consideration of environmental effects. The key refinements are as follows: • Modification to the dam alignment to completely avoid and provide buffer to the stream running west to east along the southern boundary of the TMF. The new alignment also improves tailings storage efficiency without changing the dam height, and the overall TMF footprint is reduced slightly (~3%). • The polishing pond has been relocated closer to the plant site which improves water management components and eliminates the potential for a cascade failure in the event of a tailings dam breach.

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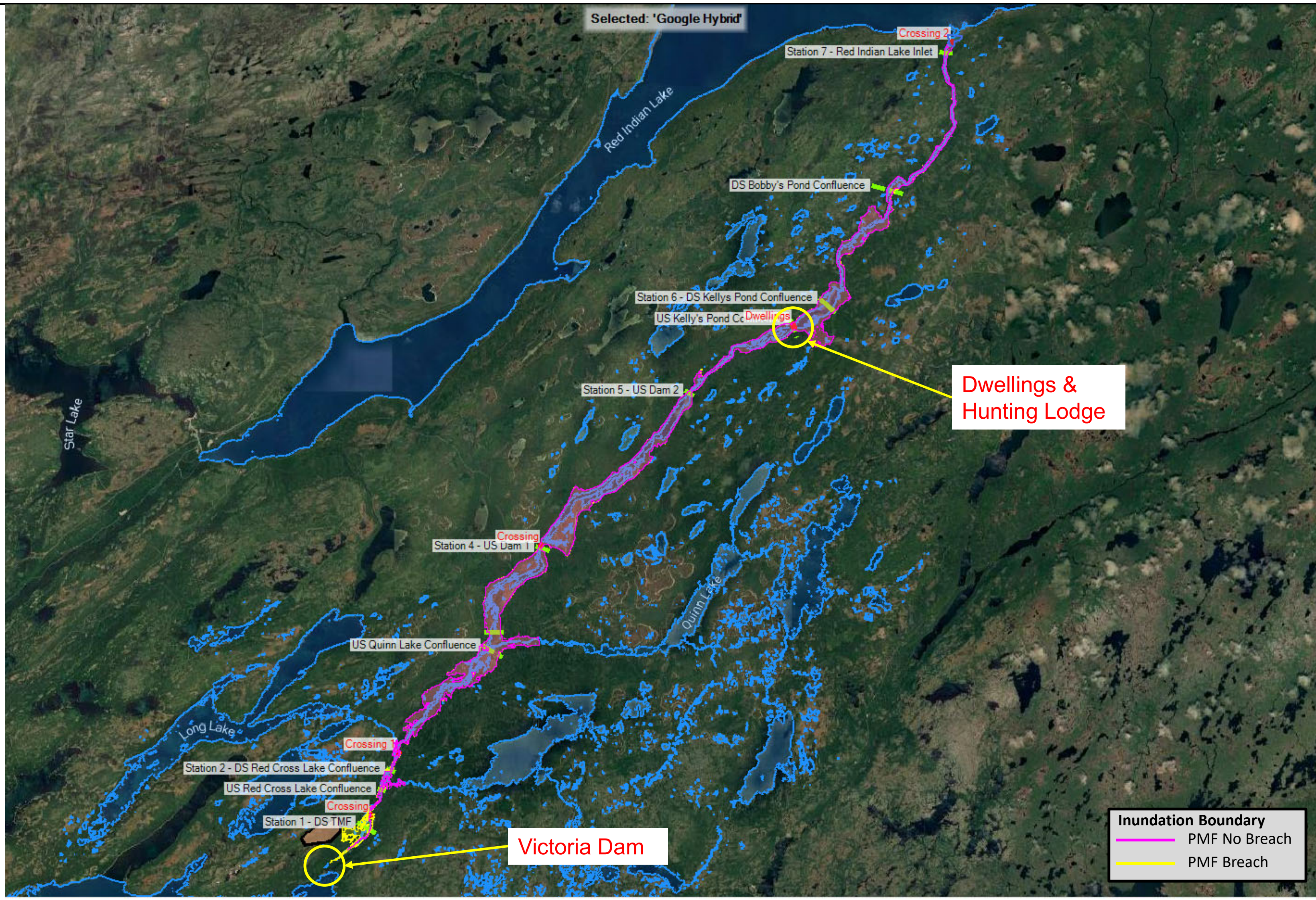
	An assessment of the available meteorological data, including the proximity of each station to the Project Area and the quality of data available from each meteorological station, is presented in the response to IR-72. Based on the available meteorological data, in consideration of the advancement of the engineering design for the TMF, and to provide a more conservative assessment of potential effects from the Project, the most conservative values for the long-term design precipitation events will be utilized in updating the dam breach analysis as further described below. For final engineering design, alternate probable maximum precipitation (PMP) values may be considered, if further collection and assessment of meteorological data indicate these are warranted. These would be included in the final design information submitted for regulatory review and approval via the permitting process. The PMP value only affects the sizing of the emergency spillway for very high consequence category dams and is used in the DBA. In selection of the PMP value, the Buchans meteorological station (ID 8400698) provides the most conservative data, with a PMP depth of 450 mm. An updated DBA utilizing the Buchans station PMP value is ongoing, and an updated DBA report will be issued separately to this IR response. It is important to note that the DBA will continue to be updated as the detailed engineering for the TMF and associated infrastructure is advanced. At this time, only the flood-induced dam breach model runs have been completed. Figures IR-63.1 to IR-63.3, attached, show the inundation extent under the 450 mm probable maximum flood (PMF) in the Victoria River, with (pink) and without (yellow) a dam breach. In the event of a dam breach under a PMP induced flood, up to a peak discharge of 1,735 m^3/s may be released from the TMF. This is approximately 8% to 16% lower than the peak discharge estimated in the DBA presented in the EIS, as a result of ongoing design refinements including relocation of the polishing pond. The incremental impact upstream and downstream of the TMF was assessed relative to the impact of the PMF. Upstream of the TMF, the mild slope of the Victoria River channel is expected to result in backwater flows towards the Victoria Dam. Based on a breach under PMP conditions, the TMF inundation could extend upstream to within 550 m (downstream) of the Victoria Dam, but will not reach the dam toe as was predicted in the DBA presented in the EIS. Downstream of the TMF, a dam breach would result in negligible incremental impact (<0.5%) on the extent of the flood boundary resulting from the natural effects of the PMF. For example, the peak flow under the updated PMP volume (450 mm) at the dwellings and hunting lodge upstream of Kelly's

ID:	**IR-63**
	Pond confluence is 2,677 m^3/s under a breach, compared to 2,654 m^3/s with no breach (Figure IR-63.4). As shown in the figure, the incremental effect (water level) due to the dam breach is almost indiscernible (<0.5%) from the natural flood level. This is consistent with the results of the DBA presented in the EIS. The updated DBA results described above result in less impact to the downstream environment than what was presented in the EIS, despite using a more conservative design flood (PMP at 450 mm versus 309 mm). This is a result of design modifications that have been made to the TMF to reduce potential environmental effects and improve engineering efficiency. No further update to the effects assessment or conclusions presented in the EIS is required.
Appendix:	None



CLIENT MARATHON GOLD CORPORATION	PROJECT DAM BREACH ASSESSMENT AND INUNDATION STUDY RESPONSE TO IR63
CONSULTANT YYYY-MM-DD 2021-04-23 PREPARED MAR DESIGNED MAR REVIEWED AC APPROVED PM	TITLE INUNDATION AREA OF SIMULATED PMF BREACH AND NO BREACH SCENARIOS PROJECT NO. 20141194 REV. B FIGURE IR63-1

CLIENT
MARATHON GOLD CORPORATION

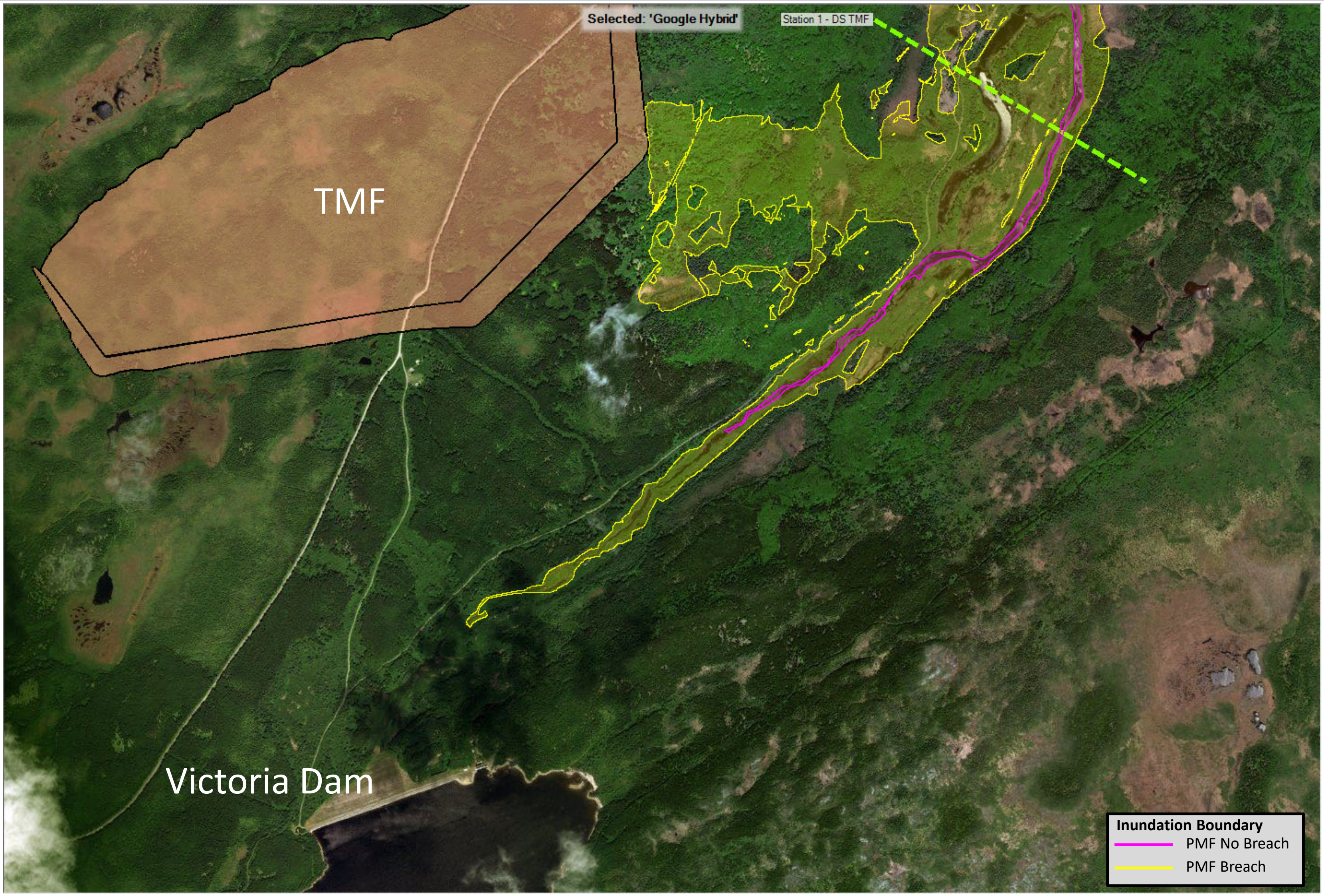
PROJECT
DAM BREACH ASSESSMENT AND INUNDATION STUDY
RESPONSE TO IR63

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-04-23
PREPARED	MAR
DESIGNED	MAR
REVIEWED	AC
APPROVED	PM

TITLE
INUNDATION AREA OF SIMULATED PMF BREACH AND NO BREACH SCENARIOS – AREA OF DWELLINGS AND HUNTING LODGE

PROJECT NO.	REV.	FIGURE
20141194	B	IR63-2



CLIENT
MARATHON GOLD CORPORATION

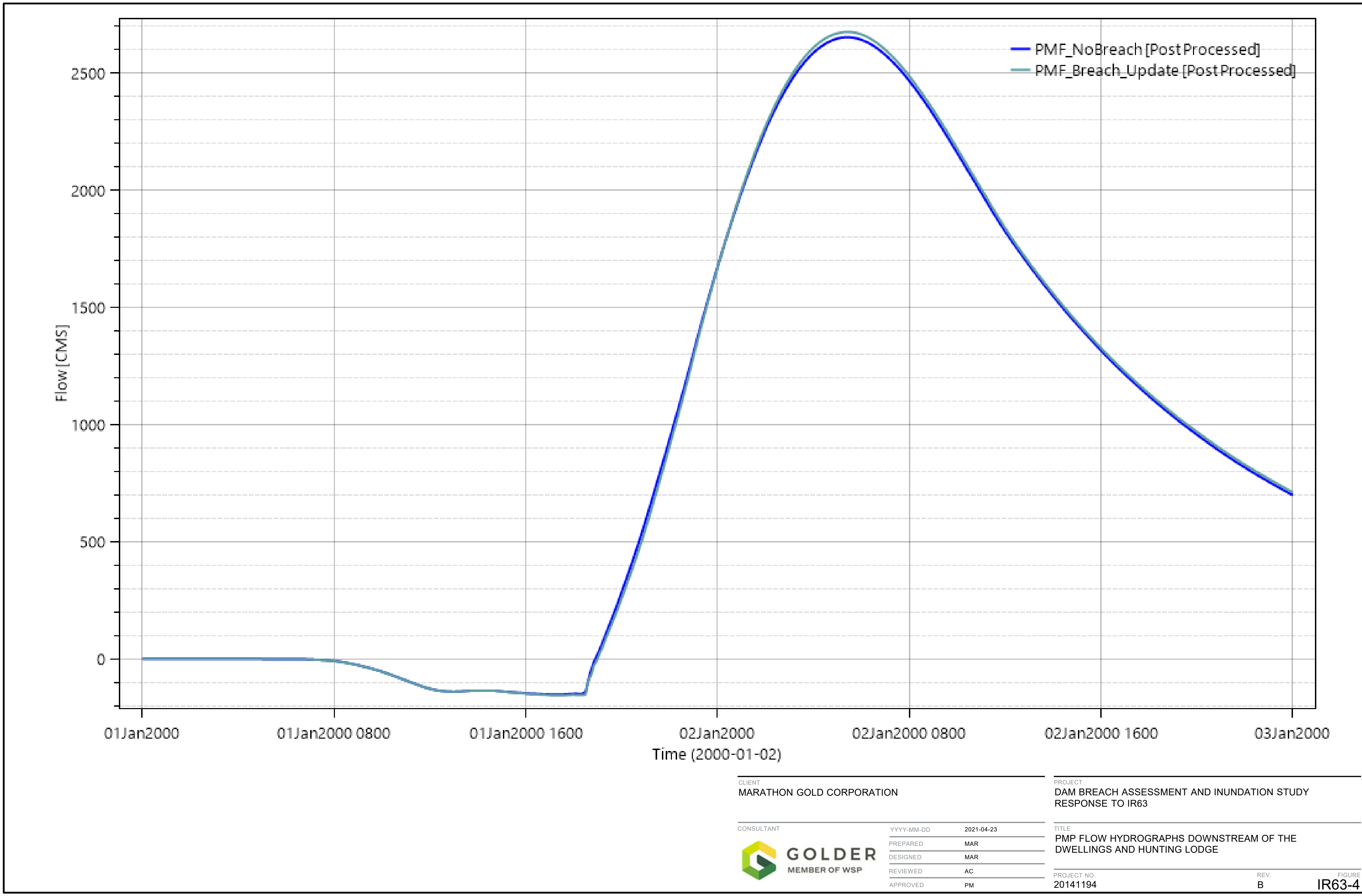
PROJECT
DAM BREACH ASSESSMENT AND INUNDATION STUDY
RESPONSE TO IR63

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-04-23
PREPARED	MAR
DESIGNED	MAR
REVIEWED	AC
APPROVED	PM

TITLE
INUNDATION AREA OF SIMULATED PMF BREACH AND NO BREACH SCENARIOS – AREA OF VICTORIA DAM

PROJECT NO.	REV.	FIGURE
20141194	B	IR63-3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PMF_Breach_Update [Post Processed]
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500
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02Jan2000 0800
02Jan2000 1600
03Jan2000
Time (2000-01-02)
CLIENT
MARATHON GOLD CORPORATION
PROJECT
DAM BREACH ASSESSMENT AND INUNDATION STUDY
RESPONSE TO IR63
CONSULTANT
GOLDER
MEMBER OF WSP
YYYY-MM-DD 2021-04-23
PREPARED MAR
DESIGNED MAR
REVIEWED AC
APPROVED PM
TITLE
PMP FLOW HYDROGRAPHS DOWNSTREAM OF THE
DWELLINGS AND HUNTING LODGE
PROJECT NO. 20141194
REV. B
FIGURE IR63-4

RESPONSE TO IR-64

ID:	**IR-64**
Expert Department or Group:	ECCC-28
Guideline Reference:	Section 7.6.1
EIS Reference:	EIS Section 21.5.1.2, Section 22.3.1.1
Context and Rationale:	The EIS guidelines state the plausible worst-case scenario and their effects should be identified and evaluated. Section 21.5.1.2 of the EIS states that "[t]he accumulation of water in the tailing management facility has been modelled for the mean and 25-year wet annual precipitation conditions. Treatment and discharge will occur for eight months a year during operation (avoiding discharges during winter months). The TMF has been sized to store the excess water during the non-discharge period, including appropriate design precipitation events." Modelling was done for the monthly data for the wettest year based on Buchans data, but individual months could be more extreme, e.g. based on Buchans long- duration intensity-duration-frequency (IDF) results, a 5-year (recurrence interval) 30-day duration extreme rainfall amount is 225 mm). This EIS does not include an assessment of extreme rain events occurring at the time of snow melt/run-off nor does it indicate what would be the expected frequency for use of the spillway to remove untreated excess water during extreme events. This information is needed for assessing the effects of an accident or malfunction and determining significance.
Information Request:	a. Update the modelling to include return-period estimates of extreme monthly values (e.g., 30-day durations) or provide a rationale to explain how the current model is sufficient. b. Assess the effects of extreme rain events occurring at time of snow melt/run-off. c. Indicate the expected frequency for use of the spillway to remove untreated excess water during extreme events.
Response:	a. The Tailings Management Facility (TMF) pond operating water volumes / levels are designed based on guidance from the Canadian Dam Association. The operating pond volumes / levels are designed based on monthly average or wet return period and not based on discrete events. The 25-year wet year precipitation was used to provide a flexible operating pond range. b. The impact of extreme events is considered additive to the operating water level in the TMF pond in the environmental design flood (EDF) storage determination. The critical EDF storage requirement for each

