capstone
MINTO MINE

Site Characterization Plan

May 2014

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1 INTRODUCTION

As a requirement for Capstone Mining Corp's Quartz Mining Licence, a Site Characterization Plan has been developed. The Plan will outline the existing condition at the Minto Mine. Table 1-1 shows how sections of this plan correspond to the Plan Requirements Guidance for Quartz Mining Projects.

Table 1-1: Concordance with Plan Requirements

Section in Guidance Document		Corresponding Section(s) in this Plan	
4.1	Introduction	1	Introduction
4.2	Geology	2	Geology
4.3	Climate and Hydrology	3 4	Meteorology Hydrology
4.5	Groundwater	6	Groundwater
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The Plan Requirements Guidance for Quartz Mining Projects references a concordance table outlining applicable proponent commitments and decision document conditions. As this plan describes the existing site conditions, none of the commitments made in the YESAB process or the conditions in the decision document are relevant to the understanding of this plan. Capstone's commitments and the conditions contained in the decision document are addressed in the appropriate documents that address the potential environmental effects of the project and the issues raised in the evaluation process.

1.1 SITE OVERVIEW

The Minto Mine is located on the west side of the Yukon River, approximately 240 km northwest of Whitehorse, Yukon (Figure 1-1) and is centered at 62°370020032'N latitude and 137°15'W longitude (NAD 83, UTM Zone 8 coordinates 6945000N, 384000E). Highway 2 (North Klondike Highway) is located on the east side of the Yukon River; the mine can be accessed in the summer by barge crossing or in winter by the ice bridge crossing at Minto Landing.

A summary the environmental conditions are summarized in Table 1-2 below.

Table1-2: Summary of Environmental Conditions in the Minto Mine Area.

Project Area Attribute Description	Project Area Attribute Description
Region:	Yukon
Topographic map sheet:	NTS 115 I/10, 115 I/11
Geographic location name code:	Minto Project
Latitude:	62° 36' N
Longitude:	137° 15' W
Drainage region:	Yukon River
Watersheds:	Yukon River, Big Creek, Wolverine Creek, Dark Creek, McGinty Creek, and Minto Creek.
Ecoregion:	Yukon Plateau (Central) - Pelly River ecoregion.
Study area elevation:	Rolling hills above mine site at 1131 to 600 m at the Yukon River Valley bottom.
Site climate:	Temperature ranges from –43.2°C (November 2006) to 30.3°C (July 2009). Mean annual temperature of –1.8°C. Mean annual rainfall is 174mm.
Vegetation communities:	Riparian, black spruce, white spruce, paper birch, lodgepole pine, buck brush/willow and ericaceous shrubs, feather moss, sedge, sagewort, grassland, mixed forest (aspen, balsam, and sub-alpine). Discontinuous permafrost is present on site. Site has been subject to recent forest fires.
Wildlife species:	Moose, caribou, Dall sheep, mule deer, grizzly and black bear, varying hare, beaver, lynx, marten, ermine, deer mouse, fox, mink, wolverine, least weasel, wolf, squirrel, porcupine coyote, muskrat, otter and wood frog. Bird species include: spruce, blue, ruffed, and sharp-tail grouse, waterfowl, raptors, and a variety of smaller birds.
Fish species:	In the Yukon River, Chinook, Coho, and chum salmon, rainbow trout, lake trout, least cisco, Bering cisco, round whitefish, lake whitefish, inconnu, Arctic grayling, northern pike, burbot, longnose sucker and slimy sculpin; In Big Creek, Chinook and chum salmon, Arctic grayling and whitefish species; In Wolverine Creek, Chinook salmon, Arctic grayling, and slimy sculpin; In Minto Creek (lower reaches only), Chinook salmon, slimy sculpin, round whitefish, Arctic grayling, longnose sucker, burbot; In McGinty Creek (lower reaches only), slimy sculpin, Arctic grayling

The Minto Mine property lies in the eastern portion of the Dawson Range, which is part of the Klondike Plateau Physiographic Region, an uplifted surface that has been dissected by erosion. The area was largely unglaciated during the last ice age and topography consists of deep and narrow valleys, rounded rolling hills, and ridges with relief of up to 600 m (2,000 ft.). The highest elevation on the property is 975 m (3,200 ft.) above sea level, compared to lower elevations in the region with elevations of 460 m (1,500 ft.) along the Yukon River.

The Minto Mine is near the height of land with relatively gentle slopes and smooth ridges that often have spines of bedrock outcrops (tors) at their crests left from long periods of weathering. Broad ridges are typically mantled with felsenmeer (fields of angular, frost-heaved, in situ rock fragments). Below the ridge crests, bedrock exposures are limited or negligible. The Project area lies in a zone of extensive discontinuous (50–90%) permafrost and is included in the western portion of the Yukon plateau central ecozone. North-facing slopes in the area are commonly underlain by permafrost. Valley-bottom deposits and upland soils usually contain ice-rich horizons. Well-drained uplands may have permafrost-free soils.

As the ecoregion is largely unglaciated, the dominant parent materials are stony residual materials along ridge tops and summits, coarse colluvium on upper slopes, and silty colluvium and loess, rich in organic matter, on lower slopes and floors of main valleys. Muck is usually capped with peat and underlain by permafrost. In the Minto Mine area, much of the colluvium on ridge slopes is coarse sand derived from decomposition of the largely granitic bedrock in the area. Overburden of relic soils that predate the last glaciation includes lacustrine deposits overlain by colluvium and organic silt in some upper valleys, some of which was exposed during excavation on the south side of the pit.

The mine development area is in the transition from the forested to non-forested (alpine) zone. Below the treeline (elev. ~1,000 m) the vegetation patterns reflect the discontinuous distribution of permafrost with stunted black spruce woodlands on cold, north-facing sites and mixed (aspen, white spruce, minor birch) forests on warm, south-facing slopes. The area has been burned over by several wild fires, the latest of which was in 2010 (Minto Landing to lower Minto Creek area). Many of the burnt trees have blown down and natural regeneration of pine and alder is occurring over much of the property and the Project area.

The climate of the region is continental with short, warm summers and very cold winters. Annual precipitation ranges from 300 to 500 mm. Mean annual temperatures are near –5°C with mean mid-winter temperatures of –23°C to –32°C, in July from +10°C to +15°C and extremes in the lower valleys ranging from –60°C to +35°C.

The area is drained by tributaries of the Yukon River. The rate of runoff is controlled by almost total vegetation ground cover and moderate slope gradients. Infiltration rate is expected to be high in areas of thicker colluvium. However, permafrost and seasonally frozen soils inhibit vertical percolation.

Topography in the Dawson Range is moderate and the active geomorphological processes in the study area are typically limited to include slow mass movement (solifluction) and some minor gully erosion. Although there are no reports of large-scale active natural landslides in the Minto Project area, smaller scale instabilities have recently been documented in the Minto Creek catchment area, downstream of the mine site. Substantial sediment loading in lower Minto Creek in the absence of effluent discharge from the site was observed throughout the open water months of 2011 (Appendix 1-3, *Minto Creek Water Quality Characterization*). This prompted a targeted water quality survey and an aerial investigation of the creek and tributaries in spring of 2012 in an attempt to identify the source(s) of the sediment. Two areas were identified in tributaries on the southern side of the Minto Creek catchment, below the area of control of the mine, where soil materials had slumped and transported a significant amount of material into the creek channel. Although ground investigations were not conducted, it is suspected that these instances may be related to thawing of frozen ground conditions, or may simply be small-scale instability of fine textured (lacustrine) soils.

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FIGURE 1-1

PROJECT LOCATION

2 Geology

2.1 Physiography

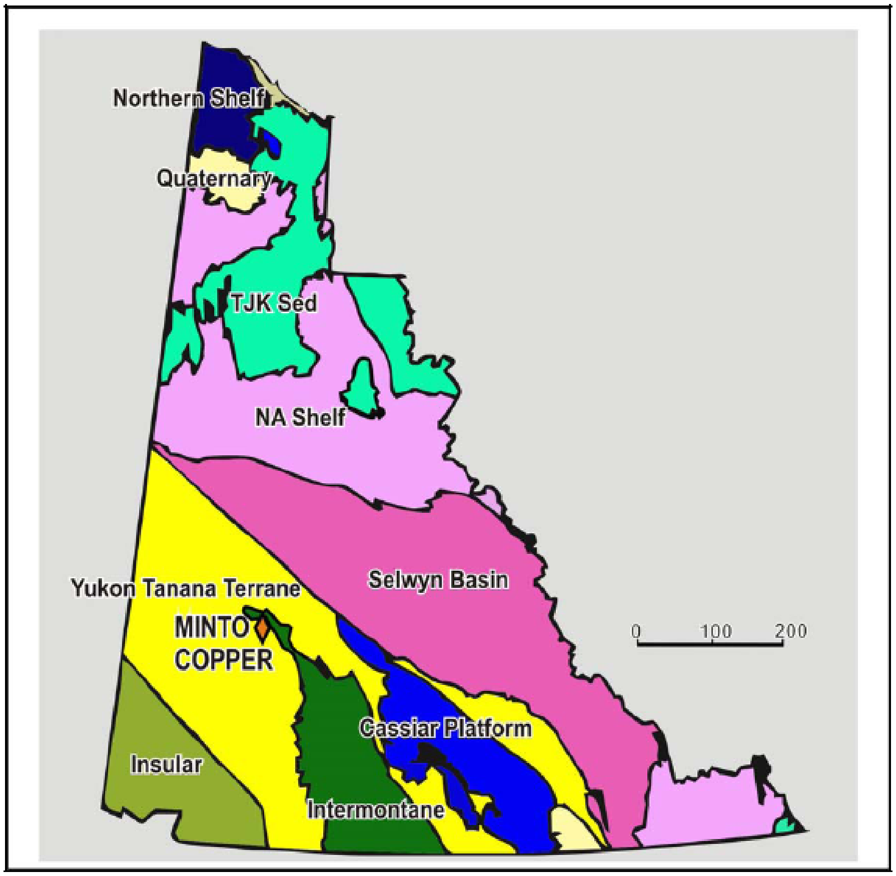
The property lies in the Dawson Range, part of the Klondike Plateau, an uplifted surface that has been dissected by erosion. Local topography consists of rounded rolling hills and ridges and broad valleys. The highest elevation on the property is approximately 1,000 m above sea level, compared to elevations of 460 m along the Yukon River. Slopes on the property are relatively gentle and do not present accessibility problems. Bedrock outcrops can often be found at the tops of hills and ridges. There are no risks of avalanche on the property.

Overburden is colluvium primarily comprised of granite-based sand from weathering of the granitic bedrock in the area and is generally thin but pervasive. It can reach plus 50 m in depth. Seams of clay and ice lenses are also present sporadically. South-facing slopes generally provide well-drained, sound foundation for buildings and roads. North-facing slopes in the area typically contain permafrost.

Vegetation in the area is sub-Arctic boreal forest made up of largely spruce and poplar trees. The area has experienced several wildfires over the years, the latest in 2010, and has no old-growth trees remaining. The fire in 2010 led to the partial evacuation of the camp and a short stoppage in production.

2.2 Bedrock Geology

The Minto Project is found in the north-northwest trending Carmacks Copper Belt along the eastern margin of the Yukon-Tanana Composite Terrain, which is comprised of several metamorphic assemblages and batholiths (Figure 2—1). The Belt is host to several intrusion-related Cu-Au mineralized hydrothermal systems. The Yukon-Tanana Composite Terrain is the easternmost and largest of the pericratonic terrains accreted to the Paleozoic northwestern margin of North America (e.g., Colpron *et al.*, 2005). It is regarded to be the product of a continental arc and back-arc system, preserving meta-igneous and metasedimentary rocks of Permian age on top of a pre-Late Devonian metasedimentary basement (e.g., Piercey *et al*. 2002).



