APPENDIX D LESSONS LEARNED AND PREDICTED RESIDUAL EFFECTS

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D.1 LESSONS LEARNED

The following tables summarize select lessons learned in closure planning at other mines in the region that are considered relevant to Snap Lake Mine.

Table 1 Snap Lake Closure Research that Included a Review of Relevant Mine Practices and Lessons Learned

Topic	Document	Subject	Lesson Learned	Management Result
Revegetation	ARKTIS, 2013. De Beers Canada Inc., Snap Lake Mine, Revegetation Research Program 2013 Annual Report. December.	Included a focused literature review of long term soil management techniques, baseline soil sampling, and completion of a preliminary volume balance for salvaged materials.	The literature review identified six key management techniques to mitigate against common negative effects to soil properties.	These methods were considered in the management of salvaged organic materials.
Revegetation	ARKTIS, 2014. De Beers Canada Inc., Snap Lake Mine, Metals Uptake and Accumulation in Vegetation. December.	Summary of processes involved in metal uptake by vegetation from substrates, review of notable assumptions and predictions from the Project EA, key findings from research completed to date at similar northern mine sites. Results were used to evaluate possible implications to closure planning for the Snap Lake Mine.	At Ekati, there is potential risk to wildlife receptors from consumption of plants growing on PK.	The North Pile facility will be capped with non-PAG rock. No reclamation activities encouraging revegetation (e.g., placement of salvaged soil, re-contouring, etc.) are planned for the North Pile.
North Pile Closure	ARKTIS, 2014. De Beers Canada Inc. Snap Lake Mine, 2013 North Pile Cryoconcentration Research. January.	Provides a background on cryoconcentration, identifies concerns relating to cryoconcentration raised during the EA process and discusses the potential implications on monitoring and management of the North Pile and the seepage waters expelled from it.	At Ekati, cryoconcentration may be contributing to high concentrations in water draining from the kimberlite pile. At Nanisivik and Rankin Inlet, cryoconcentration was found to contribute to freezing point depression.	The use of a PK pile will limit the quantity of impacted seepage due to exposure to freezing surface temperatures and permafrost aggradation. Placement of an engineered cover over PK in the North Pile will promote surface runoff and further limit infiltration and water contact with PK material prior to entering Snap Lake.

Topic	Document	Subject	Lesson Learned	Management Result
Revegetation	ARKTIS, 2014. Memorandum: Reclamation Research – Revegetation Test Plots Experimental Design. July.	Presents the proposed experimental methods for the candidate species field trials at the revegetation test plots, including a review of methods used at other mines sites.	At Ekati and Diavik, surface roughening and addition of topsoil has a positive impact on revegetation success. At Diavik, fertilizer did not significantly impact plant growth after two years. At Diavik, spring planting improved plant survival, while at Ekati survival was similar for both spring and fall planting.	Site re-contouring has been included as a key reclamation activity to promote natural recovery of local vegetation. The lessons regarding fertilizer as an amendment have been considered in development of research trials and the final site revegetation plan. Overburden was salvaged and stockpiled for use in reclamation. Where planting is considered, emphasis will be on fall or spring planting over summer planting.
Revegetation	ARKTIS, 2014. De Beers Canada Inc., Snap Lake Mine, Seed Development Research Project Desktop Review. July.	Presents a desktop review focusing on the selection of candidate plant species, application of the candidate species to different areas at the site, and recommendations for sourcing and development of a seed and seedling stock for use in revegetation.	A list of candidate species was identified that included eight graminoid species, two forb species, and six shrub species based on Traditional Knowledge value and demonstrated success in revegetation research or progressive reclamation at Ekati or Diavik.	This information was considered in development of research trials and in development of closure criteria and the final site revegetation plan.
Revegetation and Closure Criteria	ARKTIS, 2016. De Beers Canada Inc., Snap Lake Mine, Revegetation Closure Criteria. September.	Outlines proposed mine-component specific revegetation closure criteria based on available literature, monitoring data and the EA's residual impact predictions for post-closure ground conditions.	Review of revegetation performance observed at Ekati provided a range of potential levels of regrowth in terms of ground cover, species richness and timelines that may be achieved at Snap Lake.	This information was considered in development of closure criteria and the final site revegetation plan.

Table 2 Notable Lessons Learned at Similar Mine Sites which Have Been Considered in Closure Planning for the Snap Lake Project

Development	Activity Which Led to Lesson	Lesson Learned	Management Result
Site Wide			
Ekati and Diavik Diamond Mines – NWT	Fencing areas	Fencing has led to caribou mortality from entanglement. Fences can be used by predators to limit escape options of their prey.	A rock cover will be placed over the North Pile at closure. Fencing will not be erected as part of closure activities at Snap Lake.
Ekati and Diavik Diamond Mines – NWT	Revegetation research	Site re-contouring and landscaping have improved moisture conditions, which in turn have improved vegetation success.	Site re-contouring has been included as a key reclamation activity to promote natural recovery of local vegetation.
		Creating microhabitat, such as small boulder piles and mild depressions to trap moisture, has shown to be effective in enhancing plant growth opportunities, although boulder piles have only worked where vegetation is already established.	This method has been considered in development of research trials and the final site revegetation plan.
		The Ekati Diamond Mine has found that native plant cultivars applied at a low seeding rate have been the most successful in encouraging native plant recolonization.	This method has been considered in development of research trials and the final site revegetation plan.
		Summer planting has not proven successful. Seeds failed to germinate or seedlings died from moisture stress; fall or spring planting shows the most promise.	Where planting is considered, emphasis will be on fall or spring planting over summer planting.
		Grazing of newly established vegetation has been problematic at the Ekati Diamond Mine, and some method of discouraging grazers, such as Arctic hares, may be required.	Consideration of grazing needs has been accounted for when evaluating revegetation success and growth metrics.
		Salvaged glacial materials mixed with lake bed sediments containing a large portion of till have proved successful in promoting plant growth; however, the inclusion of too much lake sediments has led to soil compaction and the inhibition of plant growth.	Overburden was salvaged and stockpiled for use in reclamation.

Development	Activity Which Led to Lesson	Lesson Learned	Management Result
Diavik Diamond Mine – NWT	Incorporation of engagement and TK into closure designs	Closure design for roads and laydown areas has incorporated engagement and TK feedback to preferentially re-slope areas with less than 3 m (e.g., roads) of material outward. For areas that are greater than 3 m (e.g., laydowns), displace the deposited material to broaden the slope to limit increasing the overall disturbed extent.	This type of information has been discussed during project specific engagement sessions, and input received has been considered in the plans for final landform design of the site (Arktis, 2019).
		Closure designs to facilitate safe passage of people and wildlife have incorporated engagement and TK feedback, resulting in designs that include routes for human and wildlife travel across site where smoother surfaces would remain after closure (i.e. un-scarified areas).	This type of information has been discussed during project specific engagement sessions, and input received has been considered in the plans for final landform design of the site (Arktis, 2019).
		The revegetation strategy will incorporate priority areas for revegetation as identified from engagement and TK, and may also include strategies identified through engagement feedback: • Exclusion of areas where chemical or waste storage occurs. • Focusing revegetation around water collection areas at the base of rock piles.	Input received through engagement sessions has been incorporated through the identification of priority areas, and the Revegetation Plan (Appendix E.1).
Processed Kimberlite Facilities			
Colomac Gold Mine and Ekati Diamond Mine – NWT	Sampling of caribou fecal matter	Elevated levels of ash content were found in caribou fecal matter at both Ekati and Colomac, indicating uptake of inorganic minerals (MacDonald and Gunn, 2004).	The North Pile facility will be capped with non-PAG rock. No reclamation activities encouraging revegetation (e.g. placement of salvaged soil, re-contouring, etc.) are planned for the North Pile.
Ekati Diamond Mine, Diavik Diamond Mine, Snap Lake Mine – NWT, Jericho Diamond Project – Nunavut	Reclamation research	Caribou are known to use artificial habitats created by mine structures (e.g., roads, mine waste piles). These structures may provide a means of avoiding insect harassment, as caribou are often observed bedding or resting on these structures (Gunn et al., 1998; BHPB 2004, 2007).	Final outer slope of North Pile is designed to be 3H:1V, which will support safe wildlife passage.

