APPENDIX G

SUMMARY OF TSF MODELING

I.   GENERAL STRUCTURE OF THE WATER QUALITY MODEL

Knight Piesold, Inc. developed a water quality model using Microsoft Excel and @Risk, a Monte Carlo simulation program, to predict discharge characteristics from the lower Slate Lake tailings storage facility (TSF). Monte Carlo simulation is a stochastic technique used to make modeling calculations on a probability basis by randomly selecting input values across a defined probability distribution (e.g., normal distribution, lognormal, etc.). Inputs are randomly chosen for all stochastic inputs simultaneously. For example, worst-case scenarios might use a low precipitation value with a high tailings concentration and another might use an average precipitation value with a high tailings concentration. Values are randomly selected over and over to create multiple scenarios that represent a range of possible conditions. The model, therefore, generates a range of possible outcomes as a probabilistic distribution that illustrates the likelihood of particular outcomes.

The model relies on inputs related to hydrology, production factors, and geochemistry. Precipitation is entered into the model as a stochastic distribution, as described below. The hydrologic inputs to the model are derived from monthly precipitation values selected randomly using the Monte Carlo algorithm. All other inputs were fixed (i.e., deterministic) values. Data outputs are defined as probabilistic distributions, rather than one static value, to incorporate uncertainty into the decision-making process.

A general description of the model can be found in the Knight Piesold report "Slate Creek Lakes Tailings Storage Facility Report on Water Quality Modeling and Conceptual Closure Plan."

II.   MODEL OUTPUTS

The @Risk model generates a variety of outputs that are useful to the decision making process. Each of these outputs is presented on a monthly basis as the expected value from the distribution points selected for modeling under the Monte Carlo process. The greater number of model iterations, the more likely the expected value will equal the mean of the resulting distribution. More importantly, the user can evaluate the probability (or likelihood) of each calculated result. For example, the user can go into the model output and determine the maximum 95th percentile precipitation event across ten years. The phrase "maximum 95th percentile" is used because each month within each year has its own Monte Carlo distribution. The maximum 95th percentile event would be the largest precipitation event over the modeling period.

The output categories of interest include:

Pond Size. The model estimates the size of the tailings pond (acre-feet) needed to retain process water, surface water, and precipitation. Pond size can vary significantly depending on precipitation.   The modeling has been completed with a minimum pond volume of 600 acre-feet. This is a reasonable pond size that is well within TSF capacity while at the same time allowing for some water to be retained for dilution during very dry periods.

Parameter concentrations. The model estimates TSF concentrations for chemical constituents with WQBELs in the draft NPDES permit (except aluminum and nitrate). Aluminum and nitrate are considered separately as discussed in other sections of the Fact Sheet. Discharge concentrations are a function of geochemistry, hydrologic scenario, and operating parameters. The user is able to see both the expected value after x iterations as well as detailed probability data for each parameter.

III.   PRODUCTION INPUTS

Table 1 presents the expected parameters for tailings and tailings slurry generated at the mill. These values, while consistent with the available Kensington documents, would exceed the capacity of the TSF. The TSF is designed to hold no more than 60 percent of the tailings generated by the mining operation, assuming 2,042 tons per day over 10 years (Table 1). Thus, forty percent or more of the tailings will be used to backfill the mine in order to meet the currently designed capacity of the TSF. The Table 1 tailings parameters, adjusted for 40 percent backfill, are presented in Table 2.

Table 1. Kensington Production Inputs to TSF, under the "no backfill" scenario

S.G. of Solids:	2.79	
S.G. of Fluid:	1	
Percent Solids:	55.0%	by weight
Peak Slurry Throughput:	440	US gpm
Average Slurry Throughput:	400	US gpm
Mine Life:	10	years
S.G. of Slurry:	1.55	
Average Solids Throughput:	2042	US tons/day
Average Solids Throughput:	745,504	US tons/year
Average Fluid Throughput:	279	US gpm
Avg. Dry Density Yr. 1:	65	pcf
Avg. Dry Density Yr. 6+:	70	pcf
Total Tailings Volume:	213,000,000	ft3
Total Tailings Tonnage:	7,455,000	tons

Table 2. Kensington Production Inputs to TSF, under the "40 percent backfill" scenario

S.G. of Solids:	2.79	
S.G. of Fluid:	1	
Percent Solids:	55.0%	by weight
Peak Slurry Throughput:	266	US gpm
Average Slurry Throughput:	242	US gpm
Mine Life:	10	years
S.G. of Slurry:	1.55	
Average Solids Throughput:	1236	US tons/day
Average Solids Throughput:	451,030	US tons/year
Average Fluid Throughput:	169	US gpm
Avg. Dry Density Yr. 1:	65	pcf
Avg. Dry Density Yr. 6+:	70	pcf
Total Tailings Volume:	128,857,000	ft3
Total Tailings Tonnage:	4,510,000	tons

Consistent with 40 CFR Part 440 subpart F, EPA Region 10 initially determined that TSF water recycling is required as part of the NPDES approval process. Coeur modified aspects of its plan of operations, as described below, to incorporate TSF water recycling.

Tailings from the flotation circuit would be pumped to the tailings thickener tank, where process water will be recovered and recycled back into the milling circuit. These thickened tailings would be sent from the thickener tank to an agitator tank, and then flow by gravity through a 3.5-mile pipeline to the TSF. Tailings will be placed into the TSF, where settling would occur.

Process water associated with the tailings slurry will either remain entrained in the tailings, slowly releasing as consolidation occurs, or mixed with pond water.

The @Risk model is set up to allow alternate TSF operating scenarios including process water recycling and/or backfilling the mine with tailing; both effect the size of the TSF.
The volume of process water recycled can be varied within the model. For example, if average slurry throughput is 354 gallons per minute (gpm) with average solids content of 55 percent by weight, the water component of the slurry is 247 gpm. If the percent solids decrease to 35 percent, the volume of water in the slurry increases to 297 gpm. A portion of this water is entrained in the tailings and unavailable for immediate recycle, although some of this water is "squeezed" from the tailings over time under the weight of subsequent tailings and supernatant. The volume of water available for recycle is estimated to range between 67 and 160 gpm, at 55 percent solids. In it's NPDES application, Couer indicated a recycle rate of 100 gpm, which has been incorporated into the model.

The TSF will continuously discharge to East Slate Creek through Outfall 002. In it's revised NPDES permit application, Coeur has proposed a TSF treatment system with a capacity of 1100 gpm. This is the maximum TSF discharge volume incorporated into the model.

IV.   HYDROLOGIC INPUTS

Precipitation
Mean annual precipitation for the study area is 58.3 inches; based on historical records for Eldred Rock (closest regional station with historic precipitation data). The project site is located at an elevation of approximately 700 feet so an orographic factor of 1.25 was applied to the Eldred Rock data to obtain the estimate mean annual precipitation value (58.3 inches). The annual total was further divided into mean monthly values, also based on Eldred Rock monthly mean precipitation values. Mean monthly values range from a high of 11.02 inches in October to a low of 2.20 inches in June (Table 3). Variations from year to year are represented by coefficients of variation ranging from 0.5 to 1.0, which are reflected in monthly standard deviations. The fifth and ninety-fifth percentile precipitation values (Table 3) were calculated from @Risk Monte Carlo sampling, after 100 iterations. The Probable Maximum Precipitation (PMP) event of about 17 inches in 24 hours is not included in the model; however, this large event would be handled with the dam freeboard.

For the @RISK model, Knight-Piesold defined monthly precipitation distributions according to the mean monthly precipitation and standard deviation. The monthly distributions used in the model are truncated normal distribution type, with the lower bound set at zero. According to Knight Piesold (2002), this approach provided a reasonable fit to the historical monthly Eldred Rock precipitation values.

Table 3. Precipitation, Surface Runoff data and @Risk Model Inputs

Description	Unit	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Precipitation[1]	inches (Mean)	11.02	6.80	5.36	4.05	4.83	3.33	2.61	3.02	2.20	3.07	4.54	7.47	58.3
	% annual	18.9%	11.7%	9.2%	6.9%	8.3%	5.7%	4.5%	5.2%	3.8%	5.3%	7.8%	12.8%	100%
	5th% (inches)	5.8	3.5	2.6	1.9	2.4	1.6	1.4	1.5	1.2	1.6	2.4	3.9	
	95th% (inches)	16.6	10.2	7.8	6.0	7.2	5.0	3.9	4.4	3.4	4.6	6.8	11.1	
Runoff[2]	inches	7.86	5.34	2.34	2.24	2.01	2.00	3.75	8.49	6.81	4.29	5.54	7.64	58.3
	% annual	13.5%	9.2%	4.0%	3.8%	3.4%	3.4%	6.4%	14.6%	11.7%	7.4%	9.5%	13.1%	100.0%
	% precip	71.4%	78.5%	43.6%	55.2%	41.6%	60.1%	143.6%	281.1%	309.7%	139.6%	121.9%	102.3%	100.0%
Model Inputs														
Precipitation - mean	inches	11.02	6.80	5.36	4.05	4.83	3.33	2.61	3.02	2.20	3.07	4.54	7.47	
Precipitation - stdev	inches	3.306	2.046	1.608	1.206	1.452	0.996	0.786	0.909	0.666	0.927	1.365	2.238	
Rainfall Runoff	% precip	75%	75%	45%	45%	45%	60%	100%	100%	100%	100%	100%	100%	
Snow pack	% precip	25%	25%	55%	55%	55%	40%							
Snow pack Runoff	% snowpack							10.0%	40.0%	35.0%	10.0%	5.0%		

Notes: 1 - Precipitation distribution derived from Knight Piesold (2002). It is based on historical records for Eldred Rock.

2 - Runoff distribution based on historical records for Auke Creek at Auke Bay. This is a regional station with similar elevation and annual runoff.

3 - Total runoff is equal to rainfall runoff plus snow pack runoff. Snow pack runoff distribution determined in accordance with relationship between precipitation and runoff for regional distributions.

Monthly precipitation is the only stochastic hydrologic parameter. The remaining hydrologic inputs are deterministic values.

For each of the model iterations, @Risk selects 120 monthly precipitation values (one for each month over the ten year project period) from the user-defined monthly precipitation distributions. At the conclusion of each model run, @Risk generates an expected value for each month's total precipitation, in inches. The expected value is approximately the mean of the values selected from the distribution during the Monte Carlo simulations. As the number of iterations increases, the average solution (the mean of the described distribution(s)) provides an approximate solution to the problem. The advantage of Monte Carlo simulation lies in the fact that the user can review all selected values and the probability of occurrence for each of these. Thus, the user can review the behavior of the TSF under high, low, and average precipitation events and if desired, can evaluate the influence of changes in multiple variables simultaneously.

Evaporation
Mean annual evaporation for the project area is estimated to be 17.1 inches (Knight Piesold, 1990). Approximately 80 percent of the total annual evaporation occurs in May, June, July, and August; 20 percent in each month. The remaining 20 percent annual evaporation is divided between April and September. Evaporation does not occur from October through March. Evaporation is used in the water balance model only for the TSF surface. Therefore, the model calculates an evaporative water loss from the TSF for April through September.

Snow Pack
Mean annual snow pack accumulation is estimated to be 13.62 inches water equivalent, which is included in the annual precipitation rate of 58.3 inches (Knight Piesold, 2002). Snow accumulates in the project area from October through March. Percent snow pack for total precipitation values by month range from 25 percent in October and November, to 55 percent in December, January, and February (Table 3).

Runoff
Knight Piesold (2002) used regional precipitation and runoff records to estimate the quantity of local precipitation-related runoff. Data from Auke Creek/Bay (30 miles south of the project area) were determined to be the most suitable for runoff estimates. The Auke Creek/Bay data suggests that annual precipitation at the basin's outlet can provide a reasonable approximation of unit runoff from the basin. Increases in higher elevation precipitation would likely be offset by evapotranspiration losses and deep groundwater recharge. Therefore, for the proposed TSF, mean annual runoff would approximately equal the mean annual precipitation of 58.3 inches at the outlet of Lower Slate Creek Lake.

Monthly runoff patterns differ from monthly precipitation patterns because snow accumulates during the winter months and melts in the spring and summer months. Rainfall runoff percentages range from 45 percent in December, January, and February,

to 100 percent in April through September (Table 3). Snow pack runoff occurs from April through August, ranging from 5 percent in August to 40 percent in May. As a result, total runoff exceeds 100 percent of monthly precipitation in the period of April through August when snowmelt occurs. Runoff still accounts for about 40 to 70 percent of total monthly precipitation during winter months.