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	stage has been updated during the latest design stage to be the greater of the 30-day 100-year rainfall plus snowmelt event (occurring during the freshet) or the 7-day, 100-year rainfall event (during the non-winter months). For each stage of deposition and dam raising, the 7-day, 100-year rainfall occurring in addition to the maximum operating water level was found to be the critical EDF event (190 mm over 7 days). c. Depending on the operating volume / water level at the time of the event, any event greater than the 100-year 7-day event (i.e., critical EDF) has the potential to activate the spillway. The spillway is designed to safely convey events up to and including the probable mean precipitation (450 mm event).
Appendix:	None

RESPONSE TO IR-65

ID:	IR-65
Expert Department or Group:	MW-51
Guideline Reference:	Section 7.5 and7.6.1
EIS Reference:	Section 21.5.1.1 (p.21.13), Table 21.5
Context and Rationale:	The EIS guidelines state the proponent will conduct a qualitative analysis of the risks of accidents and malfunctions across all phases of the project and identify the probability of potential accidents and malfunctions related to the project. Where significant adverse effects are identified, the EIS will set out the probability(likelihood) that they will occur, and describe the degree of scientific uncertainty related to the data and methods used within the framework of this environmental analysis. The EIS describes several accident and malfunction scenarios that could occur throughout the Project. However, the EIS does not provide a qualitative analysis of the risks of the accidents and malfunction scenarios occurring across all phases of the project. The EIS (Table 21.5) describes accident and malfunction scenarios (e.g. Tailings management facility malfunction and fire/explosion) that could result in significant adverse environmental effects on various Valued Components (e.g. Surface water, fish and fish habitat, and Caribou). The EIS also notes that these are unlikely to occur. The EIS is not clear on how the likelihood of the worst-case scenarios of these accident and malfunction scenarios occurring has been identified.This information is needed to accurately assess residual effects after mitigation and identify follow-up monitoring requirements.
Information Request:	a. Conduct a qualitative analysis of the risks of accidents and malfunctions occurring across all phases of the project. b. Describe how it has been determined that it is unlikely for Tailings Management Facility (TMF) malfunction and fire/explosion to occur based on the worst case scenarios identified in the EIS for each.
Response:	a. The term 'risk' considers the 'likelihood' of an accidental event or expected frequency of an accidental event, and 'severity' of the expected consequence if such events were to occur. Assessment of risk involves use of a risk matrix where the product of likelihood (post-mitigation) and severity (post-mitigation) identifies the level of potential risk. Risk characterization, shown in Table IR-65.1, is based on the following: • Remote (risk is acceptable, no additional risk mitigation required)

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	• Low (risk is tolerable, continue to monitor risk, no additional risk mitigation is required) • Moderate (risk may be tolerable, review required, if warranted, additional risk mitigation may be required) • High (risk is unacceptable, additional risk mitigation needs to be applied) Based on the characterization above, a qualitative risk assessment based on likelihood and severity is provided in Table IR-65.2 for the accidents or malfunctions requiring further assessment. This included the selection of accidents or malfunctions that could occur during construction, operation and decommissioning, rehabilitation and closure of the Project, potentially resulting in environmental effects that require assessment. The determination of likelihood is based on the probability of the accident occurring given Project design and construction, monitoring and inspection programs proposed, implementation of mitigation measures, as well as professional judgement and experience of the Project Team. Severity was determined through the residual effects characterization as provided in Section 21.5 of the EIS. b. As noted in Table IR-65.2 and assessed in Section 21.5 of the EIS, significant residual effects were predicted in the unlikely event of a major industrial accident or malfunction. As noted in Section 21.6 of the EIS, this event was identified as being unlikely to occur given the Project design and safety measures in place and the emergency response plans and contingency measures that will limit the extent and nature of potential environmental effects in the event of an accident or malfunction. Design measures include conformity with industry standards (e.g., dam design and monitoring, and emergency response and contingency planning) and legislated regulatory requirements. A Tailings Management Facility (TMF) failure was determined to be unlikely as described in Table IR-65.2 and assessed in Section 21.5.1 in the EIS. However, a full assessment of an assumed dam breach is presented in Section 21.5.1.4 of the EIS. In-design safety measures will include compliance with the dam safety program established in Newfoundland and Labrador requiring dams to be designed, operated, and maintained to exceed the requirements of Canadian Dam Association (CDA) Dam Safety Guidelines. The design of the TMF was carried out to exceed minimum allowable factors of safety under static and pseudo-static loading conditions recommended in the current CDA Dam Safety Guidelines (Ausenco 2020). Seepage and stability analyses were carried out as part of the design as presented in the EIS. Based on the model results, the dams are expected to be stable under

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	the assumed loading and expected foundation conditions (Ausenco 2020). Fire / explosion was also identified to be unlikely as described in Table IR-65.2 and assessed in Section 21.5.5 of the EIS. In-design safety measures will reduce the likelihood of a fire or explosion occurring including engineering and quality controls and contingency plans to mitigate potential adverse environmental effects that could result from an accidental fire or explosion.
Appendix:	None

Table IR-65.1 Risk Characterization

Likelihood	**High**	Low	Moderate	Moderate	High
	Moderate	Low	Low	Moderate	Moderate
	Low	Remote	Low	Low	Moderate
		Very Low	**Low**	**Moderate**	**High**
	Severity*				
* Determination of severity is based on a credible worst-case event					

Table IR-65.2 Risk Assessment

Accident / Malfunction*	In-design Safety Measures	Emergency Response Measures	Description of Residual Effects	Likelihood of Event	Severity of Residual Event	Residual Risk
Tailings Management Facility (TMF) Malfunction	• Design was carried out to exceed minimum allowable factors of safety under static and pseudo-static loading conditions recommended in the current Canadian Dam Association (CDA) Dam Safety Guidelines • The TMF will be inspected, maintained and repaired in accordance with the NL *Water Resources Act* • An emergency spillway will be located on the northeastern abutment of the dam • As outlined in the CDA *Dam Safety Guidelines*, dam surveillance is a critical component of dam safety for all phases of the life of most dams	• Stop / shut down pumping of tailings to the TMF • Notification to authorities, emergency responders and others who are to be notified under the Public (Stakeholder) Safety Plan • Notification to Engineer of Record • Immediately engaging the Metal and Diamond Mining Effluent Regulations tailings/effluent emergency response plan and developing a remedial action and monitoring plan for the event, and initiate remedial action such as deploying earthworks equipment to reduce further damage to the dam and stabilize escaped tailings to the extent feasible, establishing additional containment as needed around the inundation area, and deploying turbidity curtains and/or other similar mitigation within affected watercourses	Depending on the timing and extent of a potential failure, effects to groundwater, surface water resources, fish and fish habitat, vegetation and wetlands, and wildlife habitat, may occur. Effects on these environmental components could then affect local land uses and historic resources. As assessed in Section 21.5.1.4 of the EIS, moderate to high magnitude effects were predicted for surface water resources, fish and fish habitat, vegetation, wetlands, terrain and soils, avifauna, caribou and other wildlife and historic resources. Effects were characterized as both short and long-term and both reversible and irreversible (given large amounts of sediment may remain). A significant effect was predicted for surface water resources, fish and fish habitat, caribou, and community health in the event of a large-scale release into the environment (e.g., major TMF failure with discharges of tailings into local waterbodies and other habitats outside the Project Area).	Very Low	High	Low
Topsoil, Overburden, Low and High-Grade Ore Stockpiles and Waste Rock Pile Slope Failure	• Waste rock piles will be benched and constructed to an overall slope of 3H:1V to promote long term stability • Mine waste disposal piles will be constructed according to design requirements for closure (i.e., long-term slope stability factors of safety) • Waste rock piles will be progressively rehabilitated as benches or sections are completed (ongoing over life of Project) • Mitigation measures will be applied to reduce the potential for waste rock slumping, including displacement monitoring / surveys to identify potential instability and early movements, and progressive rehabilitation (e.g., placement of soil cover and vegetation over waste rock piles) of the pile to reduce infiltration into waste rock piles by increasing evapotranspiration capacity to the extent feasible	• Emergency response measures and standard operating procedures for slope failure, including stopping work in that area, developing a specific response plan, installing silt fencing and berms as necessary, return and recontour material, will be developed during detailed Project design	The worst-case failure scenario would be a large-scale failure of a waste rock pile, which could result in slumping and release of mine rock. Slope failure related to the waste rock piles can affect surface water quantity and quality as there is potential for material to enter nearby waterbodies and fish habitat at some locations. As assessed in Section 21.5.2.4 of the EIS, residual adverse effects to surface water and fish and fish habitat were predicted to be moderate in magnitude, localized to the LAA, short-term and reversible. No significant effects were predicted.	Very Low	Moderate	Low
Fuel and Hazardous Materials Spill	• Fuel will be obtained from a licensed contractor who will be required to comply with federal and provincial regulations • Regular vehicle and equipment inspections and maintenance will be carried out to reduce the potential effects of hydraulic fluid spills • Reagent preparation and storage facilities will be located within containment areas designed to accommodate more than the content of the largest tank • Storage tanks will be equipped with level indicators, instrumentation and alarms to prevent spills and will be visually inspected annually for their liquid-containing integrity, with repairs made as required • Spill containment systems will be inspected every ten years, by a means other than visual inspection, for their liquid-containing integrity, with repairs made, as required • Transportation of hazardous materials will be conducted in compliance with the federal *Transportation of*	• Emergency response and spill contingency plans under the EMS will include consideration of spills and releases of hazardous substances, including petroleum products, accidents involving hazardous substances, medical emergencies, explosion, and fire • In the event of a spill at the mine site, the spill would be immediately contained and cleaned up using on-site spill kits and appropriate absorbent materials • Available resources including trained responders, and spill response equipment and supplies, would be redirected to the spill area to provide response • To determine the requirement for further excavation, soils will be tested for hydrocarbon in the vicinity of a spill	A spill of fuel or hazardous material as a result of a vehicle accident along the access road has the potential to affect surface water quality if it occurs in or near a watercourse or waterbody. Therefore, there is potential for adverse effects to surface water resources, fish and fish habitat, vegetation, wetlands, terrain, and soils, avifauna, caribou, other wildlife, community health, land and resources use, Indigenous groups and historic resources. In the event of a worst-case scenario spill, residual adverse effects are generally predicted to be moderate (elevated above baseline, however within acceptable limits) to high (elevated above acceptable limits or regulatory objectives) in magnitude for surface water, as well as for fish and fish habitat. The primary migration path for the Buchans herd, which may be used by over 50% of the herd, overlaps the Project Area. Due to the importance of this migratory path, effects of a fuel or hazardous material spill and subsequent clean-up efforts would likely cause caribou to avoid the areas, and in the event of a large spill effects may be	Low	Moderate	Low

Table IR-65.2 Risk Assessment

Accident / Malfunction*	In-design Safety Measures	Emergency Response Measures	Description of Residual Effects	Likelihood of Event	Severity of Residual Event	Residual Risk
	Dangerous Goods Act and the provincial *Dangerous Goods Transportation Act*. • Appropriate Project personnel will be trained in fuel handling, equipment maintenance, and fire prevention and response measures		additive to the high magnitude effect predicted for the Buchans caribou herd, particularly if a spill were to occur during the migration period for the herd. With the implementation of emergency response measures, no significant effects were predicted.			
Unplanned Release of Contact Water	• The water management design for contact water treatment is focused on sedimentation, as sedimentation will reduce total suspended solids (TSS) concentrations and the particulate fraction of metals • Design parameters for water management infrastructure includes a 15 m setback from fish-bearing waterbodies; consideration of climate change-associated precipitation events and associated flow; and maintaining flow to fish-bearing waterbodies where feasible (draining mine site components to pre-development catchment areas, where practicable) • Sedimentation pond embankments are designed to reduce seepage and will be constructed out of locally sourced, low permeability glacial till • A geotextile or granular soil filter layer will be placed between materials to reduce the opportunity for piping	• Sediment fencing will routinely be deployed, inspected and maintained as needed adjacent to wetlands and slow-moving watercourses • Where feasible, contact water would be pumped back into the collection system, which may require the installation of additional pumps should the volume of pump-back water exceed predicted rates in the TMF seepage collection ditches • The water management structure would be repaired and/or improved as required to avoid re-occurrence • Affected waterbodies would be monitored and remedial actions and reporting, if required, would take place in consultation with regulators	An unplanned release of contact water to the environment has the potential to adversely affect groundwater, surface water quality, fish and fish habitat, and vegetation and wetlands. Waterbodies that could potentially be affected include Victoria River, and Victoria Lake Reservoir, Valentine Lake and their tributaries. As assessed in Section 21.5.4.4 of the EIS, in general, residual adverse effects are predicted to be low in magnitude, short-term and reversible, except for adverse effects to fish and fish habitat where a moderate magnitude effect is predicted due to the potential for the physical disturbance of fish habitat. With the implementation of emergency response measures, no significant effects were predicted.	Low	Low	Low
Fire / Explosions	• Facilities will have a fire suppression system in accordance with the structure's function and in accordance with regulatory requirements, including NL *Occupational Health and Safety Act* and *Occupational Health and Safety Regulations* • Buffers will be provided, as required, between infrastructure and equipment • Employee training in fuel handling, fire prevention, and emergency response measures will be completed as part of the Project-wide EMS, and health and safety management systems. • Fire prevention and suppression systems, as well as response equipment and supplies, will be maintained on site at designated locations • The explosives storage and production facilities will meet government regulations including required separation distances as regulated by the Explosives Regulatory Division of Natural Resources Canada (NRCAN) • All explosives and accessories will be stored at the planned NRCAN approved magazine site and explosive storage facility • An Explosives and Blasting Management Plan will also be prepared for the safe use and storage of explosives, in accordance with environmental protection measures, provincial and federal legislation and guidelines, and corporate policies for explosives	• The emergency response plans to be developed for the Project will include measures to be implemented in the event of a fire or explosion, including actions to limit the immediate risk to the safety of employees and the public, and communication and reporting requirements • While emergency response capabilities at the mine site (e.g., firefighting and health care) will be sufficient for most accidents, a major accident may require additional support from surrounding communities • Fire departments in Grand Falls-Windsor, Buchans and Millertown, and the hospital in Buchans may be called to aid in response to larger fires or emergencies	In the event of a fire, the immediate concern would be for human health and safety, as well as concerns for habitat loss, direct mortality to wildlife and loss or damage of property. Depending on the extent of a fire, effects to atmospheric environment, surface water resources, fish and fish habitat, vegetation and wetlands, and wildlife, may occur. As assessed in Section 21.5.5.4 of the EIS, adverse residual effects are predicted to be low in magnitude, short-term and reversible. However, effects may be additive to the high magnitude effect of routine Project activities on movement of the Buchans caribou herd. A significant effect has, therefore, been predicted for caribou.	Low	Moderate	Low

Table IR-65.2 Risk Assessment

Accident / Malfunction*	In-design Safety Measures	Emergency Response Measures	Description of Residual Effects	Likelihood of Event	Severity of Residual Event	Residual Risk
Vehicle Accident	• Haul roads, site roads and the access road will be maintained in good condition • Project vehicles will be required to comply with posted speed limits on the access road, site roads and haul roads • Marathon will develop and implement a Traffic Management Plan to manage transportation of workers and materials to site, product leaving site, the number of vehicles accessing the site, and to reduce traffic delays • Marathon will implement traffic control measures, which may include gating approaches, placing large boulder and/or gated fencing to restrict public access to the mine site • Project vehicles will be driven by trained and competent drivers who will use approved routes • Project vehicles will be manually inspected on a regular schedule to confirm serviceability	• Emergency response services will be available at the Project site, as well as fire departments in Grand Falls-Windsor, Buchans and Millertown, and the hospital in Buchans to aid in emergencies • Marathon will consult and establish communications with appropriate local, provincial and federal emergency response departments as determined to be required for environmental and health and safety related emergencies • Marathon will cooperate with local officials in the incident investigation process and conduct an internal incident investigation • Where necessary, remedial action will be taken by Marathon in accordance with the results of the investigations	A vehicle accident has the potential to result in injury to or loss of life. Although public injury or mortality as a result of a vehicle accident cannot be ruled out, the likelihood is very low given the mitigation and emergency response prescribed above. In the unlikely event of a vehicle collision resulting in serious injury or loss of life, residual adverse effects on community health would be high in magnitude and irreversible. A significant effect, therefore, has been predicted for community health.	Low	Moderate	Low
* Characterization is based on a credible worst-case event						

RESPONSE TO IR-66

ID:	**IR-66**
Expert Department or Group:	-
Guideline Reference:	Section 7.6.1
EIS Reference:	EIS Section 21.5.1.3 (p. 21.16)
Context and Rationale:	The EIS guidelines state the proponent will present preliminary emergency response measures. In the event of a tailings dam failure or other tailings management facility failure, the Metal and Diamond Mining Effluent Regulations tailings/effluent emergency response plan and associated development of remedial action and monitoring is a key component of the proponent's proposed mitigation. Limited detail is provided on this plan in the EIS. This information is essential for identifying key mitigation measures.
Information Request:	Provide an outline of how the Metal and Diamond Mining Effluent Regulations tailings/effluent emergency response plan would be developed, reviewed, and implemented in the event of a tailings management facility failure.
Response:	The *Metal and Diamond Mining Effluent Regulations* (MDMER) tailings / effluent Emergency Response Plan (ERP) will be developed in concert with other response plans (e.g., hydrocarbon or hazardous materials spill response) to address the potential for an accidental/unplanned release of effluent from the Project during construction and operations. The ERP will consider an unplanned release of effluent and tailings from the Tailings Management Facility (TMF) and associated infrastructure (e.g., pipelines, water treatment plant). The MDMER ERP will contain the following information: • Detailed risk assessment of potential effluent releases, including the potential mechanisms of release, from the Project. • Roles and responsibilities of all individuals with respect to the Plan: employees and contractors, the individual who discovers / observes the release, the Incident Commander, Health and Safety and Environmental Superintendents, and senior management. This will include training requirements. • Notification and reporting procedures, including communications procedures and emergency contacts, and subsequent notification procedures and protocols for reporting to regulators and other stakeholders.