Development	Activity Which Led to Lesson	Lesson Learned	Management Result
Ekati Diamond Mine – NWT	Placement of mine rock piles.	Permafrost develops rapidly within mine rock piles with an active freeze/thaw layer of about 8 m.	Rate of PK placement can influence the rate of permafrost development in the pile. Permafrost has not been assumed as a mitigating factor for slope stability, but is anticipated to occur and improve stability compared to predictions. Placement of an engineered cover over PK in the North Pile will promote surface runoff and further limit infiltration and water contact with PK material prior to entering Snap Lake.
Diavik Diamond Mine – NWT	Incorporation of engagement and TK into closure designs	Closure designs for rock piles, either naturally or through design intent, have come to satisfy most engagement and TK feedback recommendations regarding landform design and aesthetics, wildlife and caribou access and safe passage, and habitat function. These include a design that: • Provides safe wildlife access • Limits pooling of water • Simulates natural appearance/shape of eskers • Provides denning opportunities The main design features that satisfy these conditions include: • 3H:1V outer slopes • Some steeper areas to allow snow accumulation and denning habitat • Rock cover placement • Surface grading to encourage runoff • Caribou ramps and pathways free of obstacles	Final outer slope of North Pile is designed to be 3H:1V, which will support safe wildlife passage. Placement of rock cover will create a surface that will be safe for passage. Final grading and re-shaping will encourage runoff and help satisfy aesthetics.
MEND Report 1.61.5c	Technical guidance document for cold regions cover system design	Best management practices regarding how cover system design should be conducted, and guidance on cover design to meet cover design objectives.	North Pile cover design and thickness will be based on the guidance provided by MEND.

Development	Activity Which Led to Lesson	Lesson Learned	Management Result
Snap Lake			
Diavik Diamond Mine, Ekati Diamond Mine, Snap Lake Diamond Mine – NWT	Underestimated groundwater inflows in initial site water quantity and quality predictions.	All three mines were developed where zones of enhanced permeability persisted, which led to underestimation of groundwater inflows, and in some cases the volume of high TDS water requiring management at surface.	The underground mine has been reclaimed and flooded as part of ECM to reduce water management requirements.

D.2 PREDICTED RESIDUAL EFFECTS

This section is linked with Section 5.4 of the FCRP.

The following discussion outlines the methodology from the EA effects analysis, and provides a summary of results for predicted negative residual effects of mining that were assumed to persist up until reclamation activities have been completed, or further into the post-closure phase. Effects which were classified as reversible by the end of construction, have not been included in discussion below. Monitoring results during operations and extended care and maintenance show that effects are consistent with expected results, and supporting information is also included in this section.

D.2.1 Methodology

The assessment method used for the project EAR (De Beers, 2002) involves the evaluation of residual impacts from the Project to physical and biological VECs. VECs used in the assessment include:

- Air quality;
- Noise;
- Terrestrial resources:
  - Geology and terrain;
  - Ground thermal regime;
  - ELC units;
  - Rare plant potential and traditional plant potential;
  - Biodiversity;
  - Vegetation health;
  - Wildlife (habitat, movement and behaviour, and abundance);
- Aquatic resources:
  - Hydrology;
  - Water quality;
  - Aquatic organisms and habitat:
    - Non-fish aquatic organisms – Snap Lake;
    - Non-fish aquatic organisms – North Lake, Northeast Lake, NL5 and NL6;
    - Fish habitat;
    - Fish health;
    - Fish abundance;
- Resource uses:
  - Heritage resources traditional land use;
  - Non-traditional land use;

  - Aesthetic quality;
  - Tibbitt-Contwoyto winter road; and
- Environmental health.

Each potential impact is described in terms of the following criteria: direction, magnitude, geographic extent, duration, reversibility, and frequency (including seasonal effects); as directed by the Terms of Reference provided by MVEIRB (MVEIRB, 2001). Definitions for the ranking of several of the criteria, such as geographic extent, duration, reversibility, and frequency have been standardized so that they are common within impacts to each site resource. The ranking of magnitude is often specific to the component (e.g., components of Aquatic Resources include hydrology, surface water quality, aquatic organism health). The direction of impacts may be either positive or negative. Table D-3 details the impact criteria definitions provided within the project EAR (De Beers, 2002) for the various VECs, which are used in the descriptions of predicted residual impacts and environmental consequences.

Environmental consequence provides an overall risk assessment of the residual impacts based on a ranking system with four criteria (magnitude, geographic extent, duration, and reversibility) that represent the most important aspects of the impact. The ranking of each criterion was completed using assigned values, but the values have no meaning other than to ensure that ranks are shown in the correct relative position to each other. Table D-4 presents the ranking values for the four assessment criteria used to evaluate the overall environmental consequence for each residual impact. Environmental consequence was only determined for residual impacts that are negative in direction. As professional opinions may vary on the dividing line between low and moderate, or moderate and high, the method used here has been kept as simple and transparent as possible, while still providing a standardized comparison of the risk, or environmental consequence of the Project (De Beers, 2002).

The probability of occurrence and confidence level analyses are also discussed to identify assumptions made in the assessment process. For example, a series of conservative assumptions can lead to predictions for environmental consequences from impacts that have a low probability of occurring. There will be a high level of confidence that the actual impacts will be lower than presented in the assessment. This discussion is presented within the EAR has not been included with this FCRP document.

A summary of all negative predicted residual impacts for each of the valued ecosystem components from the EAR is presented below in Table 3. No additional negative predicted residual impacts were presented in the 2014 EA Amendment (EA1314-02).

Table 3 Residual Impact Classification Criteria Definitions for the Physical and Biological Valued Ecosystem Components (De Beers, 2002)

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
Air Quality and Noise						
Air quality	**Positive:** a decrease in emissions and/or ambient concentrations **Negative:** an increase in emissions and/or ambient concentrations	**Magnitude:** varies with the air emission compound being evaluated; specifics provided in Table 7.1-10 of the Snap Lake Project Environmental Assessment Report (De Beers, 2002).	**Local:** effect restricted to the active mine area and areas within 500 m of the active mine area **Regional:** effect restricted to the RSA **Beyond Regional:** effect extends beyond the RSA	**Short-term:** <3 years **Medium-term:** 3 to 26 years **Long-term:** >26 years	**Reversible (short-term):** effects can be reversed at closure of the project **Reversible (long-term):** effects can be reversed in +100 years **Irreversible:** effects cannot be reversed	**Low:** Occurs once **Moderate:** Occurs intermittently **High:** Occurs continuously
Noise	**Neutral:** no change compared to ambient sound levels **Negative:** an increase in noise	**Negligible:** background noise (20 dBA Leq) Low: > background noise, and 40 dBA Leq at 1.5 km (continuous or intermittent sources) **Moderate:** > 40 dBA Leq at 1.5 km (continuous or intermittent sources), “50 dBA Leq at 1.5 km (continuous sources 24 hour average sound level), and 60 dBA Leq at 1.5 km (intermittent sources 1 hour average sound level) **High:** > 50 dBA Leq at 1.5 km (continuous sources 24 hour average sound level), > 60 dBA Leq at 1.5 km (intermittent sources 1 hour average sound level)	**Local:** effect is restricted to the LSA (e.g., mine footprint plus 1.5 km) **Regional:** effect extends beyond the LSA into the RSA **Beyond Regional:** effect extends beyond the RSA	**Short-term:** 3 years; includes pre-construction and construction phases **Medium-term:** 26 years; Includes operation phase **Long-term:** more than 26 years (i.e., after closure)	**Reversible (short-term):** effects can be reversed at closure of the project **Reversible (long-term):** effects can be reversed in +100 years **Irreversible:** effects cannot be reversed	**Low:** Occurs once **Moderate:** Occurs intermittently **High:** Occurs continuously