The model assumes that all runoff from the 378-acre Upper Slate Lake catchment area will generally be diverted around the TSF by pipeline. Undiverted runoff from 95 acres around the TSF will commingle with tailings water.

Stream Flow

Mean monthly flow values were used in the water balance model for both East Slate Creek and West Slate Creek. These flow rates were estimated using monthly unit runoff rates (rainfall and snow pack) for the given catchment areas. This was the only flow estimation method possible due to the lack of historic flow measurement records for the creeks. Mean monthly stream flow for East Slate Creek, below the TSF outfall, ranges from about 530 to 3,470 gpm, or 1.2 to 7.7 cubic feet per second (cfs) (Knight Piesold, 2002).

Due to the distribution of precipitation values used for each month in the @RISK model stream flow values will vary across the range of precipitation values used to calculate runoff per unit area. As such, both high and low stream flow values are incorporated into the model results, not just mean monthly values.

Conclusion

By incorporating a probabilistic approach whereby monthly distributions of probable precipitation values were used for the @RISK model, model results allow a water balance to be calculated based on all probable combinations of monthly precipitation conditions (i.e., low and high values). The many combinations of precipitation values in the distributions are then used in the model to calculate runoff conditions into and out of the TSF.

V.   GEOCHEMISTRY INPUTS

Tailings placed into the TSF during operation of the Kensington mine will interact with inflowing runoff and the standing column of water. Predictions of water quality for the TSF must therefore address the potential for sulfide oxidation (with associated acid formation) and trace element release through dissolution and desorption of constituents from the tailing. All of the geochemical characterization data available for Kensington tailings have been reviewed to evaluate the Knight Piesold (2002) mixing model and to facilitate identification of appropriate inputs for Slate Creek TSF NPDES permit development. Documents reviewed include:
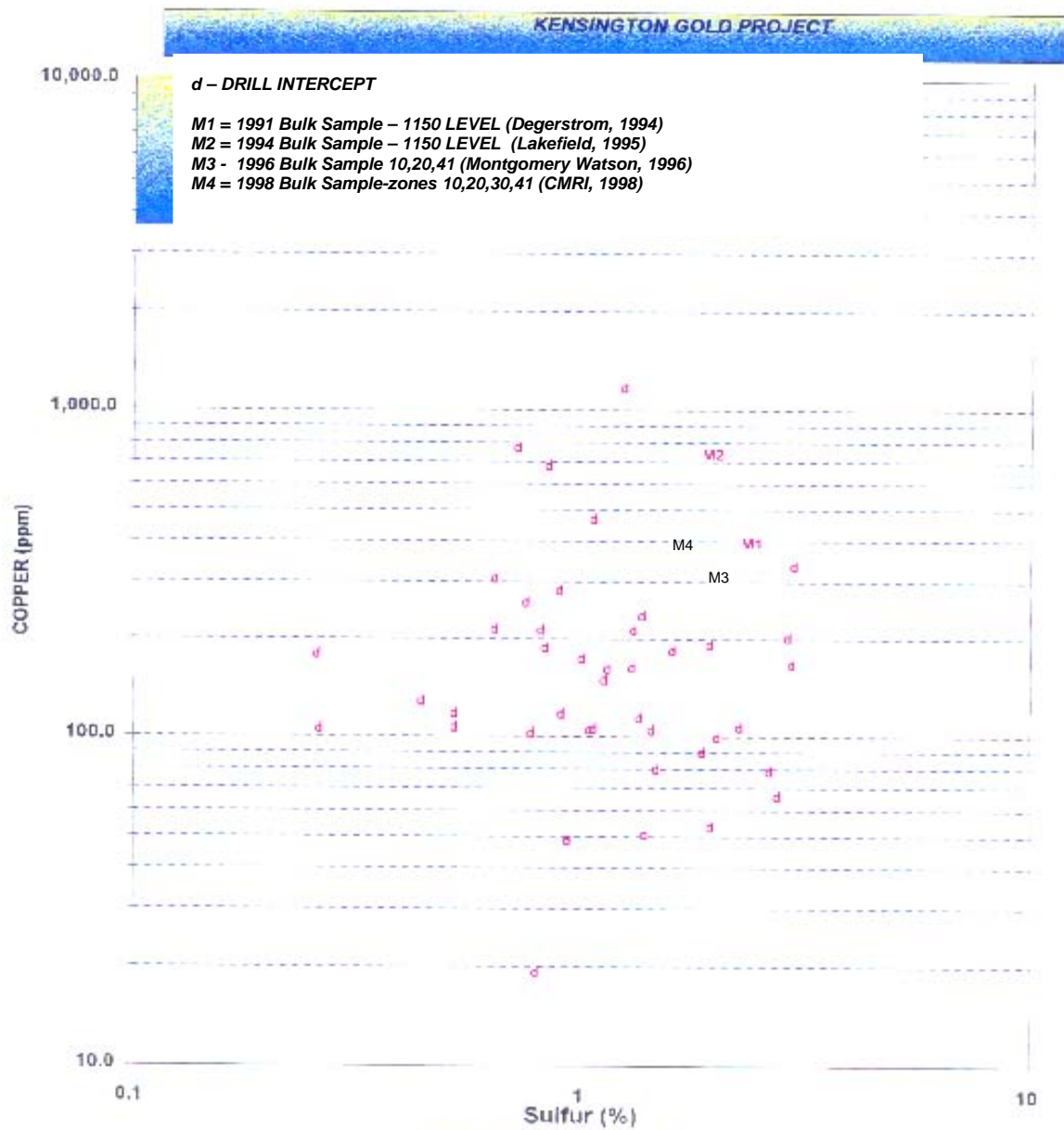
∗   Geochemica/Kensington Venture (1994), Geochemical Characterization Report
∗   Kensington Venture (1994), Ore Characterization Report
∗   Coeur Alaska (1996), Geochemical Character of the Kensington Gold Deposit

* Montgomery Watson (1996), Coeur Alaska, Inc. Kensington Mine Project: Rougher Tailings Characterization report.
* SRK (1996), Geochemistry Review and Tailings Seepage Characterization Reports
* SAIC (1997), Water Resources report
* Montgomery Watson (1998), Kensington Pilot Testing Result memo to E. Klepfer (Coeur) from Ed Cryter (MW), 12/23/98.
* Colorado Mineral Research Institute (1998), Kensington Mine Flotation and Leaching Studies
* RESCAN (2000), Assessment of the Geochemical Stability of Tailings Placed in a Submarine Environment
* Maxim Technologies (2000), Comparison of Particle Size Distributions, Mineral Compositions, and Chemical Compositions between Kensington Mine Tailings and Lynn Canal Sediment.
* Knight Piesold (2001), Coeur Alaska Inc. Kensington Project: Slate Creek Lakes Tailings Storage Facility Conceptual Design and Water Balance (Ref No. 31328/12-2)
* Knight Piesold , (2002), Coeur Alaska Inc. Kensington Project: Slate Creek Lakes Tailings Storage Facility Report on Water Quality Modeling and Conceptual Closure Plan. (Ref No. VA101-00020/1-1)

Efforts to compare and integrate data from the various testing programs raised the question of how comparable the ore used to generate the tailings for each set of analyses was between tests. Tetra Tech also reviewed whether the ore samples were representative of the overall ore body and if the chemistry of tailings generated in different metallurgical studies was consistent between tests.

Review of Ore Sampling and Metallurgical Studies
Three bulk ore samples have been collected for metallurgical testing over the life of the Kensington project. Four sets of analyses of these samples have been completed, designated M1 through M4 in Figures 1 through 7. The first bulk sample was collected in 1994 and tested by Degerstrom (results shown as M1) to evaluate cyanidation processing. As cyanidation is no longer proposed, those data are not presented here. The second bulk ore sample was a 3.8 ton composite collected by Lakefield Research known as Composite B. The composite B sample was comprised of quartz+carbonate veins and pyritic mineralization excavated from Crosscut II, on the 1,150 elevation, in zones 10, 20 and 41. This composite generated tailings and process water samples that were analyzed first by Degerstrom in 1995 (M2) and later by Montgomery Watson and SRK (M3) in 1996 (Montgomery Watson, 1996; SRK, 1996). The specific whole rock

10,000.0

d – DRILL INTERCEPT

M1 = 1991 Bulk Sample – 1150 LEVEL (Degerstrom, 1994)
M2 = 1994 Bulk Sample – 1150 LEVEL (Lakefield, 1995)
M3 - 1996 Bulk Sample 10,20,41 (Montgomery Watson, 1996)
M4 = 1998 Bulk Sample-zones 10,20,30,41 (CMRI, 1998)

1,000.0

COPPER (ppm)

100.0

10.0

0.1   Sulfur (%)   1   10

Copper Vs Sulfur

Figure 1

After Coeur, 1996,
Geologic Character of the Kensington Gold Deposit

KENSINGTON GOLD PROJECT

d – DRILL INTERCEPT

M1 = 1991 Bulk Sample – 1150 LEVEL (Degerstrom, 1994)
M2 = 1994 Bulk Sample – 1150 LEVEL (Lakefield, 1995)
M3 - 1996 Bulk Sample 10,20,41 (Montgomery Watson, 1996)
M4 = 1998 Bulk Sample-zones 10,20,30,41 (CMRI, 1998)
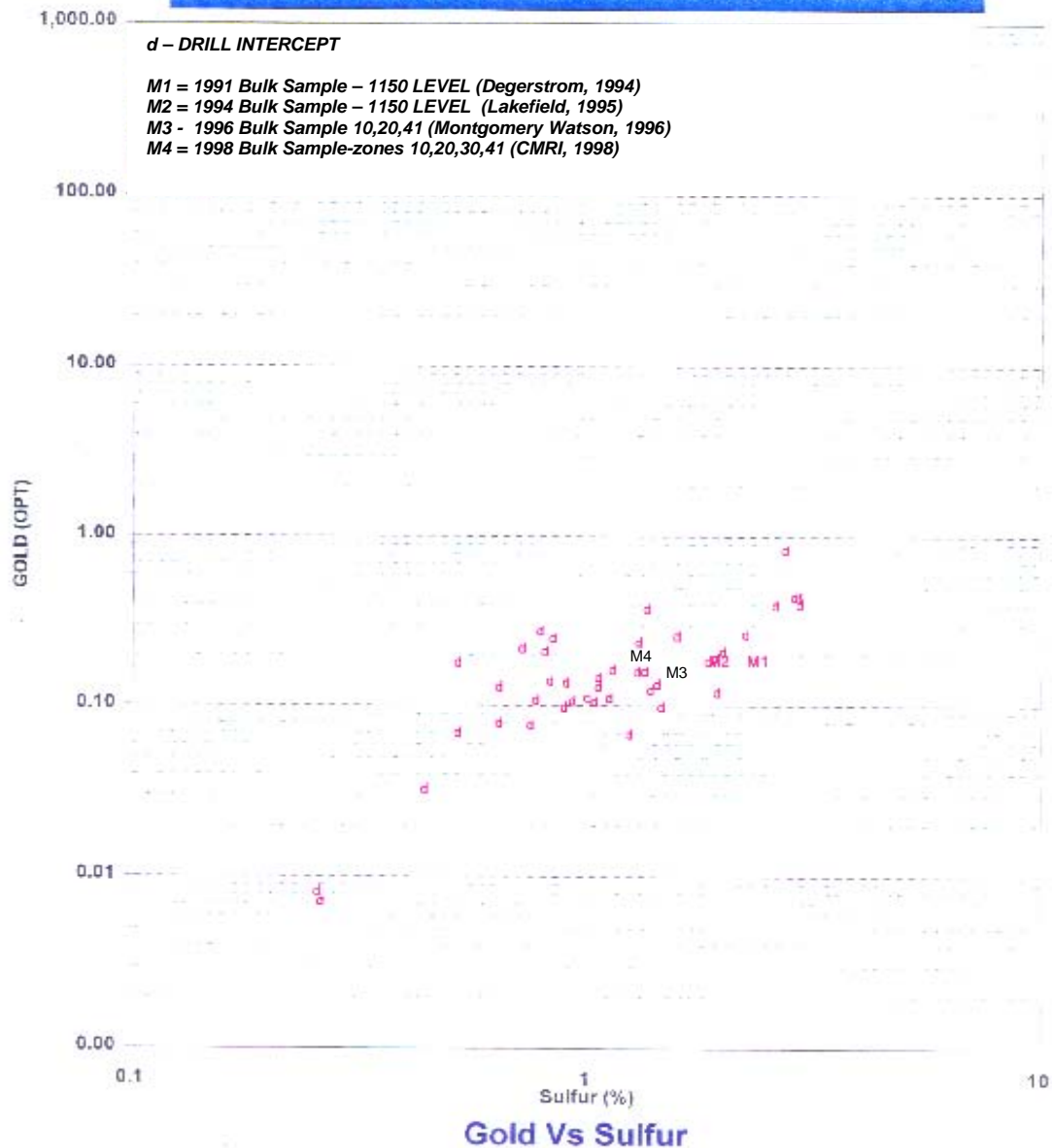
Gold Vs Sulfur

