9 AQUATIC RESOURCES

9.1 SCOPE OF ASSESSMENT

9.1.1 Terms of Reference

The Aquatic Resources section provides information required in the Terms of Reference

The Aquatic Resources section of the environmental assessment (EA) for the De Beers Canada Mining Inc. (De Beers) Snap Lake Diamond Project provides information required by the Mackenzie Valley Environmental Impact Review Board (MVEIRB) in the Terms of Reference. The Aquatic Resources section addresses specifically the Terms of Reference shown in Table 9.1-1. The entire Terms of Reference may be found in Appendix I.2 of the EA.

Table 9.1-1 Terms of Reference for Aquatic Resources

TOR Section	Environmental Assessment or Topic
2.5.2	**Description of the Existing Environment** De Beers shall provide a brief and clear textual and graphic depiction of the existing environment and its use, as it pertains to the potential impacts of the proposed development. The existing environment includes the resources being extracted over the predicted life of the mine, and contemporary/past land use and occupancy in the region, whether industrial or aboriginal. All existing reports and documents shall be appropriately referenced. De Beers will be expected to clearly and succinctly describe the following environmental components, as they relate to the proposed development: I. air and climate; II. surface and ground water quality and quantity; III. aquatic organisms and habitat.
2.6.1	**Air Quality and Climate** Climate should include not only the average or mean values but also the extremes that can be expected. The full range of weather conditions should be investigated.
2.6.4	**Water Quality and Quantity** The environmental assessment report shall provide an analysis of proposed development impacts on surface and ground waters. Impact conclusions should be the based on predicted water quality of all waste streams and containment ponds throughout the project, including mine water, seepage, surface runoff and collection ponds, process plant discharges, the minewater settling pond and the sewage treatment facility. This analysis should include the impacts on water quality and quantity, catchment areas and permafrost in relation to: I. impacts of underground blasting and its associated residues, in particular, nitrogen, nitrate, nitrite and ammonia; II. water from underground mine workings and site runoff; a. provide a detailed characterization of geochemical influence on inflowing groundwater from all potential sources, including: mine rock exposed on underground walls, materials temporarily stored underground (muck, ore and /or waste rock); and water released or leached from backfill (kimberlite paste, quarried rock concrete and mine rock concrete), particularly with respect to metals, nutrients and major ions. b. Provide a description of the predicted mine inflows and underground hydrogeology, water handling procedures, water balance predictions and contingencies for potential higher than expected flows, impacts of discharges on the hydrology of the lake and water balances for waste water containment facilities including contingencies and excess holding capacities.

Table 9.1-1 Terms of Reference for Water Resources (continued)

