4.1.4 Hydrology

This section describes the existing hydrological conditions at the James and Redmond properties. Relevant details are summarized in the subsections below with additional details, including field work and hydrological assessment details, presented in Appendix J. The impacts to the existing hydrological regime by the proposed Project, as described in Chapter 3, are presented in Chapter 7.

In general, the drainage systems in the study area are strongly influenced by the underlying geology. Streams and lakes tend to be oriented northwest/southeast to match the strike of the bedrock units. Watershed boundaries are generally quite clearly defined by exposed bedrock ridges that run in a northwest/southeast direction.

4.1.4.1 James Property

The James Property is located at the base of an eastern slope of a prominent northwest/southeast trending bedrock ridge. Bean Lake is located to the east and is the closest lake to the James Property (Figure 4.7).

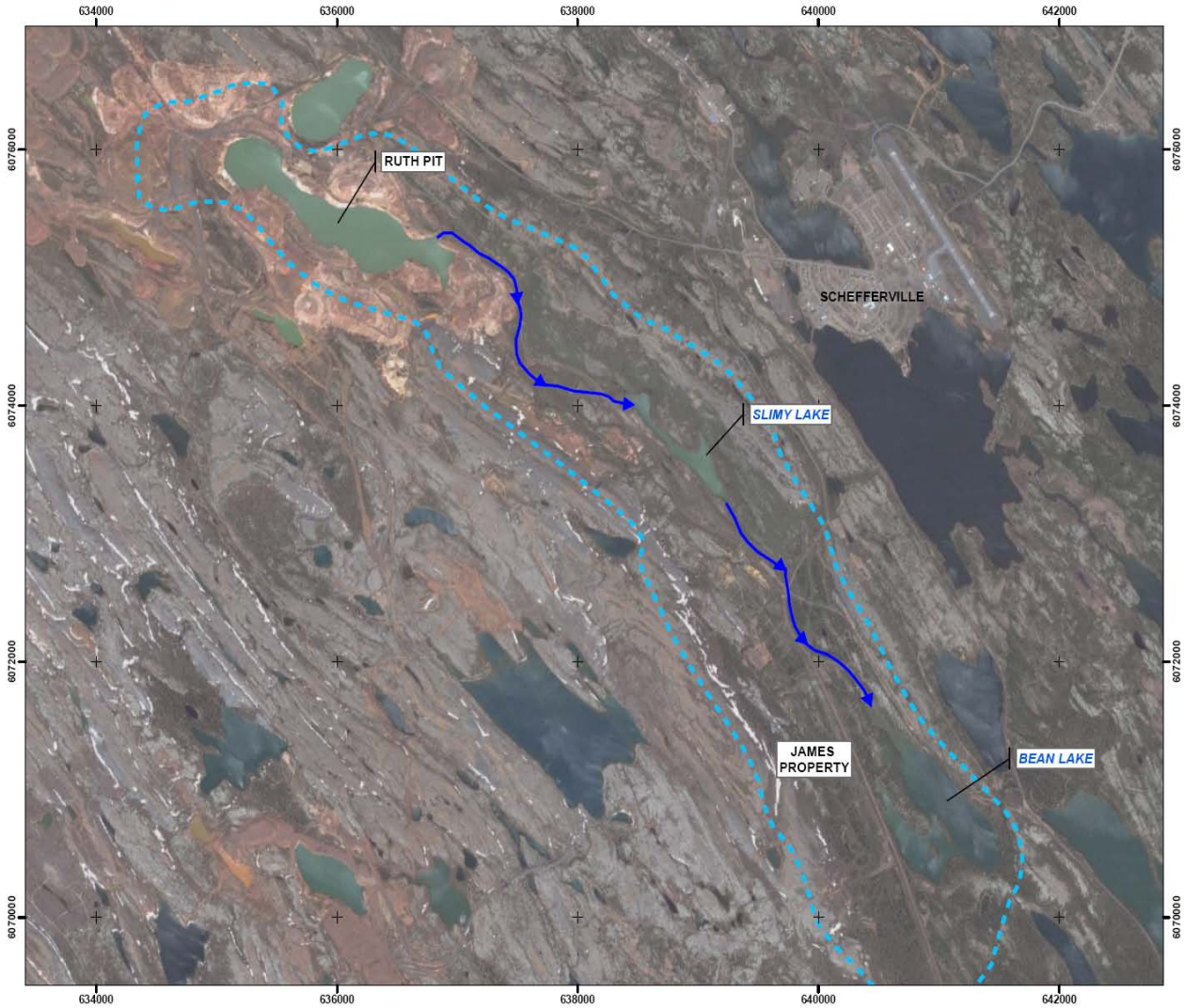

Figure 4.7 James Creek/Bean Lake Drainage Area

Bean Lake is fed primarily by James Creek which enters the lake at its northern-most point. James Creek originates at the Ruth Pit via a submerged/blocked culvert that is located along the east side and towards the south end of the pit. James Creek flows southeast past the south end of Ruth Pit into Slimy Lake, then flows out of Slimy Lake continuing southeast to Bean Lake.

There are two springs on the James Property that form an unnamed tributary that flows directly into Bean Lake. These springs (and tributary) figure prominently in the hydrological assessment of the James Property and to the water balance of the system.

Bean Lake discharges from the southeast and flows into a stream that discharges from Lejeune Lake.

Hydrological measurements were collected in 2008 using stream gauges and groundwater monitoring wells installed and monitored by WESA at appropriate locations across the James Property. WESA also completed an assessment of these measurements and other pertinent data and details of this assessment are presented in Appendix J. A summary of the relevant findings of the assessment is presented below.

James Creek/Bean Lake Water Balance

The measured combined inflows to Bean Lake (surface and groundwater) and the combined outflows (surface water flow and evaporation) are presented in Table 4.5 and Figures 4.8 and 4.9.

Table 4.5 Combined Inflows and Outflows to Bean Lake (needs some formatting)

Inflow and Outflow	June m^3/min	Sep m^3/min
SG4 (Un-named tributary)	2.4	1.2
SG8 (James Creek inlet to Bean Lake)	42.1	46.6
XS-1-N	0.4	0.4
XS-2-S	2.2	2.2
Groundwater Discharge	18.9	18.9
Total Inflow	**66.0**	**69.3**
SG5 (outlet from Bean Lake)	61.0	54.4
Evaporation	0.8	0.8
Total Outflow	**61.8**	**55.2**
Difference	4.2	14.1
Percent Difference	6.6	23

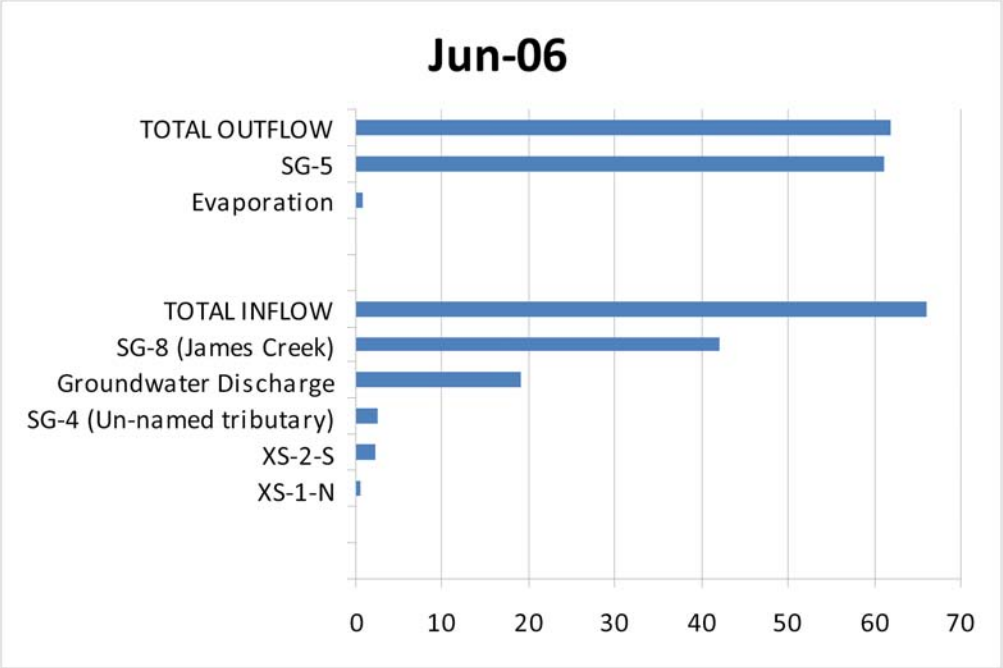

Figure 4.8 Components of the Water Balance for June 6, 2008

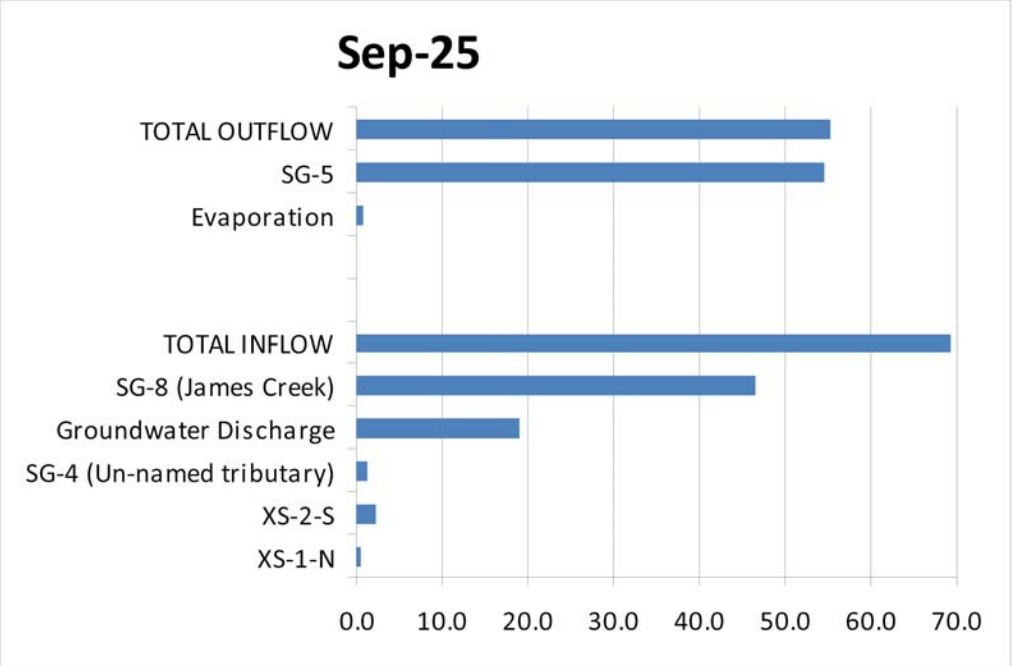

Figure 4.9 Components of the Water Balance for September 25, 2008

The difference between the total inflow and outflow amounts is assumed to represent the cumulative error in the measurements and estimations that make up the components of the water balance. The June values balance closely while the balance for September is not as close. The total inflow values to Bean Lake were consistent between the June and September 2008 measurement periods. The component with the greatest unknown degree of accuracy is the groundwater flux, because the cross-sectional area of flow was determined based on an estimate of the width and depth of the groundwater

