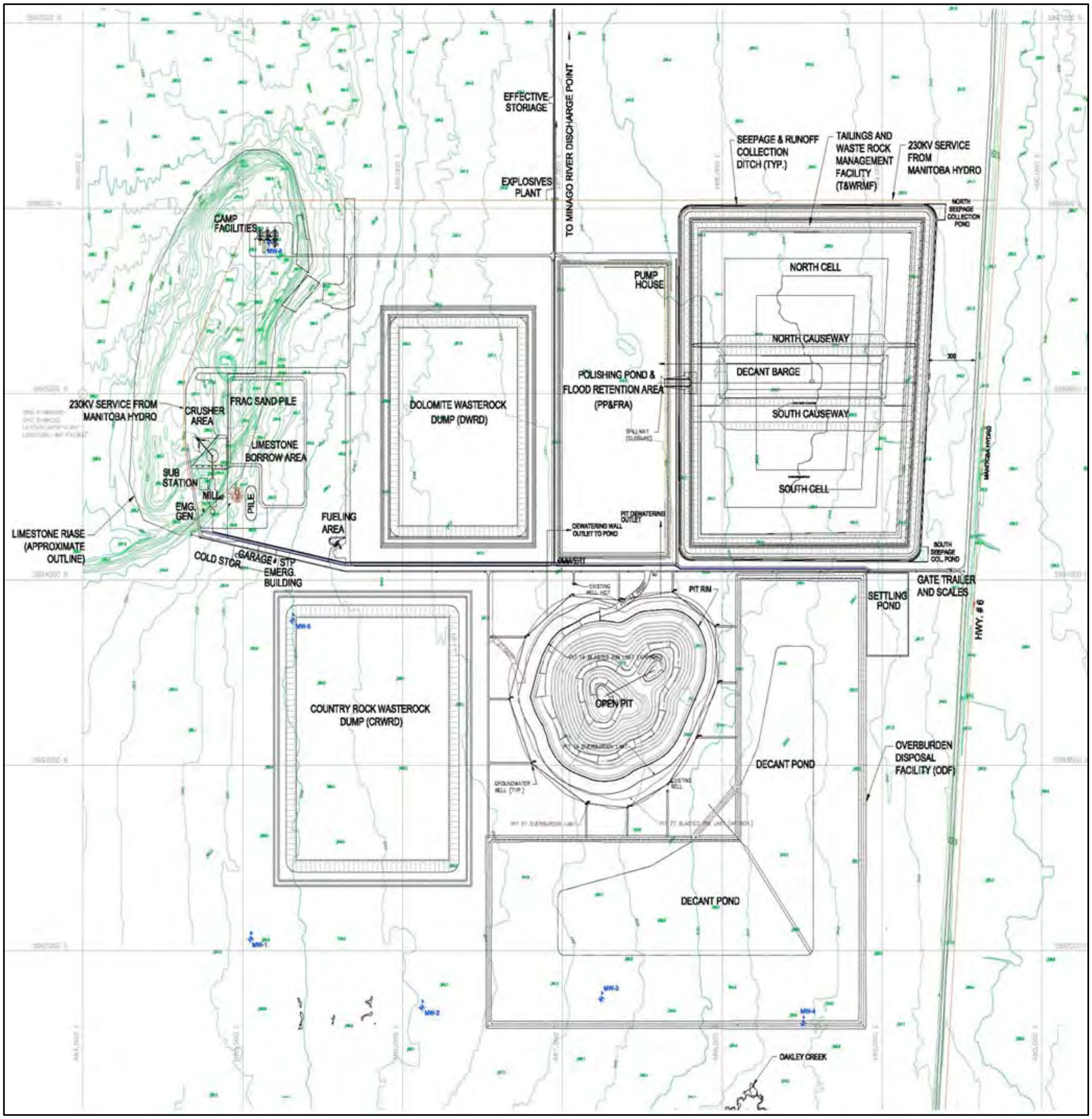
2.14 Site Water Management

This Section presents the general site water management and the description and discussion of a water balance model that was developed for the Minago Project based on the mine site layout as shown in Figure 2.14-1; metallurgical, hydrological, hydrogeological, and geochemical conditions; and related environmental baseline study results obtained to date. The goal is to manage and control site waters to ensure compliance with applicable regulations.

The water management components presented in this Section include:

- twelve dewatering wells to dewater the open pit area;
- a water treatment plant to produce potable water;
- a sewage treatment system (extended aeration system) for the disposal and treatment of on-site grey water and sewage;
- mill and Frac Sand Plant tailings and effluents that will be discharged into a Tailings and Ultramafic Waste Rock Management Facility (TWRMF);
- a Tailings and Ultramafic Waste Rock Management Facility (TWRMF) that will store tailings and the ultramafic waste rock permanently and effluents from various site operations temporarily;
- waste rock dump seepages that will be discharged to the receiving environment or into the TWRMF depending on their water quality;
- overburden dump runoff that will be discharged directly into the receiving environment (if it meets discharge requirements);
- an open pit dewatering system that will ensure safe working conditions in and around the open pit;
- a Polishing Pond and flood retention area to serve as holding pond for water that will either be recycled to site operations or discharged to the receiving environment (if it meets discharge water standards);
- a site drainage system to prevent flooding of site operations;
- site wide water management pumping systems; and
- discharge pipelines to Minago River and Oakley Creek to discharge excess water from the Polishing Pond to the receiving environment.

Among the sources of water that need to be managed are the pit dewatering well water, TWRMF supernatant and precipitation (rainfall and snowfall). Primary losses of precipitation include sublimation, evaporation, and retention as pore water in sediments and soils. Seepage losses to groundwater (e.g. from the TWRMF), which should increase due to dewatering, will likely be very small due to the thick layer of clay that is underlying the muskeg.



Source: Wardrop, 2009b

Figure 2.14-1 Mine Site Layout

The vertical hydraulic conductivity (K_V) of the overburden clay, which is an aquitard overlying the limestone, was estimated to range from 4×10^{-9} m/s to 6×10^{-9} m/s and the horizontal hydraulic conductivity, K_H, was estimated to range from 6×10^{-6} m/s to 6×10^{-9} m/s, with a geometric mean of 4×10^{-8} m/s (Golder Associates, 2008b). These hydraulic conductivities are indicative of an anisotropy ratio (K_H/K_V) of 10 (Golder Associates, 2008b).

2.14.1 General Description of the Site Water Management System

Water at Minago will be managed to ensure safe working conditions and minimum impacts to the local and regional surface and groundwater flow regimes and the aquatic environment. As water will be managed to suit site activities, the discussion of the site water management system was broken down into the following seven scenarios:

- Water Management during Construction;
- Water Management during Nickel and Frac Sand Plants Operations (Yr 1 through Yr 8);
- Water Management during Frac Sand Plant Operations (Years 9 and 10);
- Water Management during Closure;
- Water Management during Post Closure;
- Water Management during Temporary Suspension; and
- Water Management during the State of Inactivity.

Closure involves decommissioning of processing facilities and buildings and infrastructure that are no longer needed. The closure period is a transition stage between the operational and the post closure periods.

The post closure period refers to the period after all decommissioning activities of mining facilities and infrastructure have been completed and the site is in its final, post mining state.

"Temporary suspension" means that advanced exploration, mining or mine production activities have been suspended due to factors such as low metal prices and mine related factors such as ground control problems or labour disputes. Temporary suspension does not occur under normal operating conditions. The site will be monitored continuously during the Temporary Suspension (TS) of operations and dewatering of the open pit will continue as it did during operations. TS may become a "State of Inactivity", if the TS is extended indefinitely.

The "State of Inactivity" implies that mine production and mine operations at the mine site have been suspended indefinitely. The State of Inactivity also does not occur under normal operating conditions. The State of Inactivity (SI) may turn into a state of permanent closure, if prevailing conditions for the resumption of operations are not favourable. During the State of Inactivity, mine dewatering will be reduced significantly and only a minimal crew will be assigned to the site to monitor and ensure safety on site.

2.14.1.1 Water Management System during Construction

To facilitate the description of the water management model during construction, key components are illustrated with boxes in a schematic water balance diagram, given in Figure 2.14-2, and flow(s) in and out of each box are numbered (Q1 through Q24). All flows in the schematic water balance diagram are from left to right.

Following is a description of the water management model during construction, depicted in Figure 2.14-2:

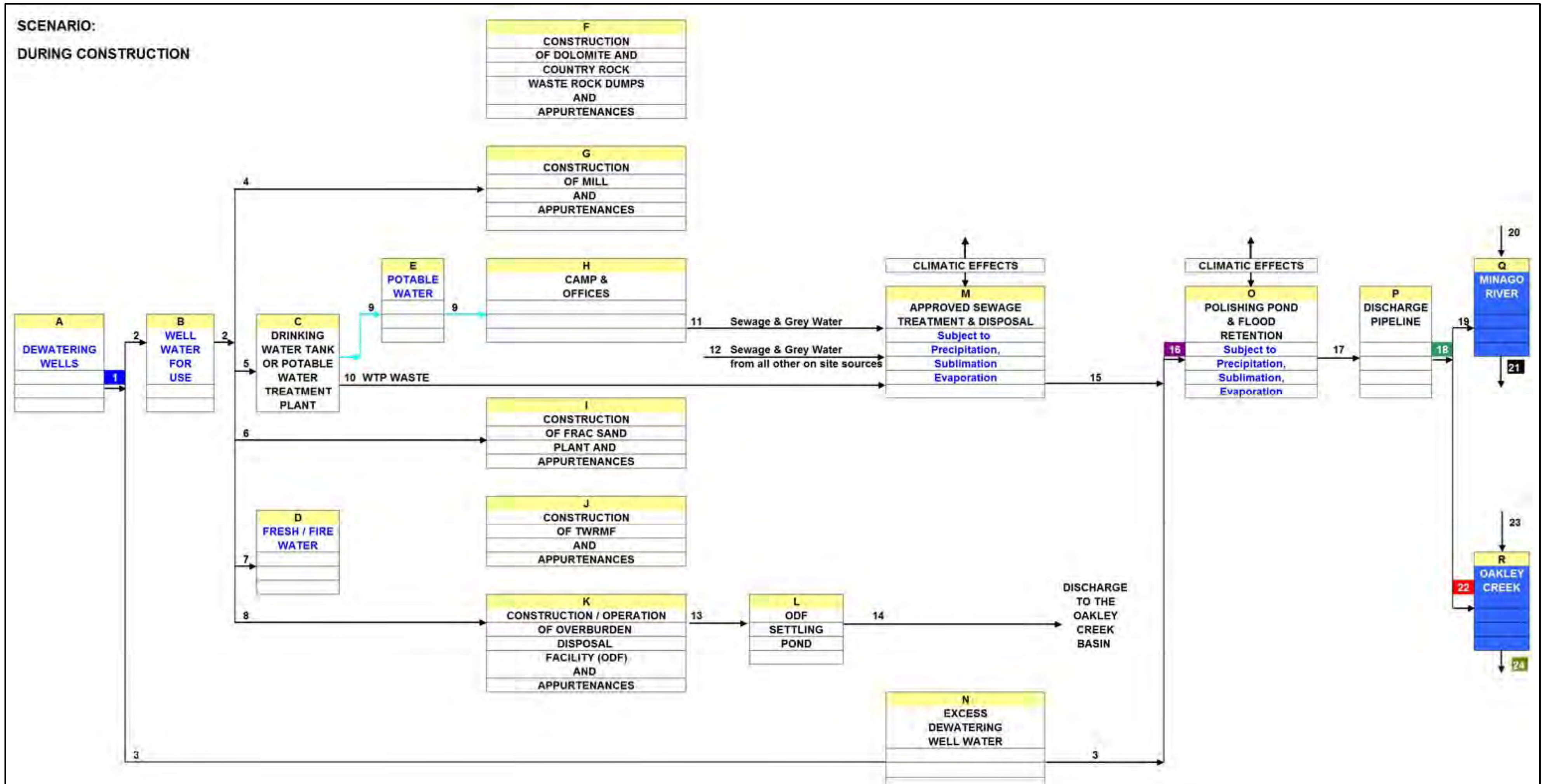
- **Dewatering Well Water (Flow Q1):**

  To allow ore extraction, the open pit area needs to be dewatered. Dewatering will start during the construction phase. Based on pumping tests conducted by GAIA in 2008, a dewatering well system has been designed, which is detailed in Section 7.6. The design consists of 12 dewatering wells located at a distance of approximately 300 m to 400 m along the crest of the ultimate open pit, pumping simultaneously from the limestone and sandstone geological units. The total pumping rate for the wellfield is predicted to be approximately 40,000 m^3/day (7,300 USgpm), and the average pumping rate for an individual well is estimated to be about 3,300 m^3/day (600 USgpm) (Golder Associates, 2008b). The associated drawdown cone, defined using a 1 m drawdown contour, is predicted to extend laterally in the limestone to a distance of approximately 5,000 to 6,000 m from the proposed open pit. Based on sensitivity analyses, the actual dewatering rate for the entire wellfield could vary from 25,000 m^3/day (4,600 USgpm) to 90,000 m^3/day (16,500 USgpm) (Golder Associates, 2008b).

  In the Minago water balance model, presented towards the end of this section, a dewatering rate of 40,000 m^3/day was assumed (32,000 m^3/day originating from the dewatering wells and 8,000 m^3/day from dewatering of the Open Pit).

- **Process Water and Dewatering Well Water (Flows Q2, Q3, Q4, Q5, Q6, Q7, and Q8):**

  Water from the dewatering wells will be used as process water (Q2) for construction activities of the mill complex and appurtenances (Q4), as input to the potable water treatment plant (Q5), as input to the Frac Sand Plant construction site (Q6), as fire water (Q7), and for the construction of the Overburden Disposal Facility (ODF) and dredging of overburden (Q8).



SYSTEM OF LINEAR EQUATIONS (FOR FLOWS)

DEWATERING WELLS	Q1 = Q2+Q3
WELL WATER FOR USE	Q2 = Q4 + Q5 + Q6 + Q7 + Q8
POLISING POND DISCHARGE WATER	Q18
MINAGO RIVER DOWNSTREAM	Q21 = Q19+Q20
OAKLEY CREEK DOWNSTREAM	Q24 = Q22+Q23

Figure 2.14-2 Water Management System during Construction

- **Potable Water / Grey Water / Sewage (Flows Q9, Q10, Q11, Q12 and Q15):**

  A water treatment plant to produce potable water will be operated at the Minago site to produce sufficient potable water for the camp (Q9), all other on-site personnel and any other processes that require potable water. Sludge from the potable water treatment plant (Q10) will be disposed of in an approved sewage treatment system.

  All on-site grey water and sewage (Q11 and Q12) will be collected and discharged to an approved sewage treatment system. Outflow from the sewage treatment system (Q15) will be discharged to the Polishing Pond.

  The sewage treatment system will be subject to the climatic effects of precipitation, sublimation, and evaporation.

- **ODF Settling Pond (Flows Q13 and Q14):**

  Construction of the Overburden Disposal Facility may require some dewatering well water and dredging of the overburden (Q13), while underway, will require almost all of the dewatering water (~35,000 m^3/day) (Wardrop, 2010). Discharge of ODF seepage will be released to the environment via an ODF Settling Pond (Q14). Only water meeting the discharge criteria will be discharged to the Oakley Creek basin for ultimate discharge to Oakley Creek.

- **Polishing Pond (PP) (Flows Q3, Q15, Q16, and Q17):**

  Storm water, outflow from the approved sewage treatment system (Q15) and excess dewatering well water (Q3) will be discharged to the Polishing Pond. This water containment will ensure that quality standards are met prior to discharge. Water contained in the Polishing Pond will be discharged to the receiving environment via a discharge pipeline system (Q18), to the Minago River (Q19) and the Oakley Creek (Q22). Detailed engineering will be undertaken to determine the exact location of the pipeline and of the discharge point. Stream crossings will be avoided and environmental impacts will be minimized as much as possible.

  The Polishing Pond will be used as water storage, final settling pond, and flood retention area. The Polishing Pond will be approximately 75 ha in area with a gross storage capacity of approximately 3.04 million m^3. The Polishing Pond will be subject to the climatic effects of precipitation, sublimation, and evaporation.

- **Discharge System to Minago River (year round) (Flow Q19):**

Discharge to the Minago River (Q19) willl occur year round at rates that will be adjusted seasonally to ensure that the discharged flows will not impact the flow regime nor the flora and fauna in Minago River negatively.

In the water balance model, it was assumed that 70% of all water to be discharged from the Polishing Pond will be directed towards Minago River during the non-winter months (May to October). In the winter months (Nov. – Apr.), 65% of all excess Polishing Pond water will be discharged to the Minago River and 35% will be stored in the Polishing Pond for discharge during the subsequent freshet (May).

- **Discharge System to Oakley Creek (Summer) (Flow Q22):**

  It was assumed that Oakley Creek will be completely frozen during the winter months and therefore no discharges are planned to Oakley Creek in the winter months. Discharge to Oakley Creek (Q22) will occur from May to October. Discharges to Oakley Creek will be adjusted seasonally to ensure that the discharged water will not impact the flow regime nor the flora and fauna in Oakley Creek negatively. It was assumed that 30% of excess Polishing Pond water will be discharged to Oakley Creek during the non-winter months (May to October).

2.14.1.2 Water Management System during Operations

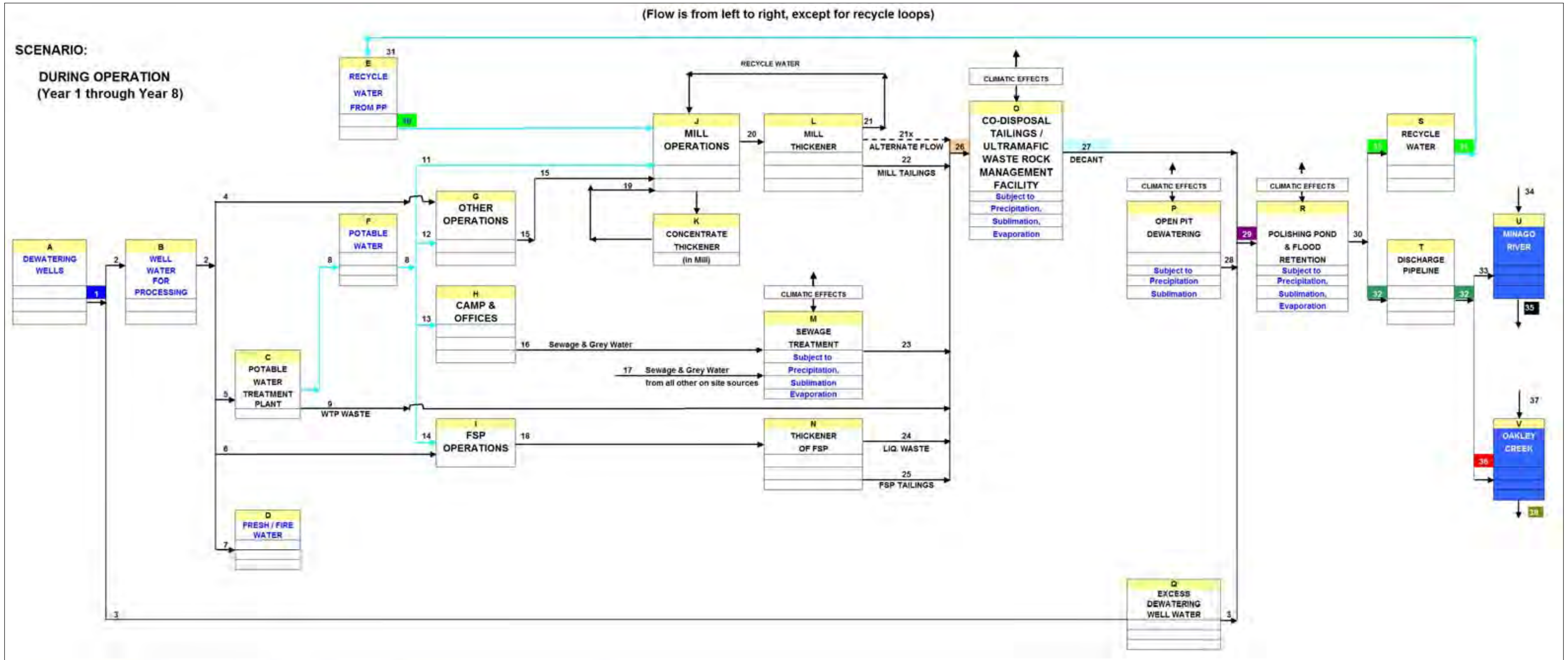
The operational period at Minago will consist of two distinct periods. In Year 1 through Year 8, both the Nickel Processing Plant and the Frac Sand Plant will be operating. In Year 9 and Year 10, the Nickel Processing Plant will be decommissioned based on current projections of nickel resources, but the Frac Sand Plant will be operating.

To facilitate the description of the water management model, key components are illustrated with boxes in the schematic water balance diagram (Figure 2.14-3) and flow(s) in and out of each box are numbered (Q1 through Q38). All flows in the schematic water balance diagram are from left to right (which is the typical flow direction) except for flows in recycle loops, which flow from right to left.

Following is a description of the water management model during the Year 1 through Year 8:

- **Dewatering Well Water (Flow Q1):**

  To allow ore extraction, the open pit area needs will be dewatered. Based on pumping tests conducted by GAIA in 2008, a dewatering well system has been designed, which is detailed in Section 7.6. The design consists of 12 dewatering wells located at a distance of approximately 300 m to 400 m along the crest of the ultimate open pit, pumping simultaneously from the limestone and sandstone geological units. The total pumping rate for the wellfield is predicted to be approximately 40,000 m^3/day (7,300 USgpm), and the average pumping rate for an individual well is estimated to be about 3,300 m^3/day (600 USgpm) (Golder Associates, 2008b). The associated drawdown cone, defined using a 1 m drawdown contour, is predicted to extend laterally in the limestone to a distance of approximately 5,000 to 6,000 m from the proposed open pit. Based on sensitivity analyses, the actual dewatering



SYSTEM OF LINEAR EQUATIONS (FOR FLOWS)

DEWATERING WELLS	Q1 = Q2+Q3
PROCESS WATER	Q2 = Q4 + Q5 + Q6 + Q7
RECYCLED WATER FROM FINAL POLISHING POND	Q10 = Q31
TMF INFLOW	Q26 = Q9+Q21x+Q22+Q23+Q24+Q25
TMF DECANT	Q27
POLISHING POND INFLOW	Q29 = Q3+Q27+Q28
DISCHARGED WATER	Q32
MINAGO RIVER DOWNSTREAM	Q35 = Q33+Q34
OAKLEY CREEK DOWNSTREAM	Q38 = Q36+Q37

Figure 2.14-3 Water Management System during the Nickel and Frac Sand Plants Operations (in Years 1 through 8)

rate for the entire wellfield could vary from 25,000 m^3/day (4,600 USgpm) to 90,000 m^3/day (16,500 USgpm) (Golder Associates, 2008b).

In the Minago water balance model, presented towards the end of this section, a dewatering rate of 40,000 m^3/day was assumed (32,000 m^3/day originating from the dewatering wells and 8,000 m^3/day from dewatering of the Open Pit).

- **Process Water and Dewatering Well Water (Flows Q2, Q3, Q4, Q5, Q6, and Q7):**

  Water from the dewatering wells will be used as process water (Q2) in the industrial complex (Q4), as input to the potable water treatment plant (Q5), as input to the Frac Sand Plant (Q6), and as fire water (Q7). Any excess dewatering well water not required for processing purposes (Q3) will be discharged to the Polishing Pond.

- **Potable Water / Grey Water / Sewage (Flows Q8, Q9, Q11, Q12, Q13, Q14, Q16, Q17, and Q23):**

  A water treatment plant to produce potable water will be operated at the Minago site to produce sufficient potable water (Q8) for the camp and offices (Q13), all other on-site personnel (Q11, Q12, and Q14), and any other processes that require potable water. Sludge from the potable water treatment plant (Q9) will be disposed of in the TWRMF.

  All on-site grey water and sewage (Q16 and Q17) will be collected and discharged to an extended aeration treatment system. Outflow from the sewage treatment system (Q23) will be discharged to the TWRMF.

  The sewage treatment system will be subject to the climatic effects of precipitation, sublimation, and evaporation.

- **Mill complex (Flows Q10, Q11, Q15, Q19, Q20, Q21, Q21x, and Q22):**

  Milling operations at Minago will be located on the north western side of the site and north of the access road (Figure 2.14-1). Schematically, the mill complex is illustrated with ‘Mill Operations’, ‘Concentrate Thickener in Mill’, and ‘Mill Thickener’ in Figure 2.14-3.

  The mill complex has the following inflows:

  1) Recycle water from the Polishing Pond (Q10);
  2) Potable water (Q11);
  3) primary crusher products and crushed ore from the Other Operations area (as well as water used for dust suppression) (Q15);
  4) recovered water from the concentrate thickener (Q19); and

5) Recycle water from the mill thickener (Q21).

Outflows from the mill complex are nickel concentrate that will be shipped for sale and tailings slurry (Q22) that will be discharged to the Tailings and Ultramafic Waste Rock Management Facility (TWRMF). If the quality of the mill recycle water does not meet the process water quality standards for the mill, a portion of the recycle water from the Mill Thickener (Q21x) may also be discharged into the TWRMF. However, the redirection of the recycle water from the Mill Thickener is not expected under normal operating conditions.

- **Frac Sand Plant (Flows Q6, Q14, Q18, Q24 and Q25):**

  The Frac Sand Plant will receive process water (Q6) consisting of dewatering well water and potable water (Q14). Liquid waste from the Frac Sand Plant (Q18) will be directed towards the thickener of the Frac Sand Plant.

  Frac Sand Plant tailings (Q25) and related liquid waste (Q24) from the Frac Sand Plant will be discharged to the TWRMF.

- **Other Operations (Flow Q15):**

  The term 'Other Operations' in the context of this site water management plan refers to the primary crusher, crushed ore tunnel, maintenance building, fueling area, and substation. The main outflow of the Other Operations Area (Q15) will be crushed ore that will be directed towards the mill complex. Grey water and sewage from the Other Operations Area will be discharged to the sewage treatment system. Hydrocarbons and other potentially deleterious substances in the Other Operations Area will be handled, stored and disposed of in an appropriate manner in compliance with all applicable regulations and guidelines and will not be discharged to the TWRMF.

- **Tailings and Ultramafic Waste Rock Management Facility (Flows Q9, Q21x, Q22, Q23, Q24, and Q25):**

  The Tailings and Ultramafic Waste Rock Management Facility (TWRMF) is a key component of the water and waste management system at Minago for liquid waste, tailings and ultramafic waste rock management. The TWRMF will serve as repository for mill and Frac Sand Plant tailings and ultramafic waste rock.

  Tailings and ultramafic waste rock will be disposed concurrently in the TWRMF and will be stored subaqueously. Key elements of the concurrent disposal of tailings and ultramafic waste rock are detailed in Section 2.13.

  Submerging tailings containing sulphide minerals, or "subaqueous disposal", is practiced at many metal mines to keep oxidative rates at a minimum and to minimize metal leaching. Based on geochemical work done to date, Minago's mill tailings contain low sulphide levels and were deemed to be non acid generating (NAG) (URS, 2009i). Sulphide levels were less than or equal to 0.07 % in the Master tailings samples tested. However, the Precambiran ultamafic waste rock is potentially acid generating (URS, 2008i).

The TWRMF will remain in place after all operations have ceased at the site. The TWRMF inflow (Q26) will consist of:

- alternate flow from the mill thickener (only if warranted) (Q21x);
- mill tailings (Q22);
- sludge from the potable water treatment plant (Q9);
- liquid waste from the Frac Sand Plant (Q24);
- tailings from the Frac Sand Plant (Q25); and
- outflow from the sewage treatment system (Q23).

The TWRMF will also be subject to the climatic effects of precipitation, evaporation and sublimation.

Outflows from the TWRMF include the TWRMF Decant (Q27) and losses due to evaporation and sublimation, and seepage. Seepage will be captured by interceptor ditches surrounding the TWRMF and will be pumped back to the TWRMF. The flow volume of the TWRMF Decant will be regulated automatically by a control system.

During the operational phase, deposited waste will be kept under a nominal 0.5 m thick water cover. The design of the facility will include several baffles and/or barriers to encourage the settlement of suspended solids and to ensure that the TWRMF decant has a low suspended solids concentration.

The TWRMF will provide 38 million m^3 of storage with a maximum water surface area of approximately 219.7 ha (Wardrop, 2010).

- **Open Pit Dewatering (Flow Q28):**

During the mining phase, the open pit will be dewatered to ensure safe and dry working conditions in the pit. Open pit dewatering (Q28) will be subject to the climatic effects of precipitation and sublimation.

The excess open pit dewatering water will be pumped to the Polishing Pond.

- **Polishing Pond (PP) (Flows Q3, Q27, Q28, Q29, Q30, Q31, Q32, Q33 and Q36):**

The Polishing Pond will be used as water storage, final settling pond, and flood retention area. The Polishing Pond will be approximately 75 ha in area with a gross storage capacity of approximately 3.04 million m^3. This water containment structure will ensure that quality standards are met prior to discharge. Water contained in the Polishing Pond will be pumped to the Minago River watershed, the Oakley Creek watershed and to the process water tank as reclaim water.

The Polishing Pond will receive decant water from the TWRMF (Q27), dewatering water from the Open Pit (Q28), excess groundwater from the twelve (12) mine dewatering wells (Q3), and precipitation. Under normal operating conditions, when meeting water quality standards, water retained by the Polishing Pond (Q30) will either be recycled to the milling process (Q31 = Q10) or discharged to the receiving environment via a discharge pipeline system (Q32), which discharges water to the Minago River (Q33) and the Oakley Creek (Q36).

Storm water from the waste rock dumps, the TWRMF and the in-pit dewatering system will also be channelled into a Polishing Pond.

The Polishing Pond will also be subject to the climatic effects of precipitation, evaporation and sublimation.

- **Discharge System to Minago River (year round) (Flow Q33):**

  Discharge to the Minago River (Q33) will occur year round at rates that will be adjusted seasonally to ensure that the discharged flows will not impact the flow regime nor the flora and fauna in the Minago River negatively.

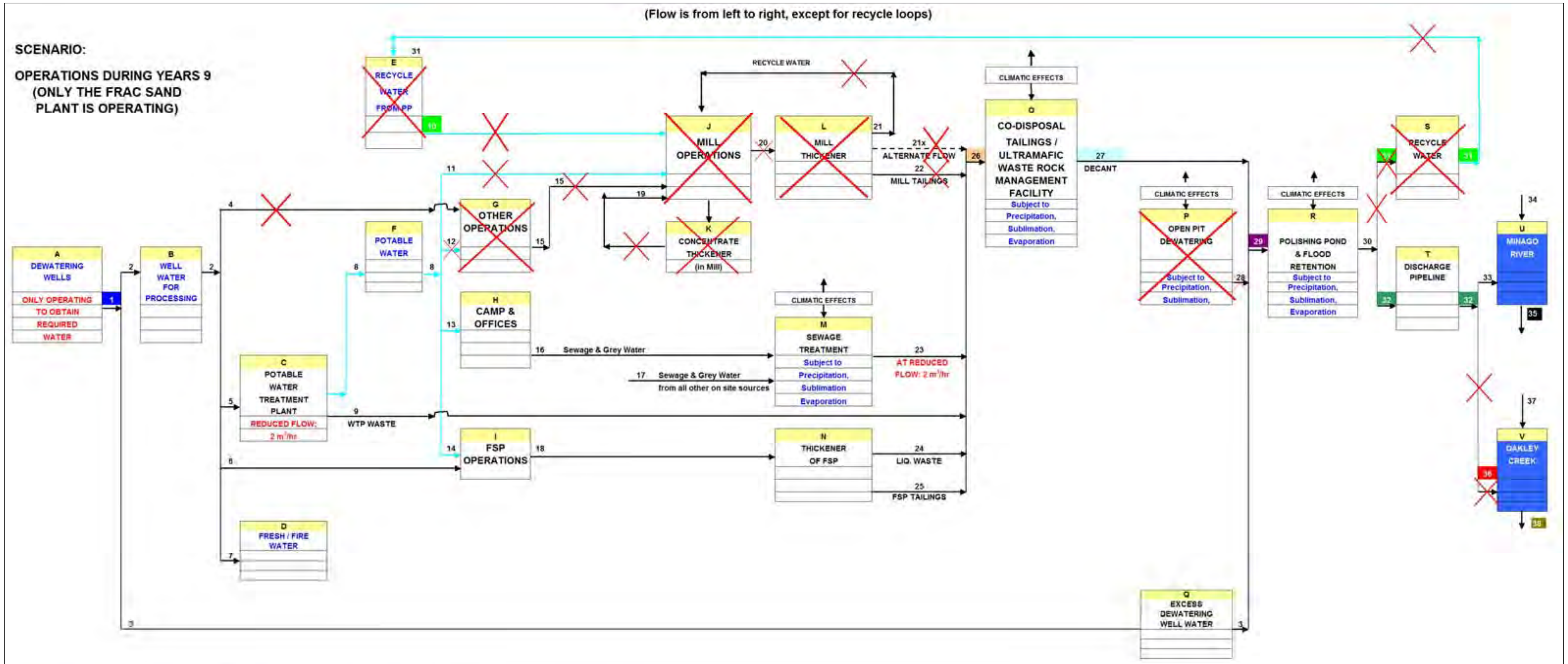
  In the water balance model, it was assumed that 70% of all excess Polishing Pond water will be directed towards the Minago River during the non-winter months (May to October) and that 65% of it will be discharged to the Minago River during the winter months (November to April).

