(by weight) is mixed in tanks on the surface and fed to upper level sumps when needed. Also located in the shaft is a 3.81 cm fuel line, which allows diesel fuel to be sent to a main storage facility on the 890 m level.

2.5.3 Management of Tailings

Originally, all waste was to be contained within the TCA. As mine capacity increased, it became necessary to expand the TCA and discharge effluent. Effluent discharge commenced on 5 September 1985. Effluent was discharged in mid summer, generally beginning on 15 July and continued for periods that extended into early September. The maximum rate of effluent discharge, as per the Nunavut Water Board water licence, has been 60 000 to 70 000 m^3/d (AQUAMIN 1996; EVS 1996). Since the initial discharge in 1985, effluent is discharged into Seep Creek, which empties into an unnamed lake. Unnamed Lake drains into Contwoyto Lake at the south end of Inner Sun Bay (Figure 2.1).

The tailings management process at Lupin is as follows:

- The tailings slurry is pumped from the mill to one of two solids retention cells (Cell 3 or Cell 5) in the TCA, where the solids settle. For the past six years, Cell 5 has been used for winter deposition and Cell 3 for summer deposition (Figure 2.2).

- Each spring, usually beginning in late June, the build-up of meltwater and tailings water is decanted from Cells 5 and 3 into Cell 4. Cell 4 has not been used for solids deposition, and functions as a primary polishing pond. Water is held in this cell for a one-year period, where cyanide undergoes natural degradation due to exposure to sunlight, air, and agitation by wind.

- The following year, water is released from Cell 4, through a gated culvert, into Pond 1, where it is held for a one-year period, before being siphoned into Pond 2 where it is held for another year. If necessary, the water can be treated with ferric-sulphate during the siphoning process to precipitate arsenic in Pond 2.

2.5.6 Effluent Monitoring

Discharge at SNP 925-10 is monitored regularly (65°43'43.8" N, 111°18'23.3" W), with annual quality reports submitted to the NWB. Total annual discharge between 1994 and 2005 ranged from 0 m^3 to 3 102 895 m^3 (Table 2.1).

Table 2.1. Total annual discharge volumes from Lupin Mine TCA (SNP 925-10), 1994 to 2005

Year	Annual Total (m^3)	Discharge Period
1994	863 868	15 - 29 Jul
1995	938 715	15 Jul – 2 Aug
1996	1 139 233	15 Jul – 7 Aug
1997	2 892 289	15 Jul – 1 Sep
1998	0	n/a
1999	0	n/a
2000	2 701 360	15 Jul – 2 Sep
2001	0	n/a
2002	3 102 895	15 Jul – 7 Sep
2003	0	n/a
2004	0	n/a
2005	1 682 135	15 Jul – 11 Aug

Note: n/a = not applicable

Water quality at SNP 925-10 is monitored for a variety of constituents at varying frequencies (Table 2.2). Constituents listed in Schedule 4 of the MMER (GC 2002), with the exception of radium-226, are routinely measured at SNP 925-10. The maximum concentrations discharged from SNP 925-10 during 2000, 2002 and 2005 (Table 2.3) are below authorized limits (GC 2002).

Table 2.2. Monitoring and sampling frequencies of TCA effluent at SNP 925-10

Constituents	Frequency
pH, Conductivity, Temperature, Total Suspended Solids, Arsenic, Cyanide, Copper, Zinc, Volume	Daily (grab)
Cadmium, Lead, Nickel, Alkalinity, Ammonia, Hardness	Weekly (grab)
24 Metals (Total), ICPMS (inductive coupled plasma mass spectrometer)	First discharge day and monthly thereafter (grab)
Static Pass/Fail Bioassay for Both Rainbow Trout and *Daphnia* Species (per Environment Canada's Environmental Protection Series Biological Test Methods)	Twice per year (grab)

Table 2.3. Maximum concentrations of MMER deleterious substances at the Lupin Mine (SNP 925-10)

Constituent	Units	2000	2002	2005	Maximum Authorized Concentration in a Grab Sample[a]
Arsenic	mg/L	0.0133	0.0800	0.0146	1.00
Copper	mg/L	0.011	0.034	0.015	0.60
Cyanide	mg/L	0.032	0.144	0.040	2.00
Lead	mg/L	<0.0020	0.0006	0.0050	0.40
Nickel	mg/L	0.1210	0.0893	0.0955	1.00
Zinc	mg/L	0.303	0.247	0.251	1.00
Radium-226	Bq/L	n/a	n/a	0.006	1.11
TSS	mg/L	2	5	<2	30.00

Note: [a] GC (2002) ; TSS = Total Suspended Solids; n/a = not available

Several metals and other constituents were measured as part of the routine water quality monitoring program at SNP 925-10 (Table 2.4). Metal concentrations and levels of conventional constituents, such as conductivity, pH and total suspended solids (TSS), have been remained at consistent concentrations. Arsenic, for example, remained below 0.015 mg/L, and conductivity ranged from 847 to 906 µS/cm.