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	• Release control and initial cleanup procedures, as well as direction to commence evaluation of medium- to long-term assessment and cleanup processes, if required. • Emergency response resources: on-site personnel, equipment, infrastructure and external/off-site resources. • MDMER document control including distribution, revision logs, and information on plan review and procedure audits. The MDMER ERP will be made available for review by regulators and will be reviewed and updated on a regular schedule, which will be outlined in the document control section of the Plan. The ERP will be implemented in the event of an unplanned or accidental release of effluent or tailings on the Project site from any source (TMF, mill or water management infrastructure). If a significant tailings release or dam breach were to occur, additional long-term steps would be required as generally described in the response to IR-67.
Appendix:	None

RESPONSE TO IR-67

ID:	**IR-67**
Expert Department or Group:	-
Guideline Reference:	Section 7.6.1
EIS Reference:	Section 21.5.1.4 (p.21.18)
Context and Rationale:	The EIS guidelines state the proponent will present emergency response procedures that would be put in place if an accident and malfunction does occur. The proponent describes cleaning up deposited tailings solids in the event of a dam failure. Depending on the specific failure scenario and conditions, it is unclear if this mitigation measure would be consistently effective. In addition, the proponent does not provide the magnitude of effects for areas where solids may not be remediated. This information is essential for identifying key mitigation measures and follow-up monitoring for potential accidents or malfunctions, as well as determining significance.
Information Request:	Provide detail on the anticipated effectiveness of cleaning up or remediating tailings solids resulting from dam failure. Include an assessment that provides the magnitude of effects for areas where it is not feasible to clean up or remediate tailings solids.
Response:	As discussed in Section 21.5.1.3, Marathon will mitigate a Tailings Management Facility (TMF) dam failure by stopping pumping of tailings to the TMF, engaging the *Metal and Diamond Mining Effluent Regulations* (MDMER) tailings / effluent emergency response plan, and initiating deployment of earthworks equipment to reduce further damage to the dam and stabilize escaped tailings to the extent feasible, establish additional containment as needed around the inundation area, and deploy turbidity curtains and/or other similar mitigation within affected watercourses until remedial actions are implemented. As also discussed in Section 21.5.1.3 of the EIS, in the event of a TMF failure, Marathon will subsequently develop a specific remedial action and monitoring plan for the event, and initiate remedial action, such as deploying earthworks equipment to reduce further damage to the dam and stabilizing escaped tailings to the extent feasible, establishing additional containment as needed around the inundation area, and deploying turbidity curtains and/or other similar mitigation within affected watercourses. In the event of a dam breach, it is anticipated that a risk assessment and investigation will be completed to map the extent and thickness of the tailings runout, and a remediation plan would be developed. This strategy was successfully executed following the Mount Polley dam failure in British Columbia (Golder 2019). It is anticipated that an accidental release of

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	tailings would cause an outwash fan or delta of tailings and dam construction material between the dam and the Victoria River as discussed in BSA 1, Attachment 1-A, but is not predicted to reach the Victoria River. Based on the dam breach analysis as presented in the EIS, tailings suspended in the release of ponded water would reach the Victoria River and be deposited in the river and lakebed of Red Indian Lake. It is anticipated that the tailings would run out primarily to the Victoria River valley, with some finer silt/clay sized tailings particles remaining in suspension eventually reaching Red Indian Lake and deposited on the lakebed. Excavators would be effective at recovering sand/silt tailings deposited in terrestrial habitats that are sufficiently thick to be recovered by excavator. These deposits would be removed and transported by truck back to a stable area of the TMF for storage. Remediation activities would likely also include bank stabilization and revegetation of riparian areas in Victoria River and other affected headwater streams draining into the Victoria River. Tailings that are thin and impractical to recover would remain in place, scarified and mixed with the native substrate to improve soil fertility. Areas may require additional imported soil and fertilizer to facilitate rehabilitation. Once soil conditions are amenable to seed germination and growth, vegetation will establish through natural ecological succession supported by planting efforts. Within the riverbed, the focus would be on remediating and rehabilitating the habitat within the river channel and stabilizing tailings in place. A two-phase approach would likely be adopted with the first phase focusing on repairing / constructing an erosion-resistant, physically stable channel, followed by a second phase focusing on re-establishing physical in-stream and riparian habitat along the channel to support a return of biological habitat function. A successful example of this approach was employed for the rehabilitation of Hazeltine Creek in BC following the Mount Polley tailings dam failure (Bronso et al. 2016). Tailings that do not pose a physical risk would be left in place and regraded/contoured and remediated as noted above. New channel morphology and habitat would be designed and constructed within the riverbed for each affected reach. Erosion protection would be installed within the channel reaches first, followed by habitat construction, similar to the case examples provided (Golder 2019; Bronso et al. 2016). It is likely that a monitored natural recovery approach would be adopted for those tailings that travel down to Red Indian Lake and deposit below water on the lakebed, given the disruption that would occur through clean-up options such as dredging. Monitoring will be required to support the successful implementation of the remediation and to verify that remedial objectives have been met.

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	Remediation can be adapted to the data obtained from the post breach monitoring program. As described in the response to IR-63, updated dam breach assessment (DBA) results that have been completed incorporating several design refinements to the TMF. The additional information provided above does not affect the conclusions in the EIS. The assessment of a TMF failure in the EIS (Section 21.5.1) was based on a conservative and worst-case scenario approach, including the acknowledgement that it may not be feasible to completely clean up or remediate tailings following a TMF failure. The assessment therefore incorporates long-term and, in some cases, potentially irreversible effects, in consideration of areas where tailing solids cannot be remediated. References: Bronsro, A., J. Ogilvie, L. Nikl, and M.A. Adams. 2016. River Rehabilitation Following a Tailings Dam Embankment Breach and Debris Flow. Golder Associates Ltd. 2019. Remediation Plan for the Mount Polley Mine Perimeter Embankment breach.
Appendix:	None

RESPONSE TO IR-68

ID:	**IR-68**
Expert Department or Group:	-
Guideline Reference:	Section 7.6.1
EIS Reference:	Section 21.5.1.4 (p.21.20)
Context and Rationale:	The EIS guidelines state that the proponent will provide the potential consequences of the accident or malfunction scenarios. The assessments from a tailings management facility failure on fish and fish habitat focuses on water quality, including sediment deposition, but does not discuss potential changes to flow/drainage patterns, channels, and physical habitat as a result of a large volume of tailings being accidentally released. This information is needed for assessing the effects of an accident or malfunction and determining significance for fish and fish habitat.
Information Request:	Provide detail on the potential changes to flow/drainage patterns, channels, and physical habitat for fish and fish habitat as a result of a large volume of tailings being accidentally released and associated mitigation and follow-up monitoring as a result of any changes.
Response:	As indicated in the EIS and based on the dam breach analysis contained in Baseline Study Appendix.1, Attachment 1-A, a Tailings Management Facility (TMF) dam breach would release impounded water and suspended tailings. The release of ponded water from a TMF dam breach would reach the Victoria River and cause a wave to propagate downstream increasing erosion and scour potential in the river. The release of tailings will cause an outwash fan or delta of tailings and dam construction material between the dam and the Victoria River as discussed in BSA 1, Attachment 1-A, but is not predicted to reach the Victoria River. The upgradient and downgradient portions of Victoria River and small headwater streams draining into Victoria River would become inundated with water and tailings. The deposition of suspended tails could smother fish redds, eggs and small less mobile benthic organisms, as well as affect fluvial patterns particularly in low gradient zones of the Victoria River. The following discusses the potential effects of suspended tailings deposition in the Victoria River as a result of a TMF breach, remedial response measures to mitigate effects and subsequent residual effects. A TMF dam breach could result in effects to fish and fish habitat from the deposition of tailings. Direct short-term effects to aquatic species include mortality of all life stages due to smothering by tailings deposition or sediment, elevated levels of suspended sediment or other contaminants in the water column, stranding, or kinematic pressures resulting from the flood

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	wave. Scour and erosion would occur as a result of the initial floodwave, with subsequent alteration of drainage patterns resulting from tailings infilling low-lying areas. Sediment deposition from the flood wave and inundated tailings would result in changes or a loss of habitat to support life processes, including changes in riparian vegetation, substrate and cover, and reduction or loss of food sources for populations of aquatic species. Indirect or sublethal longer-term effects may also include a reduction in food resources during recolonization of aquatic habitats, or changes in fish health and survival as a result of sublethal effects from changes in water quality or bioaccumulation of metals. As discussed in Section 21.5.1.3, Marathon will mitigate a TMF dam failure by: • Stopping pumping of tailings to the TMF • Engaging the *Metal and Diamond Mining Effluent Regulations* (MDMER) tailings / effluent emergency response plan • Initiating deployment of earthworks equipment to reduce further damage to the dam and stabilize escaped tailings to the extent feasible • Establishing additional containment as needed around the inundation area • Deploying turbidity curtains and/or other similar mitigation within affected watercourses until remedial actions are implemented. Remediation is possible in the watercourses downgradient of the TMF, within the Victoria River and other smaller headwater watercourses which empty into Victoria River. Areas damaged as a result of the breach would be stabilized and drainage patterns reestablished. As part of this, the habitat restoration work may include construction of new stream channels, holding pools, spawning areas, and instream cover, such as boulders or woody debris. Once all inundated areas have drained to ambient water levels, the modelled inundated area of released water is considered to be reversible over a relatively short period of time. As described in the response to IR-67, remediation activities would likely include removal of deposited tailings material to the extent possible, bank stabilization and revegetation of riparian areas in Victoria River and other affected headwater streams draining into the Victoria River. Following mitigation and remediation activities, there may be long-term changes in substrate as a result of residual tailings deposition and localized changes in channel patterns as they are re-established. It is expected that benthic invertebrate populations may recover relatively quickly (Batchelar et al. 2019), as flying adults are highly mobile. Fish populations would recover more slowly over time as a result of recolonization from downstream populations. As described in the response to IR-63, updated dam breach assessment

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	(DBA) results that have been completed incorporating several design refinements to the TMF. The information provided above does not change the results of the environmental effects assessment provided in Section 21.5.1.4 of the EIS. Monitoring would be required following a TMF failure and could include delineation of extent of physical tailings, plume delineation, tailings depth, surface and ground water quality, soil and sediment quality, physical fish habitat characteristics, benthic invertebrate community composition, fish tissue studies, fish population studies, and toxicity to aquatic organisms. The follow-up monitoring program would continue until it was determined that the remediation strategies undertaken had performed as anticipated, in consultation with appropriate regulators. Additional information on monitoring groundwater and fish tissue is provided in Section 21.5.1.3 of the EIS. Reference: Batchelar, K., P. Stecko and C. Hughes. 2019. Benthic Invertebrate Community Recovery in a Remediated Stream. British Colombia Mine Reclamation Symposium. University of British Colombia Open Collections.
Appendix:	None

RESPONSE TO IR-69

ID:	IR-69
Expert Department or Group:	-
Guideline Reference:	Section 7.6.1
EIS Reference:	Section 21.5.4.3 (p.21.43)
Context and Rationale:	The EIS guidelines state the proponent will present preliminary emergency response measures. Section 21.5.4.3 of the EIS provides a high-level overview of emergency response measures as they relate to the water management system, but there is limited detail provided on how any failure of the water management system would be detected and dealt with, measures that would be in place to ensure ongoing proper functioning of the water management system, and notification procedures in the event of an accident or malfunction. This information is essential for identifying key mitigation measures and follow-up monitoring for potential accidents or malfunctions, as well as determining significance.
Information Request:	Describe how any failure of the water management system would be detected and dealt with, measures that would be in place to ensure ongoing proper functioning of the water management system, and notification procedures in the event of an accident or malfunction.
Response:	A stand-alone Water Management Plan was included with the EIS (Appendix 2A) and will be updated as needed to reflect final detailed Project design. The Water Management Plan outlines the water management criteria and objectives for the Project, as well as water management design for the construction, operation and decommissioning, rehabilitation and closure phases of the Project. The Water Management Plan will include adaptive management processes which will set trigger thresholds for mitigation measures, and clear and well-defined thresholds, as defined in regulatory permitting, as to when regulatory and stakeholder notification and engagement is required. As detailed in the Water Management Plan, water management infrastructure associated with the management of pile runoff were designed with three outlet structures to facilitate operation and respond to changes in water flows as they occur. The primarily outlet structure was designed to allow for the slow release of water promoting sedimentation. A larger secondary outlet was sized to drain flood events, in addition to the emergency spillway that can accommodate the 200-year Annual Exceedance Probability storm event. The primary and secondary outlets discharge to a single outlet pipe equipped with a shut-off valve that allows

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	control of the rate of outflow. Measures put in place to facilitate the on-going functioning of water management infrastructure are described below. • Sediment fencing as described in Section 21.5.4.3 of the EIS. • Reversed slope primary outlet pipe, drawing discharge from the subsurface, thereby preventing the discharge of hydrocarbon or other Light Nonaqueous-Phase Liquids spills. • Water management design allowing outlets to be closed/plugged in the event that water quality exceeds regulatory discharge criteria. • Opportunities to reduce primary outlet orifice flow by a valve to extend sedimentation detention to further improve water quality. • Potential opportunities to pump water from one pond to another pond in the event of a malfunction at a specific pond. • Gravity drainage of runoff to water management ponds that negate the need for on-going operation and maintenance of pumps • Inactive storage volume to further promote sedimentation in the ponds • Floating baffle curtains can be installed to increase pond retention time and further promote sedimentation thus improving water quality, if required. The following activities will provide detection of an accident or malfunction affecting the water management infrastructure system: • Routine water management infrastructure inspection will be conducted and documented during the weekly collection of an effluent sample from each pond to observe the presence of sheens, blockages from large woody debris, ice rafting, excessive sediment accumulation, or any other issues that could impact the short- or long-term function of the infrastructure. • Water quality monitoring and associated inspection will detect issues related to increased erosion within the water management system, subsidence or sloughing below the pond water lines and track water quality in relation to regulatory criteria and trends. • Water management pond dams will undergo routine engineering inspections to observe items, such as seepage, scour or erosion, subsidence, vegetal growth etc., conducted in accordance with permitting under Section 48 of the Newfoundland and Labrador Water Resources Act and the Canadian Dam Association’s Dam Safety Guidelines, as applicable. • Weather monitoring will be conducted by Marathon throughout the mine life to prepare for large wet weather and melting events, which have increased potential to stress the water management capacity of the system. Weather events may trigger unscheduled inspections of the

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	water management features across the site depending on antecedent conditions and intensity / duration of the event. • On-site weather monitoring will be conducted to track and observe current conditions of local precipitation, temperatures, snow accumulation and other factors affecting runoff and seepage. Notification procedures in the event of an accident or malfunction of the water management infrastructure will be clearly defined in emergency response and preparedness plans for all water management infrastructure and the tailings management facility. The plan would include the immediate notification of key stakeholders, including Nalcor and the applicable regulators, including DFO. The notification procedure would be implemented by the environmental manager at the site. Please note that the Emergency Response and Spill Contingency Plan will contain additional details regarding management, mitigation and remediation of adverse effects resulting from accidental events or malfunctions. As the Project develops, these plans will be structured under the Environmental Management System and amalgamated as needed to provide for clear direction to personnel in the event of an accident or malfunction.
Appendix:	None

RESPONSE TO IR-70

ID:	**IR-70**
Expert Department or Group:	-
Guideline Reference:	Section 7.6.1
EIS Reference:	Section 21.5.4.4 (p.21.43)
Context and Rationale:	The EIS guidelines state the proponent will identify the accident and malfunction events that would potentially result in an adverse environmental effect as defined in section 5 of CEAA 2012. However, there is no discussion of effects of an accidental release of contact water on migratory birds and species at risk, and Indigenous use of lands and health. This information is needed for assessing the effects of an accident or malfunction and determining significance.
Information Request:	Provide an assessment of the potential residual adverse effects of an accidental release of contact water on migratory birds and species at risk and on Indigenous use of lands and health. Provide measures to mitigate adverse effects of contact water on the Valued Components above and applicable follow-up monitoring.
Response:	An unplanned release of contact water could result from the malfunction of catchment sumps, ditches and channels, and sedimentation ponds, including embankment / dam failure. There is also potential for accidental seepage wherever contact water is stored. For example, excess seepage could result from a damaged Tailings Management Facility (TMF) dam liner (due to improper construction or installation, or damage during operation), which could overwhelm the downstream sumps and cause uncontrolled discharge to the environment (note that a TMF malfunction, including a dam breach, is assessed separately in Section 21.5.1 of the EIS). In Section 21.5.4.4 of the EIS, an environmental effects assessment for an unplanned release of contact water was conducted for Groundwater Resources, Surface Water Resources, Fish and Fish Habitat and Vegetation, Wetlands, Terrain and Soils. These Valued Components (VCs) were selected for assessment as there is a potential for the accidental event to interact with the VC (i.e., Project-effect pathway). The effect pathways of an accidental release of contact water on migratory birds, species at risk and Indigenous use of lands and health are primarily related to the quality of water released. Untreated / contaminated water can be ingested by wildlife or people, or receptors can be exposed through dermal contact. For wildlife, release of untreated / contaminated water could also affect prey species and habitat.