- **Discharge System to Oakley Creek (Summer) (Flow Q36):**

  It was assumed that Oakley Creek will be completely frozen during the winter months and therefore no discharges are planned to Oakley Creek in the winter months (Nov. – Apr.). Discharge to the Oakley Creek (Q36) will occur from May to October. Discharges to the Oakley Creek will be adjusted seasonally to ensure that the discharged water will not impact the flow regime nor the flora and fauna in the Oakley Creek negatively. It was assumed that 30% of the excess Polishing Pond water will be discharged to the Oakley Creek during non-winter months (May – Oct.).

2.14.1.3 Water Management System during Frac Sand Plant Operations in Year 9 and 10

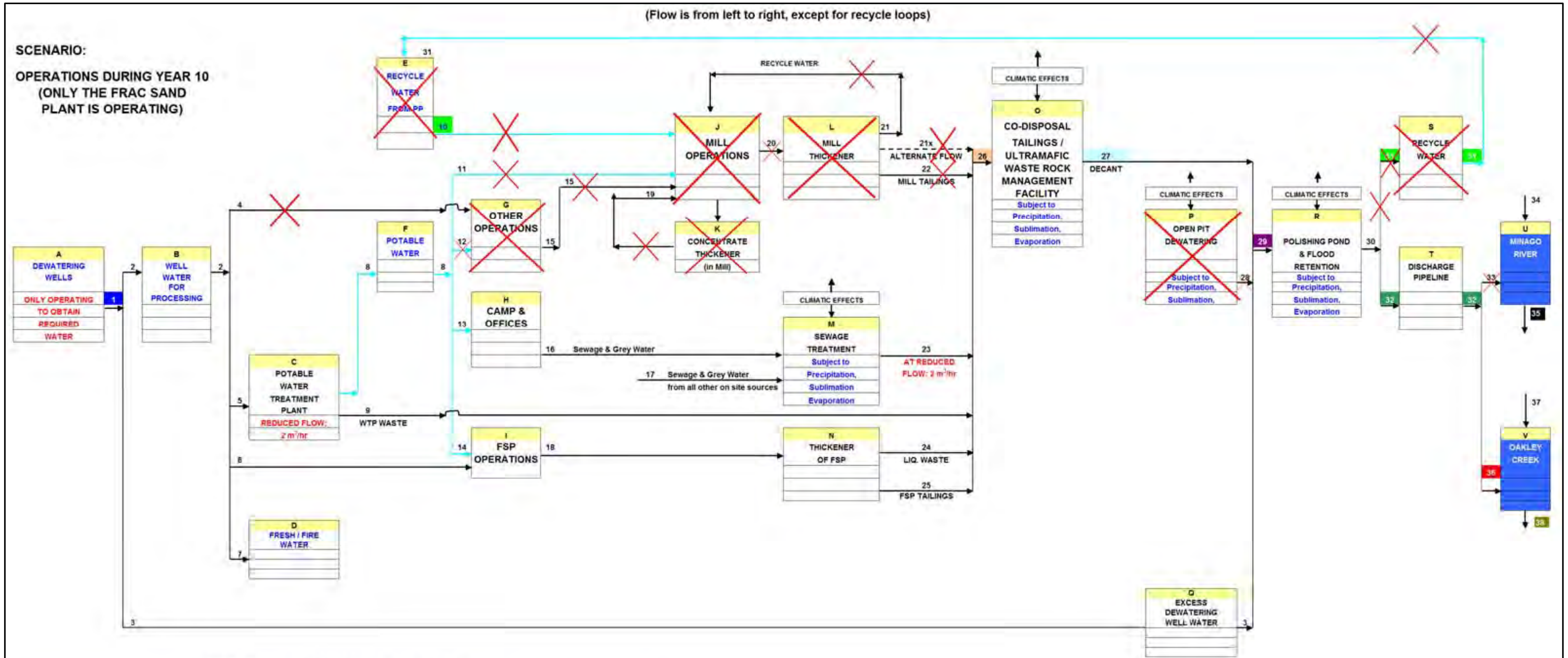
In Year 9 and Year 10, the Nickel Processing Plant will be decommissioned based on current projections of nickel resources, but the Frac Sand Plant will be operating as before. Accordingly, the extent of the water management system will be scaled back significantly. Less water will be needed for operations; and therefore, the mine dewatering program will be scaled down significantly. No water will be required nor discharged from the Nickel Processing Plant complex



SYSTEM OF LINEAR EQUATIONS (FOR FLOWS)

DEWATERING WELLS	Q1 = Q2+Q3
PROCESS WATER	Q2 = Q4 + Q5 + Q6 + Q7
RECYCLED WATER FROM FINAL POLISHING POND	Q10 = Q31
TMF INFLOW	Q26 = Q9+Q21x+Q22+Q23+Q24+Q25
TMF DECANT	Q27
POLISHING POND INFLOW	Q29 = Q3+Q27+Q28
DISCHARGED WATER	Q32
MINAGO RIVER DOWNSTREAM	Q35 = Q33+Q34
OAKLEY CREEK DOWNSTREAM	Q38 = Q36+Q37

Figure 2.14-4 Water Management System during Frac Sand Plant Operations in Year 9



SYSTEM OF LINEAR EQUATIONS (FOR FLOWS)

DEWATERING WELLS	Q1 = Q2+Q3
PROCESS WATER	Q2 = Q4 + Q5 + Q6 + Q7
RECYCLED WATER FROM FINAL POLISHING POND	Q10 = Q31
TMF INFLOW	Q26 = Q9+Q21x+Q22+Q23+Q24+Q25
TMF DECANT	Q27
POLISHING POND INFLOW	Q29 = Q3+Q27+Q28
DISCHARGED WATER	Q32
MINAGO RIVER DOWNSTREAM	Q35 = Q33+Q34
OAKLEY CREEK DOWNSTREAM	Q38 = Q36+Q37

Figure 2.14-5 Water Management System during Frac Sand Plant Operations in Year 10

during these years. The Open Pit dewatering will cease. These changes in the water management program compared to the Year 1 through Year 8 water management program are illustrated in Figures 2.14-4 and 2.14-5. Figure 2.14-4 shows conditions in Year 9 and Figure 2.14-5 illustrates conditions in Year 10.

In Figure 2.14-4, all components that will not be active in the water management system (i.e., for which flows will be zero) are shown as crossed out. All other flows and water balance components will remain the same as they will have been during the Year 1 through Year 8 operations.

Following is a short list of the flow conditions with respect to “zero” flows in Year 9 and Year 10:

- Dewatering Well Water (Flow Q1 => only one well will be operating);
- Process Water and Dewatering Well Water (Flows Q2, Q3, Q4=0, Q5, Q6, and Q7);
- Potable Water / Grey Water / Sewage (Flows Q8, Q9, Q11=0, Q12=0, Q14, Q16, Q17, Q23);
- Mill complex: It will be closed (Flows Q10=0, Q11=0, Q15=0, Q19=0, Q20=0, Q21=0, Q21x=0, and Q22=0);
- Frac Sand Plant (Flows Q6, Q14, Q18, Q24 and Q25);
- Other Operations (Flow Q15=0);
- Tailings and Ultramafic Waste Rock Management Facility (Flows Q9, Q21x=0, Q22=0, Q23, Q24, and Q25);
- Open Pit Dewatering (Flow Q28=0);
- Polishing Pond (PP) (Flows Q3, Q27, Q28=0, Q29, Q30, Q31=Q10=0, Q32, Q33 and Q36);
- Discharge System to the Minago River (year round) (Flow Q33):

  Year 9: In the Year 9 water balance model, it was assumed that 100% of all water to be discharged from the Polishing Pond will be directed towards Minago River (Q33) year round to achieve a staged reduction of discharges. The discharge will range from 1% to 5% of the average seasonal flows in the Minago River, as detailed lateron in this Section.

  Year 10: There will be no Polishing Pond discharges to Minago River (Q33=0) in Year 10.

- Discharge System to the Oakley Creek (Summer)(Flow Q36):

  It was assumed that Oakley Creek will be completely frozen during the winter months and therefore no discharges are planned to Oakley Creek in the winter months (Nov. to Apr.).

  Year 9: In the Year 9 water balance model, it was assumed that 0% of the Polishing Pond discharges will be directed towards the Oakley Creek (Q36).

Year 10: In Year 10, there will be no discharge to Oakley Creek in the winter months (Nov. to Apr.), but 100% of the Polishing Pond discharges will be directed towards Oakley Creek for the remainder of the year.

2.14.1.4 Water Management System during Closure

During the closure period, site and infrastructure decommissioning and site reclamation will take place and all processing facilities and appurtenances will be shut down. Water management during the closure period is illustrated in Figures 2.14-6 and 2.14-7. The first stage of the closure period is illustrated in Figure 2.14-6 and the second stage of the closure period is illustrated in Figure 2.14-7.

The following components will operate during the first stage of closure: dewatering wells, potable water treatment plant (at an appropriate rate based on on-site personnel), sewage treatment system, TWRMF, and the Polishing Pond. All of these components, with the exception of the dewatering wells, will be the same as was described for the Year 1 to Year 8 operational period. The dewatering wells will be used to install a 1.5 m high water cover on top of the TWRMF.

All water management components for the second stage of closure will be the same as for the first stage except for the dewatering wells. All dewatering wells will be decommissioned in the second stage of closure.

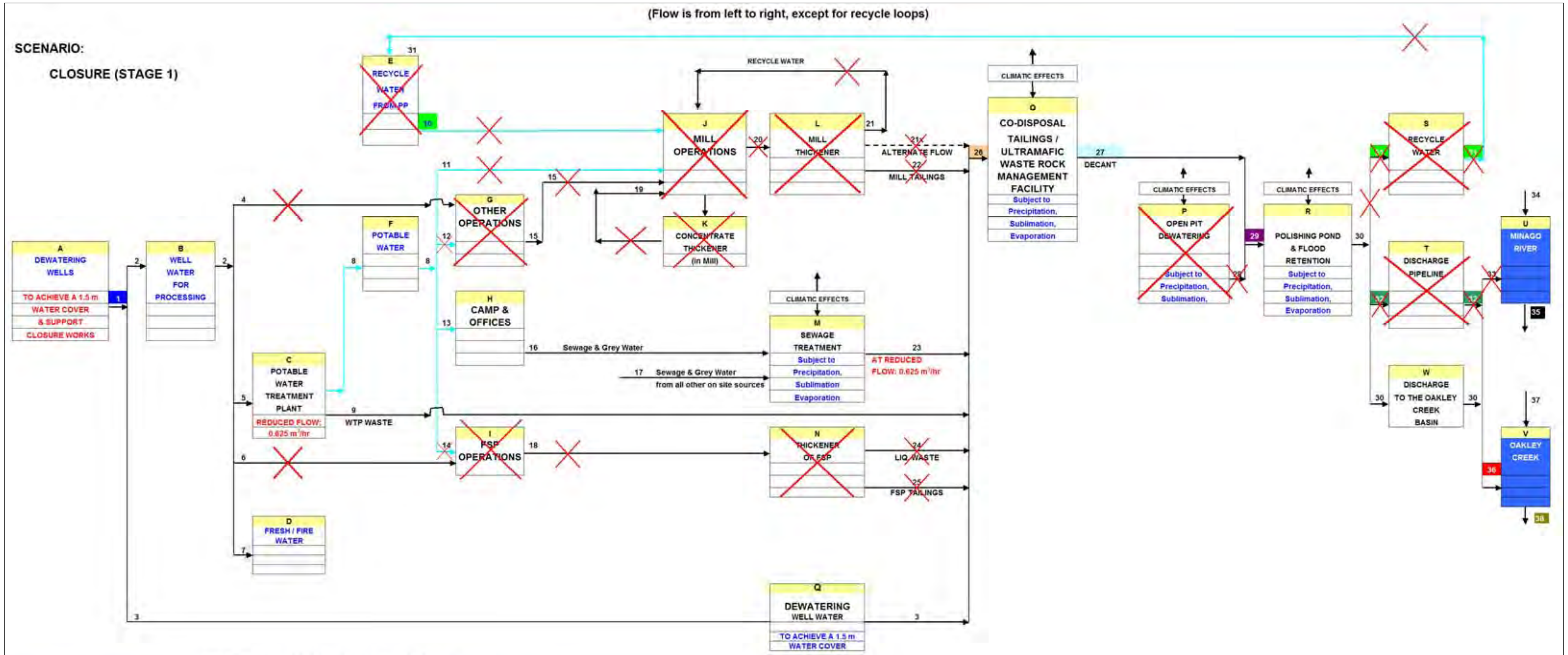
Water will be discharged from the Polishing Pond via a spillway to the Oakley Creek basin for ultimate discharge to Oakley Creek.

During the closure phase, the Tailings and Ultramafic Waste Rock Management Facility (TWRMF) will be reclaimed as a permanent pond. The access road will remain in place. Reclamation goals are a stabilized surface and a native plant community to provide wildlife habitat. The TWRMF embankments will be modified to ensure long-term saturation of the tailings and the ultramafic waste rock and to provide a spillway for ultimate passive decanting of the TWRMF at closure. The spillway will have been installed with an invert elevation approximately 1.5 m above the deposited tailings. The spillway will be installed before the closure phase and will allow controlled discharge of TWRMF supernatant (Q27) that is in excess of the 1.5 m high water cover.

2.14.1.5 Water Management System during Post Closure

Water management during the post closure period is illustrated in Figure 2.14-8. In the post closure period, all mining facilities and infrastructure will have been decommissioned with the exception of the TWRMF and the Polishing Pond.

In the post closure phase, the TWRMF will have been decommissioned and reclaimed as much as possible.



SYSTEM OF LINEAR EQUATIONS (FOR FLOWS)

DEWATERING WELLS	Q1 = Q2+Q3
PROCESS WATER	Q2 = Q4 + Q5 + Q6 + Q7
RECYCLED WATER FROM FINAL POLISHING POND	Q10 = Q31
TMF INFLOW	Q26 = Q3+Q9+Q21x+Q22+Q23+Q24+Q25
TMF DECANT	Q27
POLISHING POND INFLOW	Q29 = Q27+Q28
DISCHARGED WATER	Q32
MINAGO RIVER DOWNSTREAM	Q35 = Q33+Q34
OAKLEY CREEK DOWNSTREAM	Q38 = Q36+Q37

Figure 2.14-6 Water Management System during First Stage of Closure

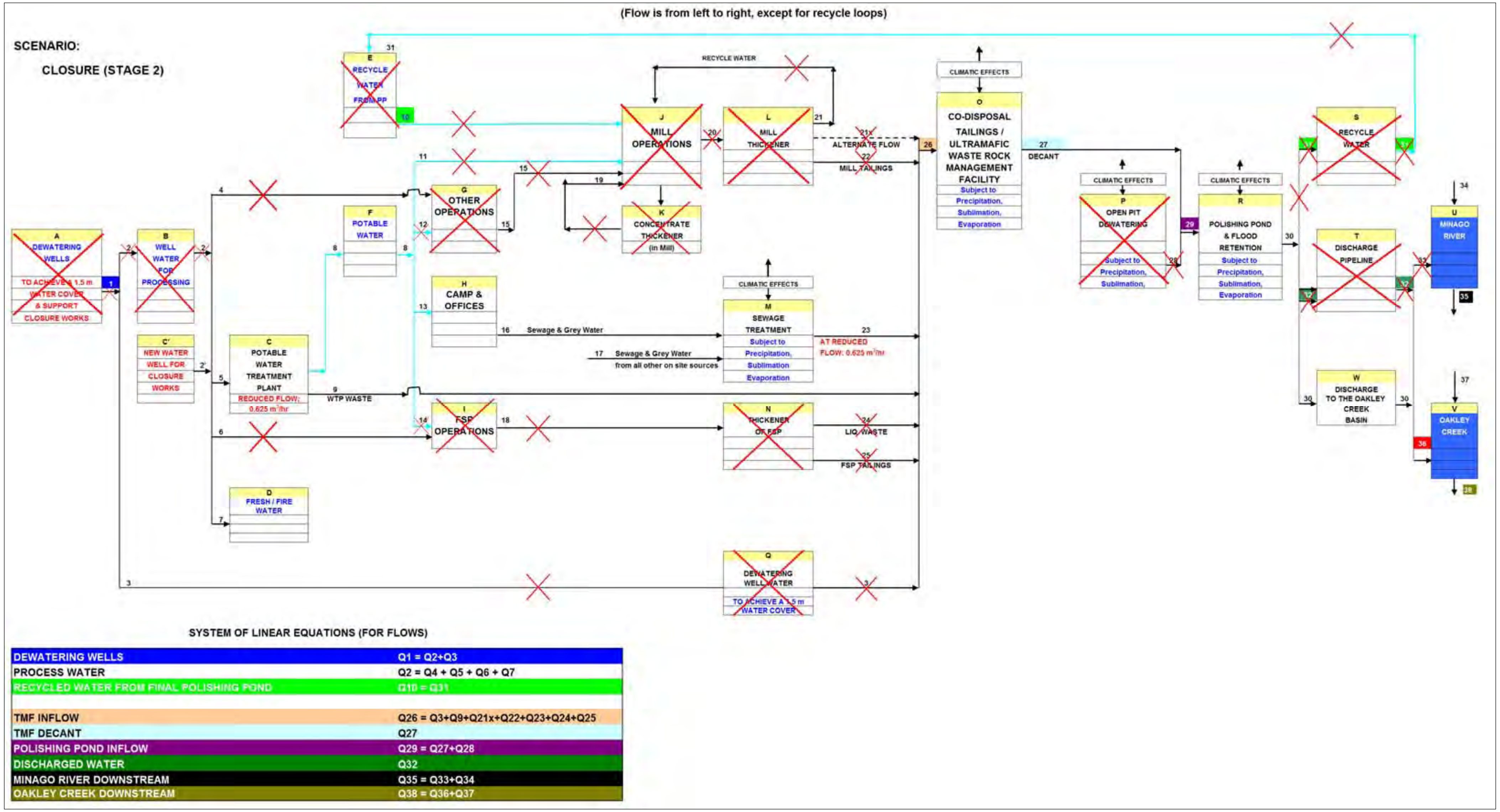
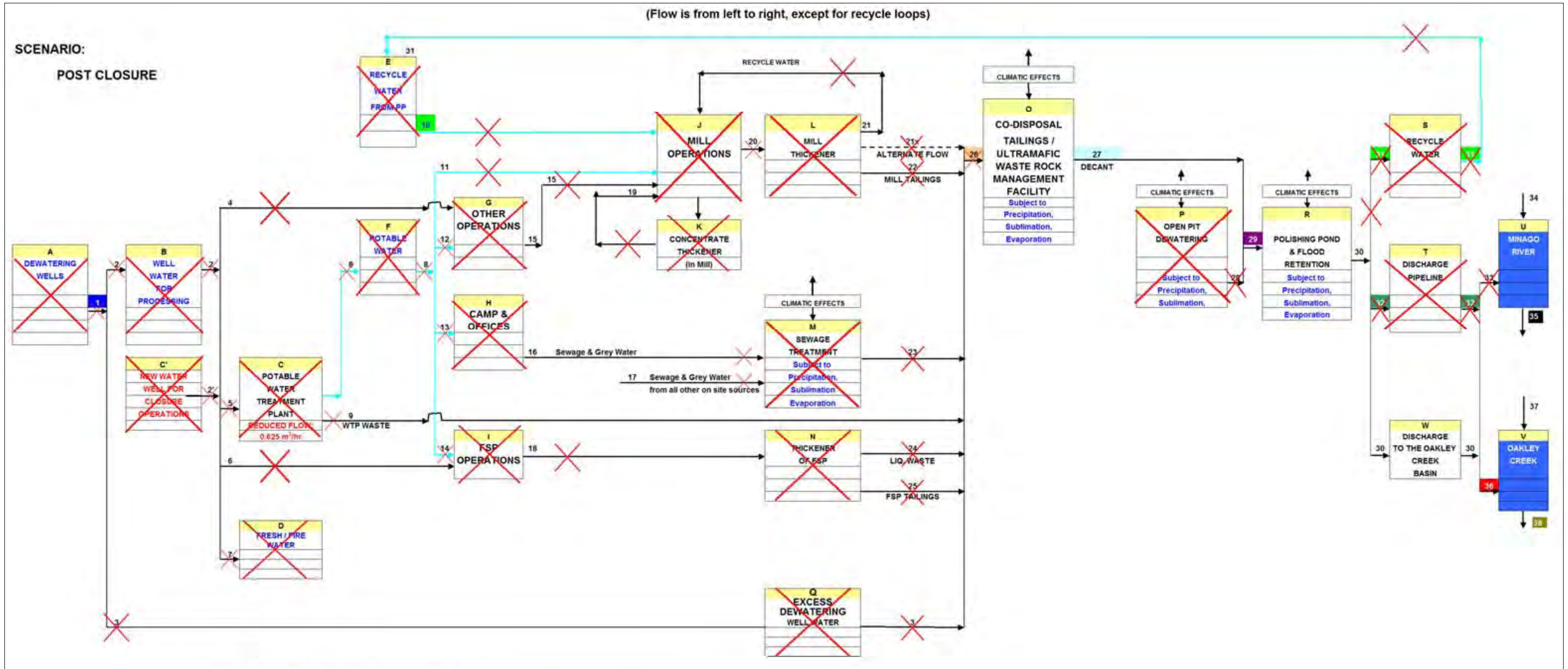


Figure 2.14-7 Water Management System during Second Stage of Closure



SYSTEM OF LINEAR EQUATIONS (FOR FLOWS)

DEWATERING WELLS	Q1 = Q2+Q3
PROCESS WATER	Q2 = Q4 + Q5 + Q6 + Q7
RECYCLED WATER FROM FINAL POLISHING POND	Q10 = Q31
TMF INFLOW	Q26 = Q3+Q9+Q21x+Q22+Q23+Q24+Q25
TMF DECANT	Q27
POLISHING POND INFLOW	Q29 = Q27+Q28
DISCHARGED WATER	Q32
MINAGO RIVER DOWNSTREAM	Q35 = Q33+Q34
OAKLEY CREEK DOWNSTREAM	Q38 = Q36+Q37

Figure 2.14-8 Post Closure Water Management System

2.14.1.6 Water Management System during Temporary Suspension

A schematic of the site water management system during the temporary suspension (TS) of operations is given in Figure 2.14-9. As the name implies, the state of Temporary Suspension is typically temporary in nature. Temporary suspension does not occur under normal operating conditions. Due to the temporary nature of the state of Temporary Suspension, only production related facilities at the site such as the mill complex (mill operations, mill thickener, concentrate thickener in the mill), Frac Sand Plant, the thickener of the Frac Sand Plant, and Other Operations will be suspended. During Temporary Suspension, recycling of water from the Polishing Pond will also cease, but the mine site and open pit will still be dewatered as was done during site operations.

Continued dewatering of the site will permit a timely start-up after the temporary suspension of site operations is lifted and normal operations resume.

All other components of the water management system that will not be shut down will be as was described previously for the Year 1 to Year 8 operational period.

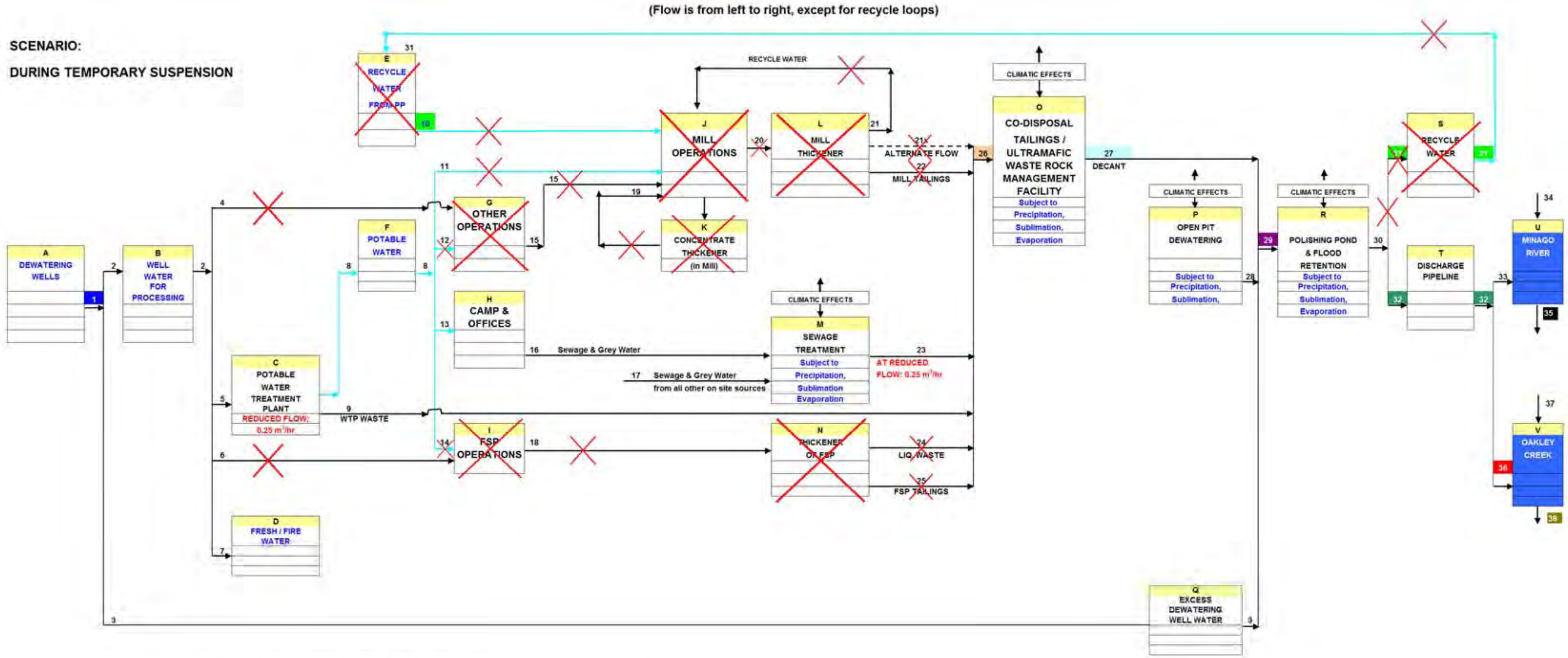
In the water balance model, it was assumed that the state of Temporary Suspension will occur at the end of Year 4.

2.14.1.7 Water Management System during a State of Inactivity

A schematic of the site water management system during a State of Inactivity (SI) is given in Figure 2.14-10. The State of Inactivity does not occur under normal operating conditions. During the State of Inactivity, all process related operations will cease and the mill complex (mill operations, mill thickener, concentrate thickener in the mill), Frac Sand Plant, the thickener of the Frac Sand Plant, and Other Operations will be shut down. Recycling of water from the Polishing Pond to the mill will also cease and dewatering of the open pit will be significantly reduced. As illustrated in Figure 2.14-10, only one out of the twelve dewatering wells will be operating to supply water for the remaining activities at Minago. Dewatering of the open pit mine will also cease.

All other components of the water management system that will not be shut down will be as was described for the Year 1 to Year 8 operational period.

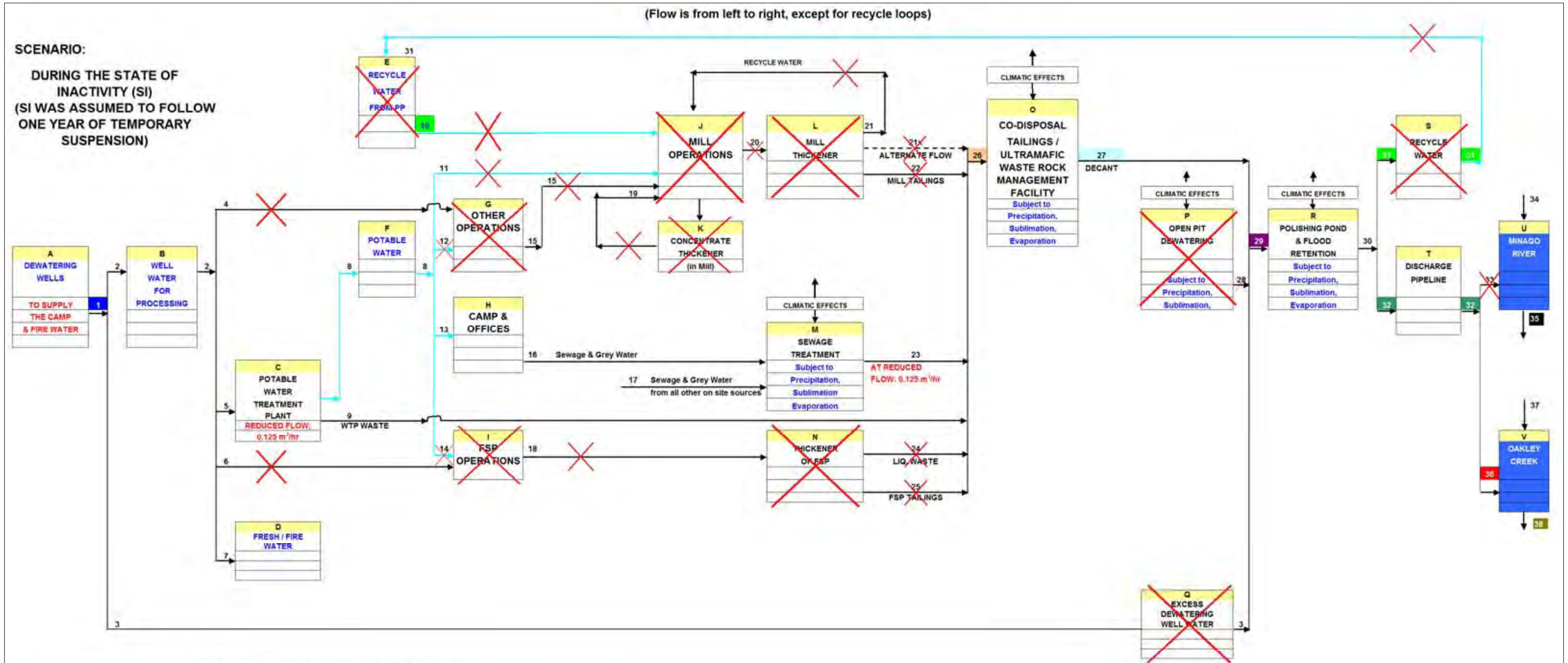
In the Minago water balance model, the State of Inactivity was assumed to have occurred after one year of Temporary Suspension at the end of Year 5.



SYSTEM OF LINEAR EQUATIONS (FOR FLOWS)

DEWATERING WELLS	Q1 = Q2+Q3
PROCESS WATER	Q2 = Q4 + Q5 + Q6 + Q7
RECYCLED WATER FROM FINAL POLISHING POND	Q10 = Q31
TMF INFLOW	Q26 = Q9+Q21x+Q22+Q23+Q24+Q25
TMF DECANT	Q27
POLISHING POND INFLOW	Q29 = Q3+Q27+Q28
DISCHARGED WATER	Q32
MINAGO RIVER DOWNSTREAM	Q35 = Q33+Q34
OAKLEY CREEK DOWNSTREAM	Q38 = Q36+Q37

Figure 2.14-9 Water Management System during Temporary Suspension



SYSTEM OF LINEAR EQUATIONS (FOR FLOWS)

DEWATERING WELLS	Q1 = Q2+Q3
PROCESS WATER	Q2 = Q4 + Q5 + Q6 + Q7
RECYCLED WATER FROM FINAL POLISHING POND	Q10 = Q31
TMF INFLOW	Q26 = Q9+Q21x+Q22+Q23+Q24+Q25
TMF DECANT	Q27
POLISHING POND INFLOW	Q29 = Q3+Q27+Q28
DISCHARGED WATER	Q32
MINAGO RIVER DOWNSTREAM	Q35 = Q33+Q34
OAKLEY CREEK DOWNSTREAM	Q38 = Q36+Q37

Figure 2.14-10 Water Management System during a State of Inactivity

2.14.2 Minago Water Balance Model

A Water Balance Model (WBM) was developed to estimate average elemental concentrations in flows that will be part of the working mine. The water balance was developed based on expected baseline inputs and outputs. Inputs and outputs are related to three main aspects including dewatering well water and its uses and discharges (chemistry and flow); mining and milling processes to produce concentrate and saleable products out of the ore (chemistry and flow); and climatic conditions (rainfall, snowfall, sublimation, and evaporation). Key input parameters and considerations of the water balance model are summarized below, first in general terms and then in detail.

As for the general description of the water management system, the water balance model is described for the following seven scenarios in this document:

- water balance during Construction (illustrated in Figure 2.14-2);
- water balance during Nickel and Frac Sand Plants Operations (in Years 1 through 8) (illustrated in Figure 2.14-3);
- water balance during Frac Sand Plant Operations (in Years 9 and 10) (illustrated in Figure 2.14-4);
- water balance during Closure (illustrated in Figures 2.14-6 and 2.14-7);
- water balance during Post Closure (illustrated in Figure 2.14-8).
- water balance during Temporary Suspension (illustrated in Figure 2.14-9); and
- water balance during the State of Inactivity (illustrated in Figure 2.14-10).