TOR Section	Environmental Assessment or Topic
2.6.4 (cont)	III. impact on water quantity, including changes in timing, volume and deviation of peak and minimum flows resulting from the development; a. provide a detailed description of predicted mixing zones in Snap Lake for any effluents discharged from the development. De Beers shall provide its assessment of water quality (metals, nutrients, major ions, process chemicals, bacteria, physical characteristics) within and at the boundaries of the mixing zone and criteria used to establish the mixing zone. b. De Beers shall provide a description of the predicted impacts of releases of any effluents, surface runoff and seepages that may be directed to land (include consideration of surface ponding), with particular attention to impact linkages on vegetation, soil and wildlife. Ensure that criteria used to predict impacts are explicit and precautionary. IV. impact of treated sewage flows to associated wetlands and downstream waters; V. siltation effects (*e.g.*, runoff along roadways and drainage channels); VI. effects of nutrients on fish and non-fish bearing water sources, including possible trophic status changes of Snap Lake; VII. dewatering of underground workings and resulting impacts on the water balance, Snap Lake water level, outflow rates, etc.; VIII. impact of development on the water shed; a. provide a detailed description of the hydrology of the Snap Lake watershed including an overview of the Lockhart River Drainage basin. IX. impact of the use of berms for waste water containment including impacts of berm materials, berm construction leaching from the berm itself, and seepage through the berm; X. water chemistry impacts of surface runoff; XI. effects of processed kimberlite and other tailing stored at the North Pile; and XII. water chemistry impacts of groundwater from underground mine workings on Snap Lake. All parameter estimates (*e.g.* water balance), reported by DeBeers should include tractable, the source of information (either estimates or empirical), assumptions built into the data, and data reporting that includes ranges and confidence estimate for parameters.
2.6.4.1	*Water Balance* A water balance should be prepared that incorporates all components of the proposed development under a range of climactic conditions.
2.6.4.2	*General Water* The assessment of proposed development impacts on water quality should also consider: I. contaminant loading and dispersion (including surface runoff and airborne contaminants); II. acid rock drainage, metal leaching and geochemistry; and III. kimberlite toxicity and implications for aquatic wildlife.
2.6.5	**Aquatic Habitat** The impacts on aquatic organisms and their habitat should be considered taking into account predicted water quality and quantity impacts and their associated effects on fish, fish habitat, and local drainage patterns. The analysis of development impacts should include: I. productive capacity of aquatic systems during construction, operations, closure and post-closure; II. impact on all lakes that may experience changes to fisheries resources[1] including, but not limited to Snap Lake and streams associated with these lakes; III. habitat loss or alteration; IV. rare and/or sensitive fish species and habitat; V. mortality (includes fishing); VI. impacts of underground blasting on fish and fish habitat on local aquatic systems; and

[1] Note that impacts should be assessed on all water bodies likely to be impacted by the proponent's activities, not just lakes and not just water bodies with fishery resources. It is important to note that the *Fisheries Act* applies to fish and fish habitat, the latter which is defined as *"spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes*". Secondly, the *Fisheries Act* does not restrict the conservation of fish and fish habitat only to fisheries. Instead, the *Fisheries Act* applies to all waters of Canada where fish or habitats are present.

Table 9.1-1 Terms of Reference for Water Resources (continued)

TOR Section	Environmental Assessment or Topic
2.6.5 (cont)	VII. impacts on all lakes and associated food webs and water use potential that may be impacted by changes in water chemistry (nutrients, bacteria, major ions, metals) due to runoff or discharges from the development. The environmental assessment report should include an overview of how the DFO, 1986 principle of No Net Loss will be achieved during the construction, operation, care and maintenance and closure stages of the proposed development
2.8	**The Effect(s) of the Environment on the Proposed Development** De Beers should assess the effect(s) of the environment on the proposed development, and activities forming part of the proposed development. De Beers should consider the full range of climate conditions (including extreme weather events, wet, dry and normal precipitation and extreme temperature spells) and climate change (*e.g.* global warming scenarios).

Source: Terms of Reference and Work Plan for the Environmental Assessment of the De Beers Canada Mining Inc. Snap Lake Diamond Project, September 20, 2001 Issued by: MVEIRB.

9.1.2 Component Description and Organization

Aquatic Resources includes four subsections

To address the Terms of Reference, the Aquatic Resources section has been subdivided into the following four subsections:

- hydrogeology;
- hydrology;
- water quality; and,
- aquatic organisms and habitat.

Each subsection includes a number of components

The hydrogeology subsection (Section 9.2) pertains to groundwater quality and quantity. Surface water flow and the water balance are included in the hydrology subsection (Section 9.3). The water quality subsection (Section 9.4) describes baseline and predicted water and sediment quality in the local and regional study areas. In the aquatic organisms and habitat subsection (Section 9.5), issues related to these organisms are identified.

Each subsection is divided into the baseline and impact assessment

Each subsection of water resources is organized under two main headings:

- baseline setting; and,
- impact assessment.

Conclusions and references are combined; cumulative effects are in Section 12

The conclusions of each of the four subsections are combined in Section 9.6. The references from all subsections are provided in Section 9.7. The units, acronyms, and glossary (Section 9.8) complete the Aquatic Resources section of the EA. The cumulative impact is presented separately in Section 12 as part of a comprehensive cumulative effects assessment of all impacts.

