Expert Report
Nevada State Environmental Commission
Appeal Hearing
Water Pollution Control Permit Renewal
NEV0087001
Big Springs Mine

Technical Report 2005-07-GBMW

September 14, 2005

Prepared for:

Great Basin Mine Watch
505 South Arlington Ave., Ste. 110
Reno, NV 89509

Review Prepared by Tom Myers, Ph.D.
Hydrologic Consultant
200 Bartlett St.
Reno, NV 89512
775-530-1483
tommyers@gbis.com

Table of Contents

Introduction 1
Water Quality Conditions 1
Water Quality Degradation 3
Total Dissolved Solids 3
Selenium 5
Trends on North Fork Humboldt River and Tributaries 6
Sulfate 6
Trend Analysis for Sulfate 12
Load Analysis 18
Sulfate 18
Selenium 21
Other Studies 22
Waste Rock Dumps 25
Reclamation 27
Contribution from the Open Pits 29
Groundwater Quality and Quantity 32
Discharge to the River 35
Conclusion 36
Remediation 38
References 39

Introduction

The Big Springs Mine is a open pit gold mine located along the North Fork Humboldt River (NFHR) at the north end of the Independence Range, Elko County Nevada. Mining of the disseminated gold deposits began in the late 1980s and stopped in 1993. Reclamation commenced in 1993 and has been declared complete. The mine also had a mill and tailings impoundment. The Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (BMRR) recently renewed the mine's water pollution control permit, NEV 87001. Great Basin Mine Watch filed an appeal of this renewal to the Nevada State Environmental Commission. This expert report reviews the hydrology, water quality trends and the facts of the degradation at the Big Springs Mine Site. There is no analysis of water quality at the tailings or heap leach piles.

For this study, the following documents were reviewed.

NDEP Fact Sheet and Draft Permit
Annual and Quarterly Monitoring reports available in NDEP files
Schaeffer and Associates, 1996
Schaeffer and Associates, 1994
Exponent, 1998
Earman and Hershey, 2004
Various memoranda and other communications available in the files at BMRR

Water Quality Conditions

The NFHR and tributaries are class A waters (NAC 445A.124.4). The NFHR is on Nevada's 303d list of impaired waters for total dissolved solids. Tributaries Dry Creek, Sammy Creek and Water Canyon Creeks are listed for selenium and TDS, arsenic, selenium and TDS, and selenium and TDS, respectively. That listing noted that the impairment was due to mining activities. This section reviews the water quality, trends in that water quality, determines the cause of the water quality degradation, and considers the probably future trends. The historic and current surface, ground-, and pit lake water quality conditions are reviewed. Statistical methods are used on the available data to consider the trends.

The NFHR and its tributaries which drain the Big Springs have monitoring records reaching back to 1986 (Figure 1). Apparently, the mining company collected baseline data on the NFHR (station S-140) prior to the completion of the environmental assessment for the mine in 1988. The mine monitored other stations for various periods of time as shown on Figure 1.

Monitoring data from 1997 to the third quarter 2004 was on file at BMRR; neither earlier nor more recent data was on file there in August 2005. Apparently, the FS had required the collection of surface data prior to the renewal of the water pollution control permit in 1997. For the period 1993 through 1996, data was obtained from the Forest Service by a Freedom of Information Act request completed in 1997. Monitoring data from 1986 through 1993 was obtained from a thesis completed at the Desert Research Institute.

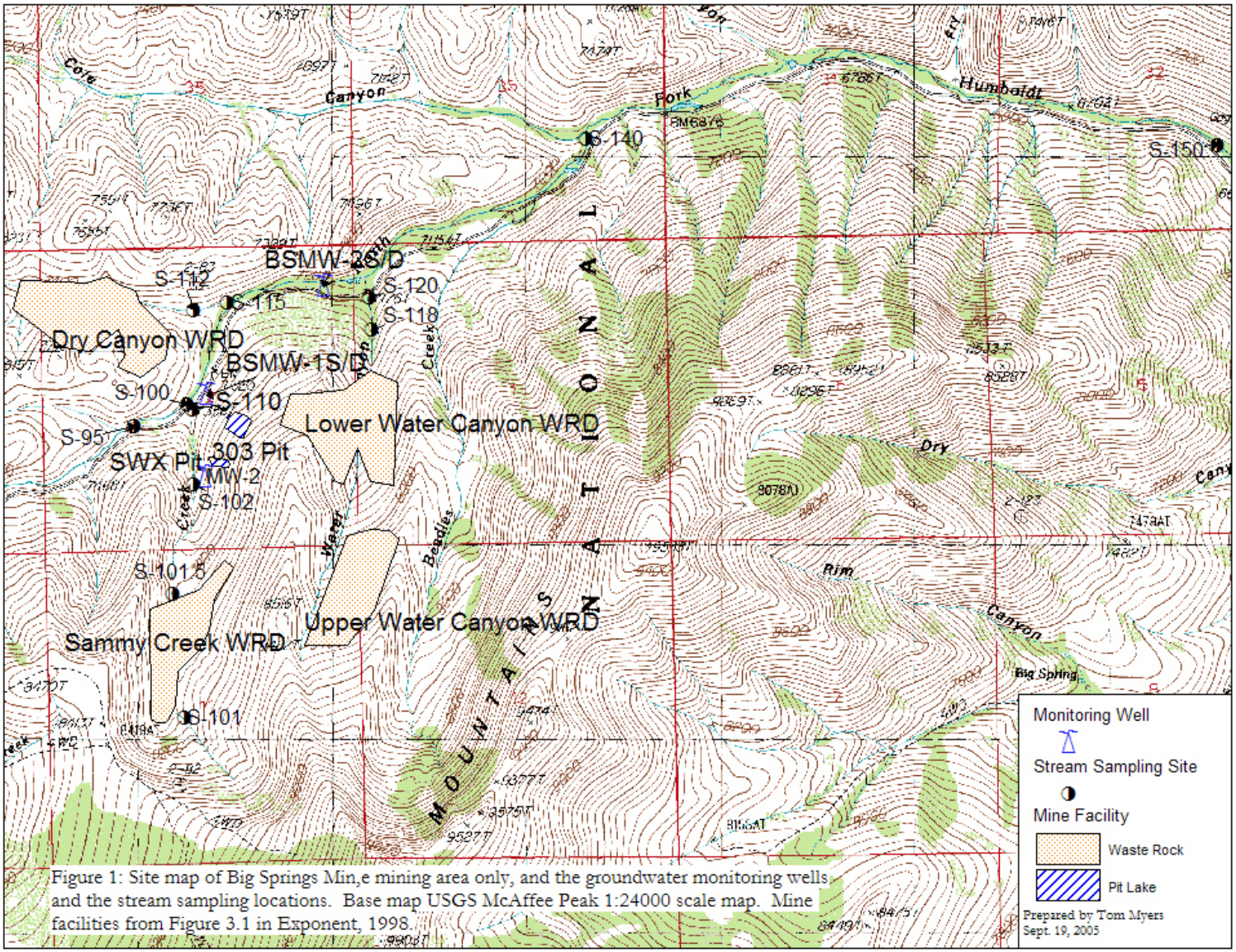

Figure 1: Site map of Big Springs Min,e mining area only, and the groundwater monitoring wells and the stream sampling locations. Base map USGS McAffee Peak 1:24000 scale map. Mine facilities from Figure 3.1 in Exponent, 1998.

The data from these different sources was entered into an Excel spreadsheet for statistical analysis and the preparation of graphics. Days for which the entry is not accessible or not measured are treated as no data for the analysis because most software treats a na or nv entry as a 0.0 for plotting and the calculation of statistics. Blank cells in the spreadsheet of data represent a constituent that was not sampled on that date either because the location was not visited (for any reason) or because the site was visited but that constituent was not sampled (again for any reason). Sites that were visited but were found to be dry had a 0 included in the flow rate column and the remaining cells were left blank. Blank cells do not affect the descriptive statistics performed on the data but the 0 flow rate would affect the average flows; regression analyses to determine trend ignored all dates for which there was no data. Water quality data reported as less than a detect value was halved for plotting and the determination of descriptive statistics. Statistical inference is not used on this censured data, therefore the treatment is appropriate.

Data for dates between 3/28/94 and 6/28/94 was obtained from two different sources: the thesis and the Forest Service. There were disparities in the data; most appeared to be due to round-off but some, such as electrical conductivity (EC), were completely different. The data used herein was the FS data because it did not include the round-off and because it contained metals.

The data sets included flow measurements, but they were not always collected. It would be desirable to extend the data set using regression with available U.S. Geological Survey gaging stations, but there was no overlap in collection for sites nearby on the NFHR and sites further downstream drained a much larger area which would have been controlled by different processes; for example, snowmelt flows would be of shorter duration and storm flows would be much more prominent at the mine site.

Appendix 2 contains a printout of the data entered for this analysis.

Prior to the completion of this report, a site visit was conducted on August 11 and 12, 2005. During this visit, Tom Myers, the author of this report, and Nicole Rinke, the attorney for Great Basin Mine Watch, walked the three drainages that discharge to the NFHR. They visited the base of the waste rock dumps to examine and photograph the seepage discharging from the dumps. They also visited points along the NFHR where the tributary streams enter the main river. Select pictures from that site visit are included in Appendix 1.

Water Quality Degradation

Total Dissolved Solids

Total dissolved solids (TDS) is the parameter which most frequently violates water quality standards for the NFHR and tributaries. For the stations on the NFHR, starting in 1993 (the earliest dates for TDS observations), every sampling date apparently shows a violation of water quality standards (Figure 2). NAC124, for class A waters, limits the TDS concentration to 500 mg/l or the increase allowed to one third over background conditions. Nineteen of the 31 observations at S-140 exceed 500 mg/l and all of them are more than one-third higher than

concurrent observations at S-95 or S-100. Only a few concentrations at S-150 exceed 500 mg/l, but the average there is 328 mg/l while the average at S-95 and S-100 is only 43 and 60 mg/l, respectively. This demonstrates the mine causes multiple violations of the class A standards for TDS on the mainstem NFHR.

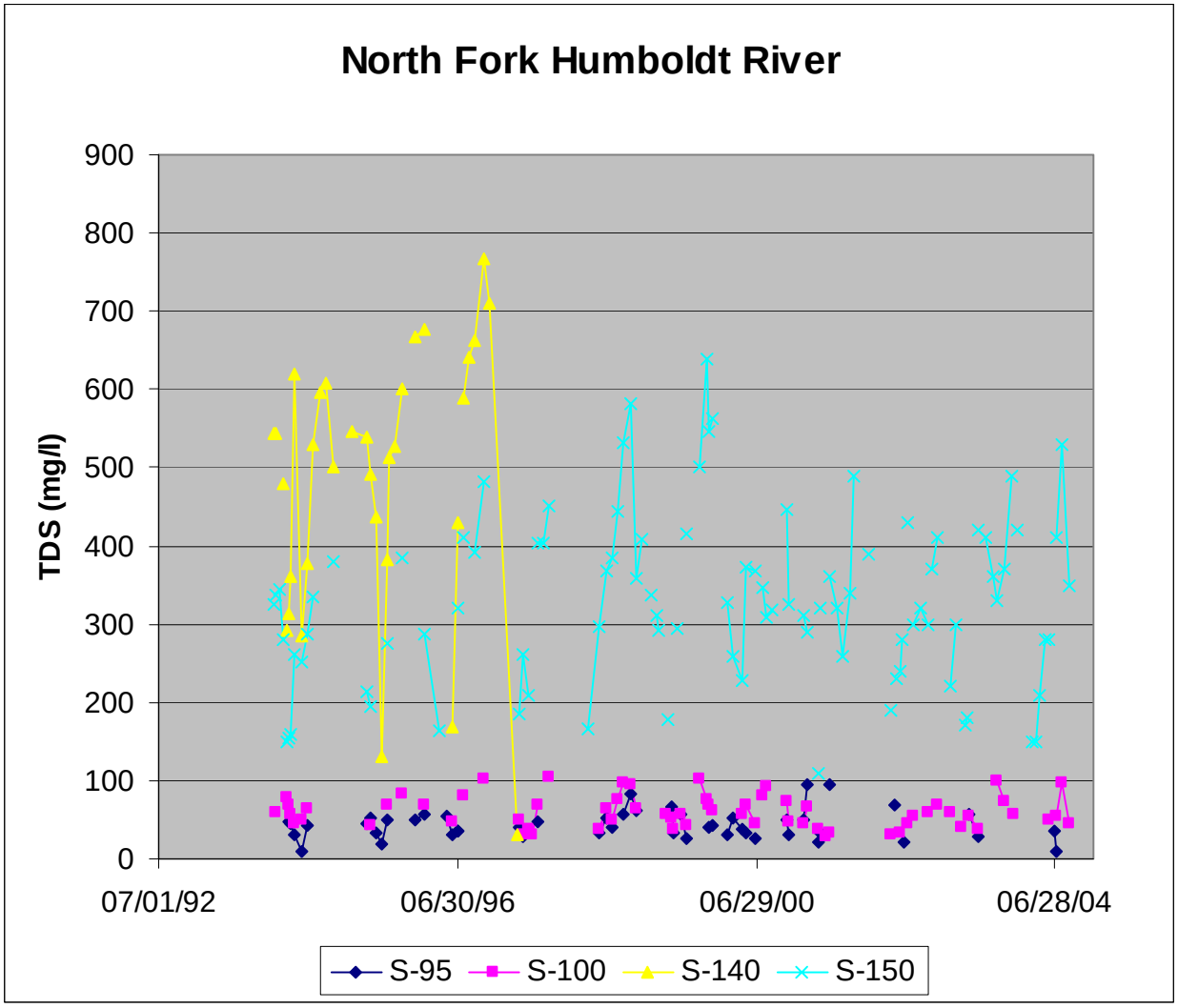

Figure 2: Graph of total dissolved solids concentrations and time for monitoring stations on the North Fork Humboldt River

On the tributaries which drain waste rock from the mines, it is also obvious that the mine causes significant increases in the concentrations and causes the streams to violate class A water quality standards (Figure 3). Sammy Creek is the only stream with monitoring sites above and below mine facilities. Above the waste rock dump at S-101, all 42 observations were less than 200 mg/l. At S-110, 72 of 94 observations exceed 500 mg/l. All of the observations taken on the same day have concentrations at S-110 with an increase of greater than one-third higher than the upstream site. At the outlet from Dry Canyon (S-115) and Water Canyon (S-120), 76 of 78 and 86 of 88 observations exceed 500 mg/l.