Figure 2

After Coeur, 1996,
Geologic Character of the Kensington Gold Deposit

100.00

d – DRILL INTERCEPT

M1 = 1991 Bulk Sample – 1150 LEVEL (Degerstrom, 1994)
M2 = 1994 Bulk Sample – 1150 LEVEL (Lakefield, 1995)
M3 - 1996 Bulk Sample 10,20,41 (Montgomery Watson, 1996)
M4 = 1998 Bulk Sample-zones 10,20,30,41 (CMRI, 1998)

M4

M4

10.00

IRON (%)

1.00

0.10

0.01

0.00

0.1

1
Sulfur (%)

Iron Vs Sulfur
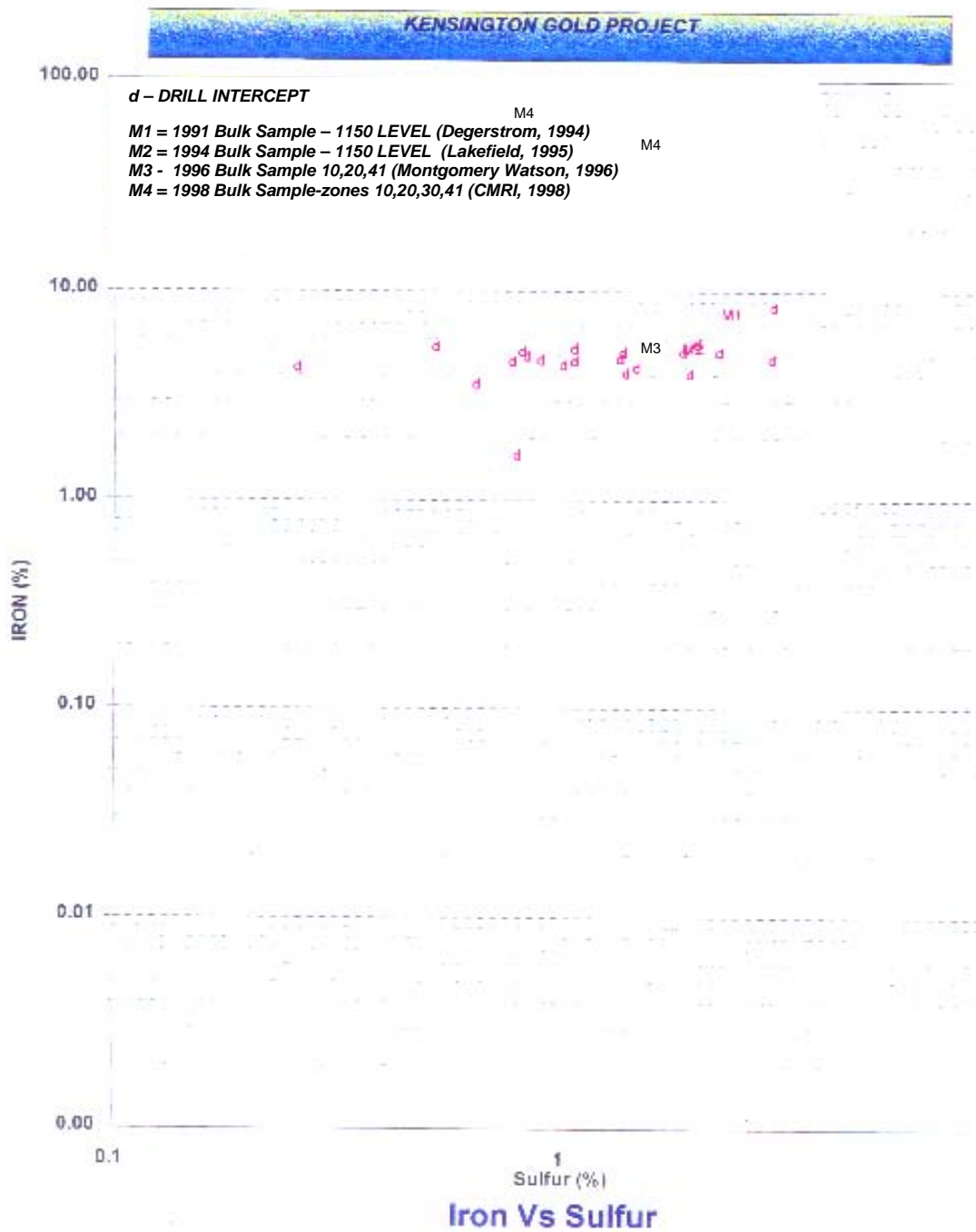
Figure 3

After Coeur, 1996,
Geologic Character of the Kensington Gold Deposit

64

d – DRILL INTERCEPT

M1 = 1991 Bulk Sample – 1150 LEVEL (Degerstrom, 1994)
M2 = 1994 Bulk Sample – 1150 LEVEL (Lakefield, 1995)
M3 - 1996 Bulk Sample 10,20,41 (Montgomery Watson, 1996)
M4 = 1998 Bulk Sample-zones 10,20,30,41 (CMRI, 1998)
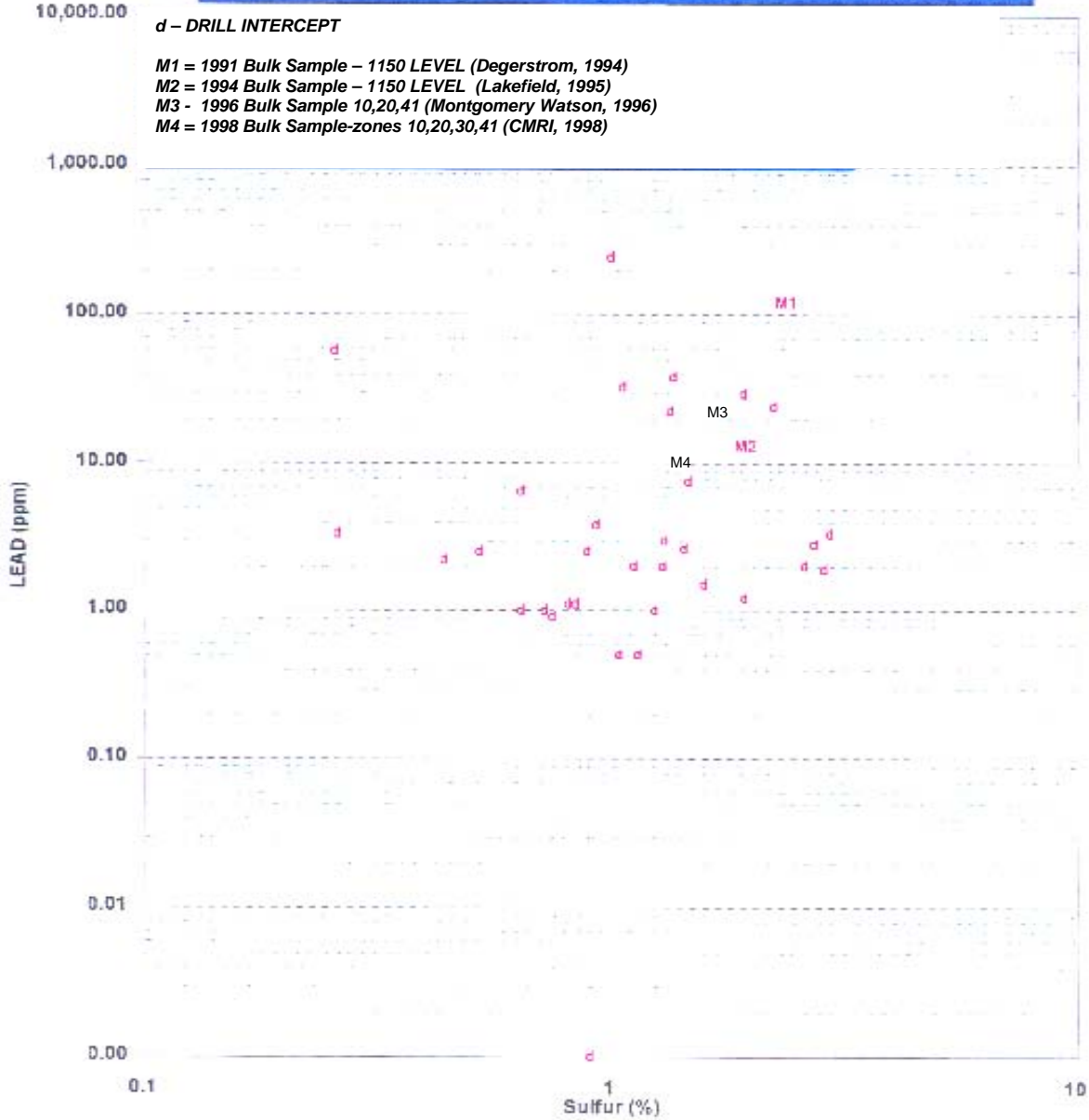
Lead Vs Sulfur

Figure 4

After Coeur, 1996,
Geologic Character of the Kensington Gold Deposit

KENSINGTON GOLD PROJECT

d – DRILL INTERCEPT

M1 = 1991 Bulk Sample – 1150 LEVEL (Degerstrom, 1994)
M2 = 1994 Bulk Sample – 1150 LEVEL (Lakefield, 1995)
M3 - 1996 Bulk Sample 10,20,41 (Montgomery Watson, 1996)
M4 = 1998 Bulk Sample-zones 10,20,30,41 (CMRI, 1998)

NICKEL (ppm)

Sulfur (%)