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	While a release of untreated contact water may result in ingestion or uptake of contaminants by wildlife, this potential is limited as adverse effects to water quality are mainly localized to the Project Area and there is anticipated to be a relatively low level of wildlife activity expected in the immediate areas of Project activities (Section 12.5.2 of the EIS). As discussed in Section 21.5.4.4, adverse effects to water quality are predicted to be low in magnitude, localized, short-term and reversible. As indicated in response to IR-54, water quality, or contact water quality within the water management systems designed for the Project is predicted to contain sediment and minor dissolved metals and other potential constituents like ammonia at very low concentrations. As a result, avifauna or other wildlife that may contact or ingest this water (if an unplanned release occurred) or adjacent vegetation would not be at an increased mortality risk. While exposure to the tailings pond could pose a threat to migratory birds, this risk is reduced through the cyanide detoxification process within the mill. As the polishing pond receives effluent post-treatment plant, the water within the polishing pond will not pose a threat to migratory birds. Therefore, in the event of an unplanned release of contact water, it is similarly not anticipated to pose a threat to migratory birds. The water quality monitoring program (Water Management Plan, Appendix 2A) to be implemented during normal operating conditions would detect exceedances of water quality guidelines in the event of an unplanned release of contact water (e.g., through seepage). If exceedances are detected, either through visual observations or results from water quality monitoring, remedial steps will be taken to reduce and eliminate the release through repairs to the drainage ditches and water management systems. A release of untreated water would also be addressed through requirements under *Metals and Diamond Mining Effluent Regulations* (MDMER) which identify the need for a tailings / effluent emergency response plan (see IR-66). The plan is required to use a risk-based approach to address the personnel, equipment, and procedures required to react to an unplanned release of tailings and/or effluent. Given the above, adverse effects to migratory birds, species at risk and Indigenous use of lands and resources are anticipated to be negligible. Given the limited interaction with wildlife, health risks for people who eat country foods are not anticipated.
Appendix:	None

RESPONSE TO IR-71

ID:	**IR-71**
Expert Department or Group:	MW-52
Guideline Reference:	Section 7.6.1
EIS Reference:	Section 21.5.4.4
Context and Rationale:	The EIS guidelines state the proponent will identify the magnitude of an accident and/or malfunction, including the quantity, mechanism, rate, form and characteristics of the contaminants and other materials likely to be released into the environment. The EIS guidelines further state the plausible worst-case scenario and their effects should be identified and evaluated. According to the EIS, the average range of diesel fuel spills was estimated at 12,000 litres spilling into the river within an hour. The EIS also assumed that 47 kg of sodium cyanide and 108.70 kg of ammonium nitrate could be spilled into the river within an hour (based on 25 kg of cyanide, 25 kg of nitrate, and 83.75 kg of ammonia). There is no evidence to support the assumption that these releases provide a worst-case scenario. This information is required to ensure the worst-case scenario has been considered in the effects analysis.
Information Request:	Provide a rationale for the assumptions used to determine volumes of diesel fuel, cyanide, nitrate and ammonia spills and evaluate whether these volumes represent a potential worst-case scenario. If not, provide an assessment of the above contaminants for a worst-case scenario.
Response:	The purpose of the accidental spill assessment and modelling was to estimate the effects of a plausible worst-case scenario spill of hazardous materials as a result of Project activities, as required by the Federal EIS Guidelines. An accidental trucking event at the Victoria River bridge was selected as the location within the Project Area with the highest potential for downstream effects on Red Indian Lake, the Exploits River and associated Atlantic salmon populations. This approach was discussed with both federal and provincial regulators prior to commencing modelling. This assessment has two key outcomes: travel times for a hazardous material spilled at the Victoria River bridge crossing to reach the Exploits River Dam under a range of flow conditions in the river and lake (i.e., from a low to a high flow condition); and concentrations of the hazardous materials at the dam under a plausible worst-case scenario. Travel times provided in the assessment are independent from the total amount of spill since travel times were estimated based on the physical mixing and hydrodynamic characteristics in the river and lake which are affected by flow, water level, winds, and dispersion. However,

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	concentrations of the hazardous material will be affected by the total amount of spill. The study determined a plausible worst-case spill condition based on available literature, the probability of spill at the Victoria River bridge crossing, and methods of transportation. As indicated in Chapter 21 of the EIS and in Appendix 21A, Canadian spill incident statistics are difficult to obtain and not publicly available. Canadian spills are typically tracked by the provinces and by Transport Canada if they occur in transit; records are not readily accessible and are often only made available through freedom of information requests. As such the spill volumes simulated in Chapter 21 and Appendix 21A of the EIS at the Victoria River bridge crossing were drawn from published papers and media accounts. To assess the reasonability of the spill volumes simulated by the Project at the Victoria River bridge crossing, US highway spill records for the 11 years covering 2010 to 2020 were accessed for further analysis and as a surrogate for Canadian spill statistics. The US Department of Transportation's (US DOT) Pipeline and Hazardous Material Safety administration maintains incident records of hazardous material releases in the United State in a publicly available and searchable database. The records include releases from a wide range of transportation modes, such as railway, maritime shipping and highway transport. The US DOT reported 18834 highway spillage incidents while materials were in-transit (excluding loading and off-loading) over the last 11 years from 01/01/ 2010 and 31/12/2020 (US DOT 2021). *Diesel Fuel* Of 18,834 US DOT highway spill incidents reported from 2010 to 2020, 402 were recorded as diesel fuel spills (2.1% of all spills), of which 50 or 12.4% of all diesel spills were reported to have entered either a waterway or sewer (US DOT 2021). The average diesel spill release volume was 1394 US Ga (5423 L) which was 37% of the average total tanker capacity reported for diesel spills. The volume of diesel simulated in the release at the Victoria River was 12,000 L, which represents approximately the 84th percentile of diesel fuel released and 30% of the maximum tanker liquid capacity. Only 15% (61 incidents) of diesel spills reported in the US were of releases larger than simulated at the Victoria River bridge crossing. The modelled scenario also assumes that all spilled diesel fuel enters Victoria River. Based on the diesel fuel spills reported in the US for the past eleven years during transportation, in most scenarios where diesel fuel entered waterways or sewers, this did not represent the full volume of spilled material. Petroleum transport tankers have many integrated safety features such as low center of gravity, internal baffles and bulkheads to limit internal liquid surge,

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	increase the strength of the tank and account for vapour expansion / contraction due to thermal conditions. These tanker engineering safety criteria reduce the likely volume of spilled material in the event of an accident (as diesel is stored within several isolated compartments within the tanker, it reduces the risk that all diesel fuel being transported would spill in the event that a tanker is breached during an accident). Coupled with extensive tanker driver safety training, mine access road speed limit controls and added access road safety precautions regarding the speed at which a bridge can be crossed, the potential for a diesel tanker spill event occurring will be further mitigated, including the likelihood of multiple compartments being breached. Considering roadway, driver training and tanker truck design safety controls along with the ranking of the simulated spill using the last 11 years of US DOT diesel spills information, the simulated volume conservatively represents a plausible worst-case spill release. *Ammonium Nitrate* Of the US DOT reported 18834 highway spills incidents, 52 were recorded as ammonium nitrate spills (0.28% of all spills), of which two (2) spills were reported to have entered either a waterway or sewer (US DOT 2021). When the US DOT database was filtered for spills where solid material was shipped in sub-containerization (i.e., bags, drums or IBC-intermediate bulk containers), the material was packaged in sub-containers ranging from 50 - 2000 lbs (22.7 – 909 kgs). The average spilled weight was 118 lb (54 kg) up to three (3) sub-container volumes released (i.e., 3- 50 lb bags), although on most cases a single sub-container was breached. When sub-containerized, the spilled weight ranged from 0.5% - 45% of the total shipped weight. The maximum solid form, sub-containerized ammonium nitrate release was 250 lb (113.6 kg) which closely compares to the 108.7 kg simulated to be released at the Victoria River. Review of the US DOT spills database indicates that when sub-containerized, ammonium nitrate releases volumes are small relative to total shipping capacity and the released volumes are typically a single sub-container. Thus, based on review of the US DOT spills database, the simulated ammonium nitrate release mass of 108.7 kg is a plausible worst-case release. *Sodium Cyanide* Just two (2) sodium cyanide releases were reported in the highway spillage category of the US DOT (2021) database. Of these, one release was of 100 lbs (45.5 kgs) from a 1000 kgs IBC and the other was a release of 1 lbs (0.45 kgs) from a 3000 lbs (1364 kgs) shipment. In neither case was environmental damage or release to a waterbody or sewer reported. Sodium cyanide is commonly shipped in briquette form making it very stable and reducing susceptibility to spill. The mass of sodium cyanide simulated in the accidental

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	release to the Victoria River was 47 kg (103 lbs), which exceeds the maximum spill reported in the US DOT database. *Summary* Based on reasonable and anticipated spill mitigations such as transport truck tanker design (e.g., multiple discrete compartments within tankers), transportation methods such as sub-containerization and anticipated driver training and mine access road safety controls, the risk of an accidental release of diesel fuel, ammonium nitrate or sodium cyanide at the Victoria River bridge crossing is considered very low. Notwithstanding the very low risk of such an accidental release, based on review of the US DOT highway spills database, the volumes simulated to be released to the Victoria River are conservative and representative of plausible worst-case condition. References: US Department of Transportation. Pipeline and Hazardous Materials Safety Administration. 2021. Hazardous Materials Incident Statistic Reports. Accessed at: https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics
Appendix:	None

RESPONSE TO IR-72

ID:	**IR-72**
Expert Department or Group:	ECCC-29
Guideline Reference:	Section 7.1.1
EIS Reference:	EIS Chapter 22 – Effects of the Environment on the Project. Section 22.3.1.1 Existing Conditions; Page 22.6
Context and Rationale:	The EIS Guidelines require historical records of relevant meteorological information (e.g., total precipitation [rain and snow]; mean, maximum and minimum temperatures; and typical wind speed and direction). The EIS only provides climate data from the Buchans station. However, the Burnt Pond station is closer to the mine site than the Buchans location. The Burnt Pond 1981-2010 climate normals indicate it has a wetter climate, with a mean annual precipitation of 1434 mm, about 200 mm greater than the Buchans location. The 1971-2000 normals show a similar difference. Accurate representative climate data is required for an assessment of potential effects of the environment on the project.
Information Request:	Update the existing climate data to incorporate the Burnt Pond climate station in addition to the Buchans data to inform the description of climate used for the Project effects assessment. Consider the additional data and discuss any anticipated changes to the prediction of effects of the environment on the Project.
Response:	In selecting climate stations within the region that could be representative of the Project Area, the following was considered: • Buchans (8400698) was selected with climate normal precipitation of 1236 mm/year and a long historical daily meteorological dataset to develop long term daily, monthly and annual climate statistics. The Buchans station meets climate code C, has 25 years of climate normal record with 97.7% of all possible observations, and is 50 km from the mine site (process plant). • The Project used Stephenville A (8403800) with climate normal precipitation of 1340 mm/year and a long historical hourly meteorological dataset (including tipping bucket rain gauge used to identify precipitation intensity, duration and frequency (IDF)) to represent event-based water resources design. The Stephenville A station meets climate code A, which applies to stations meeting World Meteorological Organization (WMO) climate standards for temperature and precipitation and the WMO 3 and 5 rule, meaning no more than 3 consecutive and no more than 5 total missing data points for precipitation and temperature.

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	• The Burnt Pond station is 30 km southwest of the mine site (process plant) and has climate normal precipitation of 1434 mm. The Burnt Pond station meets climate code D (lowest acceptable quality), has 19 years of record (toward the 30 year climate normal) with 96.7% of all possible observations. • The Exploits Dam climate station is located at the limit of the Project Local Assessment Area and Regional Assessment Area and is 55 km from the mine site (process plant) and 21 km from Buchans. The Exploits Dam climate station has a climate normal precipitation of 1104.4 mm/year and meets climate code C, has 26 years of climate data and 99.7% of all possible observations. Recognizing the climate variability represented in the regional climate stations (i.e., Buchans, Exploits Dam and Burnt Pond), the climate normal range extending from 1104.4 mm/year to 1434 mm/year, and the lower quality of the Burnt Pond climate dataset, the Buchans climate station was selected as representative of near the median of the climate normal precipitation range. The selection of the Stephenville A station to represent IDF information for event-based water management design with higher climate normal than Buchans and meeting WMO climate standards addresses the concern that the Project potentially used climate information that may under-represent the Project site. Marathon has committed to installation of an automated, datalogging and telemetered climate station on site which will inform site water resources monitoring and surveillance. Additionally, the Project will be designed and constructed to meet applicable engineering codes, standards and best management practices, such as the *National Building Code of Canada, the National Fire Code of Canada,* and *the Canadian Dam Association Guidelines*. The codes and standards account for weather variables, including extreme conditions, that could affect the structural integrity of buildings and infrastructure. Designs will also consider projected climate change over the life of the Project. For example, the Tailings Management Facility (TMF) operating volume was designed based on typical precipitation volumes. The 25-year wet year precipitation was used to provide a flexible operating range. The impact of extreme events is considered above the operating water level, in the environmental design flood (EDF) storage. The EDF storage requirements for each stage has been updated to be the larger of the 7-day, 100-year rainfall event or the 30-day 100-year rainfall plus snowmelt event during the freshet.
Appendix:	None

RESPONSE TO IR-73

ID:	**IR-73**
Expert Department or Group:	-
Guideline Reference:	Section 7.6.2
EIS Reference:	Chapter 22 – Effects of the Environment on the Project Section 22.3.1.1 – Weather and Climate
Context and Rationale:	The EIS Guidelines ask for the EIS to take into account how local conditions and natural hazards, such as severe and/or extreme weather conditions and external events could adversely affect the project and how this in turn could result in effects to the environment. There is discussion in the EIS of climate and extreme precipitation events, but there is little information on flood risk in the Project Area, including the likelihood of extreme flood events. This information is needed for a complete assessment of effects of the environment on the Project.
Information Request:	Provide information on the risk of flooding in the area, including the risk of major flood events and describe how flooding could adversely affect the project and how this in turn could result in effects to the environment. Provide any proposed mitigation measures that would be used to mitigate adverse effects of the environment on the Project.
Response:	The assessment of weather and climate on the Project is provided in Section 22.3.1 of the EIS. This assessment included the potential effects associated with flooding. If unmanaged, flooding events could cause scour and erosion of Project facilities and downstream conveyance channel resulting in the degradation of water quality to the receiving environments or lead to the changes to slope stability or the failure of erosion or sedimentation control structures / Project infrastructure. In response to this IR, additional information on flood risk and proposed mitigation is provided below. This additional information is consistent with that provided in Section 22.3.1 of the EIS and does not change the conclusions for this section. The natural features at and near the mine site, such as Valentine Lake and surrounding low-lying wetlands and Victoria Lake Reservoir, are natural attenuation features which will reduce the risk of flooding in the area. As described in Attachment 7-D of BSA.7, fluvial (alluvial) and lacustrine deposits are typically associated with active floodplains that are annually or periodically flooded. Fluvial deposits associated with the Riparian Thicket ecotype are not common in the Local Assessment Area (LAA) (approximately 0.4%) and Project Area (approximately 0.5%) and are primarily found adjacent to Victoria River; along tributaries to, and small islands within, the river system in the Project Area; and along other medium

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	to large river systems in the LAA. In addition, as the mine site is located on a natural topographic divide resulting in little to no upstream catchments, the risk of flooding of Project facilities is predicted to be negligible. The potential for flooding and subsequent scour and erosion from the Project has been controlled through proper design of the water management ponds. Where possible, Project facilities have been designed to drain to pre-development catchments to reduce effects of the Project. Water management infrastructure was designed to attenuate the Q100year (183.4 mm) flood, plus the 30-day snowmelt (April of 38.6 mm/day), which is associated with a 1% probability flood event. Additionally, pond spillways will be designed to manage the Q200 year event (198.6 mm). Therefore, the pre-development flood peak was designed to be at or lower the post-development flood peak, so not increasing flood risk as a result of the Project. In turn, effects to the environment from flooding of the Project facilities is not anticipated. To mitigate potential effects of flooding, water conveyance infrastructure is designed to resist scour and erosion during a flood using appropriately specified natural (rock) or synthetic (liner) materials. Additionally, mitigation measures such as routine maintenance, inspections, and monitoring will be implemented and regularly conducted to prevent deterioration of Project infrastructure and equipment, and support Project compliance with applicable design criteria, codes and standards, and to identify potential problems and promptly apply mitigation measures. Similarly, culvert crossings associated with the site roads were designed to accommodate the Q100 year flood event if associated with Project facility water management infrastructure. Larger floods may result in overtopping of the roadway and the temporary closure until water levels drop and minor damages of the roadway repaired. The 76 km road extending from the turnoff near the Millertown Dam to the mine site will be upgraded and will include ditching on both sides and cross drainage by culverts where required. The NL government will retain ownership of the road and existing structures (culverts, bridges), however Marathon will employ design and construction best practices and adhere to all conditions of approval regarding any upgrades to culverts required. Water retaining dams were designed in accordance with the Canadian Dam Association guidelines to accommodate the inflow design flood commensurate with the dam consequence classification. Emergency spillway structures were designed to manage a higher flood event to reduce the risk of overtopping. A dam breach assessment was conducted for each dam structure to characterize the consequences of an overtopping or piping

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	failure may occur as a result of a flood event. Flooding as a result of a dam breach of the water management ponds would result in scour and erosion within the downstream outflow path and environmental effects of low consequence. The Tailings Management Facility dam breach will result in the release of untreated water and tailings reaching Victoria River and the processing plant, as fully assessed in Section 21.5.1 of the EIS. The incremental consequence of failure has been classified as Very High.
Appendix:	None

RESPONSE TO IR-74

ID:	**IR-74**
Expert Department or Group:	-
Guideline Reference:	Section 7.6.2
EIS Reference:	Chapter 22 – Effects of the Environment on the Project Section 22.3.2.3 – Geological Hazards
Context and Rationale:	The EIS Guidelines require the EIS to take into account how local conditions and natural hazards, such as severe and/or extreme weather conditions (e.g., flooding, drought, ice jams, landslides, avalanches, erosion, subsidence, fire, outflow conditions and seismic events) could adversely affect the project and how this in turn could result in effects to the environment. The EIS states that the probability of landslides, rockfalls, subsidence, and other geological hazards is generally low, but provides limited justification or source material to corroborate this claim. The proponent also states these risks would largely be evaluated and mitigated during detailed design and engineering through a geotechnical assessment. Justification for why the probability of geological hazards is low and information on how the geotechnical assessment could be used to mitigate risk is needed for a complete assessment of effects of the environment on the Project.
Information Request:	a. Provide rationale as to why the risks of landslides, slope stability, and other geological hazards would be low. b. While full detailed design is not available at this stage, provide information on how the geotechnical assessment could be used to mitigate the risk of any effects of the environment on the project.
Response:	a. The risk of landslides, slope stability and other geological hazards are anticipated to be low given the low seismic hazard risk for the area (categorized as having a low seismic hazard by the Geological Survey of Canada). In addition, the extensive geological mapping and boreholes (geotechnical, exploration) completed across the site show there is an absence of overburden soil and bedrock rock types that would be prone to landslides, slope stability and other geological hazards. These inherent geological features combined with the natural topography across the site and planned development, results in a low risk categorization of these hazards. b. Information provided by geotechnical assessment provides details needed for Project design and construction. Geotechnical investigations for all site infrastructure, open pits, and waste and ore piles to assess

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	the site-specific conditions and associated risk of geological hazards have been completed for the feasibility study stage of the Project with additional investigations planned for 2021 to support detailed design. The updated information collected in support of the Feasibility Study has confirmed the results of previous investigations; that the ground conditions in the area are geotechnically stable with respect to geological hazards, and suitable for the construction of foundations and embankments (dams) required for development of the Project. Information obtained from these investigations will continue to be used to inform consideration of geological hazards and erosion and sediment control in the final Project design.
Appendix:	None

RESPONSE TO IR-75

ID:	**IR-75**
Expert Department or Group:	ECCC-06
Guideline Reference:	Section 7.6.2
EIS Reference:	Section 21.4.1.4 Watercourse Crossing Failure; Section21.5.4.2 Project Design and Safety Measures to Reduce Environmental Effects
Context and Rationale:	The EIS Guidelines require the EIS to take into account how local conditions and natural hazards, such as severe and/or extreme weather conditions (e.g., flooding, drought, ice jams, landslides, avalanches, erosion, subsidence, fire, outflow conditions and seismic events), could adversely affect the project and how this in turn could result in effects to the environment. In Chapter 22 of the EIS, the proponent indicates that climate and climate change can have impacts on the Project with potential to cause adverse effects to the environment through accidents or malfunctions. As such, the proponent provides projections of future changes in a number of climate change related parameters over the lifetime of the Project (Section 22.3.1).In the three quotes below, the proponent indicates that climate change will be (or is) considered in project design.21.4.1.4 Watercourse Crossing Failure (p.21.9) “With watercourse crossings designed to address the appropriate design precipitation events including climate change parameters” 21.5.4.2 Project Design and Safety Measures to Reduce Environmental Effects (p.21.42)“consideration of climate change-associated precipitation events and associated flow” “The design of the sedimentation ponds accounts for climate change” It is not clear what climate change information and methods were used to consider climate change in the design applications described. This information is needed for a complete assessment of effects of the environment on the Project.
Information Request:	Describe climate change information and methods used to apply the climate projections to relevant project design considerations.
Response:	Climate predictions presented in Chapter 22 (Effects of the Environment on the Project) of the EIS are sourced from the Government of Newfoundland (Government of Newfoundland and Labrador 2019 Climate Change – Climate Data. Available at: https://www.gov.nl.ca/eccm/occ/climate-data/). Predictions were based on the representative concentration pathways (RCPs) 8.5 scenario for two future periods, 2041-2070 and 2071-2100, at four locations as required by the EIS guidelines. Climate change precipitation and temperature projections for Red Indian Lake are also described in BSA.3, Attachment 3-C Valentine Gold Project Hydrology and Water Quality Monitoring Baseline Report (2020). Projected

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	climate change precipitation and temperature data for the Red Indian Lake region were generated using the Climate Atlas of Canada (Prairie Climate Center 2019). This online data portal provides downscaled data projections of temperature and precipitation from 24 different climate models. Projected climate changes associated with the Intergovernmental Panel on Climate Change RCPs 4.5 and 8.5 scenarios for a 30-year projection are provided. The RCP8.5 scenario was selected as it represents the highest greenhouse gas emissions, resulting from: high population, slow income growth, and modest rates of change in the technological change resulting from absence of climate change policies (Riahi et al. 2011). It is expected that future climate change could result in increased temperatures, increased frequency and intensity of precipitation, an increase in the frequency and magnitude of storm events, and increased incidence of flooding and erosion in the Project Area. Climate change projections for the region can be summarized as warmer, drier summers, with warmer and wetter conditions in fall, winter and spring. To address the potential effects of climate change (e.g., increased air temperature, precipitation, fog and visibility, winds and extreme weather events) on the Project, and in consideration of the potential normal and extreme conditions that might be encountered throughout the life of the Project, proactive design, materials selection, planning, and maintenance are required. In particular, water management infrastructure design included consideration of climate change-associated precipitation events and associated flow. For example, the Tailings Management Facility (TMF) operating volume was designed based on typical precipitation volumes. The 25-year wet year precipitation was used to provide a flexible operating range. The impact of extreme events is considered above the operating water level, in the environmental design flood (EDF) storage. The EDF storage requirements for each stage has been updated to be the larger of the 7-day, 100-year rainfall event or the 30-day 100-year rainfall plus snowmelt event during the freshet. References: Government of Newfoundland and Labrador. 2019. Climate Change – Climate Data. Available at: https://www.exec.gov.nl.ca/exec/occ/climate-data/index.html Prairie Climate Center. 2019. Climate Atlas of Canada (version 2). July 10. Accessed September 2019. https://climateatlas.ca/data/city/463/annual_precip_2030_85/climo.