From: Yukon Geologic Survey "Maps Yukon" website (www.geology.gov.yk.ca)

Figure 2—1: Yukon Geology (from Yukon Geologic Survey "Maps Yukon" website (www.geology.gov.yk.ca)

The Minto Property and surrounding area are underlain by plutonic rocks of the Granite Mountain Batholith (Early Mesozoic Age) (Figure 2—2: Regional Geology) that have intruded into the Yukon-Tanana Composite Terrain. They vary in composition from quartz diorite and granodiorite to quartz monzonite. The batholith is unconformably overlain by clastic sedimentary rocks thought to be the Tantalus Formation and andesitic to basaltic volcanic rocks of the Carmacks Group, both of which are assigned a Late Cretaceous age. Immediately flanking the Granite Mountain Batholith, to the east, is a package of undated mafic volcanic rocks, outcropping on the shores of the Yukon River. The structural relationship between the batholith and the undated mafic volcanics is poorly understood because the contact zone is not exposed

Geobarometry and geothermometry data (Tafti and Mortensen, 2004) suggests that the Granite Mountain Batholith was emplaced at a depth of at least 9 km, while the presence of euhedral to subhedral epidote, interpreted by Tafti and Mortensen as magmatic in origin, suggests a deeper emplacement depth in the order of 18 to 20 km.

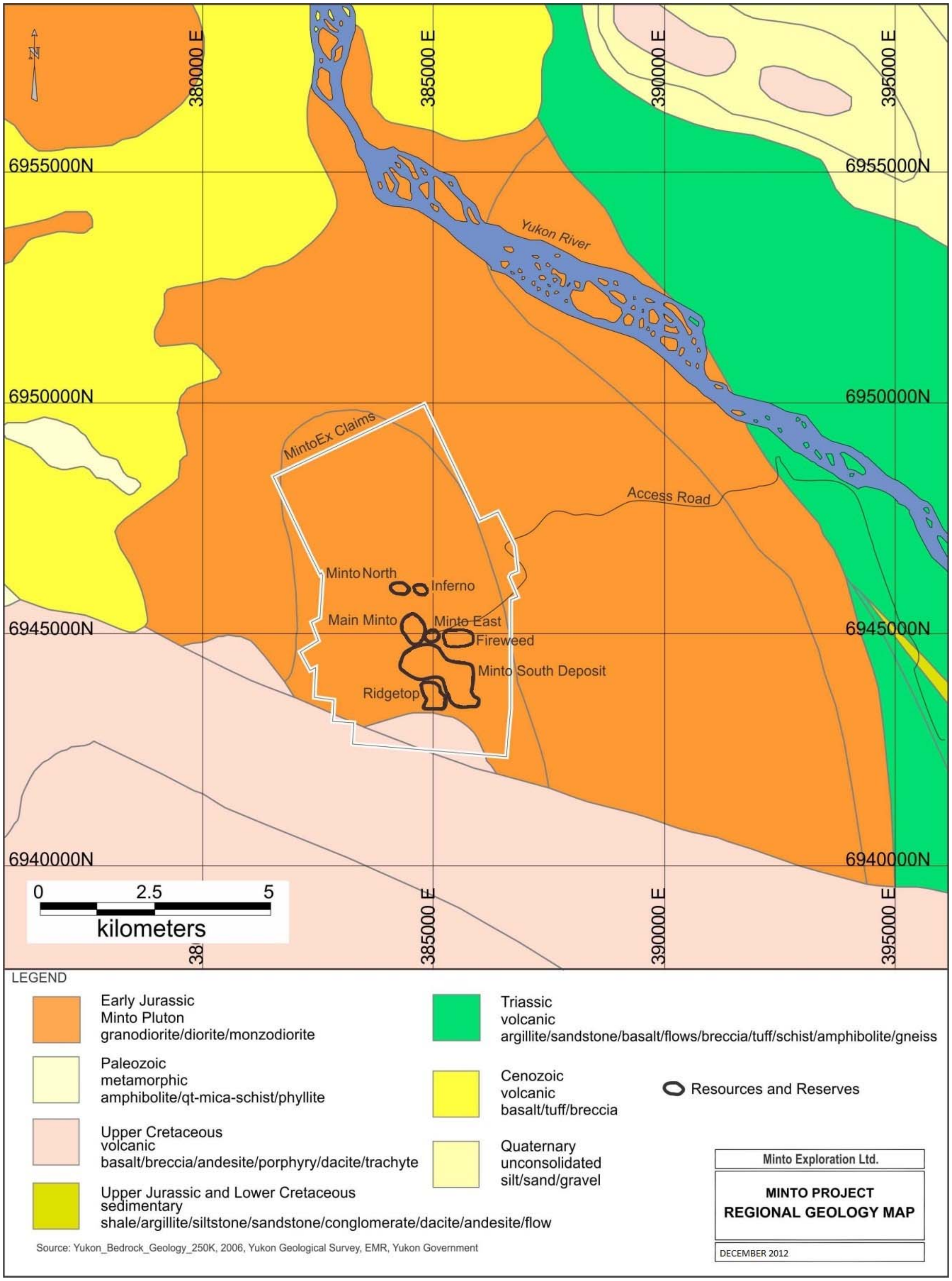


Figure 2—2: Regional Geology

2.3 Property Geology and Lithological Description

Much of the geological understanding of the rock around the Minto deposits is based on observations from diamond drill core and extrapolation from regional observations. The reason for this is poor outcrop exposure (less than 5% coverage), as well as the deep weathering and oxidation of any existing exposed outcrop. The terrain was not glaciated during the last ice age event.

Five additional deposits of mineralization are reported in this document outside of the Minto Main Deposit; Minto South Deposit, Ridgetop, Minto North, Inferno, Fireweed, and Minto East (Figure 2—2). For the purpose of this report Area 2, Area 118, Copper Keel, and Wildfire resource sub-domains are now considered continuous and reported as one deposit, namely Minto South Deposit (MSD) located immediately south of Main Minto. Names of these resource sub-domains are retained for ease of discussion when discussing regions within MSD. The Ridgetop deposit is located just over 300 m south of the Area 2/118 resource sub-domain, the Minto North and Inferno deposits are located about 700 m north of the Main Deposit, the Fireweed deposit is located just over 500m east of the south end of the Minto Main deposit, the Minto East deposit is located about 200 m east of the south end of the Minto Main deposit, while the Copper Keel and Wildfire sub-domains form a southeast extension from Area 2/118. Each of these deposits closely shares a similar style of mineralization of shallow dipping copper sulphide mineralized zones. The Main Minto deposit was exposed in the dormant open pit mine; similarly, this flat geometry is currently exposed in the Minto South Deposit (Area 2 resource sub-domain) starter pit. In addition to these mineral deposits which have NI 43-101 compliant mineral resources there are several significant mineral prospects. These deposits and prospects define a general north-northwest trend..

The hypogene copper sulphide mineralization at Minto is hosted wholly within the Minto pluton, which intrudes near the boundary between the Stikinia and Yukon-Tanana terrains, however since the contact is not exposed it is unclear if the pluton stitches the two terrains. The Minto pluton is predominantly of granodiorite composition. Hood *et al*. (2008) distinguish three varieties of the intrusive rocks in the pluton. The first variety is a megacrystic K-feldspar granodiorite. It gradually ranges in mineralogy to quartz diorite and rarely to quartz monzonite or granite, typically maintaining a massive igneous texture. An exception occurs locally where weakly to strongly foliated granodiorite is seen in distinct sub-parallel zones several meters to tens of meters thick.

A second variety of igneous rock is quartzofeldspathic gneiss with centimeter-thick compositional layering and folded by centimetre to decimetre-scale disharmonic, gentle to isoclinal folds (Hood et al., 2008). The third variety of intrusive is a biotite-rich gneiss. MintoEx geologists consider all units to be similar in origin and are variably deformed equivalents of the same intrusion.

Copper sulphide mineralization is found in the rocks that have a structurally imposed fabric, ranging from a weak foliation to strongly developed gneissic banding. For this reason all core logging by the past and present operators separates the foliated to gneissic textured granodiorite as a distinctly discernible unit. It is generally believed by MintoEx geologists that the foliated granodiorite is just variably strained equivalents of the two primary granodiorite textures and not a separate lithology.

While this interpretation, based upon detailed observations from logging of tens of kilometers of drill core is highly likely but it still needs to be conclusively proven. Tafti & Mortensen (2004) noted that the relatively massive plutonic rocks have similar mineral and chemical composition as the foliated rocks. Research in collaboration with the Mineral Deposits Research Unit ("MDRU") of the University of British Columbia is on-going.

The contact relationship between the foliated deformation zones and the massive phases of granodiorite is generally very sharp. These contacts do not exhibit chilled margins and are considered by MintoEx geologists to be structural in nature, separating the variably strained equivalents of the same rock type. Tafti and Mortensen (2004) had interpreted the sharp contacts to be zones of deformed rock within the unfoliated rock (i.e. rafts or roof pendants). Supergene mineralization occurs proximal to near-surface extension of the primary mineralization and beneath the Cretaceous conglomerate.

Conglomerate and volcanic flows have been logged in drill core by past operators. New drilling has confirmed the presence of conglomerate, but not the volcanic flows. The latter cannot be confirmed by the authors as the drill core from historic campaigns was largely destroyed in forest fires and no new drilling has intersected such rocks. However, undated volcanic rocks are mapped by Hood, near the southwest margin of the property, south of a fault that is inferred from geophysics to separate them from the Jurassic Age intrusive rocks. The conglomerate has been dated (unpublished date pers. com. Dr. Maurice Colpron - Yukon Geological Survey) as Cretaceous Age. It is now recognized as an outcrop within a borrow pit exposure located west of the airstrip as well as in numerous recent drill holes. Observations of foliated and even copper mineralized cobbles in drilling indicate that "Minto-type" mineralization was exposed, eroded and reincorporated in sedimentary deposits by the Cretaceous Age.

Other rock types, albeit volumetrically insignificant, include dykes of simple quartz-feldspar pegmatite, aplite; and an aphanitic textured intermediate composition rock. Bodies of all of these units are relatively thin and rarely exceed the one meter core intersections. These dykes are relatively late, and observed contact relationships suggest they generally postdate the peak ductile deformation event; however some pegmatite and aplite bodies observed in a rock cut located north of the mill complex are openly folded.

It is unclear if this folding is contemporaneous with foliation development in the deformed rocks or post-dates the foliation development. Observations from drill core and open cut benches in the mine show examples where the foliation and the pegmatitic/aplitic intrusions are both folded, as well as examples where the intrusions are not folded, suggesting two populations of minor dykes.

2.4 Seismic Hazard

The tectonics and seismicity of southwestern Yukon are influenced primarily by the Pacific and North American lithospheric plate margins. In Yukon's St. Elias region, northwest British Columbia and southeast Alaska, the boundary of the two lithospheric plates changes from right lateral transform to subductive. Instead of sliding past each other, the Pacific Plate is forced beneath the stable North American plate resulting in the St. Elias region being uplifted. This transfer of force along the fault into uplift or mountain building dissipates tectonic energy, reducing seismic effects on the region northeast of and across the fault (SRK 2013c).

An assessment of peak ground acceleration was performed for the Minto project area using the 2010 National Building Code Seismic Hazard Calculation. The BC Mine Waste Rock Pile Research Committee 1991 outlined that a 10% probability of exceedance in 50 years or the 1:475 event is appropriate for dump design. This peak ground acceleration in the Minto project area is approximately 0.057 g.