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
Geology and Terrain						
Ground Thermal Regime	**Neutral:** no change in ground thermal regime **Negative:** an increase in the depth of the active layer	**Negligible:** no measurable effect on the ground thermal regime **Low:** an increase in the depth of the active layer by 50% or less **Moderate:** an increase in the depth of the active layer by more than 50%, but less than 100% **High:** complete thawing of the permafrost	**Local:** effect is restricted to the LSA (e.g., mine footprint plus 500 m) **Regional:** effect extends beyond the LSA into the RSA **Beyond Regional:** effect extends beyond the RSA	**Short-term:** 3 years; includes pre-construction and construction phases **Medium-term:** 26 years; includes operation phase **Long-term:** +26 years; following closure	**Reversible Short-term:** effect can be reversed during closure of the project **Reversible Long-term:** effects can be reversed in 100 years **Irreversible:** effects cannot be reversed	**Low:** occurs once **Medium:** Occurs intermittently **High:** Occurs continuously
Ecological Land Classification and Biodiversity						
Ecological Land Classification	**Neutral:** no change in the area and/or quality of ELC units, VECs, and/or plant health in the far future **Positive:** an increase in the area and/or quality of ELC units, VECs, and/or plant health **Negative:** a decrease in the area and/or quality of ELC units, VECs, and/or quality of ELC units, VECs, and/or plant health	**Negligible:** no measurable effect (<1% change from baseline) in the area or quality of ELC units, VECs, or plant health **Low:** <10% change or loss in the area and/or quality of ELC units, VECs, and/or plant health **Moderate:** 10 to 20% change and/or loss in the area and/or quality of ELC units, VECs, and/or plant health **High:** >20% change and/or loss in the area and/or quality of ELC units, VECs, and/or plant health	**Local:** effect is restricted to the LSA (e.g., mine footprint plus 500 m) **Regional:** effect extends beyond the LSA into the RSA **Beyond Regional:** effect extends beyond the RSA	**Short-term:** 3 years; includes pre-construction and construction phases **Medium-term:** 26 years; includes operation phase **Long-term:** +26 years; following closure	**Reversible Short-term:** effect on ELC units can be reversed within 26 years during preconstruction, construction, operational and/or closure phases of the project **Reversible Long-term:** effects on ELC units can be reversed in 100 years into the far future **Irreversible:** effects cannot be reversed	**Low:** occurs once **Medium:** Occurs intermittently **High:** Occurs continuously

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
Biodiversity Landscape	**Neutral:** no change in landscape level indices (e.g., patch number, mean patch size, mean nearest neighbour) **Negative:** change reflected as either an increase or decrease in landscape level indices	**Negligible:** no measurable effect (<1% change from baseline) in landscape level indices (e.g., patch number, mean patch size, mean nearest neighbour) **Low:** <10% change in landscape level indices **Moderate:** 10 to 20% change, either an increase or decrease, in landscape level indices **High:** >20% change in landscape level indices	**Local:** effect is restricted to the LSA (e.g., mine footprint plus 500 m) **Regional:** effect extends beyond the LSA into the RSA **Beyond Regional:** effect extends beyond the RSA	**Short-term:** 3 years; includes pre-construction and construction phases **Medium-term:** 26 years; includes operation phase **Long-term:** +26 years; following closure	**Reversible Short-term:** effect can be reversed within 26 years during pre-construction, construction, operational and/or closure phases of the project **Reversible Long-term:** effects can be reversed in 100 years **Irreversible:** effects cannot be reversed	**Low:** occurs once **Medium:** Occurs intermittently **High:** Occurs continuously
Biodiversity Ecosystem	**Neutral:** no measurable change in the areas of high, moderate and/or low biodiversity potential **Negative:** a decrease in high or moderate biodiversity potential and an increase in low biodiversity potential	**Negligible:** no measurable effect (<1% change from baseline) in the areas of high, moderate and/or low biodiversity potential **Low:** <10% change in the area of high, moderate and/or low biodiversity potential **Moderate:** 10 to 20% change in the area of high, moderate and/or low biodiversity potential **High:** >20% change in the area of high, moderate and/or low biodiversity potential	**Local:** effect is restricted to the LSA (e.g., mine footprint plus 500 m) **Regional:** effect extends beyond the LSA into the RSA **Beyond Regional:** effect extends beyond the RSA	**Short-term:** 3 years; includes pre-construction and construction phases, or closure **Medium-term:** 26 years; includes operation phase **Long-term:** greater than 26 years (extends beyond closure)	**Reversible Short-term:** effect can be reversed within 26 years during pre-construction, construction, operational and/or closure phases of the project **Reversible Long-term:** effects can be reversed 100 years in the far future **Irreversible:** effects cannot be reversed	**Low:** occurs once **Medium:** Occurs intermittently or periodically **High:** Occurs continuously
Wildlife habitat, movement and behaviour, and abundance	**Neutral:** no measurable change in wildlife habitat, movement, or abundance	**Negligible:** no detectable change from baseline conditions **Low:** exceeds the average value for baseline conditions, but within the range of natural	**Local:** effect is restricted to the LSA (e.g., mine footprint plus 500 m)	**Short-term:** 3 years; includes pre-construction and construction phases, or closure	**Reversible Short-term:** effect can be reversed within 26 years during pre-construction, construction, operational and/or closure phases of the project	**Low:** occurs once **Medium:** occurs intermittently or periodically

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
	Negative: a reduction in habitat, restriction in movement, change in behaviour, or reduction in abundance	variation and well below a guideline or threshold value **Moderate:** exceeds the average value for baseline conditions, approaches the limits of natural variation, but below or equal to a guideline or threshold value **High:** predicted to exceed baseline conditions or a guideline or threshold value so that there will be a detectable change beyond the range of natural variation (i.e., change of state from baseline conditions)	**Regional:** effect extends beyond the LSA into the RSA **Beyond Regional:** effect extends beyond the RSA	**Medium-term:** 26 years; includes operation phase **Long-term:** greater than 26 years (extends beyond closure)	**Reversible Long-term:** effect can be reversed in 100 years in the far future **Irreversible:** effects cannot be reversed	**High:** occurs continuously
Hydrology						
Mean Discharge and Lake levels	**Neutral:** no change in discharge **Negative:** a change in discharge	**No Effect:** <1% change in the hydrological parameters; effect is not measurable **Negligible:** A level of change <5%. The measurement accuracy for the hydrological parameters, such as discharge using standard Water Survey of Canada (WSC) techniques is ± 5%. The level of change is measurable but with a high level of inaccuracy **Low:** A change of between 5% and 10%. The percent change of the hydrological parameters between 5% and 10% is measurable with a low level of accuracy. This level of change in hydrological conditions is noticeable, but would have a small effect on the river channel or lake shoreline geomorphic conditions	**Local:** effect is restricted to the LSA (i.e., waters showing a direct water connection with mine development) **Regional:** effect extends beyond the LSA into the RSA (i.e., Lockhart River drainage basin) **Beyond Regional:** effect extends beyond the RSA	**Short-term:** 3 years; includes pre-construction and construction phases, or closure **Medium-term:** 26 years; includes operation phase **Long-term:** greater than 26 years (extends beyond closure)	**Reversible Short-term:** effect can be reversed within 26 years during pre-construction, construction, operational and/or closure phases of the project **Reversible Long-term:** effect can be reversed in 100 years in the far future **Irreversible:** effects cannot be reversed	**Low:** occurs once **Medium:** occurs intermittently or periodically **High:** occurs continuously