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	Riahi, Keywan, Shilpa Rao, Peter Rafaj, Volker Krey, Cheolhung Cho, Vadim Chirkov, Guenther Fischer, Georg Kindermann, Nebojsa Nakicenovic, and Peter Rafaj. 2011. "RCP 8.5 - A scenario of comparatively high greenhouse gas emissions." Climatic Change 109 doi:10.1007/s10584-011-0149-y.
Appendix:	None

RESPONSE TO IR-76

ID:	**IR-76**
Expert Department or Group:	FFA CPAWS-18
Guideline Reference:	Section 7.6.3. Cumulative effects assessment
EIS Reference:	EIS - Section 20 Cumulative Effects Assessment EIS - Section 20.9.4.1 (Change in Habitat)
Context and Rationale:	The EIS Guidelines require the proponent to identify and assess the project's cumulative effects and advise the proponent to consult with federal departments, including the Agency for guidance documents. The Agency's Technical Guidance document on Assessing Cumulative Effects under the *Canadian Environmental Assessment Act*, 2012 (March, 2018) identifies methodological options for analysis of cumulative effects, including quantitative models and spatial analysis. The EIS Guidelines requires the proponent to describe the mitigation measures that are technically and economically feasible. The proponent shall assess the effectiveness of the measures applied to mitigate the cumulative effects. In cases where measures exist that are beyond the scope of the proponent's responsibility that could be effectively applied to mitigate these effects, the proponent will identify these effects and the parties that have the authority to act. In such cases, the EIS will summarize the discussions that took place with the other parties in order to implement the necessary measures over the long term. The level of analysis, as presented, does not support the conclusion that effects would be not significant. Lack of spatial consideration impedes the assessment of cumulative impacts. This information is needed to determine significance of cumulative environmental effects on all Valued Components.
Information Request:	Provide and update the assessment of potential cumulative environmental effects on all Valued Components. Include (not exclusive) the following: • the spatial extent of effects from activities (e.g., noise and light) and associated cumulative effects of creating multiple zones of avoidance in the Project Area; • the spatial range of populations of species, recognizing that effects on individuals from the same population in different areas would result in cumulative effects to the species; and • that species would be affected by multiple activities (e.g., noise from traffic, and drilling). Include consideration of various noise sources occurring at the same time and associated cumulative effects on wildlife. Update the proposed mitigation and follow-up

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	measures based on the updated analysis and update predictions regarding the significance of effects accordingly.
Response:	<u>Approach to Cumulative Effects Assessment</u> The approach used for conducting the cumulative effects assessment on each valued component (VC) is described in the *Canadian Environmental Assessment Agency's Operational Policy Statement (OPS) for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012, Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012*. The OPS suggests that spatial boundaries encompass potential environmental effects on the selected VC of the designated project in combination with other physical activities that have been or will be carried out. The spatial boundaries for the cumulative effects assessment are described in Section 20.1.2 of the EIS. As noted in this section, the spatial boundaries for the assessment of cumulative environmental effects takes into consideration, for each VC, the Project Area, Local Assessment Area (LAA), and Regional Assessment Area (RAA) as defined in the respective VC chapters (Chapters 5 to 19 of the EIS). Additionally, a cumulative effects RAA was developed to encompass the other physical activities that have the potential to cumulatively interact with the Project, as well as to account for the larger movements and distributions of the various biological and socio-economic components. A conservative approach was taken in the selection of the cumulative effects RAA, using the largest extent of the various VC RAAs to capture the potential cumulative effects. It is acknowledged that the migratory range of some VCs extends beyond the RAA boundaries and there is potential for individuals of these species to be affected by the combined residual environmental effects of the Project and effects from other stressors within and beyond the RAA boundaries (e.g., migratory birds). However, in many cases, these "external" stressors along the migratory route are reflected in the discussion of species' status and population descriptions. In accordance with the cumulative effects OPS, the cumulative effects assessment includes consideration of other physical activities that have been (past), are being (present and ongoing), and will be carried out (future) in the cumulative effects RAA. The other past, present, ongoing and future physical activities considered in this cumulative effects assessment may have already influenced the existing

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	conditions of the VCs being assessed (i.e., past and present physical activities) or may result in residual environmental effects (i.e., ongoing and future physical activities) that could interact cumulatively with (i.e., overlap spatially and temporally with) the residual environmental effects of the Project within the cumulative effects RAA. <u>Combined Project Effects</u> The combined effects of multiple Project activities or zones of influence were assessed within the individual VC assessments, rather than as part of the cumulative effects assessment. Specifically, change in habitat, as evaluated for avifauna (Chapter 10), caribou (Chapter 11) and other wildlife (Chapter 12), considered direct habitat loss or alteration, as well as indirect changes associated with sensory disturbances. Sensory disturbance is largely caused by activities generating noise, light and dust emissions. Combined Project effects associated with sensory disturbance considered the spatial extent of effects from activities generating noise, dust and light emissions, as well as the spatial range of populations of species, recognizing that effects on individuals from the same population in different areas would result in greater effects to the species and that species could be affected by multiple Project activities. The assessment of Project-related sensory disturbance on avifauna (Chapter 10), caribou (Chapter 11) and other wildlife (Chapter 12) was informed by the results of the Atmospheric Environment VC (Chapter 5), which included modelling predicting the spatial extent of air, sound and light emissions. Sound quality modelling, for example, included potential sources of sound from multiple Project activities. A complete list of sound sources is provided in Appendix 5H, Table 5H.1 and Table 5H.2 of the EIS. The assessment of combined effects of multiple Project activities, including the consideration of various noise sources occurring at the same time, was presented in the respective VC-chapter assessments. With respect to noise and as stated in Section 5.3.1.1 of the EIS, a conservative approach was used to assess Project effects on the acoustic environment, which included the following assumptions related to noise: • Worst-case conditions were incorporated into the acoustic modelling. For example, the maximum equipment operation at the mine site and the maximum hauling activities are anticipated to occur at different stages of the mine life. For the acoustics

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	assessment, it was assumed that these activity levels occur simultaneously. • The noise assessment assumed that all equipment was running simultaneously. • Noise propagation from mining activities was exaggerated by assuming that the ground near the Project will reflect more sound waves than is actually anticipated. The assessment on avifauna, caribou and other wildlife, in the respective chapters, therefore considered combined noise effects from multiple Project activities. This is similarly true for lighting levels which considered effects of Project infrastructure and activities on light trespass, glare and sky glow. A quantitative analysis of habitat loss associated with multiple Project activities was determined for representative species, including for avifauna, caribou and other wildlife. A conservative approach was used in the EIS which assumed all habitat within the Project Area will be lost, where in practice, not all vegetation will be cleared within the Project Area. This assumption was in part a recognition of combined sensory effects within both the Project Area and LAA. The consideration of sensory disturbance resulting from the Project included the combined sources of human activity, dust, light and noise. This is consistent with current literature related to sensory disturbance and wildlife, as assessing the effects of noise, for instance, in the absence of other confounding sensory effects (e.g., human presence, light, dust) can be challenging. Both direct effects on habitat from clearing and indirect effects on habitat as a result of sensory disturbance were fully assessed for each of the terrestrial wildlife VCs within the EIS. For each VC, the characterization and determination of the significance of residual effects was made in consideration of the combined Project effects on the VC. The cumulative effects of change in habitat (including indirect change as a result of sensory disturbances) from the Project in combination with other past, present, on-going and future activities were subsequently considered in the cumulative effects assessment in Chapter 20. <u>Mitigation Measures</u> Project mitigation measures (Sections 2.7.4, 10.4, 11.4 and 12.4) pertain to reducing and managing sensory disturbance including noise. For example, vehicles and heavy equipment on site will be equipped with appropriate mufflers to reduce noise, and idling times

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	will be reduced to the extent possible. It is anticipated that future developments will also have mitigation measures in place to reduce project-related effects on VCs, for example on avifauna, caribou and other wildlife that will help reduce cumulative effects. Marathon has proposed follow-up surveys to confirm effects predictions on avifauna, caribou, and other wildlife, and in the case of caribou, an adaptive management approach to address the potential Project-related adverse effects on caribou migration and populations in the Project Area. No additional mitigation measures or follow-up is proposed to address cumulative effects associated with sensory disturbance on wildlife. <u>Conclusion</u> As described above, the potential individual effects and the potential combined effects (i.e., 'cumulative' Project effects) of Project components and activities have been assessed within each VC chapter in the EIS. Subsequently, the residual effects from the Project in combination with other projects in the RAA have been considered in the cumulative effects assessment (Chapter 20). Within the cumulative effects assessment, it is assumed that, where residual effects on VCs resulting from the Project may add to effects from other projects and activities, those other projects are bound by the same regulatory requirements as the Valentine Gold Project and the application and enforcement of those requirements will be the responsibility of the appropriate provincial and federal regulators. The assessment of combined Project effects and cumulative effects has been conducted in compliance with the applicable guidance documents. Given the above information, including that the cumulative effects assessment has been conducted in accordance with the OPS, using a sufficiently large cumulative effects RAA, and fully considering combined Project effects and proposed mitigation and follow-up measures as identified within the VC-specific assessments, updating of the cumulative effects predictions provided in the EIS for each VC is not required.
Appendix:	None

APPENDIX IR-60.A
ALTERNATE MIGRATION ANALYSIS

Valentine Gold Project: Caribou Alternate Migratory Pathway Analysis

Report

March 23, 2021

Prepared for:

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VALENTINE GOLD PROJECT: CARIBOU ALTERNATE MIGRATORY PATHWAY ANALYSIS

Table of Contents

Abbreviations

COSEWIC	Committee on the Status of Endangered Wildlife in Canada
dBBMM	Dynamic Brownian bridge movement models
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
EOSD	Earth Observation for Sustainable Development
GIS	geographic information system
km	kilometres
km^2	square kilometres
LCP	Least-cost path
m	metres
Marathon	Marathon Gold Corporation
UD	Utilization Distribution
ZOI	zone of influence

1.0 INTRODUCTION

Marathon Gold Corporation (Marathon) is proposing to develop and operate an open pit gold mine near Valentine Lake, located in the central region of the Island of Newfoundland. The Valentine Gold Project (the Project) includes the mine site where Project infrastructure will be located, and an access road which is an existing road to the mine site that will be upgraded and maintained by Marathon as part of the Project. The Buchans herd of woodland caribou (*Rangifer tarandus*) migrate through the Project Area bi-annually as they travel from calving grounds in central Newfoundland in spring to wintering grounds on the south coast. The Buchans herd is designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2014) and has recently undergone population declines thought to be the result of a complex set of interactions including predation and food limitation (Government of NL 2015).

Stantec Consulting Ltd. (Stantec) completed a migration analysis of the Buchans herd as part of the Environmental Impact Statement (EIS) for the Project. Dynamic Brownian bridge movement models (dBBMM) were used to estimate utilization distributions (UD) for GPS-collared caribou during the spring and fall migration periods (Chapter 10 in Marathon 2020). The results of the dBBMM identified that the Project Area directly overlaps with the primary migration corridor that is currently used by over half of collared caribou within the Buchans herd. The Project has the potential to disrupt the main migration corridor and cause caribou to select alternative migration pathways that may be less suitable, which could ultimately cause a change in recruitment or survival; the full scope of residual effects is discussed in the EIS (Marathon 2020).

During regulatory review of the EIS, questions were raised regarding potential implications of the Project overlapping with the main migratory pathway for the Buchans herd. To address these questions, Stantec undertook a least-cost path (LCP) analysis to predict potential alternate migratory pathways that may be used by the Buchans herd during spring and fall migrations during Project activities, identify the habitat types within alternate migratory routes, and estimate changes in energetic costs based on distance travelled.

2.0 METHODS

2.1 STUDY AREA

The Project is in the Central Region of the Island of Newfoundland, approximately 60 kilometres (km) southwest of Millertown, Newfoundland and Labrador. The Project Area includes the immediate area in which Project activities and components occur and is comprised of a mine site and access road. The mine site includes the area where Project infrastructure will be located, and the access road is an existing road to the site, plus a 20 metre (m) wide buffer on either side. The Study Area includes the migratory range of the Buchans herd, and surrounding areas where potential alternate migration routes are most likely to occur (Figure 2-1).

2.2 OVERALL APPROACH

LCP analyses were used to estimate alternate migratory pathways for the Buchans herd during spring (April 1 – May 19) and fall (November 1 – December 15) migration periods[1]. LCP analyses model the relative energetic cost for an animal to move between locations. The LCP analysis is processed within a geographic information system (GIS) using a raster dataset wherein each raster cell is assigned a resistance value that represents the cost of movement associated with characteristics of the cell (e.g., landcover, terrain) (Etherington 2016). The LCP analysis identifies a single best path by choosing the combination of cells that sum to the least resistance (i.e., lowest cost) with the shortest distance between locations (Adriaensen et al 2003).

Potential alternate migratory pathways for the Buchans herd were estimated during spring and fall migration assuming a zone of influence (ZOI) around the mine site of 1 km, 5 km, 10 km, and 15 km. The zones of influence used for this analysis were selected to encompass a range of potential caribou avoidance distances reported for mine sites within the literature (see Table 11.14 in Marathon 2020). A ‘baseline’ movement pathway was predicted by running the LCP analysis with no ZOI to serve as a comparable baseline for alternate pathways. The actual ZOI for the Project will depend on several factors such as the intensity and duration of Project disturbance, topography, habitat type, and the timing of the disturbance (Marathon 2020). For each season and ZOI, LCPs were modelled under two scenarios, 1) frozen conditions, and 2) unfrozen conditions, to account for differences in seasonal use of water bodies. Migratory caribou are known to select ice and avoid open water when travelling across or near large water bodies (LeBlond et al. 2016). Given the inter-annual variability in the timing of both caribou migration and ice availability, large water bodies within the Project area may be frozen or unfrozen at the time of migration.