Nickel Vs Sulfur
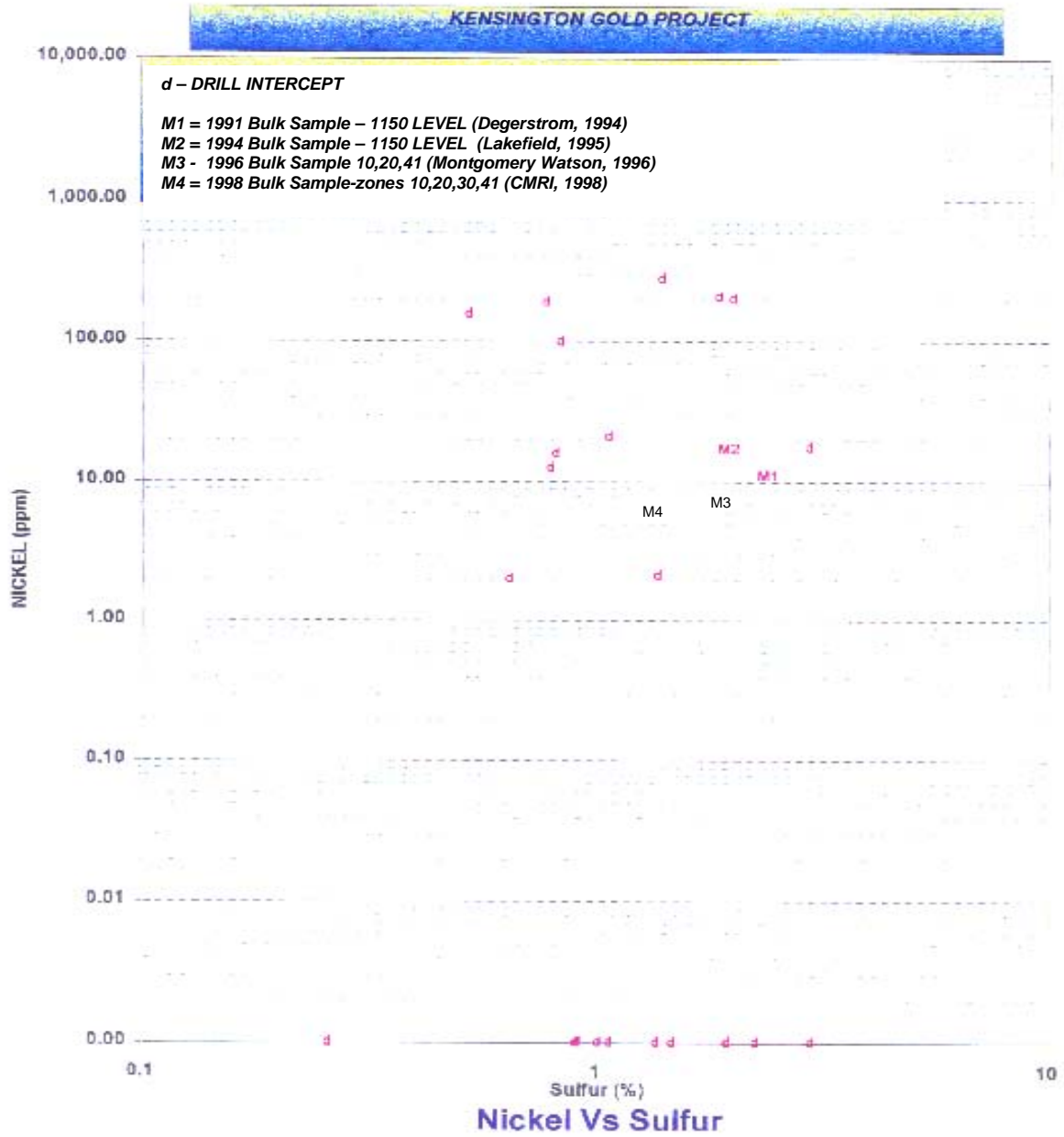
Figure 5

After Coeur, 1996,
Geologic Character of the Kensington Gold Deposit

KENSINGTON GOLD PROJECT

d – DRILL INTERCEPT

M1 = 1991 Bulk Sample – 1150 LEVEL (Degerstrom, 1994)
M2 = 1994 Bulk Sample – 1150 LEVEL (Lakefield, 1995)
M3 - 1996 Bulk Sample Zones 10,20,41 (Montgomery Watson, 1996)
M4 = 1998 Bulk Sample-zones 10,20,30,41 (CMRI, 1998)

Zinc Vs Sulfur
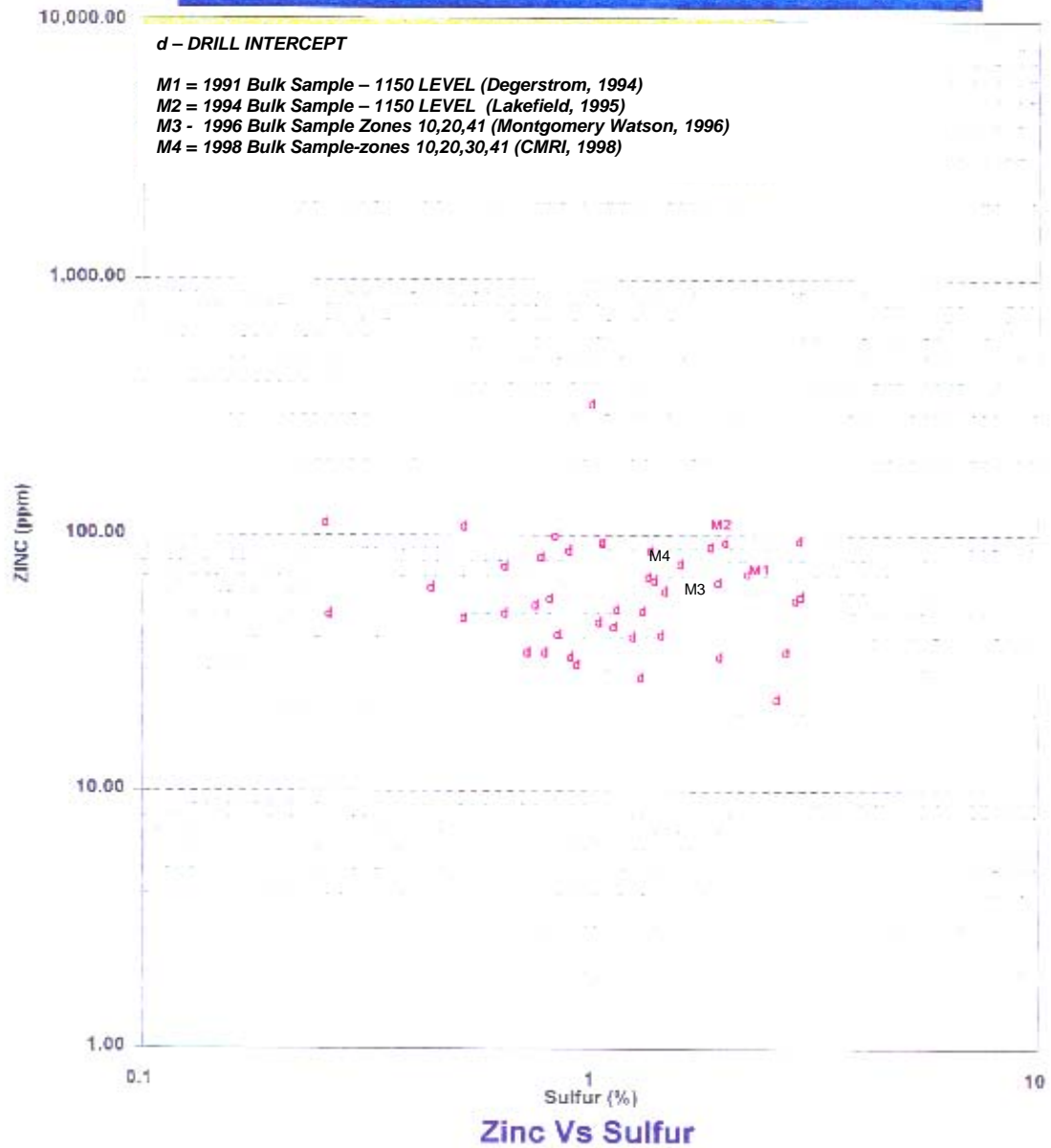
Figure 6

After Coeur, 1996,
Geologic Character of the Kensington Gold Deposit
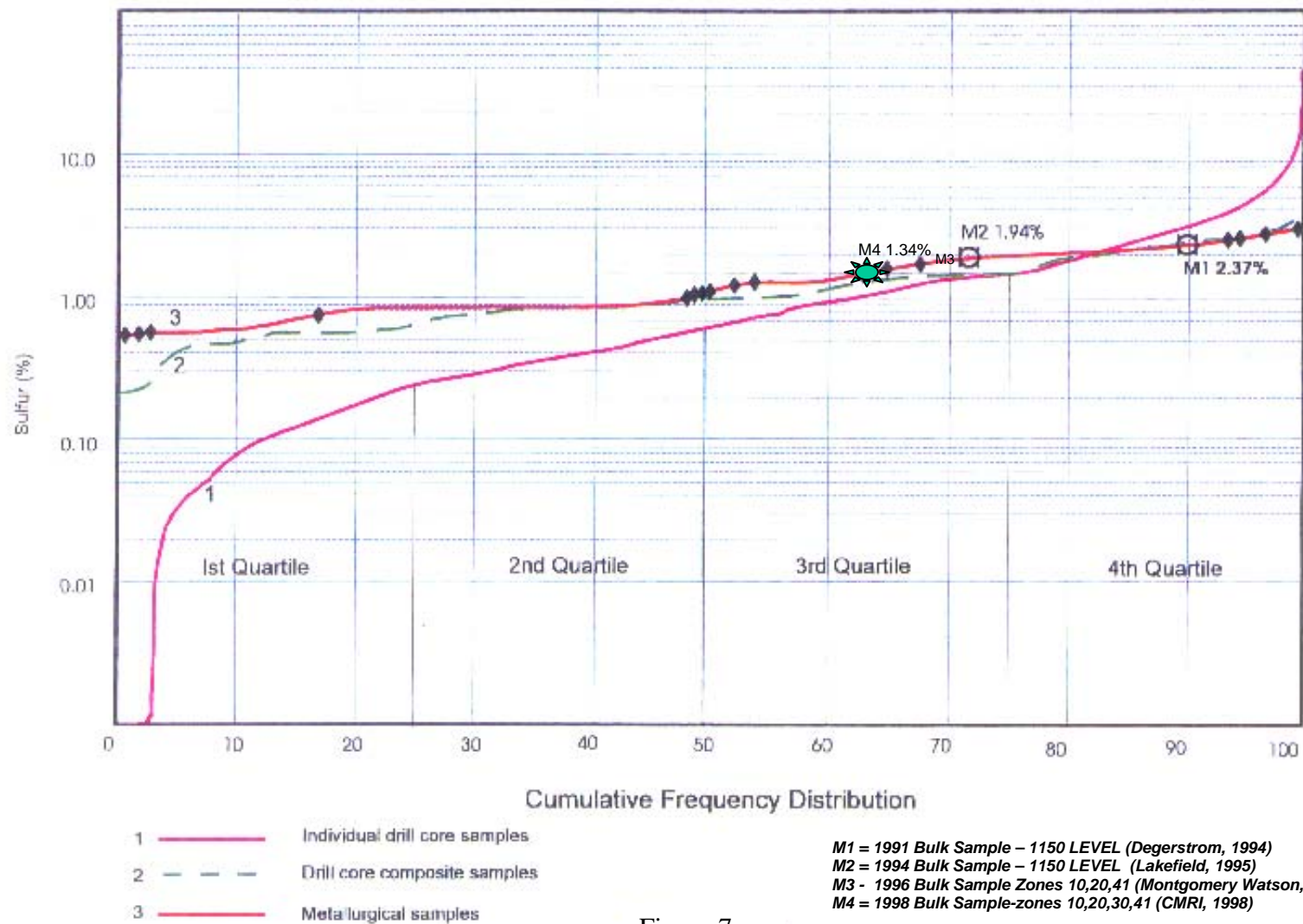
Figure 7

Cumulative Frequency Distribution

1	———	Individual drill core samples
2	– – –	Drill core composite samples
3	———	Metallurgical samples

M1 = 1991 Bulk Sample – 1150 LEVEL (Degerstrom, 1994)
M2 = 1994 Bulk Sample – 1150 LEVEL (Lakefield, 1995)
M3 - 1996 Bulk Sample Zones 10,20,41 (Montgomery Watson, 1996)
M4 = 1998 Bulk Sample-zones 10,20,30,41 (CMRI, 1998)

After Coeur, 1996,
Geologic Character of the Kensington Gold Deposit

digestion used in the M2 analysis is not known, but is obviously a more complete (i.e., four-acid) digestion than the EPA method 3051 digestion used for the M3 analyses. The gold assay, whole rock metal and sulfur geochemistry of the ore composites and the tailings are described in Tables 4 and 7 based on the 1996 M3 analyses. The five batches of tailings that were analyzed were generated in separate batches, and process water was not recycled.

A third bulk sample comprised of 3.7 tons of rock collected from zones 10, 20, 30, and 41 underwent flotation at the Colorado Mineral Research Institute (CMRI) in 1998. Roughly one ton of the sample underwent flotation in five 400-pound batches, between which process water was recycled. Whole rock analyses conducted by CMRI are shown as M4 in Figures 1 through 7. The digestion method for these whole rock analyses reported by CMRI is also not known. The whole rock metal and sulfur geochemistry of the ore composite and the tailings from the CMRI analysis (M4) is described in Tables 5 and 8. The gold grade was measured for each batch independently. A subsample collected from a single process cycle was analyzed by RESCAN. Knight Piesold used results of this analysis for mass load modeling purposes, as described in Table 6.

Additional whole rock analyses for tailings samples are reported by Maxim (2000) based on digestions using methods 3050 and 3052. No ore analyses were reported, however, and so these results have not been summarized here.

The 1997 Final Kensington Mine Project SEIS relied on the 1996 M3 whole rock data reported by Montgomery Watson and SRK. These have been updated with the 1998 CMRI results (M4). Tetra Tech's review of these two sets of data leads to the conclusion that the ore composites were representative of the ore to be mined based on three key findings.

1. Both samples were collected in a spatially and lithologically representative fashion from the main ore zones 10, 20, and 41. The primary difference is that the M3 sample, collected on the 1,150 level, would not have contained ore from zone 30 that is included in M4, because that zone occurs above the 2,050 elevation and so would not have been accessible from the 1,150 level workings during the 1995 sampling event.