9.1.3 Assessment Approach

9.1.3.1 Key Issues and Key Questions

Issues derived from a variety of sources initiate the assessment

The assessment process begins with the identification of issues associated with the Snap Lake Diamond Project that are important to the communities that may be affected. Issues were identified by a variety of means including the following:

- EA Terms of Reference;
- traditional knowledge;
- community consultation;
- discussions with territorial and federal regulators;
- scientific literature; and,
- experience of De Beers staff and their consultants.

Issues are combined into key questions

In most cases, similar issues are identified from a number of sources. Related issues are combined in the form of a question. Key questions are developed for each component of the aquatic environment (Table 9.1-2). The purpose of the assessment is to answer the key questions.

9.1.3.2 Impact Assessment

Linkages between project activities and environmental effects are analyzed to determine if they are valid

Once the key questions have been established, the impact analysis examined the ways that the Snap Lake Diamond Project could result in changes to the aquatic environment. For a change to occur, there has to be a pathway, or linkage, between a project activity and a component of the aquatic environment. Section 3, Project Description, and the baseline information in this section were used to determine linkages between specific activities and changes in the environment (*e.g.,* changes in water quantity or quality). These changes could, in turn, impact ecosystem components such as fish. Each section contains a diagram showing these linkages and then analyzes each linkage to determine if it is valid or invalid. It is possible that an issue may have been raised from experience at other projects (*e.g.,* an open pit mine) that will not occur at Snap Lake because there is no linkage. If the linkage is valid, the assessment proceeds.

Table 9.1-2 Key Questions Addressed in the Aquatic Resources Section

Question Number	Key Question
HG-1	Will the underground mine for the Snap Lake Diamond Project change groundwater quantity and groundwater levels?
HG-2	Will the underground mine for the Snap Lake Diamond Project change groundwater quality?
HG-3	Will the surface facilities for the Snap Lake Diamond Project change groundwater quantity and groundwater levels?
HG-4	Will the surface facilities for the Snap Lake Diamond Project change groundwater quality?
H1	What impacts will the Snap Lake Diamond Project have on near-surface water tables and flows, and water levels in receiving streams, lakes, and wetlands?
H2	What impacts will the Snap Lake Diamond Project have on sediment yields, and sediment concentrations in receiving streams, lakes, and wetlands?
WQ-1	What impacts will the Snap Lake Diamond Project have on surface water quality?
WQ-2	What impacts will the Snap Lake Diamond Project have on regional water quality in the Lockhart River watershed?
WQ-3	What impacts will acidifying emissions from the Snap Lake Diamond Project have on regional waterbodies?
F-1	What impacts will the Snap Lake Diamond Project have on quality and quantity of non-fish aquatic organisms?
F-2	What impacts will the Snap Lake Diamond Project have on fish habitat?
F-3	What impacts will the Snap Lake Diamond Project have on acute or chronic effects on fish health?
F-4	What impacts will the Snap Lake Diamond Project have on fish abundance?

Impacts that may persist after mitigation are residual impacts

Mitigation measures to minimize potential impacts to the aquatic environment are then identified. For some activities, mitigation may eliminate the potential impact. Potential impacts that are likely to persist after mitigation are identified as residual impacts.

Impact analysis is as quantitative as possible

The detailed analysis of impacts is done on the residual impacts. The detailed analysis is as quantitative as possible using databases, statistical analysis, geographic information system (GIS) methods, and modelling, as appropriate. To answer some questions, a more qualitative approach has to be used; then, a review of published literature, field observations, traditional knowledge, and professional judgement are used. Traditional knowledge is incorporated wherever it is available. The predicted residual impacts are presented as tables of estimated quantities (*e.g.*, predicted concentrations of metals) if possible. Impacts are analyzed at two scales: local and regional.