Table 2.4. Water quality of Lupin Mine TCA effluent at SNP 925-10

Constituent	Units	2000				2002		2005
		15-Jul	16-Jul	21-Aug	02-Sep	15-Jul	12-Aug	27-Jul
Conventional								
Field Temperature	°C	n/a	14.4	12.3	6.2	14.7	15.9	n/a
pH	units	6.95	7.00	7.05	6.53	7.01	6.95	6.39
Conductivity	µS/cm	869	887	n/a	906	858	855	847
Total Suspended Solids	mg/L	1	1	1	1	<1	<1	<2
Total Alkalinity (as $CaCO_3$)	mg/L	10	11	7	<5	20	10	<5
Total Hardness (as $CaCO_3$)	mg/L	227	227	244	239	245	218	216
Inorganic Non-metallic								
Ammonium-N	mg/L	4.57	4.00	3.91	3.07	1.08	1.36	1.88
Cyanide	mg/L	0.016	0.016	0.014	0.016	0.004	0.078	0.040
Major Ions								
Calcium (dissolved)	mg/L	78.7	78.9	n/a	n/a	84.7	75.1	74.2
Magnesium (dissolved)	mg/L	7.49	7.37	n/a	n/a	8.03	7.41	7.50
Hydroxide	mg/L	<5	<5	n/a	n/a	<5	<5	<5
Carbonate	mg/L	<6	<6	n/a	n/a	<6	12	<6
Bicarbonate	mg/L	13	14	n/a	n/a	24	<5	<5
Metals (Total)								
Aluminum	mg/L	0.063	0.056	0.090	0.096	0.055	0.080	0.128
Antimony	mg/L	<0.006	<0.006	<0.006	<0.006	<0.002	0.005	<0.0002
Arsenic	mg/L	<0.01	<0.01	<0.01	0.01	0.0149	0.0108	0.0146
Barium	mg/L	0.0142	0.015	0.0158	0.0162	0.016	0.017	0.016
Beryllium	mg/L	<0.0006	<0.0006	<0.0006	<0.0006	<0.0001	<0.0001	<0.0001
Bismuth	mg/L	<0.008	<0.008	<0.008	<0.006	<0.0005	<0.0005	<0.0005
Boron	mg/L	0.126	0.134	0.116	0.099	0.098	0.106	0.087
Cadmium	mg/L	<0.0006	<0.0006	<0.0006	<0.0006	0.0002	0.0002	0.0001
Calcium	mg/L	78.1	82.1	77.6	81.0	71.6	76.8	n/a
Chromium	mg/L	<0.0009	<0.0009	<0.0009	<0.0009	0.0007	<0.0005	<0.0005
Cobalt	mg/L	0.0626	0.0658	0.0654	0.0684	0.0559	0.0566	0.0496
Copper	mg/L	0.003	0.005	0.007	0.011	0.012	0.006	0.015
Iron	mg/L	0.068	0.075	0.227	0.250	0.980	0.267	0.200
Lead	mg/L	<0.002	<0.002	<0.002	<0.002	0.0005	0.0004	0.0005
Lithium	mg/L	0.018	0.019	0.018	0.019	0.018	0.019	0.030
Magnesium	mg/L	7.31	7.67	7.55	8.23	7.10	7.66	n/a
Manganese	mg/L	1.26	1.32	1.30	1.36	1.10	1.14	0.005
Molybdenum	mg/L	0.001	<0.001	<0.001	0.002	0.002	0.003	0.002
Nickel	mg/L	0.103	0.110	0.107	0.111	0.0807	0.0838	0.0955
Phosphorus	mg/L	0.04	<0.03	<0.03	<0.03	n/a	n/a	n/a

Note: n/a = not available

2.6 Water Quality Monitoring

Water quality is routinely monitored at several locations in the exposure area downstream of the final discharge point (Figure 2.3). The conductivity was 11 µS/cm at the mouth of Concession Creek (SNP 925-21), which does not receive effluent from Lupin Mine. Concentrations of several constituents decreased with increasing distance from the mouth of Seep Creek. In 2005, mean conductivity was 519 µS/cm at the mouth of Seep Creek (SNP 925-20), 240 µS/cm at the centre of Inner Sun Bay (SNP 925-22), 129 µS/cm at the Sun Bay narrows (SNP 925-24), and 76 µS/cm in Outer Sun Bay (SNP 925-25). Nickel, zinc, hardness, and ammonium exhibited similar data trends of decreasing concentrations with increasing distance from the final discharge point (FDP) (Table 2.5 to 2.7).

2.7 Delineation of Effluent Plume

The MMER requires an estimate of the effluent concentration at 250 m downstream of the FDP. A description of the extent of effluent contact with the surrounding water environment, to a concentration level of 1% of discharged effluent, is also required.

The common method used to estimate the effluent concentration at 250 m from the FDP is to compare the effluent conductivity to the field conductivity at a point 250 m from the FDP while the Mine is discharging effluent. The mine terminated effluent discharge on 11 August 2005; therefore, effluent was not being discharged during the EEM sampling program. Although effluent was not being discharged, the laboratory conductivity measurement was 738 µS/cm 250 m from the FDP, in Dam 1a Lake, on 21 August 2005. The effluent conductivity on 27 July 2005 was 847 µS/cm. In 1985, RL&L and DFO (1991) estimated that up to 90% of the flow in Seep Creek was due to effluent discharge into the stream system. Mine effluent discharged from the TCA is the main source of water into Dam 1a Lake; therefore, we cautiously estimate the effluent concentration to be 87% in Dam 1a Lake, 250 m from the FDP.