2. The whole rock geochemistry of the bulk ore samples used in the 1996 and 1998 samples is generally comparable, as summarized in Figures 1 to 6. The specific digestion method used by CMRI to digest the ore sample for whole rock analysis is not known, but is inferred to be the more complete four-acid digestion as this is a more common method for metallurgical analysis. The 1998 whole rock data for tailings presented in Table 1 are from a four-acid digestion; an aqua-regia digestion is also reported by RESCAN, but not included in this summary. The 1998 M4 bulk ore sample had very similar gold and lead concentrations, higher iron content, and slightly lower copper, zinc, and nickel content than the 1996 M3 sample. The gold values reported for both samples are very close to the reported deposit-wide average of 0.16 opt.

Table 4. Dissolved whole rock metal and sulfur geochemistry, M3 sample

Parameter	*M3* MW 96 (detection limit)	MW96 C1 24 hr	MW96 C2 24 hr	MW96 C3 24hr	MW96 C4 24 hr	MW96 C5 24 hr
		MONTGOMERY WATSON - LAKEFIELD 1994-1996				
Met lab name		**Lakefield**	**Lakefield**	**Lakefield**	**Lakefield**	**Lakefield**
Anal lab name		**MW/BNL**	**MW/BNL**	**MW/BNL**	**MW/BNL**	**MW/BNL**
Process		**batch**	**batch**	**batch**	**batch**	**batch**
date test	**1996**	**1996**	**1996**	**1996**	**1996**	**1996**
no. samples		**1**	**1**	**1**	**1**	**1**
composite		**3.8 ton**	**3.8 ton**	**3.8 ton**	**3.8 ton**	**3.8 ton**
Aluminum (ug/L)	500	<500	<500	<500	<500	<500
Arsenic (ug/l)	0.5	0.491	0.601	0.943	0.899	0.778
Copper (ug/l)	**2**	**<2**	**<2**	**<2**	**<2**	**<2**
Iron (ug/L)	50	<50	<50	<50	<50	<50
Lead (ug/l)	2	<2	<2	<2	<2	<2
Mercury (ug/l)	0.00001	0.00818	0.00445	0.00301	0.00298	0.0033
Nickel (ug/l)	10	**<10**	**<10**	**<10**	**<10**	**<10**
Selenium (ug/l)	0.001	0.768	0.948	1.05	1.17	1.05
Silver (ug/l)	0.008	**<0.008**	**<0.008**	**<0.008**	**<0.008**	**<0.008**
Zinc (ug/l)	10	15	13	13	13	12
Ammonia (ug/l)	50	2800	3800	4100	4500	4600
Nitrate (mg/l)	500	19,800	28000	33000	35000	36000
TDS (mg/l)		**470**	**650**	**710**	**730**	**810**
TSS, mg/L	4	<4	6	<4	<4	<4
NTU, lab		nd	nd	nd	nd	nd
SO4, field	1	**198**	**280**	**310**	**330**	**330**
toc		nd	nd	nd	nd	nd
pH, field		**nd**	**nd**	**nd**	**nd**	**nd**
pH, lab	**0.01**	**8.1**	**8**	**8.1**	**8.2**	**8.1**
Eh, field		nd	nd	nd	nd	nd
hardness		**210**	**260**	**290**	**310**	**320**
sample zones		10, 20, 41	10, 20, 41	10, 20, 41	10, 20, 41	10, 20, 41
WHOLE ROCK ORE DATA		MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1
Ore digestion		3051	3051	3051	3051	3051
Ore total S		**1.83**	**1.83**	**1.83**	**1.83**	**1.83**
Ore total sulfide		1.74	1.74	1.74	1.74	1.74
Ore total Au, opt		**0.155**	**0.155**	**0.155**	**0.155**	**0.155**
Ore Cu, ppm		**254**	**254**	**254**	**254**	**254**
Ore Fe, ppm		45,000	45,000	45,000	45,000	45,000
Ore Pb, ppm		26	26	26	26	26
Ore Hg, ppb		76	76	76	76	76

Table 4. Dissolved whole rock metal and sulfur geochemistry, M3 sample

Parameter	MW 96 (detection limit)	MW96 C1 24 hr	MW96 C2 24 hr	MW96 C3 24hr	MW96 C4 24 hr	MW96 C5 24 hr
M3		**MONTGOMERY WATSON - LAKEFIELD 1994-1996**				
Ore Mn, ppm		1351	1351	1351	1351	1351
Ore Ni, ppm		7	7	7	7	7
Ore Zn, ppm		64	64	64	64	64
WHOLE ROCK TAILS DATA		MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1
Tails digestion		3051	3051	3051	3051	3051
Tails Tot S, %		**0.04**	**0.04**	**0.04**	**0.04**	**0.04**
Tails Cu, ppm		**30**	**30**	**30**	**30**	**30**
Tails Fe, ppm		31,000	31,000	31,000	31,000	31,000
Tails Pb, ppm		25	25	25	25	25
Tails, Hg ppb		58	58	58	58	58
Tails Mn, ppm		1286	1286	1286	1286	1286
Tails Ni, ppm		6	6	6	6	6
Tails Zn, ppm		55	55	55	55	55

Table 5. Dissolved whole rock metal and sulfur geochemistry, M4 sample

M4   CMRI/1998   MONTGOMERY WATSON

Parameter	CMRI 1998 (detection limit)	CMRI D2 DUPLICATES C2	CMRI C2 Leach decant water	CMRI C3 Leach decant water	CMRI C4 Leach decant water	CMRI C5 Leach decant water	Kensington Mine Water 1998
Met lab name		CMRI	CMRI	CMRI	CMRI	CMRI	CMRI
Anal lab name		MW/BNL	MW/BNL	MW/BNL	MW/BNL	MW/BNL	MW/BNL
Process		recycle	recycle	recycle	recycle	recycle	adit
date test		1998	1998	1998	1998	1998	9/18/1998
no. samples		1	1	1	1	1	1
composite		3.7 ton	3.7 ton	3.7 ton	3.7 ton	3.7 ton	grab
Aluminum (ug/L)	250	3200	3100	2200	3200	660	3200
Arsenic (ug/l)	0.02	<2	<2	<2	<2	<2	<2
Copper (ug/l)	2	0.0795	0.0925	0.255	0.286	0.524	7.1
Iron (ug/L)	50	<10	<10	<10	<10	<10	<10
Lead (ug/l)	2	0.676	1.16	<0.08	<0.08	<0.08	<0.5
Mercury (ug/l)	0.00005	0.0196	0.0280	0.0129	0.0204	0.0309	<0.2
Nickel (ug/l)	10	5.96	6.7	3.82	4.15	3.55	19
Selenium (ug/l)	0.05	2.49	2.79	<2	2.81	2.00	<5
Silver (ug/l)	0.008	<0.05	<0.05	<0.05	<0.05	<0.05	<0.5
Zinc (ug/l)	10	71.7	75.7	10.3	6.9	3.8	11
Ammonia (ug/l)	50	1010	950	900	1050	860	<0.05
Nitrate (mg/l)	0.1, 0.3, 0.5	4.1	4.1	4.8	5.6	4.0	0.31
TDS (mg/l)	20	990	1000	900	1160	1000	460
TSS, mg/L	4	6	5	240	110	70	<4
NTU, lab	0.2	46	88	200	19	24	<0.1
SO4, field	2,6,10	710	710	680	770	550	280
toc		32.9	31.6	43.2	42.5	33.5	
pH, field	0.001	10.3	10.5	10.2	10.25	10.3	7.45
pH, lab		10.7	10.7	10.5	11	11.1	7.8
Eh, field		-43	-38	-62	-60	-43	211
hardness	10	707	658	583	654	524	349
sample zones		10, 20, 30, 41	10, 20, 30, 41	10, 20, 30, 41	10, 20, 30, 41	10, 20, 30, 41	
WHOLE ROCK ORE DATA		CMRI 1998, Tab 5	CMRI 1998, Tab 5	CMRI 1998, Tab 5	CMRI 1998, Tab 5	CMRI 1998, Tab 5	
Ore digestion		unknown	unknown	unknown	unknown	unknown	
Ore total S		1.34	1.34	1.34	1.34	1.34	
Ore total sulfide		nd	Nd	nd	nd	nd	
Ore total Au, opt		0.176[+]	0.176[+]	0.171[+]	0.187[+]	0.160[+]	
Ore Cu, ppm		326	326	326	326	326	
Ore Fe, ppm		48100	48100	48100	48100	48100	
Ore Pb, ppm		10	10	10	10	10	
Ore Hg, ppb		nd	Nd	nd	nd	nd	
Ore Mn, ppm		1560	1560	1560	1560	1560	
Ore Ni, ppm		6	6	6	6	6	
Ore Zn, ppm		70.6	70.6	70.6	70.6	70.6	

Table 5. Dissolved whole rock metal and sulfur geochemistry, M4 sample

M4		**CMRI/1998 MONTGOMERY WATSON**					
Parameter	**CMRI 1998** (detection limit)	**CMRI D2 DUPLICATES C2**	**CMRI C2 Leach decant water**	**CMRI C3 Leach decant water**	**CMRI C4 Leach decant water**	**CMRI C5 Leach decant water**	**Kensington Mine Water 1998**
WHOLE RK TAILS DATA		RESCAN, 2000	RESCAN, 2000	RESCAN, 2000	RESCAN, 2000	RESCAN, 2000	
Tails digestion		4 acid	4 acid	4 acid	4 acid	4 acid	
Tails Tot S, %		**0.06**	**0.06**	**0.06**	**0.06**	**0.06**	
Tails Cu, ppm		**27**	**27**	**27**	**27**	**27**	
Tails Fe, ppm		31600	31600	31600	31600	31600	
Tails Pb, ppm		6	6	6	6	6	
Tails, Hg ppb		10	10	10	10	10	
Tails Mn, ppm		14000	14000	14000	14000	14000	
Tails Ni, ppm		32	32	32	32	32	
Tails Zn, ppm		54	54	54	54	54	

no low level

Table 6. Dissolved whole rock metal and sulfur geochemistry, RESCAN and Knight Piesold sample

Parameter	RESCAN (detection limit)	CMRI 98 RESCAN Process water	KP 2002
	RESCAN	**KP DATA**	**2000-2002**
Met lab name		**CMRI**	
Anal lab name		**ASL**	
Process		**1998**	
date test		**CYCLE 3 ONLY**	
no. samples		**1**	
composite		**3.7 ton**	
Aluminum (ug/L)	10	600	600
Arsenic (ug/l)	0.1	0.2	0.2
Copper (ug/l)	**1**	**30**	**30**
Iron (ug/L)	30	<30	<30
Lead (ug/l)	10	<10	<10
Mercury (ug/l)	0.05	<0.05	<0.05
Nickel (ug/l)	**1**	**<1**	**<1**
Selenium (ug/l)	0.5	1.6	1.6
Silver (ug/l)	**0.1**	**0.2**	**0.2**
Zinc (ug/l)	5	<5	<5
Ammonia (ug/l)		NA	NA
Nitrate (mg/l)	0.005	4.83	4.83
TDS (mg/l)			**1000**
TSS, mg/L			240
NTU, lab			
SO4, field	**1**	**730**	**730**
toc			
pH, field	**0.01**	**9.68**	**7.5**
pH, lab	**0.01**		
Eh, field			
hardness			**473?**
sample zones		10, 20, 30, 41	10, 20, 30, 41
WHOLE ROCK ORE DATA		CMRI 1998, Tab 5	CMRI 1998, Tab 5
Ore digestion		unknown	unknown
Ore total S		**1.34**	**1.34**
Ore total sulfide		nd	nd
Ore total Au, opt		**0.169**	**0.169**
Ore Cu, ppm		**326**	**326**
Ore Fe, ppm		48100	48100
Ore Pb, ppm		10	10
Ore Hg, ppb			
Ore Mn, ppm		1560	1560
Ore Ni, ppm		6	6

Table 6. Dissolved whole rock metal and sulfur geochemistry, RESCAN and Knight Piesold sample

Parameter	RESCAN (detection limit)	RESCAN KP DATA CMRI 98 RESCAN Process water	2000-2002 KP 2002
Ore Zn, ppm		70.6	70.6
WHOLE RK TAILS DATA		RESCAN, 2000	RESCAN, 2000
Tails digestion		4 acid	4 acid
Tails Tot S, %		**0.06**	**0.06**
Tails Cu, ppm		**27**	**27**
Tails Fe, ppm		31600	31600
Tails Pb, ppm		6	6
Tails, Hg ppb			
Tails Mn, ppm			
Tails Ni, ppm		32	32
Tails Zn, ppm		54	54