The residual impact is classified as magnitude, duration, geographic extent, etc.

In the next section, the residual impact classification, the residual impact is described using criteria such as the magnitude, duration, and geographic extent of the impact. The definitions associated with the criteria (*e.g.*, high, moderate, low, or negligible magnitude) are provided in Section 9.1.5. To answer the initial question as succinctly as possible, the overall environmental consequence of the impact is estimated. Environmental consequence is determined by considering criteria representing the key characteristics (*e.g.*, magnitude, geographic extent, duration, and reversibility) together. The probability of occurrence of the impact and the level of confidence in the prediction are provided. The EA does not determine the significance of the impact.

9.1.3.3 Temporal Considerations

Construction will last three years and operations will last 22 years

The aquatics resources section assesses the impacts for the construction, operation, closure, and post-closure phases of the project. Assuming that permits for construction and operation have been received in 2003, a limited pre-construction work program will begin in 2003. Full construction will begin in early 2004 and be completed by the end of 2005. The production phase will be approximately 22 years from 2005 to 2026, although pre-production mining from underground development will occur from 2003 to 2005. The site closure activities will be carried out primarily in 2027, with limited final clean-up and the continuation of effectiveness monitoring in 2028. Reclamation and monitoring of the effectiveness of reclamation techniques will occur during the operation phase. The total elapsed duration of the project is 26 years. The proposed schedule for the Snap Lake Diamond Project is provided in more detail in Section 3.2.

9.1.4 Study Area

There is both a local and a regional study area

The impacts of the Snap Lake Diamond Project on aquatic resources are assessed at two geographical scales: local and regional. All aquatic components (hydrogeology, hydrology, water quality, and aquatic organisms and habitat) will use the same two study areas.

The regional study area is the Lockhart River drainage

The regional study area (RSA) is defined as the Lockhart River drainage (Figure 9.1-1) starting at the outlet of Snap Lake and ending at the outfall of the Lockhart River into Great Slave Lake. The Lockhart River drainage was chosen for the RSA since Snap Lake is at the headwaters of this river.

One regional study area will be used for aquatic resources

One RSA will be used for aquatic resources since all four components of this section are inter-related. Changes in hydrogeology, hydrology, and water quality are closely linked to potential impacts to aquatic organisms and habitat.

The local study area is the area that may be directly disturbed by the Snap Lake Diamond Project

The local study area (LSA) is defined as the area that may be directly disturbed by the development of the project. During design and implementation of the baseline aquatics programs in 1999 and 2000, the potential impacts of the Snap Lake Diamond Project were assumed to be restricted to the Snap Lake watershed. Consequently, the Snap Lake watershed was used initially as the LSA.

Work completed in late 2001 showed that direct groundwater effects extended north of Snap Lake

Based on the results of more recent work, however, the LSA boundary was re-examined. In August 2001, a hydrogeological drilling program, aimed at determining groundwater flow patterns and flow quantities, was conducted (Appendix IX.2). Modelling of the groundwater data was completed in December 2001 (Appendix IX.3). The modelling confirmed that Snap Lake is a recharge lake that provides water, via groundwater flows, to surrounding lakes. The model predicted that two lakes directly to the north of Snap Lake (Figure 9.1-2), hereafter arbitrarily designated as the north lake and the northeast lake, will receive groundwater that will have been in contact with the underground mine workings. North lake is connected to the northeast lake through two small waterbodies: NL5[2] and NL6.

Post-closure groundwater flow from the underground mine to north lakes is expected

At post-closure, the underground mine workings will be flooded and a fraction of the groundwater recharge from Snap Lake will flow through the flooded mine workings before flowing to the north lake and the northeast lake. The groundwater flowing through the workings is expected to chemically equilibrate with the cemented paste backfill, resulting in changes to water quality. In addition to changes in groundwater quality, groundwater flow patterns to these lakes will also be altered during operations (Section 9.2).