3 METEOROLOGY

The existing meteorology of the Project area and the climate trends and projections of the Minto region of Yukon were described in detail in EBA's report *Minto Mine – 2010 Climate Baseline Report* and subsequently in ACG's *Minto Climate Baseline Report* (2012) (Appendix 1-2). The meteorological data contained in the report was recorded by two on-site meteorological stations over a period of about seven years. Snow depth data was provided from ten annual on-site snow surveys since 1994. The data used in climate trend analyses was sourced from regional monthly and annual records provided by the Meteorological Service of Canada and applied to the Project area. Environment Canada's CGCM2 provided future temperature and precipitation scenarios for the purpose of climate forecasting for the region. Details of the data collection program and the procedures used for analysis are provided in the Climate Baseline Report in Appendix 1-2.

3.1 GENERAL REGIONAL CLIMATE

The climate in the Minto region is subarctic continental characterized by long, cold winters and short, cool summers. The area experiences moderate precipitation in the form of rain and snow and a large range of temperatures on a yearly basis with a mean annual temperature below 0°C.

3.2 SUMMARY OF METEOROLOGICAL CONDITIONS (2005-2012)

Two meteorological stations installed at the property have recorded wind speed and direction, air temperature, relative humidity, barometric pressure, solar radiation and rainfall in one-hour intervals since September 7, 2005 for the HOBO and October 15, 2010 for the Campbell Scientific station.

3.2.1 Wind

Severe rime ice build-up on the HOBO anemometer cups has resulted in extended periods of recorded zero or diminished wind speeds during the winter (EBA 2010). The Campbell Scientific anemometer has shown to be much less prone to icing. Based on the wind record from the two meteorological stations, and excluding periods where the anemometer was iced up, the two predominant wind directions at site are S to SE and N to NW. Average wind speed is 2.64 m/s at 3 m height and 2.9 m/s at 10 m.

3.2.2 Air Temperature

Summer is characterized by temperatures in the range of 10°C to 20°C. Winter is characterized by a much larger day-to-day variation in temperatures, typically between –10°C and –30°C. Diurnal variation in air temperatures tends to be less during the winter period than during the summer period. The transitions between winter and summer are characterized by a quick rise or fall in air temperatures. July has been the warmest month on average (14.6°C) while the coldest has been January (–19.1°C). The mean annual air temperature at the site is –1.8°C. The maximum air temperature ever recorded was 30.3°C. The minimum air temperature ever recorded was –43.2°C.

3.2.3 Relative Humidity

Relative humidity is highest during the winter months (typically in the range of 75% to 95%) and lowest during the spring and early summer, typically in the range of 40% to 60%. Relative humidity has a much larger day-to-day variability during the summer. The lowest recorded %RH was 10.25%. The highest was 100%. Annually, mean relative humidity is 71%.

3.2.4 Barometric Pressure

Barometric pressure recorded on-site at 885 m elevation has been converted into a meteorological standard sea level equivalent. Barometric pressure is slightly higher on average between May and September (above 1009 hPa), and lowest between October and April (below 1006 hPa), with the exception of February. Mean annual sea level equivalent barometric pressure is 1007.5 hPa.

3.2.5 Solar Incident Radiation

As would be expected at a latitude of 62.6°N, a strong seasonal pattern is evident in solar radiation, with a maximum being received near the summer solstice in late June (daily maximums on the order of 750 W/m^2), and daily maximums slightly above zero around the winter solstice. The average amount of solar radiation received at the site annually is 111 W/m^2. The highest daily average is received in June (230 W/m^2). The lowest is in December (5 W/m^2).

3.2.6 Precipitation

3.2.6.1 Rainfall

The tipping bucket rain gauge mechanism used to record precipitation at site is designed to record rainfall. However, wet snow falling into the catch tube and melting in the bucket at temperatures near 0°C would result in an instance of recorded precipitation. In order to provide an accurate estimate of total rainfall only, any recorded precipitation occurring when air temperatures were below zero was omitted from the record (EBA 2010). Based on a cumulative of average monthly rainfall, 174.2 mm of rain is expected on average at site in a single year (EBA 2010). August is the rainiest month with an average rainfall of 51.0 mm. The largest monthly rainfall total was 101.8 mm (July 2011). The largest one-day rainfall was 28.2 mm (August 25, 2008). Rainfall has been recorded in every month of the year.

3.2.6.2 Total Precipitation

On October 14, 2011, a snowfall conversion adaptor was installed on the tipping bucket of the Campbell Scientific station; however, the total precipitations record is not long enough yet to provide meaningful statistics. Environment Canada's Canadian Climate Normals (1971-2000) for Pelly Ranch indicate that on average, annual precipitation occurs 64% as rainfall and 36% as snow. With the assumption that regional precipitation is homogeneous and ignoring any significance of elevation, orographic effects or valley orientation, the Minto property can be estimated to receive an additional 100 mm of water-equivalent precipitation in the form of snow annually for a total annual precipitation of approximately 274 mm (EBA 2010).

3.2.6.3 Snowpack

Based on the ten years of snow surveys, the average water-equivalent snow depth remaining on the first day of March and April is 95.0 mm and 96.8 mm respectively. In four of the seven May surveys, the snowpack had melted entirely by May 1. In the three years where snow remained on the ground on May 1 (1995, 2006, and 2008), the mean snowpack had reduced to 10%, 27%, and 20%, respectively, of the peak measured snowpack in that year. The data indicates that the majority of runoff due to snowmelt occurs in April.

3.2.6.4 Evaporation

No evaporation data have been recorded at the Minto site. Applying Environment Canada's average daily evaporation estimates from Pelly Ranch over the period 1971–1999, corrected for elevation, suggests an annual evaporation rate at site on the order of 400 mm/year (EBA 2010). An instruction for evapotranspiration (ET) calculation was incorporated into the Campbell Scientific program and will provide ET estimates starting in July 2012.

3.3 Regional Climate Trends

3.3.1 Temperature

3.3.1.1 Past Trends

The annual mean temperature has been increasing at Pelly Ranch by 0.06°C per year on average over a 50-year period, corresponding to a total average increase of 3.0°C between 1957 and 2006. January (winter) mean temperatures have experienced the highest rate of increase (0.13°C per year on average), corresponding to a total average increase of 6.5°Cover the 50-year period. The mean annual temperature at Carmacks has been increasing by 0.06°C per year on average, corresponding to a total average increase of 3.0°C between 1964 and 2011. With respect to seasonality, January mean temperatures have been increasing by 0.19°C per year on average, corresponding to a total average increase of 9.3°C from 1964 to 2011. A close correlation between monthly average temperatures recorded at Minto and at Pelly ranch and Carmacks, as well as the proximity of the stations to the property, suggests that the 50-year trend would also be applicable to the Minto property. Winter temperatures at Minto however are approximately 3°C to 5°C higher due to a predominant Yukon winter temperature inversion of +8°C/ km up to an elevation of 1200 m (EBA 2010).

3.3.1.2 Future Trends

Using the average of five Global Climate Models that were found to perform best over Alaska and the Arctic, averages have been calculated using a 50 km buffer around the Minto Mine site, and suggest an increase in mean annual temperature of 2.0 to 2.2°C by 2030 and 2.6 to 3.8°C by 2050 from the 1961–1990 baseline.

3.3.2 Precipitation

3.3.2.1 Past Trends

Environment Canada monthly precipitation records at Pelly Ranch and Carmacks show a general increase in total annual precipitation over the last 60 years of 1.1 mm/year and 1.4 mm/year on average respectively, corresponding to an increase in annual precipitation between 1955 and 2006 of between 60 and 80 mm over the region (EBA 2010).

3.3.2.2 Future Trends

Many GCMs predict increasing mean annual precipitation at high latitudes of North America (Nohara et al. 2006). The Scenarios Network for Alaska and Arctic Planning projections suggest an increase in annual precipitation ranging from 8 to 13% by 2030 and 12 to 20% by 2050 from the 1961–1990 baseline.

4 Surface Water Hydrology

The baseline surface hydrology of the Minto Creek watershed prior to mining activity was detailed in Clearwater Consultants Ltd.'s Memorandum CCL-MC6 *Minto Copper Project—Surface Water Hydrology Conditions* (baseline memorandum attached as part of Appendix 1-1). CCL-MC6 also covered conditions during mine operations until 2009. This CCL-MC6 report has been supplemented with onsite data collection from 2009 until the end of the 2012 open water season. Additionally since 2009, data has been gathered from the McGinty Creek catchment which is located directly north of the Minto Creek catchment. The McGinty Creek catchment is similar in size to Minto Creek, and it also drains into the Yukon River. An updated *Surface Hydrology Baseline Conditions Report* prepared by ACG (2013) is presented in Appendix 1-1.

Hydrological data have been gathered by either ACG or Minto representatives. Data coverage from year to year varies, depending on when in situ dataloggers were installed and removed, and when instantaneous discharge measurements were taken. Instantaneous discharge is measured using the velocity-area method and a current meter. Solinst Water Leveloggers are used to collect continuous stage readings which are then corrected based on physical staff gauge measurements. The records are processed into continuous discharge based on the stage-discharge relationship. This relationship (stage and discharge) is established each season through rating measurements obtained during regular field visits to the sites.

The locations for which the greatest amount of data have been collected are stations W1, Minto Creek near the mouth (catchment area of 42 km^2); and W3, Minto Creek downstream of water storage pond dam (catchment area of 10.4 km^2 area). In 2010, another continuously monitored hydrometric site called MC1 was added, approximately 2 km upstream of W1. In 2011, data collection did not allow for processing of stage records into continuous discharge; however, improved monitoring allowed for successful processing in 2012.

In addition to Minto Creek, the catchment to the north has been monitored since 2009 to support development of the Minto North deposit, and is referred to as McGinty Creek. There are five stations on McGinty Creek at which discharge is measured. In 2009, four stations were established including MN-4.5, MN-2.5, MN-1.5 and MN-0.5; in 2011 a fifth site, MN-0.2, was added (Figure 4-1). Continuous hydrometric data has been collected at MN-4.5 since 2009, and additional continuous logging instruments were added to stations MN-2.5 and MN-0.5 in late 2012.

All mining to date has taken place within the Minto Creek catchment area. Phase V/VI will include the development of the Minto North Pit, which is in the McGinty Creek catchment area. McGinty Creek was named by SFN elders after the family whose traditional trapping area is in the vicinity of the Minto Mine.