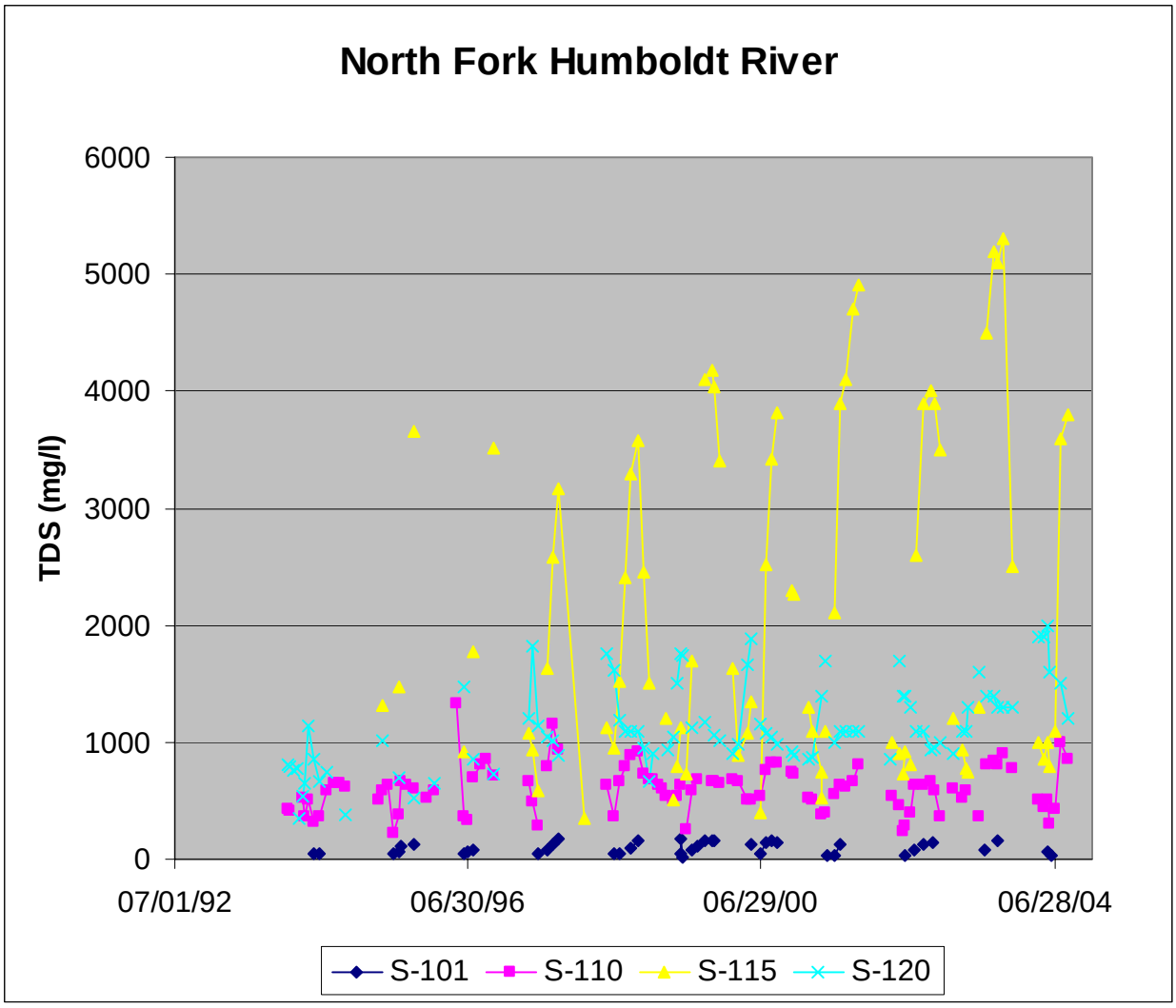

Figure 3: Graph of TDS concentrations with time for monitoring stations on tributaries of the North Fork Humboldt River.

Selenium

The selenium standards, listed in NAC445A.144, for water supply are 0.05 mg/l and for aquatic life are 0.02 and 0.005 mg/l for one-hour and 96-hour averages, respectively. Because the monitoring data is reported no more frequently than one per month, the 96-hour aquatic standard is relevant here. Only data from August 9 1993 to the present will be considered here because there are questions about the earlier data. The concentrations observed at site S-95 for two years equaled 0.01 mg/l while downstream at S-140 equaled 0.001 mg/l for every observation.

Since August 1993, at S-95 and S-100, 1 of 32 and 37 observations, respectively, exceeded the 0.005 mg/l standard. At the downstream stations, 31 of 67 observations at S-140 exceed the 0.005 mg/l standard. At S-150, 6 of 48 observations exceed the standard. At the outlet from Sammy Creek, Dry Canyon, and Water Canyon, 48 of 54, 30 of 33 and 41 of 44

observations exceeded the standard. In percent terms, on the tributaries, 91% of all observations exceed the 96-hour aquatic life standard. At S-140, just below the mine, 46% of all observations exceed the 96-hour aquatic life standard.

Trends on North Fork Humboldt River and Tributaries

Sulfate

NDEP regulates TDS concentrations which have been shown to violate standards on the NFHR and tributaries. Sulfate is a constituent of TDS, is conservative and is more directly related to mine drainage conditions than total TDS. This is because sulfate results from the oxidation of sulfides in the rock and ore followed by neutralization by the alkalinity also in the rock. There is also more long-term sulfate data available on the NFHR. Sulfate concentrations also explain significant amount of the variance in TDS concentrations at S-110 (R^2=0.92), S-115 (R^2=0.98), S-120 (R^2=0.94), S-140 (R^2=0.95), but at S-95, it only explains 17% (R^2=0.17). R2 is the coefficient of determination and it indicates the total amount of variance in the dependent variable explained by the independent variable[s] in this regression model. This suggests that trends in sulfate would be predictive of those for TDS. For trend analysis and the examination of the hydrology of the basin, sulfate was used.

Plots of sulfate on the mainstem North Fork Humboldt River show clearly that sulfate concentrations increased from low values to values exceeding 100 mg/l at a point during the early 1990s (Figure 4) at monitoring points S-140 and S-150. Close examination reveals that the increase began about the first quarter 1991. It is also evident that upstream monitoring points, S-95 and S-100, have not experienced a similar increase. Sampling of sulfate at S-140 ended in the fourth quarter 1996; after that time sampling continued at S-150 which is 2 miles downstream at a point where the concentrations could have been substantially diluted. During the fourth quarter 1996, the concentration decreased by half between the points probably due to dilution. Sulfate concentrations at S-150 appeared to moderately increase through the 1990s and to level out or drop since 2000[TJM1]. This is tested below.

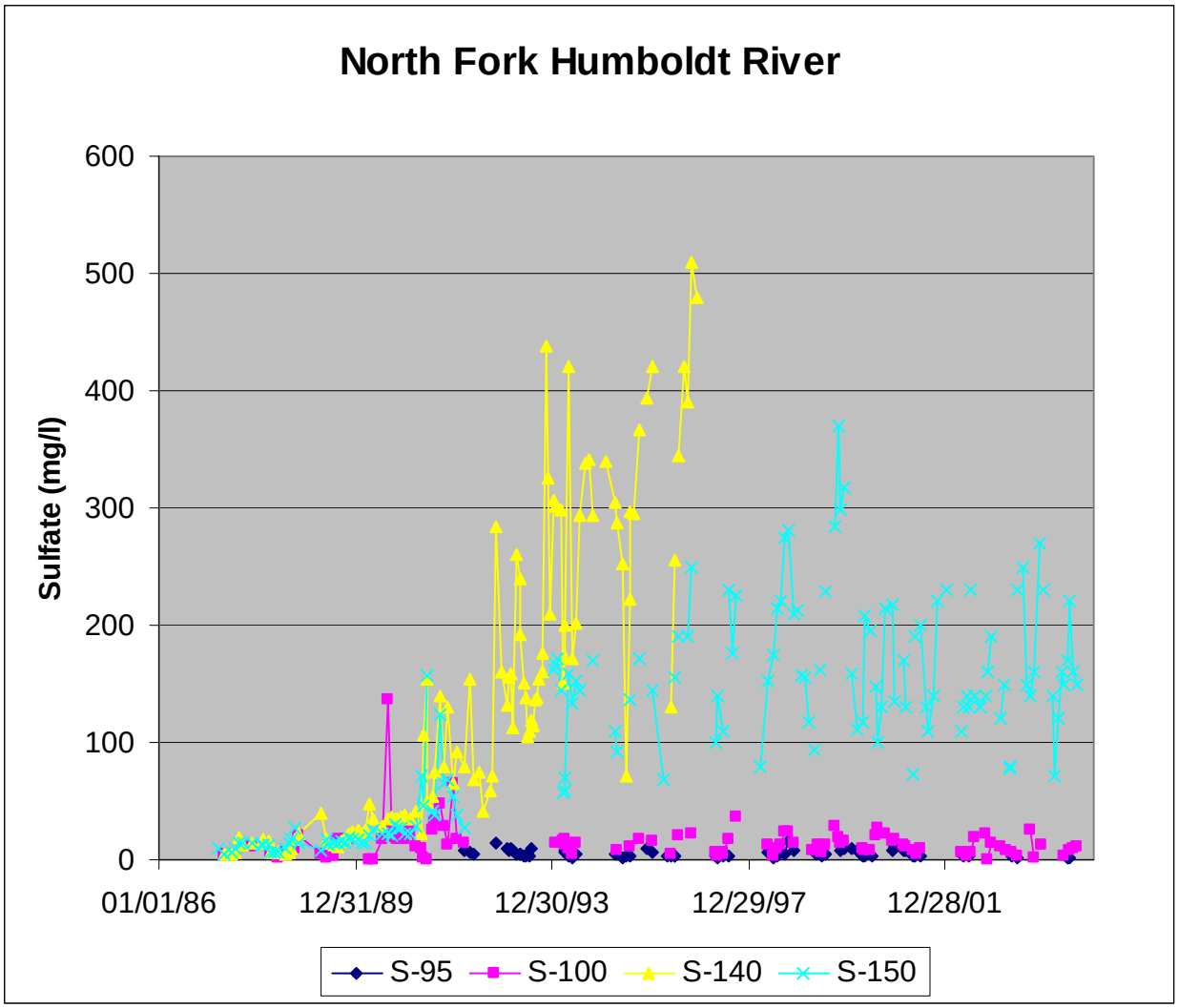

Figure 4: Graph of sulfate concentration with time for stations on the mainstem North Fork Humboldt River. See Figure 1 for the locations.

Sammy Creek is a major tributary to the NFHR. A waste rock dump was built in the canyon (Picture 1); water drains from beneath the waste rock dump (Picture 2). There were sampling points above (S-101) and below (S-101.5) the waste rock dump, just upstream from the sediment basin and trench, and at the confluence with the NFHR (S-110) (Figure 1). Monitoring data for S-110 ranges from 1987 to 2004 and provides the best record for changes on this tributary. Prior to 1991 sulfate concentrations showed a moderate upward trend followed by a jump in 1991 that corresponds with the jump at S-140 (Figure 5). During the 1990s, sulfate concentrations continued to trend upward; after 2000, sulfate concentrations apparently decreased slightly (Figure 5).