Effluent mixing in the exposure zone was described in Golder (2004) using dilution and dispersion modeling of the effluent stream into Outer Sun Bay. The model predicted that a 1% effluent concentration would extend 850 to 1200 m from the mouth of the narrows into Outer Sun Bay under average effluent discharge and ambient current velocity (average conditions). At maximum effluent discharge and high ambient current velocity (worst case conditions), the model predicted that the 1% effluent concentration would extend up to 1630 m from the mouth of the narrows into Outer Sun Bay (Figure 2.4).

Images used:
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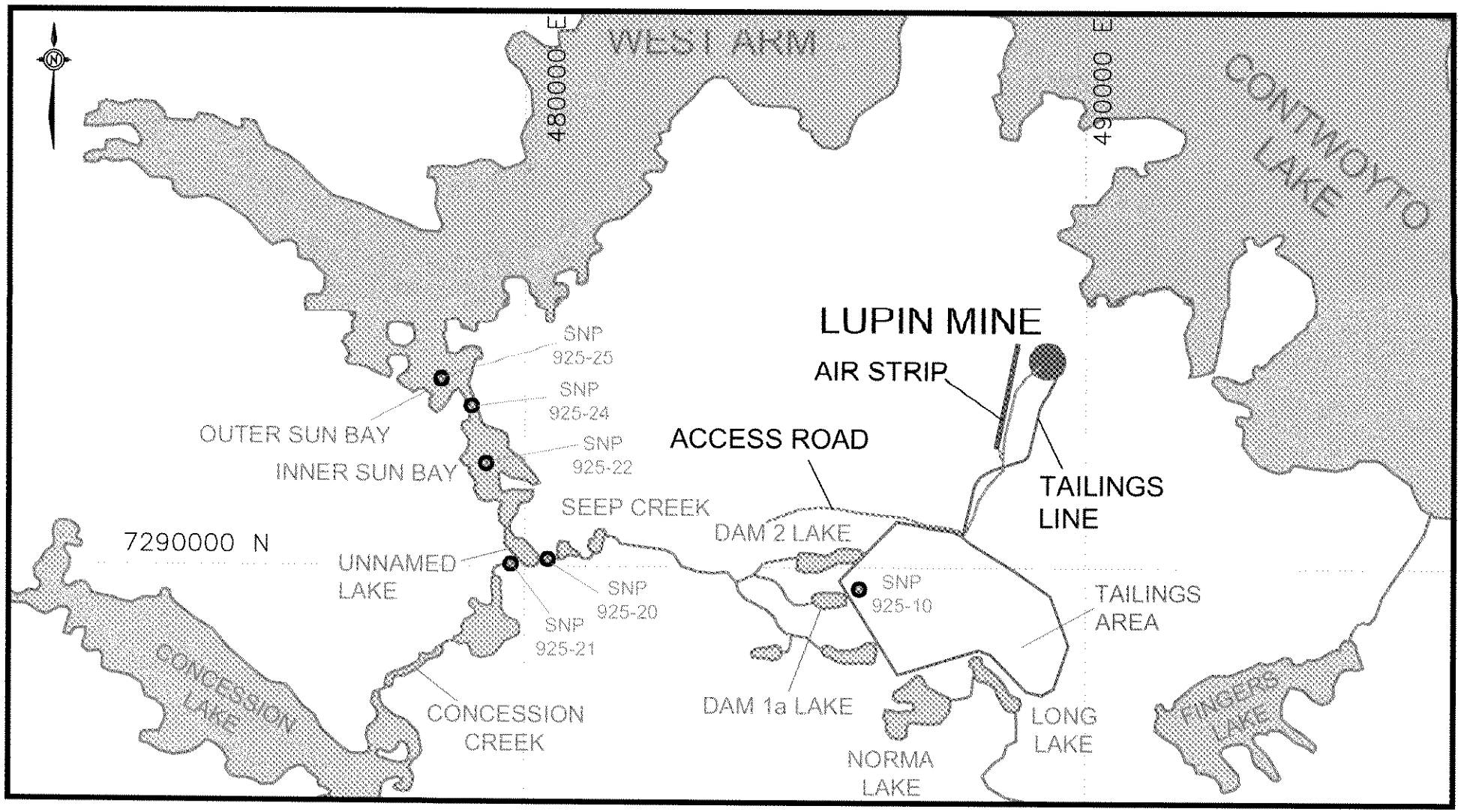

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Scale KM

PROJECT
Kinross Gold Corporation
Environmental Effects Monitoring Interpretive Report,
Lupin Gold Mine

TITLE
Exposure Area
Water Quality Monitoring Stations

Golder Associates
Edmonton, Alberta

PROJECT No.	05-1373-019		FILE No.	1730632	
DESIGN	AH	23/05/06	SCALE	As shown	REV. 0
CADD	RW	23/05/06			
CHECK					
REVIEW					

Figure: 2.3

Table 2.5. Summary of water quality monitoring data downstream of the Lupin Mine effluent discharge location