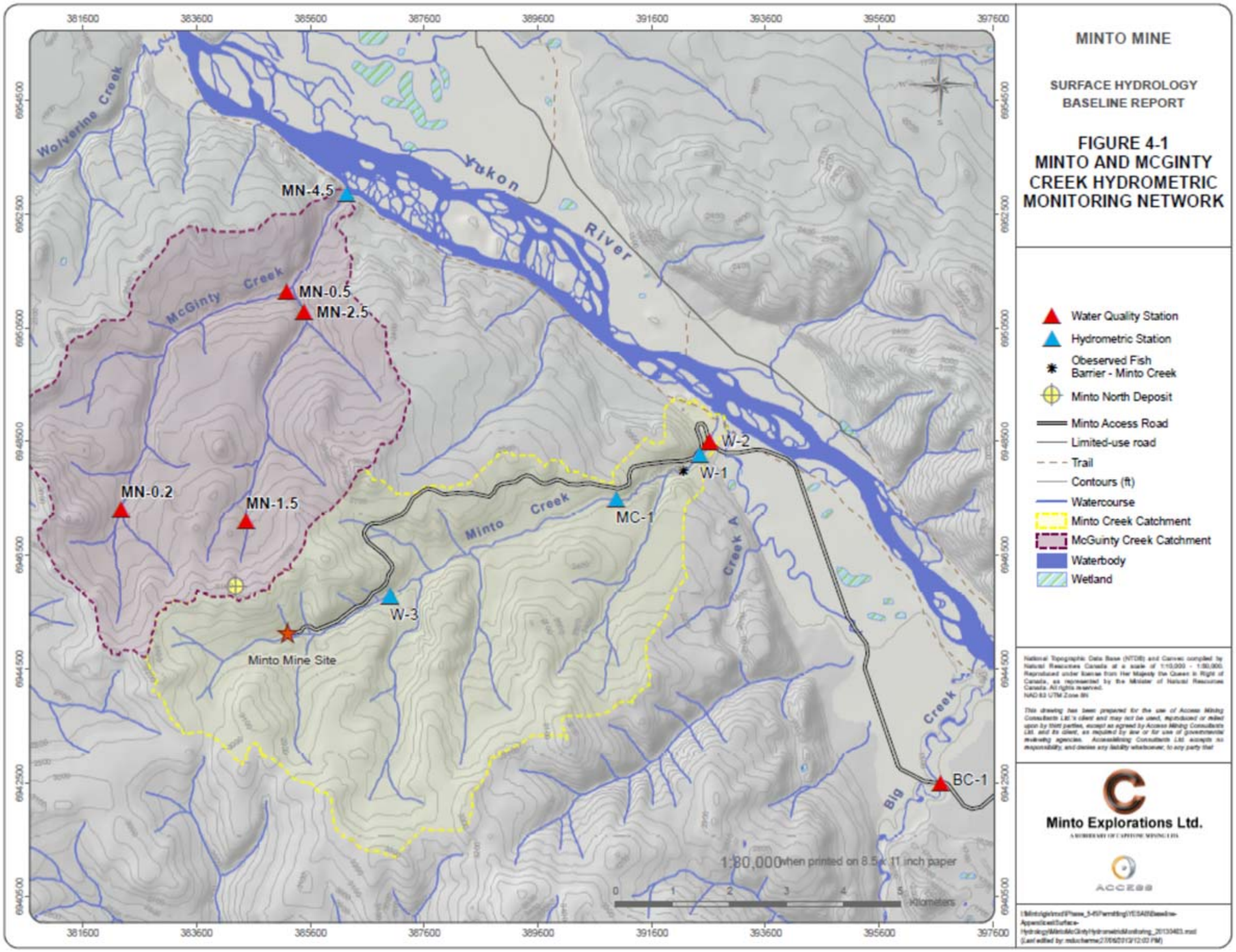


Figure 4-1: Minto and McGinty Creek Hydrometric Monitoring Network and Catchment Areas.

4.1 MINTO CREEK

Monitoring of hydrological parameters on Minto Creek began in 1993 and has continued intermittently at sites W1 and W3 (Figure 4-1). Monitoring has been more intensive since mine commissioning in 2007. W3 is an in-stream trapezoidal flume with a manufacturer-specified stage-discharge relationship. Both discharge and stage are read on an integrated gauge in the throat of the flume. A Solinst Levelogger record is calibrated with these field observations to process a continuous discharge record at this site. Sites MC1 and W1 are natural stream channels where manual velocity measurements are taken across the channel and discharge is calculated using the velocity area method. Continuous water levels from Solinst Leveloggers are processed into continuous discharge using these rating measurements. Updated mean monthly flows for W1 and W3 are presented in Table 4-1 and Table 4-2, respectively.

Table 4-1: Mean Monthly[1] Discharge (m^3/s) on Minto Creek at Station W1.

	April	May	June	July	August	September	October
1993						0.069	
1994		0.312	0.058	0.095	0.007	0.073	
1995		0.027	0.001	0.091		0.133	
1996		0.031	0.024	0.324		0.146	
1997		1.447			0.265		
1998		0.161			0.003		
1999					0.033		
2000		1.004					
2001		0.467					
2002							
2003					0.129		
2004				0.118			
2005		0.097	0.012	0.127	0.209	0.219	0.134
2006	0.203	0.354	0.15	0.02	0.0068		0.031
2007	0.645	0.175	0.053	0.061	0.025	0.034	0.035
2008		0.117	0.015	0.026	0.184	0.184	0.026
2009		0.868	0.351	0.249	0.139	0.026	
2010	0.560	0.081	0.038	0.106	0.118	0.125	0.092
2011			0.229	0.200	0.200	0.082	
2012		0.174	0.071	0.048	0.048	0.077	0.066
Mean							
Pre-mine 1993 to 2006	-[4]	0.433	0.049	0.129	0.093	0.128	0.083
Mining period 2007 to 2012	-[4]	0.283	0.126	0.115	0.119	0.088	0.055
All data 1993 to 2012	-[4]	0.380	0.091	0.122	0.105	0.106	0.064

[1]Monthly flows calculated by averaging all available flow data for a given month. Average flow in months with only a single spot flow measurement assumed equal to the spot flow measurement.
[2]Flows impacted by storage within and emergency releases from the Water Storage Pond in August and September 2008 and in June through October 2009.
[3]2010-2012 flows impacted by storage and/or release from the Water Storage Pond as evidenced by the discharge record at W3.
[4]Insufficient data for calculation.

Table 4-2: Mean Monthly1 Discharge (m3/s) on Minto Creek at Station W3.

	April	May	June	July	August	September	October
1993						0.028	
1994		0.101	0.028	0.039	0.011	0.028	
1995			0.0035	0.017		0.027	0.008
1996		0.013		0.087		0.021	
1997		0.554					
1998					0.006		
1999					0.006		
2000							
2001		0.16					
2002							
2003					0.037		
2004				0.026			
2005		0.046	0.008	0.014	0.017	0.022	0.02
2006	0.018	0.128	0.042	0.006	0.0149	0.0093	0.01
2007	0.0012	0.0118	0.0088	0.0062			
2008					0.064	0.122	0.003
2009			0.026	0.106	0.092	0.124	0.11
2010	0.002	0.004	0.005	0.034	0.071	0.086	0.070
2011			0.005	0.005	0.006	0.005	
2012	0.004	0.020	0.003	0.004	0.004	0.004	0.004
Mean							
Pre-mine 1993 to 2006	-[4]	0.167	0.02	0.032	0.015	0.023	0.013
Mining period 2007 to 2012	-[4]	0.012	0.010	0.031	0.047	0.068	0.047
All data 1993 to 2012	-[4]	0.115	0.014	0.031	0.030	0.043	0.032

[1]*Monthly flows calculated by averaging all available flow data for a given month. Average flow in months with only a single spot flow measurement assumed equal to the spot flow measurement.*

[2]*Flows impacted by storage within and emergency releases from the Water Storage Pond in August and September 2008 and in June through October 2009.*

[3]*2010-2012 flows impacted by storage and/or release from the Water Storage Pond as evidenced by the discharge record at W3.*
[4]*Insufficient data for calculation.*

Table 4-3 shows the discharge data gathered to date at station MC1. Appendix 1-1 contains the associated baseline report and the available hydrographs from 2007-2012 for stations W1, W3, and MC1.

Table 4-3: Instantaneous (2011) and Mean Monthly Discharge (2012) (m^3/s) Measured on Minto Creek at Station MC1.

	Month					
	May	June	July	August	September	October
2011[1]					0.118	0.093
2012	0.153	0.059	0.048	0.038	0.096	

[1] 2011 data based on two spot flows in September and four in October.

4.2 McGINTY CREEK

Instantaneous discharge readings gathered on McGinty Creek since 2009 are included in McGinty Creek Water Quality Characterization (Appendix 1-4). These values have been averaged to show the mean discrete discharge measured during a given month (Table 4-4). Caution should be exercised in using these to represent the actual mean monthly discharge. Comparison of the mean discrete flows for MN-4.5 (Table 4-4) to the mean monthly flows calculated from the continuous discharge (Table 4-5) show that the mean discrete measurements are generally higher. Dataloggers were installed at MN-2.5 and MN-0.5 late in the season in 2012; no continuous data are available at this time. Review of future continuous discharge records at these sites will provide better accounting of surface flows for McGinty Creek.

Table 4-4: Mean Discrete Discharge (m^3/s) measured on McGinty Creek, at station MN4.5.

	Month						
	April	May	June	July	August	September	October
MN-4.5	0.447	0.347	0.152	0.192	0.162	0.067	0.016
MN-2.5		0.161	0.043	0.070	0.050	0.018	0.010
MN-1.5	0.024	0.027	0.015	0.016	0.012	0.005	0.008
MN-0.5		0.216	0.097	0.116	0.111	0.054	0.016

Table 4-5: Mean Monthly Discharge (m^3/s) Calculated from Continuous Discharge Records on McGinty Creek, at Station MN-4.5.

	Month						
	April	May	June	July	August	September	October
2009		0.018	0.033	0.019	0.031	0.016	0.013
2010		0.028	0.051	0.079	0.047	0.034	
2011		0.482	0.096	0.13	0.138	0.068	
2012	0.224	0.245	0.189	0.082	0.052	0.173	
Mean	0.224	0.193	0.092	0.077	0.067	0.073	0.013

Grey values computed with partial data

Hydrographs from 2009–2012 at MN-4.5 are shown in the corresponding base line study (Appendix 1-1). Based on a combination of spot flow measurements and the hydrographs, it appears that maximum monthly discharge on McGinty Creek occurs in May. These data points suggest a later peak runoff on McGinty Creek than on Minto Creek; this could arise from McGinty Creek having a more northerly exposure and a resultant delayed snowmelt. However, April discharge needs to be more thoroughly documented to determine the timing of McGinty Creek's maximum monthly discharge.

5 Surface Water Quality

Surface water quality is a key consideration in the evaluation of potential effects of mining and mineral development projects. Effects from mining activities can be observed for significant distances downstream and changes to water quality parameters have the potential to impact aquatic resources and to affect human use of water resources. Both Minto and McGinty Creeks have been monitored for water quality conditions, with more intensity and duration of sampling in Minto Creek as part of the initial baseline and more recently the intensive operational monitoring under the mine water quality monitoring programs (licenced and otherwise). Characterization reports for water quality in these two watersheds have been developed with the intention of presenting either baseline or existing water quality conditions as the foundation of assessing potential effects from proposed mine expansion activities. These characterization reports are included as Appendix 1-3 (Minto Creek) and Appendix 1-4 (McGinty Creek). Key findings from the characterization reports are included below.

5.1 Minto Creek

The characterization of Minto Creek water quality includes January 2005 to December 2012 monitoring data. Minto Creek water quality data has been reviewed and characterized for key water quality monitoring stations for the pre-mine operation phase and for the operational phase (during both periods of mine effluent discharge to Minto Creek and without mine effluent discharge). A background water quality data set was also redeveloped with the addition of new appropriate data to a previous data set prepared by Minnow Environmental (Minnow 2009).

5.1.1 Background Water Quality

In 2009, to support the redevelopment of the mine WMP, Minnow Environmental compiled Minto Creek water quality monitoring data into a pooled data set that reflected background (unimpacted by development activities) conditions. This data set was screened against the CWQG to determine a rate of exceedance. An exceedance rate of >10% triggered the development of a site-specific water quality objective (SSWQO). SSQWOs were calculated for the following parameters: aluminum, chromium, copper, and iron. These SSWQOs were intended to be used as comparative metrics for ongoing water quality monitoring, for parameters that are naturally elevated above the generic CWQGs. Together, these water quality objectives (WQOs) provide a useful tool for evaluating changes in water quality, and to provide an indication of potential effect thresholds. These WQOs are not appropriate for (and were never intended to be used as) licenced water quality limits, as transpired through the mine water licence amendment process in 2010.