2.14.2.1 General Description of Inputs and Outputs of the Water Balance Model

The primary water inputs of the water balance model are due to dewatering wells that enable mining in the open pit by lowering the water table. In the water balance model, it was assumed that approximately 32,000 m^3/day will be pumped from 12 dewatering wells that surround the open pit and 8,000 m^3/day will be pumped from the Open Pit (Golder Associates, 2008b). Dewatering well water will be used for processing in the mill and Frac Sand Plant and to create potable water. However, the vast majority (approximately 84%) of the dewatering well water will be discharged unused to the Polishing Pond for subsequent discharge to the receiving environment (Minago River or Oakley Creek) during the mine operations as well as during the State of Inactivity and Temporary Suspension, should they occur.

Another major input into the water balance model are precipitation and associated climatic effects (evaporation, sublimation, etc). All large storage areas (including the waste rock dumps, the Tailings and Ultramafic Waste Rock Management Facility (TWRMF), the Open pit, the Polishing Pond, and the sewage treatment system) will be subject to climatic effects.

Input parameters and considerations used to characterize climatic effects for the Minago Project are as follows:

- **Precipitation**

  The precipitation at Minago was assumed to be 510 mm consisting of 369 mm (72%) of rain and 141 mm (28%) of snow (Golder Associates, 2009). It was assumed that 40 mm (10.8%) of the rain falls in the month of May and 329 mm (89.2%) in the period of June to October (Golder Associates, 2009).

- **Snow Storage**

  Snow sublimation and redistribution has a notable impact on the amount of water in the snowpack and therefore affects the water balance of site facilities and related watersheds. Sublimation can occur directly from snowpack surfaces or during blowing snow events with overall rates dependent on humidity and wind speed (Essery et al., 1999; Déry and Yau, 2002). Snow sublimation is highly dependent on the thermal balance of the snowpack. Golder Associates (2009) projected an average snow sublimation rate of 39% of the average annual snowfall for the Minago Project.

- **Snowmelt**

  In the water balance model, snowmelt was assumed to occur in the month of May.

- **Lake Evaporation and Evapotranspiration**

  Evaporation is the process by which water is transferred from land and water to the atmosphere. Transpiration is the evaporation of water from the vascular system of plants to the atmosphere. The combination of both processes is termed evapotranspiration and is a function of the type of surface (open water, leaf or leaf canopy, bare soil, etc.), the availability of water, and the net energy input into the system.

  The seasonal distribution of evaporation is affected primarily by solar radiation and vegetation cover (or lack of it). During the snowmelt period, evaporation is relatively small compared with the large supply of melt water within a thinly thawed active layer (Woo and Steer, 1983). Typically, evaporation is greatest following snowmelt and decreases through the summer period. Evaporation decreases as the latitude increases. Evaporation losses from lakes are greater than evapotranspiration losses from an equivalent terrestrial area.

  Lake evaporation in the vicinity of the proposed project site is expected to be 500 mm or more (EMRC, 1995), while evapotranspiration is estimated to range between 350 and 400 mm (EMRC, 1995). The majority of the water balance components at Minago will not be subjected to transpirational effects as they will be bare “brown” fields.

In the Minago water balance model, it was assumed that the evaporation from the Tailings and Ultramafic Waste Rock Management Facility (TWRMF), the Polishing Pond, and the sewage treatment system will be 50% of the lake evaporation estimated for large lakes in the vicinity of the Minago Project. Evaporation was assumed to be 56 mm in May, 218.35 mm in the period from June to October (over a period of 154 days), and 0 mm in the winter months (November to April). Evaporation losses were assumed to be negligible for the waste rock dumps (due to the coarseness of the material leading to negligible water storage on the surface) and the open pit due to the continuous removal (pumping) of water that infiltrates the open pit during operations.

- **Ice Regime**

The mean ice thickness in the vicinity of the Minago Project is expected to be between 0.75 and 1 m in lakes and rivers (Allen, 1977). The freeze-over window is expected to be early to mid November, while the ice-free date is typically in mid April (Allen, 1977).

Based on March, 2008, field measurements, Oakley Creek was found to be completely frozen near Highway #6 (at monitoring station OCW1) during the field monitoring program. As such, it is proposed not to discharge any water to Oakley Creek in the winter months.

Outputs

Discharges to Minago River and Oakley Creek watersheds are the major “output” of the water balance model. All other clean, potable, grey, and processing waters will be managed internally at the Minago Project.

2.14.2.2 Detailed Imput Parameters and Considerations of the Water Balance Model

Key input parameters and considerations of the Minago water balance model are presented below. These key input parameters and considerations include climatic conditions and the stages of Operations, Closure and Post Closure as well as Temporary Suspension and the State of Inactivity. Based on the stated input parameters and considerations, elemental concentrations and flowrates were estimated for combined flows that will have a bearing on the receiving environment.

- **Key Climatic Input Parameters and Considerations**

Key climatic parameters used for the water balance model are given in Table 2.14-1.

Table 2.14-1 Climatic Parameters and Considerations used for the Minago Water Balance Model

PRECIPITATION:		
Average annual precipitation:	**510 mm**	Source: Golder Associates (2009)
72% falls as rain:	369 mm	Source: Golder Associates (2009)
28% falls as snow:	141 mm	Source: Golder Associates (2009)
Snow Sublimation:		
39% of annual snow fall:	54.99 mm	Source: Golder Associates (2009)
Water equivalent remaining in the spring:	= 141-54.99 mm = 86.01 mm	Source: Golder Associates (2009)
Water Balance Model Assumptions:		
- It was assumed that 40 mm of rain falls in May (31 days).		Source: Golder Associates (2009)
- It was assumed that 141 mm of snow falls between November and April (180 days). It was assumed that 86.01 mm water equivalent remains of the snow precipitation in the spring.		Source: Golder Associates (2009)
- It was assumed that 329 mm of rain falls in June, July, August, September, October (2.1364 mm/day over 154 days)		Source: Golder Associates (2009)
LAKE EVAPORATION:		
Average annual lake evaporation:	566.0 mm	Source: Golder Associates (2009)
in April:	17.6 mm	Source: Golder Associates (2009)
in May:	112.0 mm	Source: Golder Associates (2009)
in period from June to October:	436.7 mm	Source: Golder Associates (2009)
Water Balance Model Assumptions:		
It was assumed that water evaporates from the sewage treatment system, TWRMF, and Polishing Pond at 50% of the lake evaporation measured for big lakes in the vicinity of the Minago Project. For the 50% evaporation model, it was assumed that 56 mm evaporate in the month of May (1.80645 mm/day over 31 days) and 218.35 mm (1.4179 mm/day over 154 days) evaporate in June, July, August, September and October.		

- **Key Input Parameters and Considerations for Nickel and Frac Sand Plant Operations (Year 1 through Year 8) (Figure 2.14-3):**
  1. The Nickel Processing Plant and the Frac Sand Plant and related appurtenances will be operating.
  2. All twelve dewatering wells will be running and the Open Pit will be dewatered.
  3. Tailings and ultramafic waste rock will be concurrently disposed in a Tailings and Waste Rock Management Facility (TWRMF).
  4. Only the deposited Ni tailings will leach at the maximum leaching rate measured during kinetic testing in the subaqueous leach column surface water.
  5. Voids in freshly deposited tailings will represent 22% of the tailings stream. Voids remaining in the ultramafic waste rock after concurrent disposal with tailings were assumed to represent 6.9% of the total volume of the waste rock and its voids (Wardop, 2010). All voids were assumed to be filled with water of the same quality as the supernatant of the TWRMF. This porewater was assumed to be unavailable for discharge from the TWRMF.
  6. On-site daily potable water consumption per person was assumed to be ~ 300 L.
  7. The TWRMF will have a water cover with a nominal thickness of 0.5 m during the operational phase.
  8. Excess groundwater from the dewatering wells will be discharged to the Polishing Pond all year round.
  9. In the winter months (Nov. to Apr.), 65% of the Polishing Pond water will be discharged to the Minago River and 35% will be stored in the Polishing Pond. During the remainder of the year (May to October), 70% of the Polishing Pond water will be discharged to the Minago River and 30% will be discharged to the Oakley Creek.

- **Key Input Parameters and Considerations for Frac Sand Plant Operation in Year 9 (Figure 2.14-4):**
  1. The Frac Sand Plant will operate and frac sand tailings will be deposited in the TWRMF.
  2. All operations will have ceased at the Nickel Processing Plant and related facilities and no more Ni tailings nor waste rock will be created or disposed.
  3. Only the deposited Ni tailings will leach at the maximum leaching rate measured during kinetic testing in the subaqueous leach column surface water.
  4. The TWRMF will have a water cover of a nominal thickness of 0.5 m.
  5. Dewatering pumps will be restricted to pump only sufficient water for frac sand processing and other site operations.

6. All of the Polishing Pond water will be discharged to the Minago River year round and discharge will be staged to prepare the aquatic habitat for complete withdrawal of discharges from the Polishing Pond.

- **Key Input Parameters and Considerations for Frac Sand Plant Operation in Year 10 (Figure 2.14-5):**

  All input parameters and considerations are as for Year 9 except for the discharge of Polishing Pond water. All of the Polishing Pond water will be stored in the winter months (Nov. to April) and discharged to the Oakley Creek watershed during the remainder of the year (May to October).

- **Key Input Parameters and Considerations for Closure:**

  The closure period was broken down into two stages (first and second) for which the input parameters and considerations are summarized below.

  Considerations for the First Stage of Closure (Figure 2.14-6):

  1. All operations will have ceased at the Mill and Frac Sand Plant and related appurtenances.
  2. Open pit dewatering will have ceased.
  3. Water will be pumped from the dewatering wells to the TWRMF to provide a 1.5 m high water cover.
  4. Only the deposited Ni tailings will leach at the maximum leaching rate measured during kinetic testing in the subaqueous leach column surface water.
  5. On-site potable water consumption was assumed to be 15 m^3/day (~ 300 L/person/day for 30 people).
  6. Polishing Pond supernatant will be discharged to the Oakley Creek basin via a spillway for ultimate discharge to Oakley Creek.

  Considerations for the Second Stage of Closure (Figure 2.14-7):

  All input parameters and considerations are as for first stage of closure except for the dewatering wells. The dewatering wells will be decommissioned, once a water cover of 1.5 m height will have been installed on top of the TWRMF.

- **Key Input Parameters and Considerations for Post Closure (Figure 2.14-8):**

  1. All decommissioning activities of mining facilities and infrastructure will have been completed.

2. Only the deposited Ni tailings will leach at the maximum leaching rate measured during kinetic testing in the subaqueous leach column surface water.
3. TWRMF supernatant in excess of the 1.5 m water cover will be discharged to the Polishing Pond via a spillway.
4. Polishing Pond supernatant will be discharged to the Oakley Creek basin via a spillway for ultimate discharge to Oakley Creek.

- **Key Input Parameters and Considerations for Temporary Suspension (TS) at the end of Year 4:**

1. All operations will have ceased at the Mill and Frac Sand Plant and related appurtenances at the end of Year 4. TS means that advanced exploration, mining or mine production activities have been suspended due to factors such as low metal prices, or mine related factors such as ground control problems and labour disputes.
2. No more tailings will be deposited into the TWRMF.
3. Only deposited Ni tailings will leach at the maximum leaching rate measured during kinetic testing in the subaqueous leach column surface water.
4. Dewatering wells will be running as usual during regular operations.
5. On-site potable water consumption was assumed to be 6 m^3/day (~ 300 L/person/day for 20 people).
6. Excess groundwater from the dewatering wells will be discharged to the Polishing Pond all year round.
7. TWRMF will have a water cover of a nominal thickness of 0.5 m. Excess supernatant from the TWRMF will be discharged to the Polishing Pond.
8. During the winter months (Nov. to Apr.), 65% of the Polishing Pond water will be discharged to the Minago River and 35% will be stored in the Polishing Pond. During the remainder of the year (May to October), 70% of the Polishing Pond water will be discharged to the Minago River and 30% will be discharged to the Oakley Creek.

- **Key Input Parameters and Considerations for The State of Inactivity (SI)**

1. State of Inactivity was assumed to have occurred after one year of Temporary Suspension at the end of Year 5. SI means that mine production and mining operations on site have been suspended indefinitely.
2. No tailings will be deposited into the TWRMF.
3. Only deposited Ni tailings will leach at the maximum leaching rate measured during kinetic testing in the subaqueous leach column surface water.

4. Operations will have ceased at the Nickel Processing Plant and Frac Sand Plant and related appurtenances.
5. One dewatering well will be running, but only to supply the camp and site activities with water.
6. On-site potable water consumption was assumed to be 3 m^3/day (~ 300 L/person/day for 10 people).
9. TWRMF will have a water cover of a nominal thickness of 0.5 m. Excess supernatant from the TWRMF will be discharged to the Polishing Pond.
10. During the winter months (Nov. to Apr.), none of the Polishing Pond water will be discharged. During the remainder of the year (May to October), 100% of the Polishing Pond water will be discharged to the Oakley Creek.

- **Key Input Parameters and Considerations for the Calculation of Flowrates:**

  Key input parameters and considerations for flowrate calculations are detailed in Table 2.14-2. Efforts were made to use flowrates that are representative of anticipated site conditions. All flowrates not detailed in Table 2.14-2 were based on material flowsheets developed by Wardrop Engineering Inc. (Wardrop) and others and are presented as part of the presentation of modeling results.

- **Key Input Parameters and Considerations for the Calculation of Elemental Concentrations:**

  Key input parameters and considerations for contaminant loadings and element concentrations in the water balance flows are summarized in Table 2.14-3. Efforts were made to use concentrations that are representative of anticipated site and geochemical conditions.

- **Key Input Parameters and Considerations for Flowrates in Minago River and Oakley Creek:**

  Key input parameters and considerations for flowrates in Minago River and Oakley Creek are summarized in Table 2.14-4.

- **Assumed Weekly Metal Leaching Rates for the Minago Tailings**

  The metal leaching rates assumed for Minago tailings are detailed in Table 2.14-5 and correspond to 10% of surface water loadings measured for the subaqeous column in kinetic tests that were run for 54 weeks (URS, 2009). Steady State was assumed after week 11 (URS, 2008i).

- **Assumed Areas of Site Faciltiies:**

  The areas of site facilities that were used in the water balance model are detailed in Table 2.14-6.

- **Input Data – Material Flow Rates and Conditions for the TWRMF:**

  Assumed material flow rates and conditions for the TWRMF are detailed in Table 2.14-7.

Table 2.14-2 Key Input Parameters and Considerations for Flowrate Calculations in the Minago Water Balance Model

Flowrates Qi (i = 1 to 38)		Mathematical Formulae to determine Qi (i = 1 - 38)
UNIT EVAPORATION (1 Unit = 1 ha)	UNIT LAKE EVAPORATION	= Q-Unit-Evapo
UNIT PRECIPITATION (1 Unit = 1 ha)		
Q1	FLOW FROM DEWATERING WELLS	
Q2	WELL WATER FOR PROCESSING	
Q3	EXCESS WATER FROM DEWATERING WELLS	
Q4	GROUNDWATER TO OTHER OPERATIONS	
Q5	GROUNDWATER TO WATER TREATMENT	as per Feasibility Study
Q6	GROUNDWATER TO FRAC SAND PLANT	
Q7	GROUNDWATER FOR FIRE FIGHTING	
Q8	POTABLE WATER	
Q9	WATER TREATMENT PLANT WASTE	
Q10	RECYCLE WATER FROM POLISHING POND	= Q32
Q11	POTABLE WATER TO MILL	
Q12	POTABLE WATER TO OTHER OPERATIONS	
Q13	POTABLE WATER TO OFFICES & CAMP	
Q14	POTABLE WATER TO FRAC SAND PLANT	
Q15	FLOW FROM OPERATIONS TO MILL	
Q16	SEWAGE & GREY WATER FROM CAMP AND OFFICES	
Q17	SEWAGE & GREY WATER FROM ALL OTHER ON SITE SOURCES	as per Feasibility Study
Q18	FLOW FROM FSP OPERATIONS TO FSP THICKENER	
Q19	FLOW FROM CONCENTRATE THICKENER IN MILL TO MILL	
Q20	FLOW FROM MILL TO MILL THICKENER	
Q21	RECYCLE WATER FROM MILL THICKENER	
Q21x	ATERNATE FLOW FOR RECYCLE WATER FROM MILL THICKENER	
Q22	MILL TAILINGS SLURRY	
Q23	SEWAGE TREATMENT OUTFLOW	
Q24	LIQ. WASTE FROM FSP	
Q25	SLURRY FROM FRAC SAND PLANT (FSP)	
Q26	TWRMF INFLOW	= Q9 + Q21x + Q22 + Q23 + Q24 + Q25
Q - Liquid Precipitation on TWRMF	Available Precipitation on TWRMF	= AREA*Q-Unit-PPT
Q - Evaporation from TWRMF	Evaporation from TWRMF	= AREA*(Q-Evapo from TWRMF)
Q - Retained Water in Tailings Voids	Retained Water in Tailings Voids	= 22% Retained Water in Voids; assumed tailings density = 1.5 tonnes/m^3
Q - TWRMF Supernatant	TWRMF Supernatant	= Q26+(Q-Remaining Supernatant)+Q-PPT on TWRMF-(Q-Evapo from TWRMF) - (Q-Retained Water in Voids)
Q27	TWRMF DECANT	= TWRMF Supernatant minus 0.5 m water during Operations
Q - Pit Dewatering	OPEN PIT DEWATERING	= 8000 m^3/day during Operations;= 0 m^3/day thereafter
Q - Precipitation on Pit	Precipitation minus Sublimation on Open Pit	= AREA*Q-Unit-PPT
Q28	TOTAL OPEN PIT DEWATERING	= (Q-Pit Dewatering)+(Q-PPT on Pit)
Q29	POLISHING POND INFLOW	= (Q3+Q27+Q28) during Operations
Q - Precipitation on Polising Pond	Precipitation minus Sublimation ON POLISHING POND	= AREA*Q-Unit-PPT
Q - Evaporation from Polishing Pond	EVAPORATION FROM POLISHING POND	= AREA*Q-Unit-Evapo
Q30	POLISHING POND OUTFLOW	= Q29 + (Q-PPT on Polishing Pond) - (Q-Evapo from Polishing Pond)
Q31	RECYCLE FROM FINAL POLISHING POND	as per Feasibility Study
Q32	FLOW TO DISCHARGE PIPELINE	as per Feasibility Study
Q33	DISCHARGE TO MINAGO	= 65% of Q32 during winter and 70% of Q32 otherwise during Operations
Q34	MINAGO UPSTREAM	as per Hydrologic Study
Q35	MINAGO DOWNSTREAM	= Q33+Q34
Q36	DISCHARGE TO OAKLEY CREEK	= 0% of Q32 during winter; 30% of Q32 otherwise during Operations
Q37	OAKLEY CREEK UPSTREAM	as per Hydrologic Study
Q38	OAKLEY CREEK DOWNSTREAM	= Q36+Q37

Table 2.14-3 Key Input Parameters and Considerations for Calculations of Elemental Concentrations in the Minago Water Balance Model

Concentration Ci (in Flow Qi)	Mathematical Formulae to determine Ci (i = 1 to 38)
UNIT EVAPORATION	
UNIT PPT (U-PPT)	= CCME Mean Detection Limits
C1	= Aug-2008 Groundwater Quality (Dissolved Metals)
C2	= Aug-2008 Groundwater Quality (Dissolved Metals)
C3	= Aug-2008 Groundwater Quality (Dissolved Metals)
C4	= Aug-2008 Groundwater Quality (Dissolved Metals)
C5	= Aug-2008 Groundwater Quality (Dissolved Metals)
C6	= Aug-2008 Groundwater Quality (Dissolved Metals)
C7	= Aug-2008 Groundwater Quality (Dissolved Metals)
C8	= CCME Mean Detection Limits
C9	not assumed
C10	= C32
C11	= CCME Mean Detection Limits
C12	= CCME Mean Detection Limits
C13	= CCME Mean Detection Limits
C14	= CCME Mean Detection Limits
C15	Internal Nickel Processing Plant Water Quality
C16	not assumed
C17	not assumed
C18	Internal FSP Water Quality
C19, C20, C21, C21x	Internal Mill Water Quality
C22	= Measured Concentration SGS Lakefield Nov. 7, 2008 Results
C23	= CCME Mean Detection Limits
C24	= Measured Dissolved Concentration for FSP Overflow
C25	= Measured Dissolved Concentration for FSP Underflow
C26	= {C9 +Q21x*C21x + Q22*C22 + Q23*C23 + Q24*C24 + Q25*C25} / Q26
C - PPT on TWRMF	= CCME Mean Detection Limits
C - Evapo from TWRMF	
C - Tailings Leachate	= {Mass of Tailings [tonnes]* Leaching Rate of Tailings [mg/kg/period]} / Q-TWRMF Supernatant [m^3/period]
C-TWRMF Supernatant	= {Q26*C26 + (Q-TWRMF Supernatant Remaining)*(C-TWRMF Supernatant Remaining) + (Q-PPT on TWRMF)*(C-PPT on TWRMF) + (Q-Tailings Leachate)*(C-Tailings Leachate) } / Q-TWRMF Supernatant
C27	= C-TWRMF Supernatant
C-Pit Dewatering	= Aug-2008 Groundwater Quality (Dissolved Metals)
C-PPT on Pit	= CCME Mean Detection Limits
C28	= {(Q-Pit Dewatering)*(C-Pit Dewatering) + (Q-PPT on Pit)*(C-PPT on Pit)} / Q28
C29	= {Q3*C3 + Q27*C27 + Q28*C28} / Q29 during Operations
C-PPT on PP	= CCME Mean Detection Limits
C-Evapo from PP	
C30	= {Q29*C29 + (Q-PPT on Polishing Pond)*(C-PPT on Polishing Pond)} / Q30
C31	= C30
C32	= C30
C33	= C30
C34	= AVERAGE 2006-2008 MINAGO RIVER WATER QUALITY (Dissolved Metals at MRW2)
C35	= {Q33*C33 + Q34*C34} / Q35
C36	= C30
C37	= AVERAGE 2006-2008 OAKLEY CK WATER QUALITY (Dissolved Metals at OCW2)
C38	= {Q36*C36 + Q37*C37} / Q38

Table 2.14-4 Estimated Flowrates in Minago River and Oakley Creek

Time Period / Stream	May m^3/s	June to October m^3/s	November to April m^3/s
Minago River	10	1.9	0.8
Oakley Creek	4	0.5	0

Table 2.14-5 Weekly Metal Leaching Rates Assumed for Minago Tailings

10% of Subaqueous Leach Column Surface Water Loading as given in URS Geochemical Memo, dated March 4, 2010				
ELEMENT	Unit	Minimum	Average	Maximum
Aluminum (Al)	mg/kg/wk	2.000E-06	2.120E-05	1.440E-04
Antimony (Sb)	mg/kg/wk	6.080E-07	9.290E-07	1.180E-06
Arsenic (As)	mg/kg/wk	2.000E-07	1.304E-06	6.400E-06
Cadmium (Cd)	mg/kg/wk	1.600E-08	7.450E-08	7.680E-07
Chromium (Cr)	mg/kg/wk	3.200E-07	1.210E-06	2.000E-06
Cobalt (Co)	mg/kg/wk	6.400E-08	6.030E-07	1.240E-06
Copper (Cu)	mg/kg/wk	1.800E-06	8.010E-06	2.240E-05
Iron (Fe)	mg/kg/wk	3.200E-06	1.570E-05	6.200E-05
Lead (Pb)	mg/kg/wk	9.280E-08	1.621E-06	1.630E-05
Molybdenum (Mo)	mg/kg/wk	6.000E-06	1.180E-05	1.960E-05
Nickel (Ni)	mg/kg/wk	1.800E-05	4.020E-05	8.420E-05
Selenium (Se)	mg/kg/wk	4.000E-07	8.720E-07	2.180E-06
Zinc (Zn)	mg/kg/wk	4.160E-06	1.300E-05	7.680E-05

Table 2.14-6 Area of Site Facilities

Designated Area	**Area (ha)**
Pit Area	190.0
Tailings and Ultramafic Waste Rock Management Facility (TWRMF)	219.7
Polishing Pond	75.0

Table 2.14-7 Input Data - Material Flow Rates and Conditions for the Tailings and Ultramafic Waste Rock Management Facility (TWRMF)

			Ultramafic WR in TWRMF (kT)	Ni Tailings in TWRMF (kT)	Water Cover Height	Discharge to Minago River from Discharge Pipeline	Discharge to Oakley Creek from Discharge Pipeline
Mill & Frac Sand Plant Operating	Year 1	Nov.-Apr.	8,802	1,806.364	0.5 m	65%	0%
		May	8,802	1,806.364	0.5 m	70%	30%
		Jun.-Oct.	8,802	1,806.364	0.5 m	70%	30%
	Year 2	Nov.-Apr.	14,326	5,360.918	0.5 m	65%	0%
		May	14,326	5,360.918	0.5 m	70%	30%
		Jun.-Oct.	14,326	5,360.918	0.5 m	70%	30%
	Year 3	Nov.-Apr.	19,993	8,915.472	0.5 m	65%	0%
		May	19,993	8,915.472	0.5 m	70%	30%
		Jun.-Oct.	19,993	8,915.472	0.5 m	70%	30%
	Year 4	Nov.-Apr.	25,725	12,470.026	0.5 m	65%	0%
		May	25,725	12,470.026	0.5 m	70%	30%
		Jun.-Oct.	25,725	12,470.026	0.5 m	70%	30%
	Year 5	Nov.-Apr.	30,107	16,024.580	0.5 m	65%	0%
		May	30,107	16,024.580	0.5 m	70%	30%
		Jun.-Oct.	30,107	16,024.580	0.5 m	70%	30%
	Year 6	Nov.-Apr.	33,133	19,579.134	0.5 m	65%	0%
		May	33,133	19,579.134	0.5 m	70%	30%
		Jun.-Oct.	33,133	19,579.134	0.5 m	70%	30%
	Year 7	Nov.-Apr.	35,430	23,133.688	0.5 m	65%	0%
		May	35,430	23,133.688	0.5 m	70%	30%
		Jun.-Oct.	35,430	23,133.688	0.5 m	70%	30%
	Year 8	Nov.-Apr.	35,659	24,847.808	0.5 m	65%	0%
		May	35,659	24,847.808	0.5 m	70%	30%
		Jun.-Oct.	35,659	24,847.808	0.5 m	70%	30%

Table 2.14-7 (Cont.'d) Input Data - Material Flow Rates and Conditions for the Tailings and Ultramafic Waste Rock Management Facility (TWRMF)

			Ultramafic WR in TWRMF (kT)	Ni Tailings in TWRMF (kT)	Water Cover Height	Discharge to Minago River from Discharge Pipeline	Discharge to Oakley Creek from Discharge Pipeline	Discharge to Oakley Creek via the Oakley Creek Basin	Comments
Frac Sand Plant Operating	Year 9	Nov.-Apr.	35,659	24,847.808	0.5 m	100%	0%	0%	Staging of Discharge to Minago River for Fisheries Habitat Conditioning
		May	35,659	24,847.808	0.5 m	100%	0%	0%	
		Jun.-Oct.	35,659	24,847.808	0.5 m	100%	0%	0%	
	Year 10	Nov.-Apr.	35,659	24,847.808	0.5 m	0%	0%	0%	No Discharge; Excess water will be stored in the Polishing Pond
		May	35,659	24,847.808	0.5 m	0%	100%	0%	
		Jun.-Oct.	35,659	24,847.808	0.5 m	0%	100%	0%	
Closure	Year 11	Nov.-Apr.	35,659	24,847.808	1.5 m	0%	0%	100%	Excess water from the Polishing Pond will be discharged to the Oakley Creek Basin
		May	35,659	24,847.808	1.5 m	0%	0%	100%	
		Jun.-Oct.	35,659	24,847.808	1.5 m	0%	0%	100%	
	Year 12	Nov.-Apr.	35,659	24,847.808	1.5 m	0%	0%	100%	Excess water from the Polishing Pond will be discharged to the Oakley Creek Basin
		May	35,659	24,847.808	1.5 m	0%	0%	100%	
		Jun.-Oct.	35,659	24,847.808	1.5 m	0%	0%	100%	
Post Closure	Year 13	Nov.-Apr.	35,659	24,847.808	1.5 m	0%	0%	100%	Excess water from the Polishing Pond will be discharged to the Oakley Creek Basin
		May	35,659	24,847.808	1.5 m	0%	0%	100%	
		Jun.-Oct.	35,659	24,847.808	1.5 m	0%	0%	100%	
Temporary Suspension (TS)	After Year 4	Nov.-Apr.	25,725	12,470.026	0.5 m	65%	0%	0%	
		May	25,725	12,470.026	0.5 m	70%	30%	0%	
		Jun.-Oct.	25,725	12,470.026	0.5 m	70%	30%	0%	
State of Inactivity (SI)	After one year of TS	Nov.-Apr.	25,725	12,470.026	0.5 m	0%	0%	0%	No Discharge; Excess water will be stored in the Polishing Pond
		May	25,725	12,470.026	0.5 m	0%	100%	0%	
		Jun.-Oct.	25,725	12,470.026	0.5 m	0%	100%	0%	

2.14.2.3 Results of the Minago Water Balance Model

Following are key results of the water balance model based on the assumptions outlined above. As for the general description of the water management, the water balance model results are presented for the following seven mine development phases: Construction, Operations, Closure, Post Closure, Temporary Suspension, and the State of Inactivity. Following the presentation of results, Contaminants of Concern respective to the water quality of the discharged water will be summarized.

Water balance models for all mine development phases were developed for three periods of the year: May, June to October, and November to April. These periods were chosen to represent average conditions during the freshet, summer, and winter.

Contaminant loadings and estimated elemental concentrations in the various flows of the Minago water balance model, presented below, are listed against the Metal Mining Effluent Regulations (Environment Canada, 2002a) and the Canadian Guidelines for the Protection of Aquatic Life (CCME, 2007). They are also summarized against the Manitoba Water Quality Standards, Objectives and Guidelines (Tier II and Tier III Freshwater Quality) (Williamson, 2002). These guideline limits are presented in Table 2.14-8. Parametric concentrations were estimated for aluminum (Al), antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), molybdenum (Mo), nickel (Ni), selenium (Se), and zinc (Zn).

The Metal Mining Effluent Regulations (MMER) were registered on June 6, 2002, under subsections 34(2), 36(5), and 38(9) of the *Fisheries Act* and replaced the MMLER and the associated *Metal Mining Liquid Effluent Guidelines* (Environment Canada, 2002a). The MMER prescribe authorized concentration limits for deleterious substances in mine effluents that discharge to waters frequented by fish. The MMER apply to all Canadian metal mines (except placer mines) that exceed an effluent flowrate of 50 m^3 per day. The MMER apply to effluent from all final discharge points (FDPs) at a mine site. A FDP is defined in the Regulations as a point beyond which the mine no longer exercises control over the quality of the effluent. The regulated MMER parameters are arsenic, copper, cyanide, lead, nickel, zinc, total suspended solids (TSS), Radium 226, and pH.

Canadian Water Quality Guidelines for the Protection of Aquatic Life define acceptable levels for substances or conditions that affect water quality such as toxic chemicals, temperature and acidity. As long as conditions are within the levels established by the guidelines, one would not expect to see negative effects in the environment (CCME, 2007). These guidelines are based on toxicity data for the most sensitive species of plants and animals found in Canadian waters and act as science-based benchmarks.

Table 2.14-8 Guideline Limits used for Interpreting Water Balance Results

Water Quality Parameter	Metal Mining Liquid Effluents (2002)		Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002)		Canadian Water Quality Guidelines for the Protection of Aquatic Life
	Monthly Mean	Grab Sample	TIER II Water Quality Objectives assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Aluminum (Al)				0.005 - 0.1	0.005
Antimony (Sb)					
Arsenic (As)	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Cadmium (Cd)			0.00302 [B]	Tier II	0.000017 $10^{\{0.86[\log(hardness)]-3.2\}}$
Chromium (Cr)			0.10331 [C]	Tier II	
Cobalt (Co)					
Copper (Cu)	0.3	0.6	0.01266 [D]	Tier II	0.002
Iron (Fe)				0.3	0.3
Lead (Pb)	0.2	0.4	0.0039 [E]	Tier II	0.001
Molybdenum (Mo)				0.073	
Nickel (Ni)	0.5	1	0.07329 [F]	Tier II	0.025
Selenium (Se)				0.001	0.001
Zinc (Zn)	0.5	1	0.16657 [G]	Tier II	0.03

Tier II Water Quality Limits for arsenic, cadmium, chromium, copper, lead, nickel, and zinc are hardness dependent as follows:

A Arsenic limits: 0.15 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow);
0.34 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

B Cadmium limits: [e{0.7852[ln(Hardness)]-2.715}]×[1.101672-{ln(Hardness)(0.041838)}] for 4 days averaging duration.
[e{1.128[ln(Hardness)]-3.6867}]×[1.136672-{ln(Hardness)(0.041838)}] for 1 hour averaging duration.

C Chromium limits: Chromium III: [e{0.8190[ln(Hardness)]+0.6848}]×[0.860] for 4 days averaging duration.
Chromium III: [e{0.8190[ln(Hardness)]+3.7256}]×[0.316] for 1 hour averaging duration.
Chromium VI: 0.011 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow);
0.016 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

D Copper limits: [e{0.8545[ln(Hardness)]-1.702}]×[0.960] for 4 Days hour averaging duration.
[e{0.9422[ln(Hardness)]-1.700}]×[0.960] for 1 hour averaging duration.