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
		Moderate: A change of between 10% and 20%. The percent change of the hydrological parameters between 10% and 20% is measurable with a reasonable degree of accuracy. The level of change in hydrological conditions begins to affect the river channel or lake shoreline geomorphic conditions **High:** A change of >20%. The percent change of the hydrological parameters higher than 20% is measurable with a high level of accuracy. This level of change begins to affect river channels or shoreline geomorphic conditions and will alter the regime characteristics of flow and channel or shoreline geomorphic conditions				
Surface Water Quality						
Surface Water (Drinking Water)	**Neutral:** no change in water quality **Negative:** an increase in surface water concentrations	**Negligible:** maximum average predicted concentration in the water body or the maximum predicted concentration at a potable water intake is less than the Canadian Drinking Water Guidelines CDWG **Low:** no definition available, category not used for this component **Moderate:** the maximum predicted concentration exceeds the CDWG for an aesthetic objective **High:** maximum average predicted concentration in the water body or the maximum predicted	**Local:** effect is restricted to the LSA (i.e., waters showing a direct water connection with mine development) **Regional:** effect extends beyond the LSA into the RSA	**Short-term:** 3 years; includes pre-construction and construction phases **Medium-term:** 26 years; includes operation phase **Long-term:** 26 years; following closure	**Reversible Short-term:** effect can be reversed within 30 years or twice the flushing period of Snap Lake **Reversible Long-term:** effects can be reversed in greater than 30 years **Irreversible:** effects cannot be reversed	**Low:** occurs once **Medium:** occurs intermittently **High:** occurs continuously

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
		concentration at a potable water intake is greater than or equal to the CDWG				
Surface Water (Aquatic Life)	**Neutral:** no change in water quality; **Negative:** an increase in surface water concentrations.	**Negligible:** concentrations above Canadian Council of Ministers of the Environment (CCME) guidelines, United States Environmental Protection Agency (U.S. EPA) criteria or site-specific water quality benchmarks in less than 1% of a waterbody, or potential chronic effects on less than 5% of the aquatic community in a waterbody **Low:** potential chronic effects on greater than 5% but less than 10% of the aquatic community in a waterbody, or up to 20% of the aquatic community in less than 10% of a waterbody **Moderate:** potential chronic effects on greater than 10% but less than 20% of the aquatic community in a waterbody, or to 20% of the aquatic community in less than 20% of a waterbody **High:** potential chronic effects on greater than 20% of the aquatic community over more than 20% of a waterbody	**Local:** effect is restricted to the LSA (i.e., waters showing a direct water connection with mine development) **Regional:** effect extends beyond the LSA into the RSA	**Short-term:** 3 years; includes pre-construction and construction phases **Medium-term:** 26 years; includes operation phase **Long-term:** 26 years; following closure	**Reversible Short-term:** effect can be reversed within 30 years or twice the flushing period of Snap Lake **Reversible Long-term:** effects can be reversed in greater than 30 years **Irreversible:** effects cannot be reversed	**Low:** occurs once **Medium:** occurs intermittently **High:** occurs continuously
Aquatic Organisms and Habitat						
Fish Habitat	**Positive:** an increase in available fish habitat **Negative:** a decrease in available fish habitat	**Negligible:** a change to <1% of fish habitat units **Low:** a change to between 1% and 10% of fish habitat units	**Local:** effect is restricted to the LSA (i.e., waters showing a direct water connection with mine development)	**Short-term:** 3 years; includes pre-construction and construction phases	**Reversible Short-term:** effect can be reversed within 26 years during pre-construction, construction, operational and/or closure phases of the project	**Low:** occurs once **Medium:** occurs intermittently

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
		Moderate: a change to between 10% and 20% of fish habitat units **High:** a change to >20% of fish habitat units	**Regional:** effect extends beyond the LSA into the RSA (i.e., Lockhart River drainage basin) **Beyond Regional:** effect extends beyond the RSA	**Medium-term:** 26 years; includes operation phase **Long-term:** 26 years; following closure	**Reversible Long-term:** effect can be reversed in 100 years **Irreversible:** effects cannot be reversed	**High:** occurs continuously
Aquatic Organisms	**Neutral:** no change in organism health **Negative:** a decrease in organism health, measured as growth or reproduction	**Negligible:** negligible impact on water quality with no effects on keystone species, sublethal effects on other species in less than 1% of the waterbody, no effects on water or sediment quality in areas of critical habitat, seasonal changes in water quality only; an effect below an establish guideline for the protection of fish populations (e.g., blasting guidelines) **Low:** low impact on water quality, sublethal effects on keystone fish food species in less than 10% of the waterbody, sublethal effects on other species in less than 10% of the waterbody, effects on water or sediment quality in less than 5% of critical habitat areas, seasonal changes in water quality only **Moderate:** moderate impact on water quality, sublethal effects on keystone fish food species in less than 20% of the waterbody, sublethal effects on other species in less than 20% of the waterbody, effects on water or sediment quality in less than 10% of critical habitat areas, seasonal changes in water quality only	**Local:** effect is restricted to the LSA (i.e., waters showing a direct water connection with mine development) **Regional:** effect extends beyond the LSA into the RSA	**Short-term:** 3 years; includes pre-construction and construction phases **Medium-term:** 26 years; includes operation phase **Long-term:** 26 years; following closure	**Reversible Short-term:** effect can be reversed within 30 years or twice the recovery period of Snap Lake **Reversible Long-term:** effects can be reversed in greater than 30 years **Irreversible:** effects cannot be reversed	**Low:** occurs once **Medium:** occurs intermittently **High:** occurs continuously

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
		High: high impact on water quality, sublethal to lethal effects on fish food keystone species in greater than 20% of the waterbody, sublethal effects on other species in greater than 20% of the waterbody, effects on water or sediment quality in greater than 10% of critical habitat areas, year-round effects on water quality; an effect above an establish guideline known to potentially cause direct mortality to fish				
Resource Uses						
Heritage resources	**Positive:** increase in information **Negative:** loss of resources and/or contextual information	**Negligible:** no physical impact occurs or no archaeological sites are expected to be present **Low:** minimal impact to valuable resources, or resources are few and of low value **Moderate:** partial impact to resources of high or moderate archaeological value **High:** severe physical impact to resources of high archaeological value	**Local:** effect restricted to areas of direct physical disturbance (local study area) **Regional:** effect extends to indirect effects of increased access/use in the region	**Short-term:** 3 years includes pre-construction and construction phases **Medium-term:** 26 years includes operation phase **Long-term:** >26 years following closure	**Reversible in the short-term:** predicted impact is reversible after mine closure **Reversible in the long-term:** predicted impact is reversible in 100 years **Irreversible:** predicted impact cannot be reversed	Not applicable
Availability of land for traditional land use purposes	**Neutral:** no change in available land for traditional land use purposes **Positive:** greater availability of land for traditional land use purposes	**Negligible:** no change in availability of land for traditional land use purposes **Low:** minimal (<10%) loss of land for traditional land use purposes	**Local:** loss of land within the local study area **Regional:** loss of land within the regional study area	**Short-term:** 3 years includes pre-construction and construction phases	**Reversible in the short-term:** predicted impact is reversible after mine closure	**Low:** occurs once **Medium:** Occur intermittently

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
	Negative: loss of land for traditional land use purposes	**Moderate:** some (10-25%) loss of land for traditional land use purposes **High:** substantial (>25%) loss of land for traditional land use purposes	**Beyond Regional:** loss of land beyond the regional study area	**Medium-term:** 26 years includes operation phase **Long-term:** >26 years following closure	**Reversible in the long-term:** predicted impact is reversible in 100 years **Irreversible:** predicted impact cannot be reversed	**High:** Occurs continuously
Ecologically representative areas	**Neutral:** no change in ecologically representative areas or no change in the possibility to establish ecologically representative areas **Positive:** increase in ecologically representative areas or the possibility to establish ecologically representative areas **Negative:** decrease in ecologically representative areas or the possibility to establish ecologically representative areas	**Negligible:** no change in ecologically representative areas **Low:** minimal (<10%) loss of potential ecologically representative areas **Moderate:** moderate (10 – 25%) loss of potential ecologically representative areas **High:** substantial (>25%) loss of potential ecologically representative areas	**Local:** effect is restricted to the local study area (e.g., mine footprint plus 500 m) **Regional:** effect extends beyond the local study area into the regional study area **Beyond Regional:** effect extends beyond the regional study area	**Short-term:** 3 years includes pre-construction and construction phases **Medium-term:** 26 years includes operation phase **Long-term:** >26 years following closure	**Reversible in the short-term:** predicted impact is reversible after mine closure **Reversible in the long-term:** predicted impact is reversible in 100 years **Irreversible:** predicted impact cannot be reversed	**Low:** occurs once **Medium:** Occur intermittently **High:** Occurs continuously
Non-traditional resource uses	**Neutral:** no change in resource use, resource availability or access	**Negligible:** no appreciable change in resource use, resource availability or access **Low:** possible small change (increase or decrease) in resource use, resource availability or access	**Local:** effect is restricted to the local study area (e.g., mine footprint plus 500 m)	**Short-term:** 3 years includes pre-construction and construction phases	**Reversible in the short-term:** predicted impact is reversible after mine closure	**Low:** occurs once **Medium:** Occur intermittently