[2] NL5 = north lake 5; NL6 = north lake 6.

Figure 9.1-1 Regional Study Area for Aquatic Resources

Figure 9.1-2 Local Study Area for Aquatic Resources

The north lakes were added to the local study area due to the potential for a direct impact through groundwater

Based on this recent information, the area receiving direct impacts was revised. The LSA was expanded in January 2002 to include the north lake, the northeast lake, and the two interconnecting waterbodies: NL5 and NL6 since there is the potential for a direct effect on groundwater water flows and groundwater water quality due to the Snap Lake Diamond Project (Figure 9.1-2). The RSA remains unchanged since the north lake and northeast lake are also part of the Lockhart River system.

9.1.5 Assessment Methods

The classification system, including definitions and methods are explained

The classification of residual impacts is based on the direction, magnitude, geographic extent, duration, reversibility and frequency of the impact as described in Section 9.1.5.1. Definitions of the residual effect classification terms that are specific to the aquatic components are provided in Section 9.1.5.2. Determination of the overall environmental consequence is described in Section 9.1.5.3.

9.1.5.1 Residual Impact Criteria

The residual impact is assessed by specific criteria

The following criteria are listed in Section 2.5.4 of the Terms of Reference (MVEIRB 2001):

- magnitude;
- geographic extent;
- timing:
- duration;
- frequency;
- reversibility of impacts;
- ecological resilience; and,
- probability of occurrence and confidence level.

Classification terms are defined

The classification used in this report generally follows the above list; however, there are some changes and additions that are described below. This section defines all of the impact classification terms as they are used in Aquatic Resources as follows.

Direction describes an impact as being neutral, positive, or negative

Direction describes an impact or effect as being neutral, positive or negative (*e.g.*, a gain in fish habitat would be classed as positive, whereas a loss in habitat would be considered negative).

Magnitude is a measure of the intensity or severity of the impact

Magnitude is a measure of the intensity or severity of an impact. It is a measure of the degree of change in a measurement or analysis endpoint. For example, any increase in the concentration of a water quality parameter (*e.g.*, copper) that is below a water quality objective would be a less severe impact than one that exceeds the objective. Magnitude is classified into four levels as negligible, low, moderate, and high; the definitions of these terms are specific to each component (*e.g.*, water quality, hydrology). They are based on scientific and traditional knowledge and the characteristics of the component. Because there is an element of professional judgement needed to assign the levels, the definitions of each level are provided in the following section. This makes the classification process transparent since reviewers can see exactly what is meant by words such as low or high.

Geographic extent refers to the geographic location where the impact is predicted to occur

Geographic extent refers to the geographic location where the impact is predicted to occur. A local geographic extent is assigned if the effect is restricted to the LSA. A regional geographical extent is assigned if the effect extends beyond the LSA into the RSA.

Frequency refers to how often an effect will occur and is expressed as low, medium, or high

Frequency refers to how often an effect will occur and is expressed as low, medium, or high. Direct losses or alteration habitat, for example, are considered to have a low frequency since site disturbance and clearing (*e.g.*, for water intake installation) will only occur once. The frequency of the effects of dust on water quality is predicted to be medium since the effects will occur intermittently throughout the open-water season. Discharge from the water treatment plant will occur continuously; therefore, the frequency will be high.

Duration is defined as the length of time that an impact will occur

Duration is defined as the length of time that an impact will occur. Duration and timing have been combined within the definition of duration used in this EA. Duration is defined by the timing of the phases of the project. The years in which these durations are expected to occur (*i.e.*, the timing of the project) is provided in Section 9.1.3.3. A short-term duration is assigned if effects are limited to the pre-construction and construction phases, which are expected to occur within the first three years. Medium-term is related to the overall duration of the active project, which is dominated by the operation phase, but also includes a blending of construction, operation, and closure since these activities overlap in time. Medium-term duration is expected to occur within 26 years. Long-term duration is assigned if the effects are predicted to extend beyond the operation and closure phases of the project (>26 years).