E Lead limits: [e{1.273[ln(Hardness)]-4,705}]×[1.46203 -{ln(Hardness)(0.145712)}] for 4 Days averaging duration.
[e{1.273[ln(Hardness)]-1.460}]×[1.46203 -{ln(Hardness)(0.145712)}] for 1 hour averaging duration.

F Nickel limits: [e{0.8460[ln(Hardness)]+0.0584}]×[0.997] for 4 Days averaging duration.
[e{0.8460[ln(Hardness)]+2.255}]×[0.998] for 1 hour averaging duration.

G Zinc limits: [e{0.8473[ln(Hardness)]+0.884}]×[0.976] for 4 Days averaging duration.
[e{0.8473[ln(Hardness)]+0.884}]×[0.978] for 1 hour averaging duration.

The Manitoba Tier II Water Quality Objectives are defined for a limited number of common pollutants (such as dissolved metals and nutrients) that are routinely controlled through licencing under the Manitoba Environment Act. Manitoba Tier II Water Quality Objectives typically form the basis for the water quality base approach when additional restrictions need to be developed to protect important uses of ground or surface waters (Williamson, 2002).

It should be noted that water quality guideline limits for heavy metals (such as cadmium, chromium, copper, lead, nickel and zinc) depend on hardness. Therefore, results presented below are listed in terms of applicable equations to determine the guideline limits based on hardness as well as for a hardness of 150 mg/L $CaCO_3$. The hardness level of 150 mg/L $CaCO_3$ was chosen as comparison for results obtained with the Minago water balance model based on water quality results obtained to date. For these results, listed in Table 2.14-9, the average hardness was 192.2 mg/L $CaCO_3$, the median hardness was 193 mg/L $CaCO_3$, and the weighted average hardness was 173.1 mg/L $CaCO_3$.

Table 2.14-9 Hardness Levels Measured at Minago

	Number of Samples	Minimum (mg/L$CaCO_3$)	Average (mg/L$CaCO_3$)	Maximum (mg/L$CaCO_3$)
Frac Sand Plant Overflow	2		171.5	194
Frac Sand Plant Underflow	2		167	192
Sub-aqueous Col. Pore Water	53	145	232	358
Sub-aqueous Col. Surface Water	53	71.2	102.8	138
Groundwater Limestone	3	242	267	287
Groundwater Sandstone	3	165	196	257
Upstream Minago (MRW2)	7	169	192	213
Downstream Minago (MRW1)	14	87.2	149	256
Upstream Oakley Cr. (OCW2)	13	169	204.8	265
Process Water (Nov. 2008 SGS Lakefield Results)	1		240	
Total	151			
Minimum		**71.2**		
Average			**192.2**	
Maximum				**358.0**
Weighted Average			**173.1**	

2.14.2.3.1 Water Balance Modeling Results during Construction (Year –3 to Year –1)

Estimated flowrates during construction prior to the dredging operations are listed in Table 2.14-10 and the corresponding water management plan is illustrated in Figure 2.14-2.

The Polishing Pond discharge to Minago River (Q19) in relation to the Minago River streamflow (Q20) will be 8% in May, 14% in the summer months (June to October) and 30% in the winter months (November to April). In absolute quantities, discharge to Minago River will range from 20,741 m^3/day to 69,360 m^3/day during construction. The Polishing Pond discharge to Oakley Creek (Q22) in relation to the Oakley Creek streamflow (Q23) will be 0% in the winter months (Nov. to Apr.), 9% in May, and 23% in the summer months (June to October). In absolute quantities, discharge to Oakley Creek will range from 0 m^3/day to 29,725 m^3/day during construction.

Table 2.14-11 presents projected parametric concentrations for the Polishing Pond outflow (Q17), Minago downstream (Q21), and Oakley Creek downstream (Q24). All projected Polishing Pond outflow concentrations meet the MMER levels and the projected water quality downstream of the mixing zones in the Minago River and the Oakley Creek meets the CCME (2007) and Manitoba Tier III Freshwater guidelines levels.

2.14.2.3.2 Water Balance Modeling Results during Operations

Year 1 through Year 8 Operations

Estimated flowrates during Year 1 through Year 8 operations are listed in Table 2.14-12 and the corresponding water management plan is illustrated in Figure 2.14-3.

The Polishing Pond discharge to Minago River (Q33) in relation to the Minago River streamflow (Q34) will be 10% in May, 19% in the summer months (June to October) and 31% to 36% in the winter months (November to April). In absolute quantities, discharge to Minago River will range from 21,160 m^3/day to 90,035 m^3/day during Year 1 to Year 8 operations. The Polishing Pond discharge to Oakley Creek (Q36) in relation to the Oakley Creek streamflow (Q37) will be 0% in the winter months (Nov. to Apr.), 10% to 11% in May, and 31% in the summer months (June to October). In absolute quantities, discharge to Oakley Creek will range from 0 m^3/day to 37,715 m^3/day during operations.

Table 2.14-13 and Table 2.14-14 present projected parametric concentrations for the Polishing Pond outflow (Q30), Minago downstream (Q35), and Oakley Creek downstream (Q38) for Year 1 through 4 and Year 5 through 8, respectively. Additional results for Q26 (TWRMF Inflow), Q27 (TWRMF Decant), and Q29 (Polishing Pond Inflow) and detailed flow estimates are provided in Appendix 2.14. All Polishing Pond outflow concentrations are projected to meet the MMER levels and the projected water quality downstream of the mixing zones in the Minago River and the Oakley Creek meets the CCME (2007) and Manitoba Tier III Freshwater guidelines levels.

Table 2.14-10 Projected Flow Rates during Construction

FLOW		During Construction prior to Dredging		
		NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER
		Minago River Flow 0.8 m^3/s; Oakley Creek Flow at 0 m^3/s	Minago River Flow 10 m^3/s; Oakley Creek Flow at 4 m^3/s	Minago River Flow 1.9 m^3/s; Oakley Creek Flow at 0.5 m^3/s
		m^3/day	m^3/day	m^3/day
UNIT EVAPORATION	UNIT LAKE EVAPORATION	0	18	14
UNIT PPT (U-PPT)	UNIT PRECIPITATION	0	41	21
Q1	FLOW FROM DEWATERING WELLS	31,999	31,999	31,999
Q2	WELL WATER FOR PROCESSING	90	90	90
Q3	EXCESS WATER FROM DEWATERING WELLS	31,909	31,909	31,909
Q4	GROUNDWATER TO MILL CONSTRUCTION	0	0	0
Q5	GROUNDWATER TO WATER TREATMENT	90	90	90
Q6	GROUNDWATER TO FSP CONSTRUCTION	0	0	0
Q7	GROUNDWATER FOR FIRE FIGHTING	0	0	0
Q9	POTABLE WATER	90	90	90
Q10	WATER TREATMENT PLANT WASTE	0	0	0
Q11	SEWAGE & GREY WATER FROM CAMP AND OFFICES	90	90	90
Q12	SEWAGE & GREY WATER FROM ALL OTHER ON SITE SOURCES	0	0	0
Q13	FLOW FROM THE ODF TO THE ODF SETTLING POND	0	0	0
Q14	DISCHARGE TO THE OAKLEY CREEK BASIN	0	0	0
Q15	SEWAGE TREATMENT OUTFLOW	0	635	97
Q16	POLISHING POND INFLOW	31,909	97,392	32,006
Q-PPT on Polishing Pond	PPT ON POLISHING POND	0	3,049	1,602
Q-Evapo from Polishing Pond	EVAPO FROM POLISHING POND	0	1,355	1,063
Q17	POLISHING POND OUTFLOW	31,909	99,086	32,545
Q18	DISCHARGE PIPELINE	20,741	99,086	32,545
Q19	DISCHARGE TO MINAGO	20,741	69,360	22,782
Q20	MINAGO UPSTREAM	69,120	864,000	164,160
Q21	MINAGO DOWNSTREAM	89,861	933,360	186,942
Q22	DISCHARGE TO OAKLEY CREEK	0	29,726	9,764
Q23	OAKLEY CREEK UPSTREAM	0	345,600	43,200
Q24	OAKLEY CREEK DOWNSTREAM	0	375,326	52,964
FLOW RATIOS:				
Q19 / Q20	RATIO OF DISCHARGE TO MINAGO TO FLOW IN MINAGO	30%	8%	14%
Q22 / Q23	RATIO OF DISCHARGE TO OAKLEY CK TO FLOW IN OAKLEY CK	0%	9%	23%

Table 2.14-11 Projected Effluent Concentrations in Site Flows during Construction prior to Dredging

SCENARIO: FLOW			WATER QUALITY PARAM.	ESTIMATED AVERAGE CONCENTRATION During Construction: Tailings only; max.tailings leaching rate NOVEMBER TO APRIL (mg/L)	Tailings only; max.tailings leaching rate MAY (mg/L)	Tailings only; max.tailings leaching rate JUNE TO OCTOBER (mg/L)	REGULATIONS: Metal Mining Liquid Effluents (2002) Monthly Mean	Metal Mining Liquid Effluents (2002) Grab Sample	Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002) TIER II Water Quality Objectives assuming hardness = 150 mg/L $CaCO_3$	Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002) Freshwater	Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2007)
Q17	POLISHING POND OUTFLOW	Al	RC17	0.009	0.009	0.009				0.005 - 0.1	0.005
Q17	POLISHING POND OUTFLOW	Sb	RC17	0.00003	0.00004	0.00005					
Q17	POLISHING POND OUTFLOW	As	RC17	0.001	0.001	0.001	0.5	1	0.15 mg/L (4-Day, 3-Year)[A]	Tier II	0.005
Q17	POLISHING POND OUTFLOW	Cd	RC17	0.00001	0.00001	0.00001			0.00302[B]	Tier II	0.000017 or $10^{\{0.86[\log(hardness)]-3.2\}}$
Q17	POLISHING POND OUTFLOW	Cr	RC17	0.0010	0.0010	0.0010			0.10331[C]	Tier II	
Q17	POLISHING POND OUTFLOW	Co	RC17	0.00008	0.00009	0.00010					
Q17	POLISHING POND OUTFLOW	Cu	RC17	0.0005	0.0005	0.0006	0.3	0.6	0.01266[D]	Tier II	0.002
Q17	POLISHING POND OUTFLOW	Fe	RC17	0.005	0.006	0.006				0.3	0.3
Q17	POLISHING POND OUTFLOW	Pb	RC17	0.00003	0.00005	0.00006	0.2	0.4	0.0039[E]	Tier II	0.001
Q17	POLISHING POND OUTFLOW	Mo	RC17	0.0007	0.0007	0.0007				0.073	
Q17	POLISHING POND OUTFLOW	Ni	RC17	0.001	0.001	0.001	0.5	1	0.07329[F]	Tier II	0.025
Q17	POLISHING POND OUTFLOW	Se	RC17	0.0002	0.0002	0.0002				0.001	0.001
Q17	POLISHING POND OUTFLOW	Zn	RC17	0.005	0.005	0.005	0.5	1	0.16657[G]	Tier II	0.03
Q21	MINAGO DOWNSTREAM	Al	RC21	0.011	0.012	0.012				0.005 - 0.1	0.005
Q21	MINAGO DOWNSTREAM	Sb	RC21	0.00004	0.00005	0.00005					
Q21	MINAGO DOWNSTREAM	As	RC21	0.0007	0.0006	0.0006	0.5	1	0.15 mg/L (4-Day, 3-Year)[A]	Tier II	0.005
Q21	MINAGO DOWNSTREAM	Cd	RC21	0.000014	0.000016	0.000015			0.00302[B]	Tier II	0.000017 or $10^{\{0.86[\log(hardness)]-3.2\}}$
Q21	MINAGO DOWNSTREAM	Cr	RC21	0.00041	0.00029	0.00033			0.10331[C]	Tier II	
Q21	MINAGO DOWNSTREAM	Co	RC21	0.00006	0.00005	0.00006					
Q21	MINAGO DOWNSTREAM	Cu	RC21	0.001	0.001	0.001	0.3	0.6	0.01266[D]	Tier II	0.002
Q21	MINAGO DOWNSTREAM	Fe	RC21	0.054	0.065	0.062				0.3	0.3
Q21	MINAGO DOWNSTREAM	Pb	RC21	0.00005	0.00006	0.00006	0.2	0.4	0.0039[E]	Tier II	0.001
Q21	MINAGO DOWNSTREAM	Mo	RC21	0.00025	0.00017	0.00020				0.073	
Q21	MINAGO DOWNSTREAM	Ni	RC21	0.001	0.001	0.001	0.5	1	0.07329[F]	Tier II	0.025
Q21	MINAGO DOWNSTREAM	Se	RC21	0.00023	0.00024	0.00024				0.001	0.001
Q21	MINAGO DOWNSTREAM	Zn	RC21	0.002	0.001	0.001	0.5	1	0.16657[G]	Tier II	0.03

Table 2.14-11 (Cont.'d) Projected Effluent Concentrations in Site Flows during Construction prior to Dredging

SCENARIO:			WATER QUALITY	ESTIMATED AVERAGE CONCENTRATION During Construction (see Figure WB-1)			REGULATIONS				
				Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Metal Mining Liquid Effluents (2002)		Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002)		Canadian Water Quality Guidelines for the Protection of Aquatic Life
				NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER			TIER II Water Quality Objectives		
FLOW			PARAM.	(mg/L)	(mg/L)	(mg/L)	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Q24	OAKLEY CREEK DOWNSTREAM	Al	RC24	N/A	0.0031	0.0031				0.005 - 0.1	0.005
Q24	OAKLEY CREEK DOWNSTREAM	Sb	RC24	N/A	0.000035	0.000035					
Q24	OAKLEY CREEK DOWNSTREAM	As	RC24	N/A	0.0004	0.0004	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q24	OAKLEY CREEK DOWNSTREAM	Cd	RC24	N/A	0.000012	0.000012			0.00302 [B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2)}$
Q24	OAKLEY CREEK DOWNSTREAM	Cr	RC24	N/A	0.0003	0.0003			0.10331 [C]	Tier II	
Q24	OAKLEY CREEK DOWNSTREAM	Co	RC24	N/A	0.0000	0.0000					
Q24	OAKLEY CREEK DOWNSTREAM	Cu	RC24	N/A	0.0002	0.0002	0.3	0.6	0.01266 [D]	Tier II	0.002
Q24	OAKLEY CREEK DOWNSTREAM	Fe	RC24	N/A	0.0470	0.0470				0.3	0.3
Q24	OAKLEY CREEK DOWNSTREAM	Pb	RC24	N/A	0.0000	0.0000	0.2	0.4	0.0039 [E]	Tier II	0.001
Q24	OAKLEY CREEK DOWNSTREAM	Mo	RC24	N/A	0.0001	0.0001				0.073	
Q24	OAKLEY CREEK DOWNSTREAM	Ni	RC24	N/A	0.0003	0.0003	0.5	1	0.07329 [F]	Tier II	0.025
Q24	OAKLEY CREEK DOWNSTREAM	Se	RC24	N/A	0.0002	0.0002				0.001	0.001
Q24	OAKLEY CREEK DOWNSTREAM	Zn	RC24	N/A	0.0009	0.0009	0.5	1	0.16657 [G]	Tier II	0.03

Notes: **NA not applicable**
August 2008 groundwater chemistry was assumed in the modeling.

A Arsenic limits: 0.15 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.34 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

B Cadmium limits: [e{0.7852[ln(Hardness)]-2.715}]×[1.101672-{ln(Hardness)(0.041838)}] for 4 days averaging duration.
[e{1.128[ln(Hardness)]-3.6867}]×[1.136672-{ln(Hardness)(0.041838)}] for 1 hour averaging duration.

C Chromium limits: Chromium III: [e{0.8190[ln(Hardness)]+0.6848}]×[0.860] for 4 days averaging duration.
Chromium III: [e{0.8190[ln(Hardness)]+3.7256}]×[0.316] for 1 hour averaging duration.
Chromium VI: 0.011 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.016 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

D Copper limits: [e{0.8545[ln(Hardness)]-1.702}]×[0.960] for 4 Days hour averaging duration.
[e{0.9422[ln(Hardness)]-1.700}]×[0.960] for 1 hour averaging duration.

E Lead limits: [e{1.273[ln(Hardness)]-4.705}]×[1.46203 -{ln(Hardness)(0.145712)}] for 4 Days averaging duration.
[e{1.273[ln(Hardness)]-1.460}]×[1.46203 -{ln(Hardness)(0.145712)}] for 1 hour averaging duration.

F Nickel limits: [e{0.8460[ln(Hardness)]+0.0584}]×[0.997] for 4 Days averaging duration.
[e{0.8460[ln(Hardness)]+2.255}]×[0.998] for 1 hour averaging duration.

G Zinc limits: [e{0.8473[ln(Hardness)]+0.884}]×[0.976] for 4 Days averaging duration.
[e{0.8473[ln(Hardness)]+0.884}]×[0.978] for 1 hour averaging duration.

Table 2.14-12 Projected Flow Rates during Year 1 through 8 Operations

FLOW		Year 1			Year 2			...	Year 7			Year 8		
		Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate		Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate
		NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER		NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER
		m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day		m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
UNIT EVAPORATION	UNIT LAKE EVAPORATION	0	18	14	0	18	14		0	18	14	0	18	14
UNIT PPT (U-PPT)	UNIT PRECIPITATION	0	41	21	0	41	21		0	41	21	0	41	21
Q1	FLOW FROM DEWATERING WELLS	31,999	31,999	31,999	31,999	31,999	31,999		31,999	31,999	31,999	31,999	31,999	31,999
Q2	WELL WATER FOR PROCESSING	5,724	5,724	5,724	5,724	5,724	5,724		5,724	5,724	5,724	5,724	5,724	5,724
Q3	EXCESS WATER FROM DEWATERING WELLS	26,276	26,276	26,276	26,276	26,276	26,276		26,276	26,276	26,276	26,276	26,276	26,276
Q4	GROUNDWATER TO OTHER OPERATIONS	1,440	1,440	1,440	1,440	1,440	1,440		1,440	1,440	1,440	1,440	1,440	1,440
Q5	GROUNDWATER TO WATER TREATMENT	96	96	96	96	96	96		96	96	96	96	96	96
Q6	GROUNDWATER TO FRAC SAND PLANT	4,188	4,188	4,188	4,188	4,188	4,188		4,188	4,188	4,188	4,188	4,188	4,188
Q7	GROUNDWATER FOR FIRE FIGHTING	0	0	0	0	0	0		0	0	0	0	0	0
Q8	POTABLE WATER	96	96	96	96	96	96		96	96	96	96	96	96
Q9	WATER TREATMENT PLANT WASTE	0	0	0	0	0	0		0	0	0	0	0	0
Q10	RECYCLE WATER FROM FPP	10,632	10,632	10,632	10,632	10,632	10,632		10,632	10,632	10,632	10,632	10,632	10,632
Q11	POTABLE WATER TO MILL	6	6	6	6	6	6		6	6	6	6	6	6
Q12	POTABLE WATER TO OTHER OPERATIONS	5	5	5	5	5	5		5	5	5	5	5	5
Q13	POTABLE WATER TO OFFICES & CAMP	72	72	72	72	72	72		72	72	72	72	72	72
Q14	POTABLE WATER TO FRAC SAND PLANT	12	12	12	12	12	12		12	12	12	12	12	12
Q15	FLOW FROM OPERATIONS TO MILL	1,440	1,440	1,440	1,440	1,440	1,440		1,440	1,440	1,440	1,440	1,440	1,440
Q16	SEWAGE & GREY WATER FROM CAMP AND OFFICES	72	72	72	72	72	72		72	72	72	72	72	72
Q17	SEWAGE & GREY WATER FROM ALL OTHER ON SITE SOURCES	24	24	24	24	24	24		24	24	24	24	24	24
Q19	FLOW FROM CONCENTRATE THICKENER IN MILL TO MILL	1,080	1,080	1,080	1,080	1,080	1,080		1,080	1,080	1,080	1,080	1,080	1,080
Q20	FLOW FROM MILL TO MILL THICKENER	32,928	32,928	32,928	32,928	32,928	32,928		32,928	32,928	32,928	32,928	32,928	32,928
Q21	RECYCLE WATER FROM MILL THICKENER	20,856	20,856	20,856	20,856	20,856	20,856		20,856	20,856	20,856	20,856	20,856	20,856
Q21x	ATERNATE FLOW FOR RECYCLE WATER FROM MILL THICKENER	0	0	0	0	0	0		0	0	0	0	0	0
Q22	MILL TAILINGS SLURRY	12,072	12,072	12,072	12,072	12,072	12,072		12,072	12,072	12,072	12,072	12,072	12,072
Q23	SEWAGE TREATMENT OUTFLOW	0	676	103	0	676	103		0	676	103	0	676	103
Q24	LIQ. WASTE FROM FSP	2,892	2,892	2,892	2,892	2,892	2,892		2,892	2,892	2,892	2,892	2,892	2,892
Q25	SLURRY FROM FSP	772	772	772	772	772	772		772	772	772	772	772	772
Q26	TWRMF INFLOW	15,736	16,412	15,839	15,736	16,412	15,839		15,736	16,412	15,839	15,736	16,412	15,839
Q - Liquid PPT on TWRMF	PPT on TWRMF	0	8,930	4,694	0	8,930	4,694		0	8,930	4,694	0	8,930	4,694
Q - Retained Water in Tailings Voids	Q - Retained Water in Tailings Voids	726	1,467	1,467	1,467	1,467	1,467		1,467	1,467	1,467	1,467	1,467	1,467
Q - TWRMF Supernatant	TWRMF Supernatant	15,010	55,342	23,084	20,372	55,342	23,084		20,372	55,342	23,084	20,372	55,342	23,084
Q27	TWRMF Decant	8,907	19,907	15,951	14,269	19,907	15,951		14,269	19,907	15,951	14,269	19,907	15,951
Q - Pit Dewatering	OPEN PIT DEWATERING	8,000	8,000	8,000	8,000	8,000	8,000		8,000	8,000	8,000	8,000	8,000	8,000
Q - Precipitation on Pit	Precipitation minus Sublimation on Open Pit	0	7,723	4,059	0	7,723	4,059		0	7,723	4,059	0	7,723	4,059
Q28	TOT. OPEN PIT DEWATERING	8,000	15,723	12,059	8,000	15,723	12,059		8,000	15,723	12,059	8,000	15,723	12,059
Q29	POLISHING POND INFLOW	43,183	128,057	54,285	48,545	137,557	54,285		48,545	123,043	54,285	48,545	121,643	54,285
Q - Precipitation on Polishing Pond	Precipitation minus Sublimation ON POLISHING POND	0	3,049	1,602	0	3,049	1,602		0	3,049	1,602	0	3,049	1,602
Q - Evaporation from Polishing Pond	EVAPORATION FROM POLISHING POND	0	1,355	1,063	0	1,355	1,063		0	1,355	1,063	0	1,355	1,063
Q30	POLISHING POND OUTFLOW	43,183	129,751	54,824	48,545	139,250	54,824		48,545	124,737	54,824	48,545	123,337	54,824
Q31	RECYCLE FROM FINAL POLISHING POND	10,632	10,632	10,632	10,632	10,632	10,632		10,632	10,632	10,632	10,632	10,632	10,632
Q32	DISCHARGE PIPELINE	21,158	119,119	44,192	24,643	128,618	44,192		24,643	114,105	44,192	24,643	112,705	44,192
Q33	DISCHARGE TO MINAGO	21,158	83,383	30,935	24,643	90,033	30,935		24,643	79,873	30,935	24,643	78,894	30,935
Q34	MINAGO UPSTREAM	69,120	864,000	164,160	69,120	864,000	164,160		69,120	864,000	164,160	69,120	864,000	164,160
Q35	MINAGO DOWNSTREAM	90,278	947,383	195,095	93,763	954,033	195,095		93,763	943,873	195,095	93,763	942,894	195,095
Q36	DISCHARGE TO OAKLEY CREEK	0	35,736	13,258	0	38,585	13,258		0	34,231	13,258	0	33,812	13,258
Q37	OAKLEY CREEK UPSTREAM	0	345,600	43,200	0	345,600	43,200		0	345,600	43,200	0	345,600	43,200
Q38	OAKLEY CREEK DOWNSTREAM	0	381,336	56,458	0	384,185	56,458		0	379,831	56,458	0	379,412	56,458
FLOW RATIOS:														
Q33 / Q34	RATIO OF DISCHARGE TO MINAGO TO FLOW IN MINAGO	31%	10%	19%	36%	10%	19%		36%	9%	19%	36%	9%	19%
Q36 / Q37	RATIO OF DISCHARGE TO OAKLEY CK TO FLOW IN OAKLEY CK	0%	10%	31%	0%	11%	31%		0%	10%	31%	0%	10%	31%

Note: A complete listing of projected flowrates during the Year 1 to Year 8 Operations are given in Appendix 2.14.

Table 2.14-13 Projected Effluent Concentrations in Site Flows during Year 1 through Year 4 Operations

SCENARIO:			ESTIMATED AVERAGE CONCENTRATION												REGULATIONS				
			Year 1			Year 2			Year 3			Year 4			Metal Mining Liquid Effluents (2002)		Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002)		Canadian Water Quality Guidelines for the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate			TIER II Water Quality Objectives		
		WATER QUALITY	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER					
FLOW		PARAM.	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Q30	POLISHING POND OUTFLOW	Al	0.119	0.139	0.154	0.169	0.169	0.156	0.171	0.174	0.160	0.174	0.181	0.165				0.005 - 0.1	0.005
Q30	POLISHING POND OUTFLOW	Sb	0.00092	0.00115	0.00130	0.00135	0.00139	0.00132	0.00136	0.00144	0.00135	0.00138	0.00149	0.00139					
Q30	POLISHING POND OUTFLOW	As	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q30	POLISHING POND OUTFLOW	Cd	0.00018	0.00021	0.00024	0.00026	0.00026	0.00024	0.00027	0.00027	0.00025	0.00028	0.00029	0.00027			0.00302 [B]	Tier II	0.000017 or $10^{\{0.86[\log(hardness)]-3.2}$
Q30	POLISHING POND OUTFLOW	Cr	0.0038	0.0043	0.0048	0.0051	0.0051	0.0048	0.0051	0.0052	0.0049	0.0052	0.0054	0.0050			0.10331 [C]	Tier II	
Q30	POLISHING POND OUTFLOW	Co	0.00245	0.00292	0.00324	0.00353	0.00353	0.00329	0.00355	0.00364	0.00336	0.00358	0.00375	0.00344					
Q30	POLISHING POND OUTFLOW	Cu	0.0084	0.0100	0.0110	0.0122	0.0122	0.0114	0.0124	0.01272	0.0118	0.0127	0.0133	0.0122	0.3	0.6	0.01266 [D]	Tier II	0.002
Q30	POLISHING POND OUTFLOW	Fe	0.527	0.628	0.696	0.762	0.761	0.704	0.765	0.781	0.717	0.769	0.804	0.733				0.3	0.3
Q30	POLISHING POND OUTFLOW	Pb	0.00141	0.00172	0.00193	0.00216	0.00220	0.00209	0.00233	0.00242	0.00228	0.00250	0.00266	0.00249	0.2	0.4	0.0039 [E]	Tier II	0.001
Q30	POLISHING POND OUTFLOW	Mo	0.0032	0.0037	0.0041	0.0045	0.0046	0.0043	0.0047	0.0049	0.0046	0.0049	0.0052	0.0049				0.073	
Q30	POLISHING POND OUTFLOW	Ni	0.120	0.142	0.158	0.174	0.173	0.160	0.175	0.178	0.164	0.177	0.184	0.168	0.5	1	0.07329 [F]	Tier II	0.025
Q30	POLISHING POND OUTFLOW	Se	0.0018	0.0022	0.0025	0.0026	0.0027	0.0026	0.0027	0.0028	0.0026	0.0027	0.0029	0.0027				0.001	0.001
Q30	POLISHING POND OUTFLOW	Zn	0.011	0.012	0.014	0.015	0.015	0.014	0.015	0.016	0.015	0.016	0.017	0.016	0.5	1	0.16657 [G]	Tier II	0.03
Q35	MINAGO DOWNSTREAM	Al	0.037	0.023	0.034	0.053	0.027	0.035	0.054	0.027	0.036	0.055	0.027	0.036				0.005 - 0.1	0.005
Q35	MINAGO DOWNSTREAM	Sb	0.00025	0.00015	0.00025	0.00039	0.00018	0.00025	0.00039	0.00018	0.00026	0.00040	0.00018	0.00026					
Q35	MINAGO DOWNSTREAM	As	0.0008	0.0007	0.0008	0.0009	0.0007	0.0008	0.0009	0.0007	0.0008	0.0009	0.0007	0.0008	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q35	MINAGO DOWNSTREAM	Cd	0.000054	0.000034	0.000052	0.000081	0.000040	0.000053	0.000083	0.000041	0.000054	0.000085	0.000041	0.000056			0.00302 [B]	Tier II	0.000017 or $10^{\{0.86[\log(hardness)]-3.2}$
Q35	MINAGO DOWNSTREAM	Cr	0.00107	0.00059	0.00095	0.00151	0.00069	0.00096	0.00152	0.00069	0.00097	0.00153	0.00070	0.00099			0.10331 [C]	Tier II	
Q35	MINAGO DOWNSTREAM	Co	0.00061	0.00030	0.00056	0.00096	0.00038	0.00056	0.00097	0.00038	0.00057	0.00098	0.00039	0.00059					
Q35	MINAGO DOWNSTREAM	Cu	0.002	0.001	0.002	0.004	0.002	0.002	0.004	0.002	0.002	0.004	0.002	0.002	0.3	0.6	0.01266 [D]	Tier II	0.002
Q35	MINAGO DOWNSTREAM	Fe	0.177	0.118	0.169	0.251	0.135	0.170	0.252	0.135	0.172	0.253	0.136	0.175				0.3	0.3
Q35	MINAGO DOWNSTREAM	Pb	0.00037	0.00020	0.00035	0.00061	0.00026	0.00038	0.00065	0.00028	0.00041	0.00070	0.00029	0.00044	0.2	0.4	0.0039 [E]	Tier II	0.001
Q35	MINAGO DOWNSTREAM	Mo	0.00085	0.00045	0.00076	0.00128	0.00055	0.00079	0.00134	0.00057	0.00083	0.00139	0.00059	0.00088				0.073	
Q35	MINAGO DOWNSTREAM	Ni	0.029	0.013	0.026	0.046	0.017	0.026	0.047	0.017	0.027	0.047	0.018	0.028	0.5	1	0.07329 [F]	Tier II	0.025
Q35	MINAGO DOWNSTREAM	Se	0.00062	0.00042	0.00061	0.00087	0.00048	0.00061	0.00088	0.00048	0.00062	0.00089	0.00048	0.00063				0.001	0.001
Q35	MINAGO DOWNSTREAM	Zn	0.003	0.002	0.003	0.005	0.002	0.003	0.005	0.002	0.003	0.005	0.002	0.003	0.5	1	0.16657 [G]	Tier II	0.03

Table 2.14-13 (Cont.'d) Projected Effluent Concentrations in Site Flows during Year 1 through Year 4 Operations

SCENARIO:			ESTIMATED AVERAGE CONCENTRATION												REGULATIONS				
			Year 1			Year 2			Year 3			Year 4			Metal Mining Liquid Effluents (2002)		Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002)		Canadian Water Quality Guideline for the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate			TIER II Water Quality Objectives		
		WATER QUALITY	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER					
FLOW		PARAM.	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Q38	OAKLEY CREEK DOWNSTREAM	Al	N/A	0.0155	0.0381	N/A	0.0193	0.0388	N/A	0.0195	0.0397	N/A	0.0198	0.0408				0.005 - 0.1	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Sb	N/A	0.000138	0.000330	N/A	0.000170	0.000336	N/A	0.000172	0.000344	N/A	0.000174	0.000353					
Q38	OAKLEY CREEK DOWNSTREAM	As	N/A	0.0005	0.0007	N/A	0.0005	0.0007	N/A	0.0005	0.0007	N/A	0.0005	0.0007	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Cd	N/A	0.000031	0.000065	N/A	0.000038	0.000067	N/A	0.000038	0.000069	N/A	0.000039	0.000072			0.00302 [B]	Tier II	0.000017 or $10^{0.86[\log(hardness)]-3.2}$
Q38	OAKLEY CREEK DOWNSTREAM	Cr	N/A	0.0007	0.0013	N/A	0.0008	0.0014	N/A	0.0008	0.0014	N/A	0.0008	0.0014			0.10331 [C]	Tier II	
Q38	OAKLEY CREEK DOWNSTREAM	Co	N/A	0.0003	0.0008	N/A	0.0004	0.0008	N/A	0.0004	0.0008	N/A	0.0004	0.0008					
Q38	OAKLEY CREEK DOWNSTREAM	Cu	N/A	0.0011	0.0027	N/A	0.0014	0.0028	N/A	0.0014	0.0029	N/A	0.0014	0.0030	0.3	0.6	0.01266 [D]	Tier II	0.002
Q38	OAKLEY CREEK DOWNSTREAM	Fe	N/A	0.1046	0.2021	N/A	0.1218	0.2040	N/A	0.1224	0.2071	N/A	0.1231	0.2108				0.3	0.3
Q38	OAKLEY CREEK DOWNSTREAM	Pb	N/A	0.0002	0.0005	N/A	0.0002	0.0005	N/A	0.0003	0.0006	N/A	0.0003	0.0006	0.2	0.4	0.0039 [E]	Tier II	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Mo	N/A	0.0004	0.0010	N/A	0.0005	0.0011	N/A	0.0006	0.0012	N/A	0.0006	0.0012				0.073	
Q38	OAKLEY CREEK DOWNSTREAM	Ni	N/A	0.0135	0.0372	N/A	0.0176	0.0377	N/A	0.0178	0.0386	N/A	0.0180	0.0396	0.5	1	0.07329 [F]	Tier II	0.025
Q38	OAKLEY CREEK DOWNSTREAM	Se	N/A	0.0004	0.0008	N/A	0.0005	0.0008	N/A	0.0005	0.0008	N/A	0.0005	0.0008				0.001	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Zn	N/A	0.0017	0.0036	N/A	0.0020	0.0038	N/A	0.0021	0.0040	N/A	0.0022	0.0043	0.5	1	0.16657 [G]	Tier II	0.03

Notes: N/A not applicable

August 2008 groundwater chemistry was assumed in the modeling.