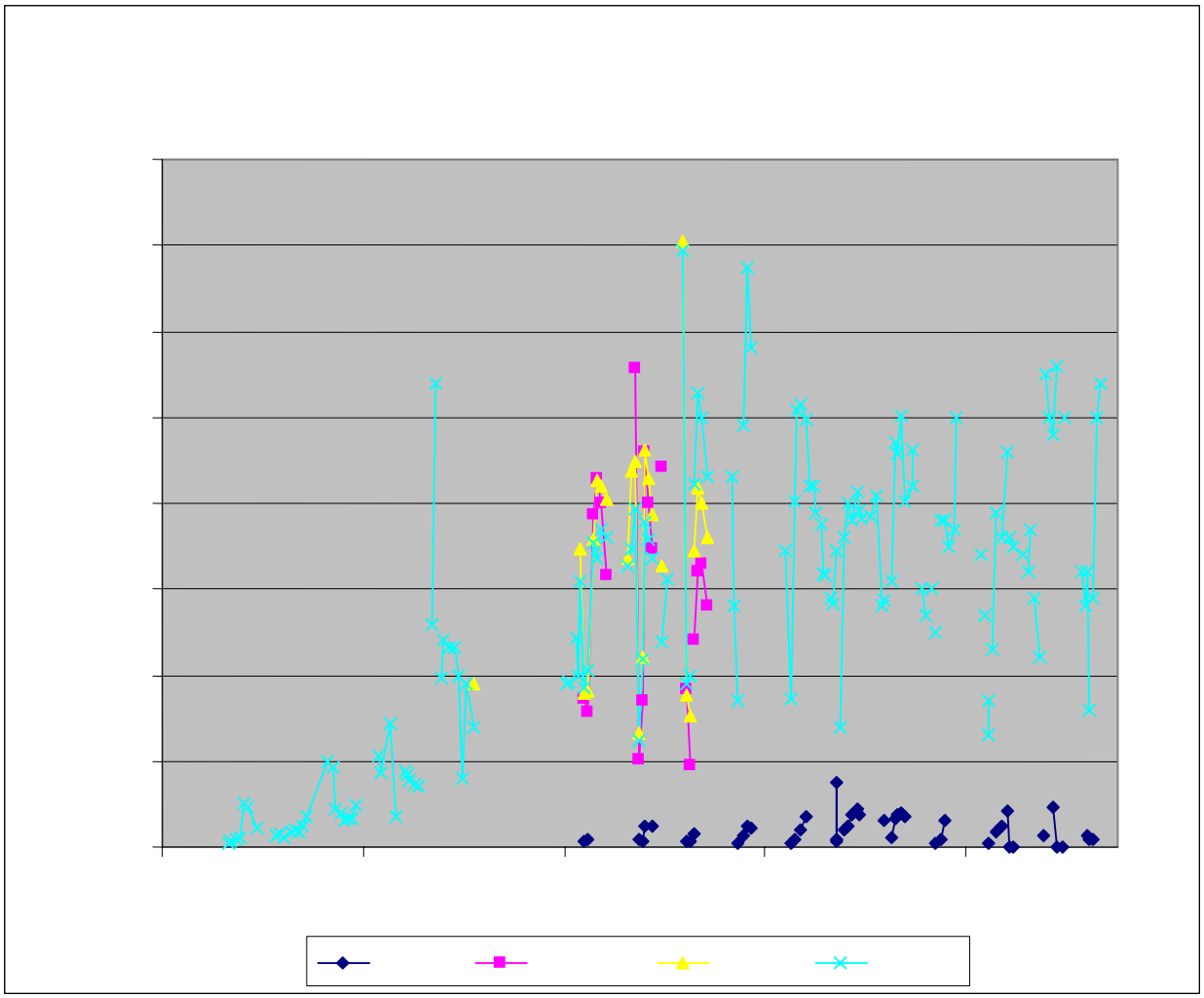

Figure 5: Graph of sulfate concentrations with time on Sammy Creek. See Figure 1 for the location of the monitoring points.

Data collection at S-101, upstream of the waste rock dump, commenced in 1994 and continues to the present (Figure 5). The data does not show trends. The highest value was 75 mg/l in May 1999; all other concentrations have been below 50 mg/l. There is a definite step increase in sulfate concentrations between S-101 and S-110. A step increase is a shift in the mean of the data. It often represents the influence of an intervention which causes the shift. Here the intervention is the construction of the mine and waste rock dumps in 1991/92.

Sammy Creek is the only tributary with monitoring points above and below a waste rock dump (S-101 and S-101.5, respectively). There is a third site about one-third mile below the dump (S-102). They were monitored concurrently only from 1994 through 1996; this is the only data available to assess the contribution of sulfate load from a waste rock dump. Flow data were collected only during 1994 and 1995. Because of the difficult access, monitoring data is available only during the late spring through fall sample periods. During the summer of 1994, the site above the waste rock dump was dry while a significant flow emanated from the

downstream side of the dump (Figure 6). The flow increases from above the waste rock dump, sometimes being zero there, to the downstream end of the dump. During dry years, 1994, the flow decreased from S-101.5 to S-102. During wet years, 1995, the stream gained from above the dump to S-102.

Table 1 shows that between 1994 and 1996, both flow and sulfate concentrations increased along the length of Sammy Creek. The median values show that the concentration of sulfate does not change substantially below the dump during baseflow conditions. But there is a substantial flow increase just below the dump. That increase decreases before the confluence with the NFHR. Median values more accurately reflect base flow conditions. Because the median sulfate concentrations remain constant while the flow rate increases and decreases suggests that the inflow below the dump also contain sulfate and that the seepage which decreases the flow removes sulfate from the stream.

The mean flow increases at each station going downstream from the dump reflecting high runoff flows; skewness is also high which reflects the high end of the range due to the effect that high runoff events have on the flow rate. Interestingly, the sulfate concentration does not change substantially in a downstream direction below the dump with increasing flow indicating again that the runoff and the baseflow have a relatively constant sulfate concentration.

Table 1: Descriptive Statistics for Flow (gpm) and Sulfate Concentration (mg/l) on Sammy Creek between 1994 and 1996 Inclusive

	S-101		*S-101.5*		*S-102*		*S-110*	
	SO4	Q	SO4	Q	SO4	Q	SO4	Q
Mean	11.78	182.15	304.53	548.74	349.96	606.28	329.00	719.57
Standard Error	2.50	107.81	30.18	250.88	27.26	264.85	24.55	357.68
Median	8.16	2.00	320.00	36.00	360.00	114.60	337.00	88.00
Mode	6.00	0.00	400.00	#N/A	#N/A	10.00	198.00	5.00
Standard Deviation	7.51	357.55	131.55	904.56	130.75	1059.40	125.18	1517.49
Sample Variance	56.37	127844.47	17304.15	818235.76	17094.41	1122321.73	15671.28	2302789.38
Range	18.30	1107.60	462.00	2471.80	574.00	3240.70	570.00	5938.50
Minimum	6.00	0.00	95.00	6.00	132.00	10.00	124.00	5.00
Maximum	24.30	1107.60	557.00	2477.80	706.00	3250.70	694.00	5943.50
Sum	106.00	2003.70	5786.00	7133.60	8049.00	9700.50	8554.00	12952.30
Count	9.00	11.00	19.00	13.00	23.00	16.00	26.00	18.00
Largest(1)	24.30	1107.60	557.00	2477.80	706.00	3250.70	694.00	5943.50
Smallest(1)	6.00	0.00	95.00	6.00	132.00	10.00	124.00	5.00

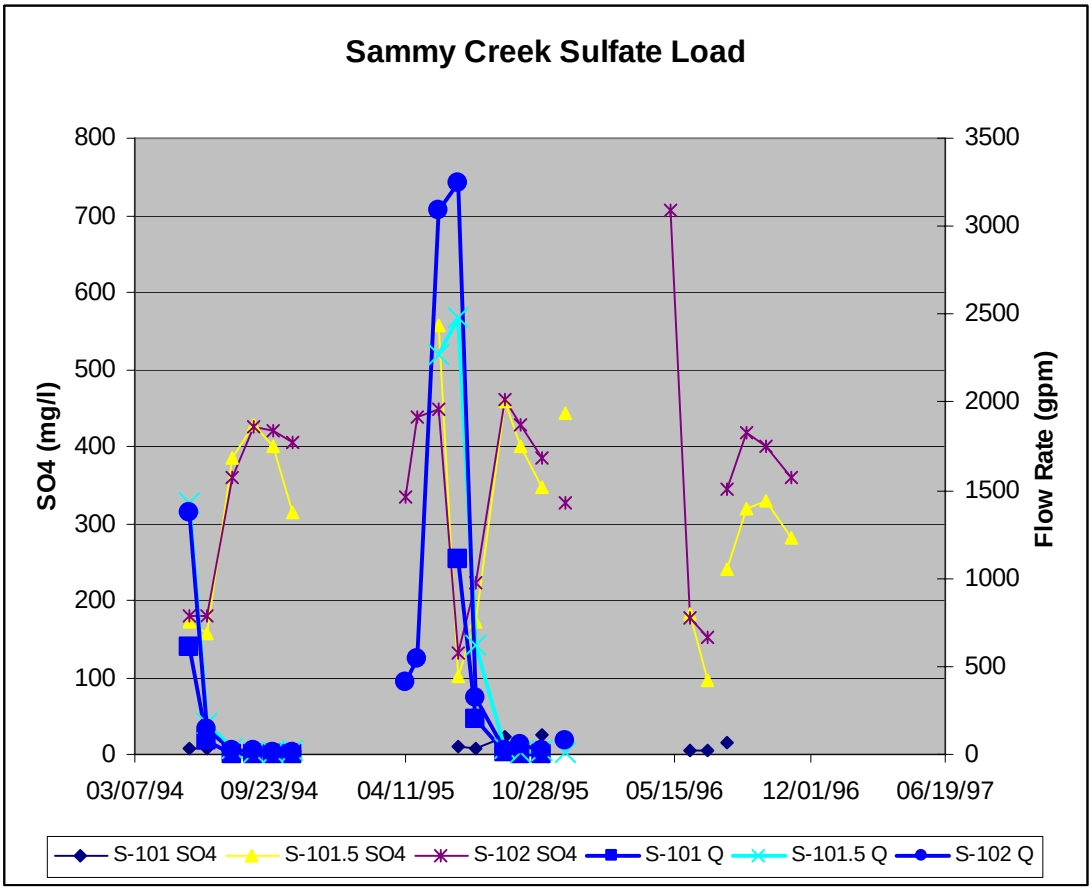

Figure 6: Graph of sulfate concentration and flow rate at stations on Sammy Creek for the period 1994 through 1996. See Figure 1 for the location of the monitoring points.

The mine constructed a diversion ditch around the waste rock in Sammy Creek to "capture surface runoff from the upper reaches of the Sammy Creek drainage, and route the runoff around the Lower Sammy Creek waste rock disposal area and back into the natural channel. By routing surface runoff, water-rock interaction is minimized within the waste rock facility (sic)" (Goodrich, 1998, page 3). This ditch was not seen during the site visit. Goodrich (1998) suggests that "[f]low measurements made by IMCI in the Sammy Creek diversion ditch in 1997 and 1998 show the ditch is functioning as designed" and estimates the flow during those years to have peaked around 2500 gpm. Sulfate concentrations at S-110 during those years do not show any decrease that would be expected from having less water leaching sulfate from the waste rock. Flows during the snowmelt period during 1997 and 1998 peaked at 5148 and 4001 gpm, respectively. The estimates by Goodrich (1998) would imply that a large proportion of the flow at S-110 did not flow through the waste rock. Sulfate concentrations at S-110 were 280 and 172 mg/l, respectively, during these two periods which is on the low end of the range observed at this station but could be due to dilution by runoff. There was no additional discussion found in the records about this diversion so it must be concluded that it no longer is effective; the sulfate data at S-110 does not indicate that the diversion affects a major portion of the loading.

Water Canyon enters the NFHR downstream from the bulk of the mine, but there is a major waste rock dump in its headwaters (Picture 3). The stream issues forth from the base of

the dump (Picture 4). Two points are sampled to monitor flows from this canyon. Monitoring point S-118 locates midway between the dump and the NFHR; monitoring point S-120 is at the confluence with NFHR. Prior to 1990, sulfate concentrations at S-120 were less than 30 mg/l; after 1990 they commenced an abrupt upward trend which appears to continue through the present with concentration reaching 1500 mg/l in May 2004 (Figure 7). The concentrations exhibit a marked seasonality with the highest concentrations being reached in the spring. This is quite variable though and suggests that leaching occurs at the beginning of each large flow period as should be expected. Infiltrating water during the spring snowmelt rinses sulfate that had accumulated due to oxidation during the previous drier period. After this initial rinsing, the concentrations drop. Thus, observations that occur during the rising leg of the hydrograph show high sulfate concentrations but observations at the same flow rate but on the declining leg of the hydrograph may have much lower sulfate concentrations. This helps to explain some of the variability in the data for Water Canyon and other tributaries.. It also suggests that the waste rock dumps contain reactive rock.

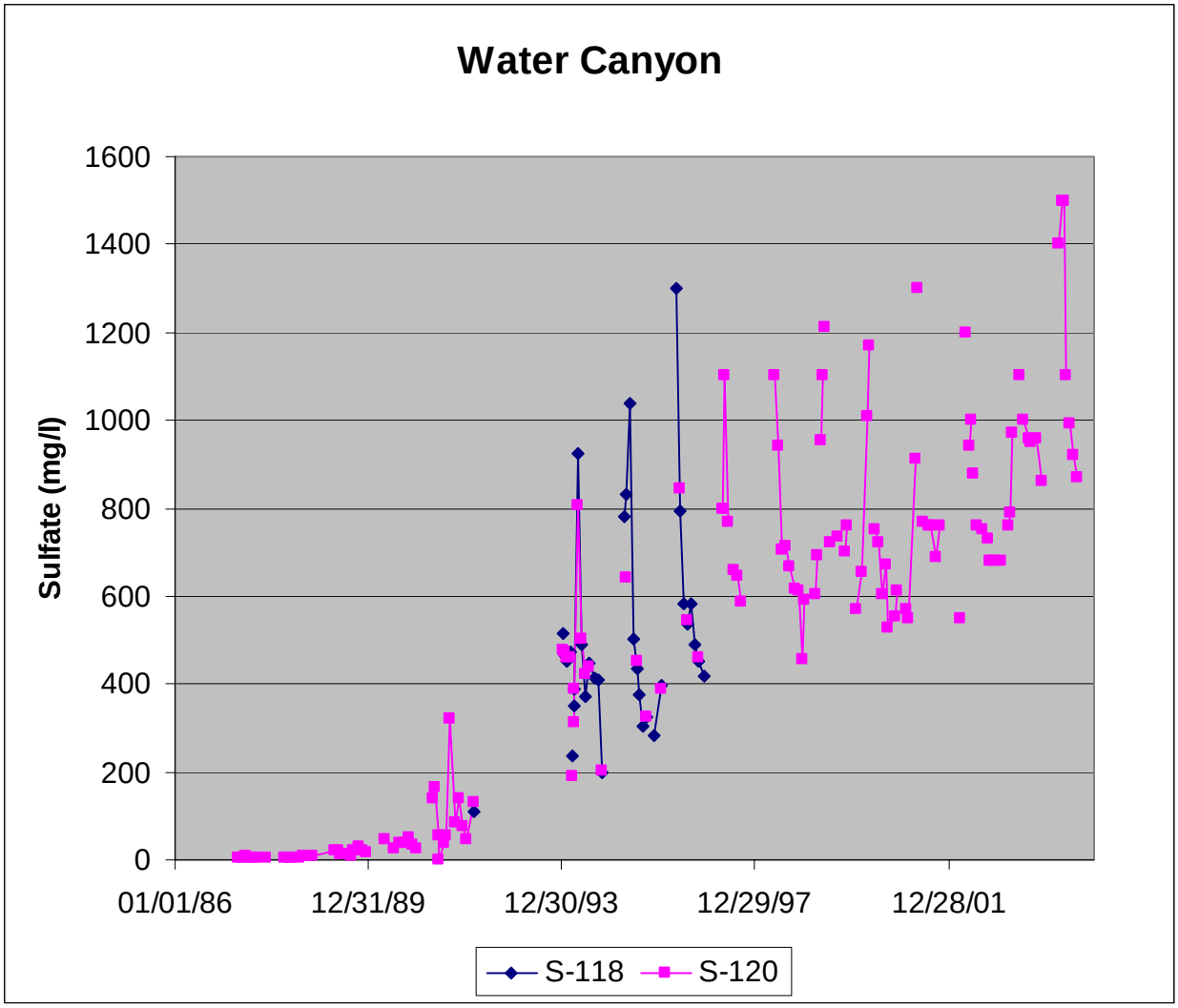

Figure 7: Graph of sulfate concentrations on Water Canyon monitoring sites.