Table 7. Total whole rock metal and sulfur geochemistry, M3 sample

	avg	TSS	pH	SO4
16 hr settling time	7.8	8-8.2	289.6	
24 hr settling time	2.8	8-8.2	289.6	

M3   MONTGOMERY WATSON - LAKEFIELD M2 1994-1996

Parameter	MW 96 (detection limit)	MW96 C1 24 hr	MW96 C2 24 hr	MW96 C3 24hr	MW96 C4 24 hr	MW96 C5 24 hr	1996 NPDES Inputs Decant Water
Met lab name		Lakefield	Lakefield	Lakefield	Lakefield	Lakefield	Lakefield
Anal lab name		MW/BNL	MW/BNL	MW/BNL	MW/BNL	MW/BNL	MW/BNL
Process		batch	batch	batch	batch	batch	
date test	1996	1996	1996	1996	1996	1996	1996
no. samples		1	1	1	1	1	max of 5 samples
composite		3.8 ton	3.8 ton	3.8 ton	3.8 ton	3.8 ton	5 composites
Aluminum (ug/L)	500	<500	<500	<500	<500	<500	<500
Arsenic (ug/l)	0.5	0.573	0.665	0.553	0.626	0.619	0.76
Copper (ug/l)	2	<2	<2	<2	<2	<2	< 2
Iron (ug/L)	50	130	150	62	99	76	50
Lead (ug/l)	2	<2	<2	<2	<2	<2	< 2
Mercury (ug/l)	0.00001	0.0009	0.00495	0.00483	0.00324	0.00339	0.0109
Nickel (ug/l)	10	<10	<10	<10	<10	<10	< 10
Selenium (ug/l)	0.001	0.871	1.03	0.787	1.13	1.23	1.23
Silver (ug/l)	0.008	<0.008	<0.008	0.0158	0.00804	<0.008	< 0.008
Zinc (ug/l)	10	<10	<10	<10	<10	<10	< 10
Ammonia (ug/l)	50	2800	3800	4100	4500	4600	4600
Nitrate (mg/l)	500	19,800	28000	33000	35000	36000	36
TDS (mg/l)		470	650	710	730	810	810
TSS, mg/L	4	<4	6	<4	<4	<4	28
NTU, lab		nd	nd	nd	nd	nd	nd
SO4	1	198	280	310	330	330	330
TOC		nd	nd	nd	nd	nd	nd
pH, field		nd	nd	nd	nd	nd	nd
pH, lab	0.01	8.1	8	8.1	8.2	8.1	8.1
Eh, field		nd	nd	nd	nd	nd	nd
hardness	10	210	260	290	310	320	nd
sample zones		10, 20, 41	10, 20, 41	10, 20, 41	10, 20, 41	10, 20, 41	10, 20, 41
WHOLE ROCK ORE DATA		MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1
Ore digestion		3051	3051	3051	3051	3051	3051
Ore total S		1.83	1.83	1.83	1.83	1.83	1.83
Ore total sulfide		1.74	1.74	1.74	1.74	1.74	1.74
Ore total Au, opt		0.155	0.155	0.155	0.155	0.155	0.155
Ore Cu, ppm		254	254	254	254	254	254
Ore Fe, ppm		45,000	45,000	45,000	45,000	45,000	45,000
Ore Pb, ppm		26	26	26	26	26	26
Ore Hg, ppb		76	76	76	76	76	76
Ore Mn, ppm		1351	1351	1351	1351	1351	1351

Table 7. Total whole rock metal and sulfur geochemistry, M3 sample

	avg	TSS	pH	SO4
16 hr settling time	7.8	8-8.2	289.6	
24 hr settling time	2.8	8-8.2	289.6	

M3   <u>MONTGOMERY WATSON - LAKEFIELD M2 1994-1996</u>

Parameter	MW 96 (detection limit)	MW96 C1 24 hr	MW96 C2 24 hr	MW96 C3 24hr	MW96 C4 24 hr	MW96 C5 24 hr	1996 NPDES Inputs Decant Water
Ore Ni, ppm		7	7	7	7	7	7
Ore Zn, ppm		64	64	64	64	64	64
WHOLE ROCK TAILS DATA		MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1	MW, 1996, Tab 1-1
Tails digestion		3051	3051	3051	3051	3051	3051
Tails Tot S, %		**0.04%**	**0.04%**	**0.04%**	**0.04%**	**0.04%**	**0.04%**
Tails Cu, ppm		**30**	**30**	**30**	**30**	**30**	**30**
Tails Fe, ppm		31,000	31,000	31,000	31,000	31,000	31,000
Tails Pb, ppm		25	25	25	25	25	25
Tails, Hg ppb		58	58	58	58	58	58
Tails Mn, ppm		1286	1286	1286	1286	1286	1286
Tails Ni, ppm		6	6	6	6	6	6
Tails Zn, ppm		55	55	55	55	55	55

+ grade measured for each batch by CMRI, whole rock geochemistry for bulk composite low level metal analyses are not available for adit water

Table 8. Total whole rock metal and sulfur geochemistry, M4 sample

Parameter	M4 CMRI 1998 (detection limit) MW/BNL	CMRI D2 DUPLICATES C2	CMRI C2 Leach decant water	CMRI C3 Leach decant water	CMRI C4 Leach decant water	CMRI C5 Leach decant water	Kensington Mine Water 1998
Settling time estimated 30 minutes							
				CMRI/1998 Montgomery Watson			
Met lab name		CMRI	CMRI	CMRI	CMRI	CMRI	CMRI
Anal lab name	MW/BNL	MW/BNL	MW/BNL	MW/BNL	MW/BNL	MW/BNL	MW/BNL
Process		recycle	recycle	recycle	recycle	recycle	
date test		1998	1998	1998	1998	1998	9/18/1998
no. samples		1	1	1	1	1	1
composite		3.7 ton	3.7 ton	3.7 ton	3.7 ton	3.7 ton	grab
Aluminum (ug/L)	500	2700	2800	3900	250	1100	3200
Arsenic (ug/l)	0.02	<2.0	<2.0	2.1	1.8	2.9	<2
Copper (ug/l)	**2**	**6.95**	**9.97**	**10.2**	**10.7**	**9.05**	**7.1**
Iron (ug/L)	50	3300	4000.0	140	1900	1500	<10
Lead (ug/l)	2	0.976	1.10	3.81	4.43	2.52	<0.5
Mercury (ug/l)	**0.00005**	**0.0264**	**0.0581**	**0.0506**	**0.0725**	**0.0332**	**<0.2**
Nickel (ug/l)	**10**	**5.88**	**8.12**	**9.18**	**11.8**	**5.81**	**19**
Selenium (ug/l)	0.05	2.96	4.7	2.91	2.56	3.18	<5
Silver (ug/l)	**0.008**	**0.05**	**0.050**	**0.050**	**0.050**	**0.050**	**<0.5**
Zinc (ug/l)	10	75.8	83.5	20.0	23.4	12.7	11
Ammonia (ug/l)	50	1010	950	900	1050	860	<0.05
Nitrate (mg/l)	0.1, 0.3, 0.5	4.1	4.1	4.8	5.6	4.0	0.31
TDS (mg/l)	20	**990**	**1000**	**900**	**1160**	**1000**	**460**
TSS, mg/L	**4**	**6**	**5**	**240**	**110**	**70**	**<4**
NTU, lab	**0.2**	**46**	**88**	**200**	**19**	**24**	**<0.1**
SO4	**2,6,10**	**710**	**710**	**680**	**770**	**550**	**280**
TOC		32.9	31.6	43.2	42.5	33.5	nd
pH, field	**0.001**	**10.3**	**10.5**	**10.2**	**10.25**	**10.3**	**7.45**
pH, lab	**0.001**	**10.7**	**10.7**	**10.5**	**11**	**11.1**	**7.8**
Eh, field		-43	-38	-62	-60	-43	211
Hardness	**10**	**707**	**658**	**583**	**654**	**524**	**349**
sample zones		10, 20, 30, 41	10, 20, 30, 41	10, 20, 30, 41	10, 20, 30, 41	10, 20, 30, 41	adit
WHOLE ROCK ORE DATA		CMRI 1998, Tab 5	CMRI 1998, Tab 5	CMRI 1998, Tab 5	CMRI 1998, Tab 5	CMRI 1998, Tab 5	
Ore digestion		unknown	unknown	unknown	unknown	unknown	
Ore total S		**1.34**	**1.34**	**1.34**	**1.34**	**1.34**	
Ore total sulfide		nd	nd	nd	nd	nd	
Ore total Au, opt		**0.176[+]**	**0.176[+]**	**0.171[+]**	**0.187[+]**	**0.160[+]**	
Ore Cu, ppm		**326**	**326**	**326**	**326**	**326**	
Ore Fe, ppm		48100	48100	48100	48100	48100	
Ore Pb, ppm		10	10	10	10	10	
Ore Hg, ppb		nd	nd	nd	nd	nd	
Ore Mn, ppm		1560	1560	1560	1560	1560	

Table 8. Total whole rock metal and sulfur geochemistry, M4 sample

	Settling time estimated 30 minutes						
M4		*CMRI/1998 Montgomery Watson*					
Parameter	**CMRI 1998 (detection limit)**	**CMRI D2 DUPLICATES C2**	**CMRI C2 Leach decant water**	**CMRI C3 Leach decant water**	**CMRI C4 Leach decant water**	**CMRI C5 Leach decant water**	**Kensington Mine Water 1998**
Ore Ni, ppm		6	6	6	6	6	
Ore Zn, ppm		70.6	70.6	70.6	70.6	70.6	
WHOLE ROCK TAILS DATA		RESCAN, 2000	RESCAN, 2000	RESCAN, 2000	RESCAN, 2000	RESCAN, 2000	
Tails digestion		4 acid	4 acid	4 acid	4 acid	4 acid	
Tails Tot S, %		**0.06**	**0.06**	**0.06**	**0.06**	**0.06**	
Tails Cu, ppm		**27**	**27**	**27**	**27**	**27**	
Tails Fe, ppm		31600	31600	31600	31600	31600	
Tails Pb, ppm		6	6	6	6	6	
Tails, Hg ppb		10	10	10	10	10	
Tails Mn, ppm		14000	14000	14000	14000	14000	
Tails Ni, ppm		32	32	32	32	32	
Tails Zn, ppm		54	54	54	54	54	

+ grade measured for each batch by CMRI, whole rock geochemistry for bulk composite low level metal analyses are not available for adit water

no low level

3. Total sulfur content was also somewhat lower in M4, but like the M3 sample plotted in the third quartile of the sulfur distribution for individual and composite drill samples as shown in Figure 7.

Samples M3 and M4 both plot in the upper third of the sulfur and metal distributions, and conservatively represent the range of trace element geochemistry in the Kensington deposit.

Tailings Flotation and Process/Decant Water Sampling
Both sets of flotation tests were conducted using the same metallurgical process, with differences in the recycling of process water and pH adjustment through lime addition. In the 1996 Montgomery Watson tests, two process water chemistry measurements were made for each batch, after 16 hours and 24 hours of settling time. The five analyses of process decant water collected after 24 hours (MW96 C1-C5 24 hr.) are summarized in Table 4 for dissolved concentrations and Table 7 for total concentrations.

In the 1998 CMRI/Montgomery Watson work, the process (or decant) water was analyzed for the last four of the five cycles (CMRI C2-C5), for both dissolved and total concentrations (Tables 5 and 8). Unlike the results of the initial 1996 process water testing, concentration of solutes increased with each cycle due to the use of recycling in 1998. Water collected from the Kensington Mine workings for use in the flotation process was also analyzed, as shown in Tables 5, 6, and 8. The 1998 test process was

somewhat modified by the use of additional lime to achieve higher pH, as a basis for improving recovery. This resulted in higher hardness concentrations. As pH will be adjusted to optimize recovery and maintain minimum ore grades in concentrates shipped to smelter during mine life, hardness should be expected to vary between 200 and 600 mg/L. For this reason, data generated through analysis of M2 and M3 tailings are both relevant for the TSF evaluation.