Constituent[a]	Mouth of Seep Cr. (SNP 925-20)									Mouth of Concession Cr. (SNP 925-21)								
	2000			2002			2005			2000			2002			2005		
	n	Mean[c]	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
pH (units)	7	6.03	0.25	7	6.48	0.15	6	5.70	0.45	7	6.43	0.32	7	6.28	0.41	6	6.67	0.14
Conductivity (□S/cm)	3	887	37	7	748	114	6	519	279	3	14	6	7	12	1	6	11	1
TSS[b]	7	0.53	0.17	7	0.93	0.73	5	<2	0	7	0.96	1.35	7	<1	0	5	<2	0
Total Arsenic	7	0.0024	0.0006	7	0.0036	0.0006	6	0.0032	0.0013	7	0.0004	0.0003	7	0.0011	0.0017	6	0.0007	0.0002
Total Cyanide	7	0.007	0.004	7	0.015	0.014	6	0.016	0.008	7	<0.002	0	7	0.003	0.004	6	0.002	0
Total Cadmium	7	<0.0006	0	7	0.00017	0.00003	6	0.00017	0.00010	7	<0.0006	0	7	<0.00001	0	6	<0.00001	0
Total Copper	7	0.005	0.002	7	0.004	0.002	6	0.005	0.002	7	0.001	0.001	7	0.001	0.001	6	<0.001	0
Total Lead	7	<0.002	0	7	0.0002	0.0002	6	0.0001	0.0001	7	0.001	0.001	7	0.0001	0.0001	6	0.0001	0
Total Nickel	7	0.115	0.009	7	0.0755	0.0084	6	0.0762	0.0411	7	0.008	0.018	7	0.0006	0.0003	6	0.0006	0.0001
Total Zinc	7	0.228	0.026	7	0.146	0.017	6	0.159	0.091	7	0.008	0.01	7	0.003	0.003	6	0.002	0.001
Total Alkalinity (as $CaCO_3$)	7	<5	0	7	7.4	9.2	6	<5	0	7	<5	0	7	<5	0	6	6	1
Hardness (as $CaCO_3$)	7	231	9.1	7	199	34.3	6	135	75.4	7	4	0.6	7	5	0.3	6	3	1.4
Ammonium	7	2.72	0.48	7	0.72	0.31	6	0.64	0.47	7	0.32	0.16	7	0.03	0.02	6	<0.05	0

Note: [a] Concentration units are mg/L, unless otherwise listed; [b] Total suspended solids; [c] where a portion of the results were below the method detection limits, half of this limit was used to calculate means; SD=standard deviation; 2005 water quality data is presented in Appendix B

Table 2.6. Summary of water quality monitoring data downstream of the Lupin Mine effluent discharge location

Constituent[a]	Centre of Inner Sun Bay (SNP 925-22)									Sun Bay Narrows (SNP 925-24)								
	2000			2002			2005			2000			2002			2005		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
pH (units)	7	6.33	0.33	7	6.37	0.09	17	6.36	0.27	7	6.47	0.29	7	6.36	0.29	7	6.47	0.18
Conductivity (µS/cm)	3	296	130	7	336	88.5	17	240	155	3	78.4	48.5	7	267	114	7	129	101
TSS[b]	7	0.47	0.2	7	<1	0	17	<2	0	7	0.37	0.3	7	<1	0	6	<2	0
Total Arsenic	7	0.001	0.0004	7	0.014	0.0003	17	0.0017	0.0006	7	0.0007	0.0005	7	0.0011	0.0002	7	0.0012	0.0003
Total Cyanide	7	0.007	0.01	7	0.007	0.004	17	0.010	0.008	7	0.006	0.012	7	0.004	0.002	7	0.006	0.003
Total Cadmium	7	<0.0006	0	7	0.00006	0.00002	17	0.00017	0.00019	7	<0.0006	0	7	0.00003	0.00002	7	0.00005	0.00002
Total Copper	7	0.002	0.001	7	0.003	0.004	17	0.002	0.001	7	0.002	0.002	7	0.002	0.001	7	0.001	0.001
Total Lead	7	<0.002	0	7	0.0002	0.0002	17	0.0004	0.0003	7	<0.002	0	7	0.0002	0.0003	7	0.0005	0.0003
Total Nickel	7	0.041	0.016	7	0.027	0.007	17	0.029	0.020	7	0.012	0.011	7	0.0163	0.0073	7	0.0130	0.0108
Total Zinc	7	0.08	0.034	7	0.054	0.017	17	0.070	0.055	7	0.025	0.022	7	0.038	0.014	7	0.029	0.023
Total Alkalinity (as $CaCO_3$)	7	<5	0	7	<5	0	17	<5	0	7	<5	0	7	<5	0	7	<5	0
Hardness (as $CaCO_3$)	7	88	25	7	82.7	21.9	17	57.8	38.4	7	31.2	22.6	7	64.3	26.4	7	31.1	23.5
Ammonium	7	1.06	0.28	7	0.24	0.12	17	0.40	0.14	7	0.57	0.28	7	0.15	0.1	7	0.17	0.09

Note: [a] Concentration units are mg/L, unless otherwise listed; [b] Total suspended solids; [c] where a portion of the results were below the method detection limits, half of this limit was used to calculate means; SD=standard deviation; 2005 water quality data is presented in Appendix B

Table 2.7. Summary of water quality monitoring data downstream of the Lupin Mine effluent discharge location