[1] The dates used to bound the spring and fall migration periods apply generally to caribou on the Island of Newfoundland and were obtained from Emera (2013)

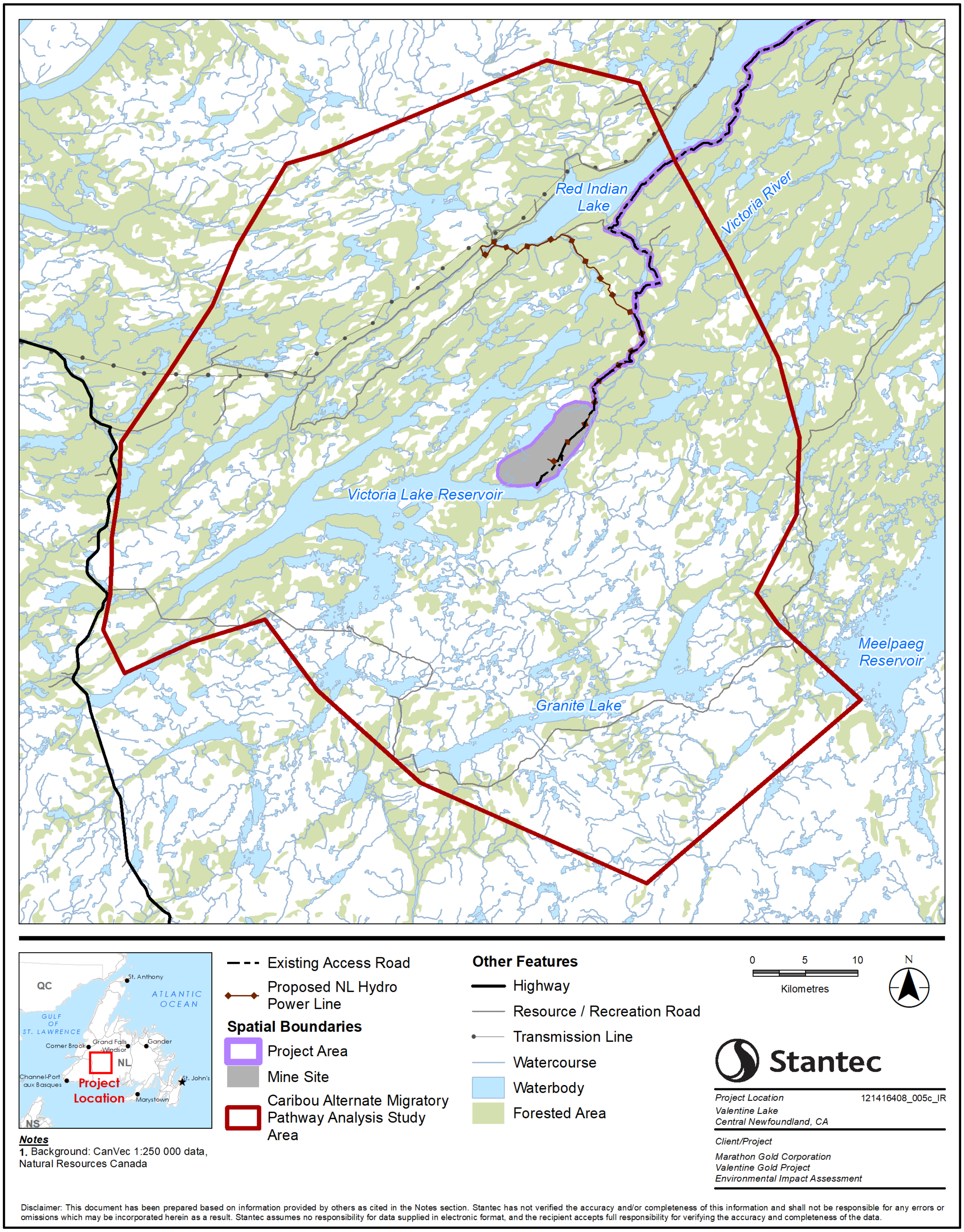

Figure 2-1 Caribou Alternate Migratory Pathway Analysis Study Area

2.3 GEOSPATIAL DATA

In the EIS, 12 habitat types within the Project Area were mapped using Ecological Land Classification (ELC) data (Marathon 2020). The coverage of ELC data was limited to a relatively small area outside the Project Area (Figure 11-3; Marathon 2020), and therefore did not cover the spatial extent needed for the LCP analyses over all ZOIs. Subsequently, habitat types for the LCP analyses were mapped using 17 landcover classes using data from the Earth Observation for Sustainable Development (EOSD) of Forests (Canadian Forest Service 2006) and spatial data for harvested forests and anthropogenic features including roads, cabins, transmission lines, and hydroelectric data retrieved from the Government of Newfoundland databases (Government of NL 2020a, 2020b, 2020c, 2020d). The available spatial data for habitat types within the Study Area could not be combined with the ELC data as methods of delineation were not comparable. Consequently, the habitat value ranks assigned to ELC habitat types in the EIS do not directly link to the EOSD habitat data. For this reason, the value of habitat types for caribou movement used in this analysis were ranked using resistance values that are informed by the dBBMM, as described below.

2.4 LEAST-COST PATH ANALYSIS

The resistance values (i.e., cost) were informed by the habitat types selected by caribou within the main movement pathways identified from the dBBMM (Marathon 2020). The proportion of each habitat type within the main movement pathways (25-50% and 50-75% UD quartiles) during spring and fall migrations from the dBBMM were extracted and transformed to create resistance values, such that high use habitat types were assigned low resistance values. The inverse proportion of habitat types were rescaled between 1 – 8 to create a resistance surface where 1 represents a low cost to movement and 8 represents a high cost to movement (Table 2.1). Through this transformation, it is assumed that the habitat types with a higher probability of selection along the main movement pathways from the dBBMM afford lower costs to movement compared to habitat types within low-use migration pathways, or paths that were not used at all.

Table 2.1 Habitat Descriptions and Resistance Value Inputs for the LCP Analysis

Habitat Types[1]	Description[1]	Spring Migration		Fall Migration	
		0.25-0.75 UD (%)[2]	Resistance Value	0.25-0.75 UD (%)[3]	Resistance Value
Coniferous sparse	10-25% crown closure; coniferous trees are 75% or more of total basal area	33.8	1.0	36.7	1.0
Wetland-Shrub	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is tall, low, or a mixture of tall and low shrub.	13.7	5.2	12.8	5.6
Water	Lakes, reservoirs, rivers, streams, or salt water.	11.3	5.7	9.5	6.2
Shrub low	At least 20% ground cover which is at least one-third shrub; average shrub height less than 2 m.	9.2	6.1	11.2	5.9
Exposed Land	River sediments, exposed soils, pond or lake sediments, reservoir margins, beaches, landings, burned areas, road surfaces, mudflat sediments, cutbanks, moraines, gravel pits, tailings, railway surfaces, buildings and parking, or other non-vegetated surfaces.	7.2	6.5	6.8	6.7
Coniferous open	26-60% crown closure; coniferous trees are 75% or more of total basal area.	6.5	6.6	7.8	6.5
Coniferous dense	Greater than 60% crown closure; coniferous trees are 75% or more of total basal area.	5.5	6.9	4.9	7.1
Wetland-Herb	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is herb	3.2	7.3	3.4	7.4
Rock/Rubble	Bedrock, rubble, talus, blockfield, rubbley mine spoils, or lava beds.	2.4	7.5	0.9	7.8
Mixedwood open	26-60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area.	1.6	7.7	2.1	7.6
Wetland-Treed	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is coniferous, broadleaf, or mixed wood.	1.2	7.8	0.9	7.8
Shrub tall	At least 20% ground cover which is at least one-third shrub; average shrub height greater than or equal to 2 m.	0.7	7.9	0.6	7.9

Table 2.1 Habitat Descriptions and Resistance Value Inputs for the LCP Analysis

Habitat Types[1]	Description[1]	Spring Migration		Fall Migration	
		0.25-0.75 UD (%)[2]	Resistance Value	0.25-0.75 UD (%)[3]	Resistance Value
Mixedwood dense	Greater than 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area	0.4	7.9	0.4	7.9
Broadleaf dense	Greater than 60% crown closure; broadleaf trees are 75% or more of total basal area.	0.2	8.0	0.2	8.0
Broadleaf sparse	10-25% crown closure; broadleaf trees are 75% or more of total basal area.	0.2	8.0	0.2	8.0
Broadleaf open	26-60% crown closure; broadleaf trees are 75% or more of total basal area.	0.0	8.0	0.0	8.0
Herb	Vascular plant without woody stem (grasses, crops, forbs, gramminoids); minimum of 20% ground cover or one-third of total vegetation must be herb.	0.0	8.0	0.0	8.0
Harvested forest	Forests that are regenerating as a result of harvesting.	1.4	7.7	0.1	8.0
Anthropogenic	Roads, cabins, transmission lines, hydroelectric infrastructure.	0.4	8.0	0.3	8.0

Notes:

1 Habitat types and definitions from Earth Observation for Sustainable Development of Forests (Canadian Forest Service 2006); harvested forest and anthropogenic habitat types from the Government of Newfoundland databases (Government of NL 2020a, 2020b, 2020c, 2020d).

2 Proportion habitat types within the main movement pathways (25-50% and 50-75% UD quartiles) from the dBBMM (Marathon 2020) during spring migration

3 Proportion habitat types within the main movement pathways (25-50% and 50-75% UD quartiles) from the dBBMM (Marathon 2020) during fall migration

Complete barriers were set to null (i.e., infinite resistance). Each ZOI was classified as a complete barrier, under the assumption that caribou will entirely avoid each ZOI around the mine site. Classifying the ZOIs as complete barriers is a conservative measure; within the literature, caribou avoidance of mine sites is observed at varying degrees within a ZOI which depends on several factors including season, habitat, and the intensity or type of disturbance. For example, Boulanger et al. (2021) identified yearly and spatial variation in the ZOI for caribou around mines site that is influenced by the annual variation in habitat selection, available forage, perceived level of disturbance, and drought. Caribou avoidance may also be influenced by memory, learning, and social behavior; not all caribou within a study area will exhibit the same degree of avoidance. Although the ZOI for mine sites vary among studies, caribou have been documented to reduce their use of habitat within 2 km to 14 km of mines (e.g., Weir et al. 2007; Polfus et al. 2011; Boulanger et al. 2012; Johnson et al. 2015).

Large waterbodies including Victoria Lake Reservoir, Red Indian Lake, and Meelpaeg Lake were classified as complete barriers in the unfrozen scenarios under the assumption that caribou would circumnavigate open water instead of swimming across. Narrow portions of these lakes (i.e., <1 km) were not included as barriers. Slopes greater than 38° were considered adverse to caribou movement and classified as complete barriers (McNay and McKinley 2007).

The start and end locations for the LCP analysis were identified using the 20-50% and 50-75% UD quartiles along the migration route termini identified in the EIS (Marathon 2020). The LCP analysis assumes that caribou would begin migration from these locations and follow the LCP between these points. As the LCP analysis creates a single pixel width output (25 m), the resistance raster was resampled to 300 m using a bilinear technique in ArcGIS to create a potential migration corridor that is biologically relevant.

For each LCP produced, the proportion of each habitat type, total path length, and total path cost were calculated; values for spring and fall migration paths were summed to produce annual migration values. The path cost for each ZOI was divided by the cost of the baseline LCP to get the relative increase in cost for each alternate pathway.

3.0 RESULTS

The baseline LCP (i.e., no ZOI) was compared to the movement pathways identified by the dBBMM during spring (Figure 3-1) and fall (Figure 3-2) migration periods for congruence. Generally, the baseline LCP movement pathway and the dBBMM results had a high degree of similarity, suggesting that caribou are currently migrating along the shortest, least cost path, and that the additional LCP analyses can serve as reasonable predictors of potential alternate migration pathways. In spring, the baseline LCPs for frozen and unfrozen conditions generally followed the same route as the main movement pathway from the dBBMM for the first part of the migration, then moved east of the dBBMM route through the mine site; the unfrozen scenario LCP follows the dBBMM route more closely in the latter portion of the migration, whereas the frozen scenario LCP crosses Red Indian Lake (Figure 3-1). In fall, the baseline LCPs for frozen and unfrozen conditions followed a similar pattern to spring; the pathways followed the same route as the main movement pathway from the dBBMM for most of the migration except where the pathways move east of the dBBMM route near the first part of the migration, with the frozen scenario LCP crossing Red Indian Lake.

The LCP analyses predicted alternate pathways for each ZOI under frozen and unfrozen conditions during spring migration (Figure 3-3) and fall migration (Figure 3-4). In spring, the alternate pathways navigate around the east side of the mine site at increasing distances with each ZOI, except at the 5 km ZOI under frozen conditions where the alternate pathway moves around the west side of the mine site across Victoria Lake Reservoir. Alternate pathways under frozen conditions are shorter in each ZOI compared to unfrozen conditions because caribou are predicted to travel directly across sections of Granite Lake, Victoria Lake Reservoir, and Red Indian Lake under frozen conditions. In fall, the alternate pathways follow similar routes around the east side of the mine site as the spring predictions for each ZOI and scenario except at the 5 km ZOI under frozen conditions where the alternate pathway moves south across Red Indian Lake and east around the mine site.

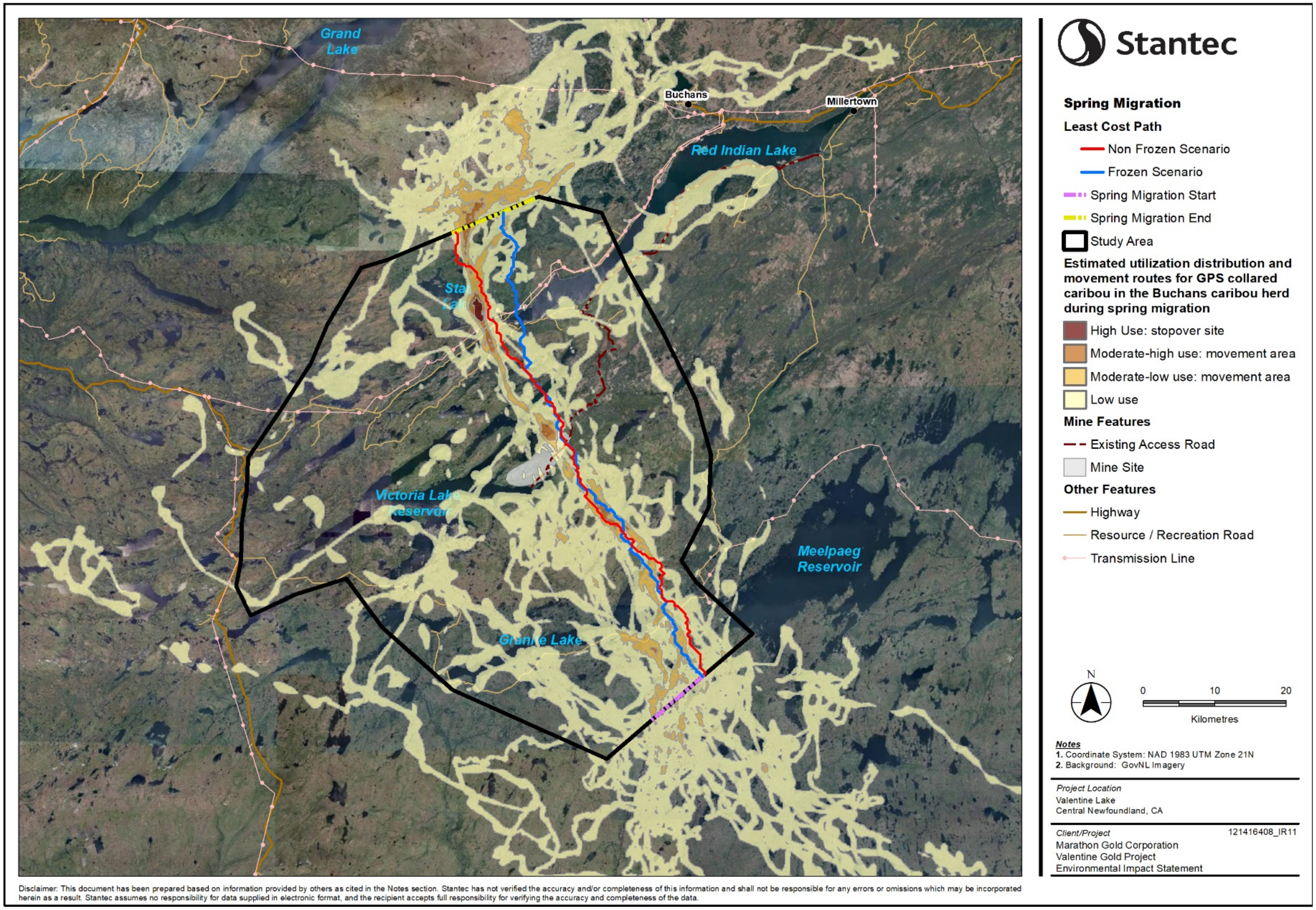

Figure 3-1 Baseline Least Cost Path and dBBMM Routes for the Buchans Herd during Spring Migration

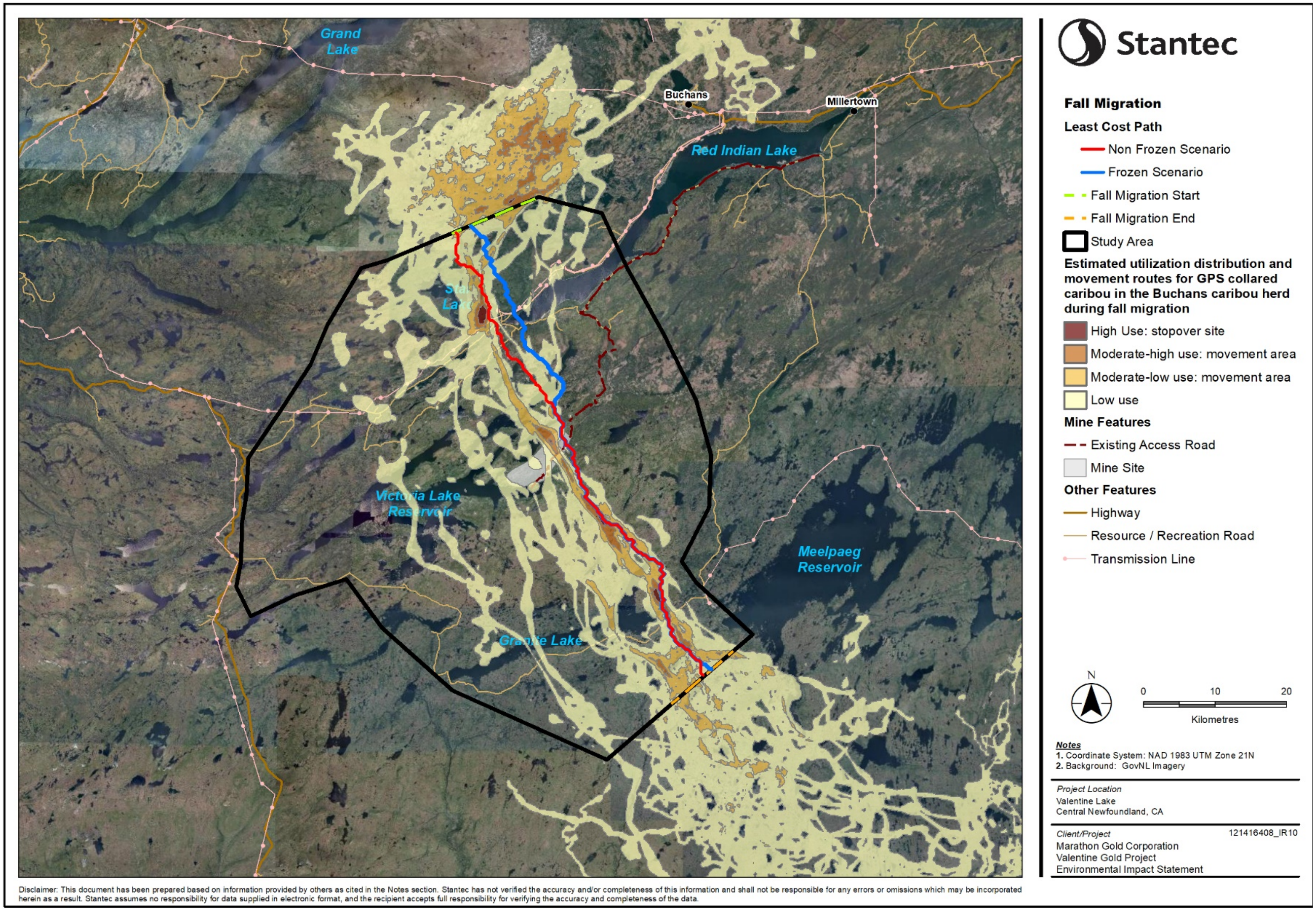

Figure 3-2 Baseline Least Cost Path and dBBMM Routes for the Buchans Herd during Fall Migration