The mine water-quality monitoring program has continued to monitor stations within the operational area, downstream stations which are exposed to the influence of mine effluent discharge, and downstream stations which are not exposed to effluent. Data from these non-exposed stations are considered to be relevant the background water quality condition in Minto Creek, and were therefore added to the pre-existing 2009 background data set. New background data sets were developed for periods up to the end of 2010 and to the end of 2012. A comparison of the summary statistics of these two data sets shows the substantial change in background water quality in Minto Creek in 2011 and 2012 without the influence of any site effluent discharge (see discussion below).

The 2012 background data set was utilized to redevelop SSWQOs and followed the same process as Minnow in 2009 (with the exception of removing high TSS results.) This resulted in a substantial increase in the SSWQOs for the 2009 parameters (aluminum, chromium, copper, iron) and the addition of SSWQOs for the parameters fluoride and phosphorus. These SSWQOs (in addition to the 2009 SSWQOs and combined with the CWQGs) are used for screening purposes in the Aquatic Resources Effects Assessment analyses in section 8. The background water quality data are also used in the water quality prediction work (presented in section 7 and the associated appendices) as the ‘unimpacted’ source term for undisturbed catchment areas.

5.1.2 Downstream Water Quality (Station W2)

Generally speaking, during the pre-mine operation phase, aluminum, cadmium, chromium, copper, and iron concentrations showed exceedances of the CWQGs. These natural elevations were primarily associated with natural mineralization and/or elevated TSS concentrations. A much more robust data set exists for the operations with no discharge phase which also showed exceedances of the CWQGs for the same parameters as during pre-operations: aluminum, cadmium, chromium, copper, and iron.

In 2011 TSS levels in lower Minto Creek were observed to increase at stations MC1 and W2, the source of which has since been identified as a substantial natural release of soil materials into a tributary of the Minto Creek watershed (downstream of the mine.) This had a leveraging effect upon metal concentrations, increases of which have also been observed in the lower stations of Minto Creek.

At station W2, the following observations are made of the water quality between the discharge and non-discharge phases, as compared to the W2 non-freshet water licence limits:

- Exceedances of the aluminum limit are highest during the operations with no discharge phase; in particular, the limit was exceeded more often than not during 2011 and 2012.
- Cadmium exceedances at W2 compared to the non-freshet limit are higher during mine discharge periods.
- Copper exceedances at W2 compared to the non-freshet limit appear to remain the same between the discharge and non-discharge periods.
- Frequency of iron exceedances is highest during the non-discharge periods.
- Selenium and nitrate frequency of exceedance is substantially higher during periods of mine discharge.

- The total phosphorus limit is exceeded for most of the samples.

These comparative results illustrate the propensity for water quality in lower Minto Creek to exceed the W2 water use licence standards frequently, in mine non-discharge periods.

5.1.2.1 McGinty Creek

Water quality data for McGinty Creek has accumulated at five stations over the course of more than three years of monthly monitoring since May 2009, as conditions allowed. Activities to date within the upper watershed consisted of exploration drilling in the vicinity of the Minto North deposit in 2008 and early 2009 (all predating the water quality monitoring activities.)

Parameters that show regular exceedances of the CWQG include total aluminum, cadmium, chromium, copper, iron, lead, zinc, and fluoride. Parameters that have been shown to infrequently exceed the CWQG include arsenic, mercury, silver, ammonia, and pH. Many parameters show spikes in concentrations in the summers of 2010 (August), 2011 (July) and 2012 (June). These spikes in parameters correspond with spikes in TSS and can be attributed to corresponding heavy precipitation events. When TSS concentrations are elevated due to heavy rains or freshet runoff, it is not uncommon for TSS-associated metals to be elevated as well.

Concentrations are typically highest at station MN-1.5. Parameter concentrations appear lowest in the winter, rising again in the spring with peak levels recorded in July and August during precipitation/runoff events. A set of WQOs was developed for McGinty Creek (using the entire McGinty Creek monitoring data set to identify SSWQOs, and the CWQGs where they were not routinely exceeded.) The WQOs are utilized as a screening tool in section 8 where they are compared with predictive water quality modeling for the McGinty Creek catchment. The summary statistics for the water quality data set also provided for the appropriate development of an 'unimpacted' source term for the water quality modeling work.

6 GROUNDWATER

In August 2010, SRK produced a Groundwater Baseline Conditions report for the Minto Mine area. The 2010 report included an assessment of data collected from groundwater wells in the area and resulted in a conceptual model of the groundwater flow system and its interaction with receiving surface water bodies. A monitoring program was devised and subsequently upgraded to monitor any effects on groundwater quality and quantity as the Phase IV mine plan was carried out. In 2013, an updated *Minto Mine Phase V/VI Expansion: Hydrogeological Characterization Report* was provided by SRK (Appendix 1-5).

SRK used drilling information and piezometer installation information to inform the conceptual model and help determine appropriate locations for the multi-layer wells that were installed in 2009 and 2012. These wells were installed downgradient of the waste rock and overburden dumps, Main pit, Minto North and the DSTSF.

Generally, the groundwater chemistry was observed to be similar to the surface water mean annual concentrations (significantly less than 1 order of magnitude) (Groundwater Baseline Conditions report, SRK 2010, Appendix 1-1).

Groundwater flow is dominated by topography and most will be confined below the permafrost layer where it occurs. Minor seasonal shallow subsurface flow will occur above the permafrost in those areas. It is believed that flows both above and below site permafrost ultimately reports to Minto Creek. The site is broken down into sub areas and flow regimes are described in detail within the 2013 *Minto Mine Phase V/VI Expansion: Hydrogeological Characterization Report* (in Appendix 1-1).

7 WILDLIFE

Wildlife assessments were completed within, or near, the Project area between 1994 and 2012. These assessments are summarized in ACG's *Summary of Wildlife Baseline Surveys Conducted 1994–2012* (Appendix 1-7).

The completed assessments mainly focused on moose (*Alces alces*), Dall's sheep (*Ovis dalli*), caribou (*Rangifer tarandus dalli*), and raptors. Other wildlife observations and sign (tracks, scat, browse, etc.) were also recorded during these surveys. The existing conditions for wildlife at the Minto Mine are summarized in Table 7-1 (EBA 2010), which lists the wildlife surveys and studies conducted since 1994 in the Minto Mine area.

Table 7-1: Wildlife Surveys and Studies Undertaken in the Minto Mine Project Area.

Dates	Type of Survey	Conducted By
January–March 2012	Late Winter Ungulate Studies	EDI, Environment Yukon
Fall 2012	Klaza Caribou Herd Study	Environment Yukon
March 2011	Late Winter Ungulate Study	EDI, Environment Yukon on behalf of Casino Mining Corporation
July 2010	Baseline Ecosystems and Vegetation Report*	Access Consulting Group
March 2010	Minto Mine Environmental Baseline Ecosystems and Vegetation Report	EBA Engineering Consultants Ltd.
February 2010	Late Winter Moose (Aerial)	Access Consulting Group
December 2010	Post-rut Moose Survey (Aerial)	Access Consulting Group
June 2009	Dall Sheep Survey (Aerial)	Environment Yukon
2007	Moose Survey	Environment Yukon
2003	Klaza Caribou Herd Survey	Environment Yukon
1994	Spring Wildlife Survey Spring Dall Sheep Survey Summer Raptor Survey Summer Wildlife Ground Pellet Survey	Hallam Knight Piesold Ltd.

*The 2010 Baseline Ecosystems and Vegetation Study (ACG 2010a) was not focused primarily on wildlife; however, general wildlife observations were made during the vegetation survey and were recorded on plot data sheets. This ground-based survey provided information regarding the presence of smaller animals as well as larger mammals that can be more easily seen by aerial surveys.

Since the last wildlife baseline studies inventory (EBA 2010a), there have been three YG-led wildlife studies conducted that included the Minto site and vicinity. Two of these were late-winter ungulate surveys performed in 2011 and 2012. The survey area encompassed the Carmacks West moose management unit and the Klaza caribou herd range, for a total area of 6,430 km^2. In January 2013, ACG contacted the Mayo Regional Biologist, Mark O'Donoghue, for further information on these studies. Mr. O'Donoghue provided the following bulleted summary (via email) regarding recent ungulate surveys in the Project area:

- "A late-winter distribution survey of moose and caribou in March 2011 covering a very large area west and south of the Yukon River (south to about the Nansen Road, west to about the Klotassin River, so covering the Minto Mine area). This was repeated by EDI in March 2012.
- "A survey of sheep along the Yukon River from Minto to Fort Selkirk in June 2011 and June 2012—these have been done since 2000.
- "A census of Klaza caribou in October 2012 (which followed a composition survey in September). This was done in alpine areas to the west and southwest of the mine.
- "A survey to map lambing range of sheep and alpine raptor nests in the Dawson Range in May 2012, to the west and southwest of the Minto Mine. This was only partially completed because of poor weather and we are aiming to complete it in 2013 so there's no survey report yet. This survey was well to the west and southwest of the mine site, though."

The sheep survey referenced is attached in Appendix 1-7aAwhich includes a figure of the surveyed area. Other surveys were not officially available as of March 2013.

7.1 MOOSE

The following section summarizes the existing information on moose in the Project area.

7.1.1 2007 Early-Winter Moose Survey

The early-winter 2007 moose survey for the Carmacks West Moose Management Unit was conducted by YDOE. The following information has been summarized from O'Donoghue et al. (2008).

This survey was conducted in a much larger study area than the surveys conducted by ACG during the winter of 2009/2010, which were specifically focused on the area surrounding the Minto Mine site. However, the densities should be comparable as they are similar habitat types and YG's survey included the study area of the ACG 2010 surveys. The total survey area within this management unit is 4,206 km^2, of which 4,081 km^2 was considered to be suitable moose habitat. A stratified sampling approach was used for this survey, in which the survey area is covered by a grid and each square within the grid is classified as to contain high quality moose habitat or low quality moose habitat (methods as per Kellie and DeLong 2006).

During this survey, a total of 208 moose were observed, with a total population estimate of 520 moose for the study area. The calculated moose density of 124 moose per 1,000 km^2 is considered low. Average moose densities for Yukon Territory are 150 to 249 per 1,000 km^2 (EDI 2011). From the survey data, biologists estimated a ratio of 21 calves and 10 yearlings per 100 cows; this suggests that the survival rate for the previous two years was relatively low. The sex ratio of 75 bulls per 100 cows is considered to be a healthy sex ratio. The average sex ratio for other areas surveyed within Yukon is 68 bulls per 100 cows.

7.1.2 Aerial Moose Survey - Winter 2009/2010

Aerial moose surveys were completed on December 15, 2009 (post-rut) and February 23, 2010 (late-winter) by ACG (2010). For both of these surveys, the study area included the Minto and McGinty creek drainages (Figure 3 in ACG's *Summary of Wildlife Baseline Surveys Conducted* (2012) (Appendix 1-7)). Results of the 2009 and 2010 moose surveys are presented in Table 7-2. More detailed information for these surveys can be found in the ACG 2010 report.

Assuming a 600 m visibility on both sides of the helicopter, the total area surveyed was 112 km^2. Using this survey area, the moose density for the post-rut survey was estimated to be approximately 125 moose per 1,000 km^2, which is nearly the same density found in the 2007 early-spring aerial survey conducted by YG. The calf-to-cow ratio estimated from this data was 25 calves and no sub-adults for every 100 adult cows, and the estimated adult sex ratio was 50 mature bulls for 100 cows, which is low and could be a factor in the low recruitment ratio.

