KINROSS GOLD CORPORATION

George Lake Project

Application for Renewal of Water License

Section 6.0 – Attachment B – Summary of Environmental Baseline Survey Work

Baseline Environmental Studies – George Lake Project

Baseline Environmental Studies for the George Lake Project include information gathered for studies conducted at the Goose Lake Project, which is also owned by Kinross Gold Corporation. The George Lake Project is located approximately 35 kilometres northwest of the Goose Lake Project, and the topography, geomorphology, geology and environmental conditions are very similar for both Project Areas. To provide a comprehensive set of information on the George Lake Project, information collected for the Goose Lake Project Area is therefore provided here as well.

DEPTH OF PERMAFROST

1. STUDY SCOPE

Depth of permafrost is important for mine construction and operation because it defines the depth of the active layer (freeze-thaw layer) and the potential for movement of shallow groundwater during the summer season. Thermistor strings to measure temperature were targeted for both the George and Goose lake areas; however only the Goose Lake site was examined in 1997.

2. METHODS

Thermistor strings were installed at 4 foot (1.2 m) intervals to a depth of 25 feet down an open (unfrozen) drill hole at Goose Lake in late summer 1997. The drill hole is designated 97GO-014. The approximate location is shown on Figure 4.1-1. Actual depths below the surface will be adjusted for the slope of the diamond drill hole prior to data evaluation. Thermistors were connected to a junction box grouted in place on a stand above the drill hole. The thermistor resistances were measured on two occasions with a digital ohmmeter and converted by means of a calibration chart supplied by the manufacturer, R Technical, to temperatures.

3. RESULTS

Table 1 lists results of the two measurements made in early and mid September 1997. The table indicates permafrost was at 1.5 m.

Table 1 - Goose Lake Thermistor Data

Location: Drill Hole: 97GO-014			
Date	**Depth (m)**	**Resistance (ohms)**	**Temp (°C)**
05-Sep-97	1.2	5.16	7.1
	2.4	6.14	3.8
	3.6	7.09	0.8
	4.8	7.63	-0.8
	12	8.52	-2.0
	14.2	8.90	-3.0
21-Sep-97	1.2	6.28	3.1
	2.4	6.88	1.7
	3.6	7.15	0.8
	4.8	7.56	-0.8
	12	8.03	-1.7
	14.2	8.39	-2.6

FISH AND AQUATIC HABITAT STUDIES

1. INTRODUCTION

This section describes methods used and information obtained by NDM during August 1997 fisheries studies in the Goose Lake area of Nunavut. As many samples of fish tissues, benthic invertebrates, periphyton and sediments have yet to be analyzed by laboratories, the quantified results are not reported here. Instead, the kinds of data that will be generated are reviewed, with comments on likely results, based on our experience with surveys of this kind. Results are discussed in the context of their adequacy for CEAA, Inuit and DFO requirements, and recommendations provided on further aquatic environmental work for the project.

2. METHODS

Field work was conducted August 11-22, 1997 and included sampling of fish, benthic invertebrates, periphyton (attached algae) and sediments from Goose Lake, several tributary streams and from Big Lake to the northwest (which served as a control or reference lake).

Fish sampling was conducted primarily with gillnets, electrofishing gear and minnow traps. Gill nets were set in a gang of four (4) 8 foot (2.4 m) by 50 foot (15.2 m) nets of 1, 1.5, 2 and 2.5 inch stretched mesh sizes. A single net of 2.5 inch monofilament mesh that was 25 feet deep was set in the canyon area of Goose Lake in the "head" and "beak" of the lake (Figure 1). Electrofishing, with a Smith Root backpack electrofishing unit was used for tributary creeks. Minnow trapping with canned shrimp and tuna as bait was used in creeks, ponds and lakes.

Benthic invertebrates were sampled in creeks with a 30 cm diameter by 30 cm tall Waters and Knapp sampler, while those from the lakes were taken from a boat with a 6 inch square (232.26 cm^2) Ponar grab. Seven (7) replicate samples were taken at each of five (5) sites sampled. Five (5) of these are being analyzed at a taxonomic laboratory for species identification and enumeration.

Periphyton (algae, mainly single-celled "diatoms", on rocks) were sampled with a toothbrush from 5 cm by 5 cm areas on five (5) randomly selected rocks at each site. The five subsamples were combined to form one sample from 125 cm^2 of surface area. This procedure was repeated at each station, with one sample preserved in Lugol's solution for taxonomic identification and the other sample frozen for subsequent chemical analyses, for total organic carbon (TOC) and chlorophyll a content.