zone that discharges to Bean Lake, and the zone may differ from the estimate. More wells closer to the lake would be required before a more precise groundwater flux estimate could be developed; however, this is not considered to be necessary at this time because flow estimates were sufficiently accurate for assessment purposes. The outflow estimate from Bean Lake was lower in September than in June; it is possible that the groundwater discharge to Bean Lake decreased over the course of the summer and/or that water from the lake was lost to groundwater later in the season.

Overall, the June and September water balance 'snapshots' were quite similar: the flows were similar, and the relative contributions of the various components in the balance were similar. They are therefore considered to be representative of the entire ice-free season.

Summary of James Property Hydrology

The hydrological measurements collected for the James Property watershed have been very useful in gaining a general understanding of the water balance for the region as well as more specific details for the proposed James North and South open pit developments. Based on the assessment conducted by WESA, the collected data provides much more useful and representative information than the alternative method of estimating runoff obtained from published runoff rates for Labrador due to the impacts from the existing pits and natural springs in the area. For example, when the monthly cumulative flow measurements for the Bean Lake inlet and outlet locations were compared to the monthly runoff values that were estimated using published runoff rates for the closest available station (Station 03LE002, The Hydrology of Labrador, 1997), it was determined that the flow measurements were approximately double what would be predicted using the runoff rates and the watershed area. The difference in this determination is related to the flow from Ruth Pit and the two natural springs which were captured in WESA's assessment.

The hydrology and hydrogeology of the James Property has distinctive characteristics because of the influence of the two groundwater springs. The approach that was taken to assess the water balance focused on these springs and the groundwater/surface water interactions at the James Property and the overall water balance of Bean Lake.

Data was collected from the main surface water inputs to Bean Lake and the outlet from Bean Lake from early June until October 2008. Prior to this period, during the preceding winter months, snow and ice pack studies were conducted and observations of surface water feature conditions in winter were conducted and recorded to provide full seasonal data. The results of the flow monitoring during 2008 indicate that the ranges of flows at most of the stream gauge locations were low during the June to October 2008 monitoring period. It is also noted that the period of seasonal runoff in Labrador occurs from May to August, with June generally contributing the most runoff of any month through the year (NLDEC 1997).

Stream flow measurements over the spring/summer/fall of 2008 appear to represent seasonally above average flow conditions and the flow rates drop substantially during the winter months. Longer term monitoring will be undertaken in the future to confirm these conditions.

Figure 4.10 shows a plot of the flow at the Bean Lake outlet monitoring station over the course of the 2008 monitoring period. Also shown on this graph are the precipitation events over that time frame (obtained from Schefferville weather station). A direct correlation can be seen between precipitation events and increased flow, with a delay of approximately one day as a result of the attenuative effect of Bean Lake.

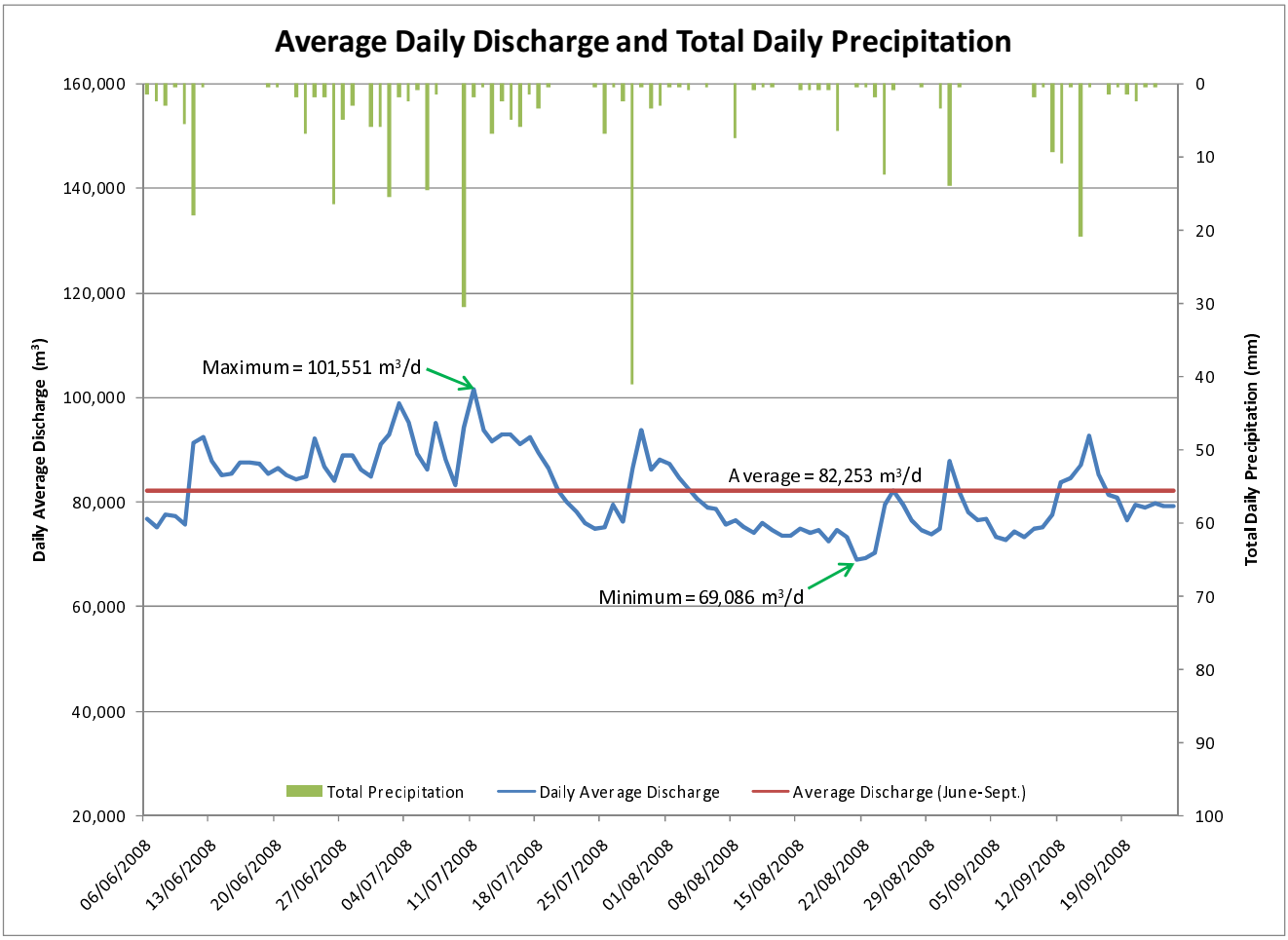

Figure 4.10 Average Daily Discharge from Bean Lake Outlet and Total Daily Precipitation

4.1.4.2 Redmond Property

Open pit mining was conducted at the Redmond property by IOC until the early 1980s in the Redmond 1 and Redmond 2 open pits. Both of these pits have filled with groundwater and surface water over the years since mining occurred. Other than the surface water in the two open pits, the main surface water feature at the Redmond Property is a small stream that starts in a pond northeast of the former railway turnaround area north of the Redmond 2 pit and flows southeast past the north side of the Redmond 1 pit and eventually discharges into Redmond Lake (Figure 4.11, “Redmond Pit” is IOC Redmond 1).