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
	Positive: increase in resource use, resource availability or access **Negative:** decrease in resource use, resource availability or access	**Moderate:** some change (increase or decrease) in resource use, resource availability or access **High:** possible substantial change (increase or decrease) in resource use, resource availability or access	**Regional:** effect extends beyond the local study area into the regional study area **Beyond Regional:** effect extends beyond the regional study area	**Medium-term:** 26 years includes operation phase **Long-term:** >26 years following closure	**Reversible in the long-term:** predicted impact is reversible in 100 years **Irreversible:** predicted impact cannot be reversed	**High:** Occurs continuously
Aesthetic quality	**Neutral:** no change in the natural aesthetics in the vicinity of the project **Negative:** a change in the natural aesthetics in the vicinity of the project	**Negligible:** no appreciable change in aesthetics in the vicinity of the project **Low:** changes to the environment will not change the general impression in the vicinity of the project; the colour, texture and form of the landforms and objects introduced will not vary much from those already existing in the landscape **Moderate:** changes to the environment may be noted by an observer, but would be considered innocuous or minor; the colour, texture and form of the landforms and objects introduced differs from those already present **High:** changes to the environment occur which an observer may consider as making a substantial change to the surroundings; the colour, texture and shape of the landforms and objects introduced differs substantially from those already present	**Local:** effect is restricted to the local study area (e.g., mine footprint plus 500 m) **Regional:** effect extends beyond the local study area into the regional study area **Beyond Regional:** effect extends beyond the regional study area	**Short-term:** 3 years includes pre-construction and construction phases **Medium-term:** 26 years includes operation phase **Long-term:** >26 years following closure	**Reversible in the short-term:** predicted impact is reversible after mine closure **Reversible in the long-term:** predicted impact is reversible in 100 years **Irreversible:** predicted impact cannot be reversed	**Low:** occurs once **Medium:** Occur intermittently **High:** Occurs continuously

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
Tibbitt - Contwoyto winter road	**Neutral:** no increase in traffic volume or camp use, no change in access, or no improvement to infrastructure **Positive:** decrease in traffic volume or camp use, improvement in access, or improvement in infrastructure **Negative:** increase in traffic volume or camp use, decrease in access, or deterioration of infrastructure	**Negligible:** no change (<1%) in traffic volumes or camp use, no improvement in access or infrastructure **Low:** minimal (<10%) change in traffic volumes or camp use, minimal improvement in access or infrastructure **Moderate:** moderate (10-25%) change in traffic volumes or camp use, moderate improvement in access or infrastructure **High:** substantial (>25%) change in traffic volumes or camp use, substantial improvement in access or infrastructure	**Local:** effect is restricted to the local study area	**Short-term:** 3 years includes pre-construction and construction phases **Medium-term:** 26 years includes operation phase **Long-term:** >26 years following closure	**Reversible in the short-term:** predicted impact is reversible after mine closure **Reversible in the long-term:** predicted impact is reversible in 100 years **Irreversible:** predicted impact cannot be reversed	**Low:** occurs once **Medium:** Occur intermittently **High:** Occurs continuously

Table 4 Scoring Methodology for Residual Impact Classification Values and Environmental Consequence (De Beers, 2002)

Magnitude	Geographic Extent	Duration	Reversibility	Environmental Consequence[1]
Negligible (0)	Local (0)	Short-term (0)	Reversible (short-term) (0)	Negligible (≤ 5)
Low (5)	Regional (5)	Medium term (5)	Reversible (long-term) (5)	Low (> 5 to ≤ 20)
Moderate (10)	Beyond Regional (10)	Long-term (10)	Irreversible (15)	Moderate (> 20 to ≤ 30)
High (15)				High (> 30)

Notes:

[1] The environmental consequence will be determined by adding the numbers of the impact criteria. The ranking of environmental consequence was based on professional judgement. Additional detail is provided within the project EAR (De Beers, 2002).

D.2.2 Predicted Residual Impacts

Using the methodology discussed in Section D.3.1, the predicted residual impacts were assessed and the associated environmental consequences were evaluated for each impact that was determined to be in a negative direction.

This section discusses any negative, predicted residual impacts that were expected to exist beyond the closure of the Project site for both physical and biological VECs. The environmental consequence (risk) assessment is also presented for the originally predicted post-closure negative impacts. Residual impact criteria (e.g., direction, magnitude, reversibility, etc.) noted in the following sub-sections are defined in Table D-3 above. Complete details including the environment consequence calculations, residual impact criteria classification, probability of occurrence and level of confidence all VECs are available within Sections 6 through 11 of the Project EAR (De Beers, 2002). These EAR findings are re-evaluated in light of the FCRP, and any revisions to outcomes are noted.

D.2.2.1 Air Quality

The bulk of the mining activity at Snap Lake occurred below ground in a wet environment, thus the particulate emissions were low relative to open pit mining operations in the region. The air quality assessment included the impact assessment of SO_2, NO_2, TSP, PM_{10}, and $PM_{2.5}$, as well as, deposition of PAHs and trace metals, and releases of greenhouse gases (GHG).

Results of the residual impacts assessment included:

- Classification of the changes in SO2, NO2, TSP, PM10, and PM2.5 concentrations to the ambient air quality, as well as changes to acid deposition, indicated that any changes were limited to the operations time period, would be reversible in less than 3 years, and impacts were predicted to have a negligible or low, environmental consequence.
- Residual impacts from the release of PAHs and trace metals are discussed under the Environmental Health Assessment heading.
- Activities and operations at the Project resulted in the emission of carbon dioxide and other greenhouse gases (GHG). The release of GHG has been linked to global warming. There is also a high degree of uncertainty related to predicting the impact of GHG at the regional or local study areas. In view of the uncertainty pertaining to reversibility, no environmental consequence has been assessed for this impact.

Air dispersion modelling completed by Arktis for the ECM and Post Closure phases (Arktis, 2018) shows that the predicted mass-loadings are less than the NPRI and GNWT thresholds during the Post Closure phase, which aligns with the conclusions from the EA.

D.2.2.2 Noise

Impacts from the significant noise-producing activities such as on-site construction activity, on-site equipment operation and air traffic are not expected to occur beyond the Active Closure phase. The environmental consequences of noise related impacts from the construction and operations phase were assessed to be negligible to low, and reversible within the timeline expected for the completion of closure activities. This conclusion remains valid.

D.2.2.3 Terrestrial Resources

Geology and Terrain

Overall, losses to certain terrain units in the LSA were expected due to project development. Predicted residual impacts to boulder (moraine veneer), moraine, organic (shallow), organic (deep) and deep water terrain units were evaluated. Irreversible loss or alteration to all terrain units was expected to occur within the Project footprint, with the exception of the boulder (moraine veneer) terrain unit which was expected to have an increased area at closure. Irreversible losses, of negligible magnitude are also expected for the esker landform. The losses to terrain units within the LSA were ranked as having a low to high environmental consequence.

As of 2018, the total land disturbance associated with the Project within the LSA was 188 ha (Arktis, 2018). The current land disturbance area is less than the predicted disturbance area from the EAR (13% of the total LSA).

Ground Thermal Regime

The results of the impact analysis indicate that, during construction and operation, the mine, mill, and ancillary structures would have low magnitude of impact on the ground thermal regime. Upon closure of the facilities, the heated structures will be removed and the ground thermal regime is expected to return to a frozen condition. An active layer will be developed on an annual basis and permafrost will be re-established. Since the depth of the active layer would be altered where the subsurface materials have been changed (e.g., crushed granite or sand has been added), the impact is considered irreversible. The North Pile was predicted to be completely frozen within about two years following cessation of deposition activities and an active layer would develop in the deposited PK. The environmental consequence was considered to be low to moderate.