For the late-winter survey, estimated densities were approximately 45 moose per 1,000 km^2. The yearling to cow ratio was 1:1 sub-adults to cows, and no calves were observed during this survey. The estimated adult sex ratio was 300 mature bulls for 100 cows. The difference in this ratio from the YG survey result could be attributed to a small survey area, low number of observations and lack of visual confirmation of gender. It should be noted that on seven occasions during this survey fresh tracks were observed without an associated moose observation.

Table 7-2: Summary of Moose Observations during the 2009 and 2010 Winter Surveys.

Survey	Total	Adult Male	Adult Female	Sub-adult	Calf	Unknown
Post-rut survey December 15, 2009	14	4	8	0	2	0
Late-winter survey February 23, 2010	5	3	1	1	0	0

7.2 Caribou

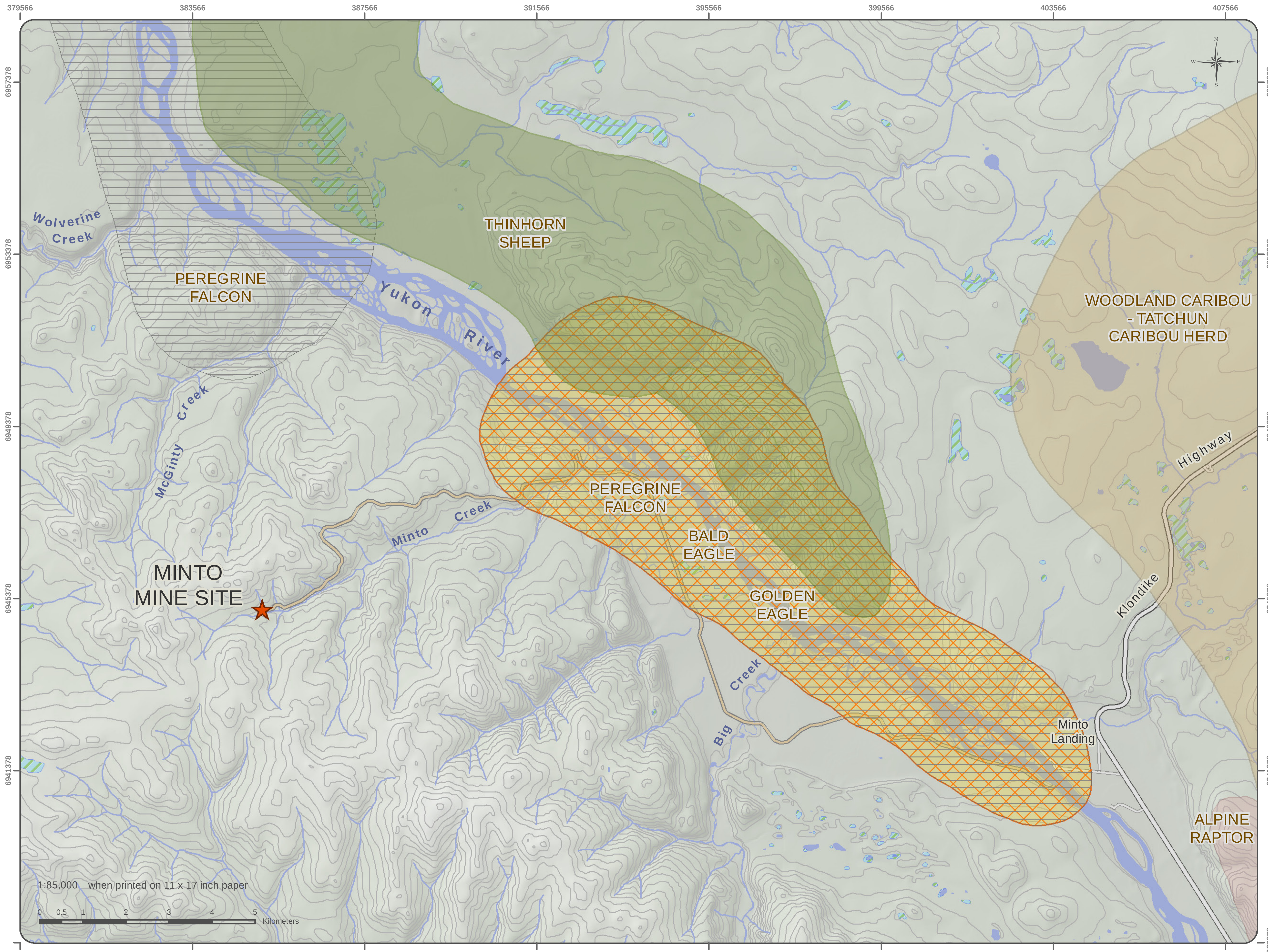
Two woodland caribou herds have the potential to occur within the Minto Mine area: the Klaza and Tatchun. Although neither range for these herds overlap with the Project area, caribou may still occasionally pass through, as documented by HKP during baseline surveys in 1994. No caribou were observed in the Project area during the 2009 and 2010 aerial surveys conducted by ACG.

7.2.1 Klaza Herd

In 2005, the Klaza herd population was estimated at 650 and predicted to increase (Yukon Environment 2005). There are concerns for this caribou herd, as the impacts of increased exploration projects and road development may combine to reduce their population. The herd's range is west of the Minto site. Because the area around the Minto Mine site has experienced numerous fires recently, the habitat is of minimal value for caribou, according to Troy Hegel of Environment Yukon, a caribou, sheep, & goat biologist (pers. comm.). A wildlife key area (WKA) for woodland caribou winter range was identified approximately 9 km west-northwest of the Project area (Yukon Environment 2010). Members of Klaza herd could travel through the site area occasionally and sightings should be recorded and reported. A recent fall (rut) count of the Klaza herd was conducted by Environment Yukon, Environmental Dynamics Inc. (EDI), and Little Salmon Carmacks First Nation members in 2012. The results of this study have yet to be released.

7.2.2 Tatchun Herd

The Tatchun Caribou herd's range is to the east of the Yukon River and does not overlap with the Minto Mine Project area (Figure 7-1). This caribou herd is small, heavily harvested, and should be managed carefully. In 2005, the population estimate for the Tatchun herd was 500 animals. A rutting season composition survey that focused on this range was conducted in 2007, and indicated that the count was much lower than in previous years. The reduced count could result from caribou congregating in areas such as tree cover, where they could not be detected (Yukon Environment 2007). Another count was conducted in the fall of 2012; results are still under analysis and the report is pending.



MINTO MINE
WILDLIFE BASELINE REPORT

FIGURE 7-1 WILDLIFE KEY AREAS

JUNE 2013

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Wildlife Key Area data compiled by the Yukon Department of Environment.
Publication Date: May 2009
Obtained from Geomatics Yukon.
Canvec compiled by Natural Resources Canada at a scale of 1:10,000 - 1:50,000. Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.

Projection: NAD 83 UTM Zone 8N

ACCESS

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(Last edited by: jlindeman;25/06/2013/16:11 PM)

7.3 SHEEP

Dall's sheep are known to inhabit the Project area, particularly the Minto Bluffs along the east side of Yukon River (O'Donoghue 2009). Although the access road to the Minto Mine passes near sheep habitat (Figure 7-1), sheep habitat within the project area itself is limited, and sheep are not expected to occur in the project area for any extended length of time.

Between 2000 and 2009, Yukon Department of Environment conducted annual sheep surveys within close proximity of the Minto Mine site. The survey area extends from the Minto Landing airstrip downstream (north) along the Yukon River to Fort Selkirk (O'Donoghue 2009). Surveys have also been conducted opportunistically by air (in 1989, 1991, 1994, and 2000) and by boat (2000–2009). Between 2000 and 2008, sheep surveys of the Minto–Pelly Bluffs resulted in the observations of between 31 and 91 sheep annually; with the majority of observations being ewes, yearlings, and lambs. During the 2009 survey, 97 sheep were observed, 34 of which were observed on the Minto Bluffs (which is located about 8 kilometres downstream of Minto, across the river from the Minto Mine site). This is the highest recorded population for this area. Most sheep observed during these surveys have been located on the Minto Bluffs, Split Mountain, and Mount Hansen (O'Donoghue 2009).

Aerial sheep surveys were conducted in 1994 as part of the wildlife baseline studies conducted prior to the start-up of Minto Mine. This survey focused on the cliffs on the northeast side of the Yukon River from Minto Landing. Unfortunately, data from this survey were not included in the final report. This report did indicate that sheep were observed, but location(s) were not mentioned.

7.4 OTHER WILDLIFE

Fur and big game harvest statistics indicate that the following species occur in the Minto project area: grizzly bear, black bear, coyote, gray wolf, red fox, wolverine, marten, least weasel, river otter, beaver, and lynx. Cougars may also have the potential to occur in the area as they are known to follow mule deer (Smith et al. 2004); however, the probability of an occurrence is considered to be low.

Of the species listed above, the following species or sign of the species have been observed, on site: grizzly bear, black bear, gray wolf, lynx, river otter (HKP 1994, Capstone 2007, Capstone 2008, ACG and Horizon Ecological Consultants 2010).

Small mammals common to the area include red squirrel, varying hare, fox, mink, weasel, vole, and shrew. The Minto Mine site is situated at the apex of five drainages that are part of the Yukon River watershed, so wildlife uses the area to access the valleys offering conduits from lowlands to highlands for seasonal foraging and hunting (ACG 2010).

A total of 13 raptor species (*Summary of Wildlife Baseline Surveys Conducted* (2012) (Appendix 1-7)) have the potential to occur within the study area. Raptors may breed throughout the study area, with select areas attracting higher breeding densities (e.g., riparian zones) than other areas (e.g., pine stands). Species that have been observed and documented in the Project area include the red-tailed hawk (HKP 1994), peregrine falcon (Mossop, pers. comm. as cited in HKP 1994), and golden eagle. Only one aerial-based raptor survey was conducted as part of the Minto Mine baseline studies (HKP 1994).

High quality riparian cliff habitat for raptors exists along the Yukon River downstream of the Minto Mine access road. A WKA (wildlife key area) for golden eagle summer nesting habitat has been identified approximately 3 km to the east of the project area (Yukon Environment 2010b) (Figure 7-1). This WKA is primarily associated with the steep bluffs along the Yukon River and includes a buffer area. No cliff-nesting raptor habitat has been identified within the Project area itself. The access road to the Minto Mine, however, runs adjacent to potential nesting areas for cliff-nesting raptors, such as the golden eagle and peregrine falcon.

Game birds that have been observed or that have the potential to occur in the study area include grouse (spruce, ruffed, sharp-tailed) and ptarmigan (willow, white-tailed, and rock). Of the species of grouse that live in Yukon, the sharp-tailed grouse is currently the only species of management concern. Sharp-tailed grouse have a limited distribution in Yukon due to the lack of suitable habitat. Gravel outwashes with fairly stable aspen parkland habitat and wet sedge-hummock meadows after fire are considered suitable habitat for this species. Sharp-tailed grouse have been observed in the Project area.

7.5 SPECIES AT RISK

There are currently eleven wildlife species in Yukon rated as “threatened,” “of conservation concern,” or “of special concern” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2011). Ten of these species have ranges that could include the area around Minto Mine site. Species that have the potential to occur in the study area are listed in Table 7-3

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Table 7-3: List of Species at Risk in Yukon Considered Possible to Occur in the Study Area.