Reversibility is classified as reversible (short term), reversible (long term), or irreversible

Reversibility is an indicator of the potential for recovery from the impact. The reversibility category is classified as reversible in the short term, reversible in the long-term, or irreversible. Since confusion can arise between the terms long-term duration and reversible in the long-term, these two terms are differentiated by the endpoint of the impact. The endpoint of duration is the cessation of the activity causing the disturbance or the elimination of the source (*e.g.*, when chemicals no longer leach from the underground backfill). From this point forward the environment may be recovering from the impact; this aspect is classified as reversibility.

Impacts are reversible when the aquatic ecosystem returns to an equivalent capability

Throughout the EA, reversible in the long-term is assigned if the effect can be reversed in 100 years following closure of the project. Due to the slowness of geochemical processes and groundwater movement, as well as the uncertainty associated with these processes, it is not always possible to identify the duration of the reversal. The meaning of long-term will be described further in some sections. If effects (*e.g.*, post-closure changes in groundwater quality) are not predicted to re-establish to a baseline equivalent capability then these effects are considered irreversible. The concept that aquatic ecosystems are completely reversible (*i.e.*, can be completely restored to the original condition) is debatable. Therefore, this EA uses equivalent capability to determine reversibility.

Ecosystems are not truly reversible because they continually respond to change

"All systems change, all the time, and our actions are an inevitable part of that change" (Matthews *et al.* 1996). The post-development state of an ecosystem will be different; it may be equally functional with the desired structure, but it will not be the same as before development (Landis and McLaughlin 2000).

Ecological resilience is the rate of ecosystem recovery

Ecological resilience is usually defined as the rate of ecosystem recovery following a disturbance (DeAngelis 1980; Cottingham and Carpenter 1994). Resilience is assessed as the rate at which the ecosystem returns to a stable state. Each of these concepts is also embodied in the classification of reversible in the short- or long-term described above. The concept of recovery is central to the understanding of the resilience of an ecosystem; therefore, there is overlap with the concept of reversibility. A broader definition of ecological resilience is the capacity of a system to absorb disturbances (Raufflet 2000).

Since ecological resilience is currently being debated by scientists, it will be discussed, but not rated

Because of the lack of consensus in the literature on ecological resilience and the lack of scientific knowledge on the resilience of Arctic and sub-arctic ecosystems, resilience could not be used as a criterion for the assessment of impacts in the same manner as magnitude, geographic extent, duration or frequency. To do so would imply that there is sufficient scientific consensus on this topic to make it possible to classify ecological resilience. Therefore, impact assessments in this terrestrial section will consider ecological resilience as discussed in the paragraph above, but not assign a particular rating.

The probability of occurrence will usually be low because most predictions overestimate the impact

Probability of Occurrence is the likelihood that the environmental consequence indicated in the impact prediction will occur if the project goes ahead. Because of the uncertainty inherent in most predictions of future conditions, conservative assumptions were used in these predictions. Therefore, it is likely that the project impact will have a lower environmental consequence than predicted.

Level of confidence is directly linked to the degree of certainty in the prediction

Level of Confidence is directly related to the degree of certainty in the impact prediction. There are a number of sources of uncertainty. These include lack of data about the environment, natural variability in the data, errors in obtaining and handling data, capability of the model (which is always based on a simplification of the environment) and a lack of understanding of Arctic ecosystem processes (including recovery).

9.1.5.2 Definitions of Criteria

Criteria are defined in Table 9.1-3

The criteria described above are ranked for each section of Aquatic Resources. Definitions for the ranking of some criteria such as geographic extent, duration, reversibility, and frequency have been standardized so that they are common to all terrestrial resources. However, the ranking of magnitude is often specific to the component (*e.g.*, groundwater). The definitions are provided in Table 9.1-3.