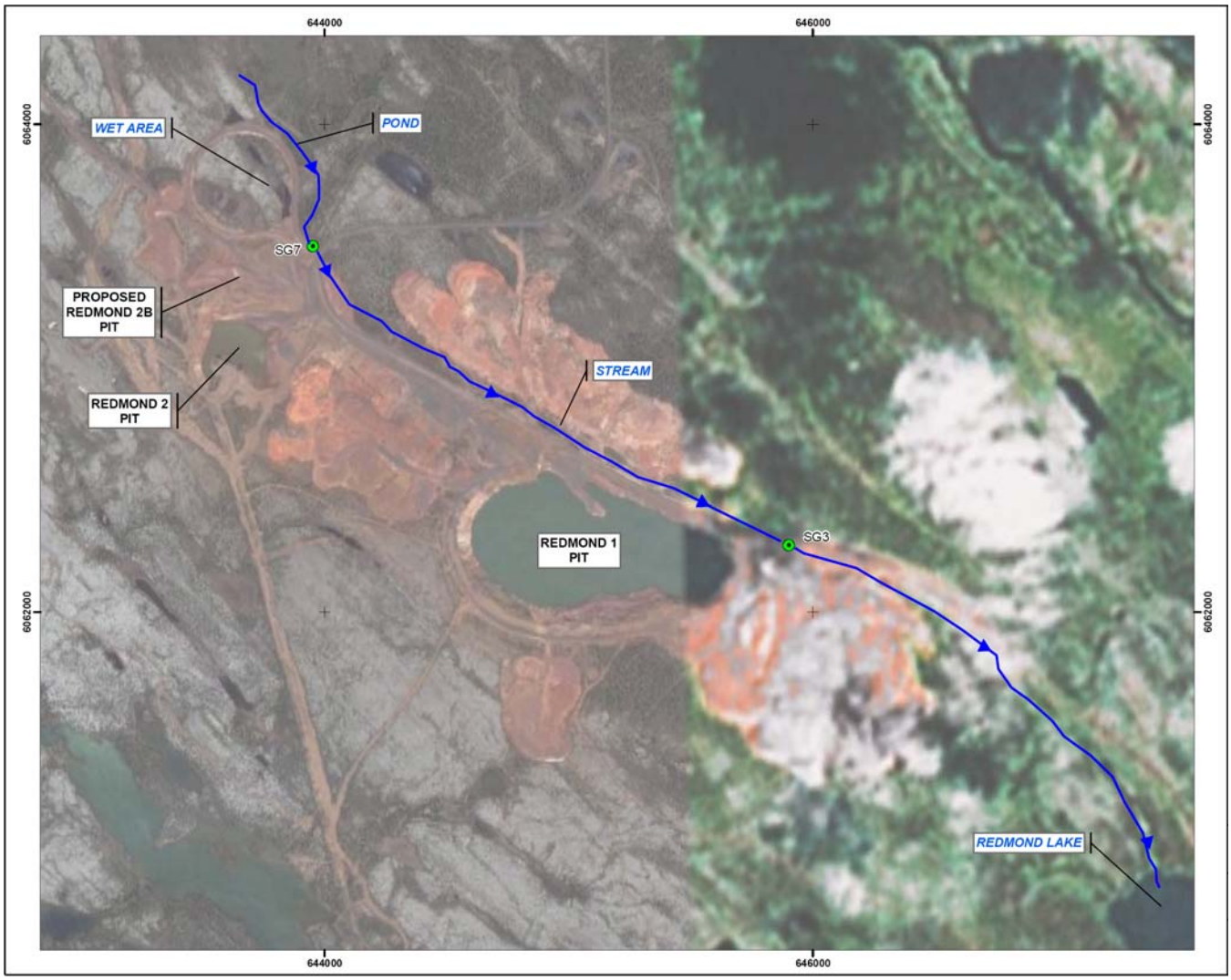

Figure 4.11 Redmond Property Drainage Area

The proposed Redmond 2B pit will be located immediately to the northwest of the existing Redmond 2 pit. Runoff from this area flows to the north and northeast toward the wetland in the former railway turnaround area. There is a wetland community located north of the proposed Redmond 2B pit within the turnabout area, outside of the development limits. This wetland is considered a fen wetland type according to the Canadian Wetland Classification System and receives water through a combination of precipitation, overland flow and groundwater inputs. The railway turnabout structure acts as a barrier to water and flow to and from this wetland is significantly restricted. This can be seen through the conformed 'circle' shape of the wetland vegetation, as physically defined by the turnabout. There is a stream that originates east and outside of the turnabout area which flows to Redmond Lake. The drainage area to this stream is largely from vegetation communities to the northeast of the turnabout and a spring north of Redmond 1 to the north. Water from Redmond 1 pit is thought to be the source of the spring via subsurface flow. There is no surface flow connection between Redmond 1 and any streams/ponds or Redmond 2 and any streams/pond, and there is no intention to dewater the Redmond 1 pit or to discharge water to Redmond 1 pit as part of this project.

Hydrological measurements were collected in 2008 using stream gauges and groundwater monitoring wells installed and monitored by WESA at appropriate locations across the Redmond Property. WESA also completed an assessment of these measurements and other pertinent data and details of this assessment are presented in Appendix J. A summary of the relevant findings of the assessment are presented below.

Summary of the Redmond Property Hydrology

The hydrology of the Redmond Property is described in terms of the contributions made by surface water and groundwater discharge. Flows were examined in early spring, mid-summer and fall.

Details of the flow measurements collected in the one stream located on the Redmond Property are provided in Appendix J. Stream flow measurements over the spring/summer/fall of 2008 appear to represent seasonally above average flow conditions and the flow rates drop substantially during the winter months. Longer term monitoring will be undertaken in the future to confirm these conditions.

Groundwater in the wells located within the proposed future Redmond 2B pit footprint was encountered at a depth of approximately 25 metres below ground surface, at an elevation of approximately 530 m asl. Groundwater in the shallower wells located north of the proposed pit was encountered at depths ranging from approximately four to seven metres below ground surface, at elevations ranging between approximately 526 and 528 m asl. The ground surface north of the proposed pit area is currently approximately 20 metres lower than in the pit area, so this is why groundwater is so much shallower there. Groundwater is estimated to flow to the north.

4.1.5 Ambient Water Quality

4.1.5.1 Groundwater Quality

Well Installation and Sampling Methodology

A total of 27 groundwater monitoring wells were installed at eight well nest locations at the James Property and six wells at three well nest locations were installed at the Redmond Property (Figure 4.12 and Figure 4.13).

Samples were collected in laboratory supplied bottles. Filtered and unfiltered samples were collected for dissolved and total metals analyses. The filtered samples were filtered in the field using in-line 0.45 micron dedicated water filters. The samples were shipped to ALS Laboratory Group in Kitchener, Ontario where they underwent analyses for metals and general chemistry.

Groundwater samples were also collected from the pumping wells during the two pumping tests that were conducted at the James Property. These samples were collected using submersible pumps.