Constituent[a]	Outer Sun Bay (SNP 925-25)								
	2000			2002			2005		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
pH (units)	7	6.51	0.28	7	6.39	0.35	7	6.63	0.13
Conductivity (□S/cm)	3	25.3	19.8	7	40.7	25.7	7	76	81
TSS[b]	7	0.46	0.27	7	0.8	0.6	6	<2	0
Total Arsenic	7	0.0012	0.0021	7	0.0006	0.0001	7	0.0013	0.0002
Total Cyanide	7	0.001	0.001	7	0.002	0.001	7	0.005	0.007
Total Cadmium	7	<0.0006	0	7	<0.00001	0	7	0.00003	0
Total Copper	7	0.001	0.001	7	0.002	0.002	7	0.001	0.001
Total Lead	7	<0.002	0	7	0.0002	0.0004	7	0.0007	0.0005
Total Nickel	7	0.002	0.001	7	0.0026	0.0016	7	0.0039	0.0036
Total Zinc	7	0.009	0.004	7	0.007	0.004	7	0.012	0.007
Total Alkalinity (as $CaCO_3$)	7	<5	0	7	<5	0	7	<5	0
Hardness (as $CaCO_3$)	7	6.63	3.86	7	9.97	5.52	7	20.6	25.2
Ammonium	7	0.28	0.16	7	0.04	0.02	7	<0.05	0

Note: [a] Concentration units are mg/L, unless otherwise listed; [b] Total suspended solids; [c] where a portion of the results were below the method detection limits, half of this limit was used to calculate means; SD=standard deviation; 2005 water quality data is presented in Appendix B

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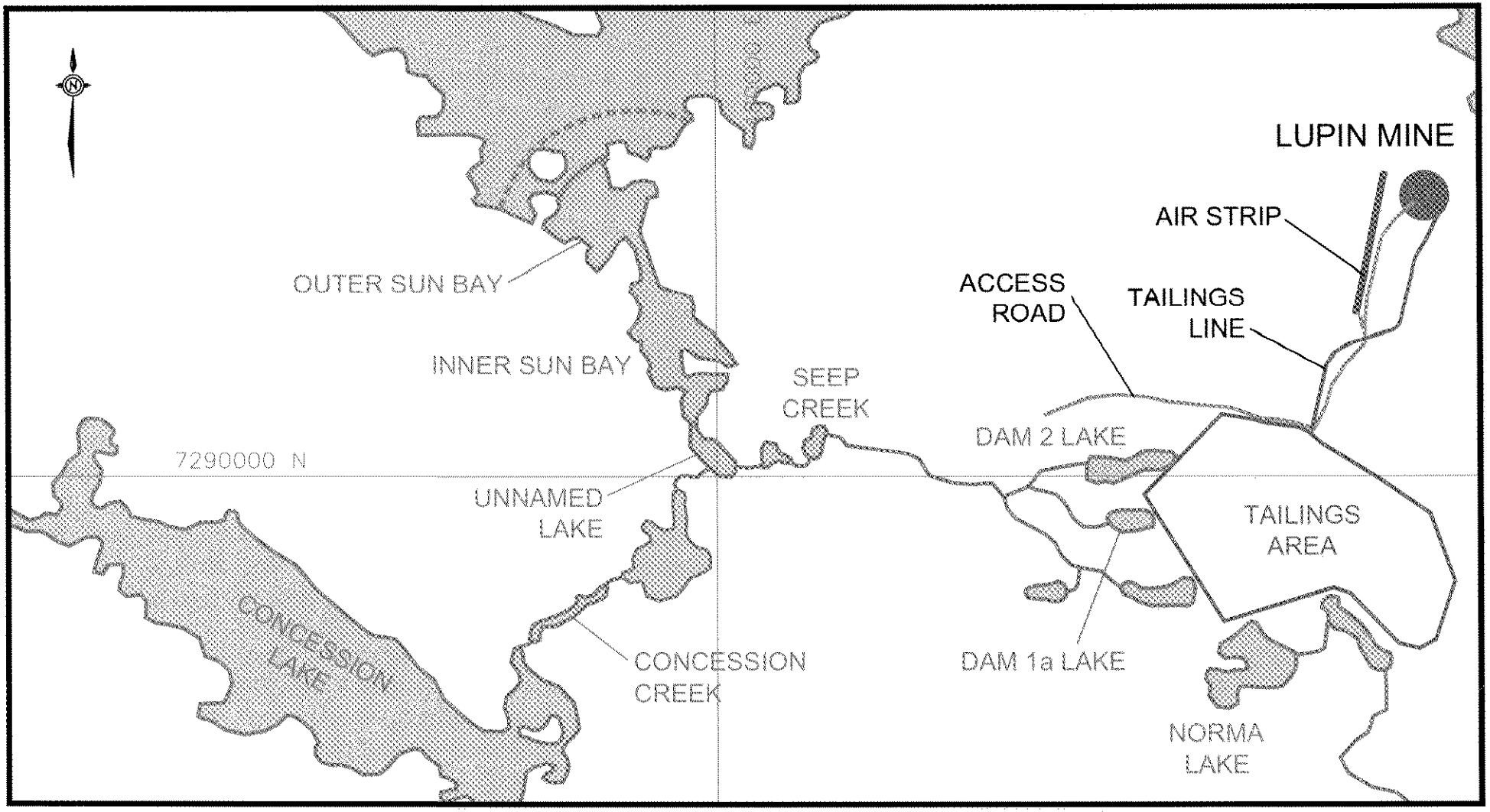


LEGEND

- Average conditions (1% concentration)
- Worst case conditions (1% concentration)

1.5 0 1.5
SCALE KM

PROJECT
Kinross Gold Corporation
Environmental Effects Monitoring Interpretive Report, Lupin Gold Mine

TITLE
Dispersion of Effluent Plume

Golder Associates
Edmonton, Alberta

PROJECT No.		05-1373-019	FILE No.		1730633
DESIGN	AH	23/05/06	SCALE	As shown	REV. 0
CADD	RW	23/05/06			
CHECK					
REVIEW					

Figure: 2.4

Water quality is monitored in Outer Sun Bay (SNP 925-25), approximately 500 m from the mouth of the narrows. Based on monitoring data in 2000 and 2002, effluent concentrations of 1.3 to 3.4% were present in the bay. These values are consistent with the results of the dilution and dispersion analysis, and indicate that there is sufficient mixing in Outer Sun Bay.