Dry Canyon enters the NFHR from the north between Sammy Creek and Water Canyon (Figure 1 and Picture 5). Water seeps from under the waste rock to the drainage which drains the northeast edge of the dump (Picture 6). Monitoring at S-115 commenced in 1991 and sulfate concentrations have been on an upward trend since then (Figure 8). They reached their highest value at 4000 mg/l in October 2003. Baseflow concentrations that occur in August through the November are trending upward while the concentrations during the spring high flow period are remaining steady. Monitoring at S-112 mostly occurred when there was no data collected at S-115; the six coincident points do not provide much information because on some dates the concentration increased and others it decreased.

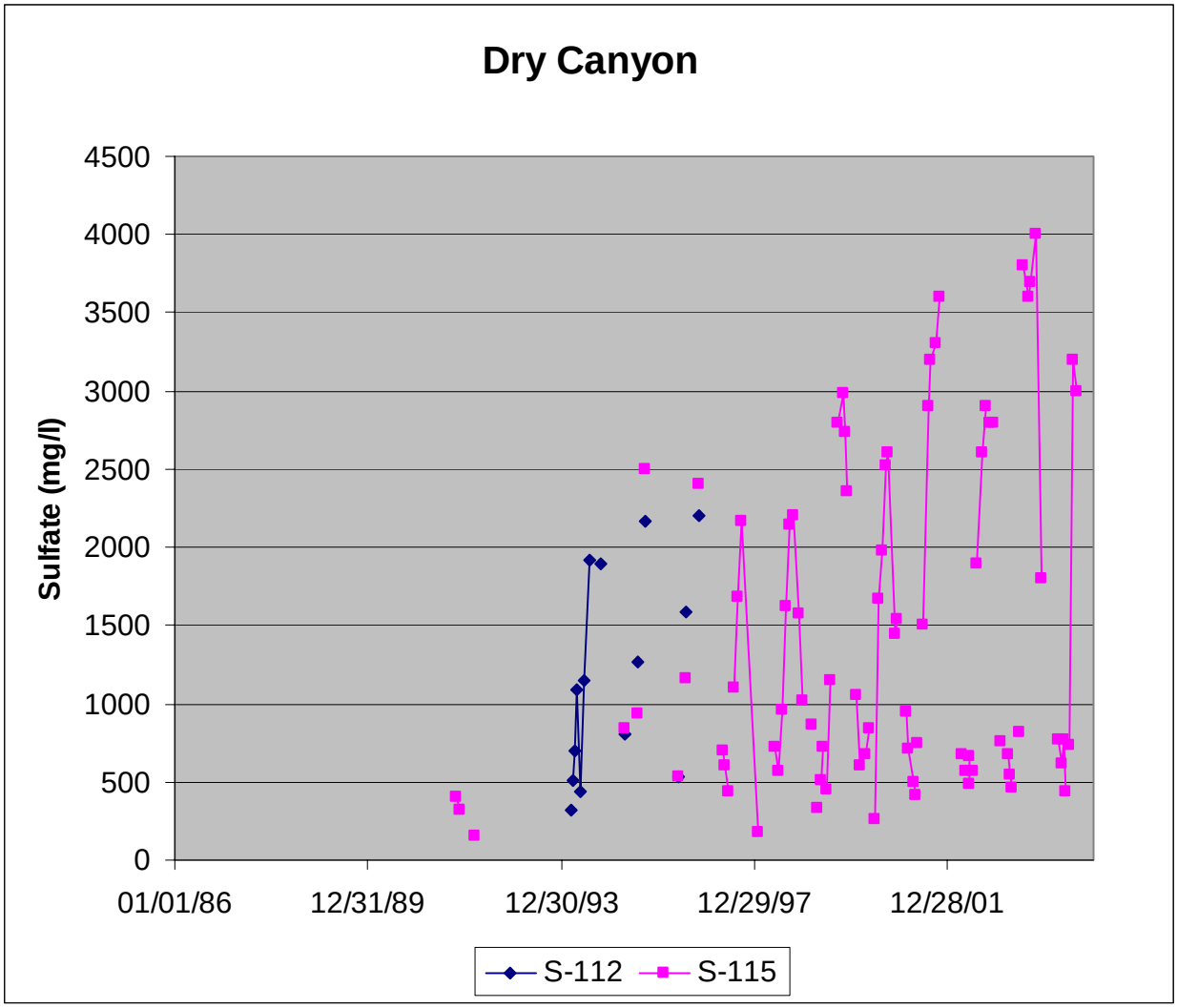

Figure 8: Graph of sulfate concentration with time on Dry Canyon. See Figure 1 for the locations of the monitoring points.

Trend Analysis for Sulfate

Because the monitoring data for point S-150 apparently showed jumps and trends for the sulfate concentration monitoring data, a detailed trend analysis was performed on the data for S-150 and for the longest term stations on the tributaries to explain the trend observed at S-150. Trend analysis may be accomplished using regression of the concentration data with time if the

concentration determined at any given time may be assumed to be normally distributed. Over time the concentration data is not stationary because the mean (and expected value) changes if there is a trend. The sulfate data for these stations meet this requirement, although some of the very early data on the tributaries is close to 0. The data was also not censured due to non-detect values as was the case for most of the metals monitored here. High outliers on either end of the time period may bias the trend analysis, but that does not occur here.

The regression model used to determine trend and shifts utilized the method of piecewise regression with shifts. The shift being tested occurred at the beginning of 1991. The model determines three different slopes, or trends if significant, for the period before January 1 1991, the period between January 1 1991 and January 1 2000 and the period after January 1 2000.

$$Y = b_0 + b_1 x_1 + b_2 (x_1 - 33239) x_2 + b_3 (x_1 - 36526) x_3 + b_4 x_2$$

Y is SO_4 concentration, b_0 through b_4 are coefficients determined with multiple regression, x_1 is the Julian day, x_2 is an indicator variable for the time period being before or after January 1 1991, x_3 is an indicator variable for the time period being before or after January 1 2000, and the number 33239 and 36526 are Julian day for the two breakpoints, respectively. Coefficient b_0 is the y-intercept, b1 is the slope of sulfate concentrations with time prior to January 1 1991, b_1+b_2 is the slope between January 1 1991 and January 1 2000, and b_1+b_3 is the slope after January 1 2000. Coefficient b_4 is the magnitude of a shift in the data which occurred at the beginning of 1991. Neter et al (1985) provide a detailed explanation of the statistical technique. Dry Canyon does not have data prior to 1991, therefore the model for sulfate concentration leaving that canyon is simpler as follows:

$$Y = b_0 + b_1 x_1 + b_3 (x_1 - 36526) x_3$$

The resulting equations, shown in Figure 6, confirm the trends and shifts in sulfate concentrations. Sulfate concentrations at S-150 shift upward by about 40 mg/l at the beginning of 1991 and follow an upward trend during the 1990s and a flat downward trend during the 2000s. Similar shapes were observed on Sammy Creek with an upward shift of about 130 mg/l at the beginning of 1991. Water Canyon and Dry Canyon outflow sulfate concentrations trended upward throughout the period of analysis. The shift in 1991 for Water Canyon was 101 mg/l.

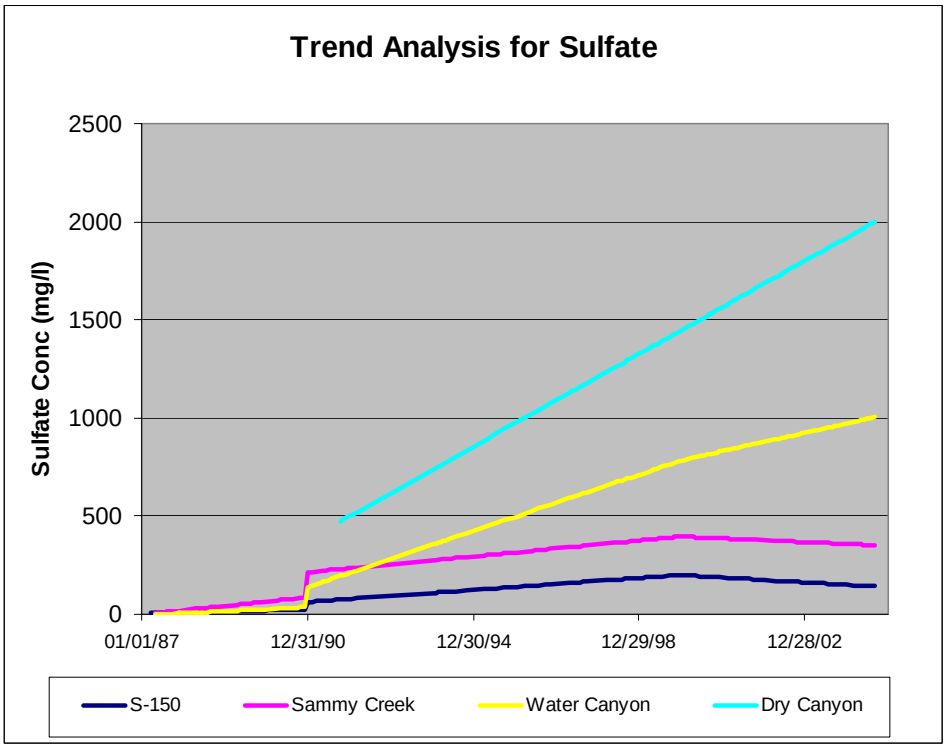

Figure 9: Trend analysis for sulfate at four stations. R2 for S-150, Sammy Creek, Water Canyon and Dry Canyon is 0.669, 0.612, 0.808, and 0.087. All are significant at p<0.05. The value for Dry Canyon is very small which reflects the variability caused by the very significant seasonality with concentrations varying from less than 1000 mg/l to greater than 4000 mg/l.

Table 2: Slope of trend regression lines for each station for the data pre-1991, 1991-2000 and 2000-2004, inclusive.

	Pre-1991	1992-1999	2000-2004	Shift in 1991
S-150	0.113	0.0419	-0.0345	39.5
Sammy Creek	0.0598	0.0551	-0.0258	127.
Water Canyon	0.0288	0.196	0.130	101.
Dry Canyon	-	0.324	0.267	-

The trend analysis establishes that sulfate concentrations have gone up on two tributaries and stabilized since 2000 on the NFHR and one tributary. To determine which tributaries control the concentrations on the mainstem, the concentration on the NFHR at S-140 and S-150 were regressed against the concentrations in the tributaries. To accomplish this regression, it is necessary to find data collected at all stations at the same time. The highest numbers of observations were taken from tributaries at their confluence with the NFHR rather than at the upstream location as shown here in Table 3.

Table 3: Number of samples at the various monitoring sites Between 1986 and 2004.

Stream	Monitoring Site	Number of Observations
NFHR	S-150	151
	S-140	118
	S-95	66
	S-100	107
Sammy Creek	S-101	44
	S-101.5	19
	S-102	24
	S-110	146
Dry Canyon	S-112	14
	S-115	82
Water Canyon	S-118	33
	S-120	133

Observations are not always taken on the same day. This causes a problem because conditions controlling the concentration emanating from a tributary may change quickly. For example, during the rising leg of a snowmelt hydrograph, the sulfate may initially flush which would cause higher loads than would occur after the bulk of the sulfate has been removed. Runoff from a storm may occur for only a day or two but may cause significant but localized effects. For these reasons, for completing a regression analysis it is important that all observations be affected or caused by the same conditions. Because the flow travel time through the watershed probably does not exceed one day, it is preferable to use only data collected on the same day. Of the total 241 sampling visits made to the watershed between 1986 and September 2004, 19 were less than or equal to 7 days apart and an additional 42 visits were less than 14 days since the previous visit. There is also a trend towards the short times between visits occurring during the 2000s rather than earlier (Figure 10). This indicates that few coincident observations were available for the analysis during the more recent years.

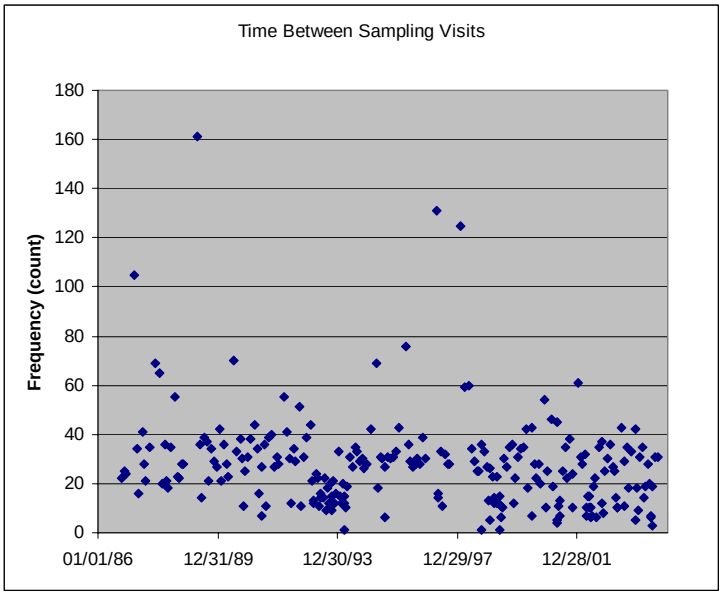

Figure 10: Scatter plot of the time between sampling visits on the NFHR.