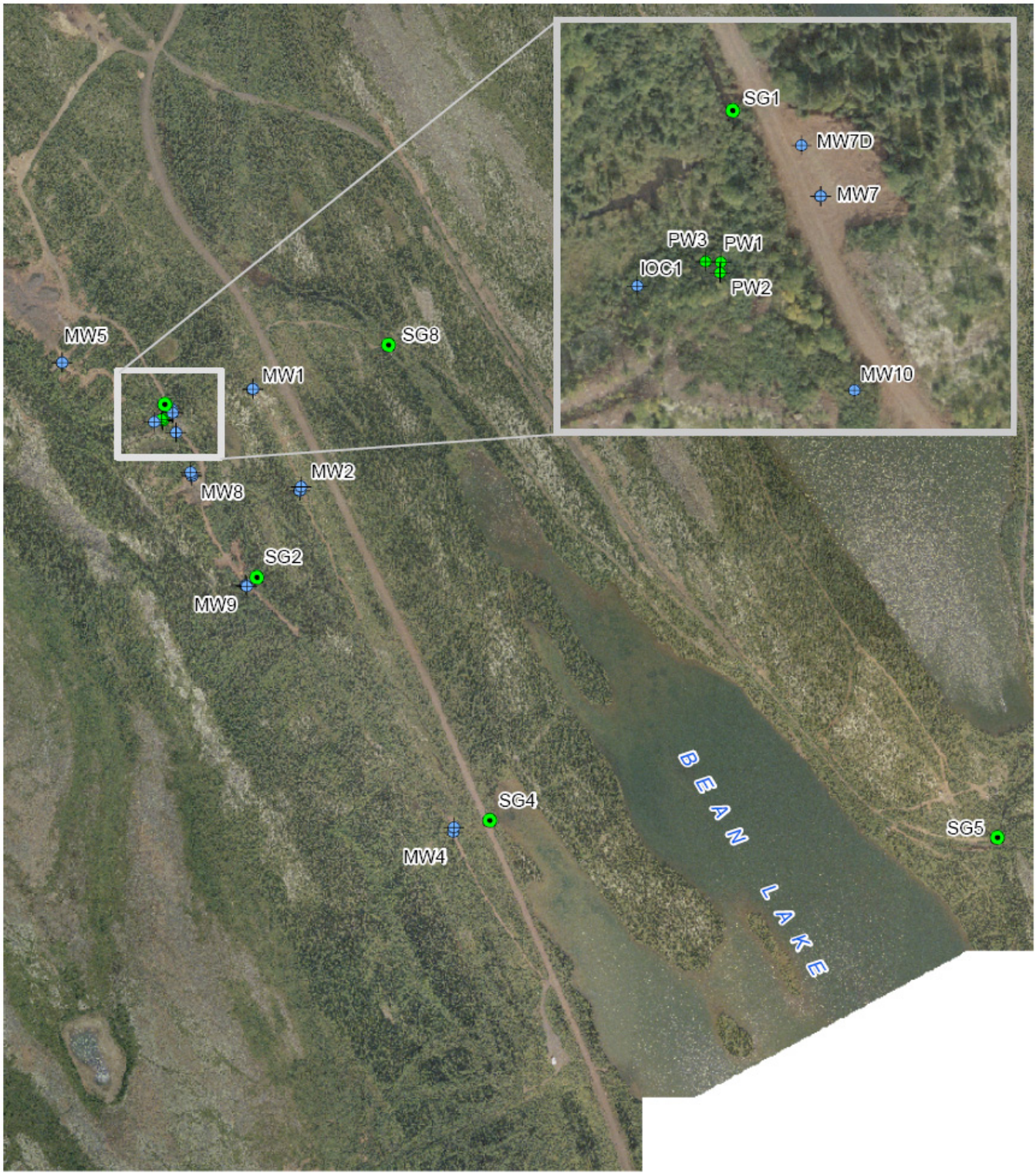

Figure 4.12 James Property Monitoring Wells and Stream Gauges Locations

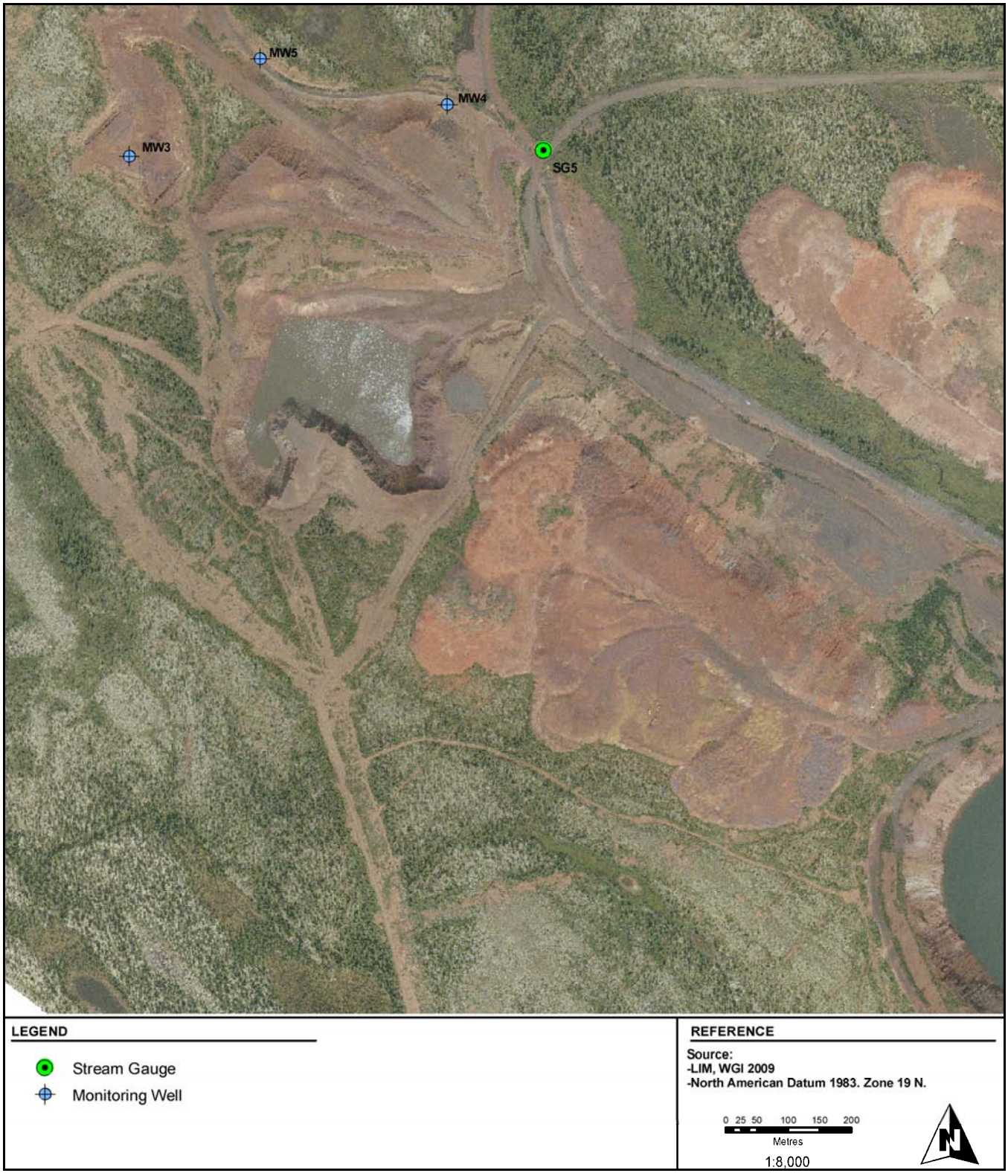

Figure 4.13 Redmond Property Monitoring Wells

Results

James Property

The groundwater chemistry results for the James Property wells have been summarized in Appendix I. For the unfiltered samples, the Total Suspended Solids (TSS) concentrations ranged from 270 to 67000 mg/L and the Total Dissolved Solids (TDS) concentrations ranged between <20 and 1800 mg/L. The water is quite soft, ranging from 8 to 78 mg/L as CaCO3. As there are no CWQG for dissolved metals, the dissolved metals sample results have been discussed in context of the total metal guidelines presented in the CWQG.

The TSS concentrations from the groundwater monitoring wells and pumping test wells were higher than the TSS limits listed in Environmental Control of Water and Sewage Regulations, 2003. The water quality from the perimeter dewatering wells will be much lower in TSS after the full scale wells have been developed. LIM acknowledges that this water will have to meet the required Provincial and Federal effluent limits prior to discharge to the environment. In this case the filters will be the first stage of water treatment followed by discharge to a settling pond which will be designed to retain the water/effluent for sufficient time to settle any remaining suspended solids, and then allow direct discharge to the environment under the appropriate regulatory criteria.

Total Metals

The total iron results for the unfiltered samples ranged between <0.05 and 130 mg/L. The only other metals that were consistently detected in the unfiltered samples were aluminum (range of <0.01 and 61.9 mg/L), cobalt (<0.005 to 0.08 mg/L), copper (<0.001 to 0.08 mg/L), manganese (range of 0.002 to 37.4 mg/L), titanium (<0.002 and 0.3 mg/L), vanadium (range of <0.001 and 0.07 mg/L) and zinc (0.007 and 0.77 mg/L). The results were compared to the Canadian Water Quality Guidelines for Freshwater Aquatic Life (CWQG). At most well locations, total iron exceeded the CWQG of 0.3 mg/L, copper exceeded the CWQG of 0.002 mg/L, and zinc exceeded the CWQG of 0.03 mg/L.

Dissolved Metals

The dissolved iron results were all below detection limit with the exception of wells JA-MW5C (0.48 mg/L) and JA-MW7B (0.08 mg/L). The aluminum results were below detection limit except at well JA-MW1-A1 (0.08 mg/L), copper ranged from <0.001 mg/L to 0.004 mg/L, manganese ranged from 0.001 to 0.101 mg/L, and zinc ranged between 0.003 and 0.123 mg/L. Dissolved iron did not exceed the CWQG at any well locations at the James Property. Dissolved copper exceeded the CWQG of 0.002 mg/L in 11 of the 30 groundwater samples collected from monitoring wells at the James Property. Dissolved zinc exceeded the CWQG of 0.03 in 8 of the 30 samples collected from the monitoring wells. The dissolved metals results were consistently considerably lower than the total metals results.

Pumping Wells Water Chemistry

Pumping tests were conducted on pumping wells that were installed southeast of the James North Spring. Water quality from the pumping wells is considered to be more representative of water quality to be expected initially from the dewatering system than individual monitoring well results because the pumping wells draw water from a larger portion of the aquifer than do individual monitoring wells. Total and dissolved metals and general chemistry samples were collected from the pumping wells.

The groundwater chemistry results for the pumping tests that were conducted at the James Property were generally similar to the average groundwater monitoring well with respect to parameters detected

and their concentrations. The total iron concentrations in the water from the pumping wells ranged from <0.05 to 1.8 mg/L, the total copper concentrations were between <0.001 and 0.017 mg/L, and the total zinc concentrations were between 0.01 and 0.039 mg/L. The water from the pumping wells did not contain detectable dissolved iron or copper. The dissolved zinc concentrations in the pumped water ranged from 0.004 to 0.007 mg/L, and were well below the CWQG of 0.03 mg/L.

The water purged and sampled from each monitoring well and pumped from the pumping wells during the pumping test was brownish red in colour. This reddish colour in the water was present over the duration of the pumping tests. Discussions with a former IOC employee who was involved with dewatering work when IOC was operating mines in the Schefferville area have revealed that water from the IOC dewatering wells would commonly be red when the dewatering wells were first installed and started pumping, but that the water would normally clear up after several weeks of pumping (D. Hindy, pers. com.). It is possible that this will also occur with dewatering of the proposed future James and Redmond 2B pits.

Redmond Property

The groundwater chemistry results for the monitoring wells installed at the Redmond property can be found in Appendix I. TSS results for the unfiltered samples ranged between 11000 and 27000 mg/L. TDS results ranged from 30 to 450 mg/L. The hardness levels ranged between 14 and 65 mg/L (CaCO3).

The TSS concentrations from the groundwater monitoring wells and pumping test wells were higher than the TSS limits listed in Environmental Control of Water and Sewage Regulations, 2003. The water quality from the perimeter dewatering wells will be much lower in TSS after the full scale wells have been developed. This water will be discharged to and held within the Redmond 2 Pit, and therefore, no treatment will be required.

Total Metals

The total iron results ranged from <0.05 to 212 mg/L. Aluminum ranged between <0.01 and 43.8 mg/L. The results for cobalt were between <0.0005 and 0.232 mg/L. Copper ranged from <0.001 to 0.38 mg/L. The manganese concentrations were between 0.005 and 45.7 mg/L, and zinc ranged between 0.018 and 1.14 mg/L. At most well locations, total iron exceeded the CWQG of 0.3 mg/L, copper exceeded the CWQG of 0.002 mg/L, and zinc exceeded the CWQG of 0.03 mg/L.

Dissolved iron was only detected at one well (Red-MW3B at 0.07 mg/L). Aluminum was detected only at RED-MW3A and 3B (0.02 and 0.07 mg/L respectively), manganese ranged from <0.001 to 0.017 mg/L, and the zinc concentrations were between 0.004 to 0.083 mg/L.

Dissolved Metals

The dissolved metals concentrations in the wells at Redmond were consistently lower than the total metals concentrations. The concentrations of TSS and total and dissolved metals tended to be higher in water collected from groundwater monitoring wells at Redmond than at the James monitoring wells.

4.1.5.2 Surface Water Quality

Surface water sampling followed the protocols outline in Environment Canada's Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring, June 2002

Results of surface water samples collected by AECOM in the Redmond and James properties in 2007 and 2008 (Appendix I) were compared with the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQG, FWAL) and the Guidelines for Canadian Drinking Water Quality (GCDWQ). In general, the results for the Redmond property (Appendix I), James property (Appendix I), and offsite areas adjacent to James were consistent with the good water quality reported by LIM from baseline data collected seasonally since 2005.

James Property

Sampling sites for the James deposit (Figure 4.14) are situated as follows:

- JP1: In James Creek, located under the main road to Redmond Property;
- JP5: Located adjacent to Silver Yard on James Creek. Also located upstream of JP1;
- JP 2: James Creek prior to discharge into Bean Lake;
- JP3: Unnamed tributary. Culvert at the road at southern edge of James property;
- JP4: Spring that discharges to JP3; and,
- JP6: Spring that merges with JP4 and discharges to JP3.