A Arsenic li 0.15 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.34 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

B Cadmium [e{0.7852[ln(Hardness)]-2.715}]×[1.101672-{ln(Hardness)(0.041838)}] for 4 days averaging duration.
[e{1.128[ln(Hardness)]-3.6867}]×[1.136672-{ln(Hardness)(0.041838)}] for 1 hour averaging duration.

C Chromiun Chromium III: [e{0.8190[ln(Hardness)]+0.6848}]×[0.860] for 4 days averaging duration.
Chromium III: [e{0.8190[ln(Hardness)]+3.7256}]×[0.316] for 1 hour averaging duration.
Chromium VI: 0.011 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.016 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

D Copper li [e{0.8545[ln(Hardness)]-1.702}]×[0.960] for 4 Days hour averaging duration.
[e{0.9422[ln(Hardness)]-1.700}]×[0.960] for 1 hour averaging duration.

E Lead limit [e{1.273[ln(Hardness)]-4.705}]×[1.46203 -{ln(Hardness)(0.145712)}] for 4 Days averaging duration.
[e{1.273[ln(Hardness)]-1.460}]×[1.46203 -{ln(Hardness)(0.145712)}] for 1 hour averaging duration.

F Nickel lim [e{0.8460[ln(Hardness)]+0.0584}]×[0.997] for 4 Days averaging duration.
[e{0.8460[ln(Hardness)]+2.255}]×[0.998] for 1 hour averaging duration.

G Zinc limit [e{0.8473[ln(Hardness)]+0.884}]×[0.976] for 4 Days averaging duration.
[e{0.8473[ln(Hardness)]+0.884}]×[0.978] for 1 hour averaging duration.

Table 2.14-14 Projected Effluent Concentrations in Site Flows during Year 5 through Year 8 Operations

SCENARIO:			ESTIMATED AVERAGE CONCENTRATION												REGULATIONS				
			Year 5			Year 6			Year 7			Year 8			Metal Mining Liquid Effluents (2002)		Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002)		Canadian Water Quality Guidelines for the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate			TIER II Water Quality Objectives		
		WATER QUALITY	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER					
FLOW		PARAM.	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Q30	POLISHING POND OUTFLOW	Al	0.176	0.188	0.170	0.179	0.196	0.177	0.182	0.206	0.184	0.185	0.212	0.189				0.005 - 0.1	0.005
Q30	POLISHING POND OUTFLOW	Sb	0.00140	0.00155	0.00143	0.00142	0.00162	0.00149	0.00145	0.00170	0.00155	0.00147	0.00175	0.00159					
Q30	POLISHING POND OUTFLOW	As	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q30	POLISHING POND OUTFLOW	Cd	0.00029	0.00031	0.00028	0.00030	0.00033	0.00030	0.00031	0.00035	0.00031	0.00031	0.00036	0.00033			0.00302 [B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2}$
Q30	POLISHING POND OUTFLOW	Cr	0.0052	0.0056	0.0051	0.0053	0.0058	0.0053	0.0053	0.0060	0.0055	0.0054	0.0062	0.0056			0.10331 [C]	Tier II	
Q30	POLISHING POND OUTFLOW	Co	0.00361	0.00389	0.00353	0.00365	0.00404	0.00365	0.00370	0.00421	0.00379	0.00374	0.00433	0.00387					
Q30	POLISHING POND OUTFLOW	Cu	0.0130	0.0140	0.0127	0.0133	0.0147	0.0133	0.0137	0.0156	0.0140	0.0140	0.0161	0.0144	0.3	0.6	0.01266 [D]	Tier II	0.002
Q30	POLISHING POND OUTFLOW	Fe	0.774	0.830	0.752	0.781	0.860	0.774	0.788	0.896	0.802	0.797	0.920	0.820				0.3	0.3
Q30	POLISHING POND OUTFLOW	Pb	0.00269	0.00293	0.00271	0.00287	0.00321	0.00295	0.00306	0.00353	0.00322	0.00320	0.00375	0.00338	0.2	0.4	0.0039 [E]	Tier II	0.001
Q30	POLISHING POND OUTFLOW	Mo	0.0052	0.0056	0.0052	0.0054	0.0060	0.0055	0.0056	0.0064	0.0059	0.0058	0.0068	0.0061				0.073	
Q30	POLISHING POND OUTFLOW	Ni	0.179	0.191	0.173	0.181	0.199	0.179	0.183	0.208	0.186	0.186	0.214	0.191	0.5	1	0.07329 [F]	Tier II	0.025
Q30	POLISHING POND OUTFLOW	Se	0.0027	0.0030	0.0028	0.0028	0.0031	0.0029	0.0028	0.0033	0.0030	0.0029	0.0034	0.0031				0.001	0.001
Q30	POLISHING POND OUTFLOW	Zn	0.017	0.018	0.017	0.018	0.020	0.018	0.019	0.022	0.020	0.020	0.023	0.021	0.5	1	0.16657 [G]	Tier II	0.03
Q35	MINAGO DOWNSTREAM	Al	0.055	0.028	0.037	0.056	0.028	0.038	0.057	0.028	0.039	0.057	0.029	0.040				0.005 - 0.1	0.005
Q35	MINAGO DOWNSTREAM	Sb	0.00040	0.00018	0.00027	0.00041	0.00019	0.00028	0.00042	0.00019	0.00029	0.00042	0.00019	0.00029					
Q35	MINAGO DOWNSTREAM	As	0.0009	0.0007	0.0008	0.0010	0.0007	0.0008	0.0010	0.0007	0.0008	0.0010	0.0008	0.0009	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q35	MINAGO DOWNSTREAM	Cd	0.000088	0.000042	0.000058	0.000090	0.000044	0.000061	0.000093	0.000045	0.000064	0.000095	0.000046	0.000066			0.00302 [B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2}$
Q35	MINAGO DOWNSTREAM	Cr	0.00154	0.00070	0.00101	0.00155	0.00071	0.00103	0.00157	0.00072	0.00106	0.00159	0.00073	0.00108			0.10331 [C]	Tier II	
Q35	MINAGO DOWNSTREAM	Co	0.00099	0.00039	0.00060	0.00100	0.00040	0.00062	0.00101	0.00040	0.00064	0.00102	0.00041	0.00066					
Q35	MINAGO DOWNSTREAM	Cu	0.004	0.002	0.003	0.004	0.002	0.003	0.004	0.002	0.003	0.004	0.002	0.003	0.3	0.6	0.01266 [D]	Tier II	0.002
Q35	MINAGO DOWNSTREAM	Fe	0.255	0.137	0.177	0.256	0.138	0.181	0.258	0.139	0.186	0.260	0.140	0.188				0.3	0.3
Q35	MINAGO DOWNSTREAM	Pb	0.00075	0.00031	0.00048	0.00080	0.00033	0.00052	0.00085	0.00035	0.00056	0.00088	0.00037	0.00058	0.2	0.4	0.0039 [E]	Tier II	0.001
Q35	MINAGO DOWNSTREAM	Mo	0.00145	0.00061	0.00092	0.00151	0.00063	0.00098	0.00158	0.00066	0.00104	0.00163	0.00068	0.00107				0.073	
Q35	MINAGO DOWNSTREAM	Ni	0.048	0.018	0.028	0.048	0.018	0.029	0.049	0.019	0.030	0.050	0.019	0.031	0.5	1	0.07329 [F]	Tier II	0.025
Q35	MINAGO DOWNSTREAM	Se	0.00090	0.00049	0.00065	0.00091	0.00049	0.00066	0.00092	0.00050	0.00068	0.00093	0.00051	0.00069				0.001	0.001
Q35	MINAGO DOWNSTREAM	Zn	0.005	0.003	0.004	0.005	0.003	0.004	0.006	0.003	0.004	0.006	0.003	0.004	0.5	1	0.16657 [G]	Tier II	0.03

Table 2.14-14 (Cont.'d) Projected Effluent Concentrations in Site Flows during Year 5 through Year 8 Operations

SCENARIO:		WATER QUALITY	ESTIMATED AVERAGE CONCENTRATION												REGULATIONS				
			Year 5			Year 6			Year 7			Year 8			Metal Mining Liquid Effluents (2002)		Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002)		Canadian Water Quality Guidelines for the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate			TIER II Water Quality Objectives		
			NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER					
FLOW		PARAM.	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Q38	OAKLEY CREEK DOWNSTREAM	Al	N/A	0.0201	0.0421	N/A	0.0205	0.0436	N/A	0.0210	0.0453	N/A	0.0213	0.0464				0.005 - 0.1	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Sb	N/A	0.000177	0.000363	N/A	0.000180	0.000375	N/A	0.000184	0.000389	N/A	0.000187	0.000398					
Q38	OAKLEY CREEK DOWNSTREAM	As	N/A	0.0005	0.0007	N/A	0.0005	0.0008	N/A	0.0005	0.0008	N/A	0.0006	0.0008	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Cd	N/A	0.000040	0.000075	N/A	0.000042	0.000079	N/A	0.000043	0.000083	N/A	0.000044	0.000086			0.00302 [B]	Tier II	0.000017 or $10^{0.86[\log(hardness)]-3.2}$
Q38	OAKLEY CREEK DOWNSTREAM	Cr	N/A	0.0008	0.0014	N/A	0.0008	0.0015	N/A	0.0008	0.0015	N/A	0.0008	0.0015			0.10331 [C]	Tier II	
Q38	OAKLEY CREEK DOWNSTREAM	Co	N/A	0.0004	0.0009	N/A	0.0004	0.0009	N/A	0.0004	0.0009	N/A	0.0004	0.0009					
Q38	OAKLEY CREEK DOWNSTREAM	Cu	N/A	0.0015	0.0031	N/A	0.0015	0.0032	N/A	0.0015	0.0034	N/A	0.0016	0.0035	0.3	0.6	0.01266 [D]	Tier II	0.002
Q38	OAKLEY CREEK DOWNSTREAM	Fe	N/A	0.1240	0.2151	N/A	0.1252	0.2204	N/A	0.1267	0.2270	N/A	0.1280	0.2312				0.3	0.3
Q38	OAKLEY CREEK DOWNSTREAM	Pb	N/A	0.0003	0.0007	N/A	0.0003	0.0007	N/A	0.0003	0.0008	N/A	0.0004	0.0008	0.2	0.4	0.0039 [E]	Tier II	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Mo	N/A	0.0006	0.0013	N/A	0.0006	0.0014	N/A	0.0007	0.0015	N/A	0.0007	0.0015				0.073	
Q38	OAKLEY CREEK DOWNSTREAM	Ni	N/A	0.0182	0.0408	N/A	0.0186	0.0422	N/A	0.0190	0.0439	N/A	0.0193	0.0449	0.5	1	0.07329 [F]	Tier II	0.025
Q38	OAKLEY CREEK DOWNSTREAM	Se	N/A	0.0005	0.0008	N/A	0.0005	0.0009	N/A	0.0005	0.0009	N/A	0.0005	0.0009				0.001	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Zn	N/A	0.0023	0.0045	N/A	0.0024	0.0048	N/A	0.0025	0.0051	N/A	0.0026	0.0053	0.5	1	0.16657 [G]	Tier II	0.03

Notes: **N/A not applicable**

August 2008 groundwater chemistry was assumed in the modeling.

A Arsenic limits: 0.15 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.34 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

B Cadmium limit: [e{0.7852[ln(Hardness)]-2.715}]×[1.101672-{ln(Hardness)(0.041838)}] for 4 days averaging duration.
[e{1.128[ln(Hardness)]-3.6867}]×[1.136672-{ln(Hardness)(0.041838)}] for 1 hour averaging duration.

C Chromium limi Chromium III: [e{0.8190[ln(Hardness)]+0.6848}]×[0.860] for 4 days averaging duration.
Chromium III: [e{0.8190[ln(Hardness)]+3.7256}]×[0.316] for 1 hour averaging duration.
Chromium VI: 0.011 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.016 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

D Copper limits: [e{0.8545[ln(Hardness)]-1.702}]×[0.960] for 4 Days hour averaging duration.
[e{0.9422[ln(Hardness)]-1.700}]×[0.960] for 1 hour averaging duration.

E Lead limits: [e{1.273[ln(Hardness)]-4.705}]×[1.46203 -{ln(Hardness)(0.145712)}] for 4 Days averaging duration.
[e{1.273[ln(Hardness)]-1.460}]×[1.46203 -{ln(Hardness)(0.145712)}] for 1 hour averaging duration.

F Nickel limits: [e{0.8460[ln(Hardness)]+0.0584}]×[0.997] for 4 Days averaging duration.
[e{0.8460[ln(Hardness)]+2.255}]×[0.998] for 1 hour averaging duration.

G Zinc limits: [e{0.8473[ln(Hardness)]+0.884}]×[0.976] for 4 Days averaging duration.
[e{0.8473[ln(Hardness)]+0.884}]×[0.978] for 1 hour averaging duration.

The projected outflow from the Polishing Pond meets MMER requirements at all times. Projected results range from 0.17 to 0.21 mg/L for Al, from 0.013 to 0.016 mg/L for Cu, from 0.75 to 0.92 mg/L for Fe, from 0.003 to 0.004 mg/L for Pb, from 0.17 to 0.21 mg/L for Ni, and from 0.003 to 0.003 mg/L for Se.

Year 9 and Year 10 Operations

Estimated flowrates during Year 9 and Year 10 are listed in Table 2.14-15 and the corresponding water management plan is illustrated in Figure 2.14-4.

Year 9

The Polishing Pond discharge to Minago River (Q33) in relation to the Minago River streamflow (Q34) will be 1% in May, 4% in the summer months (June to October) and 5% in the winter months (November to April). In absolute quantities, discharge to Minago River will range from 3,665 m^3/day to 10,670 m^3/day during Year 9 operations. The Polishing Pond discharge to Oakley Creek (Q36) in relation to the Oakley Creek streamflow (Q37) will be 0% year round.

Table 2.14-16 presents projected parametric concentrations for the Polishing Pond outflow (Q30), Minago downstream (Q35), and Oakley Creek downstream (Q38). Additional results for Q26 (TWRMF Inflow), Q27 (TWRMF Decant), and Q29 (Polishing Pond Inflow) are provided in Appendix 2.14. All Polishing Pond outflow concentrations are projected to meet the MMER levels and the projected water quality downstream of the mixing zones in the Minago River and the Oakley Creek meets the CCME (2007) and Manitoba Tier III Freshwater guidelines levels.

Year 10

The Polishing Pond discharge to Minago River (Q33) in relation to the Minago River streamflow (Q34) will be 0% year round. The Polishing Pond discharge to Oakley Creek (Q36) in relation to the Oakley Creek streamflow (Q37) will be 9% in May, 14% in the summer months (June to October) and 0% in the winter months (November to April).

Table 2.14-16 presents projected parametric concentrations for the Polishing Pond outflow (Q30), Minago downstream (Q35), and Oakley Creek downstream (Q38). Additional results for Q26 (TWRMF Inflow), Q27 (TWRMF Decant), and Q29 (Polishing Pond Inflow) are provided in Appendix 2.14. All Polishing Pond outflow concentrations are projected to meet the MMER levels and the projected water quality downstream of the mixing zones in the Minago River and the Oakley Creek meets the CCME (2007) and Manitoba Tier III Freshwater guidelines levels.

Table 2.14-15 Projected Flow Rates during Year 9 and Year 10 Operations

	FLOW	Year 9			Year 10		
		Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate
		NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER
		m³/day	m³/day	m³/day	m³/day	m³/day	m³/day
UNIT EVAPORATION	UNIT LAKE EVAPORATION	0	18	14	0	18	14
UNIT PPT (U-PPT)	UNIT PRECIPITATION	0	41	21	0	41	21
Q1	FLOW FROM DEWATERING WELLS	4,236	4,236	4,236	4,236	4,236	4,236
Q2	WELL WATER FOR PROCESSING	4,236	4,236	4,236	4,236	4,236	4,236
Q3	EXCESS WATER FROM DEWATERING WELLS	0	0	0	0	0	0
Q4	GROUNDWATER TO OTHER OPERATIONS	0	0	0	0	0	0
Q5	GROUNDWATER TO WATER TREATMENT	48	48	48	48	48	48
Q6	GROUNDWATER TO FRAC SAND PLANT	4,188	4,188	4,188	4,188	4,188	4,188
Q7	GROUNDWATER FOR FIRE FIGHTING	0	0	0	0	0	0
Q8	POTABLE WATER	48	48	48	48	48	48
Q9	WATER TREATMENT PLANT WASTE	0	0	0	0	0	0
Q10	RECYCLE WATER FROM FPP	0	0	0	0	0	0
Q11	POTABLE WATER TO MILL	0	0	0	0	0	0
Q12	POTABLE WATER TO OTHER OPERATIONS	0	0	0	0	0	0
Q13	POTABLE WATER TO OFFICES & CAMP	36	36	36	36	36	36
Q14	POTABLE WATER TO FRAC SAND PLANT	12	12	12	12	12	12
Q15	FLOW FROM OPERATIONS TO MILL	0	0	0	0	0	0
Q16	SEWAGE & GREY WATER FROM CAMP AND OFFICES	36	36	36	36	36	36
Q17	SEWAGE & GREY WATER FROM ALL OTHER ON SITE SOURCES	12	12	12	12	12	12
Q19	FLOW FROM CONCENTRATE THICKENER IN MILL TO MILL	0	0	0	0	0	0
Q20	FLOW FROM MILL TO MILL THICKENER	0	0	0	0	0	0
Q21	RECYCLE WATER FROM MILL THICKENER	0	0	0	0	0	0
Q21x	ATERNATE FLOW FOR RECYCLE WATER FROM MILL THICKENER	0	0	0	0	0	0
Q22	MILL TAILINGS SLURRY	0	0	0	0	0	0
Q23	SEWAGE TREATMENT OUTFLOW	0	349	55	0	349	55
Q24	LIQ. WASTE FROM FSP	2,892	2,892	2,892	2,892	2,892	2,892
Q25	SLURRY FROM FSP	772	772	772	772	772	772
Q26	TWRMF INFLOW	3,664	4,013	3,719	3,664	4,013	3,719
Q - Liquid PPT on TWRMF	PPT on TWRMF	0	8,930	4,694	0	8,930	4,694
Q - Retained Water in Tailings Voids	Q - Retained Water in Tailings Voids	0	0	0	0	0	0
Q - TWRMF Supernatant	TWRMF Supernatant	9,766	44,410	12,430	9,766	44,410	12,430
Q27	TWRMF Decant	3,664	8,975	5,297	3,664	8,975	5,297
Q - Pit Dewatering	OPEN PIT DEWATERING	0	0	0	0	0	0
Q - Precipitation on Pit	Precipitation minus Sublimation on Open Pit	0	7,723	4,059	0	7,723	4,059
Q28	TOT. OPEN PIT DEWATERING	0	0	0	0	0	0
Q29	POLISHING POND INFLOW	3,664	8,975	5,297	3,664	30,247	5,297
Q - Precipitation on Polishing Pond	Precipitation minus Sublimation ON POLISHING POND	0	3,049	1,602	0	3,049	1,602
Q - Evaporation from Polishing Pond	EVAPORATION FROM POLISHING POND	0	1,355	1,063	0	1,355	1,063
Q30	POLISHING POND OUTFLOW	3,664	10,668	5,836	3,664	31,941	5,836
Q31	RECYCLE FROM FINAL POLISHING POND	0	0	0	0	0	0
Q32	DISCHARGE PIPELINE	3,664	10,668	5,836	0	31,941	5,836
Q33	DISCHARGE TO MINAGO	3,664	10,668	5,836	0	0	0
Q34	MINAGO UPSTREAM	69,120	864,000	164,160	69,120	864,000	164,160
Q35	MINAGO DOWNSTREAM	72,784	874,668	169,996	69,120	864,000	164,160
Q36	DISCHARGE TO OAKLEY CREEK	0	0	0	0	31,941	5,836
Q37	OAKLEY CREEK UPSTREAM	0	345,600	43,200	0	345,600	43,200
Q38	OAKLEY CREEK DOWNSTREAM	0	345,600	43,200	0	377,541	49,036
FLOW RATIOS:							
Q33 / Q34	RATIO OF DISCHARGE TO MINAGO TO FLOW IN MINAGO	5%	1%	4%	0%	0%	0%
Q36 / Q37	RATIO OF DISCHARGE TO OAKLEY CK TO FLOW IN OAKLEY CK	0%	0%	0%	0%	9%	14%

Table 2.14-16 Projected Effluent Concentrations in Site Flows Year 9 and Year 10 Operations

SCENARIO:			ESTIMATED AVERAGE CONCENTRATION						REGULATIONS				
			Year 9			Year 10			(2002)		TIER II Water Quality Objectives		the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate					
FLOW		WATER QUALITY PARAM.	NOVEMBER TO APRIL (mg/L)	MAY (mg/L)	JUNE TO OCTOBER (mg/L)	NOVEMBER TO APRIL (mg/L)	MAY (mg/L)	JUNE TO OCTOBER (mg/L)	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Q30	POLISHING POND OUTFLOW	Al	0.448	0.313	0.235	0.215	0.196	0.138				0.005 - 0.1	0.005
Q30	POLISHING POND OUTFLOW	Sb	0.00422	0.00324	0.00291	0.00289	0.00271	0.00236					
Q30	POLISHING POND OUTFLOW	As	0.006	0.005	0.005	0.006	0.006	0.005	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q30	POLISHING POND OUTFLOW	Cd	0.00099	0.00073	0.00068	0.00074	0.00067	0.00056			0.00302 [B]	Tier II	0.000017 or
Q30	POLISHING POND OUTFLOW	Cr	0.0113	0.0082	0.0061	0.0048	0.0045	0.0034			0.10331 [C]	Tier II	
Q30	POLISHING POND OUTFLOW	Co	0.00901	0.00635	0.00469	0.00406	0.00373	0.00265					
Q30	POLISHING POND OUTFLOW	Cu	0.0393	0.0286	0.0247	0.0261	0.0240	0.0192	0.3	0.6	0.01266 [D]	Tier II	0.002
Q30	POLISHING POND OUTFLOW	Fe	1.772	1.208	0.779	0.555	0.500	0.273				0.3	0.3
Q30	POLISHING POND OUTFLOW	Pb	0.01304	0.01008	0.01070	0.01318	0.01218	0.01076	0.2	0.4	0.0039 [E]	Tier II	0.001
Q30	POLISHING POND OUTFLOW	Mo	0.0249	0.0196	0.0218	0.0278	0.0257	0.0230				0.073	
Q30	POLISHING POND OUTFLOW	Ni	0.447	0.308	0.219	0.190	0.172	0.113	0.5	1	0.07329 [F]	Tier II	0.025
Q30	POLISHING POND OUTFLOW	Se	0.0070	0.0054	0.0044	0.0038	0.0036	0.0031				0.001	0.001
Q30	POLISHING POND OUTFLOW	Zn	0.068	0.054	0.058	0.071	0.066	0.059	0.5	1	0.16657 [G]	Tier II	0.03
Q35	MINAGO DOWNSTREAM	Al	0.034	0.016	0.020	N/A	N/A	N/A				0.005 - 0.1	0.005
Q35	MINAGO DOWNSTREAM	Sb	0.00026	0.00009	0.00015	N/A	N/A	N/A					
Q35	MINAGO DOWNSTREAM	As	0.0009	0.0007	0.0008	N/A	N/A	N/A	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q35	MINAGO DOWNSTREAM	Cd	0.000066	0.000025	0.000039	N/A	N/A	N/A			0.00302 [B]	Tier II	0.000017 or $10^{\{0.86[\log(hardness)]-3.2\}}$
Q35	MINAGO DOWNSTREAM	Cr	0.00078	0.00033	0.00043	N/A	N/A	N/A			0.10331 [C]	Tier II	
Q35	MINAGO DOWNSTREAM	Co	0.00050	0.00013	0.00021	N/A	N/A	N/A					
Q35	MINAGO DOWNSTREAM	Cu	0.003	0.001	0.001	N/A	N/A	N/A	0.3	0.6	0.01266 [D]	Tier II	0.002
Q35	MINAGO DOWNSTREAM	Fe	0.155	0.083	0.094	N/A	N/A	N/A				0.3	0.3
Q35	MINAGO DOWNSTREAM	Pb	0.00071	0.00018	0.00042	N/A	N/A	N/A	0.2	0.4	0.0039 [E]	Tier II	0.001
Q35	MINAGO DOWNSTREAM	Mo	0.00138	0.00036	0.00087	N/A	N/A	N/A				0.073	
Q35	MINAGO DOWNSTREAM	Ni	0.024	0.005	0.009	N/A	N/A	N/A	0.5	1	0.07329 [F]	Tier II	0.025
Q35	MINAGO DOWNSTREAM	Se	0.00059	0.00031	0.00039	N/A	N/A	N/A				0.001	0.001
Q35	MINAGO DOWNSTREAM	Zn	0.004	0.002	0.003	N/A	N/A	N/A	0.5	1	0.16657 [G]	Tier II	0.03

Table 2.14-16 (Cont.'d) Projected Effluent Concentrations in Site Flows during Year 9 and Year 10 Operations

SCENARIO:			ESTIMATED AVERAGE CONCENTRATION						REGULATIONS				
			Year 9			Year 10			(2002)		TIER II Water Quality Objectives		the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate					
		WATER QUALITY	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
FLOW		PARAM.	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)					
Q38	OAKLEY CREEK DOWNSTREAM	Al	N/A	N/A	N/A	N/A	0.0190	0.0188				0.005 - 0.1	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Sb	N/A	N/A	N/A	N/A	0.000261	0.000311					
Q38	OAKLEY CREEK DOWNSTREAM	As	N/A	N/A	N/A	N/A	0.0008	0.0009	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Cd	N/A	N/A	N/A	N/A	0.000069	0.000077			0.00302 [B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2)}$
Q38	OAKLEY CREEK DOWNSTREAM	Cr	N/A	N/A	N/A	N/A	0.0006	0.0007			0.10331 [C]	Tier II	
Q38	OAKLEY CREEK DOWNSTREAM	Co	N/A	N/A	N/A	N/A	0.0003	0.0003					
Q38	OAKLEY CREEK DOWNSTREAM	Cu	N/A	N/A	N/A	N/A	0.0022	0.0024	0.3	0.6	0.01266 [D]	Tier II	0.002
Q38	OAKLEY CREEK DOWNSTREAM	Fe	N/A	N/A	N/A	N/A	0.0885	0.0769				0.3	0.3
Q38	OAKLEY CREEK DOWNSTREAM	Pb	N/A	N/A	N/A	N/A	0.0010	0.0013	0.2	0.4	0.0039 [E]	Tier II	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Mo	N/A	N/A	N/A	N/A	0.0023	0.0028				0.073	
Q38	OAKLEY CREEK DOWNSTREAM	Ni	N/A	N/A	N/A	N/A	0.0148	0.0136	0.5	1	0.07329 [F]	Tier II	0.025
Q38	OAKLEY CREEK DOWNSTREAM	Se	N/A	N/A	N/A	N/A	0.0005	0.0006				0.001	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Zn	N/A	N/A	N/A	N/A	0.0061	0.0076	0.5	1	0.16657 [G]	Tier II	0.03

Notes: **N/A not applicable**

August 2008 groundwater chemistry was assumed in the modeling.

A Arsenic limits: 0.15 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.34 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

B Cadmium limit: [e{0.7852[ln(Hardness)]-2.715}]×[1.101672-{ln(Hardness)(0.041838)}] for 4 days averaging duration.
[e{1.128[ln(Hardness)]-3.6867}]×[1.136672-{ln(Hardness)(0.041838)}] for 1 hour averaging duration.

C Chromium limi Chromium III: [e{0.8190[ln(Hardness)]+0.6848}]×[0.860] for 4 days averaging duration.
Chromium III: [e{0.8190[ln(Hardness)]+3.7256}]×[0.316] for 1 hour averaging duration.
Chromium VI: 0.011 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.016 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

D Copper limits: [e{0.8545[ln(Hardness)]-1.702}]×[0.960] for 4 Days hour averaging duration.
[e{0.9422[ln(Hardness)]-1.700}]×[0.960] for 1 hour averaging duration.

E Lead limits: [e{1.273[ln(Hardness)]-4,705}]×[1.46203 -{ln(Hardness)(0.145712)}] for 4 Days averaging duration.
[e{1.273[ln(Hardness)]-1.460}]×[1.46203 -{ln(Hardness)(0.145712)}] for 1 hour averaging duration.

F Nickel limits: [e{0.8460[ln(Hardness)]+0.0584}]×[0.997] for 4 Days averaging duration.
[e{0.8460[ln(Hardness)]+2.255}]×[0.998] for 1 hour averaging duration.

G Zinc limits: [e{0.8473[ln(Hardness)]+0.884}]×[0.976] for 4 Days averaging duration.
[e{0.8473[ln(Hardness)]+0.884}]×[0.978] for 1 hour averaging duration.

2.14.2.3.3 Water Balance Results during Closure

Estimated flowrates during the first and second stages of the closure period are listed in Table 2.14-17. The water balance during the first stage of Closure is illustrated in Figure 2.14-6 and the second stage of Closure is illustrated in Figure 2.14-7.

During the first stage of Closure, a water cover will be installed on top of the TWRMF and no discharges to the receiving environment will occur from the TWRMF nor from the pipeline discharge system. After closure, water from the Polishing Pond will be discharged into a cross-ditch to report to the Oakley Creek. The major cross-ditch will report to the ditch at Highway 6 and to the Oakley Creek through the low lying marsh on the east side of Highway 6.

The Polishing Pond discharge to Minago River (Q33) in relation to the Minago River streamflow (Q34) will be 0% during the second stage of Closure (after the installation of a water cover on top of the tailings).

The Polishing Pond discharge to Oakley Creek (Q36) in relation to the Oakley Creek streamflow (Q37) will be 0% in the winter months (Nov. to Apr.), 2% in May, and 5% in the summer months (June to October). In absolute quantities, discharge to Oakley Creek will range from 0 m^3/day to 5,500 m^3/day during the second stage of Closure.

Table 2.14-18 presents projected parametric concentrations during the two stages of Closure for the Polishing Pond outflow (Q30), Minago downstream (Q35), and Oakley Creek downstream (Q38). Additional results for Q26 (TWRMF Inflow), Q27 (TWRMF Decant), Q29 (Polishing Pond Inflow) are given in Appendix 2.14.

During the first and second stages of Closure, the projected outflow from the Polishing Pond will meet MMER requirements at all times. During both stages of Closure, the projected water quality in Minago River and Oakley Creek downstream of the mixing zones meets the Manitoba Freshwater guidelines for the protection of aquatic life for all parameters.

2.14.2.3.4 Water Balance Results during Post Closure

During the Post Closure period, all discharge pipeline systems to Minago River and Oakley Creek will have been dismantled and excess water from the TWRMF (Q27 = TWRMF Decant) will be discharged via a spillway to the Polishing Pond for subsequent discharge to the receiving environment – the Oakley Creek basin and ultimately Oakley Creek. The active and inactive water balance components during the Post Closure period are illustrated in Figure 2.14-8.

Projected flowrates during the post closure period are listed in Table 2.14-19. Projected Polishing Pond outflow rates range from 0 m^3/day in the winter months (Nov. to Apr.) to 2,117 m^3/day in the period from June to October to 5,375 m^3/day in May.