Stations S-95 and S-100 were both sampled frequently but only rarely at the same time. They are far enough apart, and separated by a crossing in the river, to not consider them as the same point. For the 37 samples collected on the same date, the correlation coefficient was 0.85, but the mean concentration more than doubles from 4 to 9 mg/l in the downstream direction. For the multiple regression analysis, S-100 was used because there were more observation points at that station. Also, for the consideration of S-140, it was not possible to use S-115 because there were only 9 coincident observations.

The model for S-140 was much more accurate, in that it had a much higher correlation coefficient, than that for S-150. The R^2 is 0.796 for S-140 and is 0.226 for S-150 even though the model for S-150 contained one additional variable (S-115).

$$S_{140} = -18.03 + 0.264S_{100} + 0.508S_{110} + 0.288S_{120}$$

Sxxx is sulfate concentration at station xxx. The coefficients for S_{110} and S_{120} were significant (p=0.0000026 and 0.0000039, respectively), but that for S_{100} was not (p=0.550). This indicates that sulfate concentration in the tributaries controls the variation in sulfate concentration in the NFHR. The data set for S-140 spans the period 1987 to 1996 which includes the periods prior to and after the construction of and closure of the mine. It is not necessary to consider data sets divided before and after mine construction or closure. The scatter plot (Figure 11) shows the variation of sulfate at S-140 with that at the upstream tributaries while the concentration appears random as related to that at S-100. The concentration in the NFHR adjacent to and just below the mine site varies with the concentrations observed in the tributaries which are directly affected by the mine.

A primary reason the observations at S-150 are less well explained is the distance between stations and the factors which could affect the sulfate concentration between the stations. A primary possibility is dilution – concentrations at S-150 are substantially less than at S-140 – due to inflow from the sides.

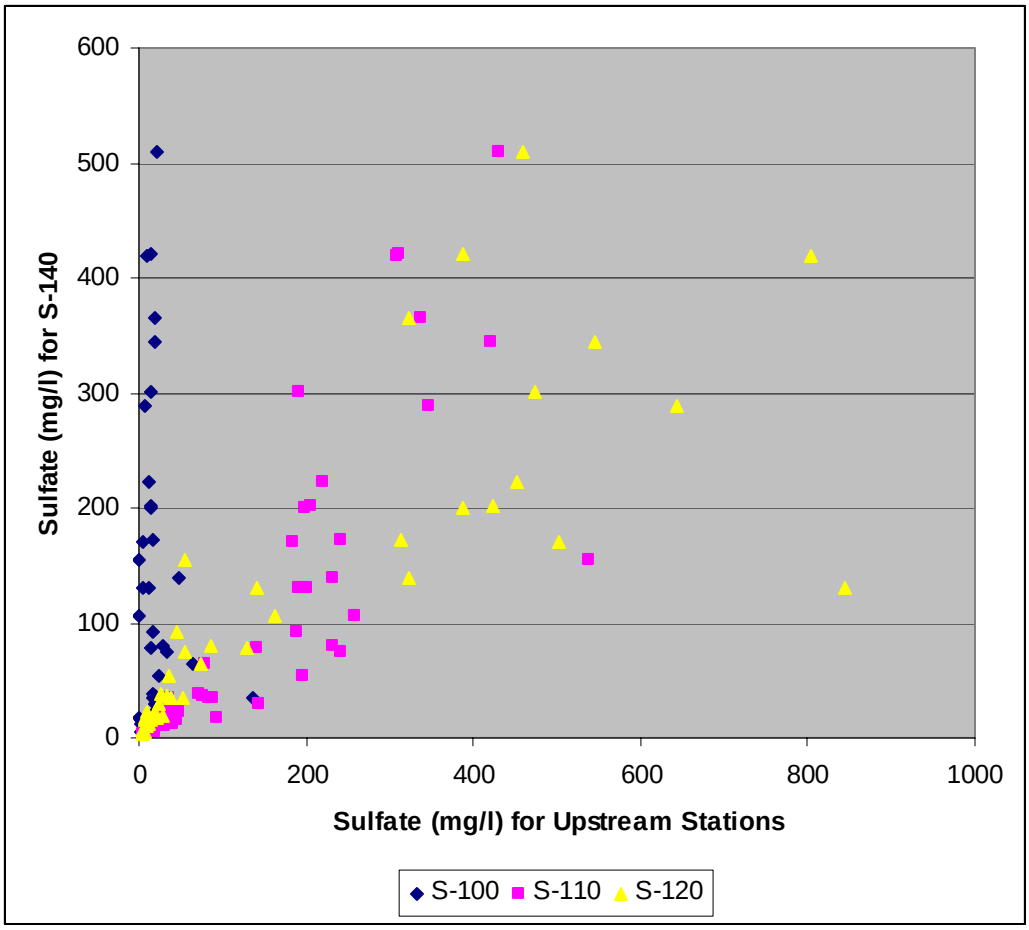

Figure 11 Scatter plot of sulfate concentrations in the NFHR and at upstream tributaires.

It is possible that sulfate concentration would vary with the flow rates at the various sites. Because there are few occurrences with sulfate and flow measurements at all three tributaries and at S-140 (only 7), a simple regression between sulfate concentration at S-140 and flow rate (gpm) from each tributary was run. The best fit model was between S-140 sulfate concentration and S-110 flow rate. The model is:

$$S_{140} = 290.7 - 0.022Q_{110} \qquad R^2=-.14$$

Here, Q_{110} is flow rate in gpm at station S-110. If the variation was due to the extra flow leaching sulfate from the waste rock, it would be expected that the coefficient would have a positive sign. However, all of the regressions resulted in a negative, although not significant, coefficient. Rather than leaching, the effect on concentration at S-140 is due to the dilution at higher flows emanating from the watershed. This could indicate the contribution from the waste rock is relatively constant, due to the tributaries flowing through the waste rock dumps, and increased flow causes dilution.

Load Analysis

Sulfate

The majority of the sulfate concentration on the NFHR results from inflow from the tributaries. Analysis on Sammy Creek shows that most of the concentrations increases occur through the waste rock dump that exists within the stream. A loading analysis was completed to better show from where the sulfate emanates.

Load, in pounds/day, is calculated by multiplying the flow rate (gpm) and the sulfate concentration (mg/l) and applying the appropriate conversion factors. The flow and sulfate concentrations were collated to determine an adequate data base for analysis. It was necessary to have both flow and sulfate measurements for stations up and down-stream in the NFHR (S-100 and S-150) and for the tributaries (S-110 for Sammy Creek, S-115 for Dry Canyon, and S-120 for Water Canyon). Station S-150 was used because of the additional concurrent data, especially during more recent years, of both sulfate concentration and flow rate. The data were tabulated in a spreadsheet (Table 4). There were 29 concurrent observations between 1995 and 2004; this time period spans substantial wet and dry periods.

Delta load NFHR is the change in load from above to below the mine site on the NFHR (S-150 – S-100). The calculation was made using the upstream and downstream sites that had the most concurrent observations. The choice has been to not consider other permutations of upstream and downstream sites to avoid confusion; the exception is that the difference between S-140 and S-150 is considered below. The delta load averaged just over 8800 lb/d and the median is just over 3600 lb/d; these values represent 195 and 625 times increases over the load upstream at S-100 entering river reach affected by the mine. As high as these are, the values are actually less than the sum of the load from the three tributaries . The inflow load, Trib Load, averages just over 9700 lb/d with the median being just less than 4200 lb/d. This indicates that a substantial amount of sulfate loading dissipates in the reach. This is not due to dilution because the load would remain the same even if perfectly clean water, without sulfate, is added to the river. It suggests that flow, including sulfate, must leave the river; most likely there is seepage into the river bed[TJM2].

However, during this time period, the flow on the river, accounting for tributary inflow, increased between S-110 and S-140 by 428 gpm. This indicates there is a groundwater inflow to river or unmeasured surface inflow.

Exponent (1998) completed a mass balance for sulfate and water for just the baseflow periods from 1991 through 1997 but used the NFHR station S-140. The data collection including sulfate had essentially ended in 1997 at S-140. Exponent found that the difference between load and flow at S-140 and the sum of the upstream stations (S-100 and the tributaries), which indicated an increase in the river not due to just the tributaries, was due to groundwater inflow. The flow increase averaged 212 gpm which was of the same order as the total flow from the river and tributaries during baseflow (which averaged 198 gpm). These flow increases are about half of those found using the data set from 1995 through 2004 in the previous paragraph.

Table 4: Load in Pounds/Days for the NFHR and Tributaries

			Sammy Creek	Water Canyon	Dry Canyon			
	s-100	s-150	S-110	S-115	S-120	Delta Load NFHR	Trib Load	Load Lost in River
04/29/95	59.27	9548.73	1976.15	9286.91	1418.69	9489.46	12681.75	3192.29
07/26/95	10.20	3631.51	719.26	1685.42	3488.16	3621.30	5892.84	2271.54
10/01/95	1.84	1217.03	234.89	600.86	447.37	1215.19	1283.12	67.93
05/14/97	268.27	59616.24	17322.10	21631.00	16946.69	59347.97	55899.79	-3448.18
06/16/97	118.47	22507.90	3652.75	7592.96	10669.01	22389.43	21914.73	-474.70
07/29/97	4.90	4679.39	1583.99	1031.08	3791.19	4674.48	6406.26	1731.78
09/23/97	6.62	1608.81	733.11	260.77	2412.51	1602.19	3406.39	1804.20
05/25/98	599.38	69721.04	16587.91	27624.88	19616.91	69121.66	63829.70	-5291.96
06/28/98	52.35	25688.31	5152.94	8297.05	16763.54	25635.96	30213.53	4577.57
07/27/98	14.80	7745.92	1739.13	2226.55	3903.03	7731.12	7868.71	137.59
08/21/98	0.44	3817.63	978.68	1460.09	1600.02	3817.19	4038.80	221.60
09/15/98	5.79	3681.26	1798.26	2571.69	1256.54	3675.47	5626.49	1951.02
10/21/98	12.76	2029.48	718.15	2643.79	805.57	2016.72	4167.51	2150.79
11/24/98	8.47	5427.57	624.37	949.36	832.42	5419.09	2406.15	-3012.95
11/09/99	3.36	5933.94	234.94	492.11	588.00	5930.57	1315.04	-4615.53
12/01/99	4.63	7618.92	345.19	1418.03	910.91	7614.29	2674.13	-4940.16
04/21/00	38.28	5191.01	739.53	4596.23	570.46	5152.73	5906.21	753.49
05/09/00	57.68	7771.20	1041.58	5182.38	1293.53	7713.52	7517.49	-196.02
07/26/00	1.20	439.87	163.79	301.03	441.89	438.67	906.71	468.04
08/17/00	1.59	167.23	104.35	356.91	325.55	165.64	786.80	621.16
10/04/00	5.43	387.56	145.29	468.67	284.99	382.12	898.95	516.82
11/27/00	11.39	523.95	327.29	784.12	332.28	512.56	1443.69	931.13
12/07/00	6.27	243.35	277.60	185.07	332.04	237.08	794.70	557.62
06/25/01	3.00	1802.58	114.16	1081.55	555.20	1799.58	1750.91	-48.67
09/16/03	1.50	928.69	201.89	889.27	1027.47	927.19	2118.64	1191.45
10/19/03	0.17	1328.62	174.97	1297.86	830.63	1328.46	2303.46	975.01
07/01/04	5.17	1454.08	1062.92	4446.37	8363.63	1448.92	13872.92	12424.00
08/01/04	5.47	961.38	150.22	2884.13	5527.92	955.91	8562.27	7606.36
09/01/04	2.64	901.29	324.46	1802.58	3659.24	898.65	5786.29	4887.64
Average	45.22	8847.40	2042.41	3932.71	3758.46	8802.18	9733.59	931.41
Median	5.79	3631.51	718.15	1460.09	1256.54	3621.30	4167.51	621.16

Considering the load balance completed here, during baseflow periods (September through December), only three of the dates had a negative loss, or an increase in load in the river. These were November/December readings in 1998 and 1999; the magnitude of the increase was substantial. The increases were up to ten times the actual loads on the river and tributary. Therefore, the increases most likely reflect groundwater inflow which could be a return flow, as suggested above, from high flows which recharged the alluvium near the river during previous high flow. The substantial load increases in the river during May 1997 and 1998 coincided with high flows it is possible that leaching from other unidentified sources increased the load but it is also possible that some of the increase is due to the uncertainty in measuring the flow at S-150.

The station at S-140 was not sampled concurrently with the data base above, but there are 14 observations concurrent with monitoring at S-150 during 1994 and 1995. During nine of those sampling events, the load decreased from S-140 to S-150. On average, the load decreased by 373 lb/d, but this value is not very meaningful. Much of the loss occurred during the spring 1995 which was wet compared to 1994 (Figure 12). During 1994, the load tended to increase between the stations. This suggests there is some exchange between the river and banks with flow and sulfate seeping into the banks during wet years and some flow discharging back to the river during drier periods. This is supportive of the results found above and in the mass balance performed by Exponent (1998). The fluctuations shown in Figure 9 caused some of the variability found in the regression analyses.