Sediments were taken with large plastic jars in depositional areas at or near each available (wetted) water quality monitoring site. One large sample was taken from each site for particle size analysis and TOC.

Aquatic habitat surveys were completed from aerial, on-ground and in situ (wading, boat and diver) observations and measurements. Standard DFO Stream Survey Forms were used to record information on habitat characteristics in the field. Key information on wetted areas, depths, flow types, substrate types, gradients and fish species was also mapped in accordance with standard DFO procedures for FISS (Fisheries Information Summary System) and British Columbia Resources Inventory Committee (RIC) standards. Photographs were taken of many areas in the field to illustrate habitat types and conditions during the August 1997 field program.

3. RESULTS

3.1 Habitat

The primary observation on aquatic habitat conditions in Goose Lake in August 1997 was that the lake was "landlocked" with no (fish-navigable) surface flow into the lake (at the "beak") from the mainstem stream and none from Goose Lake to Propeller Lake downstream. The small tributaries to Goose Lake were also at very low water levels with some large ponds and stream sections isolated, or dry. Big Lake, which was used as a "control" or reference lake for future monitoring purposes, is upstream in the same drainage system as Goose Lake, and was also "landlocked" during the field study period. There is likely subsurface flow along the mainstem and some tributary streams, but fish populations are clearly isolated for some parts of the year (winter and late summer, at least).

Goose Lake had a maximum depth of approximately 8 m, as did Big Lake. Both lakes have soft silt/mud substrate at depth (4-8 m) and large boulder with scattered sands in shallower areas (<4 m). Both lakes also have some areas of sand/gravel beach with scattered boulders. Tributary creeks near the proposed minesite (Creeks 1 and 2) have soft-bottom ponds in their lower reaches and very small (<0.5 m wide) headwater streams, some formed along caribou trails. Ponds in lower reaches of Creeks 1 and 2 are accessible to fish from Goose Lake, while other ponds around the lake are often inaccessible due to low water levels (and freezing in winter), and are likely too shallow and isolated to support fish. There is a small area of gravels suitable for fish spawning in Creek 2 but none in Creek 1. Other creeks were dry and had mainly "soil" (fine) substrate types and/or large rock.

Key habitat requirements for fish, including spawning areas, juvenile rearing areas and overwintering habitat, all exist in limited quantities in the Goose Lake system. Spawning areas for resident lake trout, whitefish, grayling and burbot likely includes some littoral (shallow-water) areas of the lake. This is especially true for lake trout and whitefish, which are fall-spawners whose eggs incubate over winter under the ice. Grayling and burbot, as well as sculpins and stickleback, are spring and summer spawning species that likely also utilize the creeks. Juvenile rearing areas exist in lake shallows as well as in some of the ponds in the lower reaches of tributary creeks. Overwintering habitat is limited to lake depths over 2-3 m, which occurs in Goose Lake in the main body and "head/beak" of the lake. All of the small tributary ponds are too shallow to provide viable year-round fish habitat.

3.2 *Fish*

Species Composition

Fish species captured in the Goose Lake area (including in-flowing tributaries) included:

- lake trout (Salvelinus namaycush);
- round whitefish (Prosopium cylindraceum);
- Arctic grayling (Thymallus arcticus);
- burbot (Lota lota);
- slimy sculpin (Cottus cognatus); and
- ninespine stickleback (Pungitius pungitius).

In Big Lake, fish species encountered included only lake trout, whitefish, burbot and sculpins, the last two of these only in stomach contents of lake trout. Minnow traps in Big Lake consistently showed no catches. No wetted area suitable for sampling was found in Big Lake tributary streams.

Catch, size, age and sexual condition data are being compiled, along with those for metals content, in tabular form.

Relative Abundance

Relative abundance of large fish species showed lake trout as the dominant species by numbers in both lakes. Those creeks where fish were caught showed sculpins, stickleback and juvenile burbot, in decreasing order of abundance. Relative abundance of fish species in Goose and Big lakes is approximately the same as found by Sekerak (1990) in the George Lake area, where lake trout were also the predominant species captured, followed by round whitefish.