Of the 19 surface samples collected on the James property, all were within the applicable referenced guidelines with the following summarized exceptions.

JP4, JP5

Zinc concentrations in surface water samples collected in late winter, 2008, at JP4 and JP5 sites exceeded CWQG, FWAL guideline of 30 ug/L. These variances suggest a seasonal variability, e.g., zinc concentrations were elevated in March and April 2008 at sites JP4 and JP5 in comparison to 2007 values, which were below the applicable guidelines.

Offsite Upgradient Samples

In addition to the samples listed above, additional samples were collected offsite at upgradient locations to observe nearby background concentrations near but off of LIM's James property. The following summarizes the sampling locations (Figure 4.14):

- Slimy 1: Spring adjacent to Slimy Lake, Located 1.5 km upstream from JP5 and is headwater lake for James Creek;
- Slimy Lake: adjacent to the Silver Yard area;
- Bean L. Out: Outlet for Bean Lake and encompasses the entire watershed for the James and Silver Yard locations;
- Bean: Located in Bean Lake adjacent to James property;
- Ruth Out: Origin of James Creek and located approximately 4 km upstream from JP5; and
- Ruth Pit: Surface water samples from proposed processing water supply and reject line from Silver Yard Benefaction area.

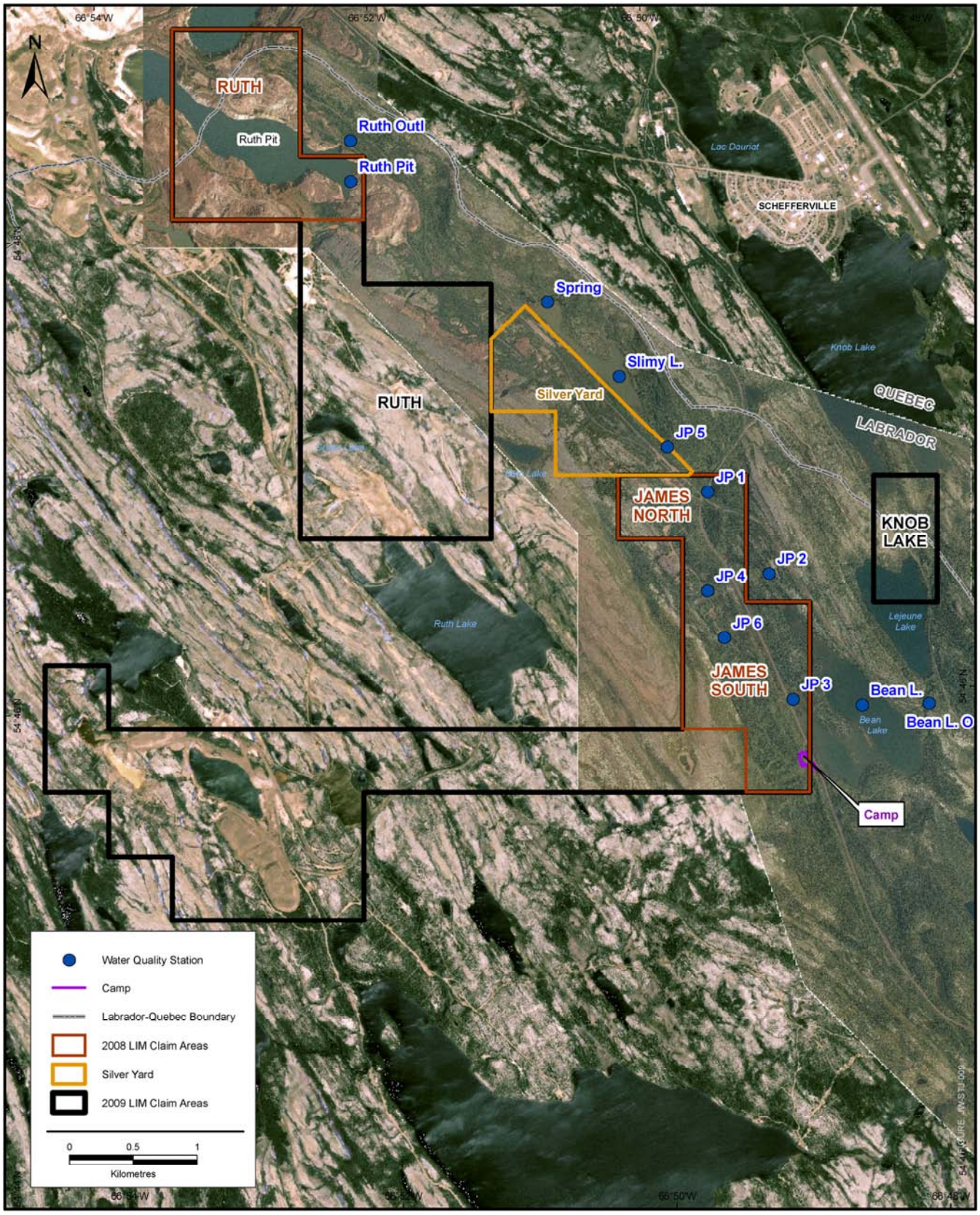

Figure 4.14 Surface Water Sampling Stations, James

The following summarizes the exceedances of the applicable guidelines at the offsite sampling locations:

- Slimy 1 and Bean.

Zinc concentrations in surface water samples collected in late winter, 2008, at Slimy 1 and Bean Lake sites exceeded CWQG, FWAL guideline of 30 ug/L. The spring at Slimy appears to indicate bedrock mineral characteristics, with exceedances for aluminum and manganese also being noted. Aluminum concentrations return to acceptable levels before station JP5, but zinc and manganese remained elevated until Bean Lake. Variances based on continual monitoring of Bean Lake suggest there is a seasonal variability, but Slimy 1 spring appears to maintain a higher level of zinc than other surface water features associated with the Project. This type of seasonality has been observed and reported (Wetzel 1983 and Goldman 1994).

Redmond Property

Screening results from sampling of the Redmond Property in 2005 and 2006 indicated that surface water quality is very good: pH approximately neutral, alkalinity and hardness were very low, electrical conductivity was also very low (11 – 36 µS/cm), with TDS very low (5 – 18 ppm), as well.

For the five samples locations on the Redmond property (Figure 4.15), a total of 20 surface water quality samples have been collected since April 2006. Of these samples, all surface water results generally meet CWQG, FWAL and the GCDWQ, with the exceptions described below.

RP2

The pH value of 6.46 recorded in the pit in April 2007 was marginally below 6.5, the CWQG, FWAL pH guideline value. Of a total of ten samples, the remaining nine pH recorded values were all within the applicable pH range. It is noted that the lab report provides pH to two decimal points as compared to the CWQG, FWAL, which reports to one decimal place. In consideration of this, the result is approximately the same as the lower end of the acceptable CWQG, FWAL range. Water in the pit is dilute with a total dissolved solids value of 12 mg/L and alkalinity results less than the detection limit of 5 mg/L.

RP3, RP4, RP5

Iron and manganese results in April and March 2007 and 2008 at RP3, RP4 and RP5 were elevated up to 60 times the GCDWQ and CWQG, FWAL. In September, these results return to within acceptable guidelines. Therefore, this pattern suggests a seasonally dependent variation consistent with anoxic conditions that frequently develop under ice cover in late winter in small shallow ponds in many shield locations. Based on general limnological documentation, iron in sediments has been observed to go back into solution under anoxic conditions to levels even more elevated than those observed here. Under ice free conditions, iron and manganese rapidly oxidize and precipitate, leaving iron concentrations in water well within GCDWQ guideline of 300 ug/L. This is observed in the September sampling episodes. For example, iron concentrations of 5800 ug/L at RP4 in April 2007 were reduced to 70 ug/L in September of the same year. Similarly, manganese concentrations at RP3 of 780 ug/L observed in March 2007 were reduced to 10 ug/L in September, well below the GCDWQ guideline of 50 ug/L.