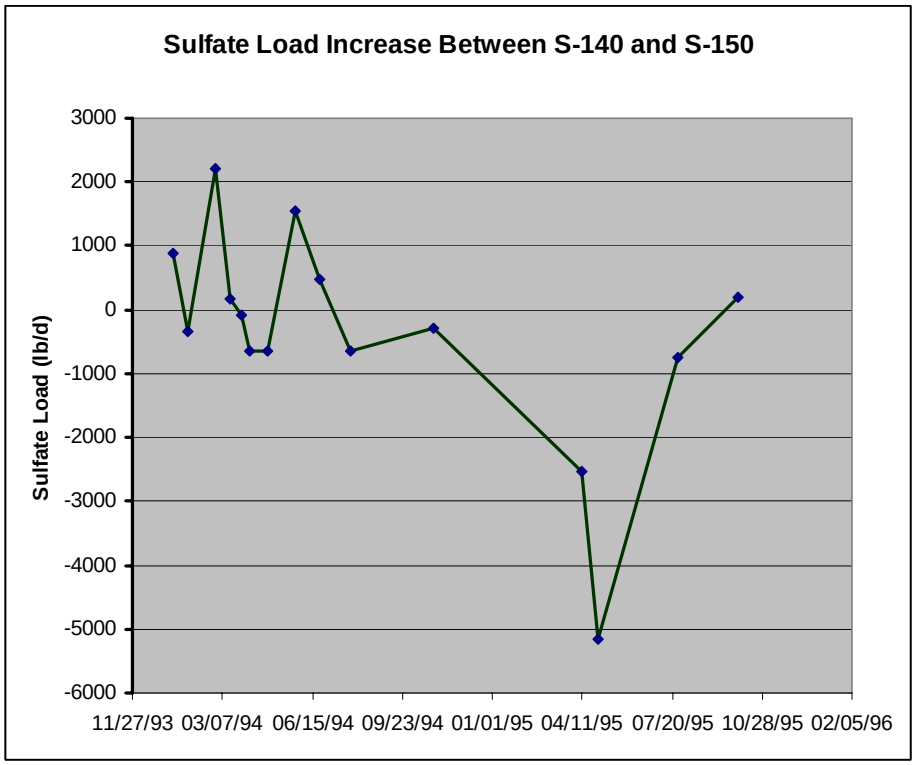

Figure 12: Sulfate load increase between S-150 and S-140.

Exponent (1998) also suggests some source of sulfate to the NFHR other than the tributaries. Two springs on terraces south of the NFHR have high sulfate and other constituent concentrations and are clearly magnesium sulfate waters suggesting they have been affected by the mine. However, Exponent linked these to seepage from the pit lake which is unlikely if its estimate of seepage is correct[TJM3]. Exponent (1998) estimated that 20 to 40 gpm would seep through the pit lakes in the long term at steady state. Spring 1, which has been affected by the mine, is 2000 feet horizontally and about 200 feet below the surface of the CX pit lake. A straight line between the lake and spring has a gradient of 0.1. The pit lakes began to form in 1993, 4 years prior to the measurements reported here for spring 1. Flow from the lake to the spring would have 4 years which would result in a hydraulic conductivity of 13.7 feet/day. This is reasonable for fractured bedrock. But, if it is correct, and if the area over which it applies is as small as 200 feet high by 500 feet wide, the flow to the spring area would exceed 700 gpm. The other possibility is that a fracture connects the lake with the spring, but there is no evidence; in

fact, the geologic cross-section provided by Exponent (1998) indicates the flow would cross a fault. Exponent (1998), in its discussion on flow paths (Exponent 1998, Chapter 4) does not identify a path to the spring. Also, the water quality in the springs is much closer to that observed in the tributaries than in the pit lake. Based on the expected groundwater flow paths, the waste rock dumps, probably those in Water Canyon, affect the springs along the NFHR more than the pit lakes.

If the seepage ranging from 20 to 40 gpm from the pit lakes reaches Sammy Creek, as discussed below in the section on pit lakes, and if the sulfate concentration is about 800 mg/l as observed in the pit lakes, the lakes contribute a load to Sammy Creek of about 192 to 385 lb/d or about 9 to 19 percent of the average load from Sammy Creek. This calculation assumes that there is no attenuation of sulfate in the Sammy Creek alluvium. The pit lakes provide a significant load to Sammy Creek.

Water Canyon and Dry Canyon each produce almost 4000 lb/d of load or about 1.7 times the amount produced by Sammy Creek. In Dry Canyon, this was due to very high sulfate concentrations during lower flow periods. In Water Canyon, the relatively high sulfate concentrations in high flows yield the large observed load. However, all three tributaries contributed substantially to high concentrations on the NFHR.

Selenium

The flow and sulfate concentration analyses show that the Big Springs mine contributes substantial sulfate load to the NFHR. Figure 13 shows that selenium concentrations vary with time throughout the watershed in a similar fashion to sulfate. Dry Canyon appears to be the largest source, but all tributaries contribute significant selenium. Tuttle et al (2003) also found that selenium concentrations, based on the monitoring data, correlated with sulfate.

> Prior to mining, selenium was not detected in water samples from four sites (sites S-110, S-120, S-140, and S-150; Table 6). From 1994-98, this element was not detected in the NFHR upstream of mining activity (site S-95) but was detected in 2 of 16 samples collected in Sammy Creek upstream of mining activities (site S-101). The maximum concentration at site S-101 was 0.003 mg/L (Table 6). Conversely, from 1994-98, selenium was detected in more than 90 percent of the samples collected from sites in the tributaries downstream of waste rock dumps (sites S-110, S-115, and S-120) and in about two-thirds of the samples collected from the NFHR immediately down stream of mining activity (sites S-140 and S-150). The mean concentrations in affected tributaries generally exceeded 0.01 mg/L, with the maximum concentration exceeding 0.1 mg/L. When 1994-96 data from the tributaries (sites S-110, S-115, and S-120) were examined, selenium concentrations were positively correlated with sulfate concentrations ($p<0.001$; $r_2=0.518$, $n=71$). (Tuttle et al, 2003, page 17)

Based on this FWS analysis, selenium is released from the waste rock in a similar fashion as sulfate. This corresponds with the findings that Dry Canyon selenium concentrations are highest.

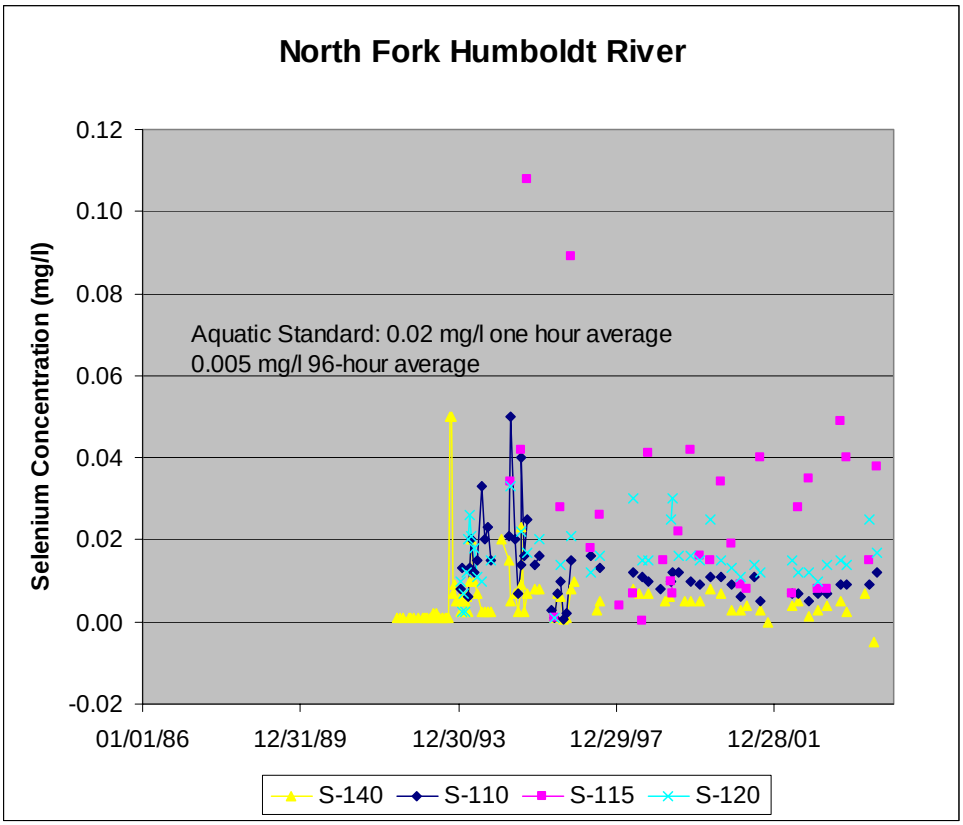

Figure 13: Graph of selenium concentration with time at the NFHR stations. See Figure 1 for the location of the stations.

Other Studies

Other analyses and studies have concluded that the mine has caused sulfate, selenium and other constituents such as total dissolved solids (TDS) to exceed standards. The section reviews these studies.

Schaeffer and Associates (1994) reported on a synoptic study performed May 26, 1993. On Sammy Creek, the flow increased from 3 cubic feet per second (cfs) above the waste rock dump to 14.67 cfs just below the dump. Below that the flow decreased and increased (stations S-101.5B to S-102) and decreased again to 9.34 cfs at S-110 where it enters the NFHR. The large flow increase from above to below the dump is due to seepage of meteoric water through the dump. However, the sulfate load increased from 300 lb/day above the dump to 15,477 lb/day at the inflow to the river. This was a 50 fold increase. This is similar to the flow increases and loading analyzed above. Sulfate loads from Dry Canyon and Water Canyon were 19509 lb/d and 3949 lb/d, respectively, at the point of flow into the river. Also, these loads are similar to those found above.

The Schaeffer synoptic study (Schaeffer and Associates, 1994) showed that sulfate load on the NFHR above Sammy Creek (S-100) was 211 lb/day. Downstream from the inflow from

Sammy Creek, Dry and Water Canyons, Schaeffer measured a sulfate load equal to 37,181 lb/d. This was a 175 fold increase along the NFHR.

Schaffer and Associates (1996) compared water quality parameters for various locations along the NFHR and the side drainages. Aluminum, calcium, iron, hardness, potassium, EC, magnesium, manganese, nitrate, sulfate and TDS increased significantly from upstream of the Sammy Creek waste rock dump to the toe of the dump. Further downstream, there were some decreases in concentration. The decrease going downstream from the dump is likely due to dilution. Also, the analysis did not separate pre-mine and post-mine values. Calcium, iron, hardness, carbonate, potassium, pH, EC, magnesium, manganese, sodium, nitrate, sulfate, TDS and total alkalinity significantly increased between the location that a haul road crosses the river and site near Cole Canyon downstream from the mine. The concentration of many constituents in the river increased with time. The most commonly increasing constituents were TDS and sulfate. These trends were found even though the analysts made no attempt to account for activities in the watershed, or interventions, which could affect the data. For example, the samples before the mine was built should have shown no increase. During construction, it would be expected that the concentrations would increase with time. After the mine ceased operations, it is likely that the concentration would remain the same but not necessarily increase. That the "level" periods did not prevent the discovery of a trend indicates the strength of that trend. Also, the Schaffer study was completed too soon after the commencement of reclamation to have been affected by changes due to that reclamation.

Earman and Hershey (2004) identified a step increase caused by the mine but ignored by Schaeffer and Associates (1996). A substantial increase in concentration of many constituents and parameters occurred in 1991. The concentrations of many constituents and parameters, including EC, calcium, magnesium, chloride, bicarbonate, and sodium "were low for the years 1987 through 1990, then began increasing in 1991, with minimum values for the years 1992 through 1995 being higher than maximum values for the years 1987 through 1990." (Earman and Hershey, 2004, page 1047). This coincides with the analyses completed above. They also indicated that this increase coincided with the opening of the South Sammy Creek pit in late 1990 to early 1991. This pit added "waste rock with higher levels of sulfide mineralization than had been excavated previously" (Earman and Hershey, 2004, page 1051).

The huge load increase found by Schaeffer and Associates (1994) is consistent with findings by Earman and Hershey (2004) in that the water type on the NFHR changes completely from above to below the site. Based on sampling performed Earman and Hershey, the change is from a calcium-bicarbonate type upstream to a magnesium-sulfate type downstream. They also noted a statistically significant increase in EC, bicarbonate, chloride, sulfate, nitrate, sodium, potassium, calcium, magnesium, fluoride, manganese, selenium and strontium in their data. While acknowledging that on mineralized river, many increases could be natural, they used data collected before mine construction to show that pre-mining, samples all along the river had been of a calcium-bicarbonate type. They also used geochemical modeling to verify and explain the changes as being due to the input of waste rock to the system. The mine has changed the type of water in the NFHR[TJM4].

Exponent (1998) also found that there was a substantial increase in contaminant loading on the NFHR. For sulfate, it found that concentrations "increase with time in **all mine-area surface waters**" (Exponent, 1998, page 3-2, emphasis added). "Sulfate concentrations at S-110 increased from about 30 mg/L in 1987 to about 600 mg/L in 1997. An increase from 10 mg/L sulfate to 200 mg/L sulfate is evident at the … NFHR canyon mouth at S-150" (Exponent, 1998, page 3-2, without figure references). It also pointed out, agreeing with Earman and Hershey (2004), that "[a]t several sampling section, especially those downstream of the mine, water composition changes from calcium-bicarbonate type in 1989 to magnesium-sulfate type in 1997" (Id.). Sulfate was not the only contaminant found to increase because it found that "TDS also increased from 1987 through 1997 for **all sampling sites around and downstream of the mining area**" (Id., emphasis added).