Process or decant water samples were collected after tailings were allowed to settle. Unlike the 1996 Montgomery Watson data, which specifically collected decant water following 16 and 24 hours of settling time, no information on the time allowed for precipitation of solids prior to sampling was provided for the 1998 CMRI samples. Decant water was removed by pumping down to one inch above the tailings solid after 30 minutes of settling, but it is unclear when decant water samples were actually collected from this initial split. Comparison of the total suspended solids data, which are higher for the majority of the 1998 samples, suggests that decant water samples were collected by CMRI before full settling occurred. If samples were collected in less than 100 minutes, CMRI data indicates that settling would be incomplete. Total analyses of 1998 samples are therefore somewhat conservative, in that they reflect high concentrations of suspended solids that will not be permitted to occur in discharge. As with the predicted variance in hardness, the range of TSS and associated differences in chemistry that are observed between the 1996 and 1998 samples address a range of operational conditions.

Both sets of decant water samples appear to have been collected, filtered, and preserved using the same procedure, and ultraclean technique was used to obtain samples for low level analysis by Battelle National Laboratories for both datasets (Table 9). Limited quality assurance/quality control data are available, and some errors in transcription were identified and corrected during data review.

Table 9. Low level copper data from 1998 CMRI/Montgomery Watson decant analyses

Sample Source	Low Level Copper Total (ug/L)	Low Level Copper Dissolved (ug/L)
C2- 9/16/1998	9.97	0.0925
C3- 9/17/1998	10.2	0.255
C4- 9/17/1998	10.7	0.286
C5- 9/18/1998	9.05	0.524

Acid Generation Potential
Acid generation is not expected to result from weathering or leaching of tailings from the Kensington Operation (USFS, 1997 EIS). Current plans involve mining a select, higher-grade portion of the deposit, and so the potential for acid generation was revisited as part of this data review. The relative concentrations of sulfide and acid-neutralizing minerals determine the potential for acid generation. As the majority of metals at Kensington occur in association with sulfide in the vein systems, or as telluride complexes associated with the sulfide minerals, total sulfur is a useful indicator element for metal concentrations as well.

Total sulfur, whole rock geochemistry, and acid base accounting data are available to characterize ore geochemistry across the deposit. The range and average total sulfur content is summarized in Table 10 for the 583 samples reported by Geochemica (1994) as well as for the subset of this population with gold contents higher than 0.09 ounces per ton (opt) and the currently proposed cutoff grade of 0.14 opt. The average total sulfur content of samples tested in the Montgomery Watson tailings flotation and the SRK column study (1.85 weight percent) is higher than the average for all samples (0.40 opt), suggesting that previous test results may be conservative in characterizing the ore body as a whole, but that ore may have been somewhat lower in total sulfur content prior to flotation, relative to the average total sulfur values of 2.7 percent and 3.1 percent under the two cutoff grade scenarios. Despite the higher averages, however, the quantity of sulfide estimated to remain in tailings is very small as shown in Table 10.

Table 10. Summary of total sulfur content for Kensington ore samples, by grade cutoff

	All Ore Samples n = 583	Samples Au > 0.09 opt n=193	Samples Au >0.14 opt n=144
Mean Au, opt	0.16	0.47	0.59
Min Total Sulfur, wt. %	0.01	0.03	0.03
Max Total Sulfur, wt. %	22	22	22
Mean Total Sulfur, wt. %	0.397	2.687	3.075
Tailings 90% efficiency	0.04	0.27	0.31
Tailings 98% efficiency	0.008	0.05	0.06

Figure 8 shows a general trend of increasing total sulfur with increasing gold concentration for the baseline samples reported by Geochemica (1994), which is somewhat better developed below a gold grade of 0.5 opt. The use of a higher cutoff grade is therefore expected to increase the average total sulfur content of the mined ore. This increase is expected to have a minimal effect on tailings chemistry as 90 to 98 percent of sulfide will be removed during flotation, leaving less than 0.31 percent sulfur, as shown in Table 10. Material with a total sulfur concentration of 0.3 weight percent (or below) will not produce acid rock drainage (Jambor et al, 2000). Reference to Figure 9 shows that the total sulfur distribution is lognormal, so that sulfur concentrations above the mean values are very rare and unlikely to dominate water quality in the impoundment. The proposed shift in grade therefore does not alter the previous conclusion that acid mine water will not be produced by the Kensington tailings.

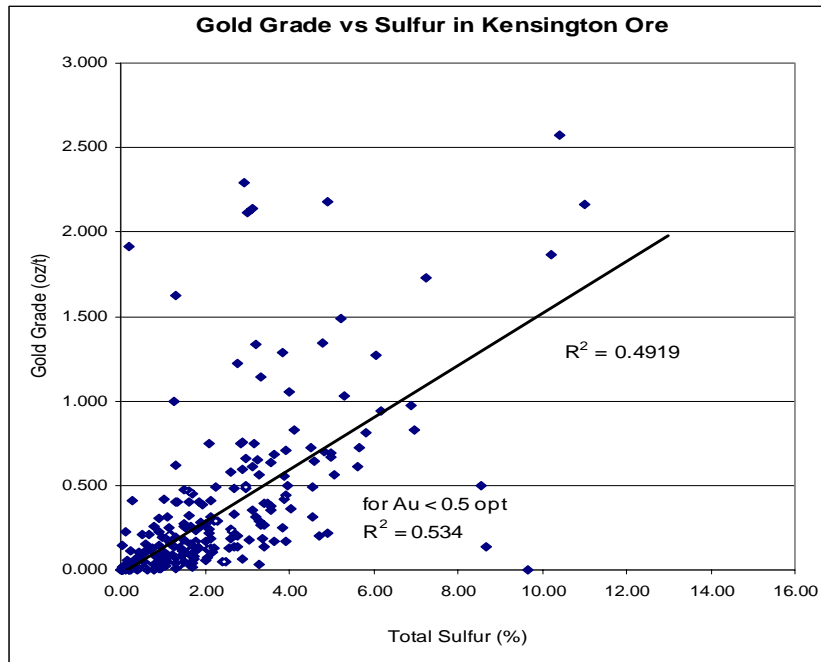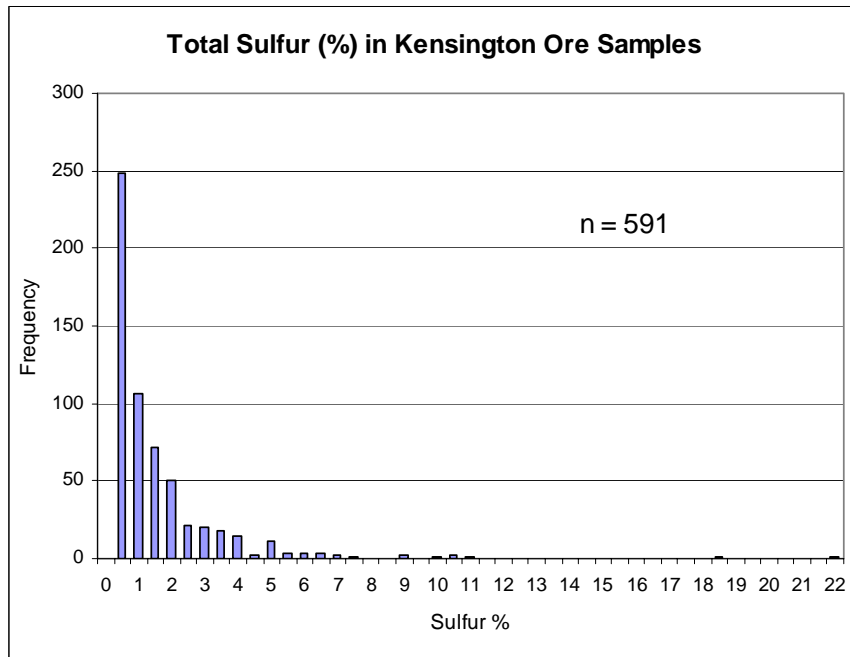**Figure 8. Comparison of gold and total sulfur content, Kensington ore samples**

Figure 9. Distribution of total sulfur concentrations (weight percent) from Kensington ore samples


Trace Element Release Potential

There are several geochemical analyses that estimate metal-release potential for tailings generated by the proposed Kensington operation. These include historic pre-1996 humidity cell and MWMP analyses of combined flotation and cyanidation tailing, as well

as more recent column leach tests and studies of decanted process water from rough tailings generated in flotation tests by Montgomery Watson (1996) and CMRI (1998). Tetra Tech agrees with the SRK conclusion (SRK, 1996a) that none of the combined (rough with CIL) tailings data are applicable to the currently proposed metallurgical process. These data are therefore not presented in this review. Column tests conducted by SRK (1996) to evaluate weathering within the dry TSF facilities as a result of unsaturated flow conditions are also not pertinent to evaluation of the subaqueous tailings management plan, so that the results of the 1996 SRK column work are also not presented. Removing the column test and mixed tailings data leaves the 1996 Montgomery Watson decant water analyses used in the 1997 NPDES evaluation and the 1998 CMRI/Montgomery Watson process water data. Also, RESCAN analyzed a sample from a single cycle of flotation processing in the 1998 CMRI study; this analysis was originally used by Knight Piesold for input into the Slate Creek TSF.

Process Water Analyses

The Montgomery Watson (MW96 C1-C5 24 hr, 1996) and CMRI/Montgomery Watson (CMRI C2-C5, 1998) process water data for rough tailings are summarized in Tables 7 and 8, for dissolved and total concentrations respectively. Also presented in Table 6 are the dissolved concentrations reported by RESCAN (2000) and used by Knight Piesold (2002) in the Slate Creek TSF water quality model; no total concentration data are available for this sample. Tables 5 and 8 also provide total concentrations measured in a sample from the Kensington mine; no dissolved concentration data are available for the mine water. These results are summarized for total copper in Figure 10 and dissolved copper in Figure 11. The 30 ug/L (Knight Piesold 2002) was not identified as total or dissolved. Data for sulfate are shown as Figure 12.

Figure 10. Total copper values from Montgomery Watson 1996, CMRI/Montgomery Watson (1998), and Knight Piesold (2002)
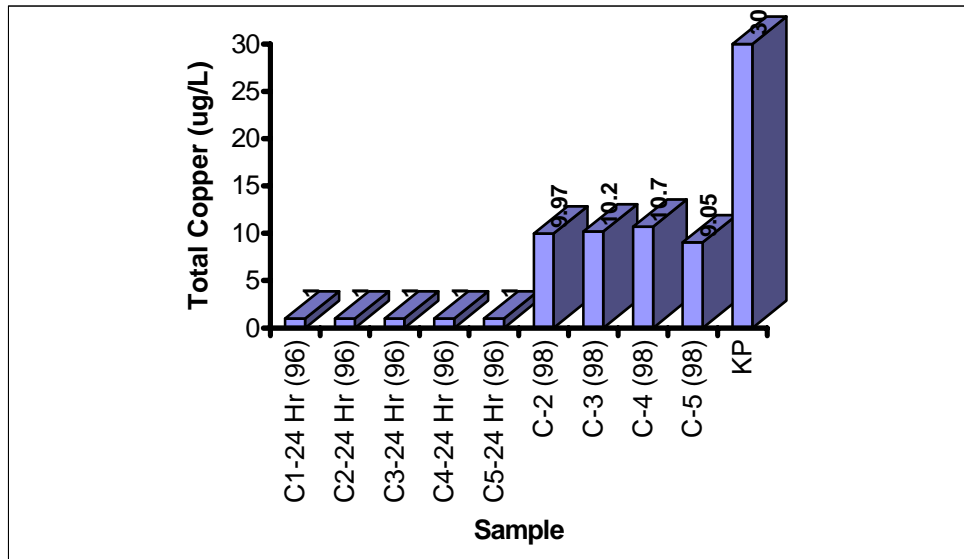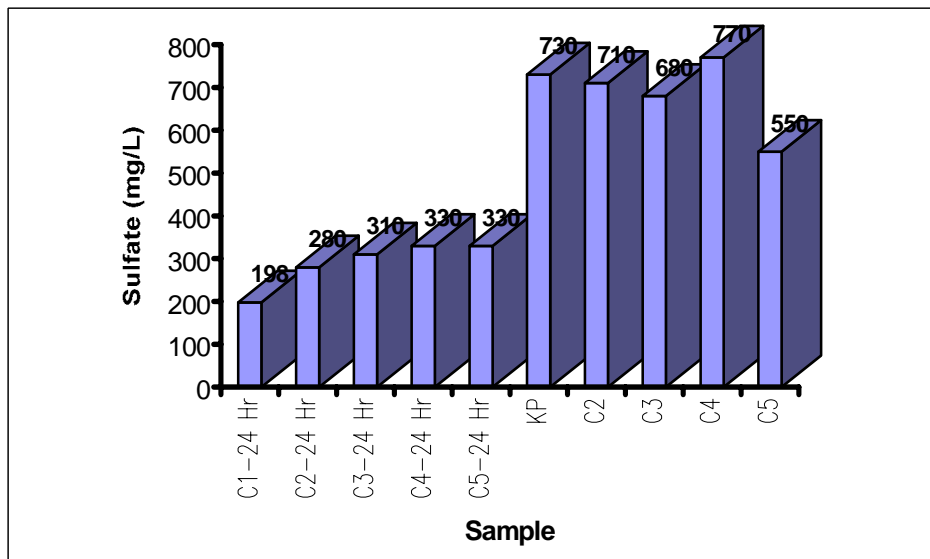