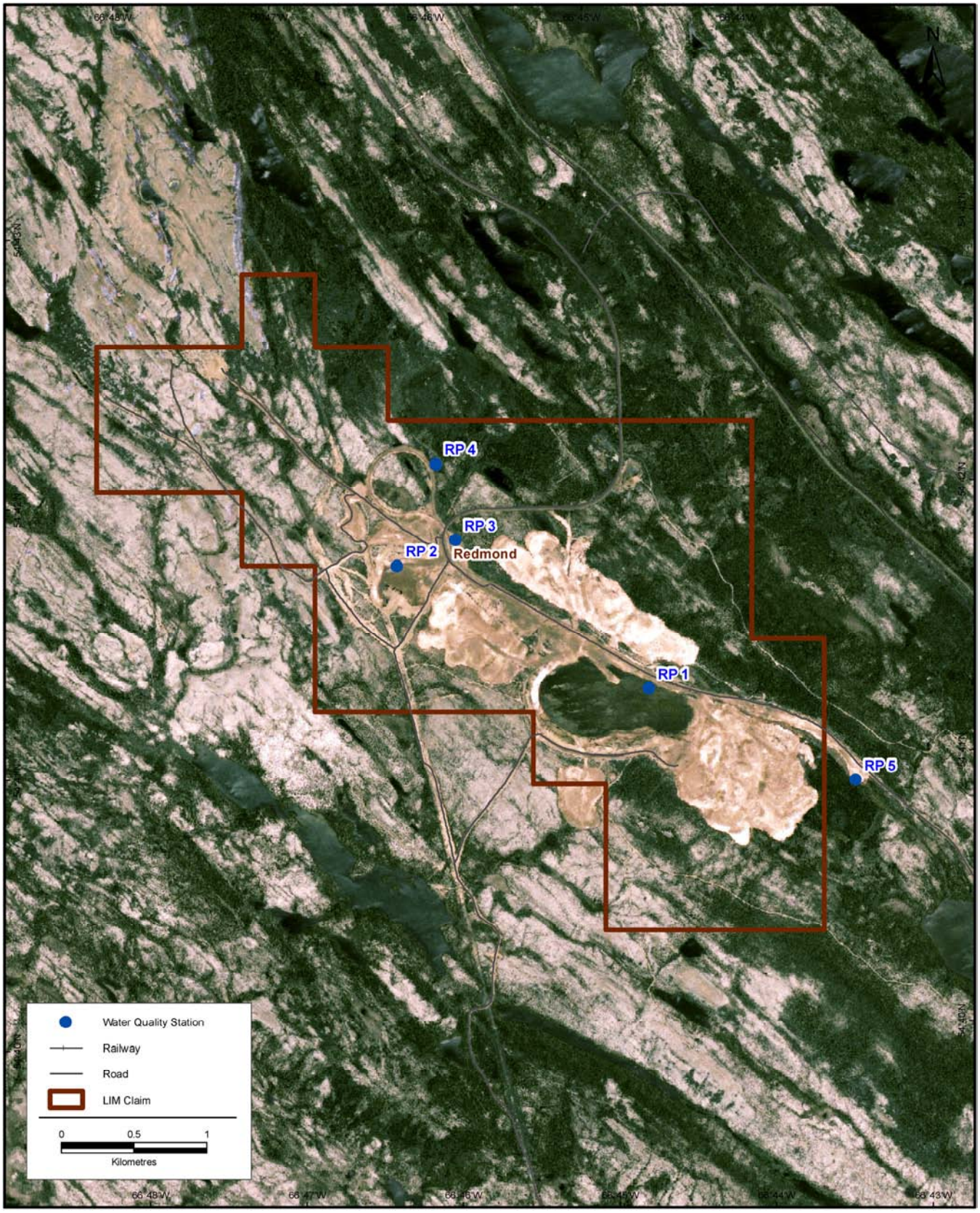

Figure 4.15 Surface Water Sampling Stations, Redmond

RP3 and RP4

Colour, an aesthetic parameter, was reported at RP3 at levels at or exceeding the GCDWQ guideline during the April and September 2007 sampling episodes. This location, at the culvert, could not be accessed during the Spring 2008 sampling program.

Colour at RP4 exceeded the GCDWQ guideline in April 2008, but was within acceptable limits in April 2007 and September 2007.

These exceedances also appear to be associated with seasonal variation.

RP5

It should also be noted that a total zinc concentration of 153 ug/L was noted for RP5 in March 2008. The dissolved zinc value for the same sample was reported as <3 ug/L. This was the first sample collected at this location and additional samples, as well as duplicates, will be collected seasonally to verify the viability of the total zinc result.

Manganese was also noted at 111 ug/L, exceeding the GCDWQ guideline of 50 ug/L. It should be noted the JP5 is in an exposed area conveying flows over historic stockpile of low grade iron ore.

4.2 Biological Environment

4.2.1 Wetlands and Flora

4.2.1.1 Description of Study Area

James North and James South Properties

Approximately 50 percent of this area has been disturbed due to past mining activities. Two pits are planned at James North and James South that will be established on either side of a spring that divides the two properties.

Silver Yard

The proposed beneficiation area is to be situated at the Silver Yard, located north of the James North property. Although the former rail spur lines have been removed, linear infrastructure (roads and the spur rail bed) are still present and in good condition. The Project includes the re-establishment of the railway spur along the existing rail spur bed, the placement of a semi-mobile washer and crusher, stockpile areas and a loading area to facilitate transport of ore via rail cars.

Redmond Property

More than 90 percent of the Redmond property has been disturbed by past mining activities. Abandoned and flooded pits, a former rail line turnaround, a rail bed, and historic rock stockpiles are present on the property.

4.2.1.2 Methods

Field Sampling

Detailed investigations of the existing on-site natural vegetation communities for all three sites included a comprehensive plant species inventory as well as a description of site and soil conditions.

Vegetation Inventory

Twenty-nine detailed ecological plots were established in the James, Redmond and Silver Yard areas to describe vegetation within the four sites. Plots were located within areas of varying species composition and were described using a combination of aerial photograph interpretation, satellite imagery interpretation, soil profile examinations and multilayer (canopy, sub-canopy, groundcover) vegetation inventories. Soil pits approximately 30-50 cm (depending on geological conditions) were excavated to examine soil profiles at each plot. A vegetation inventory examined a $10m^2$ area around the soil pit. The abundance of individual plant species along with their location within the flora strata was noted.

Vegetation communities were classified and delineated utilizing the following systems: The Canadian Wetland Classification System (National Wetlands Working Group, 1997) and The Canadian Vegetation Classification System (National Vegetation Working Group, 1990).

A hand-held global positioning system (GPS) was used to record the location of all the plots. Representative photographs were taken at each site.

4.2.1.3 Results

Appendix K presents a floral species list for each vegetation community delineated and representative photographs of each ecological plot.

Climate and Ecological Site Context

The Schefferville region is situated within the Labrador Uplands Ecoprovince, Smallwood Reservoir-Michikamau Ecoregion. The region has a continental, subarctic climate with cool, short summers and long, severe, cold winters.

Black spruce (*Picea mariana*) is the dominant tree species. White spruce (*Picea glauca*) and tamarack (*Larix laricina*) also occur. Open stands of lichen-spruce woodland with an understory of feathermoss are dominant. The general aspect of the region is that of a rolling plain with numerous lakes and isolated rugged hills composed of Achaean granites, gneisses and acidic intrusives that occur about 150 m above the general landscape. Humo-Ferric Podzolic soils are dominant with major inclusions of Ferro-Humic Podzols, Mesisols, and Organic Cryosols.

James Property

The James site is situated within a valley between two parallel ridges trending northwest to southeast. Former mining operations for this property ceased in 1982. Since then, disturbed areas have been left to re-vegetate resulting in alternating communities of spruce forest and birch/alder/spruce forest particularly along the northeastern flank of the most southwesterly ridge.

Seven upland and one wetland vegetation community were observed within the James property. Vegetation is typical of the varying land classes encountered in the area. The predominant tree species is black spruce, white spruce, and tamarack with various mixed stands of birch (Betula spp.). Ground vegetation is consistent with the typical biophysical land classes associated with spruce-moss, spruce-shrub and open lichen forests. The shrub layer consists mostly of birch (*Betula pumila*), willow (*Salix* spp.) and alder (*Alnus* spp.). Some sedge-dominant wetland pockets (fens) also occur where surface drainage is poor.

The following describes the vegetation communities on the James Property:

- **Intermediate, closed deciduous shrub stand dominated by birch species** - is one of the major vegetation communities within the study area. It covers the gentle to moderately steep slopes of the ridges, as well as the lower parts of the slopes. The community is dominated 80 percent by shrub species including dwarf birch and green alder (*Alnus viridis ssp. crispa*). Tree cover is sparse and consists of black spruce. Ground cover, comprised mainly of bunchberry (*Cornus canadensis*), with some mosses and lichens, is also sparse covering approximately 5 percent of the ground. This vegetation community is not located within the Project footprint.
- **Intermediate, open deciduous tree stand dominated by black spruce** - is located on the low and moderate slopes of the ridges and dominated by intermediate trees with tall and low shrubs. The tall shrub layer consists of dwarf birch; the low shrub species are lowbush blueberry (*Vaccinium angustifolium*), black crowberry (*Empetrum nigrum*) and redberry (*Vaccinium vitis-idea*). Tree cover is 40 to 60 percent and consists of black spruce (*Picea mariana*). Groundcover is sparse (5 percent), dominated by aster (Aster sp.) and willowherb (*Epilobium* sp.). This vegetation community is partially within the Project footprint.
- **Intermediate, open deciduous stand dominated by birch species** - is an example of the regeneration of previous forest harvesting, which occurred approximately 25 to 30 years ago. The tree cover is approximately 40 percent and consists of mountain paper birch (*Betula papyrifera*), resin birch (*Betula glandulosa*) and black spruce. The high shrub layer includes dwarf birch and green Alder (Alnus viridis ssp. crispa); the low shrub species are Labrador tea (*Ledum groenlandicum*), lowbush blueberry, bog bilberry (*Vaccinium uliginosum*), black crowberry and redberry. Groundcover is sparse to non-existent. This community is partially within the Project footprint.
- **Tall, closed deciduous shrub stand dominated by green alder** - is typical along the access roads and distributed in narrow strips (3-5 m in width). This vegetation is also associated with recently (5 to 7 years) disturbed areas such as exposed till. The community is dominated strictly by green alder. The tree cover is sparse (5 percent) and consists of black spruce and mountain paper birch. The ground cover consists of bare ground and rocks. This community is partially within the Project footprint.
- **Tall, closed coniferous forest dominated by black spruce with mosses** – occurs at lower parts of the slopes with limited drainage. The community is dominated by 70% tree cover, including black spruce (90 percent of tree cover) and white spruce (10 percent of tree cover). Shrub cover is 10 percent and consists of birch, Labrador tea, lowbush blueberry, bog bilberry and black crowberry. Groundcover is relatively dense (25 to 30 percent) and dominated by bunchberry, twinflower (*Linnaea borealis*) and wood cranesbill (*Geranium sylvaticum*). This community is within the Project footprint.
- **Tall, open coniferous forest dominated by black spruce with birch associates** – is prevalent on drier parts of lower and medium gentle slopes with better drainage. This community is dominated by tree and shrub species. Tree cover is 50 percent and includes black spruce and white spruce. Shrub cover on the plot is about 40 to 50 percent and the dominant plants are dwarf birch, Labrador tea, black crowberry, lowbush blueberry and bog bilberry. Ground cover is sparse and dominated by bunchberry. This community is partially within the Project footprint.
- **Open, nonvascular lichen stand** – occurs along the highest points of the ridges. It is dominated by lichen species and exposed rock. This community is outside the Project footprint.