Table 2.14-17 Projected Concentrations in Flows around the Minago Site during Closure

		Year 11			Year 12		
		Closure (Stage 1)	Closure (Stage 2)	Closure (Stage 2)	Closure (Stage 2)		
		Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate
		NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER
	FLOW	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
UNIT EVAPORATION	UNIT LAKE EVAPORATION	0	18	14	0	18	14
UNIT PPT (U-PPT)	UNIT PRECIPITATION	0	41	21	0	41	21
Q1	FLOW FROM DEWATERING WELLS	12,000	0	0	0	0	0
Q2	WELL WATER FOR PROCESSING	15	15	15	15	15	15
Q3	EXCESS WATER FROM DEWATERING WELLS	11,985	0	0	0	0	0
Q4	GROUNDWATER TO OTHER OPERATIONS	0	0	0	0	0	0
Q5	GROUNDWATER TO WATER TREATMENT	15	15	15	15	15	15
Q6	GROUNDWATER TO FRAC SAND PLANT	0	0	0	0	0	0
Q7	GROUNDWATER FOR FIRE FIGHTING	0	0	0	0	0	0
Q8	POTABLE WATER	15	15	15	15	15	15
Q9	WATER TREATMENT PLANT WASTE	0	0	0	0	0	0
Q10	RECYCLE WATER FROM FPP	0	0	0	0	0	0
Q11	POTABLE WATER TO MILL	0	0	0	0	0	0
Q12	POTABLE WATER TO OTHER OPERATIONS	0	0	0	0	0	0
Q13	POTABLE WATER TO OFFICES & CAMP	15	15	15	15	15	15
Q14	POTABLE WATER TO FRAC SAND PLANT	0	0	0	0	0	0
Q15	FLOW FROM OPERATIONS TO MILL	0	0	0	0	0	0
Q16	SEWAGE & GREY WATER FROM CAMP AND OFFICES	15	15	15	15	15	15
Q17	SEWAGE & GREY WATER FROM ALL OTHER ON SITE SOURCES	0	0	0	0	0	0
Q19	FLOW FROM CONCENTRATE THICKENER IN MILL TO MILL	0	0	0	0	0	0
Q20	FLOW FROM MILL TO MILL THICKENER	0	0	0	0	0	0
Q21	RECYCLE WATER FROM MILL THICKENER	0	0	0	0	0	0
Q21x	ATERNATE FLOW FOR RECYCLE WATER FROM MILL THICKENER	0	0	0	0	0	0
Q22	MILL TAILINGS SLURRY	0	0	0	0	0	0
Q23	SEWAGE TREATMENT OUTFLOW	0	125	22	0	125	22
Q24	LIQ. WASTE FROM FSP	0	0	0	0	0	0
Q25	SLURRY FROM FSP	0	0	0	0	0	0
Q26	TWRMF INFLOW	11,985	125	22	0	125	22
Q - Liquid PPT on TWRMF	PPT on TWRMF	0	8,930	4,694	0	8,930	4,694
Q - Retained Water in Tailings Voids	Q - Retained Water in Tailings Voids	0	0	0	0	0	0
Q - TWRMF Supernatant	TWRMF Supernatant	18,088	110,112	23,000	18,308	110,112	23,000
Q27	TWRMF Decant	0	3,806	1,601	0	3,806	1,601
Q - Pit Dewatering	OPEN PIT DEWATERING	0	0	0	0	0	0
Q - Precipitation on Pit	Precipitation minus Sublimation on Open Pit	0	7,723	4,059	0	7,723	4,059
Q28	TOT. OPEN PIT DEWATERING	0	0	0	0	0	0
Q29	POLISHING POND INFLOW	0	3,806	1,601	0	3,806	1,601
Q - Precipitation on Polishing Pond	Precipitation minus Sublimation ON POLISHING POND	0	3,049	1,602	0	3,049	1,602
Q - Evaporation from Polishing Pond	EVAPORATION FROM POLISHING POND	0	1,355	1,063	0	1,355	1,063
Q30	POLISHING POND OUTFLOW	0	5,499	2,140	0	5,499	2,140
Q31	RECYCLE FROM FINAL POLISHING POND						
Q32	DISCHARGE PIPELINE						
Q33	DISCHARGE TO MINAGO						
Q34	MINAGO UPSTREAM						
Q35	MINAGO DOWNSTREAM						
Q36	DISCHARGE TO OAKLEY CREEK	0	5,499	2,140	0	5,499	2,140
Q37	OAKLEY CREEK UPSTREAM	0	345,600	43,200	0	345,600	43,200
Q38	OAKLEY CREEK DOWNSTREAM	0	351,099	45,340	0	351,099	45,340
FLOW RATIOS:							
Q33 / Q34	RATIO OF DISCHARGE TO MINAGO TO FLOW IN MINAGO	0%	0%	0%	0%	0%	0%
Q36 / Q37	RATIO OF DISCHARGE TO OAKLEY CK TO FLOW IN OAKLEY CK	0%	2%	5%	0%	2%	5%

Table 2.14-18 Projected Concentrations in Flows around the Minago Site during Closure

SCENARIO: FLOW		WATER QUALITY PARAM.	ESTIMATED AVERAGE CONCENTRATION: Closure (Stage 1) Tailings only; max.tailings leaching rate NOVEMBER TO APRIL (mg/L)	Closure (Stage 2) Tailings only; max.tailings leaching rate MAY (mg/L)	Closure (Stage 2) Tailings only; max.tailings leaching rate JUNE TO OCTOBER (mg/L)	Year 12 - Closure (Stage 2) Tailings only; max.tailings leaching rate NOVEMBER TO APRIL (mg/L)	Year 12 - Closure (Stage 2) Tailings only; max.tailings leaching rate MAY (mg/L)	Year 12 - Closure (Stage 2) Tailings only; max.tailings leaching rate JUNE TO OCTOBER (mg/L)	REGULATIONS: (2002) Monthly Mean	(2002) Grab Sample	TIER II Water Quality Objectives assuming hardness = 150 mg/L $CaCO_3$	Freshwater	the Protection of Aquatic Life (CCME, 2007)
Q30	POLISHING POND OUTFLOW	Al	0.000	0.062	0.081	0.000	0.093	0.112				0.005 - 0.1	0.005
Q30	POLISHING POND OUTFLOW	Sb	0.00000	0.00104	0.00135	0.00000	0.00134	0.00166					
Q30	POLISHING POND OUTFLOW	As	0.000	0.003	0.004	0.000	0.004	0.005	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q30	POLISHING POND OUTFLOW	Cd	0.00000	0.00027	0.00038	0.00000	0.00046	0.00055			0.00302 [B]	Tier II	0.000017 or $10^{0.86[\log(hardness)]-3.2}$
Q30	POLISHING POND OUTFLOW	Cr	0.0000	0.0021	0.0027	0.0000	0.0027	0.0033			0.10331 [C]	Tier II	
Q30	POLISHING POND OUTFLOW	Co	0.00000	0.00103	0.00132	0.00000	0.00136	0.00161					
Q30	POLISHING POND OUTFLOW	Cu	0.0000	0.0089	0.0118	0.0000	0.0137	0.0168	0.3	0.6	0.01266 [D]	Tier II	0.002
Q30	POLISHING POND OUTFLOW	Fe	0.000	0.095	0.113	0.000	0.107	0.126				0.3	0.3
Q30	POLISHING POND OUTFLOW	Pb	0.00000	0.00540	0.00748	0.00000	0.00903	0.01113	0.2	0.4	0.0039 [E]	Tier II	0.001
Q30	POLISHING POND OUTFLOW	Mo	0.0000	0.0095	0.0121	0.0000	0.0136	0.0163				0.073	
Q30	POLISHING POND OUTFLOW	Ni	0.000	0.041	0.052	0.000	0.058	0.069	0.5	1	0.07329 [F]	Tier II	0.025
Q30	POLISHING POND OUTFLOW	Se	0.0000	0.0017	0.0023	0.0000	0.0023	0.0029				0.001	0.001
Q30	POLISHING POND OUTFLOW	Zn	0.000	0.031	0.042	0.000	0.048	0.059	0.5	1	0.16657 [G]	Tier II	0.03
Q35	MINAGO DOWNSTREAM	Al	N/A	N/A	N/A	N/A	N/A	N/A				0.005 - 0.1	0.005
Q35	MINAGO DOWNSTREAM	Sb	N/A	N/A	N/A	N/A	N/A	N/A					
Q35	MINAGO DOWNSTREAM	As	N/A	N/A	N/A	N/A	N/A	N/A	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q35	MINAGO DOWNSTREAM	Cd	N/A	N/A	N/A	N/A	N/A	N/A			0.00302 [B]	Tier II	0.000017 or $10^{0.86[\log(hardness)]-3.2}$
Q35	MINAGO DOWNSTREAM	Cr	N/A	N/A	N/A	N/A	N/A	N/A			0.10331 [C]	Tier II	
Q35	MINAGO DOWNSTREAM	Co	N/A	N/A	N/A	N/A	N/A	N/A					
Q35	MINAGO DOWNSTREAM	Cu	N/A	N/A	N/A	N/A	N/A	N/A	0.3	0.6	0.01266 [D]	Tier II	0.002
Q35	MINAGO DOWNSTREAM	Fe	N/A	N/A	N/A	N/A	N/A	N/A				0.3	0.3
Q35	MINAGO DOWNSTREAM	Pb	N/A	N/A	N/A	N/A	N/A	N/A	0.2	0.4	0.0039 [E]	Tier II	0.001
Q35	MINAGO DOWNSTREAM	Mo	N/A	N/A	N/A	N/A	N/A	N/A				0.073	
Q35	MINAGO DOWNSTREAM	Ni	N/A	N/A	N/A	N/A	N/A	N/A	0.5	1	0.07329 [F]	Tier II	0.025
Q35	MINAGO DOWNSTREAM	Se	N/A	N/A	N/A	N/A	N/A	N/A				0.001	0.001
Q35	MINAGO DOWNSTREAM	Zn	N/A	N/A	N/A	N/A	N/A	N/A	0.5	1	0.16657 [G]	Tier II	0.03

Table 2.14-18 (Cont.'d) Projected Concentrations in Flows around the Minago Site during Closure

SCENARIO:			ESTIMATED AVERAGE CONCENTRATION						REGULATIONS				
			Closure (Stage 1)	Closure (Stage 2)	Closure (Stage 2)	Year 12 - Closure (Stage 2)			(2002)		TIER II Water Quality Objectives		the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate					
FLOW		WATER QUALITY PARAM.	NOVEMBER TO APRIL (mg/L)	MAY (mg/L)	JUNE TO OCTOBER (mg/L)	NOVEMBER TO APRIL (mg/L)	MAY (mg/L)	JUNE TO OCTOBER (mg/L)	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Q38	OAKLEY CREEK DOWNSTREAM	Al	N/A	0.0036	0.0064	N/A	0.0041	0.0078				0.005 - 0.1	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Sb	N/A	0.000050	0.000096	N/A	0.000054	0.000111					
Q38	OAKLEY CREEK DOWNSTREAM	As	N/A	0.0004	0.0005	N/A	0.0004	0.0006	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Cd	N/A	0.000017	0.000030	N/A	0.000020	0.000038			0.00302 [B]	Tier II	0.000017 or $10^{[0.86[\log(hardness)]-3.2]}$
Q38	OAKLEY CREEK DOWNSTREAM	Cr	N/A	0.0003	0.0004	N/A	0.0003	0.0004			0.10331 [C]	Tier II	
Q38	OAKLEY CREEK DOWNSTREAM	Co	N/A	0.0000	0.0001	N/A	0.0001	0.0001					
Q38	OAKLEY CREEK DOWNSTREAM	Cu	N/A	0.0003	0.0007	N/A	0.0004	0.0009	0.3	0.6	0.01266 [D]	Tier II	0.002
Q38	OAKLEY CREEK DOWNSTREAM	Fe	N/A	0.0512	0.0534	N/A	0.0514	0.0540				0.3	0.3
Q38	OAKLEY CREEK DOWNSTREAM	Pb	N/A	0.0001	0.0004	N/A	0.0002	0.0005	0.2	0.4	0.0039 [E]	Tier II	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Mo	N/A	0.0002	0.0007	N/A	0.0003	0.0009				0.073	
Q38	OAKLEY CREEK DOWNSTREAM	Ni	N/A	0.0009	0.0026	N/A	0.0011	0.0034	0.5	1	0.07329 [F]	Tier II	0.025
Q38	OAKLEY CREEK DOWNSTREAM	Se	N/A	0.0003	0.0003	N/A	0.0003	0.0004				0.001	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Zn	N/A	0.0011	0.0025	N/A	0.0014	0.0034	0.5	1	0.16657 [G]	Tier II	0.03

Notes: **N/A not applicable**

August 2008 groundwater chemistry was assumed in the modeling.

A Arsenic limits: 0.15 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.34 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

B Cadmium limits: [e{0.7852[ln(Hardness)]-2.715}]×[1.101672-{ln(Hardness)(0.041838)}] for 4 days averaging duration.
[e{1.128[ln(Hardness)]-3.6867}]×[1.136672-{ln(Hardness)(0.041838)}] for 1 hour averaging duration

C Chromium limits: Chromium III: [e{0.8190[ln(Hardness)]+0.6848}]×[0.860] for 4 days averaging duration.
Chromium III: [e{0.8190[ln(Hardness)]+3.7256}]×[0.316] for 1 hour averaging duration.
Chromium VI: 0.011 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.016 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

D Copper limits: [e{0.8545[ln(Hardness)]-1.702}]×[0.960] for 4 Days hour averaging duration.
[e{0.9422[ln(Hardness)]-1.700}]×[0.960] for 1 hour averaging duration.

E Lead limits: [e{1.273[ln(Hardness)]-4.705}]×[1.46203 -{ln(Hardness)(0.145712)}] for 4 Days averaging duration
[e{1.273[ln(Hardness)]-1.460}]×[1.46203 -{ln(Hardness)(0.145712)}] for 1 hour averaging duration.

F Nickel limits: [e{0.8460[ln(Hardness)]+0.0584}]×[0.997] for 4 Days averaging duration
[e{0.8460[ln(Hardness)]+2.255}]×[0.998] for 1 hour averaging duration.

G Zinc limits: [e{0.8473[ln(Hardness)]+0.884}]×[0.976] for 4 Days averaging duration.
[e{0.8473[ln(Hardness)]+0.884}]×[0.978] for 1 hour averaging duration.

Table 2.14-19 Projected Flow Rates during Post Closure

	FLOW	Year 13 - Post Closure		
		Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate
		NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER
		m³/day	m³/day	m³/day
UNIT EVAPORATION	UNIT LAKE EVAPORATION	0	18	14
UNIT PPT (U-PPT)	UNIT PRECIPITATION	0	41	21
Q1	FLOW FROM DEWATERING WELLS	0	0	0
Q2	WELL WATER FOR PROCESSING	0	0	0
Q3	EXCESS WATER FROM DEWATERING WELLS	0	0	0
Q4	GROUNDWATER TO OTHER OPERATIONS	0	0	0
Q5	GROUNDWATER TO WATER TREATMENT	0	0	0
Q6	GROUNDWATER TO FRAC SAND PLANT	0	0	0
Q7	GROUNDWATER FOR FIRE FIGHTING	0	0	0
Q8	POTABLE WATER	0	0	0
Q9	WATER TREATMENT PLANT WASTE	0	0	0
Q10	RECYCLE WATER FROM FPP	0	0	0
Q11	POTABLE WATER TO MILL	0	0	0
Q12	POTABLE WATER TO OTHER OPERATIONS	0	0	0
Q13	POTABLE WATER TO OFFICES & CAMP	0	0	0
Q14	POTABLE WATER TO FRAC SAND PLANT	0	0	0
Q15	FLOW FROM OPERATIONS TO MILL	0	0	0
Q16	SEWAGE & GREY WATER FROM CAMP AND OFFICES	0	0	0
Q17	SEWAGE & GREY WATER FROM ALL OTHER ON SITE SOURCES	0	0	0
Q19	FLOW FROM CONCENTRATE THICKENER IN MILL TO MILL	0	0	0
Q20	FLOW FROM MILL TO MILL THICKENER	0	0	0
Q21	RECYCLE WATER FROM MILL THICKENER	0	0	0
Q21x	ATERNATE FLOW FOR RECYCLE WATER FROM MILL THICKENER	0	0	0
Q22	MILL TAILINGS SLURRY	0	0	0
Q23	SEWAGE TREATMENT OUTFLOW	0	0	0
Q24	LIQ. WASTE FROM FSP	0	0	0
Q25	SLURRY FROM FSP	0	0	0
Q26	TWRMF INFLOW	0	0	0
Q - Liquid PPT on TWRMF	PPT on TWRMF	0	8,930	4,694
Q - Retained Water in Tailings Voids	Q - Retained Water in Tailings Voids	0	0	0
Q - TWRMF Supernatant	TWRMF Supernatant	18,308	109,987	22,978
Q27	TWRMF Decant	0	3,681	1,579
Q - Pit Dewatering	OPEN PIT DEWATERING	0	0	0
Q - Precipitation on Pit	Precipitation minus Sublimation on Open Pit	0	7,723	4,059
Q28	TOT. OPEN PIT DEWATERING	0	0	0
Q29	POLISHING POND INFLOW	0	3,681	1,579
Q - Precipitation on Polishing Pond	Precipitation minus Sublimation ON POLISHING POND	0	3,049	1,602
Q - Evaporation from Polishing Pond	EVAPORATION FROM POLISHING POND	0	1,355	1,063
Q30	POLISHING POND OUTFLOW	0	5,375	2,117
Q31	RECYCLE FROM FINAL POLISHING POND			
Q32	DISCHARGE PIPELINE			
Q33	DISCHARGE TO MINAGO			
Q34	MINAGO UPSTREAM			
Q35	MINAGO DOWNSTREAM			
Q36	DISCHARGE TO OAKLEY CREEK	0	5,375	2,117
Q37	OAKLEY CREEK UPSTREAM	0	345,600	43,200
Q38	OAKLEY CREEK DOWNSTREAM	0	350,975	45,317
FLOW RATIOS:				
Q33 / Q34	RATIO OF DISCHARGE TO MINAGO TO FLOW IN MINAGO	0%	0%	0%
Q36 / Q37	RATIO OF DISCHARGE TO OAKLEY CK TO FLOW IN OAKLEY CK	0%	2%	5%

The projected parametric concentrations for the Polishing Pond outflow (Q30), Minago downstream (Q35), and Oakley Creek downstream (Q38) are given in Table 2.14-20. Additional results for Q26 (TWRMF Inflow), Q27 (TWRMF Decant), Q29 (Polishing Pond Inflow) are given in Appendix 2.14.

During the Post Closure, the projected outflow from the Polishing Pond will meet MMER requirements at all times. During the Post Closure period, the projected water quality in Oakley Creek downstream of the mixing zones will meet the Manitoba Freshwater guidelines for the protection of aquatic life for all parameters.

2.14.2.3.5 Water Balance Modeling Results during Temporary Suspension and a State of Inactivity

Estimated flowrates during Temporary Suspension and the State of Inactivity are listed in Table 2.14-21 and the corresponding water management diagrams are shown in Figure 2.14-9 and Figure 2.14-10, respectively.

During the Temporary Suspension of operations, the Polishing Pond discharge to Minago River (Q33) in relation to the Minago River streamflow (Q34) will be 11% in May, 20% in the summer months (June to October) and 38% in the winter months (November to April). In absolute quantities, discharge to Minago River will range from 26,000 m^3/day to 95,000 m^3/day during the Temporary Suspension of operations.

During the Temporary Suspension of operations, the projected Polishing Pond discharge to Oakley Creek (Q36) to the Oakley Creek streamflow (Q37) will be 0% in the winter months (Nov. to Apr.), 12% in May, and 32% in the summer months (June to October). In absolute quantities, discharge to Oakley Creek will range from 0 m^3/day to 40,715 m^3/day during the Temporary Suspension of operations.

During the State of Inactivity, the projected Polishing Pond discharge to Minago River (Q33) in relation to the Minago River streamflow (Q34) will be 0% year round. During the State of Inactivity, the projected Polishing Pond discharge to Oakley Creek (Q36) in relation to the Oakley Creek streamflow (Q37) will be 0% in the winter months (Nov. to Apr.), 7% in May, and 11% in the summer months (June to October). In absolute quantities, discharge to Oakley Creek will range from 0 m^3/day to 24,830 m^3/day during the State of Inactivity.

Table 2.14-22 presents projected parametric concentrations for the Polishing Pond outflow (Q30), Minago downstream (Q35), and Oakley Creek downstream (Q38) during Temporary Suspension and the State of Inactivity. Additional results for Q26 (TWRMF Inflow), Q27 (TWRMF Decant), and Q29 (Polishing Pond Inflow) are given in Appendix 2.14.

During Temporary Suspension, the projected outflow from the Polishing Pond will meet MMER requirements at all times. During Temporary Suspension, the projected water quality in Minago

Table 2.14-20 Projected Concentrations in Flows around the Minago Site during Post Closure

SCENARIO:			ESTIMATED AVERAGE CONCENTRATION			REGULATIONS				
			Year 13 - POST CLOSURE			(2002)		TIER II Water Quality Objectives		the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate					
		WATER QUALITY	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
FLOW		PARAM.	(mg/L)	(mg/L)	(mg/L)					
Q30	POLISHING POND OUTFLOW	Al	0.000	0.119	0.114				0.005 - 0.1	0.005
Q30	POLISHING POND OUTFLOW	Sb	0.00000	0.00161	0.00222					
Q30	POLISHING POND OUTFLOW	As	0.000	0.005	0.006	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q30	POLISHING POND OUTFLOW	Cd	0.00000	0.00060	0.00054			0.00302 [B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2)}$
Q30	POLISHING POND OUTFLOW	Cr	0.0000	0.0031	0.0040			0.10331 [C]	Tier II	
Q30	POLISHING POND OUTFLOW	Co	0.00000	0.00159	0.00191					
Q30	POLISHING POND OUTFLOW	Cu	0.0000	0.0180	0.0203	0.3	0.6	0.01266 [D]	Tier II	0.002
Q30	POLISHING POND OUTFLOW	Fe	0.000	0.118	0.131				0.3	0.3
Q30	POLISHING POND OUTFLOW	Pb	0.00000	0.01214	0.01107	0.2	0.4	0.0039 [E]	Tier II	0.001
Q30	POLISHING POND OUTFLOW	Mo	0.0000	0.0171	0.0224				0.073	
Q30	POLISHING POND OUTFLOW	Ni	0.000	0.072	0.087	0.5	1	0.07329 [F]	Tier II	0.025
Q30	POLISHING POND OUTFLOW	Se	0.0000	0.0029	0.0035				0.001	0.001
Q30	POLISHING POND OUTFLOW	Zn	0.000	0.063	0.062	0.5	1	0.16657 [G]	Tier II	0.03
Q35	MINAGO DOWNSTREAM	Al	N/A	N/A	N/A				0.005 - 0.1	0.005
Q35	MINAGO DOWNSTREAM	Sb	N/A	N/A	N/A					
Q35	MINAGO DOWNSTREAM	As	N/A	N/A	N/A	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q35	MINAGO DOWNSTREAM	Cd	N/A	N/A	N/A			0.00302 [B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2)}$
Q35	MINAGO DOWNSTREAM	Cr	N/A	N/A	N/A			0.10331 [C]	Tier II	
Q35	MINAGO DOWNSTREAM	Co	N/A	N/A	N/A					
Q35	MINAGO DOWNSTREAM	Cu	N/A	N/A	N/A	0.3	0.6	0.01266 [D]	Tier II	0.002
Q35	MINAGO DOWNSTREAM	Fe	N/A	N/A	N/A				0.3	0.3
Q35	MINAGO DOWNSTREAM	Pb	N/A	N/A	N/A	0.2	0.4	0.0039 [E]	Tier II	0.001
Q35	MINAGO DOWNSTREAM	Mo	N/A	N/A	N/A				0.073	
Q35	MINAGO DOWNSTREAM	Ni	N/A	N/A	N/A	0.5	1	0.07329 [F]	Tier II	0.025
Q35	MINAGO DOWNSTREAM	Se	N/A	N/A	N/A				0.001	0.001
Q35	MINAGO DOWNSTREAM	Zn	N/A	N/A	N/A	0.5	1	0.16657 [G]	Tier II	0.03

Table 2.14-20 (Cont.'d) Projected Concentrations in Flows around the Minago Site during Post Closure

SCENARIO:			ESTIMATED AVERAGE CONCENTRATION			REGULATIONS				
			Year 13 - POST CLOSURE			(2002)		TIER II Water Quality Objectives		the Protection of Aquatic Life
			Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate					
		WATER QUALITY	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
FLOW		PARAM.	(mg/L)	(mg/L)	(mg/L)					
Q38	OAKLEY CREEK DOWNSTREAM	Al	N/A	0.0044	0.0079				0.005 - 0.1	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Sb	N/A	0.000058	0.000136					
Q38	OAKLEY CREEK DOWNSTREAM	As	N/A	0.0005	0.0006	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q38	OAKLEY CREEK DOWNSTREAM	Cd	N/A	0.000022	0.000037			0.00302 [B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2)}$
Q38	OAKLEY CREEK DOWNSTREAM	Cr	N/A	0.0003	0.0005			0.10331 [C]	Tier II	
Q38	OAKLEY CREEK DOWNSTREAM	Co	N/A	0.0001	0.0001					
Q38	OAKLEY CREEK DOWNSTREAM	Cu	N/A	0.0004	0.0011	0.3	0.6	0.01266 [D]	Tier II	0.002
Q38	OAKLEY CREEK DOWNSTREAM	Fe	N/A	0.0515	0.0542				0.3	0.3
Q38	OAKLEY CREEK DOWNSTREAM	Pb	N/A	0.0002	0.0005	0.2	0.4	0.0039 [E]	Tier II	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Mo	N/A	0.0004	0.0011				0.073	
Q38	OAKLEY CREEK DOWNSTREAM	Ni	N/A	0.0013	0.0043	0.5	1	0.07329 [F]	Tier II	0.025
Q38	OAKLEY CREEK DOWNSTREAM	Se	N/A	0.0003	0.0004				0.001	0.001
Q38	OAKLEY CREEK DOWNSTREAM	Zn	N/A	0.0016	0.0035	0.5	1	0.16657 [G]	Tier II	0.03

Notes: **N/A not applicable**

August 2008 groundwater chemistry was assumed in the modeling.

A Arsenic limits: 0.15 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.34 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

B Cadmium limits [e{0.7852[ln(Hardness)]-2.715}]×[1.101672-{ln(Hardness)(0.041838)}] for 4 days averaging duration.
[e{1.128[ln(Hardness)]-3.6867}]×[1.136672-{ln(Hardness)(0.041838)}] for 1 hour averaging duration.

C Chromium limi Chromium III: [e{0.8190[ln(Hardness)]+0.6848}]×[0.860] for 4 days averaging duration.
Chromium III: [e{0.8190[ln(Hardness)]+3.7256}]×[0.316] for 1 hour averaging duration.
Chromium VI: 0.011 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.016 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

D Copper limits: [e{0.8545[ln(Hardness)]-1.702}]×[0.960] for 4 Days hour averaging duration.
[e{0.9422[ln(Hardness)]-1.700}]×[0.960] for 1 hour averaging duration.

E Lead limits: [e{1.273[ln(Hardness)]-4.705}]×[1.46203 -{ln(Hardness)(0.145712)}] for 4 Days averaging duration.
[e{1.273[ln(Hardness)]-1.460}]×[1.46203 -{ln(Hardness)(0.145712)}] for 1 hour averaging duration.

F Nickel limits: [e{0.8460[ln(Hardness)]+0.0584}]×[0.997] for 4 Days averaging duration.
[e{0.8460[ln(Hardness)]+2.255}]×[0.998] for 1 hour averaging duration.

G Zinc limits: [e{0.8473[ln(Hardness)]+0.884}]×[0.976] for 4 Days averaging duration.
[e{0.8473[ln(Hardness)]+0.884}]×[0.978] for 1 hour averaging duration.

Table 2.14-21 Projected Flow Rates during Temporary Suspension and State of Inactivity

		TS after Year 4			SI after one year TS		
		Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate
		NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER
FLOW		m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day
UNIT EVAPORATION	UNIT LAKE EVAPORATION	0	18	14	0	18	14
UNIT PPT (U-PPT)	UNIT PRECIPITATION	0	41	21	0	41	21
Q1	FLOW FROM DEWATERING WELLS	31,999	31,999	31,999	2,666	2,667	2,667
Q2	WELL WATER FOR PROCESSING	6	6	6	3	3	3
Q3	EXCESS WATER FROM DEWATERING WELLS	31,993	31,993	31,993	2,663	2,664	2,664
Q4	GROUNDWATER TO OTHER OPERATIONS	0	0	0	0	0	0
Q5	GROUNDWATER TO WATER TREATMENT	6	6	6	3	3	3
Q6	GROUNDWATER TO FRAC SAND PLANT	0	0	0	0	0	0
Q7	GROUNDWATER FOR FIRE FIGHTING	0	0	0	0	0	0
Q8	POTABLE WATER	6	6	6	3	3	3
Q9	WATER TREATMENT PLANT WASTE	0	0	0	0	0	0
Q10	RECYCLE WATER FROM FPP	0	0	0	0	0	0
Q11	POTABLE WATER TO MILL	0	0	0	0	0	0
Q12	POTABLE WATER TO OTHER OPERATIONS	0	0	0	0	0	0
Q13	POTABLE WATER TO OFFICES & CAMP	6	6	6	3	3	3
Q14	POTABLE WATER TO FRAC SAND PLANT	0	0	0	0	0	0
Q15	FLOW FROM OPERATIONS TO MILL	0	0	0	0	0	0
Q16	SEWAGE & GREY WATER FROM CAMP AND OFFICES	6	6	6	3	3	3
Q17	SEWAGE & GREY WATER FROM ALL OTHER ON SITE SOURCES	0	0	0	0	0	0
Q19	FLOW FROM CONCENTRATE THICKENER IN MILL TO MILL	0	0	0	0	0	0
Q20	FLOW FROM MILL TO MILL THICKENER	0	0	0	0	0	0
Q21	RECYCLE WATER FROM MILL THICKENER	0	0	0	0	0	0
Q21x	ATERNATE FLOW FOR RECYCLE WATER FROM MILL THICKENER	0	0	0	0	0	0
Q22	MILL TAILINGS SLURRY	0	0	0	0	0	0
Q23	SEWAGE TREATMENT OUTFLOW	0	63	13	0	43	10
Q24	LIQ. WASTE FROM FSP	0	0	0	0	0	0
Q25	SLURRY FROM FSP	0	0	0	0	0	0
Q26	TWRMF INFLOW	0	63	13	0	43	10
Q - Liquid PPT on TWRMF	PPT on TWRMF	0	8,930	4,694	0	8,930	4,694
Q - Retained Water in Tailings Voids	Q - Retained Water in Tailings Voids	0	0	0	0	0	0
Q - TWRMF Supernatant	TWRMF Supernatant	6,103	40,461	8,725	6,103	40,440	8,722
Q27	TWRMF Decant	0	5,025	1,592	0	5,005	1,589
Q - Pit Dewatering	OPEN PIT DEWATERING	8,000	8,000	8,000	0	0	0
Q - Precipitation on Pit	Precipitation minus Sublimation on Open Pit	0	7,723	4,059	0	7,723	4,059
Q28	TOT. OPEN PIT DEWATERING	8,000	15,723	12,059	0	0	0
Q29	POLISHING POND INFLOW	39,993	134,018	45,644	2,663	23,133	4,252
Q - Precipitation on Polishing Pond	Precipitation minus Sublimation ON POLISHING POND	0	3,049	1,602	0	3,049	1,602
Q - Evaporation from Polishing Pond	EVAPORATION FROM POLISHING POND	0	1,355	1,063	0	1,355	1,063
Q30	POLISHING POND OUTFLOW	39,993	135,712	46,183	2,663	24,827	4,791
Q31	RECYCLE FROM FINAL POLISHING POND	0	0	0	0	0	0
Q32	DISCHARGE PIPELINE	25,996	135,712	46,183	0	24,827	4,791
Q33	DISCHARGE TO MINAGO	25,996	94,998	32,328	0	0	0
Q34	MINAGO UPSTREAM	69,120	864,000	164,160	69,120	864,000	164,160
Q35	MINAGO DOWNSTREAM	95,116	958,998	196,488	69,120	864,000	164,160
Q36	DISCHARGE TO OAKLEY CREEK	0	40,713	13,855	0	24,827	4,791
Q37	OAKLEY CREEK UPSTREAM	0	345,600	43,200	0	345,600	43,200
Q38	OAKLEY CREEK DOWNSTREAM	0	386,313	57,055	0	370,427	47,991
FLOW RATIOS:							
Q33 / Q34	RATIO OF DISCHARGE TO MINAGO TO FLOW IN MINAGO	38%	11%	20%	0%	0%	0%
Q36 / Q37	RATIO OF DISCHARGE TO OAKLEY CK TO FLOW IN OAKLEY CK	0%	12%	32%	0%	7%	11%

Table 2.14-22 Projected Effluent Concentrations in Flows during Temporary Suspension and the State of Inactivity