Species	Status	Source
Birds		
Peregrine Falcon* (Falco peregrinus anatum - tundrius)	Special concern	COSEWIC (2007), Yukon Wildlife Act (2002)
Short Eared Owl* (Asio flammeus)	Special concern	COSEWIC (2008)
Common Nighthawk* (Chordeiles minor)	Threatened	COSEWIC (2007)
Olive-sided Fly Catcher* (Contopus cooperi)	Threatened	COSEWIC (2007)
Rusty Blackbird* (Euphagus carolinus)	Special concern	COSEWIC (2006)
Gyrfalcon (Falco rusticolus)	Specially protected	Yukon Wildlife Act (2002)
Trumpeter Swan (Cygnus buccinator)	Specially protected	Yukon Wildlife Act (2002)
Barn Swallow* (Hirundo rustica)	Threatened	COSEWIC (2011)
Bank Swallow* (*Riparia riparia*)	Conservation concern	Yukon Environment (2011)
Canada Warbler (Wilsonia canadensis)	Threatened	COSEWIC (2008)
Northern Shrike (Lanius excubitor)	Conservation concern	Yukon Environment (2011)
Mammals		
Wolverine* (Gulo gulo)	Special concern	COSEWIC (2004)
Grizzly Bear* (Ursus arctos)	Special concern	COSEWIC (2009)
Woodland Caribou* (Rangifer tarandus caribou)	Special concern	COSEWIC (2002), SARA (2002)
Mule Deer (Odocoileus hemionus)	Specially protected	Yukon Wildlife Act (2002)
Mountain Goat (Oreamnos americanus)	Conservation concern	Yukon Environment (2011)
Cougar (Puma concolor)	Specially protected	Yukon Wildlife Act (2002)
Collared Pika* (Ochotona collaris)	Special concern	COSEWIC (2011)
Little Brown Bat (*Myotis lucifugus)*	Endangered	COSEWIC (2012)

* *confirmed presence in the mine site vicinity*

8 AQUATIC RESOURCES

8.1 OVERVIEW

A complete report on Aquatic Resources is presented in the *Aquatic Resources Baseline Report* (ACG 2012) (Appendix 1-6), which constitutes an update to EBA's 2010 report. A summary of the key findings of ACG's report is presented in the sections below.

The Minto Mine region includes the Yukon River and its smaller tributaries, including 7 km upstream to Big Creek and 13 km downstream to Wolverine Creek. The local study area related to the Minto Mine centres on three small drainages in the mine area that drain directly to the Yukon River: Minto Creek, Creek A, and McGinty Creek.

8.1.1.1 Minto Creek

Minto Creek, with its headwaters in the mine area, is the primary drainage affected by Phase V/VI. Minto Creek flows northeast from the existing mine site ~17 km to the Yukon River, and covers an approximate area of 41 km^2. The creek has five primary tributaries along its length, and flows through large tracts of land that have been recently influenced by forest fire. Water from the mine area flows into the upper reaches of Minto Creek through the water storage pond and other conveyances. Investigations into Minto Creek have found it to be generally shallow, ephemeral in nature, and to have frequent build-ups of layered ice during the winter (sometimes to the substrate).

8.1.1.2 Creek A

Creek A is a small watercourse that drains an area adjacent to the Minto Mine access road and the Yukon River. The headwaters of Creek A originate approximately 4 km southeast of Minto Creek and flow for 7 km along a riparian floodplain into the Yukon River. The drainage area of Creek A is traversed by the Minto Mine access road, including one direct watercourse crossing.

8.1.1.3 McGinty Creek

McGinty Creek (formerly referred to as Unnamed Creek B) is located to the north of Minto Creek and flows north-northeast for 9.5 km to the Yukon River confluence. Minto North Pit, which is to be mined as part of Phase V/VI, is located near McGinty Creek headwaters and within the McGinty Creek catchment area.

8.2 Fish and Fish Habitat

8.2.1 Regional Overview (Yukon River)

A variety of resident and migratory fish species inhabit the Yukon River near Minto Mine. These include Chinook, Coho and chum salmon, lake trout, least cisco, Bering cisco, round whitefish, lake whitefish, inconnu, Arctic grayling, northern pike, burbot, longnose sucker, and slimy sculpin.

Previous studies on the Yukon River within the vicinity of Minto Mine have identified both spawning and rearing areas for salmon. Spawning shoals are present in the Ingersoll Islands (downstream of the Project area) as well as around islands upstream of Minto Mine, near Big Creek. These offer an extensive network of side channels and sloughs which provide good spawning gravel.

This portion of the Yukon River also provides rearing habitat for Chinook salmon, as evidenced by past studies in the Project area. Juvenile Chinook salmon (JCS) generally spend up to 1.5 years feeding and growing in fresh water tributaries prior to out-migrating to the ocean, and feed or stage in various tributaries to the Yukon River during this slow out-migration. Usage of the Project area tributaries by JCS is outlined further below.

As outlined in Appendix 1-6, Yukon River salmon runs have observed moderate variability over the last 50 years; however, there has been a general decrease in salmon returns over the last ten to fifteen years. Chinook returns began to drop markedly beginning in 1998, and poor runs are still observed to this time. Chum salmon returns demonstrated a marked reduction in 1997 through 2002, but have been demonstrating trends that are more positive for summer and fall since 2001 and 2003, respectively.

8.2.2 Local Fish Habitat Investigations

Minto Creek

Fish and fish habitat studies of Minto Creek have been ongoing for many years, with contemporary studies including those from 1994 through to 2012. A summary of effort and catches is presented in Table 8-1 while complete results can be found in Appendix 1-6. Generally, Minto Creek has been noted to provide only limited habitat to fish. Flows within the stream are quite variable on a yearly basis, with intermittent flows and extensive ice build-up during winter that limits the potential for overwintering habitat for fish. Also, the distribution of fish within Minto Creek has been observed to be limited to the lower 1.5 km of the watercourse, as there is a barrier and steep canyon upstream of that location. As noted above, Chinook salmon, slimy sculpin, Arctic grayling, longnose sucker, burbot, and round whitefish have been captured in Minto Creek; however, the latter have not been observed since the original baseline studies in 1994. Slimy sculpin have been observed consistently, but at a low density.

During baseline studies, it was noted that trends in annual Chinook salmon occurrence in Minto Creek can be related to water temperature on a seasonal basis. During the early summer (e.g., May/June), the occurrence of JCS has been low, with individuals captured more frequently near the Yukon River confluence. Catches in July, August, and September have generally been higher; presumably, because out-migrating Chinook seek out non-natal tributaries as foraging habitat and cover. During the summer of 2009, there was a marked increase in Chinook salmon captures which coincided with an emergency release of water from the Minto Mine tailings dam (catch per unit effort (CPUE) of at least three times the previous highest catch records). Similarly, high numbers of JCS were captured in 2010, when the mine was discharging water into Minto Creek. It is believed that the stable, elevated flow and warmer, more consistent temperature regime (i.e., a narrower diurnal temperature fluctuation) associated with the release may have attracted JCS into the system from the Yukon River. In response to the observed high density of JCS in Minto Creek during these releases, a fish transfer program was initiated during the fall of 2009 and 2010 to prevent these fish being stranded by the onset of winter.

Creek A

Creek A was investigated during the 1994 baseline study program at the Project site, at which time no fish were observed or captured (including a site at the road-crossing location). Creek A is not considered to offer high quality habitat for fish.

McGinty Creek

Arctic grayling and slimy sculpin were captured in McGinty Creek in 1994, through electrofishing and minnow trapping. Because substantial deadfall caused by a forest fire changed creek conditions, only minnow trapping was used in 2009–2011, yielding very low numbers of slimy sculpin. Since these captures were consistently made in close proximity to the Yukon River, these fish were presumed to be associated with the Yukon River, as opposed to McGinty Creek. These results are similar to those found in the 1994 survey, in that fish were only captured in close proximity to the Yukon River confluence. The physical nature of the McGinty Creek drainage is not conducive to a consistent year-round use by fish. Many factors, including gradient, discharge volume, depth, configuration, and paucity of an upstream reservoir, limit wintering habitat potential for fish. Also, several potential natural fish barriers were observed and documented in the lower reach of McGinty Creek.

Table 88-1: Minto Fish Habitat Studies: 1994-2012.

Study Timing		Study Type	Minto Creek		Creek A		McGinty Creek	
Year	Month		Effort	Catches	Effort	Catches	Effort	Catches
1994	June	Baseline Environmental Studies	EF, MT	Rw, Ss	EF	-	EF, MT	Ss, Ag
	August	Baseline Environmental Studies	EF, MT, A	Ss, Ag	EF	-	EF, MT	Ss, Ag
	September	Baseline Environmental Studies	EF, MT	Ag	EF	-	EF	-
2006	September	Baseline / Permitting	MT	-	-	-	-	-
2007	May	Baseline / Permitting	EF, MT	Cs	-	-	-	-
	June	Baseline / Permitting	EF, MT	Cs, Ss	-	-	-	-
	August	Baseline / Permitting	MT	Cs, Ag, Ss	-	-	-	-
	September	Baseline / Permitting	MT	Cs	-	-	-	-
2008	June	EEM, Cycle 1	EF, MT	-	-	-	-	-
	September	EEM, Cycle 1	EF, MT	Cs	-	-	-	-
2009	May	Baseline, Minto North	-	-	-	-	MT	Ss
	June	Baseline, Minto North	MT	-	-	-	MT	Ss
	July	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
	September/ October	Fish Relocation, Minto North	-	-	-	-	MT	-
2010	June	Mark-Recapture Study	MT	Cs, Ss	-	-	-	-
	July	Mark-Recapture Study, Minto North	MT	Cs, Ss	-	-	MT	Ss
	August	Mark-Recapture Study	MT	Cs, Bb, Ag	-	-	-	-
	September	Mark-Recapture Study	MT	Cs, Bb, Ss, Ag	-	-	-	-
	October	Mark-Recapture Study	MT	Cs, Bb	-	-	-	-
	November	Fish Relocation	MT	Cs	-	-	-	-
2011	July	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
	August	Ongoing Monitoring	MT	Cs, Ls	-	-	-	-
	September	Ongoing Monitoring, Minto North	MT	Cs, Ss, Ls	-	-	MT	-
	October	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
2012	June	Ongoing Monitoring	MT, EF	Ss, Ag	-	-	-	-
	July	Ongoing Monitoring	MT	Ss	-	-	-	-
	August	Ongoing Monitoring	MT	-	-	-	-	-
	September	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-

Effort: EF=backpack electrofishing, MT=minnow trapping, A=angling
Catches: Cs=Chinook salmon, Ag=Arctic grayling, Ss=slimy sculpin, Rw=round whitefish, Bb=burbot, Ls=longnose sucker

8.2.3 Aquatic Environment and Habitat

Stream Sediments

Stream sediments were studied for particle size and metal concentrations in 1994, and annually since 2006. Sediment particle size distribution was notably different when comparing earlier sampling years to more recent years. The change in distribution from 1994–2009 compared to 2010–2012 reflects methodological changes that were implemented in 2010. Sediment metal concentrations were also complicated by the change in methodology. With this qualification in mind, concentrations of arsenic, copper, and occasionally chromium exceeded the interim sediment quality guideline (ISQG) levels over the years but not greater than the probable effect level (PEL). Copper was the only metal that consistently exceeded guideline levels every year, including during baseline sampling in 1994. This could indicate that there are naturally high levels of copper at the exposure area. Arsenic was above the ISQG in most sampling years except during baseline sampling in 2007 and 2009.

Additional detailed results for sediment physical and chemical parameters are available in Appendix 1-6.

Benthic Invertebrate Community

Benthic macroinvertebrates (benthos) are non-backboned animals inhabiting the bottom substrates of aquatic habitats. The abundance, diversity, and taxonomic composition of benthos can be used as indicators of changing environmental conditions as their distribution and abundance can be influenced by a wide variety of physical parameters. Baseline and numerous other benthic invertebrate studies were undertaken in the Minto Mine area from 2006–2012.