The following describes the two specific fen wetlands of low, closed herb grammoid stands dominated by sedge species:

- **Low, closed herb graminoid stand dominated by sedge species** – is a fen that can be characterized as moderately rich with slightly higher concentrations of dissolved minerals and dominated by sedges and brown moss. Sedge species dominate the sub-stratum (95 percent) and willow/berry bearing shrubs constitute the low-lying canopy on elevated hummocks. Tree cover is less than 5 percent and consists of stunted spruce and tamarack trees on hummocks. Organic soils occur up to 30 centimetres deep consisting of slightly decomposed roots of sedges, grass and moss. Dominant species include water sedge (Carex aquatilis); willow shrubs (Salix sp.), buckbean (Menyanthes trifoliata), leatherleaf (Chamaedaphne calyculata), redberry (Vaccinium vitis-idea) and black crowberry (Empetrum nigrum.). This community is within the Project footprint.
- **Low, closed herb graminoid stand dominated by sedge species** – is a fen located in a local depression that receives most of the water from direct precipitation and runoff from the slopes. The fen has an outflow stream on the west side. Sedge species dominate the sub-stratum and Sphagnum mosses constitute the ground cover. Shrub cover is less than 5 percent and consists of three species of willow (Salix sp.). Organic soils are up to 20 centimetres deep consisting of slightly decomposed roots of sedges and leaves. Sedge species are predominated by water sedge (Carex aquatilis); wildflower species include buckbean (Menyanthes trifoliata) and silverweed (Potentilla palustris). The vegetation community is within the Project footprint.

Silver Yard

The Silver Yard property is similar to the Redmond site as it has numerous service roads. The service roads, with a north-south orientation, are extensively bordered with alder and willow regeneration. The Silver Yard is within a large valley bordered on the east by a talus slope forested at the base, and to the west, by another slope heavily covered with spruce at the base thinning to almost no vegetation near the summit.

The following describes the vegetation communities identified for the Silver Yard:

- **Low, closed deciduous shrub stand dominated by birch species** - is dominated by shrub species (80 to 90 percent cover) that include dwarf birch and Labrador tea. Tree cover is sparse and consists of black spruce. Groundcover is also sparse (5 to 10 percent), dominated by bunchberry. The site has a north-easterly aspect and a slope of 9° (20 percent). This community is partially within the Project footprint.
- **Intermediate, closed deciduous shrub stand dominated by alder species** – is prevalent on recently disturbed exposed till surfaces and is dominated by green alder. Other shrubs include dwarf birch, bog bilberry willows. The tree cover is sparse (<5 percent) and consists of black spruce. The ground cover is sparse and consists of grasses (<5 percent) and mosses and lichens. Bare ground and rocks occur over approximately 50 percent of the plot. This community is partially within the Project footprint
- **Intermediate, closed deciduous shrub stand dominated by birch species** – is located along the western lakeshore of Slimy Lake and is dominated by shrub species. These include dwarf birch, willow and skunk currant (*Ribes glandulosum*). Trees are absent. Ground cover is approximately 40 percent and it is dominated by horsetail (*Equisetum sp.*), Aster (*Aster sp.*) and yarrow (*Achillea millefolium*). This community is partially within the Project footprint.

Redmond Property

The Redmond site has a wide range of habitat types, largely due to the presence of former mine and pit operation. The habitats range from completely bare ore piles and service roads, to heavily blanketed areas with alder and willow thickets. This area also has a large, flooded pit in the southwest corner of the site. The undisturbed areas are mostly mature black spruce at lower elevations, with stunted spruce – lichen stands along the ridge summits.

The following describes the vegetation communities identified for the Redmond Property:

- **Low, sparse deciduous shrub stand dominated by crowberry with lichen patches** - is the main vegetation community that is widely distributed on the top of ridges. It covers approximately 100 percent of this area along with the lichen-shrub dominated stands. There is approximately 60 to 70 percent exposed bedrock that includes granite/gneiss. Low-lying shrub species cover approximately 15 percent of the area and consist of black crowberry, bog bilberry, dwarf birch, net-veined willow (*Salix reticulata*), and redberry. Lichen species represent 10 percent of vegetative cover in this community. This community is partially within the Project footprint.
- **Low, open deciduous shrub stand dominated by crowberry and lichen species** – is located on steeper slopes and hilltops. The community is dominated by lichen species and shrubs. Lichen species include coral lichen (*Cladina stellaria*) and reindeer lichen (*Cladina rangiferina*). Total cover of lichens is 95 to 100 percent. The shrub canopy is dominated by black crowberry, dwarf birch, Labrador tea and redberry. This community is partially within the Project footprint.
- **Intermediate, closed deciduous shrub stand dominated by green alder and a variety of herbaceous plants** – is located in the narrow valley between two hills. The community is dominated by shrub species. Total shrub cover is 90 percent. Species observed include green alder, dwarf birch, willow and skunk currant. Groundcover is approximately 15 percent and is dominated by bunchberry, wood cranesbill, aster and violet. The dominant moss species is red-stemmed feathermoss (*Pleurozium schreberi*). This community is partially within the Project footprint
- **Intermediate, open deciduous shrub stand dominated by birch and sphagnum moss** – is located in a depression that collects water to form a fen that is flat to slightly concave. Sedge species dominate the sub-stratum (75 to 80 percent) and sphagnum mosses constitute 95 percent the ground layer. The dominant species of sedge is beaked sedge (*Carex rostrata*); wildflower species include buckbean (*Menyanthes trifoliata*). Shrub cover is about 30 percent and consists of dwarf birch and two species of willow (*Salix s*p.). Organic soils up to 20 centimetres deep consist of slightly decomposed sphagnum moss. This community is outside the Project footprint.
- **Tall, open coniferous tree stand dominated by tamarack, polytrichum and sphagnum moss** – is situated on the edge of the fen (described above) and forms the transition zone between the slopes and the bottom of the depression. This community is dominated by shrubs and trees. The tree species include black spruce and tamarack. The shrub canopy is dominated by dwarf birch, Labrador tea, bog bilberry and bog rosemary (*Andromeda polifolia*). Moss cover is dense and consists of haircap moss (*Polytrichum* sp.) and sphagnum moss (*Sphagnum* sp.). Ground cover is sparse (5 percent), with bunchberry, willow herb (*Epilobium* sp.) and grasses. This community is outside the Project footprint.
- **Tall, closed coniferous tree stand dominated by white spruce** - is dominated by shrubs and trees. The tree layer is entirely white spruce while the shrub layer is dominated by dwarf birch, Labrador tea and lowbush blueberry. Moss and lichen cover are relatively dense and consist of red-stemmed feathermoss and star-tipped reindeer lichen (*Cladina stellaris*). Groundcover is sparse, and dominated by bunchberry and grasses. This community is outside the Project footprint.

- **Low, closed herbaceous graminoid stand dominated by sedge species** – is a fen located between the access road and the stream on the riparian zone of the stream. Sedge and grass species dominate the sub-stratum (90 percent) and willow shrubs constitute the canopy. Moss cover represents less than 10 percent of the plot. Open water constitutes 10 to 15 percent of the plot. Organic soils occur up to 20 cm deep consisting of slightly decomposed roots of sedges, grass and silty clay (from the road). This community is outside the Project footprint.
- **Northern Ribbed Fen** – is located in the narrow valley between the ridges. This community is dominated by low shrubs and sphagnum mosses. The tree species include stunted forms of black spruce and tamarack. The shrub canopy is dominated by leatherleaf (*Chamaedaphne calyculata*), cloudberry (*Rubus chamaemorus*), dwarf birch and Labrador tea. The sphagnum cover is dense. The wildflower species include buckbean. Organic soils occur up to 50 centimetres deep consisting of black to dark brown peat. This community is outside the Project footprint.
- **Northern Ribbed Fen** – hollow/shallow pools – Sedge species dominate the sub-stratum (10 to 60 percent). The rest of the site consists of open water. Wildflower species include buckbean, cottongrass (*Eriophorum* sp.), leatherleaf and three-leaved false soloman's seal (*Maianthemum trifolium*). Organic soils up to 40 centimetres deep consist of highly decomposed sphagnum moss. This community is outside the Project footprint.

Rare Plant Species

Based on recent fieldwork conducted by AECOM and a search of the Atlantic Canada Conservation Data Centre (AC CDC) database, there are no known occurrences of plant species listed under the federal *Species at Risk Act* or the *Provincial Endangered Species Act* within the Project footprint.

4.2.1.4 Wetlands

Wetland communities within the study area have been classified according to the Canadian Wetland Classification System (National Wetlands Working Group, 1997). The corresponding Vegetation Classification (National Vegetation Working Group, 1990) designation has also been described in Section 4.2.1.3.

Wetland communities within the study area generally occur within depressions or along the foot of surrounding ridges. Wetland communities have also been observed along the road network, lakes and watercourses. All wetland communities within the subject properties are comprised of either fen or swamp forms. Fens are peatlands with fluctuating water tables. The waters in fens are rich in dissolved minerals and are dominated by moderately decomposed sedge and brown moss peats of variable thicknesses. A swamp is a treed or tall shrub (also called thicket) dominated wetland that is influenced by minerotrophic groundwater, either on mineral or organic soils. The essential features of the swamp class are the dominance of tall woody vegetation, generally over 30% cover and the wood-rich peat laid down by this vegetation. Table 4.6 below lists all the wetland communities observed within the James, Silver Yards and Redmond properties.

Table 4.6 Wetland Communities observed within James, Silver Yard and Redmond Properties

Color	Map Unit*	Community Designation	Community Location
Fen Wetland	16	Low, closed herbaceous sedge stand**	
	16a	Basin Fen	Occurs within topographically confined basins isolated from inflow/outflow streams. Three ecological plots were conducted for this community within the James and Redmond properties.
	16b	Stream Fen	Occurs along the banks of permanent /semi-permanent streams that are low gradient and slow moving. One ecological plot within the Redmond property was conducted for this community.
	16c	Floating Fen	Occurs adjacent to ponds or lakes. The peat surface is generally less than 0.5 m above water level. Dominant species were noted within this wetland type. A combination of cranberry, buckbean and leatherleaf species occur within this community.
	16d	Northern Ribbed Fen	Occurs within elongated hollows and contains a series of parallel ridges. One ecological plot was conducted within the Redmond property for this community.
Swamp Wetland	17	Riparian Swamp	
	17a	Intermediate, sparse tamarack evergreen stand with willows	Occurs along fen communities and contains tamarack and willow species. Dominant species were noted within this wetland type
	17b	Tall, open tamarack, black spruce, evergreen stand with sphagnum moss	Occurs in low lying areas within water conveyance along fen communities. One ecological plot was conducted for this community within the Redmond Property.
	17c	Tall, closed black spruce evergreen stand with sphagnum moss	Occurs in low lying areas within water conveyance along fen communities. One ecological plot was conducted for this community within the James Property.