SCENARIO:			WATER QUALITY	ESTIMATED AVERAGE CONCENTRATION						REGULATIONS				
				TS after Year 4			SI after one year TS			Metal Mining Liquid Effluents (2002)		Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002)		Canadian Water Quality Guidelines for the Protection of Aquatic Life
				Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate			TIER II Water Quality Objectives		
				NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER					
FLOW			PARAM.	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	(CCME, 2007)
Q30	POLISHING POND OUTFLOW	RC30	Al	0.009	0.028	0.024	0.009	0.097	0.138				0.005 - 0.1	0.005
Q30	POLISHING POND OUTFLOW	RC30	Sb	0.00003	0.00023	0.00023	0.00003	0.00091	0.00146					
Q30	POLISHING POND OUTFLOW	RC30	As	0.001	0.001	0.001	0.001	0.002	0.003	0.5	1	0.15 mg/L (4-Day, 3-Year)[A]	Tier II	0.005
Q30	POLISHING POND OUTFLOW	RC30	Cd	0.00001	0.00004	0.00004	0.00001	0.00023	0.00036			0.00302[B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2)}$
Q30	POLISHING POND OUTFLOW	RC30	Cr	0.0010	0.0015	0.0014	0.0010	0.0032	0.0043			0.10331[C]	Tier II	
Q30	POLISHING POND OUTFLOW	RC30	Co	0.00008	0.00049	0.00042	0.00008	0.00178	0.00255					
Q30	POLISHING POND OUTFLOW	RC30	Cu	0.0005	0.0021	0.0019	0.0005	0.0089	0.0137	0.3	0.6	0.01266[D]	Tier II	0.002
Q30	POLISHING POND OUTFLOW	RC30	Fe	0.005	0.089	0.071	0.005	0.337	0.466				0.3	0.3
Q30	POLISHING POND OUTFLOW	RC30	Pb	0.00003	0.00052	0.00056	0.00003	0.00350	0.00597	0.2	0.4	0.0039[E]	Tier II	0.001
Q30	POLISHING POND OUTFLOW	RC30	Mo	0.0007	0.0014	0.0014	0.0007	0.0054	0.0087				0.073	
Q30	POLISHING POND OUTFLOW	RC30	Ni	0.001	0.020	0.016	0.001	0.085	0.121	0.5	1	0.07329[F]	Tier II	0.025
Q30	POLISHING POND OUTFLOW	RC30	Se	0.0002	0.0006	0.0006	0.0002	0.0018	0.0029				0.001	0.001
Q30	POLISHING POND OUTFLOW	RC30	Zn	0.005	0.007	0.007	0.005	0.021	0.033	0.5	1	0.16657[G]	Tier II	0.03
Q35	MINAGO DOWNSTREAM	RC35	Al	0.011	0.014	0.014	N/A	N/A	N/A				0.005 - 0.1	0.005
Q35	MINAGO DOWNSTREAM	RC35	Sb	0.00004	0.00007	0.00008	N/A	N/A	N/A					
Q35	MINAGO DOWNSTREAM	RC35	As	0.0007	0.0006	0.0007	N/A	N/A	N/A	0.5	1	0.15 mg/L (4-Day, 3-Year)[A]	Tier II	0.005
Q35	MINAGO DOWNSTREAM	RC35	Cd	0.000014	0.000019	0.000021	N/A	N/A	N/A			0.00302[B]	Tier II	0.000017 or $10^{(0.86[\log(hardness)]-3.2)}$
Q35	MINAGO DOWNSTREAM	RC35	Cr	0.00044	0.00035	0.00042	N/A	N/A	N/A			0.10331[C]	Tier II	
Q35	MINAGO DOWNSTREAM	RC35	Co	0.00006	0.00009	0.00011	N/A	N/A	N/A					
Q35	MINAGO DOWNSTREAM	RC35	Cu	0.001	0.001	0.001	N/A	N/A	N/A	0.3	0.6	0.01266[D]	Tier II	0.002
Q35	MINAGO DOWNSTREAM	RC35	Fe	0.052	0.071	0.070	N/A	N/A	N/A				0.3	0.3
Q35	MINAGO DOWNSTREAM	RC35	Pb	0.00005	0.00010	0.00014	N/A	N/A	N/A	0.2	0.4	0.0039[E]	Tier II	0.001
Q35	MINAGO DOWNSTREAM	RC35	Mo	0.00028	0.00025	0.00034	N/A	N/A	N/A				0.073	
Q35	MINAGO DOWNSTREAM	RC35	Ni	0.001	0.003	0.004	N/A	N/A	N/A	0.5	1	0.07329[F]	Tier II	0.025
Q35	MINAGO DOWNSTREAM	RC35	Se	0.00023	0.00028	0.00030	N/A	N/A	N/A				0.001	0.001
Q35	MINAGO DOWNSTREAM	RC35	Zn	0.002	0.002	0.002	N/A	N/A	N/A	0.5	1	0.16657[G]	Tier II	0.03

Table 2.14-22 (Cond.'d) Projected Effluent Concentrations in Flows during Temporary Suspension and the State of Inactivity

SCENARIO:				ESTIMATED AVERAGE CONCENTRATION						REGULATIONS				
				TS after Year 4			SI after one year TS			Metal Mining Liquid Effluents (2002)		Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson, 2002)		Canadian Water Quality Guidelines for the Protection of Aquatic Life
				Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate	Tailings only; max.tailings leaching rate			TIER II Water Quality Objectives		
			WATER QUALITY	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	NOVEMBER TO APRIL	MAY	JUNE TO OCTOBER	Monthly Mean	Grab Sample	assuming hardness = 150 mg/L $CaCO_3$	Freshwater	
FLOW			PARAM.	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)					(CCME, 2007)
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Al	N/A	0.0053	0.0079	N/A	0.0090	0.0162				0.005 - 0.1	0.005
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Sb	N/A	0.000054	0.000081	N/A	0.000092	0.000177					
Q38	OAKLEY CREEK DOWNSTREAM	RC38	As	N/A	0.0004	0.0005	N/A	0.0005	0.0007	0.5	1	0.15 mg/L (4-Day, 3-Year) [A]	Tier II	0.005
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Cd	N/A	0.000016	0.000020	N/A	0.000027	0.000047			0.00302 [B]	Tier II	0.000017 or $10^{\{0.86[\log(hardness)]-3.2\}}$
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Cr	N/A	0.0004	0.0006	N/A	0.0005	0.0007			0.10331 [C]	Tier II	
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Co	N/A	0.0001	0.0001	N/A	0.0002	0.0003					
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Cu	N/A	0.0004	0.0006	N/A	0.0007	0.0015	0.3	0.6	0.01266 [D]	Tier II	0.002
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Fe	N/A	0.0545	0.0556	N/A	0.0697	0.0920				0.3	0.3
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Pb	N/A	0.0001	0.0002	N/A	0.0003	0.0006	0.2	0.4	0.0039 [E]	Tier II	0.001
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Mo	N/A	0.0002	0.0004	N/A	0.0005	0.0010				0.073	
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Ni	N/A	0.0024	0.0041	N/A	0.0059	0.0122	0.5	1	0.07329 [F]	Tier II	0.025
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Se	N/A	0.0003	0.0003	N/A	0.0003	0.0005				0.001	0.001
Q38	OAKLEY CREEK DOWNSTREAM	RC38	Zn	N/A	0.0013	0.0022	N/A	0.0020	0.0039	0.5	1	0.16657 [G]	Tier II	0.03

Notes: N/A not applicable

August 2008 groundwater chemistry was assumed in the modeling.

A Arsenic limits: 0.15 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.34 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

B Cadmium limits: [e{0.7852[ln(Hardness)]-2.715}]×[1.101672-{ln(Hardness)(0.041838)}] for 4 days averaging duration.
[e{1.128[ln(Hardness)]-3.6867}]×[1.136672-{ln(Hardness)(0.041838)}] for 1 hour averaging duration.

C Chromium limits: Chromium III: [e{0.8190[ln(Hardness)]+0.6848}]×[0.860] for 4 days averaging duration.
Chromium III: [e{0.8190[ln(Hardness)]+3.7256}]×[0.316] for 1 hour averaging duration.
Chromium VI: 0.011 mg/L for averaging duration 4 days (4-Day, 3-Year or 7Q10 Design Flow); 0.016 mg/L for averaging duration 1 hr (1-Day, 3-Year or 1Q10 Design Flow)

D Copper limits: [e{0.8545[ln(Hardness)]-1.702}]×[0.960] for 4 Days hour averaging duration.
[e{0.9422[ln(Hardness)]-1.700}]×[0.960] for 1 hour averaging duration.

E Lead limits: [e{1.273[ln(Hardness)]-4,705}]×[1.46203 -{ln(Hardness)(0.145712)}] for 4 Days averaging duration.
[e{1.273[ln(Hardness)]-1.460}]×[1.46203 -{ln(Hardness)(0.145712)}] for 1 hour averaging duration.

F Nickel limits: [e{0.8460[ln(Hardness)]+0.0584}]×[0.997] for 4 Days averaging duration.
[e{0.8460[ln(Hardness)]+2.255}]×[0.998] for 1 hour averaging duration.

G Zinc limits: [e{0.8473[ln(Hardness)]+0.884}]×[0.976] for 4 Days averaging duration.
[e{0.8473[ln(Hardness)]+0.884}]×[0.978] for 1 hour averaging duration.

River and Oakley Creek downstream of the mixing zone will meet the Manitoba Tier III Freshwater guidelines for all parameters.

During the State of Inactivity, projected outflow from the Polishing Pond meets MMER requirements at all times. During the State of Inactivity, the projected water quality in Oakley Creek downstream of the mixing zone meets the Manitoba Tier III Freshwater guidelines for all parameters.

2.14.2.3.6 Storm Water Management

The site storm water management at the Minago Project is designed to accommodate a 1-in-20 year storm event over a 5-day period (120 mm) (Wardrop, 2009b).

Site water will be pumped to designated area settling ponds and sumps, or discharged to the local watersheds via runoff. Surface runoff from the industrial area, Overburden Disposal Facility, Dolomite Waste Rock Dump (WRD) and Country Rock WRD will be benign and is not expected to require treatment. The storm water falling on no-process areas including the Dolomite WRD and the Country Rock WRD will report to the natural environment. Settling ponds will nonetheless be built to control major events in the Overburden Disposal Facility areas. Seepage from the Tailings and Ultramafic Waste Rock Management Facility (TWRMF) will be collected in a perimeter ditch around the exterior of the facility and will be pumped back into TWRMF. The Polishing Pond and flood retention area will contain the storm water from the TWRMF, mine dewatering and site runoff. During operations, this water will be pumped to the Minago River and the Oakley Creek watersheds, and a portion will be diverted back to the process water tank (Wardrop, 2009b). Storm water release from the Polishing Pond will be staged over several days as needed to condition the Minago River and the Oakley Creek watersheds. After closure, water from the Polishing Pond will be discharged into the cross-ditch to report to the Oakley Creek. The major cross-site ditch will report to the ditch at Highway 6 and to the Oakley Creek through the low lying marsh on the east side of Highway 6.

2.14.2.3.7 Contaminants of Concern (CoC)

All discharges to the receiving environment are expected to meet the MMER guidelines during all stages of the mine development, closure and post closure periods. Table 2.14-23 summarizes the projected Polishing Pond water quality for the different mine development and closure stages against the MMER guideline limits (Environment Canada, 2002a). On the basis of the projected discharge water quantity for all phases of operation, there will be no contaminant of concern (CoC) for this project as all contaminants meet MMER guidelines.

2.14.3 Seepage Control

Seepage from the TWRMF will be collected with interceptor ditches surrounding the TWRMF. To ensure good capture of seepage from the tailings dam, the interceptor channel will be deep

Table 2.14-23 Water Quality of Polishing Pond Discharges

SCENARIO:		ESTIMATED AVERAGE CONCENTRATION																		REGULATIONS	
		DURING CONSTRUCTION	DURING OPERATIONS							Year 11			Year 12			Year 13				Metal Mining Liquid Effluents (2002)	
			Year 1 through Year 8	Year 9			Year 10			Closure (Stage 1)	Closure (Stage 2)	Closure (Stage 2)	Closure (Stage 2)			POST CLOSURE					
	WATER QUALITY	Maximum	Maximum	NOV. TO APRIL	MAY	JUNE TO OCTOBER	NOV. TO APRIL	MAY	JUNE TO OCTOBER	NOV. TO APRIL	MAY	JUNE TO OCTOBER	NOV. TO APRIL	MAY	JUNE TO OCTOBER	NOV. TO APRIL	MAY	JUNE TO OCTOBER	OVERALL MAXIMUM		
FLOW	PARAM.	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Monthly Mean	Grab Sample
POLISHING POND OUTFLOW	As	0.001	0.002	0.006	0.005	0.005	0.006	0.006	0.005	0.000	0.003	0.004	0.000	0.004	0.005	0.000	0.005	0.006	0.006	0.5	1
POLISHING POND OUTFLOW	Cu	0.0006	0.0161	0.0393	0.0286	0.0247	0.0261	0.0240	0.0192	0.0000	0.0089	0.0118	0.0000	0.0137	0.0168	0.0000	0.0180	0.0203	0.0393	0.3	0.6
POLISHING POND OUTFLOW	Pb	0.00006	0.00375	0.01304	0.01008	0.01070	0.01318	0.01218	0.01076	0.00000	0.00540	0.00748	0.00000	0.00903	0.01113	0.00000	0.01214	0.01107	0.01318	0.2	0.4
POLISHING POND OUTFLOW	Ni	0.001	0.214	0.447	0.308	0.219	0.190	0.172	0.113	0.000	0.041	0.052	0.000	0.058	0.069	0.000	0.072	0.087	0.447	0.5	1
POLISHING POND OUTFLOW	Zn	0.005	0.023	0.068	0.054	0.058	0.071	0.066	0.059	0.000	0.031	0.042	0.000	0.048	0.059	0.000	0.063	0.062	0.071	0.5	1

enough to drain the local groundwater around it and to capture the seepage from the TWRMF. A good level of maintenance of this channel will be provided as any sustained channel blockage, local infilling or pump malfunction will reduce the effectiveness of the channel.

Horizontal seepage through the deposited tailings will be captured by a filter drain system to be constructed within the perimeter embankment of the TWRMF. The filter drain system will discharge to the interceptor channel close to the base of the embankment. The collected water in the interceptor channel will be pumped back into the TWRMF.

2.14.4 Control Systems

Automatic gauging stations will be installed upstream and downstream on Minago River and Oakley Creek. These gauging stations will provide a continuous record of water levels and flows in Minago River and Oakley Creek.

2.14.5 Effluent Monitoring

Monitoring programs will be implemented to assess project effects. Potential project effects on water quality in local watersheds during the operational and closure phases may be caused by the following:

- discharge from the Polishing Pond into the Oakley Creek and the Minago River; and
- introduction of sediments (total suspended solids) to receiving waters due to runoff from areas disturbed during mine facility construction.

Baseline and proposed monitoring programs during opeations and closure are summarized below.

2.14.5.1 Baseline Monitoring Program

Surface water quality in watercourses surrounding the Minago Project was assessed by Wardrop (2007) from May to October 2006, URS (2008g) from May to August 2007, and KR Design Inc. from September 2007 to May 2008. Wardrop (2007) monitored water quality in Oakley Creek and Minago Project River while URS (2008g) and KR Design Inc. regularly monitored water quality in Oakley Creek, Minago River, William River, and Hargrave River. One-time assessments of surface water quality were also completed for William Lake, Little Limestone Lake, Russell Lake, and two locations near the confluence of William River and Limestone Bay on Lake Winnipeg. The selected locations for surface water sampling stations were based on:

- a review of topographic maps, orthophoto and drainage features at and surrounding the Minago site;

- consideration of the simultaneous collection of hydrological data, stream sediment and benthic samples during one or more of the surface water sampling events;
- consideration of the selection of representative stations both upstream and downstream of the Project site for the development of long-term sampling stations to monitor long-term trends in surface water quality during the exploration, development, operation and post-closure phases of the Project's mine life.

Water samples were analyzed for field parameters (pH, temperature, conductivity, oxidation-reduction potential (ORP), and dissolved oxygen (DO)), nutrients, major ions, metals, Radium-226, and other physicochemical parameters. Collection methods conformed to the guidelines outlined in the federal Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring (MMER-EEM; Environment Canada, 2002b). Details are provided in Section 7.5: Surface Water Quality.

2.14.5.2 Chemical Monitoring

Chemical monitoring will be undertaken during the operational and closure phases, in accordance with permit and MMER requirements. An application for amendment setting out a revised program for approval will be submitted to the respective agency. In addition to meeting permit requirements of the day, monitoring will be limited in scope to those parameters given in Schedule 4 of the MMER. In accordance with MMER, monitoring will continue as per the proposed program for three additional years. During the closure phase, chemical monitoring data will be reviewed for continual improvement.

2.14.5.3 Biological Monitoring

Biological monitoring will be undertaken to meet permit and MMER related requirements. Toxicity testing will be part of the biological monitoring program and will continue as required. In accordance with MMER, monitoring will continue as per the proposed program for seven additional years.

2.14.5.4 Physical Monitoring

Monitoring programs to assess physical parameters will be undertaken during the operational, closure, and post closure phases. In the event of any significant improvement or deficiency during the post closure monitoring phase (expected to last 4-6 years after closure), Victory Nickel will apply for an amendment setting out a revised program for approval.

2.14.5.5 Operational and Closure Water Quality Monitoring Programs

Victory Nickel intends to design its environmental protection programs in an environmentally sensitive manner to ensure that the above effects do not occur. However, in order to assess impacts, Victory Nickel will undertake a regional study during the operations and after closure. This regional study area will include water bodies and watersheds beyond the local project area that reflect the general region to be considered for cumulative effects and that provide suitable reference areas for sampling. The regional study will encompass water sampling in:

- Minago River downstream and upstream of the Polishing Pond discharge;
- Hargrave River;
- upstream and downstream of the Oakley Creek and William River confluence;
- William River;
- Limestone Bay; and
- Cross Lake.

Monitoring sites have already been established as outlined in Table 2.14-24 and Figure 2.14-11. These sampling sites will also be used during the operations, TS, SI and closure stages.

2.14.5.6 Proposed Water Quality Characterization

The proposed water quality monitoring parameters and associated minimum detection limits are given in Table 2.14-25. The respective QA/QC criteria and procedures for closure will be similar to the ones used during operations.

A water quality monitoring program was established as part of the environmental baseline studies. These streams will continue to be sampled during the operational and closure phases to determine potential impact(s) over time. The stations that will be sampled during the closure phase are provided in Table 2.14-26.

Table 2.14-24 Sampling Locations

Victory Nickel Sample Location (as of Sept. 15, 2007)	UTM (NAD 83)		UTM (NAD 83)		Description
	Northing	Easting	Latitude	Longitude	
HRW1	6028072	495606	54°24.041' N	99°04.051' W	Hargrave River immediately west of Highway 6
MRW1	6005277	488671	54°11.721' N	99°10.420' W	Minago Project River immediately west of Highway 6
MRW2x	6001166	472571	54°09.470' N	99°25.206' W	Minago Project River near Habiluk Lake (~ 100 m downstream of MRW2)
MRW3	6007895	494274			Minago Project River downstream of Highway 6 near powerline cut
OCW1	5990510	489322	54°03.762' N	99°09.786' W	Oakley Creek immediately east of Highway 6
OCW2	5990961	487463	54°04.002' N	99°11.492' W	Oakley Creek immediately downstream of north tributary
OCW3	5990892	487230	54°03.965' N	99°11.707' W	Oakley Creek immediately upstream of north tributary
WRW2x	5987162	495416	54°01.963' N	99°04.199' W	William River approx. 6 km upstream of the Oakley Creek confluence
WRW1x	5986554	498523	54°01.637' N	99°01.350' W	William River approx. 100 m downstream of the Oakley Creek confluence
WRAOC	5986647	498452	54°01.685' N	99°01.416' W	William River approx. 50 m upstream of the Oakley Creek
OCAWR	5986744	498457	54°01.738' N	99°01.414' W	Oakley Creek approx. 50 m above William River
WRALSB	5969206	503935	53°52.278' N	98°56.410' W	William River approx. 100 m above Limestone Bay
LSBBWR	5968889	504092	53°52.107' N	98°56.262' W	Limestone Bay approx. 250 m below William River
Little Limestone Lake	5954922	478725			Little Limestone Lake (at end of road)
Russell Lake	5967117	482571			Russell Lake (at end of road)
William River (Winter)	5973774	485141	53°54.730' N	99°13.574' W	William River east of Highway 6
William River at Road	5973791	485078			William River west of Highway 6
William Lake	5973831	479083			William Lake at end of access road
Polishing Pond	TBA*	TBA*	TBA*	TBA*	Polishing Pond Outflow to Receiving Environment during Closure

Note: * TBA To Be Announced

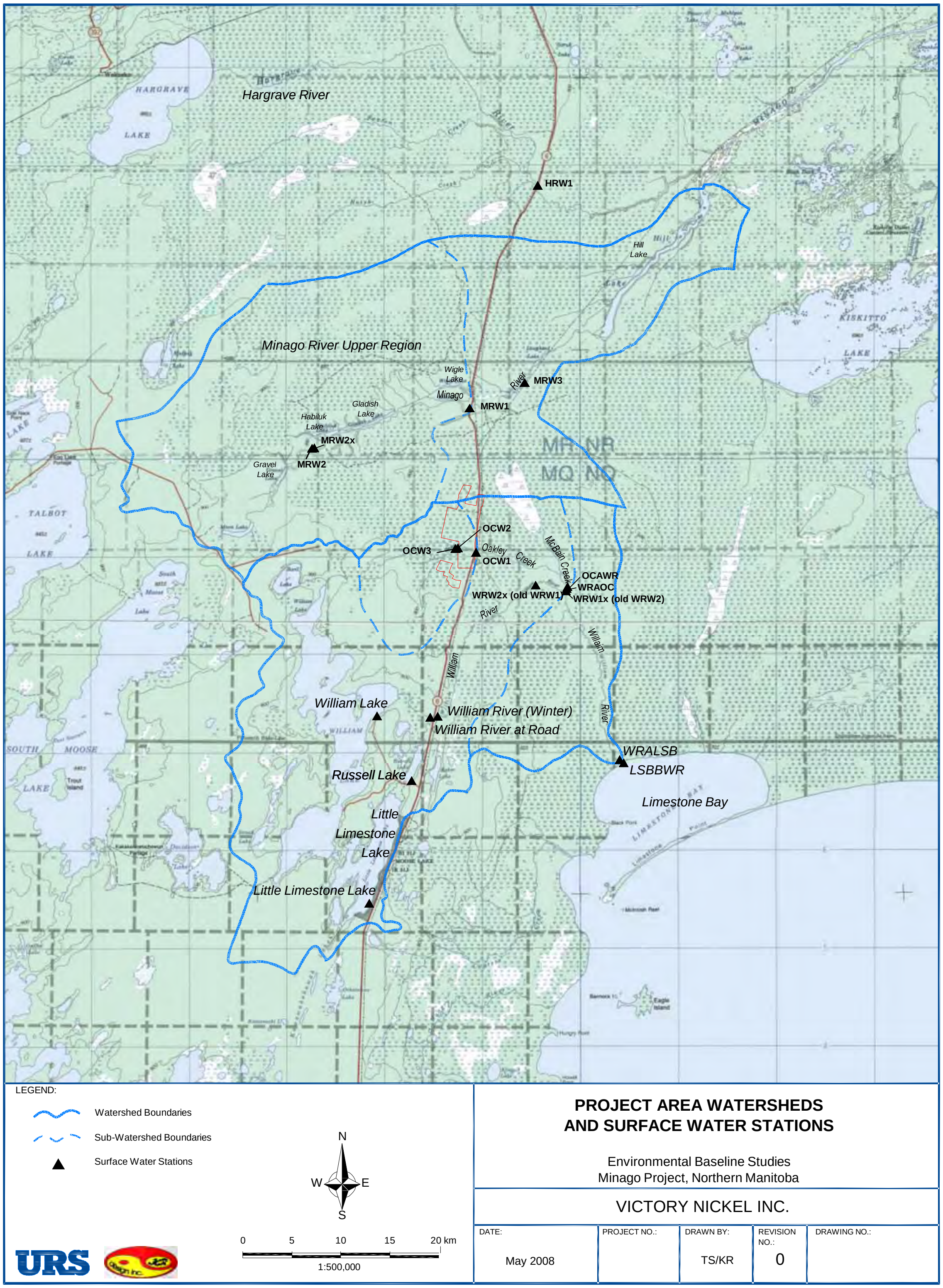


Figure 2.14-11 Minago Project – Site Watersheds

Table 2.14-25 Water Quality Monitoring Parameters and Detection Limits

Parameter		Detection limit (mg/L)	Analytical Method
Aluminum, total and dissolved	Al	0.001	ICP / ICP MS
Antimony, total and dissolved	Sb	0.00005	ICP / ICP MS
Arsenic, total and dissolved	As	0.00005	ICP / ICP MS
Barium, total and dissolved	Ba	0.00005	ICP / ICP MS
Beryllium, total and dissolved	Be	0.0005	ICP / ICP MS
Bismuth, total and dissolved	Bi	0.0005	ICP / ICP MS
Boron, total and dissolved	B	0.001	ICP / ICP MS
Cadmium, total and dissolved	Cd	0.00005 to 0.02	ICP / ICP MS
Calcium, total and dissolved	Ca	0.05	ICP / ICP MS
Chromium, total and dissolved	Cr	0.0001	ICP / ICP MS
Cobalt, total and dissolved	Co	0.0001	ICP / ICP MS
Copper, total and dissolved	Cu	0.0001	ICP / ICP MS
Iron, total and dissolved	Fe	0.01	ICP / ICP MS
Lead, total and dissolved	Pb	0.00005	ICP / ICP MS
Lithium, total and dissolved	Li	0.001	ICP / ICP MS
Magnesium, total and dissolved	Mg	0.05	ICP / ICP MS
Manganese, total and dissolved	Mn	0.00005	ICP / ICP MS
Mercury (total) , total and dissolved	Hg	0.00005	Cold Oxidation (CVAAS)
Molybdenum, total and dissolved	Mo	0.00005	ICP / ICP MS
Nickel, total and dissolved	Ni	0.0001	ICP / ICP MS
Phosphorus, total and dissolved	P	0.05	ICP / ICP MS
Potassium, total and dissolved	K	0.2	ICP / ICP MS
Selenium, total and dissolved	Se	0.0005	ICP / ICP MS
Silicon, total and dissolved	Si	0.05	ICP / ICP MS
Silver, total and dissolved	Ag	0.00001	ICP / ICP MS
Sodium, total and dissolved	Na	2	ICP / ICP MS
Strontium, total and dissolved	Sr	0.0001	ICP / ICP MS
Thallium, total and dissolved	Tl	0.00005	ICP / ICP MS

Table 2.14-25 (Cont.'d) Water Quality Monitoring Parameters and Detection Limits

Parameter	Detection limit (mg/L)		Analytical Method
Tin, total and dissolved	Sn	0.0001	ICP / ICP MS
Titanium, total and dissolved	Ti	0.01	ICP / ICP MS
Vanadium, total and dissolved	V	0.001	ICP / ICP MS
Zinc, total and dissolved	Zn	0.001	ICP / ICP MS
Total alkalinity	$CaCO_3$	1	Titration to pH=4.5
Ammonia	N	0.005	Colorimetry
Nitrate	N	0.005	Ion Exchange Chromatography
Nitrite	N	0.001	Colorimetry
Nitrite + nitrate	N	0.005	Ion Exchange Chromatography
Sulphate	SO_4	0.03	Ion Exchange Chromatography
Total dissolved solids		1 to 5	Filtration/Gravimetric
Total suspended solids		1 to 5	Filtration/Gravimetric
Turbidity		1.0 (NTU)	Nephelometric
Conductivity		1.0 (µS)	Conductivity cell
pH (RelU)		0.1 (RelU)	Potentiometric
Cyanide (total)	CN	0.005	Distillation/UV Detection
Fluoride	F	0.02	Colorimetry
Chloride	Cl	0.5	Colorimetry

Table 2.14-26 Sediment and Surface Water Monitoring Stations

VICTORY NICKEL Water Quality Monitoring Stations	Description	Monitoring Frequency – Water Quality: during Operational Phase	Water Quality: during Closure and Post Closure Phases	Flow: during Operational Phase	Flow: during Closure and Post Closure Phases	Duration: No. of Years	Applicable Regulations
HRW1	Hargrave River immediately west of Highway 6	M	Q	Q	Q	6	IP
MRW1	Minago River immediately west of Highway 6	M	Q	M	Q	6	IP
MRW2	Minago River near Habiluk Lake	SA	A	SA	A	6	IP
MRW2X	Minago River near Habiluk Lake (100 m downstream of MRW2)	Q	A	Q	A	6	IP
MRW3	Minago River downstream of Highway 6 near powerline cut	M	Q	M	Q	6	CCME / MB Tier II
OCW1	Oakley Creek immediately east of Highway 6	M	Q	M	Q	6	CCME / MB Tier II
OCW2	Oakley Creek immediately downstream of north tributary	M	A	M	A	6	IP
OCW3	Oakley Creek immediately upstream of north tributary	M	A	M	A	6	IP
WRW2X	William River approx. 6 km upstream of the Oakley Creek confluence	SA	A	SA	A	6	IP
WRW1X	William River approx. 100m downstream of the Oakley Creek confluence	M	A	M	A	6	IP
WRAOC	William River approx. 50 m upstream of the Oakley Creek	Q	Q	Q	Q	6	IP
OCAWR	Oakley Creek approx. 50 m above William River	Q	Q	Q	A	6	IP
WRALSB	William River approx. 100 m above Limestone Bay	Q	Q	Q	Q	3	IP
LSBBWR	Limestone Bay approx. 250 m below William River	Q	Q	Q	Q	1	IP
Little Limestone Lk	Little Limestone Lake (at end of road)	A	A	A	A	1	IP
Russell Lake	Russell Lake (at end of road)	A	A	A	A	1	IP
William River (Winter)	William River east of Highway 6	A	A	A	A	1	IP
William River at Road	William River east of Highway 6	A	Q	Q	Q	6	IP
William Lake	William Lake at end of access road	A	A	A	A	1	IP
Polishing Pond	Polishing Pond Outflow	M	M	M	Q	6	MMER

Note: A= Annually, Q= Quarterly, SA= Semi Annually; IP= Internal Programs; MMER= Metal Mines Effluent Regulation Monitoring Point (Polishing Point Outflow); CCME/MB Tier II Monitoring Station (OCW1 and MRW3).

2.15 Site Facilities and Infrastructure

The proposed project will be comprised of an open pit mine, an ore concentrating plant, a frac sand plant, and supporting infrastructure. The Ore Concentrating Plant will process 10,000 tonnes per day of ore through crushing, grinding, flotation, and gravity operations to produce nickel concentrate. The Frac Sand Plant will produce 1,500,000 t/a of various sand products including 20/40 and 40/70 frac sand, glass sand, and foundry sand products. The general site layout is illustrated in Figure 2.1-2.

The proposed infrastructure for the Project will include (adapted from Wardrop, 2009b):

- site haul and access roads and laydown areas;
- open pit (described in Section 2.9);
- Mill Process and Frac Sand Plant (described in Section 2.10);
- Crusher and Concentrator Facilities;
- a Tailings and Ultramafic Waste Rock Management Facility (TWRMF);
- waste rock and overburden disposal dumps;
- water and wastewater facilities, including an open pit dewatering system, site de-watering systems with associated pipelines and pumping stations, a sewage treatment system, a potable water treatment plant, a Polishing Pond and site infrastructure piping;
- a fuelling storage and dispensing facility for mobile equipment;
- equipment repair and maintenance facilities;
- miscellaneous service buildings including emergency services building, cold storage building, process and fresh water pump house, security guardhouse and scale house;
- an explosives storage;
- electrical power supply, transformation and distribution;
- modular facilities, including mine site staff dormitories, wash/laundry facilities, staff kitchen/cafeteria, mine dry, a modular office complex and a recreational facility;
- storm water management systems;
- life safety and security systems;
- data and communication systems; and
- other refuse disposal.

The modular camp, which is designed to accommodate 300 people, will form the basis of the accommodation for the construction workforce.

All infrastructure facilities will be located at least 300 m from Highway 6, to provide a visual tree-line barrier from traffic to the Minago operation. Only the guard house and scale house will initially be visible from Highway 6. Since the tailings dam will be of limited height and will be set back from the road, the tree lined barrier will limit visibility (Wardrop, 2009b).

The major infrastructure facilities such as the mill, crushing facility and truck garage will be located in the northwest corner of the site where the overburden thickness is minimal. This area has the highest site elevation therefore eliminates concerns on site drainage and flooding (Wardrop, 2009b).

The minimum distance requirements to separate the explosive plant operations from other operations and the necessary minimum clearances to the 230 kV and other electrical lines have been taken into account in the site layout.

2.15.1 Site Roads

Site roads will be located throughout the site to provide access to all operational areas of the mine (Wardrop, 2009b). Roads will vary in width and general cross section depending on the location, staging and ultimate use of the roadway. Initial road widths of 6 m, 8 m, 12 m, 20 m and 30 m will be used throughout the mine site and will be constructed so that the finished roadway surface is a minimum 0.8 m – 1.0 m above the surrounding ground elevation.

Haul roads will facilitate movement of the 218 tonne trucks with the required clearances. The roads carrying highway truck traffic for incoming supplies and materials and outgoing ore concentrate will be designed to accommodate a Super B-Train loading (GVW 62,500kg) and roads carrying mining ore will accommodate GVW 324,000kg haul trucks (Wardrop, 2009b).

A number of the roads will have elevated berm sections to accommodate utilities/pipelines. The elevated berms will prevent vehicles from wandering across the roadway and into the utilities themselves.

Parking areas will be illuminated and equipped with electrical plugs where necessary.

The intersection of the mine site access road with Highway 6 will require improvements to accommodate turning and slow moving truck traffic entering and exiting the site. The improvements will include pavement widening to create auxiliary acceleration/deceleration lanes.

2.15.2 Crushing and Concentrator Facilities

A crusher building was designed with a footprint of 19 m x 12 m. The crusher will be 51 m high and has a truck dumping area on one side of the building at a relative height of 30 m. The crusher will be contained in a fully enclosed building and has been designed to accommodate a

45 tonne bridge crane. The crusher foundation has been designed as a thick slab, assumed to be sitting on or near the bedrock layer.

The concentrator building is designed as a main building (27 m wide x 150 m long x 29 m high). This main area will house a ball mill, sag mill, pebble crusher, conditioner, and flotation units. Four separate lean-to buildings are also included in the design of the concentrator. The first lean-to building will be 9 m wide x 22.5 m long x 9.5 m high and houses the switch rooms and motor control centers (MCCs). The second lean-to building will be a 5.5 m wide x 4.5 m long x 2.44 m high and is designed as an unloading area. The third lean-to building will be 16 m wide x 60 m long x 23 m high and houses the reagent area. The final lean-to building associated with the concentrator will be 14 m wide x 90 m long x 26 m high and houses the stock tank, concentrate thickener, and a storage area.