Size and Condition

The length, weight, condition factor ($K = W*10^5/L^3$) and length:weight relationship (expressed as $Log_{10}W = a + b(Log_{10}L)$ are being calculated for fish sampled in August 1997. The condition factors (K, which should be approximately 1.0 for a "normally shaped" fish) showed that most of the fish in both Goose and Big Lake areas were within the norm for the species. The length:weight relationships will be determined, but should also be typical of the species.

Age and Growth

Ages of fish have not yet been determined (laboratories at AMC Technical Services, Nanaimo, and North/South Consultants Inc, Winnipeg). The former lab has scales and otoliths for the completely sampled fish (those also taken for metals analyses), while the latter laboratory has pelvic fin rays. Results should be available by November.

Maturity and Reproduction

Several large (adult) lake trout and round whitefish showed ripening gonads in August 1997, indicating that they would spawn in the fall (September) of that year. Other large adult fish showed very small gonads, indicative of fish populations that do not spawn every year, as many do not in northern regions due to slow development in cold temperatures. Sekerak (1990) noticed the same regimen in George Lake samples.

Once age data have been received, NDM will estimate approximate age at maturity of large species, especially lake trout, for which the greatest numbers of samples were obtained.

3.3 Benthic Invertebrates

Stream Benthos

Stream benthic samples are being analyzed. From field observations, there were relatively few organisms in most samples, with mayflies, caddisflies and dipterans (two-winged flies, including black flies and mosquitoes) and round worms (nematodes) the predominant taxa in shallow, slow-flowing streams with gravel/sand substrates. Laboratory results will provide sufficient data for statistical work on numbers, for future comparison.

Lake Benthos

Lake benthic samples are also still being analyzed, but appeared from field observations to contain very few organisms in soft silt/mud substrates sampled with the Ponar grab in both Goose and Big lakes. Organisms noted in the field included round worms and dipteran larvae. There are likely several microscopic species also in lake bottoms.

3.4 Periphyton

Periphyton samples from the lakes and streams are still being analyzed for species composition, abundance, total organic carbon (TOC) and chlorophyll a. There was considerable growth on rocks in most areas sampled. The TOC data may be confused by detritus in the samples.

3.5 Sediments

The large, single samples of sediments taken in several sampling areas (notably Creeks 1 and 2) are also being analyzed for particle size and TOC, although the latter parameter may not be possible due to use of plastic jars.

4. DISCUSSION

Results of August 1997 baseline fisheries studies for the Goose Lake project indicate that:

- Lake trout, round whitefish, Arctic grayling and burbot are large fish species in Goose Lake, while slimy sculpins and ninespine stickleback comprise small species. Big Lake also shows lake trout to be the dominant species, followed by whitefish. Sculpins also exist in Big Lake, and likely other species (e.g. burbot and/or grayling) exist there as well;

- Fish in both Goose and Big lakes appear to be typical for the species in northern latitudes with respect to size, body shape, community structure, reproductive development, age and growth (data will likely confirm);

- Year-round habitat available to fish is limited in both Goose and Big lakes to the lakes and lowermost reaches of a few small tributary streams, as the small streams, including inlet and outlet mainstem creeks, are either frozen in winter, or dry in late summer. Spawning habitat for fall spawners (trout, whitefish) is very likely in boulder/gravel areas in the lake shallows (2-4 m). Spring/summer spawners (burbot, grayling, sculpin, stickleback) likely use both the lake shallows, where gravels and cobbles exist in some areas, and lower reaches of some tributary creeks;

- Both stream and lake benthic invertebrate populations are comprised of relatively few species and individuals per unit area (subject to revision after laboratory results). The diver surveys revealed several planktonic invertebrate species (e.g. copepods, dipterans) in the water column in seemingly low numbers (relative to other lakes surveyed). Plankton production may be a limiting factor to fish production in the lakes. If so, the key limiting factor may be nutrients (nitrogen and phosphorous compounds) in the water column; however, this has not been confirmed;

- Periphyton communities were likely at their peak annual standing crop and biomass when sampled in August 1997, judging by the degree of build-up observed. Periphyton (and, in the lakes, phytoplankton) are the primary producers in the systems and provide food for herbivorous benthic (and planktonic) invertebrates. As there was a dense growth of periphyton on most rocks in the euphotic zone of the lakes and streams, primary production does not appear to be a limiting factor in fish production in the lake. As periphyton depend to a large degree on sunlight and inorganic nutrients (especially N and P compounds), nutrients associated with the substrates appear (from the algal growth) to be sufficient for good algal growth;