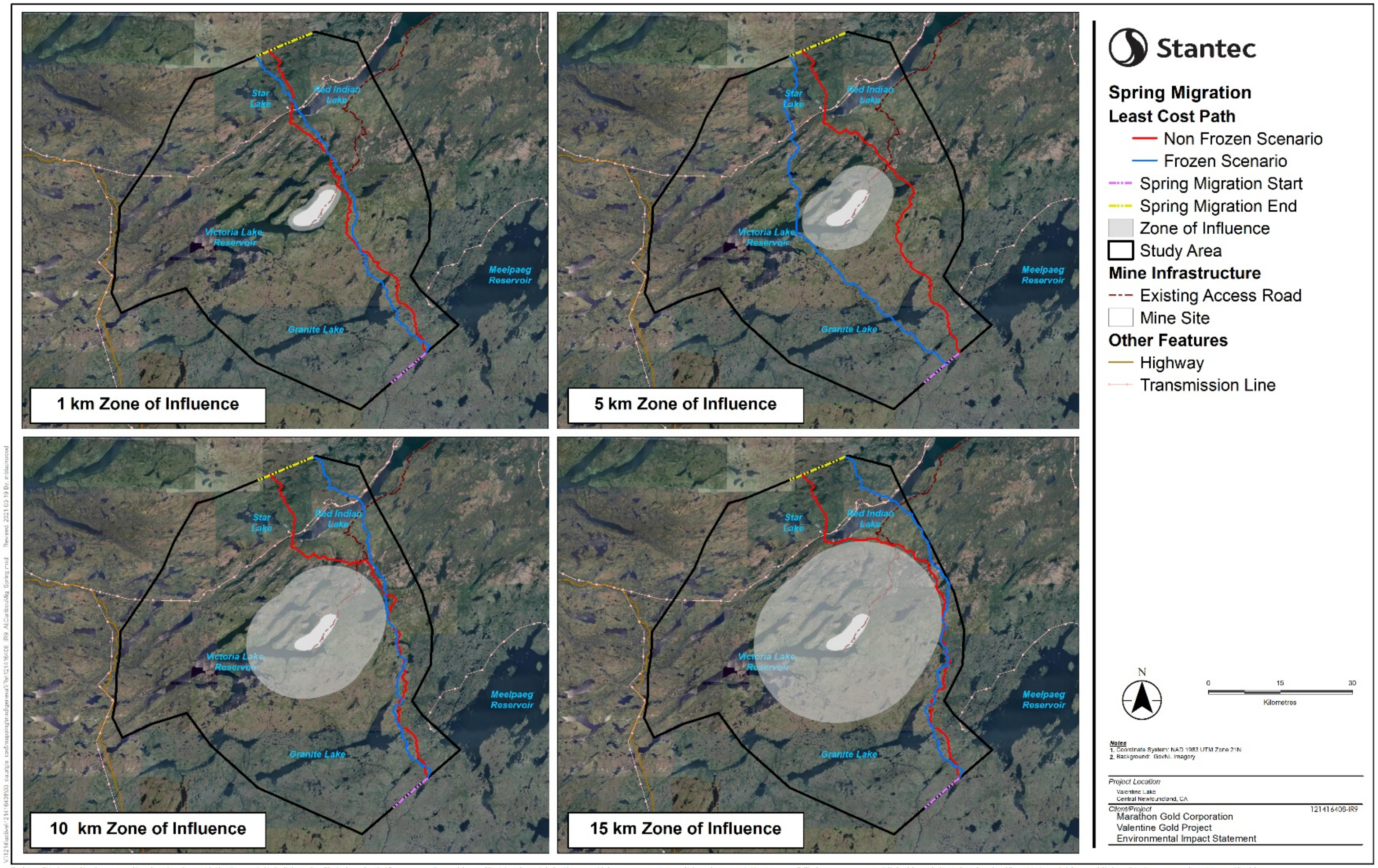

Figure 3-3 Estimated Alternative Migration Pathways for Caribou in the Buchans Herd During Spring Migration Under Frozen and Unfrozen Conditions

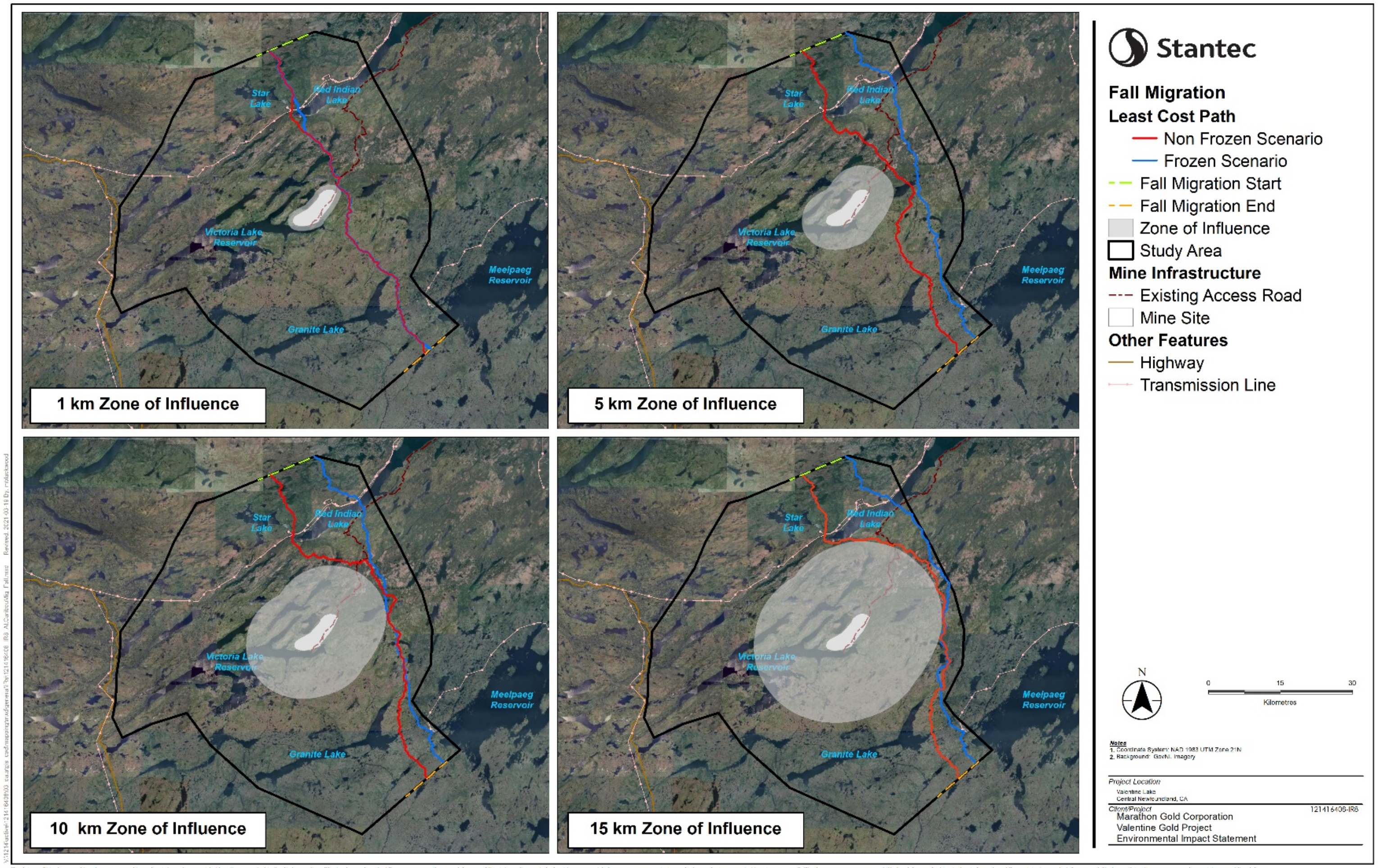

Figure 3-4 **Estimated Alternative Migration Pathways for Caribou in the Buchans Herd During Fall Migration Under Frozen and Unfrozen Conditions**

The annual length of potential alternate migration pathways under frozen conditions ranged from 169 km (1 km ZOI) to 183 km (15 km ZOI); caribou are predicted to migrate between 0 km and 13 km further than the estimated baseline LCP (Table 3.1). The 1 km ZOI pathways are the same length as the 0 km ZOI pathways but have slightly higher relative costs because the 1 km ZOI pathways traverse habitat types with higher resistance values than the 0 km ZOI pathways. The unitless cost value generated by the analysis ranges from 1.01 times (1 km ZOI) to 1.16 times (15 km ZOI) greater than the baseline LCP.

The length of alternate migration pathways under unfrozen conditions are longer than frozen conditions and ranged from 175 km (1 km ZOI) to 199 km (15 km ZOI); caribou are predicted to travel between 6 km to 30 km further than the estimated baseline LCP (Table 3.1). The unitless cost value generated by the analysis ranges from 1.04 times (1 km ZOI) and 1.41 times (15 km ZOI) greater than the baseline LCP.

Table 3.1 Predicted Annual Migration Length and Relative Cost for each ZOI under Frozen and Unfrozen conditions

ZOI (km)	Annual Migration[1]			
	Frozen		Unfrozen	
	Length (km)	Relative Cost	Length (km)	Relative Cost
0	169	1.00	169	1.00
1	169	1.01	175	1.04
5	176	1.04	184	1.11
10	173	1.05	191	1.18
15	183	1.16	199	1.41

NOTES:
[1] Values for spring and fall LCPs were combined.

The proportion of each habitat type within the potential alternate migratory pathways for each ZOI under frozen and unfrozen conditions is summarized in Table 3.2. The baseline LCP under frozen conditions had the highest proportion of coniferous sparse (45.8%) followed by coniferous open (12.7%), shrub low (8.4%), coniferous dense (8.1%), wetland-shrub (8.1%) and water (5.5%). The baseline LCP under unfrozen conditions had the highest proportion of coniferous sparse (44.7%) followed by coniferous open (13.3%), conifer dense (9.7%), wetland shrub (7.7%), and shrub low (7.4%). Coniferous sparse and coniferous open were the two highest proportions for each ZOI under frozen and unfrozen conditions; the proportion of coniferous sparse decreased with increasing ZOI, and the proportion of coniferous open generally increased with increasing ZOI. The proportion of harvested forest and anthropogenic disturbance increased with increasing ZOI in both frozen and unfrozen conditions. Within all ZOIs during frozen and unfrozen conditions, the relative change in the proportion of coniferous sparse and wetland-treed habitats decreased, and the proportion of mixedwood open and anthropogenic habitats increased compared to the baseline LCP.

Table 3.2 Proportion and Percent Difference of Habitat Types within the LCP Alternate Migration Pathways Relative to the Baseline LCP

Habitat Types	Frozen[1,2]					Unfrozen[1,2]				
	0 km	1 km	5 km	10 km	15 km	0 km	1 km	5 km	10 km	15 km
Coniferous sparse	45.8	44.2 (-3.5)	41.4 (-9.5)	40.7 (-11.1)	39.9 (-12.9)	44.7	43.5 (-2.8)	42.9 (-4.1)	42.9 (-4.1)	38.9 (-13.0)
Coniferous open	12.7	12.2 (-3.8)	13.5 (6.3)	14.9 (17.1)	15.3 (20.8)	13.3	13.2 (-0.8)	13.2 (-1.0)	14.2 (6.1)	15.5 (15.9)
Shrub low	8.4	8.0 (-4.9)	7.6 (-9.7)	7.4 (-12.2)	7.3 (-13.8)	7.3	7.4 (2.2)	7.9 (9.1)	7.8 (7.1)	7.5 (3.3)
Coniferous dense	8.1	10.0 (23.5)	10.4 (28.5)	9.9 (22.7)	10.4 (28.4)	9.7	10.4 (7.2)	8.0 (-17.6)	8.1 (-16.2)	9.7 (0.2)
Wetland-shrub	8.1	8.1 (-0.5)	8.0 (-1.7)	7.4 (-8.1)	8.2 (1.6)	7.7	7.9 (2.3)	8.7 (12.9)	8.1 (4.8)	8.8 (14.2)
Water	5.5	5.9 (9.0)	7.5 (36.8)	7.6 (40.2)	7.0 (28.8)	5.3	4.4 (-18.4)	5.0 (-6.3)	5.3 (-0.6)	3.4 (-36.5)
Exposed land	4.2	4.2 (-0.3)	4.0 (-6.3)	4.0 (-6.5)	4.6 (7.6)	4.3	4.7 (9.1)	5.6 (30.0)	4.6 (6.2)	5.2 (20.1)
Wetland-Herb	2.1	2.1 (-0.9)	2.4 (14.9)	2.6 (22.8)	2.6 (22.8)	1.9	2.1 (7.0)	2.3 (16.4)	2.4 (24.5)	2.6 (36.8)
Mixedwood open	1.0	1.1 (10.3)	1.2 (19.9)	1.3 (27.3)	1.1 (10.0)	0.9	1.0 (4.7)	1.4 (52.0)	1.5 (64.5)	1.4 (48.3)
Wetland-Treed	0.7	0.6 (-14.5)	0.5 (-29.2)	0.5 (-27.7)	0.5 (-30.1)	1.2	0.8 (-34.5)	0.8 (-34.4)	0.7 (-38.4)	0.6 (-50.3)
Rock/Rubble	0.6	0.6 (-7.1)	0.4 (-44.8)	0.2 (-61.1)	0.2 (-64.4)	1.0	1.1 (14.9)	1.2 (22.3)	1.0 (8.0)	1.2 (25.3)
Mixedwood dense	0.6	0.6 (14.3)	0.9 (59.3)	1.0 (79.8)	0.5 (-9.1)	0.6	0.6 (-8.2)	0.8 (22.7)	1.2 (85.8)	0.9 (32.6)
Shrub tall	0.4	0.4 (1.6)	0.3 (-19.9)	0.3 (-38.3)	0.2 (-53.1)	0.4	0.4 (2.4)	0.5 (13.5)	0.5 (14.0)	0.4 (-4.9)
Broadleaf sparse	0.3	0.1 (-46.6)	0.2 (-25.3)	0.2 (-9.7)	0.1 (-48.4)	0.2	0.1 (-21.6)	0.4 (130.2)	0.1 (-14.8)	0.2 (-11.1)
Broadleaf dense	0.2	0.2 (31.1)	0.4 (127.2)	0.5 (185.6)	0.2 (9.6)	0.3	0.2 (-23.3)	0.2 (-17.6)	0.4 (51.7)	0.3 (18.5)
Herb	0.0	0.0 (-36.6)	0.0 (-69.7)	0.0 (-100.0)	0.0 (-74.5)	0.1	0.0 (-88.0)	0.0 (-84.2)	0.0 (-85.2)	0.0 (-100.0)
Broadleaf open	0.0	0.0 (-28.6)	0.0 (-66.0)	0.0 (-100.0)	0.0 (-100.0)	0.1	0.1 (24.8)	0.1 (32.9)	0.1 (24.7)	0.1 (44.7)
Harvested Forest	0.8	0.8 (-0.5)	0.5 (-33.3)	0.8 (-5.2)	1.2 (50.7)	0.4	1.3 (259.6)	0.3 (-18.8)	0.2 (-44.4)	1.5 (335.6)
Anthropogenic	0.5	0.7 (49.9)	0.8 (73.2)	0.6 (37.3)	0.6 (41.9)	0.6	0.9 (48.1)	0.8 (31.6)	0.8 (40.9)	1.8 (209.9)
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NOTES:

1 Values for spring and fall LCPs are combined.

2 Each cell contains a pair of values: the first value is the proportion of that habitat type, and the second value in parenthesis is the percent difference relative to baseline (i.e., 0 km).

The proportions of habitat types within the baseline and alternate migratory pathways from the LCP analyses (Table 3.2) were compared to proportions of habitat types selected within the main movement pathways from the dBBMM (Table 2.1). Conifer sparse was the habitat type with the highest proportion in the LCP analyses and dBBMM models; the LCP analyses produced paths with higher proportions of coniferous open and coniferous dense whereas the dBBMM model had higher proportions of wetland-shrub, water, and exposed land.

4.0 DISCUSSION

The LCP analysis provides conservative estimates of potential alternate migratory pathways that may be used by the Buchans herd if the Project proceeds. The results are conservative because the analyses assume that caribou will completely avoid the mine site and each ZOI tested (i.e., 1 km, 5 km, 10 km, and 15 km). The estimated increase in annual migration pathway length ranges from 0 km to 30 km and the estimated associated cost is 1.01 to 1.41 times greater than baseline. Alternate migratory pathways are likely to exist within the ZOIs as individual caribou may show varying degrees of avoidance of the Project. In other words, the ZOIs may not be complete barriers to all migrating caribou, and some caribou may choose to migrate closer to the mine site than others. For example, Plante et al. (2018) determined that caribou avoid mine sites by varying degrees, with some individuals having a 3 km ZOI and other individuals having a 21 km ZOI.

Most potential alternate migratory pathways under different ZOIs were predicted to navigate around the east side of the mine and across the mine access road; one path moved west around the mine site across Victoria Lake Reservoir based on frozen conditions. The length of alternate migration paths may be influenced by the amount of ice present on waterbodies within the Study Area, and whether caribou choose to swim across or circumnavigate open waterbodies. Baseline LCPs and alternate migratory pathways traversed primarily open habitats comprised of coniferous forest, shrub low, and wetland-shrub types. The decrease in coniferous sparse habitat with increasing ZOI suggests alternate migratory pathways contain habitat types that are less suitable for migration, which could ultimately cause a change in caribou recruitment or survival either through energetic constraints (shortages) or increased mortality risk if predators prefer habitat types that caribou would typically avoid.

LCP analyses are built upon a set of assumptions regarding the processes that influence animal movement (Sawyer et al. 2011; Chetkiewicz and Boyce 2009). Resistance values are intended to represent the suite of factors that may influence animal movement across a landscape (Adriaensen et al 2003). The strength of LCP analyses depends on the data used to inform the resistance values; constraints in the availability of data can influence the biological realism of model outputs. In this analysis, resistance values were derived from empirical data on habitat types selected by collared caribou from the Buchans herd within their migratory pathway. The LCP analyses assume that habitat types with a higher probability of selection along the current migration route afford lower costs to movement compared to habitat types within low-use migration pathways, or paths that were not used at all.

Differences in the location and habitat type proportions between the baseline LCP and the main movement pathways from the dBBMM can be explained by differences in model assumptions and parameterization. The LCP analysis is a movement model that predicts a single optimal path between the seasonal grounds based on resistance values; the dBBMM analyzes telemetry data from collared caribou and provides a probabilistic estimate of animal occurrence between locations to identify a collection of individual movement paths that connect to high use areas (migratory stopovers) where caribou stop to forage and rest (Marathon 2020). Because the purpose of this analysis was to model caribou movement, the LCP resistance values were informed by the habitat types selected by caribou within the main movement pathways (25-50% and 50-75% quartiles) from the dBBMM; habitat values within the migratory stopover sites were not used to inform the LCP resistance values. This approach to the LCP analyses could explain why the baseline LCP does not intersect with the two stopover areas identified within and north of the Project Area. In addition, the LCP selects the most direct route with the lowest cost between locations.