2.8 Exposure and Reference Area Characterization

2.8.1 Seep Creek and Seep Creek Ponds – Exposure Area

Aquatic habitat in the receiving environment downstream of the tailings area (Figures 2.1 and 2.3) is comprised of three shallow lakes (Dam 2 Lake, Dam 1a Lake, and Unnamed Lake), two streams (Seep Creek and Concession Creek), two shallow ponds, and two embayment areas of Contwoyto Lake (Inner and Outer Sun bays). With the exception of Dam 2 Lake, all of the small lakes and ponds freeze to the bottom in winter. Much of Inner Sun Bay also freezes to the bottom. Due to low winter flows, both Seep Creek and Concession Creek freeze to the bottom in winter. As a consequence, over-wintering habitat for fish is limited primarily to Outer Sun Bay and the main body of Contwoyto Lake (RCPL and RL&L 1985).

Seep Creek is approximately 6.5 km in length, flowing from its source in Dam 2 Lake and Dam 1a Lake (via separate branches which join about 2 km downstream) to Unnamed Lake (Figures 2.1 and 2.3). The stream channel in upper Seep Creek is generally poorly defined, often flowing through marshy areas, or between large boulders or through bedrock fractures. This section of the creek generally was less than 0.5 m in depth and less than 2 m wide. The dominant substrate type is boulders, although localized areas of cobble and gravel are present. Lower Seep Creek (i.e., the 400 m section upstream of Unnamed Lake) is characterized by a well developed channel varying in width from 1 to 4 m, although during freshet, maximum wetted width was about 20 m. The dominant substrate type is boulder, with localized areas of cobble and gravel (RCPL and RL&L 1985).

Two ponds are located near the downstream end of Seep Creek. The maximum depths of these ponds are approximately 1.5 m; the surface area of the upstream-most pond (Pond 1) was 3 ha, and the surface area of the downstream-most pond (Pond 2) was 2 ha.

Lake trout, Arctic grayling, cisco, round whitefish, ninespine stickleback and slimy sculpin have been documented in Seep Creek (RCPL and RL&L 1985). RL&L and DFO (1991) indicated that fish use the stream for spawning, feeding and juvenile rearing in the early part of the open water season. The majority of the fish were moving downstream

when captured in 1990 RL&L and DFO (1991) suggested that this was in response to decreasing water leve s as snowmelt run-off subsided. RCPL and RL&L (1985) documented Arctic gra ing spawning in Seep Creek in 1983 and 1984.

2.8.2 Fingers Creek nd Fingers Lake – Reference Area

Fingers Creek flows fo approximately 3 km between Fingers Lake and Contwoyto Lake (Figure 2.1). The upst am end of the channel was braided and contained substrate composed primarily of ilt and boulders, with some cobble. The stream channel widened to approximately two t three metres in the mid-section of the stream. The substrate consisted of cobble, gra el, and silt, with limited boulders also present. The downstream end of the creek featu d a narrow channel, approximately 1.0 m wide, with substrate dominated by cobble a d boulders. The upstream section was primarily shallow flat habitat, whereas the m dstream and downstream sections were primarily shallow run habitat. The average de th was 0.5 m through the upstream and midstream sections, and approximately 0.3 m in he downstream section. Approximately 20% of the entire creek, and 40% of the midstre a n section, contained aquatic vegetation and periphytic algae. The banks were vegetated a d stable, and were composed primarily of fines.

Fingers Lake has a ma mum depth of 6 m and a surface area of 370 ha (Moore 1978). Fingers Lake is a clear ater lake with little aquatic vegetation, except in the deposition areas. The lake is shal wer toward the north-east end of the lake, and the substrate is primarily cobble and b ulders extending from the north-east shore to approximately 400 m into the lake. Th re is a boat dock on the south-west end of the lake. The north, east and west shores ha steep drop-offs and boulders near shore. The south shore of the lake has a gradual slope and there are four narrow shallow bays on the south-east side of the lake that are primari depositional habitat.

Moore (1978) encounte d lake trout and Arctic char in Fingers Lake. Fish capture data has not been collected f Fingers Creek.

3.0 STUDY DESIGN

This section provides a brief overview of the Lupin EEM Study Design, as well as the required components of the First Biological Monitoring Study. In addition, the information in this section includes any deviations in the approved study design (Golder 2004 and 2005). Each component and deviation of the First EEM Study Design was approved by either the TAP, prior to the start of the 2005 sampling program, or the Authorization Officer (AO) during the 2005 sampling program (Appendix A).

3.1 Components of the Biological Monitoring Study

The objective of the MMER EEM biological monitoring program is to determine whether mine effluent is having a significant impact on fish, fish habitat or the use of fisheries resources. Depending on effluent conditions, there are two possible components of the EEM Biological Monitoring Program:

- a benthic invertebrate community survey; and,
- a fish survey, consisting of a fish population study and a fish tissue study.