Tuttle et al (2003) completed a stream sampling event on the NFHR and tributaries during a period in late July 1998. Table 5, developed from their Tables 7 and 8, shows clearly that during July 1998, metals and many ions substantially increased through the reach of NFHR affected by the mine. Measurements on the tributaries show that the additional loading emanated from the tributaries. During this period, the biggest change was for manganese. Although there were substantial concentrations of nickel, selenium and zinc on the tributary flow, the concentration found in the river did not substantially increase. For some metals on some tributaries, there were substantial differences between total and dissolved concentrations. It is possible that total loads settled out and that dissolved loads adhered to suspended sediments and also settled out. Tuttle et al's (2003) findings that concentrations of arsenic, cadmium, manganese, nickel, selenium, and zinc in bottom sediment were elevated supports this. They also sampled Cole Creek, an unaffected by mining stream draining into the NFHR from the north side of the creek. Concentrations on this creek also resembled the other site upstream from the mine.

Table 5: Water Quality Data Collect by Tuttle et al (2003), Concentration in mg/l

Site	pH	Hard-ness	TDS	S	Ca	Cl	F	Mg	K	Na		
NFHR above mine	7.0	24	48	3.4	5.5	0.2	0.04	3.1	0.9	2.3		
NFHR below mine	7.7	544	851	496	85	2.3	0.1	81	1.4	4.9		
Sammy Creek	7.8	347	607	315	59	1.2	0.28	48	1.2	4.9		
Dry Canyon	9.5	975	1660	936	97	1.5	0.09	187	2.2	4.3		
Water Canyon	7.4	837	1390	741	130	3.1	0.04	122	1.7	3.6		
Cole Creek	7.1	53	82	3.8	14	0.4	0.05	3.6	1	3.2		
Cont-inued	Al*	Al	As*	As	Mn*	Mn	Ni*	Ni	Se*	Se	Zn*	Zn
NFHR above mine	0.16	0.09	0.01	0.01	0.006	0.004	<0.015	<0.015	<0.001	<0.001	0.006	0.004
NFHR below mine	0.19	0.06	0.018	0.014	0.064	0.049	<0.015	<0.015	<0.001	<0.001	0.003	<0.002
Sammy Creek	0.35	0.11	0.019	0.011	0.184	0.187	0.039	0.039	0.010	0.010	0.036	0.04
Dry Canyon	0.13	0.07	0.005	0.004	0.059	0.027	0.016	<0.015	0.013	0.016	0.014	0.003
Water Canyon	0.08	0.05	0.013	0.012	0.024	0.023	0.026	<0.015	0.009	0.008	0.009	0.008
Cole Creek	0.14	0.07	<.001	<.001	0.01	0.01	<.015	<.015	<.001	<.001	0.003	<.002
*: Total concentration.												

In a response to GBMW's review of the renewal permit, Gorman (2005, page 3) dismisses these studies by stating they are based on old data collected prior to reclamation and closure activities. He also noted that post-closure data has been collected and submitted to NDEP. It is this data that was reviewed above in the section on Trend Analysis on the North Fork Humboldt River and Tributaries to show that conditions have not improved since these other studies were completed. There is no evidence in the files suggesting otherwise.

Waste Rock Dumps

Analysis of monitoring data completed for this report and other studies have found that the tributaries to the NFHR that drain the Big Springs mine have added substantial sulfate and metals loading to the river. The most likely source of contamination is the waste rock that has been dumped in each of the tributaries; in all three drainages, the waste rock has been piled over the stream or on top of springs. The final closure plan indicates the lower Sammy Creek, Dry Canyon, and both Water Canyon dumps "were developed using the cross-valley method of construction" (IMC, 1996, page 14). These all had "[u]nder-dump drainage systems [which]

were developed beneath the cross-valley type dumps through natural gravity segregation of waste rock that occurs during dumping operations. The under-dump drainage systems are intended to allow surface runoff from the contributing watersheds to flow through the base of the dumps (sic)" (IMC, 1996, page 14). This basically means that the dumps were designed to be within the drainages with coarser rock naturally segregating from the bulk of the rock during the dumping. They were designed to convey drainage water from above the dump through the dump and to downstream channels. There is no provision made to separate or segregate the drainage from the waste rock. It would be useful to identify whether this waste rock could leach high sulfate concentrations and some metals to the river. High sulfate would be caused by pyrite oxidation followed by carbonate neutralization; high sulfate but neutral pH and not high metals concentration would be the result. There are several studies that address the leaching from waste rock; this section reviews these studies.

The waste rock reportedly has only low to moderate amounts of sulfide and rather high amounts of carbonate which could neutralize acid generation (Fact Sheet, page 3 and Schaeffer and Associates, 1996, page 30). Mine drainage could have elevated TDS and sulfate due to sulfide oxidation and high calcium and magnesium from carbonate neutralization (Schaeffer and Associates, 1996, Earman and Hershey, 2004). However, Schaeffer also reports that because the sulfides were not isolated, there could be local spots of acid mine drainage. Schaeffer and Associates (1994b, page 3) indicate that acid generation "by a minority of rock material (5 to 15%) in a waste rock dump may trigger degradation of drainage quality". The report indicates that "water infiltrating through the waste rock dumps appears to be the primary mechanism for transport of the elevated and dissolved constituents" (Schafer and Associates, 1996, page 30).

However, the Schafer and Associates indicate that the South Sammy Creek dump has the best chance to generate AMD and other contaminants and that Dry Canyon has the lowest chance. Waste rock from the South Sammy Pit had much higher sulfide concentrations (Earman and Hershey, 2004) and it may have been piled together in the same dump creating a hotspot. But, this counters the results found above in the section on trend analysis showing that Dry Canyon Creek contributes the highest concentration of sulfate and selenium to the NFHR.

Their conclusions do not follow from an examination of the data presented in Table 1 of Schafer and Associates (1994b). They based their conclusion on the higher ABA (acid base accounting) value found for the Dry Canyon Dump. This high average results from the very high neutralizing value found for several of the samples; these caused the average NP (neutralizing potential) to not be very representative. The ratio of neutralizing potential to acid generating potential (NP/AP) gives a clearer picture of the situation. The NP/AP for Dry Canyon, Lower Sammy Creek, Sammy Creek, Upper Water Canyon and Lower Water Canyon dumps was 9.4, 39.1, 16.7, 21.9 and 55.8, respectively. The value for Dry Canyon is substantially lower than that for the other dumps although it still exceeds the 3.0 and 1.2 values commonly used as benchmarks, respectively, for determining whether a dump will produce acid. More telling for the Dry Canyon dump is the fact that 5 of 20 samples, or 25%, had individual AP/NP less than 3.0. Sixteen of the 20 values are less than the reported average. Just four samples with high AP/NP, 34.1, 29.9, 12.9 and 28.0, cause the reported average to be much higher than is representative of the dump. This indicates that portions of the dumps have the

potential to produce oxidation products including sulfate; the geochemical data does not contradict the finding of the analysis of flows and concentrations on the NFHR.

NDEP agrees that the waste rock dumps are contaminating the river. The Fact Sheet also acknowledges that the "interaction of meteoric waters with the sulfide minerals in the waste rock is considered at least a significant source of the higher TDS, sulfate, and selenium values as compared to the receiving North Fork of the Humboldt River." Stated simply, this means that rain and snowmelt seeps through and reacts with the rock and then seeps to the river where it increases the TDS, sulfate and selenium concentration.

But AngloGold does not agree with NDEP. In a response to BMRR regarding the comments provided by GBMW on the draft permit, Gorman (2005) suggested that the contribution of pollutants to the river is minimal.

> In our opinion, capping and covering the RDAs [rock disposal areas] has minimized any contribution from them to the observed flow in the stream channel below the RDAs. The vast majority, if not all, of the water observed downgradient of the RDAs originates from the undisturbed watershed upgradient of them. No NPDES permit is required for these flows because the applicable requirements have not been triggered (e.g., there is no addition of a pollutant). The water upgradient of the RDAs is simply being conveyed by the rock drains under the RDAs in much the same fashion as a metal culvert under a highway. (Gorman, 2005, page 10)

As documented above throughout this report, nothing in Gorman's discussion is correct. On Sammy Creek, the only waste rock dump with monitoring above and below the dump, there is a substantial flow increase. There is no monitoring upstream of the other dumps; Water Canyon appears to be perennial but Dry Canyon appears to be an otherwise ephemeral watershed. Sulfate concentrations increase many fold and there the flow almost always violates standards for selenium; there is clearly an addition of a pollutant. In fact, if addition of pollutant is the triggering mechanism for a NPDES permit, there should be one at this site. Gorman refers to the rock drains. Upon a visit to the site as documented in the pictures in Appendix 1, there was no evidence of drains. Even if there were drains constructed, they clearly did not prevent pollutants from reaching the stream under the dumps.

Gorman (2005, page 10) continues by stating that "if there is measurable contribution from the RDAs to the water flow observed in the streams below them, that contribution does not materially impact the water quality of the stream flow". Gorman's statement has no basis in fact considering the data and trend analyses presented throughout this report.

Reclamation

The fact sheet (page 5-6) indicates that reclamation has been completed on the six waste rock dumps. Reclamation of the waste rock dumps may stop or reduce the seepage into the dumps. However, these angle of repose dumps have a substantial surface area which will never be truly reclaimed. Precipitation will seep into the sides of the dumps forever. Also, runoff from

the reclaimed top onto the dump side slopes will seep into the dumps. This seepage will leach contaminants for as long as sulfide remains to be oxidized.

The closure plan (IMC 1996) indicated that the reclamation would substantially reduce the seepage through the waste rock dumps. Table 6 shows the area of the dumps, the predicted percentage decrease in seepage or water movement through the dumps, the expected seepage rate and the measured flow rate in the tributary below the dumps.

Table 6: Area of and Flow Rate Expected from Various Waste Rock Dumps (IMC 1996)

Tributary and/or Dump	**Dump Area (acres)**	**Expected Percent Decrease**	**Expected Flow Rate (gpm)**	**Average Flow Rate from Monitoring Reports (gpm)**
Dry Canyon	64.5	75	7.7	463
Upper Water Canyon	30.6	53	4.2	
Lower Water Canyon	25.5	86	1.5	247
Sammy Creek	26.5*	95	1.4	455
* - Area for upper and lower dumps combined; flow rate not reported for each separately.				

It is not possible to estimate how much the flow rate would be if the reclamation had not been "completed". However, based on monitoring data in Sammy Creek showing that a high proportion of the flow discharging to the NFHR emanates from the waste rock and that during the site visit by the author it was apparent that much of the flow reaching the NFHR emanated from the dumps or seeped into the streams just downstream from the dump, it is apparent that seepage from the dumps is responsible for a substantial portion of the total discharge. It is also obvious that the seepage reduction hoped for in the closure plan has not occurred.

Gorman (2005, page 10) suggests that angle of repose slopes represent only about 10% of the total area of dumps implying that the remainder is reclaimed and should not be allowing significant seepage. This statement contradicts data presented by Gorman (2005, page 7) presented here in Table 7.

Table 7: Area of Waste Rock Dumps and Amount Seeded (Gorman 2005, page 7)

Waste Rock Dump	Total Area (acres)	Flat or Seeded Area (acres)
Upper Sammy Creek	3.3	1.8
Lower Sammy Creek	23.2	14.9
Dry Canyon	64.5	40.3*
Lower Water Canyon	25.5	17.8
Upper Water Canyon	30.6	14
Total	147.1	88.8

*- Gorman notes that 3:1 slopes account for 21 acres on this dump; whether the entire area has been seeded is not clear, but during the site visit it did not appear so.

88.8 acres is only 60% of the total area; adding the 21 acres of 3:1 side slope from Dry Canyon is only 75% of the total area. This statement is not supported by the available documentation and data.

Contribution from the Open Pits

There were many small open pits excavated at this site. Some extended below the water table and needed dewatering. Lakes formed in the SWX and 303 pits. Picture 7 shows the SWX pit lake. Sulfate concentrations are high but variable (Figure 14). They exhibit a seasonal variation with dilution from surface water inflow apparently causing lower concentrations during the spring. Magnesium concentrations are also high and follow the same dilution cycles. Manganese concentrations are also high ranging to almost 0.6 mg/l.

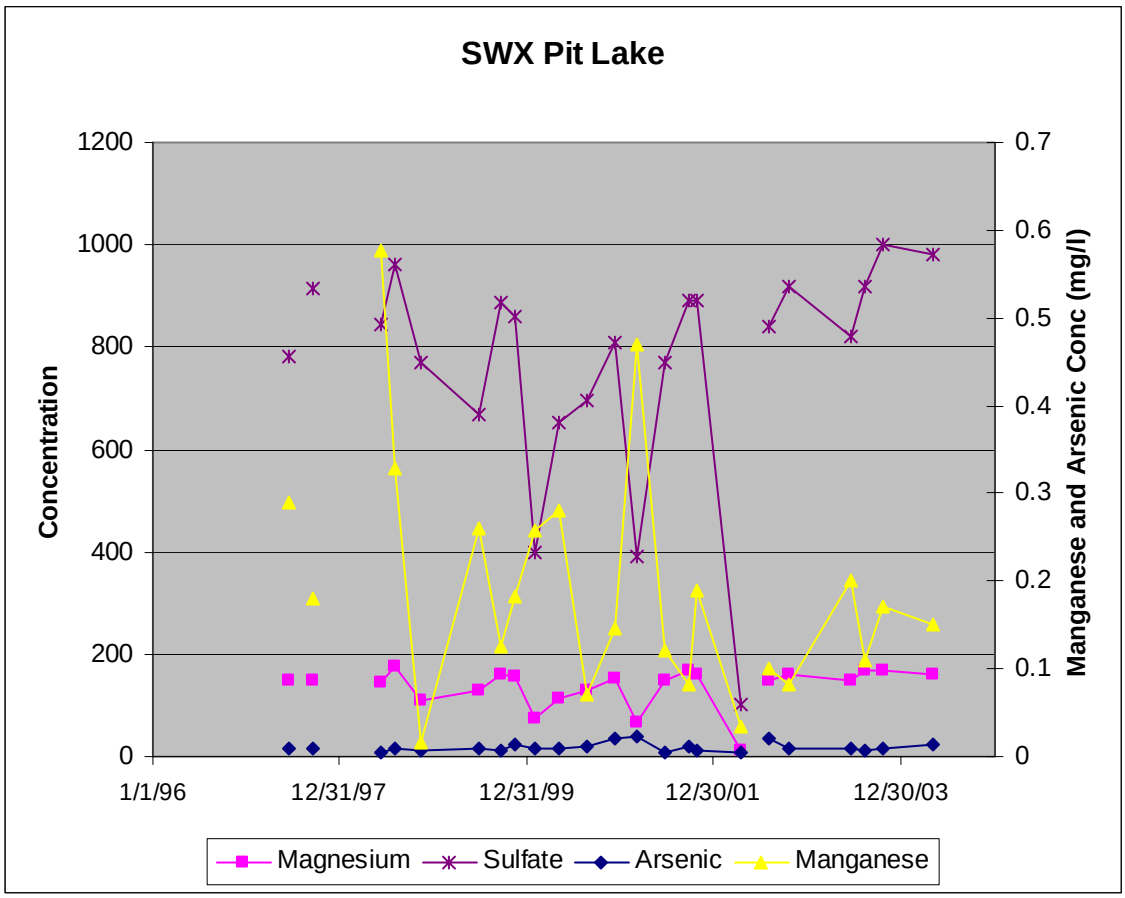

Figure 14: Graph of various contaminant concentrations at the SWX Pit Lake.