Monitoring at site has shown that freezing of the pile is taking longer than the 3 years predicted in the EAR; however, freezing is still expected, and the current pile remains stable (DeBeers, 2017). Also, the North Pile has been designed to be physically stable even if the pile material is unfrozen (De Beers, 2002; Golder, 2018).

Potential influences of a warming climate over time post-closure could lead to thawing of the North Pile and porewater would seep to surface waters. This potential residual effect is address within the Aquatic Resources section.

ELC Units

The Project was predicted to result in the direct loss or alteration of 559.5 ha of ELC units in the LSA and an additional 83.7 ha of ELC units in the RSA during construction and operation of the Mine. Specifically, the following eight ELC units would be lost or altered:

- Heath/boulder;
- Esker complex;
- Heath tundra;
- Open spruce forest;

- Birch seep;
- Tussock-hummock;
- Sedge wetland; and
- Deep water.

The current land disturbance area is less than the predicted disturbance area from the EAR, and the losses of the ELC units from site clearing and site disturbance did not result in the complete removal of any one ELC unit from the LSA. The magnitude of the impacts were expected to be negligible for each ELC unit, and the residual impacts were considered to be reversible over the long term (within 100 years) or irreversible. The environmental consequences of the residual impacts were rated to be low to negligible.

Closure activities will introduce new permanent features to the landscape, including two influent storage ponds (12.9 ha), and two constructed wetlands (11.9 ha).These water control features are mitigations to ensure water quality entering Snap Lake meets the effluent quality criteria set by the MVLWB. Although these features were not explicitly considered in the EAR, they are located within the area assessed as disturbed by mining in the EAR and represent an improvement over the original design.The wetlands are designed to serve an important water quality function for nutrients, and will represent a more complex type of land cover that may provide habitat for some aquatic and/or wildlife species over the long term. The direction of this effect could be viewed as either neutral or positive. The geographic extent is local, and the magnitude is considered negligible (>1% of LSA). Residual effects are expected to be negligible.

Rare Plant Potential and Traditional Plant Potential

The two valued ecosystem components (VECs) assessed include rare plant potential and traditional plant potential. There was no known loss to rare plants during construction or operation and none are anticipated for closure phases of the Mine. Several ELC units expected to experience loss or alteration were assigned a high rare plant potential. The negative residual impacts to rare plant potential were expected to be negligible, but irreversible. Negative residual impacts to traditional plant potential were considered of negligible magnitude and reversible over the long term (within 100 years). The residual impacts to rare and traditional plant potential were expected to have a moderate and low environmental consequence, respectively.

The current land disturbance area is less than the predicted disturbance area from the EAR, and therefore the conclusions with respect to residual effects for rare plant potential and traditional plant potential remain valid.

Biodiversity

Residual impacts to biodiversity were evaluated at the landscape and ecosystem level. There will be landscape level residual effects on the heath/bedrock/boulder, heath tundra, esker complex, open/closed spruce forests, birch seep/tall riparian shrub, tussock-hummock/sedge wetlands, and deep/shallow water biodiversity ELC units. The residual effects were considered to be negative in direction, and low to negligible in magnitude. The effects were considered to be reversible in the long-term (100 years) with the proposed closure activities, and the environmental consequences of the residual impacts were considered to be low. Residual impacts to ecosystem level biodiversity in the RSA and LSA were expected to be low (less than 10% in area of high/moderate/low biodiversity potential), reversible in the long term (100 years), with a corresponding low environmental consequence.

The current land disturbance area is less than the predicted disturbance area from the EAR, and therefore the conclusions with respect to residual effects for biodiversity remain valid.

Vegetation Health

The EAR identified potential effects on plant health associated with road dust. Residual impacts on plant health from dust were not expected to extend beyond completion of closure activities, and therefore the effects are considered reversible in the short-term. Operational dustfall monitoring and reclamation research (Arktis, 2013) has supported the EAR predictions, and the conclusion is still considered valid.

Wildlife

Eight VECs were selected for study of residual impacts to wildlife habitat, movement and behaviour, and abundance within the Project EAR:

- Bathurst caribou herd;
- Barren-ground grizzly bears;
- Wolves;
- Foxes;
- Wolverines;
- Upland breeding birds (passerines, shorebirds, ptarmigan);
- Raptors (peregrine falcon, gyrfalcon); and
- Waterfowl.

Wildlife Habitat

According to the EAR (De Beers, 2002), residual effects were predicted to occur to wildlife habitat from both direct and indirect linkages. Direct impacts include site clearing activities within the Project footprint, indirect linkages may include negative impacts to vegetation in the LSA which results in the loss of wildlife habitat.

Re-vegetation of disturbed areas at the Mine was expected to result in complete habitat revegetation within the succession time frame with native plant species. Therefore, the impact on wildlife habitat was considered reversible in the long-term (100 years). The magnitude of the negative impacts to the home ranges of the VECs were assessed as negligible, with the exception of upland breeding birds with a low magnitude due to the much smaller home range. The resulting environmental consequence of direct habitat loss from construction of the Mine was predicted to be low for all wildlife VECs.

The EAR predicted that dust could reduce the quantity or health of vegetation and, consequently reduce the quality of wildlife habitat. Impacts of dust on wildlife habitat were only expected during the operations phase of the Mine, residual effects were not expected to extend beyond the completion of closure activities. Operational monitoring of dustfall and vegetation did not detect significant effects on vegetation quantity or health in the area around the mine.

Residual impacts of reclamation activities following mine operations were also assessed and the environmental consequences of these impacts were positive. Reclamation activities will seek to return

wildlife habitat to a capability equivalent to that present before development of the Project. Impact assessment analysis was not competed for positive impacts.

The closure activities outlined in the FCRP continue to support the conclusions of the EAR. A combination of active and passive revegetation is planned, which over the long-term will progress toward conditions reflective of the surrounding area. Post Closure conditions will be an improvement from the current status, and effects to wildlife due to loss of habitat have not been observed as a result of Operations.

Wildlife Movement and Behaviour

Residual impacts of blasting, vehicle and aircraft traffic, winter and esker access roads, and habitat fragmentation on wildlife movement and behaviour were classified. For all wildlife VECs, the magnitude of the various impacts was low to negligible in magnitude, occurring only during the construction and operations phase, and reversible by the completion of closure activities. The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

Wildlife Abundance

Residual impacts of attraction of wildlife to the Project, wildlife-human interactions, vehicle/aircraft-wildlife collisions, toxic spills and increased access for hunting and trapping to wildlife VECs were classified. All impacts to wildlife abundance were considered to exist only during the construction and operations phase and would be reversible upon completion of closure activities. The same effects assessed for construction and operations would be expected during active reclamation work; however, upon completion of the closure activities outlined in the FCRP, the residual effects conclusions of the EAR remain valid.

D.2.2.4 Aquatic Resources

Hydrology

The development of the Mine resulted in some disturbance to the hydrologic systems in the Snap Lake drainage basin. Classification of the residual effects from the Mine to Snap Lake, North Lake and Northeast Lake outflow and water elevation, as well as, runoff volumes within the Snap Lake sub-basins A through S was completed. Results indicated that the duration of effects would be limited to the operations phase and would be reversible within a 3 year timeline. Environmental consequences of these impacts were predicted to be negligible or low. The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

Classification of the residual impacts of surface disturbances from the Project on sediment yields and concentrations in receiving streams, lakes, ponds, and wetlands indicated the effects were expected to be within the range of natural background levels and the direction and magnitude of this impact would be negligible. The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

Water Quality

It was predicted the development of the Mine would result in changes to local and regional water quality. Impacts to water quality in Snap Lake and the north lakes (NL5, NL6, North Lake and Northeast Lake) were evaluated with consideration to guidelines for drinking water and the protection of aquatic life.