Montgomery Watson (1996) detection limit = 2 ug/L

Figure 11. Dissolved copper values from Montgomery Watson 1996, CMRI/Montgomery Watson (1998), and Knight Piesold (2002)
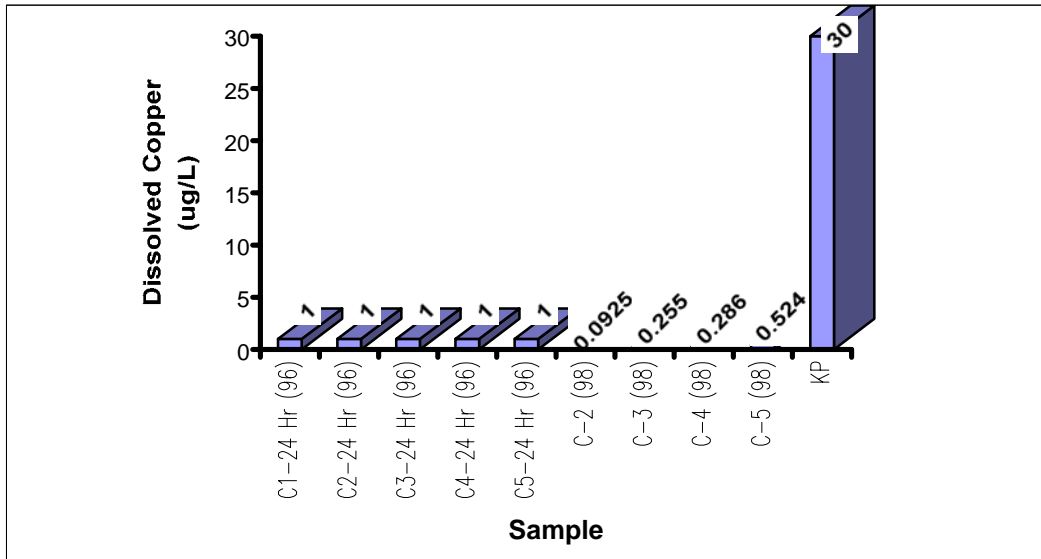
Montgomery Watson (1996) detection limit = 2 ug/L

Figure 12. Sulfate data from Montgomery Watson 1996, CMRI/Montgomery Watson (1998), and Knight Piesold (2002)


Comparison of the total values indicates that the higher concentrations of suspended solids result in higher (more conservative) metal concentrations in the 1998 process water than were measured in the 1996 samples. Hardness is also considerably higher in the 1998 samples, due to the use of additional lime in the flotation process.

Comparison of the dissolved (sub-0.45 um filtration) concentrations indicates that results are consistent between testing programs, although different detection limits were used. It is important to recall that process water samples from the 1996 program are from

independent flotation batch tests, while the 1998 samples are from a system that recycled water between cycles. Also, the higher pH of the 1998 samples is reflected in the elevated aluminum, selenium, mercury and zinc concentrations. Significant differences were observed in detections of copper using standard ICP-MS and ultralow level methods. Dissolved concentrations measured by ICP ranged from 2.7 to 8.6 ug/L, while concentrations detected in ultralow analyses ranged from 0.08 to 0.52 ug/L. The ICP-MS measurements indicate concentrations close to the detection limit of 2 ug/L that are almost certainly within the practical quantitation limit of the instrument. Dissolved concentrations were also greater than total concentrations in the sample from cycle 2 and in the mine water measurements made by ICP-MS. These results indicate a potential bias in ICP-MS analytical data. Review of the QA/QC data for a field blank (sample B2, not shown in the table) indicates no contamination due to lab method. Comparison of the duplicate sample D2 indicates significant differences between the total concentrations reported, however, for copper, mercury, selenium, and TSS. These differences in the metal concentrations may be a result of the differences in TSS or may be due to variance below the practical quantitation limit for the method. There may also have been problems with equipment decontamination between samples; review of the Montgomery Watson procedure indicates that equipment may not have been acid-rinsed between samples, in contrast to the ultra-clean technique used in collecting samples for low-level analysis. For these reasons, the low-level data have been reported in Tables 4 and 5.

In addition, a filtered water sample from cycle 3 was analyzed independently by ASL laboratories on behalf of RESCAN Environmental (2000). Knight Piesold originally used the RESCAN data (dissolved concentrations only, see Table 6) in their 2002 mass-loading model for the Slate Creek TSF. Comparison of the ASL data with the more comprehensive Montgomery Watson ICAP-MS and the low-level Battelle National Laboratories data indicates that the single ASL sample fails to characterize the range of chemistry observed in the other analyses. Comparison of this analysis with dissolved concentrations reported by Montgomery Watson and Battelle National Labs for CMRI C3 (also of cycle 3 process water) shows general agreement for all constituents except for copper, although the detection limits used were considerably higher for some elements. Unfortunately, there are no available quality assurance data for this analysis. With the exception of the copper value, it is thus tempting to retain the ASL analysis in the data set, although it duplicates the CMRI C3 analysis. However, the dissolved copper concentration reported by ASL, and used by RESCAN and Knight Piesold, is two orders of magnitude higher than the corresponding low level value reported by Battelle National Labs. Comparison of the dissolved data in Figure 13 shows the 30-ug/L copper concentration reported by ASL to be a statistical outlier, a value more in line with the total concentration data reported in Tables 7 and 8, which would significantly alter the population average. For these reasons, the analysis reported by ALS, and used by RESCAN/Knight Piesold, was replaced with the data reported by Montgomery Watson and Battelle National Laboratories.

Figure 13. Dissolved copper histogram, based on Montgomery Watson 1996, CMRI/Montgomery Watson (1998), and Knight Piesold (2002)
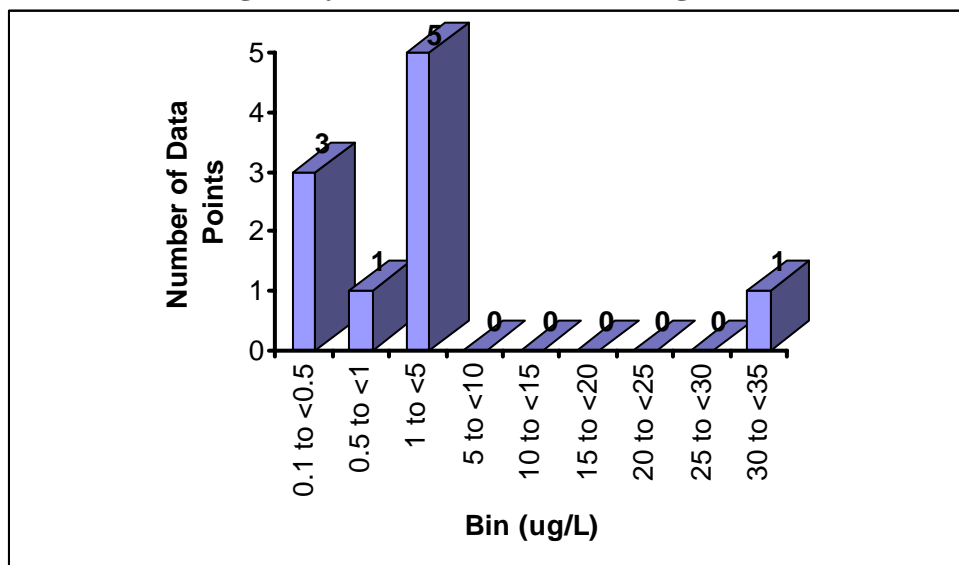
Montgomery Watson (1996) detection limit = 2 ug/L

TSF Water Quality Model Inputs

The total concentration values used to calculate the 1997 NPDES permit limits, which incorporated either the 1996 Montgomery Watson process water analyses or the average of column effluent concentrations (SRK, 1996), whichever was greater, are also shown in Table 4. Where a pollutant was not detected in any samples, the value in the 1997 model was assumed to be zero. Zinc was not detected in the fourth pore volume of the column test, which appeared to be an error because zinc was detected in all other pore volumes. The fourth pore volume result was, therefore, replaced by the average of the 5 pore volumes. In addition, Tetra Tech found an apparent error in determining the appropriate mercury value from the Montgomery Watson data.

Comparison of these various analyses shows that no one analysis is conservative for all parameters. The available data and supporting information therefore do not provide compelling support for the use of any one set of analyses as a basis for the NPDES permit. The data vary considerably for some constituents, in some cases over orders of magnitude, increasing the difficulty identifying a single analysis or source of data that is considered representative of the conditions that will exist during and after operations in the Slate Creek tailings facility. Use of the RESCAN values by Knight Piesold was conservative for the elements aluminum, cadmium, chromium, copper, lead, selenium, silver, TDS and sulfate, but fails to represent the range of chemistry observed in the various analyses reported for the individual metallurgical cycles. The observed variability and fairly small number of samples also make it more difficult to justify the use of a measure of central tendency (mean or median) as a basis for modeling.

Tetra Tech believes that the tailings decant water, obtained by allowing tailings solids to settle following flotation, is most representative of geochemical conditions that will exist within the pond during operations. Because the material will be stored in a subaqueous

setting, sulfide oxidation and associated acid production will not occur. The process of metal-release will more likely result from dissolution and desorption, rather than oxidation or significant changes in pH. As model inputs, Tetra Tech therefore used the maximum total constituent concentrations from the five analyses of decant water from 1996 (MW 1996 C1-C5) and the four analyses of decant water from 1998 (CMRI C2-C5) to represent the range of major ion and trace element chemistry that will occur in the process water.

VI.   BACKGROUND WATER QUALITY

Coeur collected background water quality for Slate and Johnson Creeks during 2000 and 2001 (Coeur 2002). As model inputs for "natural" flows into the TSF, Tetra Tech used the maximum total constituent concentrations as shown in Table 11 for the monitoring station immediately downstream of Lower Slate Lake. Where a constituent was not detected in any samples, the background concentration was set as zero in the model.

Table 11. East Slate Creek Background Water Quality

Parameter	Units	Background Concentration
Ammonia	mg/L	0
Arsenic	ug/L	0.52
Cadmium	ug/L	0
Chromium	ug/L	0.63
Copper	ug/L	0.39
Iron	ug/L	300
Lead	ug/L	0
Mercury	ug/L	0
Nickel	ug/L	0.799
Selenium	ug/L	0
Silver	ug/L	0
Sulfate	ug/L	2.68
TDS	mg/L	21.5
Zinc	ug/L	0.535

VII.   MODEL RESULTS

Table 11 summarizes the results of the @Risk modeling to characterize the untreated water in the TSF (this is consistent with Table 4-3 in the Fact Sheet). As discussed throughout this Appendix, these results reflect minimum, average, and maximum projected constituent concentrations for 1,000 "life of mine" precipitation distributions. Note also that with the maximum treatment and discharge flow of 1100 gpm, the pond volume never approaches the TSF capacity.

Table 11. Projected TSF Water Quality

Parameter	Units	Projected TSF Discharge		
		Minimum	Mean	Maximum
Ammonia	mg/L	0.128	0.57	0.7
Arsenic	ug/L	0.59	0.82	0.9
Cadmium	ug/L	0.0056	0.025	0.031
Chromium	ug/L	0.94	2.0	2.3
Copper	ug/L	0.68	1.7	1.9
Iron	ug/L	400	760	900
Lead	ug/L	0.12	0.55	0.67
Mercury	ug/L	0.002	0.01	0.01
Nickel	ug/L	0.97	1.8	2.1
Selenium	ug/L	0.13	0.59	0.71
Silver	ug/L	0.02	0.02	0.02
Sulfate	ug/L	24	98	118
TDS	mg/L	114	218	246
Zinc	ug/L	2.8	11	13

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