2.15.3 Tailings and Ultramafic Waste Rock Management Facility

The Tailings and Ultramafic Waste Rock Management Facility (TWRMF) will be a key component of the water and waste management system at Minago for liquid waste, nickel mill and Frac Sand Plant tailings, und ultramafic waste rock. Mine waste contained in the TWRMF will be stored subaqueously.

Submerging mine waste containing sulphide minerals, or “subaqueous disposal”, is practiced at many metal mines to keep oxidative rates at a minimum and to minimize metal leaching. Based on geochemical work done to date, Minago’s nickel tailings will contain low sulphide levels and were deemed to not become acid generating (URS, 2008a). Sulphide levels were less than or equal to 0.07 % in the Master tailings samples tested. However, Minago’s ultramafic waste rock is potentially acid generating (URS, 2009i).

The TWRMF will receive water from the mill tailings thickener, sewage treatment plant, waste frac sand and the underflow from the frac sand clarifier. Typical tailings water inputs include 503 m^3/h from the process plant and 118 m^3/h from the waste receiving pump box. The waste receiving pump box will contain 100.4 m^3/h of waste frac sand, 12.4 m^3/h of underflow from the frac sand clarifier and 5 m^3/h from the sewage treatment plant (Wardrop, 2009b).

The following design considerations were taken into account for the TWRMF (Wardrop, 2009b):

- Ultramafic waste will be co-deposited with tailings in the TWRMF. This will contain all contaminants into a single area without contaminating other areas. The containment structure (21 m high) will be built initially followed by the construction of a perimeter ramp inside the TWRMF area. This will allow for co-depositing of tailings and ultramafic waste. The tailings will be deposited onto the ultramafic waste to fill in voids within the rock.
- To support the Tailings and Ultramafic Waste Rock Management Facility (TWRMF), a ring main pipe, a floating barge pumping station, and three perimeter ditch pumping stations will be provided. A ring main pipe with spigots will be located along the entire perimeter ramp and placement of tailings will be accomplished by opening and closing of

valves along a ring main pipe to eliminate accumulations of solids in a particular area and allow for uniform discharge.

- The tailings deposition will create a decant pond sized for not less than five days of retention time. A minimum water depth of 1.5 m will be maintained in the pond at all times.
- Decant water from the tailings pond will be pumped to the Polishing Pond and flood retention area for subsequent water recycling or discharge to the receiving environment.
- Seepage ditches around the perimeter of the TWRMF will collect the seepage and runoff and transfer the water back into the facility.
- The TWRMF site will be located in permanently-flooded terrain. The construction of the TWRMF dam will be preceded by construction of roads surrounding the site.
- The pond in the TWRMF will be operated under average precipitation conditions, but with the barge pumps capable of pumping a 1-in-20 year, 5 day major rainfall event. The maximum discharge rate will be based on the expected requirements for a major rainfall event over a two week period. The nominal discharge rate will be increased and decant water will be pumped over a two week period during such an event.
- The TWRMF will provide adequate volume for containment of tailings, ultramafic waste and supernatant water. Ice formation over the tailings due to discharge in subfreezing temperatures during winter operations is envisaged, and contingency storage capacity has been provided in the design.

Seepage from the TWRMF will be collected in a perimeter ditch and pumped back into the facility by three 15 hp submersible pumps. Three pumping stations will be located along the low-elevation east-side ditch area. The tailings water from the TWRMF pond will be pumped to the Polishing Pond and flood retention area by three 60 hp vertical turbine pumps, each capable of pumping 530 m^3/h. These pumps will be mounted on a floating barge pump station (Wardrop, 2009b).

2.15.4 Waste Rock and Overburden Disposal Dumps

Ultramafic waste rock will be co-disposed with tailings in the Tailings and Ultramafic Waste Rock Management Facilty (TWRMF). Non-reactive dolomite and country waste rock will be hauled to the designated dump areas. No water quality problems are anticipated from these dump areas since the rock is non-reactive and will not contain contaminants. The majority of the runoff will discharge directly to the environment while a minimal amount of rainfall will runoff to the roadway ditches and eventually to the overburden settling pond. There are no anticipated problems with TSS during a major event due to the nature of coarse waste rock (Wardrop, 2009b).

The overburden dump area will be surrounded by a containment berm. Weirs will allow for discharge of water to a settling pond. Due to restraints on total suspended solids (TSS), the settling pond will be used for settlement prior to discharge to the Oakley Creek watershed. Flocculent addition may be required to meet water quality standards. Placement of material in the overburden dump will be complete within the first two years of construction and re-vegetation of the surface will occur immediately after completion (Wardrop, 2009b).

During a 1-in-20 year, 5-day major rainfall event, the overburden settling ponds will be used for settlement and storage with the presence of an overflow line to discharge benign rainfall. Once the vegetation is established, it is anticipated that the runoff will be benign and will meet TSS water quality standards. The areal boundaries of the Overburden Disposal Facility dump will contain a permeable dyke/road, which will contain a filter cloth and sand bed to filter the water through the roadway. Due to the benign nature of the runoff, water will be discharged to the environment instead of the flood retention area (Wardrop, 2009b).

2.15.5 Water and Wastewater Facilities

The water and wastewater management components at Minago will include:

- dewatering wells to dewater the open pit area;
- a water treatment plant to produce potable water;
- a sewage treatment facility for on-site grey water and sewage;
- mill and Frac Sand Plant tailings and effluents that will be discharged into a Tailings and Ultramafic Waste Rock Management Facility (TWRMF);
- a Tailings and Ultramafic Waste Rock Management Facility (TWRMF) that will store tailings and ultramafic waste rock permanently and effluents from various site operations temporarily;
- waste rock dump seepages that will be discharged into the TWRMF or the receiving environment depending on their water quality;
- overburden dump runoff that will be discharged directly into the receiving environment (if it meets discharge requirements);
- an open pit dewatering system that will ensure safe working conditions in and around the open pit;
- a Polishing Pond and flood retention area to serve as holding pond for water that will either be recycled to site operations or discharged to the receiving environment (if it meets discharge water standards);
- a site drainage system to prevent flooding of site operations;
- site wide water management pumping systems; and
- discharge pipelines to Minago River and Oakley Creek to discharge excess water from the Polishing Pond / flood retention area and the country rock, dolomite rock, and overburden dumps to the receiving environment.

Due to the complexity of the water and wastewater management system, its components, flow volumes, seasonality and elemental concentrations are presented and discussed in a separate subsection (Section 2.14). However, the proposed sewage treatment, potable water treatment, site infrastructure piping and dewatering facilities are also outlined below.

2.15.5.1 Sewage Treatment Plant

The domestic sewage generated on the site will be collected by sanitary sewers and conveyed to an extended aeration mechanical sewage treatment plant. The sewage treatment plant will use an extended aeration system, supplied by Canwest Tanks and Ecological Systems Ltd. or equivalent (Wardrop, 2009b).

The proposed plant meets Manitoba Conservation requirements, and will meet 25/25 mg/L Five-day Biochemical Oxygen Demand (BOD_5) and Total Suspended Solids (TSS) targets. The plant design incorporates nitrification to reduce ammonia concentrations in the effluent to within Manitoba Conservation's winter and summer restrictions. Nitrogen or phosphorous removal is not expected to be required, since the discharge will flow into the catchment area of Lake Winnipeg (Wardrop, 2009b).

The sewage treatment plant will be located east of the maintenance building to allow all sewage to flow by gravity to the plant. A separate sewage pumping station with a fibreglass tank will be located at the modular complex facility to pump the raw sewage from the complex building to the sewage treatment plant.

The treatment plant will accommodate 450 people at 230 L/capita/day plus 10% for the water treatment plant backwash. The average daily flow will be 113,800 L/day (Wardrop, 2009b). The per capita BOD_5 contribution will be 0.091kg/capita/day. The daily BOD_5 loading will be 40.9 kg BOD_5/day (Wardrop, 2009b).

The tanks, which will be buried, will be constructed with fibreglass materials that meet CSA BL66 standards. The effluent will be disinfected using ultraviolet (UV) radiation (Wardrop, 2009b).

The treated effluent will be discharged to the waste receiving pump box, and then discharged to the TWRMF. The treatment plant will include an on-line lockable refrigerated composite sampler that will available to Manitoba Conservation for independent effluent sampling. Treated effluent sampling and analyses will be perforemd on a monthly basis to detect BOD_5, ammonia, TSS, and fecal coliforms (Wardrop, 2009b).

A grease trap will be installed at the discharge from the camp kitchen prior to the connection with the sewer system (Wardrop, 2009b).

The domestic wastewater sludge storage tank will be periodically de-sludged using three submersible pumps installed in the sludge storage tank. The sludge will be pumped into a tanker truck and hauled to the lagoon at Grand Rapids for disposal. The estimated sludge production is 0.15 to 0.23 m^3/h (Wardrop, 2009b).

An insulated pre-fabricated building will house the blowers, control panel, the lockable, refrigerated composite sampler and similar equipment. The building will be skid-mounted and installed on a crushed stone base. There will be no special electrical code requirements since none of the electrical equipment will be exposed to sewage or sludge (Wardrop, 2009b).

2.15.5.2 Potable Water Treatment Plant

The potable water supply will be drawn from the fresh/fire water storage tank and the ground water wells. Potable water will be used for the safety shower/eye wash stations, personal consumption, washrooms, canteen and dry. Potable water will not be used for fire water, process water or general plant distribution. Potable water will be pumped to the modular complex and the maintenance building, primary crusher building, crushed ore delivery tunnel, security building, and frac sand plant (Wardrop, 2009b).

Since raw water will be supplied from a confined aquifer, it is not considered Groundwater Under Direct Influence of Surface Water (GUDI). Accordingly, no special preventitive precautions will be needed for giardia, cryptosporidium or similar parasites (Wardrop, 2009b).

Potable water treatment will consist of a bank of manganese greensand pressure filters to remove iron and manganese to less than 0.05 mg/L and 0.3 mg/L, respectively. These aesthetic limits are recommended by Manitoba Conservation as well as Health Canada's Canadian Guidelines for Drinking Water Quality. The filtration rate will be 6.1 m^3/hr per m^2 (Wardrop, 2009b).

Post-chlorination treatment will be performed by sodium hypochlorate (bleach) with an inline residual chlorine analyser. If the chlorine residual exceeds the range of the high and low level set points, an alarm will alert the operator to review the problem and adjust the chlorine levels appropriately (Wardrop, 2009b).

The treatment plant will include enough treated water storage to accommodate an average day's consumption, expected to be 4.3 m^3/hr; peak demand flows are expected to reach up to 17.3 m^3/hr. The treatment plant will be located west of the modular complex building since the complex building requires the greatest amount of potable water (Wardrop, 2009b).

2.15.5.3 Site Infrastructure Piping

Water supply pipes and sewers will be High Density Polyethylene (HDPE) and will be buried on a benched part of the roadways to prevent freezing. In high density peat areas, concrete pipe weights may be required to secure the pipes and prevent flotation (Wardrop, 2009b).

The domestic sewers will be 50 to 200 mm diameter low pressure force mains in some areas. Gravity sewers will be utilized in areas with suitable ground conditions (Wardrop, 2009b).

2.15.5.4 Dewatering Facilties

Open pit dewatering will be accomplished by perimeter groundwater pumps as well as open-pit centrifugal and submersible pumps to properly dewater the pit (Wardrop, 2009b).

The groundwater pumps will consist of twelve 75 hp Grundfos groundwater pumps which will discharge approximately 35,000 m^3/d directly into the retention area while approximately 5,000 m^3/d will be diverted to the fresh water tank (Wardrop, 2009b).

The open-pit will be de-watered by the use of 11 centrifugal pumps and 6 submersible pumps. The dewatering pumps were sized to accommodate a 1-in-20 year, 5-day major rainfall event, and to eliminate down times within the pit due to flooding and will allow for the pit to be dewatered more rapidly. Pumping stations will be located on designated levels throughout the pit to optimize head loss and pipe lengths. The open pit dewatering will be performed by three separate pumping loops in series and will discharge to the Polishing Pond and flood retention area (Wardrop, 2009b).

2.15.6 Fuelling Storage and Dispensing Facility

A fuel storage facility will be centrally located within the industrial area. The diesel fuel storage capacity for the mining operation will be 380,000 L, which includes the fuel requirements for explosives (Wardrop, 2009b). The fueling system will consist of four 95,000 L above-ground double-walled diesel fuel tanks, a diesel fuel pumphouse, and a receiving station.

The fuel storage facility will be self-contained to ensure that inadvertent spills do not end up into the receiving environment. The facility will be equipped with a spill kit and will be inspected on a regular basis. Fuel will be supplied by a third party.

Bulk quantities of petroleum hydrocarbons will be stored and handled in accordance with Manitoba Regulation 188/2001 and any subsequent amendments.

Standard vehicles will be serviced using a dual-fuel dispensing unit and one 4,500 L double-walled diesel fuel tank and one 4,500 L double-walled gasoline tank (Wardrop, 2009b).

2.15.7 Miscellaneous Service Buildings

Miscellaneous service buildings will include an emergency services building, a process and fresh water pump house, a cold storage building, equipment repair and maintenance facilities, a fire protection water pump house, and a security guardhouse and scale house.

The emergency vehicle garage will be a pre-engineered building with an area of approximately 240 m^2. The garage will house an ambulance and a fire truck and will have one small office and storage space for emergency equipment (Wardrop, 2009b).

The process and freshwater pumphouse will be two pre-engineered buildings side by side with a combined area of approximately 170 m^2. The pumphouse complex will be located east of the ore processing facility. A monorail will be installed above each pump system to facilitate maintenance.

A 950 m^2 cold storage warehouse will be located south of the general maintenance building.

The general maintenance building will include (Wardrop, 2009b):

- seven heavy vehicle repair bays including four drive-through bays;
- a light vehicle repair bay, a tire bay, a welding bay, and a wash bay;
- a lube storage facility;
- a machine/hydraulic shop, a fabrication/welding shop, an electrical shop, and an instrumentation shop;
- a 1,290 m^2 storage warehouse;
- five offices, a lunch room and washroom facilities; and
- an upper level mezzanine with mechanical and compressor rooms.

A fire protection water pump house will be located directly beside the fresh water tank. In the event of a fire, the fire water pumps will discharge water from the fresh water tank to the appropriate area. Fire protection will be required at the modular complex building, frac sand plant, mill, maintenance building, fueling area, and primary crusher building.

The security guardhouse and scale house will be located at the entrance to the site, near Highway 6. The guardhouse and scale house will be a single-storey 3.6 m x 6 m modular trailer complete with a washroom facility (Wardrop, 2009b).

2.15.8 Explosive Storage

All explosives will be handled, transported and disposed of in compliance with the Explosive Act.

2.15.9 Power Supply

The primary source of electrical power will be the Manitoba Hydro 230 kV line along the east side of Highway 6. From the connection at Highway 6, a 6-km, 230 kV power transmission line will feed the main substation located to the west of the process plant in the northwest corner of the site. The connection from the Manitoba Hydro 230 kV line will be provided with gas-filled isolation switches (Wardrop, 2009b).

The main substation will consist of two main transformers rated at 50 MVA each capable of supplying the full load. The transformers will transform the power down from 230 kV to 13.8 kV to the main 13.8 kV switch room via metal clad switchgear (Wardrop, 2009b).

The electrical system will be sized and configured for full redundancy, allowing the transformers to operate in parallel or individually while maintaining full production. Each transformer will be able to accommodate the full operational loads in the event of a failure of the other. The main sub-station will be protected by a secure chain link fence surrounding a crushed stone bed for easy maintenance and to ensure effective drainage (Wardrop, 2009b).

Power from the main switchgear room will be distributed at 13.8 kV via overhead line to the various distribution centres around the site. Outdoor oil filled transformers will transform the primary 13.8 kV to 6,600 V, 4160 V and 600 V as required (Wardrop, 2009b).

2.15.9.1 Emergency Power

Two diesel generator sets rated at 1.5 MW, 13.8 kV with associated switchgear will be housed in a dedicated building located near the main electrical substation (Wardrop, 2009b). The system will be designed to provide power during the construction phase and emergency power during the operations phase for life sustaining and critical process equipment. The emergency power system will feed the entire plant grid with operators isolating non emergency switchgears to direct the standby power to the critical services. Most importantly, the emergency power would provide essential power to feed the dewatering pumps during a utility power failure. Diesel generators will provide redundancy as the 230 kV primary power feed from the main 230 kV Manitoba Hydro AC Line (Wardrop, 2009b).

2.15.9.2 Estimated Load

The peak connected load is estimated to be 42.4 MW (50 MVA), based upon the power requirements of operations and auxiliary equipment on the site and an average power factor of 0.85. The estimated operating load for the five cost centres including future growth is 30.0 MVA (Wardrop, 2009b).

2.15.10 Modular Building Complex including Accommodation

The following buildings will be part of the modular building complex (Wardrop, 2009b):

- mine site staff dormitories;
- mine staff kitchen/cafeteria;
- mine dry including male and female facilities and shift change rooms;

- mine office complex, and
- recreational facilities.

All modular facilities will have wheelchair access and will be connected with an enclosed walkway. The buildings will be designed for use in a heavy-duty industrial environment, with an expected life of approximately 20 years (Wardrop, 2009b).

The mine site staff dormitories will be sized to accommodate 300 personnel, including the construction crew. The dormitory complex will consist of 120 double sleeper units, 60 single sleeper units and 6 executive suites (Wardrop, 2009b).

The project will employ 422 staff members; however, workers will rotate on a 12-hour shift schedule, and each shift worker will vacate the site once for every 2-week shift period. In addition, some daytime workers that commute from Grand Rapids will not require accomodations. Accordingly, it is not necessary for the dormatories to accommodate all 422 workers.

The kitchen/cafeteria will be sized for 200 personnel and will house food storage and food preparation areas, the kitchen and cafeteria and a kitchen staff office. The kitchen/cafeteria area will be approximately 883 m^2 (9500 ft^2 (50’ W x 190’ L)).

The mine dry will accommodate 306 lockers (102 per mudroom area) with two male and one female facility.

The office complex will accommodate up to 60 personnel. The office complex will be approximately 790 m^2 (8,500 ft^2 (50’ W x 170’ L)) and will form part of the modular dormitory building. The office complex will be accessible from the exterior and interior of the building complex (Wardrop, 2009b).

2.15.11 Storm Water Management

The site storm water management at the Minago Project is designed to accommodate a 1-in-20 year storm event over a 5-day period (120 mm) (Wardrop, 2009b).

Site rainfall will be pumped to the Polishing Pond and retention area, contained in designated area settling ponds, or discharged to the local watershed via runoff. Rainfall onto the plant area, Overburden Disposal Facility, dolomite dump and country rock dump will be benign and is not expected to require treatment. Settling ponds will nonetheless be built to control major events in the Overburden Disposal Facility areas. Seepage from the Tailings and Ultramafic Waste Rock Management Facility (TWRMF) will be collected in a perimeter ditch around the exterior of the facility and will be pumped over the dyke back into it. A Polishing Pond and flood retention area will contain the storm water from the TWRMF, mine dewatering and site runoff. This water will be pumped to the Minago River watershed, and a portion will be diverted back to the process water tank (Wardrop, 2009b).

2.15.11.1 Ultramafic Waste Rock Dump

The ultramafic waste rock will be deposited directly into the TWRMF, limiting the potential contamination to a single area. The TWRMF is designed to accommodate a 1-in-20 year, 5-day major rainfall event. The nominal discharge from this area will be increased and pumped over a two week period during such an event (Wardrop, 2009b).

2.15.11.2 Overburden Disposal Facility

The Overburden Disposal Facility dump area will be surrounded by a containment berm. Weirs will allow water to discharge to the settlings pond, which will be used for storage of excess water and precipitation. Due to restraints on TSS, settling ponds will be used for settlement prior to discharging to the Oakley creek watershed. Flocculent addition may be required to meet water quality standards. Placement of material in the Overburden Disposal Facility will be complete within the first two years of construction and vegetation of the surface will commence immediately after completion (Wardrop, 2009b).

During a 1-in-20 year, 5-day major rainfall event, the settling ponds will be used for settlement and storage with the presence of an overflow line to discharge benign rainfall. Once the vegetation is established, it is anticipated that the rainfall will be benign and will meet TSS water quality standards. The area boundaries of the Overburden Disposal Facility dump will contain a permeable dyke/road which will contain a filter cloth and sand bed to filter water through the roadway. Due to the benign nature of the runoff, water will be discharged to the environment instead of the flood retention area (Wardrop, 2009b).

2.15.11.3 Plant Area

The plant area runoff including the frac sand plant and sand storage pile will be clean water and will be discharged directly to the environment. Since the plant area is located in the northwest corner of the site, benign rainfall will runoff through the roadway ditches to the Overburden Disposal Facility settling pond as well as runoff to the Oakley Creek watershed (Wardrop, 2009b).

2.15.11.4 Dolomite and Country Rock Dumps

The non-reactive dolomite and country rock will be hauled to designated dump areas (Figure 2.15.1). The majority of the runoff will discharge directly to the environment, while a minimal amount will runoff to the roadway ditches and eventually to the Overburden Disposal Facility settling pond. There are no anticipated problems with TSS during a major event due to the nature of coarse waste rock (Wardrop, 2009b).

2.15.11.5 Polishing Pond and Flood Retention Area

During a 1-in-20 year, 5-day major rainfall event (120 mm), the Polishing Pond and flood retention area will acquire approximately 550,000 m^3 of water over a surface area of 750,000 m^2, which will produce an average depth of approximately 0.75 m throughout the settling area. The roads surrounding the Polishing Pond and flood retention area will have a minimum height of 1 m (0.75 m depth and 0.25 m freeboard). This height will allow for sufficient water storage capacity for the effects of rainfall on the open pit and TWRMF during a major event (Wardrop, 2009b).

The majority of the site water accumulated in the Polishing Pond and flood retention area will be pumped to the Minago River watershed while 12,000 m^3/d will be diverted to the process water tank as reclaim water. Due to the high head and flow capacities, three 600 hp vertical turbine pumps will be used to generate the flow through an 800 mm (32") HDPE pipe to the Minago River watershed. In the summer months, the water will be discharged to the Minago River watershed by a distribution manifold, while in winter months the pipe outlet will discharge directly to an open ditch after the distribution manifold (Wardrop, 2009b).

2.15.12 Life Safety and Security Systems

The fire alarm and detection systems will be analog addressable systems from a single manufacturer with proven and reliable technology. The system will integrate all detection and annunciation devices with main annunciation panel located at the security station. The security system will employ proven and reliable technology to integrate door alarms and motion sensors for key areas into a central system monitored at the security station. The system will also provide monitored card access for offices, IT rooms and other secure areas (Wardrop, 2009b).

2.15.13 Data and Communication Systems

The telecommunications design will incorporate proven, reliable and state-of-the-art systems to ensure that personnel at the mine will have adequate data, voice and other communications channels available. The telecommunications system will be procured as a design-build package with the base system installed during the construction period then expanded to encompass the operating plant (Wardrop, 2009b).

The requirements for communications, particularly satellite bandwidth, are a function of the voice and data requirements of the active participants in the project. The expectation is that the need for satellite bandwidth will build to a peak during the plant construction phase, and then taper off slightly as the initial construction crew yields to plant operations (Wardrop, 2009b).

Closed Circuit TV (CCTV) cameras will be installed at various locations throughout the plant, including the primary crushing facility, the stockpile conveyor discharge point, the stockpile reclaim tunnel, the SAG and pebble crushing area, and the concentrate handling building. The cameras will be monitored from the plant control rooms (Wardrop, 2009b).

2.15.13.1 Site Wide Radio Communications System

The site radio communication system will operate in simplex and duplex modes. In simplex mode, only one user may communicate at a time. The system will also be capable of transmitting and receiving both voice and data. Site wide communications system will be comprised of the following (Wardrop, 2009b):

- fixed radios/repeaters,
- portable radios, and
- frequency assignment/approvals.

2.15.13.2 Site Wide Fibre Communications System

The site fibre communication system will be capable of operating in single and multimode depending on the length of fibre run. The fibre trunk will act as the main route of communication for the process LAN, business LAN, VoIP communication, and possibly security communication. The fibre trunk will connect all areas to the process mill and office complex (Wardrop, 2009b).

2.16 Transportation

2.16.1 Existing Access and Roads

The Minago Property is located directly adjacent to Manitoba Provincial Highway 6, a major north-south highway transportation route. The major transportation hubs closest to the Minago site are Winnipeg and Churchill, Manitoba (Figure 2.16-1). To date, the site has only been accessed via a winter road in the winter and by Argo or helicopter in the summer.

The Property may be served by the Hudson Bay Railway Company (HBR), with rail lines accessible from Ponton, MB, approximately 65 km north of the mine site.

Due to the Property's proximity to Provincial Highway 6, Wardrop assumed that all inbound freight for equipment and construction services will arrive by highway transportation. Operational inbound freight was also assumed to arrive via road transport.

2.16.2 Proposed Mine Access Road

The road network to be constructed on the Minago Property will be located in the VNI Mineral Lease Parcel.

In the proposed site layout, illustrated in Figure 2.1-2, roads will be located throughout the site to provide access to all operational areas of the mine. Roads will vary in width and general cross section depending on the location, staging and ultimate use of the roadway. Initial road widths of 6 m, 8 m, 12 m, 20 m and 30 m will be used throughout the mine site and will be constructed so that the finished roadway surface is a minimum 0.8 m – 1.0 m above the surrounding ground elevation (Wardrop, 2009b). Haul roads will facilitate movement of the 218 tonne trucks with the required clearances. The roads carrying highway truck traffic for incoming supplies and materials and outgoing ore concentrate will be designed to accommodate Super B-Train loading (GVW 62,500kg) and roads carrying mining ore will accommodate GVW 324,000kg haul trucks (Wardrop, 2009b).

All roads inpit and around the waste rock dumps and tailings storage facility will be 30 metres in width. The 30 metre roads will allow the trafficking of the 218 tonne trucks. In-pit ramps are designed with an overall width of 30 m. The designed width includes an outside berm at 3.0 m wide and 1.8 m high; ditches at 2.5 m for two-lane traffic to accommodate a 218 tonne haul trucks. All of these 30 m roads will be decommissioned at the end of the mining operations.

The 8 m wide service road network will be for light equipment and not for ore trucks. These service roads include a 10 km road along the discharge pipeline to the Minago River and roads in and around the overburden storage area. All of the service roads will be decommissioned, except for the main access road into the center of the site.

All other 6-20 m wide service roads will be decommissioned, once these roads are not needed anymore.

Source: Wardrop, 2009b

Figure 2.16-1 Minago Shipping Routes

2.16.3 Concentrate Haulage Route

The saleable products of the Minago Mine will include nickel concentrate, two types of fracturing sand, and a flux sand product. It is anticipated that approximately 49,500 t/a of 22.3% nickel concentrate on an average year before transportation losses and 900,000 t/a of Frac Sand Plant products will be marketed annually.

Nickel concentrate may either be hauled by truck to Thompson, MB for smelting or the proposed Railway Siding along the Omnitrax Canada railway line near Ponton, MB or be trucked to Winnipeg for further transport to a suitable smelter for processing (Figure 2.16-2). Wardrop determined that shipping the concentrate by typical highway-type tractor trailer for 223 km (one way) to the smelter in Thompson, MB, is likely the most viable option (Wardrop, 2009b).

A separate study, entitled "Transportation Analysis for the Minago Sand Project" (Wardrop, 2008b), was completed for frac sand products to examine potential methods of bulk transportation from the Minago operation, such as railroad and highway-type haul trucks. It was assumed that the sand products produced at the Minago operation will either be trucked from the mine site directly to buyers, or trucked to a rail siding located at Ponton, MB, where it will be loaded into rail cars for onward shipment (Figure 2.16-2). This siding would be serviced by HBR, which has a working relationship with CN Rail. Alternatively, the sand may be trucked into Winnipeg where both CN Rail and CP Rail lines can be accessed. The Company will not own the facility at Ponton. OmniTrax will own the loadout facility.

2.16.4 Decommissioning Plans

Once the traffic around the site areas is reduced to a point where vehicle access is no longer required, most roads will be decommissioned. However, main access roads to the TWRMF and waste rock storage areas will only be partially decommissioned to permit vehicle access in case of emergency. Partial decommissioning will consist of narrowing the road width to 8 m, but leaving existing culverts in place. Regular decommissioning will consist of removing culverts and replacing them with cross-ditches and swales, ripping and scarifying road surfaces and revegetating them with the Minago custom revegetation mixture.

Access will remain for ATVs or similar transport for monitoring and inspections and with minimal effort vehicle access could be re-established.

Once the railway sidings will no longer be required, it will be decommissioned unless someone wants to take the facility over for further use. The two railside buildings will be removed with the exception of concrete foundations. Concrete foundations will be broken up to ground level and removed from the site. The dismantled materials will be sold to vendors as prevailing market conditions permit and remaining debris will be disposed of in an appropriate manner. Any diesel power gensets will be decommissioned and sold to vendors. Power distribution lines will be

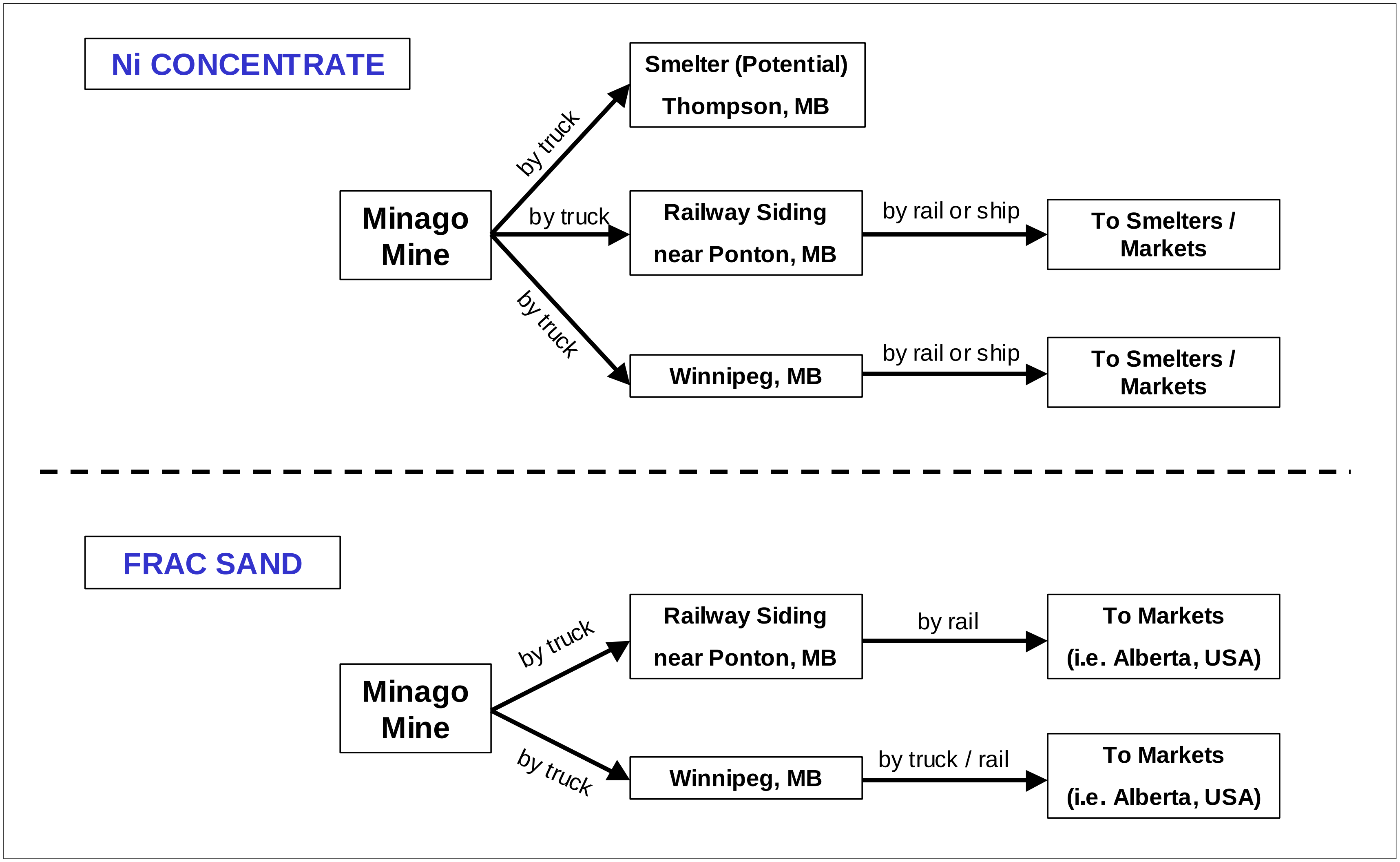


Figure 2.16-2 Concentrate and Frac Sand Haulage Routes

removed from the site and salvaged if possible. The disturbed areas will then be reclaimed using the Minago's revegetation shrubs.

2.16.5 Workforce Logistics

The Minago operation will be staffed by workers on a rotating 14-day basis. The majority of the operational workforce will be comprised of residents from surrounding local communities. Victory Nickel may provide bus service to and from the mine site through a contracted local bus company.

2.16.6 Environmental Impact

There will be no significant increase in environmental impact from these transportation decisions because current and well-established transportation routes and practices already exist on the Provincial Highway 6 corridor.