Classification of residual impacts on the post closure water quality of Snap Lake for the protection of aquatic life indicated that the negative effects would be of negligible magnitude, reversible within 30 years or twice the flushing period of Snap Lake; and result in low environmental consequence.

Classification of residual impacts on the water quality of Snap Lake as a drinking water supply indicated that the effects would be negative in direction, of negligible magnitude, reversible within 30 years or twice the flushing period of Snap Lake; and result in low environmental consequence.

Classification of residual impacts of altered groundwater discharge to lakes North of Snap Lake (NL5, NL6, North Lake and Northeast Lake) for the protection of aquatic life indicated that the negative effects would be of low (Northeast Lake) to moderate (NL5, NL6 and North Lake) magnitude, reversible within 30 years or twice the flushing period of Snap Lake; and result in low environmental consequence.

Classification of residual impacts of post-closure groundwater discharge to lakes North of Snap Lake (NL5, NL6, North Lake and Northeast Lake) for drinking water supply indicated that the negative effects would be of negligible magnitude, reversible within 30 years or twice the flushing period of Snap Lake; and result in low environmental consequence.

Residual impacts on the regional water quality in the Lockhart River watershed were analyzed and the maximum concentrations of all parameters were predicted to be below general guidelines or site-specific water quality benchmarks. As baseline water quality was found to be consistent throughout the Lockhart River watershed, general environmental guidelines and site specific water quality benchmarks appropriate for Snap Lake were considered appropriate for lakes throughout the watershed. Based on these factors, there was no valid linkage for the Project to impact regional water quality in the Lockhart River watershed and a residual impact assessment was not necessary.

Classification of residual impacts from acidifying emissions on regional waterbodies (local lakes, regional lakes, regional streams) indicated that the duration of impacts would be limited to the construction and operations phase, the negative effects to local and regional lakes would be negligible in magnitude, reversible within 30 years or twice the flushing period of Snap Lake and the associated environmental consequences would be low to negligible. The magnitude of the impacts to streams in the form of spring acid pulses was undetermined, largely because of limited information regarding this phenomenon. Therefore, the environmental consequence was classified as undetermined.

In 2014 the Environmental Assessment Report was updated to look at the potential impact of changing the effluent limits for total dissolved solids (TDS) and its constituents: chloride; nitrate; nitrite; fluoride; and sulphate. Predictions indicate that Snap Lake would return to the TDS aesthetic level, as noted by the Board, as 500 mg/L within seven years following cessation of mining. Water palatability rating would return to good (600 mg/L) earlier, by 2032 (De Beers, 2014).

Water quality effects in Snap Lake have most recently been evaluated in the 2018 AEMP Re-evaluation (Golder, 2018). This evaluation found that changes to water quality in Snap Lake and downstream are not expected to cause adverse effects to resident aquatic life, do not pose a human health risk, and have not adversely affected the drinkability of the water. Concentrations of most water quality parameters that had increased during Operations are decreasing in the main basin of Snap Lake during Care and Maintenance, and are expected to continue to decrease during Active Closure and Post Closure.

Post Closure water quality predictions have been updated to support development of the FCRP using three related water quality models: the site water quality model, the Snap Lake hydrodynamic model, and the effluent quality criteria (EQC) model. The site water quality model incorporates the site water balance and water quality data from the Snap Lake Environmental Database to predict concentrations of water quality parameters over a period of approximately 30 years. Only nitrate concentrations were estimated to exceed acute water quality guidelines in the sump overflow. The EQC model integrates the predictions of site water quality model with results of the hydrodynamic model, and demonstrate that at the edge of the mixing zone in Snap Lake concentrations of all parameters are below low-action trigger levels (75%) of the updated AEMP benchmarks without application of water treatment with the exception of nitrate. The EQC model estimates that an effluent quality criterion of 25 mg/L nitrate would be necessary to achieve the AEMP benchmark. A pair of constructed wetlands is planned to provide the necessary level of removal.

Based on these recent monitoring results, the updated modelling predictions, and planned closure activities, the residual effects conclusions of the EAR remain valid.

Aquatic Organisms and Habitat

Chemicals carried forward from an initial screening water quality assessment to the formal impact assessment on non-fish aquatic organisms were those that exceeded a negligible residual impact rating. These chemicals included: hexavalent chromium, total dissolved solids within Snap Lake; and trivalent chromium, hexavalent chromium, aluminum, copper, molybdenum, nitrate and pH within the north lakes. Impacts from elevated concentrations in the water column and/or sediment were assessed to three trophic levels of non-fish aquatic organisms including phytoplankton, zooplankton and benthos.

Non Fish Aquatic Organisms – Snap Lake

Residual impacts to non-fish aquatic organisms (phytoplankton, zooplankton and benthos) in Snap Lake from elevated hexavalent chromium and total dissolved solids concentrations were classified. The water quality in Snap Lake is expected to gradually return toward baseline conditions in the Post Closure period. Negligible magnitude impacts were predicted from elevated chromium during the construction and operations phase; therefore, impacts in Post Closure would also be negligible as reversibility was assessed to be long term (greater than 30 years). Effects from elevated total dissolved solids concentrations are expected to have a negligible to low magnitude, and would also be reversible over the long term (greater than 30 years). Environmental consequences for all residual impacts are rated as low. The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

Non Fish Aquatic Organisms – North Lake, Northeast Lake, NL5 and NL6

The environmental consequences to NL5 and NL6 are from elevated trivalent chromium concentrations in the water column, the consequences were considered to be low. Residual impacts of elevated trivalent chromium concentrations on non-fish aquatic organisms (phytoplankton, zooplankton and benthos) within NL5 and NL6 lakes were classified as having negligible magnitude, and being reversible over the long term (greater than 30 years).

Residual impacts from elevated chemical concentrations in both the water column and sediments on non-fish aquatic organisms (phytoplankton, zooplankton and benthos) within the North Lake were classified as having negligible to moderate magnitude, and being reversible over the long term (greater than 30 years).

The EAR outlined that the environmental consequences of the impacts within North and Northeast Lakes were considered to be low to moderate. Consequences of increases in trivalent chromium, copper, molybdenum and aluminum in the sediment porewater of the North and Northeast lakes are low across the three non-fish aquatic organisms. Hexavalent chromium and pH are predicted to cause moderate environmental consequences in the north and northeast lakes. This is true for phytoplankton, zooplankton, and benthos. The moderate impacts from chromium are predicted based upon exceedance of chronic toxicity thresholds. The moderate impacts from pH are predicted because of the potential for acutely lethal effects in up to 10% of the North and Northeast lake sediments. Impacts of elevated nitrate concentrations in sediment porewater were expected to have a positive effect and environmental consequences were not evaluated.

The results from the 2018 AEMP re-evaluation suggest that the discharge of treated Mine effluent is not adversely affecting zooplankton in Snap Lake. Because the discharge of treated effluent has been greatly reduced during ECM, and will remain so through Active Closure and into Post Closure, lake water quality and biological conditions are expected to return to near-baseline over time. This is supported by updated water quality modelling predictions to support the FCRP. Therefore the residual effects conclusions of the EAR remain valid.

Fish Habitat

The EAR found that indirect effects on fish habitat may occur because of changes in the abundance or quality of non-fish aquatic organisms (discussed in previous section) that are consumed by fish. Classification of the residual impacts and environmental consequences for the potential effects to fish habitat considered several activities for each of the following waterbodies: Snap Lake (dust deposition, in stream structures, sediment yield and change to food source resulting in change to habitat), streams within the Snap Lake basin (influence of mine footprint activities), North and Northeast Lakes (change to food source resulting in change to habitat), and the North Lake outlet stream (changes to groundwater discharge). Residual impacts from these activities to fish habitat are expected to be negligible to low in magnitude and reversible in the short term (by the completion of closure activities). The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

Fish Health

The water quality in Snap Lake is expected to gradually return toward baseline conditions in the Post Closure period; therefore the changes to water quality are expected to be reversible within the long term (greater than 30 years). Negligible magnitude impacts to the chronic effects on fish health in Snap Lake were predicted from elevated hexavalent chromium and total dissolved solids, and the consequent effects to fish food organisms. These impacts in Post Closure would also be negligible before completely disappearing once the elevated chemical concentrations return to baseline.