As discussed in the EIS, Project effects resulting in a change in movement for the Buchans herd are predicted to be irreversible, high in magnitude, and long term in duration due to the overlap of the Project Area with the main migration corridor (Marathon 2020). The LCPs identified in this analysis provide data-driven estimates of potential alternate migratory routes. These potential alternate routes do not imply that caribou will successfully reach their seasonal grounds, as alteration to the migration route due to Project activities could result in changes to the timing of movement or movement rate and increase in energetic costs, which may ultimately cause a change in recruitment or survival.

Mitigation measures will be implemented to reduce adverse effects on caribou movement such as reducing the potential size of the ZOI by limiting mining activities during the migration period, and facilitating caribou crossing along snowbanks or ditches along potential alternate routes (Marathon 2020). The migration analyses could be refined through ongoing monitoring of collared caribou, including monitoring more individuals, to further understand the caribou movement response if the Project proceeds.

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APPENDIX IR-60.B
MITIGATION TABLE

Table IR-60B.1 Evaluation of Mitigation Hierarchy to Reduce Potential Adverse Project Effects on Caribou

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
1) Avoid Measures taken during the planning phase to avoid removal or alteration of caribou habitat types or biophysical attributes (e.g., trails)	• Do not block trails or access to important seasonal or annual habitats (e.g., move, remove or resize / reshape components)	• Relocate or shift waste rock pile towards the northeast or southwest of Marathon pit [note that the open pit cannot be relocated and therefore the impact on the migration corridor due to the open pit development is permanent] – possibility to maintain relatively small portions of the migration corridor beyond the width of the open pit – due to adjacent habitat and topography, limited ability to reshape the waste rock pile without encroaching on fish and fish habitat and causing greater effects on wetlands – may have other environmental implications (e.g., increased haul truck travel and resulting fuel use, greenhouse gas (GHG) and air contaminant emissions)	• Mitigation dismissed
		• Split the waste rock pile so that a portion is northwest, and a portion is southwest, of the Marathon pit – possibility to maintain relatively small portions of the migration corridor beyond the width of the open pit (note uncertainty in how caribou will respond when area is rehabilitated) – may have other environmental implications (e.g., increased haul truck travel and resulting fuel use, GHG and air contaminant emissions) – visual implications due to placement of waste rock on higher ridge – could serve as a long-term barrier to caribou approaching the pit from the south to reduce potential to fall into the open pit (during operations) or open pit lake (post-closure) (note uncertainty in how caribou will respond when area is rehabilitated)	• Mitigation not implemented - to be discussed with NLDFFA-Wildlife Division

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
		• Relocate the overburden stockpile and low-grade ore stockpile – possibility to maintain portions of the migration corridor during operations – may have other environmental implications (e.g., increased haul truck travel and resulting fuel use, GHG and air contaminant emissions) – stockpiles will be removed prior to, or as part of, rehabilitation and closure activities	• Mitigation not implemented - to be discussed with NLDFFA-Wildlife Division
		• Relocate the Tailings Management Facility (TMF) – is sited to reduce potential effects on Victoria Dam and fish and fish habitat – only suitable location that considers all Valued Components and long-term dam safety with respect to Victoria Dam	• Mitigation dismissed
		• Relocate access road – no feasible road alternative that would not cross caribou migration corridor – site access road has existed long before exploration started on property, was utilized for forestry access, and is and will be required by NL Hydro for access to the Victoria Dam	• Mitigation dismissed
		• Relocate power line – line to be constructed, operated, and decommissioned by NL Hydro – consultations with Marathon on the design – power line to be aligned to the extent feasible with adjacent, existing roads through the primary caribou migration corridor to avoid creating a new linear corridor – no feasible route alternative that would not cross caribou migration corridor	• Mitigation dismissed
	• Consider alternative methods that result in less disturbance to caribou	• No alternative to open pit mining of the gold resource located at the Marathon pit site (the majority of the gold reserve associated with the Project) that would achieve the purpose and need for the Project (refer to Chapter 2 of the EIS)	• Mitigation dismissed

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
	• Avoid direct disturbance of undisturbed habitat	• Project footprint and disturbed areas will be limited to the extent practicable through all components and Project phases. For example, construction laydown areas will utilize the future footprint for other mine components.	• Mitigation implemented (design) / future
		• Vegetation will be maintained around high activity areas to the extent practicable, to serve as a buffer to reduce sensory disturbance	• Mitigation will be implemented
		• In the EA registration, an additional deposit (Victory Deposit) was included for consideration, however, based on consultation with Wildlife Division regarding additional effects on caribou migration and other factors, this deposit is no longer being considered	• Mitigation implemented
	• Implement restricted activity period to avoid disturbance during caribou migration	• Caribou activities during the migratory periods will be monitored in the vicinity of the Project through visual observation, aerial surveys, and/or telemetry data from GPS collars – 60 telemetry collars currently being deployed in cooperation with NLDFFA-Wildlife Division to provide additional information (ongoing)	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted with respect to monitoring and caribou proximity
		• Activities in the Marathon pit area that may result in sensory disturbance to caribou (e.g., blasting, loading, hauling) will be reduced or ceased while caribou are migrating through the corridor and within a set distance from the site	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on conditions regarding caribou proximity
		• Traffic along the access road will be further reduced during migration periods – supplies will be stockpiled and/or delayed and shift changes will be altered to the degree possible to reduce traffic during these periods. In addition, speed limits will be reduced and nighttime driving avoided to the extent practicable, to further reduce sensory disturbance and risk of collisions.	• Mitigation will be implemented
		• Project features (e.g., open pits, TMF) will be monitored during migratory periods; fencing/barricades may be installed as needed around the crest of the pits or at the TMF to reduce risks to caribou	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted regarding the acceptability and use of fencing

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
2) Reduce Measures taken to reduce adverse effects (including direct, indirect, and cumulative effects) that cannot be completely avoided, as far as is practically feasible.	• Creation of comprehensive Wildlife Management Plan (WMP) as part of the Project Environmental Protection Plan (EPP)	• Outline mitigations specific to caribou to reduce Project-effects on change in habitat, change in movement, and change in mortality risk. The WMP will be included in employee and contractor induction/orientation packages. During all Project phases, the EPP will be included as part of the contract with all suppliers and contractors who will do work at the site.	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted regarding monitoring requirements and specific mitigation included in the WMP
		• Develop a protocol for reporting caribou sightings to the on-site environmental team and the NLDFFA-Wildlife Division; the on-site environmental team will be notified if caribou are observed within 500 m of Project activities (this is in addition to the temporal reduction or cessation of activities in the Marathon pit area while caribou are migrating through the corridor and within a set distance from the site)	• Mitigation will be implemented
		• Identify opportunities to reduce adverse effects (adaptive management)	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on adaptive management strategies
	• Prevent caribou access to the mine site	• Fully enclose the mine site: – unlikely to be substantially more effective at reducing potential adverse effects than partial diversion – could have potential effects on other wildlife and land and resource users – Wildlife Division raised concerns about fencing/barricading the site, as this may compound adverse effects on caribou migration – may also be a concern to Indigenous groups and other stakeholders	• Mitigation dismissed
	• Divert caribou away from hazards and / or through an alternate route	• Fencing or barricades will be installed as needed around the crest of the pits, and may be installed around the TMF or other Project features to limit interactions with specific components at the mine site and reduce risks to caribou – e.g., rock berms, wire fences, or snow fencing	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted regarding the acceptability and use of any barrier, including design considerations and placement

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
		• Install a barrier adjacent to pit crests (high walls) for mine closure (requirement of Newfoundland and Labrador Department of Industry, Energy and Technology (NLDIET)	• Mitigation will be implemented
		• Create an ingress/egress area for animals at pit lake surface interfaces for mine closure (requirement of NLDIET)	• Mitigation will be implemented
		• If caribou do not demonstrate avoidance of the mine site, additional measures could be implemented to discourage caribou use of the site, such as more extensive fencing around the mine or altering habitats in strategic locations to enhance alternate migration pathways	• Mitigation not implemented - to be discussed with NLDFFA-Wildlife Division
	• Facilitate road crossings	• Breaks in snowbanks will be created at ~200 m intervals, to the extent practicable, to provide caribou crossing opportunities; where feasible, breaks will be aligned on opposite sides of the road and with existing wildlife trails (where they occur)	• Mitigation will be implemented
		• Snow berms will typically be <1 m tall to facilitate caribou crossing during spring and fall migration	• Mitigation will be implemented
		• Install artificial crossing structures (e.g., bridges) along site roads (access and haul roads) and the existing access road – Mitigation is generally tied to fully fenced linear corridors only, where the bridge serves as the only crossing point – NLDFFA – Wildlife Division has indicated extensive fencing is not preferred – The open pit and waste rock pose more significant barriers, and installing crossing structures over these features is not considered feasible (see below)	• Mitigation dismissed
		• Road signage warning of caribou crossing areas will be posted at regular intervals	• Mitigation will be implemented
	• Facilitate crossing of mine infrastructure	• Artificial crossing structures at the Marathon pit and waste rock piles are not feasible due to the size of mine infrastructure and activities associated with open pit mining	• Mitigation dismissed

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
	• Reduce effects on energetic demands	• Supplemental feeding – e.g., transplant lichen or distribute caribou pellets to increase forage value on winter and calving grounds	• Mitigation to be discussed with NLDFFA-Wildlife Division
		• Increase forage value along potential alternate migration routes – Alternate migration pathways identified in a Caribou Alternate Migration Pathway Analysis undertaken for the Project are predicted to have increased energetic costs for caribou – Low certainty in identifying areas for mitigation prior to Project operation, as the alternate pathway analysis cannot predict the likelihood that caribou will use the alternate routes identified	• Mitigation to be discussed with NLDFFA-Wildlife Division
	• Reduce effects on vegetation	• Project footprint and disturbed areas will be limited to the extent practicable (design, construction, and operations)	• Mitigation has been implemented for design and will be implemented for construction and operations
		• Vegetation will be retained, promoted and maintained around all activity areas to the extent practicable	• Mitigation will be implemented
		• Existing riparian vegetation will be maintained to the extent practicable	• Mitigation will be implemented
		• Where crossing of wetlands beyond the area to be cleared is unavoidable, protective layers such as matting or biodegradable geotextile or other approved materials will be used between wetland root / seed bed and construction equipment if ground conditions are encountered that create potential for rutting, admixing, or compaction	• Mitigation will be implemented – Marathon has purchased 2,000 “bog mats” previously used for the cross-island transmission line
	• Reduce sensory disturbance from noise – mitigations to be always applied, with additional measures during migration periods outlined above	• The on-site environmental team will be notified if caribou are observed within 500 m of Project activities (e.g., vegetation clearing, heavy equipment use); activities may be reduced or delayed (this is in addition to the temporal reduction or cessation of activities in the Marathon pit area while caribou are migrating through the corridor and within a set distance from the site). This data will be tracked and used to develop trends and identify high-use areas – mitigations will be adapted as required in accordance with the data.	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on the extent of activity reduction and conditions regarding caribou proximity

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
		• Visual surveys for caribou will be undertaken prior to blasting, with blasting delayed if caribou are observed within 500 m	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on conditions regarding caribou proximity
		• Applicable equipment will have exhaust systems which will be regularly inspected and maintained so mufflers remain operating in accordance with manufacturers' recommendations	• Mitigation will be implemented
		• Where practicable in accessible areas (e.g., along cleared rights-of-way), trees and other vegetation will be left in place or allowed to grow to obstruct the view of Project facilities, reducing the change in viewshed and muffling noise	• Mitigation will be implemented
		• Vehicle traffic will be reduced by transporting employees to the site by bus	• Mitigation will be implemented
		• Sensory disturbance associated with the transportation of workers and materials to/from the site will be managed through a Traffic Management Plan to reduce sensory disturbance	• Mitigation will be implemented
		• Project vehicles will be required to comply with posted speed limits in all areas, with additional speed restrictions implemented during caribou migration periods	• Mitigation will be implemented
		• Project-related air traffic will maintain a minimum ferrying distance altitude of 500 m to the extent feasible	• Mitigation will be implemented
		• Since submitting the EA Registration in 2019, Marathon has relocated the high-grade ore and run-of-mine stockpiles, crusher, mill and mine services components approximately 2 km to the west, in part to reduce noise and other sensory disturbance on caribou	• Mitigation was implemented
	• Reduce sensory disturbance and effects on vegetation from fugitive / windblown dust	• Project vehicles on access and site roads will be required to comply with posted speed limits	• Mitigation will be implemented
		• Vehicle traffic will be reduced by transporting employees to the site by bus	• Mitigation will be implemented

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
		• Vehicles (including off-highway vehicles) used by Marathon personnel will be restricted to roads, trails and corridors to the extent practicable	• Mitigation will be implemented
		• The TMF will be designed and managed to reduce the area of exposed dry surfaces, where possible, to reduce the potential for windblown dust emissions	• Mitigation will be implemented
		• Emission control technologies will be implanted where necessary to reduce air contaminant emissions	• Mitigation will be implemented
		• All Project components will be progressively rehabilitated (including revegetation) to reduce dust emissions, including waste rock piles and overburden/topsoil stockpiles	• Mitigation will be implemented
		• Dust suppression will be applied on an as-needed basis during high wind conditions or if measured ambient particulate matter concentrations are in exceedance of the Newfoundland and Labrador Ambient Air Quality Standards	• Mitigation will be implemented
		• Water will be applied on roads as needed to mitigate dust emissions	• Mitigation will be implemented
	• Reduce sensory disturbance from light	• The on-site environmental team will be notified if caribou are observed within 500 m of Project activities (e.g., vegetation clearing, heavy equipment use); activities may be reduced or delayed (this is in addition to the temporal reduction or cessation of activities in the Marathon pit area while caribou are migrating through the corridor and within a set distance from the site)	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on the extent of activity reduction and conditions regarding caribou proximity
		• Only the amount of lighting required for safe construction and operation activities will be installed; exterior lights will be shielded from above where required	• Mitigation will be implemented
		• Mobile and permanent lighting will be located such that unavoidable light spill from the working area is not directed toward receptors outside of the Project area, to the extent practicable	• Mitigation will be implemented
		• Lights will be designed to avoid excessive use of mobile flood lighting units and will be turned off when they are not required	• Mitigation will be implemented

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
		• Full cut-off luminaires will be used wherever practicable to reduce glare, light trespass and sky glow from Project lighting	• Mitigation will be implemented
	• Reduce sensory disturbance from vibrations	• Visual surveys for caribou will be undertaken prior to blasting, with blasting delayed if caribou are observed within 500 m (this is in addition to the temporal reduction or cessation of activities in the Marathon pit area while caribou are migrating through the corridor and within a set distance from the site)	• Mitigation will be implemented • NLDFFA-Wildlife Division to be consulted on conditions regarding caribou proximity
3) Restore Measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to effects that cannot be completely avoided and/or reduced (often most applicable at end of Project, but can be applied in stages as areas no longer are required)	• Restore caribou habitat	• Plan for closure during Project design – ensuring that Project features are designed and developed such that progressive and final rehabilitation activities do not require major re-work or significant alteration of the adjacent land and environment	• Mitigation implemented / ongoing
		• Develop a conceptual Rehabilitation and Closure Plan (RCP) as required under the *Mining Act* – as the Project proceeds the RCP will become more prescriptive and comprehensive prior to implementation – final RCP will include specific consideration of benefit to caribou values	• Mitigation will be implemented
		• The overburden and topsoil stockpiles, haul roads, and water management features associated with the Marathon pit area will be removed and these areas rehabilitated to as close to pre-development conditions as possible	• Mitigation will be implemented
		• Disturbed areas will be graded and/or scarified and covered with overburden and organic materials, where required; areas will be seeded (using native seed mix) to promote natural re-vegetation – part of progressive and final rehabilitation	• Mitigation will be implemented
		• Plant vegetation, as part of progressive and final rehabilitation, that is suitable habitat for caribou (and not preferred by moose)	• Mitigation to be discussed with NLDFFA-Wildlife Division
		• Plant trees to manage line-of-sight to reduce visual and noise disturbance, as required during Project construction and operation	• Mitigation to be discussed with NLDFFA-Wildlife Division
	• Restrict access to public by decommissioning/blocking roads	• Decommissioning and rehabilitation of roads on the mine site during closure that are not required for long-term monitoring	• Mitigation will be implemented

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
	• Progressive rehabilitation (revegetation) of waste rock pile	• Waste rock piles will be progressively rehabilitated over the life of the Project; requires advance planning to determine the nature of waste rock piles upon closure – waste rock piles will be constructed from the ground up using slopes and benches of 10 m height; when a bench is finished in one area, the horizontal bench and downhill slope will be covered with overburden / organics (anticipated 0.3 m in total thickness) and revegetated	• Mitigation to be discussed with NLDFFA-Wildlife Division regarding the nature of the waste rock piles upon closure
	• Re-establish natural watercourses	• Project design considers avoidance of natural watercourses, however, given the hydrologic conditions at site, total avoidance is not feasible. Natural watercourses affected by the Project will be re-established during rehabilitation and closure to the extent practicable.	• Mitigation implemented / ongoing
4) Offset This measure may be implemented after all previous steps in the mitigation hierarchy have been exhausted and residual effects are still considered unacceptable. This step usually involves regulatory consultation; offset measures can be delivered in a variety of ways, but if delivered as "restorative" these are typically implemented outside of Project workspaces.	• Restore other habitats that have been previously degraded	• Restoration of degraded habitats outside of the Project footprint to offset Project residual effects – securing areas for restoration that are not part of a Marathon Lease can be challenging (e.g., Crown land; other tenures)	• Not considered to date
	• Management actions by regulators	• Physical interventions to improve ecological conditions (e.g., altering habitat to 'replace' the affected habitat, reduce predation in area)	• Not considered to date; would need to be implemented by the Government of NL
		• Reduce caribou harvest to offset for potential increased mortality risk	• Not considered to date; would need to be implemented by the Government of NL
		• Implement initiatives to reduce predation risk to caribou (e.g., coyote and black bear reduction strategies)	• Not considered to date; would need to be implemented by the Government of NL
		• Vehicle restrictions (including off-highway vehicles) in other areas (i.e., outside of the Project Area) to reduce stress on caribou during sensitive periods	• Not considered to date; would need to be implemented by the Government of NL
		• Legislative mechanisms (e.g., establishing protected areas) to preserve ecological conditions and habitats in other areas	• Not considered to date; would need to be implemented by the Government of NL

Step	Mitigation Strategy	Evaluation of Mitigation	Mitigation Status
	• Maternal penning	• Place females in an enclosure to birth and raise young to an age when predation risk is low – costly and poses challenges for migratory herds; intrusive measure unlikely to be considered acceptable by regulators, stakeholders and public	• Not considered to date; will likely be dismissed

APPENDIX IR-61.A
HUMAN HEALTH RISK ASSESSMENT

(Submitted as Separate PDF)