According to the MMER EEM requirements, Kinross was required to complete a benthic invertebrate study and a fish population study because the mine effluent concentration in the exposure area was greater than 1% within 250 m of the FDP. Kinross was not required to complete a mercury study for fish tissues because the concentration of mercury in the TCA and discharged effluent was below the MMER limit of 0.10 µg/L (Appendix B). The TAP requested that liver and muscle tissues from Arctic grayling be collected for possible copper analysis, pending the results of the fish population survey (Appendix A).

3.1.1 Benthic Invertebrate Community Survey

The biological monitoring component of the MMER EEM program requires an evaluation of the effects of mine effluent on fish habitat, which is determined by examining the BIC structure. The information collected as part of this study included benthic invertebrate taxonomic enumeration, sediment particle size, water quality, and limnology.

Sampling was completed in the exposure (Seep Creek Ponds) and reference (Fingers Lake) areas. The original study design proposed the use of Concession Lake as the reference area, however, appropriate habitat within Concession Lake could not be identified; therefore Fingers Lake was sampled. The survey investigated whether the

mine effluent affected the BIC, using several community descriptors (density and richness) and indexes (Simpson's Diversity Index [SDI], Evenness, and Bray-Curtis Index [BCI]). Detailed methods are provided in Section 5.0 of this report.

Supporting environmental variables, including sediment quality from BIC stations and water quality from BIC and fish survey stations, were measured within the exposure and reference areas. Detailed sampling methods and results are presented in Section 4.0 of this report.

3.1.2 Fish Survey

The fish survey is a requirement of the MMER EEM program. Fish were collected from an exposure area (Seep Creek and Dam 1a Lake) and a reference area (Fingers Creek). The survey investigated whether the mine effluent affected the fish population, using several descriptors (age distribution, energy use and energy storage).

Juvenile Arctic grayling (*Thymalus arcticus*) and slimy sculpin (*Cottus cognatus*) were selected as the primary target sentinel species for a lethal sampling program. Ninespine stickleback (*Pungitius pungitius*) were to be a contingent target species under a non-lethal sampling program. However, in consultation with the AO, the fish study design was modified during the field survey to focus on juvenile Arctic grayling due to the low numbers of slimy sculpin and ninespine stickleback in the catch. The AO requested that 100 ninespine stickleback from the exposure area be measured for length and weight, and a sub-sample of 30 fish be examined for parasites. Due to the small size of fish collected in the sampling program, liver tissues were small and difficult to collect. In consultation with the AO, liver tissues were composited into approximately 2.0 g samples, and whole carcasses were preserved for future copper analysis. Detailed methods and results are provided in Section 6.0 of this report.

4.0 WATER QUALITY AND SEDIMENT QUALITY SURVEY

The goal of the EEM water quality and sediment quality survey was to generate supporting environmental data to aid in the interpretation of results of the biological monitoring survey, as well as provide a basis upon which chemical habitat within the study areas can be compared (EC 2002).

Water quality monitoring was conducted concurrently with fish and invertebrate surveys to monitor variables specified in Schedule 4 of the MMER (GC 2002). The Seep Creek and associated Dam 1a Lake and Ponds served as the exposure sites (Figure 4.1; Table 4.1) whereas Fingers Lake and Fingers Creek served as the reference sites (Figure 4.2; Table 4.2). *In situ* field measurements were conducted at each sampling location in the exposure area, and in Fingers Creek. Field measurements were not taken at the BIC stations in the reference area due to equipment malfunction. One composite sample for laboratory analyses was collected from each of the BIC survey reference and exposure areas. For the fish survey, one additional grab sample from Fingers Creek, and one grab sample from Dam 1a Lake were collected for laboratory analyses.

Physical and chemical information acquired from the sediment samples was also used to help characterize the benthic invertebrate habitat and identify potential confounding factors. Sampling was conducted at the benthic invertebrate sampling stations (Figures 4.1 and 4.2; Tables 4.1 and 4.2), concurrently with the BIC survey during the late summer of 2005.

4.1 Methods

4.1.1 Water Quality

4.1.1.1 Field Sampling and Measurements

Water samples in the reference and exposure areas were collected according to the methods outlined in the MMER technical guidance document (TGD) (EC 2002).

Grab water samples were collected at each BIC sampling site in the exposure and reference areas, approximately 0.2 – 0.5 m below the water surface. The grab samples were combined to form composite samples for the Seep Creek Ponds, and for Fingers Lake. A single grab sample was collected in each of the fish survey exposure (Dam 1a Lake, Site SCD1) and reference areas (Fingers Creek, Site FC2). The analytical laboratories provided pre-washed and sterilized sample bottles. When required, the appropriate preservatives were added in the field, and all samples were kept cool on ice until delivered to the analytical laboratory.

The following variables were measured in the field:

- water temperature;
- dissolved oxygen (DO);
- pH;
- conductivity;
- turbidity; and,
- air temperature.