9.1.5.3 Environmental Consequence

The primary choices made in developing this method were to keep the process simple and transparent

Environmental consequence provides an overall assessment of the residual effects based on a ranking system that incorporates the key criteria. Combining the criteria shown in the residual impact classification into a single answer to the key question involves choices. The choices that have been made in this EA include the following:

- the method is transparent;
- the results will be shown as a bar graph (Figure 9.1-3) and as words in the residual impact classification table;
- the criteria will be added to form the bars of the graph;
- the criteria will be given equal weight except for the following:
    - only one criterion related to time will be used to prevent time from being over-weighted;
    - reversibility and magnitude will be slightly over-weighted due to the greater severity of the consequence of an irreversible impact of high magnitude.

Table 9.1-3 Definitions of Impact Criteria for Aquatic Resources

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
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; **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.	**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.

Table 9.1-3 Definitions of Impact Criteria for Aquatic Resources (continued)

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
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 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 concentration at a potable water intake is greater than or equal to the CDWG.	**Local**: effect is restricted to the LSA (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.
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.

Table 9.1-3 Definitions of Impact Criteria for Aquatic Resources (continued)

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
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; **Moderate**: a change to between 10% and 20% of fish habitat units; **High**: a change to >20% of fish habitat units	**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; **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.

Table 9.1-3 Definitions of Impact Criteria for Aquatic Resources (continued)

Resource	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
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; **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.	**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.

1. Magnitude criteria are set assuming that no keystone species are affected at the prescribed percentage effect levels.
2. Magnitude criteria are set assuming that no critical habitat is affected with the prescribed areal extent percentages.
3. Magnitude ratings are based on the requirement that no lethal effects will occur at any point in the receiving lake on any species. All assessed effects are sublethal.

CDWG = Canadian Drinking Water Guidelines.

< = less than; ≤ less than or equal to; > = greater than.

Figure 9.1-3 Generic Environmental Consequence

Numbers have been used only to determine relative positions in the bar graph

The words (*e.g.*, negligible, low, moderate, high) used to rank the criteria (*e.g.*, magnitude) have been assigned numbers to create the bar graph, but the numbers have no meaning other than to ensure that ranks are shown in the correct relative position to each other. The numbers used are shown in Table 9.1-4. Environmental consequence is only determined for residual impacts that are negative in direction.

Table 9.1-4 Generic Residual Impact Classification

Magnitude	Geographic Extent	Duration	Reversibility
Negligible (0)	local (0)	short-term (0)	reversible (short-term) (0)
Low (5)	regional (5)	medium-term (5)	reversible (long-term) (5)
Moderate (10)	beyond regional (10)	long-term (10)	irreversible (15)
High (15)			

Environmental consequence is ranked as negligible, low, moderate, or high

The environmental consequence has been determined by adding the numbers and comparing the sum to the scale determined on the following basis:

- negligible = ≤ 5;
- low = > 5 to ≤ 20;
- moderate = > 20 to ≤ 30; and,
- high = > 30.

The ranking of environmental consequence was based on professional judgement

The relative positions of negligible, low, moderate, and high are shown on the graph. Since the true environmental consequence would occur over a continuum rather than four categories, the position of the lines determining the consequence scale is based on professional judgement. For example, an impact that was of moderate magnitude, regional extent, medium-term duration, and irreversible was deemed to be a high environmental consequence. If the same impact was reversible in the long-term, it was deemed to be a moderate environmental consequence. If it was reversible in the short-term, it was deemed to be a low environmental consequence. Professional judgement was used *a priori* to determine the ranking. The determination of environmental consequence for each residual impact followed this method and was not modified within individual sections.

The environmental consequence method is simple and transparent

Because other professionals may have other opinions on the method or scale, the method used here to bring all the information together has been kept as simple and transparent as possible, while still providing a standardized comparison of the consequence of the project across all parts of the EA. This method of determining environmental consequence will be used to summarize all residual impacts in the EA.