Residual impacts to fish health in the lakes north of Snap Lake from impacted Post Closure groundwater discharge causing elevated chemical concentrations within the water column and the effects to fish food organisms were also evaluated.

Elevated concentrations of trivalent chromium within the water column of NL5 and NL6 and the indirect effects of chromium via impacts to fish food organisms was considered to be of negligible magnitude impact to fish health, and low environmental consequence. Elevated concentrations in North and Northeast Lake

of trivalent and hexavalent chromium in the water column and porewater, copper, molybdenum, pH, aluminum and nitrate in porewater, and the subsequent negative effects to fish food organisms were considered to be of negligible to moderate impact to fish health, and low to moderate environmental consequence. All impacts to the lakes north of Snap Lake were considered to require greater than 30 years to be reversed and return to baseline conditions.

In 2014 laboratory toxicity tests were conducted on organisms subjected to progressively greater TDS concentrations which resulted in negligible chronic effects on resident taxa in Snap Lake. All representative plants and animals (which form part of the food chain upon which fish depend) were tolerant of Snap Lake TDS (De Beers, 2014).

The 2018 AEMP Re-evaluation shows that fish from Snap Lake are in good health, and continuing to successfully survive, grow, and reproduce. Because the discharge of treated effluent has been greatly reduced during ECM, and will remain so through Active Closure and into Post Closure, lake water quality and biological conditions are expected to return to near-baseline over time. This is supported by updated water quality modelling predictions to support the FCRP. Therefore the residual effects conclusions of the EAR remain valid.

Fish Abundance

Potential linkages to impacts in fish abundance within Snap Lake identified changes in fish harvesting, blasting activity, fish habitat and fish health. No significant impacts are predicted from increased fish harvesting and as discussed above, only negligible magnitude impacts are predicted to fish habitat and fish health within Snap Lake. These linkages were considered invalid and no impact assessment was completed.

Potential effects from blasting activities to fish population abundance were considered a valid linkage. Impact assessment results for blasting activities indicated that a negligible magnitude impact was expected, as well as, negligible environmental consequence.

Residual impacts to fish abundance in the outlet stream from North Lake, as well as, NL5 and NL6 lakes due to reductions in groundwater discharge were considered to be of low magnitude, result in low environmental consequence and would be reversible within 30 years.

Several low and/or moderate magnitude residual impacts to fish and fish food organisms within North and Northeast Lakes were identified in impact assessments discussed in the previous sections. These individual impacts were assessed for importance to overall fish abundance. Impacts included: elevated pH, nitrate, aluminum and hexavalent chromium within sediment porewater, as well as, chromium, copper and aluminum via fish food organisms. Overall the residual impacts to fish population abundance were of moderate and low magnitude for North and Northeast Lakes, respectively. Effects of the impacts were considered to require greater than 30 years to return to baseline conditions.

The 2018 AEMP Re-evaluation shows that operation of the Mine has resulted in minimal changes to the fish community in Snap Lake, which is consistent with EAR predictions. The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

D.2.2.5 Resource Uses

Heritage Resources

Direct impacts from activities related to the construction of the mine site and associated infrastructure, including the winter roads and esker quarry, had the potential to impact heritage resources. The results of the archaeological studies completed prior to, and as part of the EAR indicated that, provided development continued as planned, no heritage resources were likely to be encountered during construction and operation of the mine.

Indirect impacts such as recreational use of the Mine area due to its development were included in the impact analysis. Due to the size of the workforce, the minimal use by other users of lands and resources near the Mine and its infrastructure, and the lack of archaeological sites expected near the development, effects were expected to have low magnitude of impacts and be limited to the operations phase. Should impacts occur to heritage resources, the effects would likely be irreversible.

Given that heritage resources have not been encountered to date at the Mine, it is considered unlikely that Active Closure activities would now encounter something new. As such, the residual effects conclusions of the EAR remain valid.

A significant positive impact on heritage resources from the Project is the increase in information regarding heritage resource sites in the LSA.

Traditional Land Use

The RSA is not intensely used for traditional land use purposes. A small amount of fishing was identified in the RSA. No existing traplines were identified during the EA; however, the area has been used in the past for trapping activities. As well, people have travelled through the area to hunt wolves. Recent hunting for caribou in the RSA was not identified. No permanent or seasonal camps were identified in the RSA. No traditionally significant areas were identified within the RSA. Residual impacts to traditional land uses were expected to be limited to the construction and operation phases of the mine and will not extend beyond completion of closure activities. The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

Non-traditional Resource Use

The EAR identified that there would be a loss of land associated with the development of the Project; however, the Project footprint comprises only 0.01% of the Coppermine River Uplands Ecoregion and the RSA comprises 5.8% of the region. Therefore, the magnitude of the impact of this loss of land on the availability of land for ecologically representative areas is negligible.

Impacts to domestic hunting, commercial and recreational fishing, recreation and tourism, permanent and seasonal camps, subsurface mineral resources exploration and extraction were expected to be negative in direction, but only occurring during the construction and operations phase of the mine. Effects of the impacts are expected to be reversible at the completion of closure activities. The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

Aesthetic Quality

Residual impacts of infrastructure, steam plumes, the North Pile and site lighting are not expected to extend beyond the operations phase. Only the North Pile will remain following completion of mitigation measures (closure activities) at the Mine, which will involve covering the PK with local quarried materials, contouring, and limitations on the final height of the pile in order to blend with the surrounding landforms.

Residual impacts of the Mine on the Lockhart Lake Camp are not expected to continue following completion of closure activities.

The closure activities outlined in the FCRP, and closure objective SW5 (Landscape features (shape and vegetation) match aesthetics of the surrounding natural area) continue to support the residual effects conclusions of the EAR.

Tibbitt – Contwoyto Winter Road

Residual impacts of the Project on the Tibbitt-Contwoyto winter road are not expected to continue following completion of closure activities. The closure activities outlined in the FCRP continue to support the residual effects conclusions of the EAR.

D.2.2.6 Environmental Health

An environmental health risk assessment was completed as part of the EAR to evaluate whether health effects would occur to people and wildlife that might be present in the LSA and RSA or consuming caribou meat and/or fish from the RSA, during both the operations and closure phase of the Project. The risk assessment was used to evaluate:

- The metals and PAHs that will be released from the Project;
- The metals and PAHs that will exceed baseline concentrations and/or established guidelines for the protection of human or wildlife health; and,
- The people and wildlife that might come in contact with the substances.

The methodology of the environmental health risk assessment was different from that employed in the sections above. A detailed description of the human and wildlife health risk assessment methodologies can be found in Section 11.1.5, of the Project EA (De Beers, 2002). The risk assessment was deemed necessary because it is a useful tool to determine if chemicals at a site pose a human or wildlife health risk.

Conclusions of the risk assessment indicated that exposure levels of metals and PAHs would be at levels safe for humans and wildlife exposure in the LSA and RSA. No impacts were predicted for human and wildlife health for the post closure condition as exposure to chemicals released from the Project is expected to be less than the adopted exposure limits at completion of closure activities. A detailed description of risk assessment results can be found in Sections 11.3 and 11.4 of the Project EAR (De Beers, 2002).

To support development of the FCRP, environmental health risks have been re-evaluated (Appendix I of the FCRP). Applicable guidelines related to various media (e.g., air, water, soil, sediment) and exposure paths (e.g., wildlife, humans) across the site have been compiled to define levels that are considered safe for use by people and wildlife. These guidelines will be utilized when conducting a Phase II/III Environmental Site Assessment, and will inform the development of remedial action plans, where appropriate. This process

will support achievement of closure objectives SW3 (surface runoff and seepage water quality that is safe for people, vegetation, aquatic life, and wildlife), as well as NP1 (prevent PK from entering the surrounding terrestrial and aquatic environment) and I3 (contaminated soils and waste disposal areas that cannot contaminate land and water). Through achieving these closure objectives, environmental health will be protected, and the residual effects conclusions of the EAR remain valid.

REFERENCES

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