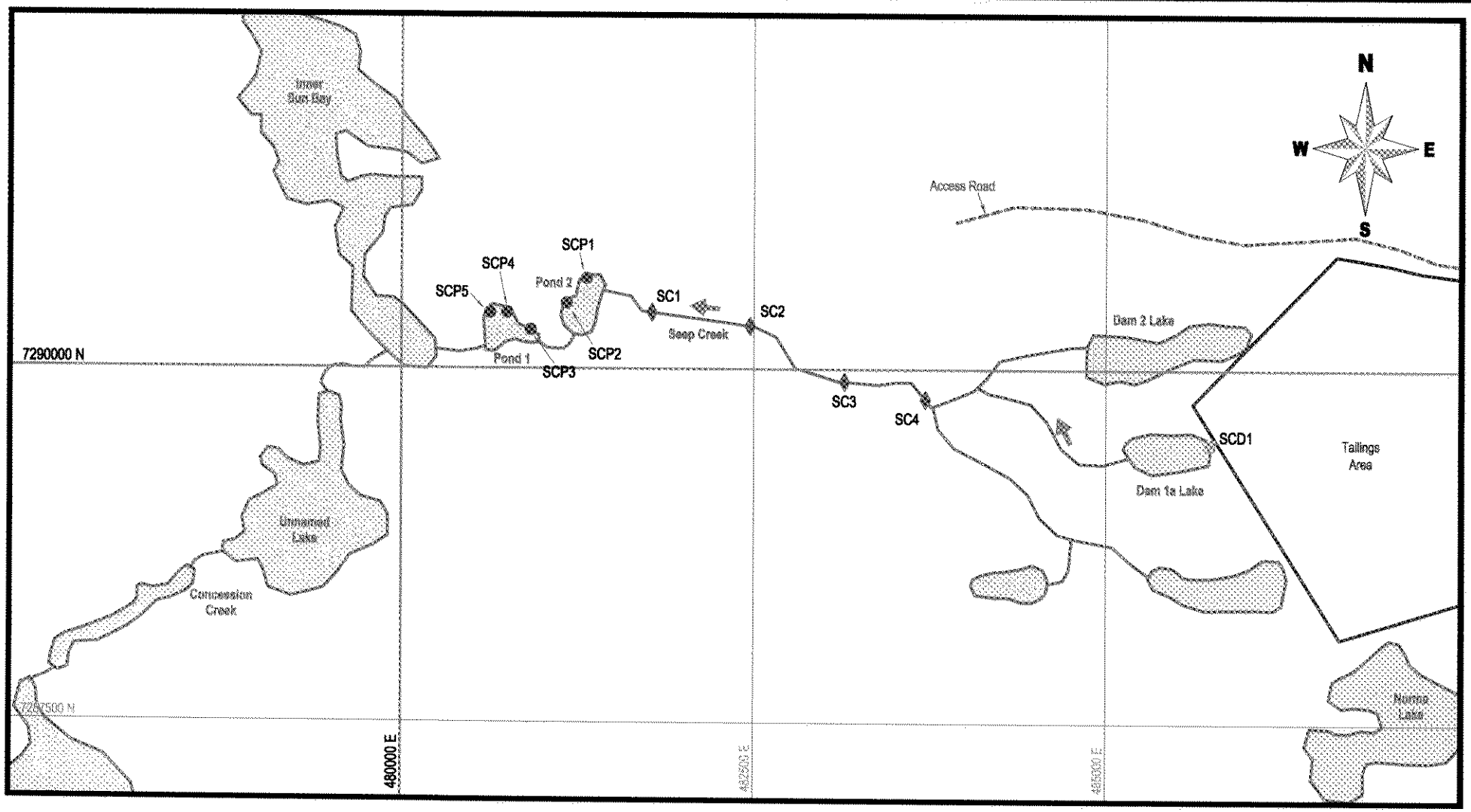
Temperature, DO, and pH were measured with an Oakton™ 300 series meter, and conductivity with an Oakton™ TDS Testr 3. Air temperature was measured with a hand-held alcohol thermometer, and turbidity was measured with a LaMotte 2020 turbidity meter. In addition, all sampling sites were geo-referenced as Universal Transverse Mercator (UTM) and longitude-latitude coordinates with a hand-held GARMIN™ model 12 global positioning system (GPS) unit.

4.1.1.2 Laboratory Analysis

Major ions and total and dissolved metals were analysed by the Alberta Research Council (ARC) Laboratory in Vegreville. All other variables were analysed by Enviro-Test Laboratories (ETL) in Edmonton.

Water samples were analysed for the following variables:

- deleterious substances listed in Schedule 4 of the MMER (i.e., arsenic, copper, cyanide, lead, nickel, zinc, total suspended solids, and radium-226);
- nutrients and carbon (i.e., ammonia, nitrite and nitrate, total phosphorus, total organic carbon, and dissolved organic carbon);
- physical characteristics (i.e., pH, conductivity, alkalinity and total hardness, total and dissolved metals); and,
- major ions (i.e., chloride, calcium, magnesium, potassium, sodium, sulphate).



LEGEND

- Direction of flow
- Watercourse
- Water quality, field limnology, sediment
- Water quality, field limnology
- Field limnology

800 0 800

Scale Metres

PROJECT

Kinross Gold Corporation
Environmental Effects Monitoring Interpretive Report, Lupin Gold Mine

TITLE

Water Quality, Field Limnology and Sediment in the Exposure Area Locations

Golder Associates
Edmonton, Alberta

PROJECT No.		05-1373-019	FILE No.		1730634
DESIGN	AH	23/05/06	SCALE	As shown	REV. 0
CADD	RW	23/05/06			
CHECK					
REVIEW					

Figure: 4.1