Basic results of the 2008 and 2011 environmental effects monitoring (EEM) benthic analyses indicated that Minto Creek (treatment) had a significantly higher benthic invertebrate density and slightly lower number of taxa (not significant) compared to McGinty Creek (reference). The 2011 EEM benthic results show that Minto Creek had significantly higher number of taxa and higher density compared to both reference sites. Increased taxa, higher density, and lower evenness are indicative of a site that is experiencing nutrient enrichment.

Under the terms of Minto's Water Use License #QZ06-006, benthic macroinvertebrate communities are required to be annually monitored in Minto Creek. In 2011, the mean number of taxa in lower Minto Creek was less than in the reference area in lower Wolverine Creek and less than the 1994 baseline (this result is contrary to the 2011 EEM results, but could be explained by the use of a different reference site, or by temporal variability). However, the 2011 count was an increase over that measured in 2006, another year that the mine did not discharge. Changes in density and evenness over time likely reflected high temporal variability of benthic invertebrate communities in the region, also evident at reference areas.

A detailed report on Minto Creek sediment, periphyton and benthic invertebrate community was prepared by Minnow (2012) and is presented in Appendix F of Appendix 1-6.

Periphyton

Periphytic algae are simple aquatic plants which inhabit the substrate of water bodies. They can provide a valuable biological monitoring tool to assess potential impacts of nutrient enrichment and metal toxicity. Chlorophyll a is the primary photosynthetic pigment common to all algae. Determining chlorophyll a concentrations provides a measure of algae biomass and thus, the primary productivity of a given location. Periphyton was sampled in 1994, 2011, and 2012, in Minto Creek (exposure) and Wolverine Creek (reference). Overall, the periphyton community of lower Minto Creek relative to lower Wolverine Creek had lower density and taxon richness. Periphyton communities of lower Minto Creek and lower Wolverine Creek in 2011 both differed from the community documented at lower Minto Creek in 1994.

Detailed results and analysis are presented within Appendix 1-6 (specifically appendices F and I to Appendix 1-6).

9 Vegetation

The Minto Mine lies within the Boreal Cordillera ecozone and is situated in the far western part of the Yukon Plateau ecoregion, adjacent to the Klondike Plateau ecoregion in the west. This area was part of the eastern extent of Beringia, which remained ice-free approximately 15–20 thousand years ago. Endemic and rare plant species are associated with the Beringia area as it was a unique and isolated ecosystem. These remnant species are usually associated with grasslands and wetlands.

The Minto property lies within the eastern part of the Dawson Range, with elevations from 700 to 950 m; the landscape has rounded mountains intersected by broad valleys and drainages that are part of the Yukon River watershed. Discontinuous permafrost occurs on northern slopes and low-lying areas where sunlight is reduced.

Forest fires are frequent in this part of Yukon as it lies in the rain shadow of the St. Elias–Coast Mountains and receives less than 300mm of precipitation per year (Smith et al. 2004). As a result, the study area around Minto Mine has experienced numerous fires over the last forty years, rendering it a complex mosaic of plant communities at various stages of succession.

The following subsections summarize vegetation surveys conducted in the Project area. For further detail, please see the *Vegetation Baseline Survey* (2010) in Appendix 1-8.

9.1 Vegetation Survey (2010)

Vegetation surveying and mapping was undertaken by ACG and Horizon Ecosystem Consulting in 2010 and resulted in the *Vegetation Baseline Survey* (2010) (Appendix 1-8). A previous survey was conducted in 1994 by Hallam Knight Piesold (HKP), before any mine development had begun in the area. The 2010 report provides a record of current vegetation communities that exist within a 3,626 ha study area and estimates the type and area of vegetation to be removed in the Project area. In the intervening years between the 1994 and 2010 studies, the local landscape has been altered by the footprint of the current mine, further exploration and three major fires (See Fire History Map, of the *Vegetation Baseline Report*, ACG 2010).

In the 2010 Vegetation Baseline Survey, different vegetation communities that exist within the study area were identified through aerial photo interpretation and delineated into polygons. Since most of the study area is regenerating from past fire disturbances, a mosaic of vegetation communities at different successional stages was delineated and classified. It was found that willow and trembling aspen have the greatest crown cover within the study area as they are indicative of early forest succession. Lodgepole pine is a later successional species that will gradually dominate mid and upper slopes of well-drained southern aspects.

Shade-tolerant white spruce was often found in the understory as seedlings. It is a climax species that will eventually overgrow the pine and trembling aspen communities, particularly on cooler aspects.

Black spruce is also a climax species that is adapted to wetter, cooler sites, often the persistent species in white/black spruce mixed areas along the toe of slopes and valley bottoms. Small areas of grasslands are scattered along dry crests and steep south facing slopes; these locations do not retain enough moisture to sustain tree growth and are more likely to contain rare or uncommon plants.

Approximately 82.04 ha of vegetated land will be disturbed by the proposed mine expansion. Most of the planned expansion is along ridge tops and mid slopes; the main vegetation to be removed are upland willow species, trembling aspen, Lodgepole pine, and associated understory growth. These areas have already been impacted by drilling, road development, and other exploration activities.

The ecosystem map (Appendix 1-8) was designed to be used as a land management and planning tool. As the mine expands its footprint, the map can be referred to for a quick assessment of which type of vegetation communities will be directly disturbed and how much area is involved. Sensitive areas that should be avoided, if possible, include: riparian corridors, bog/wetlands, mature forests, and grasslands.

9.2 Site Conditions: Vegetation Types

During the survey, plants species with 0.5% or greater coverage were identified and recorded on data sheets at each plot. Rare or uncommon species were searched for within plots and between plots, as well as uncommon ecosystems, i.e., wetlands and grasslands. No rare plants were found during the field investigations. That does not mean that the rare species do not exist within the study area, only that they were not located in the areas or in the season that the fieldwork was undertaken. The main plant communities identified in and around the Minto property are briefly described in the subsections below.

Trembling Aspen/Lodgepole Pine

This association is found in early successional forests originating after fire disturbance, on mesic to subxeric sites. Lodgepole pine (*Pinus contorta latifolia*) is more dominant than trembling aspen (*Populus tremuloides)* on well-drained south facing slopes and terraces. Coarse soils are often exposed, and lichens are well represented in the ground cover. Typically, these sites have low growing shrubs such as lingonberry (*Vaccinum vitis idaea*), kinnikinnick (*Arctostaphylos uva-ursi*), and prickly rose (*Rosa acicularis*).

Black Spruce/Labrador Tea/Sphagnum

Found in low lying areas and north facing slopes (cool sites), usually sparse to open forests (<50% crown cover), common shrubs in this ecosystem include Labrador tea, scrub birch, willow, and bog blueberry. Herbs present were sweet coltsfoot (*Petasites frigidus*), cloudberry (*Rubus chamaemorus*), and horsetail (*Equisetum sp.)* Sites are poorly drained (hydric to mesic) with peat horizons over mineral soils, often associated with permafrost.

White/Black Spruce

This association is typically located on south facing lower slopes with upland willow species and Labrador tea. A thick carpet of feather mosses and sphagnum covers the mineral soil. Ground cover shrubs include lingonberry, bog blueberry, and crowberry.

Willow/Trembling Aspen

This was the most common vegetation association in study area, indicative of regenerative growth (>10yrs) after a fire event. Most trees and shrubs are less than 5 m tall; cover can be open to closed as the canopy layer is of uniform height. Other species that may be present include: Alder (*Alnus crispa*) and Alaskan birch (*Betula neoalaskan*) on north facing slopes. Lodgepole pine and white spruce are also present in the understory and will eventually overtop other competing species to form the dominant canopy as the forest matures. The moisture regime ranges from subhygric to subxeric.

Willow/Scrub Birch

Willow (*Salix sp.)* and scrub birch (*Betula glandulosa*) occur in fluvial ecosystems adjacent to streams and fens. Other shrubs present are bog blueberry (*Vaccinum uliginosum*), Labrador tea (*Ledum groenlandicum*), and shrubby cinquefoil (*Potentilla fruticosa*). Associated graminoids include water sedge (*Carex aquatilis*), bluejoint grass (*Calamagrostis canadensis*), and rushes (*Juncus sp*.). Sphagnum, feather, and glow mosses are common.

Trembling Aspen/Grassland

This association features sparse to open cover of trembling aspen (*Populus tremuloides*), often with lodgepole pine (*Pinus contorta latifolia*) present as a minor component. Found on steep south and southwest facing slopes, its understory shrubs include prickly rose (*Rosa acicularis*), soapberry (*Shepherdia canadensis*), kinnikinnick (*Arctostaphylos uva-ursi*), purple reedgrass (*Calamagrostis purpurascens*), Glaucous bluegrass (Poa glauca), Threadleaf sedge (Carex filifolia), Death camas (*Zygadenus elegans*), common yarrow (*Acillea millefolium*), pussytoes (*Antennaria sp*.), and prickly saxifrage (*Saxifraga tricuspidata*).

10 Geochemistry and Geotechnical Information

10.1 Geochemistry

Minto conducted pre-production testing and continues to conduct operational monitoring. Detailed information on geochemistry can be found in Appendix XX to this plan.

The primary conclusions from the pre-production testing were that Main Pit waste rock was expected to be net acid neutralizing, and that the main acid neutralizing mineral was calcite (calciumcarbonate, CaCO3). The primary conclusions of both the Area 2/ Area 118 and underground development preproduction tests were that bulk granodiorite waste rock was expected to be net acid neutralizing, and that some mineralized waste rock was expected to have NP:AP values less than the threshold value of 3 specified by the water use license (YWB 2012 and its predecessors).

Since mining commenced at Minto, operational ABA monitoring has been carried out on composite samples of blast hole cuttings from each waste blast according to the BC Research Standard Method, as specified by Water Use Licence QZ96-006. Results to date include all Main Pit results along with samples from the parts of Stage 1 and Stage 2 of Area 2 Pit that have already been mined. Semi-annual waste rock monitoring reports have been prepared and submitted to regulators as part of the mine's compliance reporting. The results show that Main Pit waste rock generally had low AP and NP:AP ratios greater than the threshold value of 3. Results for Area 2 Pit waste rock were mixed with most samples having NP:AP values greater than 3. There were sufficient samples with NP:AP less than 3 that Minto modified its waste rock management strategy.

No pre-production characterization tests were carried out on tailings from Main Pit ore. For the Phase IV deposits (Area 2 and Area 118), a range of preproduction tests were carried out on residues from locked cycle testing. Residues from metallurgical testing carried out on Area 2 and Area 118 ore samples were subjected to additional testing for purposes of ML/ARD characterization. Results of the pre-production testing on Phase IV tailings indicated that the material would be net acid neutralizing, and that risks of neutral pH metal leaching were similar to those for Main Pit tailings from full-scale operations.

Operational monitoring of Main Pit tailings was carried out to track the ABA characteristics of the tailings produced over the operating period. Results of operational ABA monitoring of Main Pit and Area 2 Pit (Stages 1 and 2) tailings confirm excess of neutralization potential (NP) over acid potential (AP), indicating that the tailings produced to date are net acid neutralizing

10.2 Geotechnical Information

The geotechnical stability of individual structures is addressed in physical stability reports or preliminary design reports specific to each facility, including the Main Dam and various waste rock dumps. The site has in the past experienced slope instabilities and slow movements along a suspected shear zone underlying parts of some existing facilities. Risks related to slope instabilities are being addressed in the individual reports for each facility. The following attachments to the application contain detailed information:

- Attachment 8 – Tailings Management Plan, particularly the Main Dam Preliminary Design appendix
- Attachment 9 – Waste Rock and Overburden Management Plan, particularly the appendices therein addressing waste dump stability.