James Property

There are nine wetlands (totalling 6.906 ha) within the 64.5 ha James Property, with only approximately 0.5 ha within the actual proposed mining footprint. A map of wetland locations on the James Property is provided in Figure 4.16.

The following wetland communities were observed within the James property:

- Low, closed herb graminoid stand dominated by sedge species: Basin Fen;
- Low, closed herb graminoid stand dominated by sedge species: Stream Fen;
- Riparian Swamp: Intermediate, sparse tamarack evergreen stand with willows; and
- Riparian Swamp: Tall, closed evergreen tree stand dominated by black spruce with mosses.

Silver Yard Area

There are no wetlands identified within the Silver Yard footprint area.

Redmond Property

Within the Redmond property, there are 14 wetlands comprising 38.5 ha, however, there are no wetlands within the proposed mining footprint. The following wetland communities were observed within the Redmond property:

- Low, closed herb graminoid stand dominated by sedge species: Basin Fen;
- Low, closed herb graminoid stand dominated by sedge species: Floating Fen;
- Low, closed herb graminoid stand dominated by sedge species: Stream Fen;
- Low, closed herb graminoid stand dominated by sedge species: Northern Ribbed Fen;
- Riparian Swamp: Intermediate, sparse tamarack evergreen stand with willows;
- Riparian Swamp: Tall, open tamarack black spruce, evergreen stand with sphagnum moss; and
- Riparian Swamp: Tall, closed black spruce evergreen stand with sphagnum moss.

The wetlands discussed in the Avifauna section (Section 4.2.3) are outside of the proposed development footprint area for the Redmond property. Wetlands were classified as per the Canadian Wetland Classification System.

Where feasible, wetlands will be avoided. Effects on the wetlands outside the Project footprint will be avoided or minimized through the implementation of the EPP (Section 8.5) and ongoing environmental planning.

Wetland Evaluation

The Wetland Evaluation Guide developed by the North American Wetlands Conservation Council (Canada) produced in 1992 was used as a guideline to assess the true ecosystem value of the potentially affected wetlands. Approximately 0.5 ha of wetland will be disturbed within the zone of influence (i.e., mining footprint) at the James Property. The location of all wetlands (Jc, Je and Jf) within the James property footprint is presented in Figure 4.16. Table 4. 7 presents the form, area and relative position to the mining footprint for all wetlands within the James Property.

To assess the ecosystem value of these affected wetland areas, their functions or capabilities need to be understood. Wetland functions provide many benefits to society and are defined as the capabilities of wetland environments to provide goods and services including basic life-support systems.

All of the affected wetland areas are similar in size and contain similar habitat composition (e.g., they are all sedge dominant basin fens). Therefore, this wetland evaluation will be utilized for all three wetland systems.

Table 4.7 Wetlands within James Property

Label*	Type	Total Area (ha)	Area within Foot Print
Ja	Stream Fen	0.8	
Jb	Intermediate, sparse tamarack evergreen stand with willows	0.8	
Jc	Basin Fen Intermediate, sparse tamarack evergreen stand with willows	0.2 0.15	0.2
Jd	Basin Fen	0.12	
Je	Basin Fen	0.14	0.14
Jf	Basin Fen	0.16	0.16
Jg	Stream Fen	0.95	
Jh	Stream Fen Intermediate, sparse tamarack evergreen stand with willows Tall, closed black spruce evergreen stand with sphagnum moss	1.2 1 1.3	
Ji	Floating Fen	0.086	
	Total area for James Property	64.5 ha	
	Total wetland area for James Property	6.906 ha	
	Total wetland area within footprint	0.49 ha	
	Percent of James Property comprised of wetland	10.70%	
	Percent of James Property wetland area within footprint	7.1%	

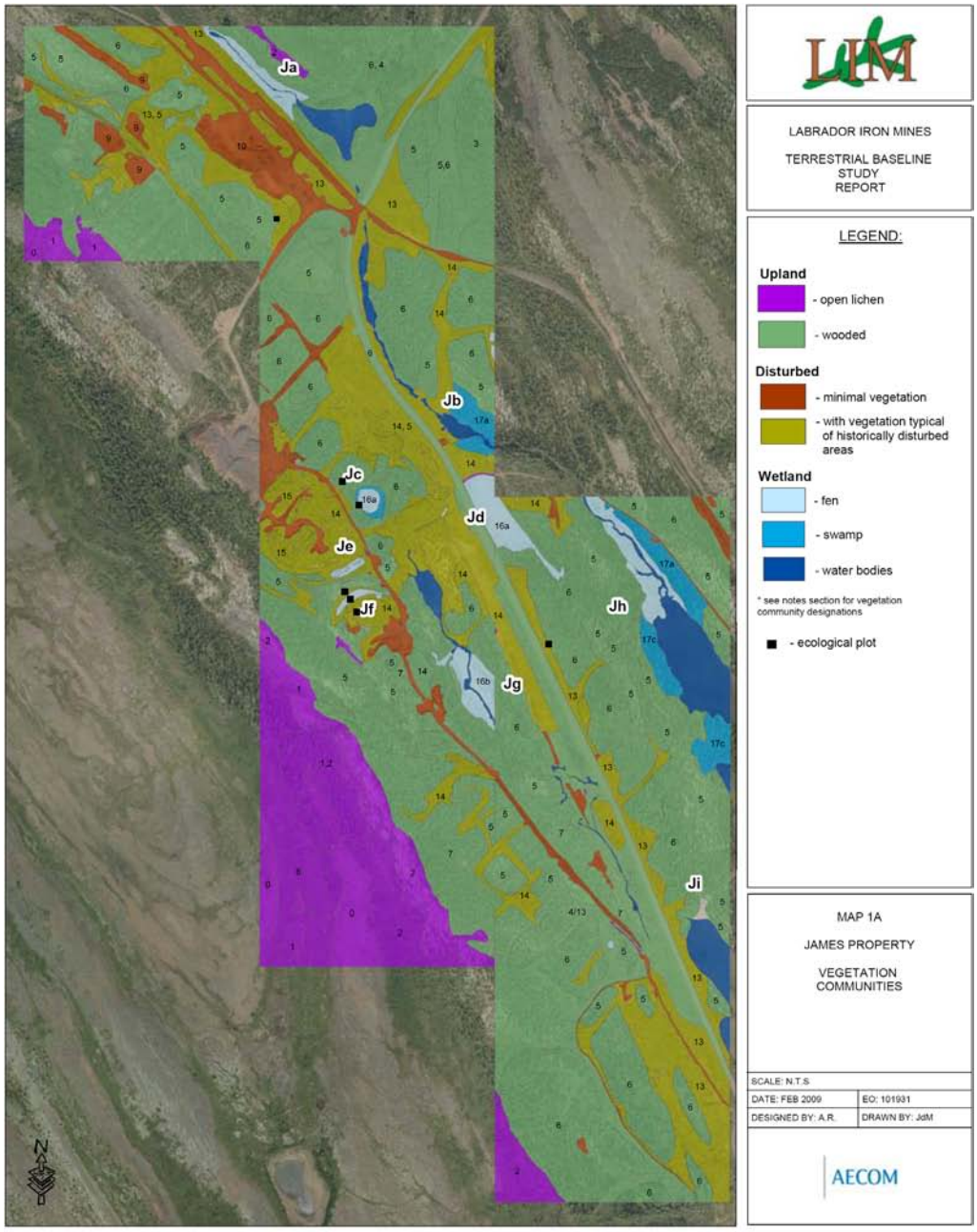

Figure 4.16 Wetlands Map, James Property

Potential wetland functions, as adapted in the Wetland Evaluation Guide, are:

- **Regulation/ Absorption** – climate regulation via methane and carbon dioxide release/storage, absorption of toxic substances and heavy metals, stabilization of biosphere processes, water storage and cleansing;
- **Ecosystem Health** – nutrient cycling, food chain support, habitat, biomass storage, genetic and biological diversity;
- **Science/Information** – specimens for research, zoos, botanical gardens, representative and unique ecosystems;
- **Aesthetic/Recreational** – non-consumptive uses such as viewing, photography, bird watching, hiking and swimming;
- **Cultural/Psychological** – wetland uses may be part of community traditions, religious or cultural uses, future (option) opportunities;
- **Subsistence Production** – natural production of game birds, fish, plants (e.g., berries, rushes, wild rice); and
- **Commercial Production** – production of foods (e.g., fish, crops), fibre (e.g., wood, straw), soil supplements (e.g., peat).

The major functions that the wetland systems are capable of within the James property mining footprint include: water storage and habitat for resident wildlife. However, these attributes are not considered significant since all wetland systems are less than 0.2 ha in size and receive water inputs only during rain events and snow melt. They also have low biodiversity where wetland systems are made up of one vegetation type; sedge dominant basin fen. This provides habitat for resident bird species and amphibians, but considering that this habitat type occurs elsewhere, no major impact to these species is anticipated.

Photograph 1 – view of wetland system "Jf"

Photograph 2 – view of wetland system "Jc"

Given the location of the wetlands within the proposed James Property mining footprint, scientific study, aesthetic/recreational, cultural/psychological and subsistence/commercial production function values are very low to non-existent. The contribution of the wetlands to the remaining functions of regulation/absorption and ecosystem health are also considered low due to their small size (all are less than 0.2 ha) and similarity of habitats to other wetlands in the region.