The Fact Sheet also notes that the pit lakes are flow through systems wherein groundwater seeps in from upgradient and flows through to downgradient aquifers. Exponent (1998) studied the groundwater flow including chemistry and water balance in the area of the pits and waste rock dumps. It found that, based on both simulated water balance and chemical evidence, about 20 to 40 gpm flows through the pit lakes. The report also indicates that it is likely that discharge from the lakes likely flows through the Unit D dolomitic siltstone, which intersects the pits, to the NFHR.

> The primary groundwater flow path that is likely to provide a hydraulic connection between the pit lakes, Sammy Creek, and the NFHR is along the north-northwesterly groundwater flow gradient in the Unit D dolomitic siltstone occupied by the SWX and 303 pit lakes. Discharge of groundwater migrating along this pathway appears to be the source of a system of springs and seeps along the banks of the NFHR north of the pit lakes. It is highly probable that a substantial component of the groundwater migrating in this bedrock flow system ultimately discharges into the NFHR. (Exponent, 1998, page 6-2).

The "system of springs and seeps" is important because spring 1, located northeast of the CX pit and north of the Water Canyon waste dumps on a terrace just above the NFHR had very high concentrations during a July 27 1997 visit (Exponent 1998, Table 3-1); the water in that spring had sulfate concentrations of 1400 mg/l and clearly showed an impact of mining. However, as explained above, most of the discharge to the spring is probably from the waste rock which is closer because the flow rate that would be required from the pit lakes to reach the spring is an order of magnitude higher than predicted by Exponent.

It appears more likely that the majority of seepage from the pit lakes, ranging from 20 to 40 gpm, reaches Sammy Creek before it reaches the NFHR[TJM5]. This would be reflected by the increase and flow and load observed during the period that monitoring occurred at S-101.5 and S-102. It also reflects the fact that Sammy Creek is just a few hundred feet west and at least 50 feet below the CX pit. There is not an intervening fault that would prevent seepage from reaching Sammy Creek; Exponent (1998, Figure 4-1) shows that both pits with lakes likely breached Schoonover Fault if it had been a hydraulic barrier.

The pits themselves are stable. Based on a site visit in August 2002, Self (2002) reported that the embankments were stable and that even if a rare event such as a landslide caused the pits to overtop their embankments, they would not fail. This author, during his visit in August 2005, observed the SWX pit and concurs that the embankment will not fail. Self (2002, first page) suggests that the "reservoirs appear to be naturally controlled by a perched water table" based on "a recorded differential time (delta T) showing influence upon 303 Pit from SWX Pit". There is clearly a connection between the pit lakes but no evidence that the groundwater is perched.

The mine commenced a pilot groundwater diversion program to remove water from the shallow bedrock aquifer near the pits to control the water level (AngloGold, 2000). The mine diverted groundwater from well MW-2 (Figure 1) to an infiltration trench in the alluvium of Sammy Creek just below the SWX pit. Water discharged from MW-2 under artesian pressure. The total amount of water diverted was 24.2 million gallons (AngloGold, 2005). During the years 2001 through 2004, the well diverted annual average flow rates of 16.9, 15.4, 9.7 and 3.4 gpm, respectively. It is not indicated whether the decreasing flow rates were due to decreasing pressure head or control of the well. It is also not known what effect this diversion may have on the seepage from the pit lakes. Because the diversions were intended to prevent the pit lakes from overflowing and the seepage calculations assume the pit lakes will not reach the level at which they would overflow, it is likely that the seepage from the pit lakes will not be affected by the diversions at MW-2.

Figure 15 shows the water quality from that well; the period spans the time prior to use. However, only sulfate has increased since the diversions began. This could be expected because of the high sulfate concentrations in the pit lakes. However, if MW-2 diverts groundwater before it reaches the pit, because the MW-2 sulfate concentrations are less than 25% of those in the pit lakes it indicates the pit lake sulfate results from oxidation in the pit walls. The arsenic concentrations at MW-2 exceed the MCL consistently with some values being more than 0.17 mg/l. This exceeds the values in the pit lakes. Either MW-2 does not divert groundwater that would actually reach the pits, surface inflows to the pits dilute the arsenic concentrations, or the arsenic attenuates in the pit walls. Because the pumping apparently does control the water level and because the pit wall rock is not substantially different than the bedrock near MW-2 (dolomitic siltstone), it seems likely that dilution controls the arsenic concentration in the pit lakes.

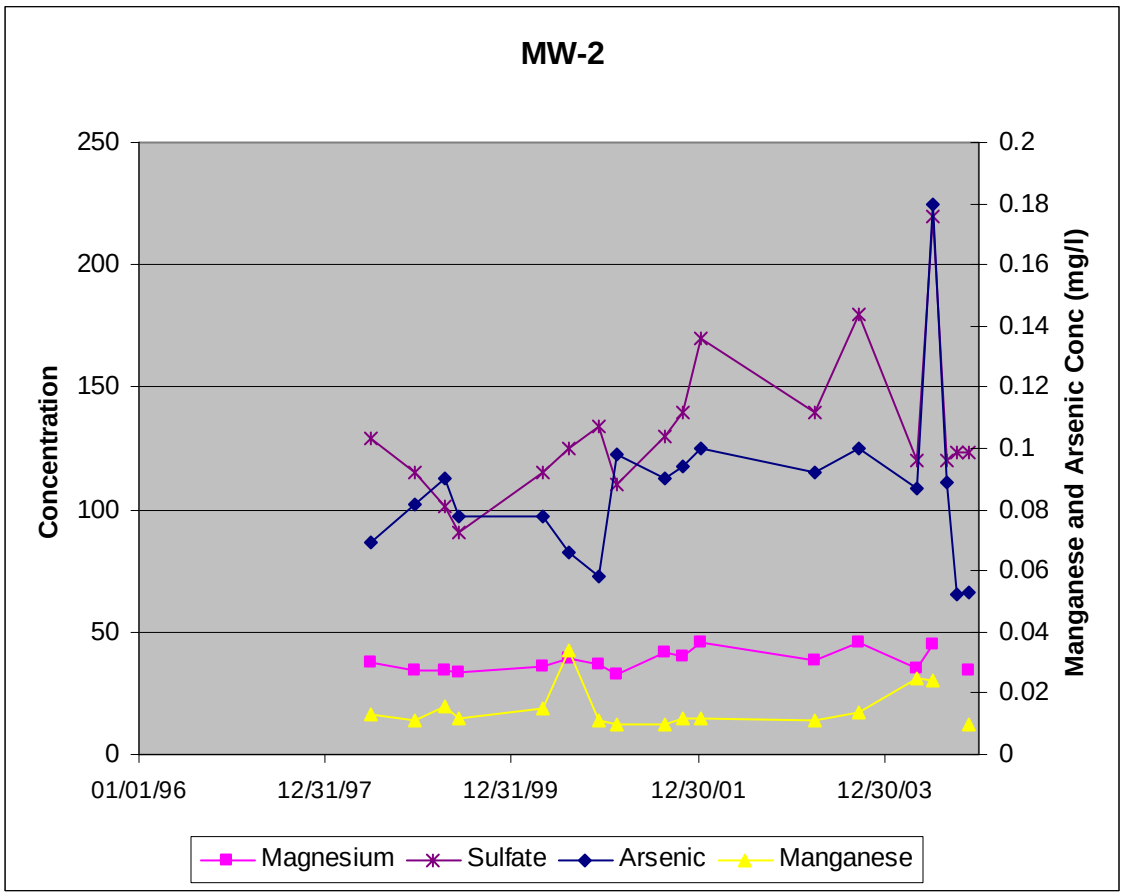

Figure 15: Graph of concentrations of various contaminants at diversion well MW-2. Note the dual vertical axes.

The diversion at MW-2 may be helping to control the pit lake levels. But there are two aspects of the original application which were incorrect that could affect the ongoing contaminant loading in the watershed. Goodrich (2000) summarized AngloGold's reasons for the infiltration basin being permitted as a "minor modification" which is allowable if it will not increase the potential for the facility to degrade waters of the state. First, Goodrich (2000) indicates the water will be diverted to a "natural alluvial aquifer unimpacted by site mining activity". This is not correct because the alluvium downstream from the Sammy Creek waste

rock dumps is likely affected by seepage of waste rock contaminated water into the alluvium. Second, Goodrich refers to the diversion of "natural ground water flow unimpacted by site mining activity". The groundwater is "umimpacted" only if waste rock located above the pits does not affect the groundwater. More importantly, the application (AngloGold, 2000, Table 1) shows arsenic concentrations in MW-2 ranging from 1.3 to 3.0 times the Nevada standard. The diversion is to shallow groundwater in the alluvium adjacent to Sammy Creek. Because Sammy Creek is occasionally a gaining stream and occasionally a losing stream (see the mass balance analysis for Sammy Creek above), there is a groundwater flux between the alluvium and the stream. Additionally, water in the Sammy Creek alluvium which does not enter Sammy Creek would enter the NFHR alluvium and eventually the river. This discharge therefore is an addition of arsenic to the groundwater near Sammy Creek.

There were other pits at the mine that were previously backfilled to protect water quality Lewis (1997). In 1997, the USSC and MSSC pit contained from 10-20 and from 30-40 feet of water, respectively. These pits were backfilled because of the "flow of surface runoff into the … pits" (Lewis, 1997). These pits had not required dewatering, therefore the assumption was that the pit lakes were due to surface inflow. Lewis (1997) indicated that surface diversions had not been sufficient to prevent the lakes from forming. The pit backfill will be covered to prevent surface run-on from seeping into the backfill. Lewis (1997, page 2) description is worth repeating here:

> The cover system for the partially backfilled MSSC and USSC pits will entail installation and compaction of fine-grained material over the pit backfill surfaces. The compacted material will be sloped to the pit outlet at two to four percent to minimize infiltration and promote the runoff of precipitation … Compaction of the cover system will be achieved by truck traffic over the backfill surface. Uncompacted growth medium will be applied over the compacted layer and then be seeded with the USFS approved reclamation seed mix.

Lewis concludes the section on pit backfill by stating that "[m]aximizing surface runoff through compacting and sloping the pit backfill covers to the pit outlet **will address the long-term water quality issues** associated with open water in the pits and will provide the most effective reclamation option" (Lewis, 1997, page 2, emphasis added).

Groundwater Quality and Quantity

The tributaries and mainstem have been shown to have connections with the nearby alluvial groundwater. For this reason, the quality of that groundwater may affect the current and future surface water quality conditions.

The mine began reporting groundwater quality data in 1997 for monitoring wells MW-2, BSMW-1S, -1D, -2S and -2D (Figure 1). BSMW-1S and -1D lie near the NFHR just below the confluence with Sammy Creek. BSMW-2S and -2D lie in the NFHR floodplain between Dry Canyon and Water Canyon. The S and D indicate shallow or deep and alluvium or bedrock well completions. MW-2 was constructed in 1987; in 2000 the mine began to pump from it as

discussed above in an attempt to divert groundwater from the pits. As noted, sulfate concentrations have increased in MW-2 (Figures 15 and 16).

Sulfate concentrations have also increased during 2003 and 2004 at BSMW-1S (Figure 16). They have not at either of the pit lakes. This could reflect travel time for seepage from the pit lakes reaching the floodplain of the NFHR. This would reflect conclusions by Exponent (1998). It is also possible that higher sulfate loads from the waste rock in Sammy Creek and Dry Canyon have reached the alluvium in the NFHR. The concentrations do not show a seasonal fluctuation, therefore they may not be due to seasonal flooding. They do reflect the concentrations observed at S-140 before it was discontinued. Sulfate concentrations at BSMW-2S and -2D, which lie further downstream, are both increasing albeit from a lower initial value (Figure 17). At BSMW-2S, the sulfate concentrations are all below 120 mg/l, but the four observations during 2003-4 exceed all but one of the observations in 2001 and earlier. A similar statement holds for BSMW-2D, although the concentrations are all less than 25 mg/l. Lower sulfate concentrations in the deeper levels and in bedrock reflect the slow vertical movement through the floodplain aquifer. The slow but steady increases in the sulfate concentrations in the groundwater reflect that the state of the aquifers is slowly changing due to the groundwater/surface water interchange that has been suggested above in the mass balance analysis.

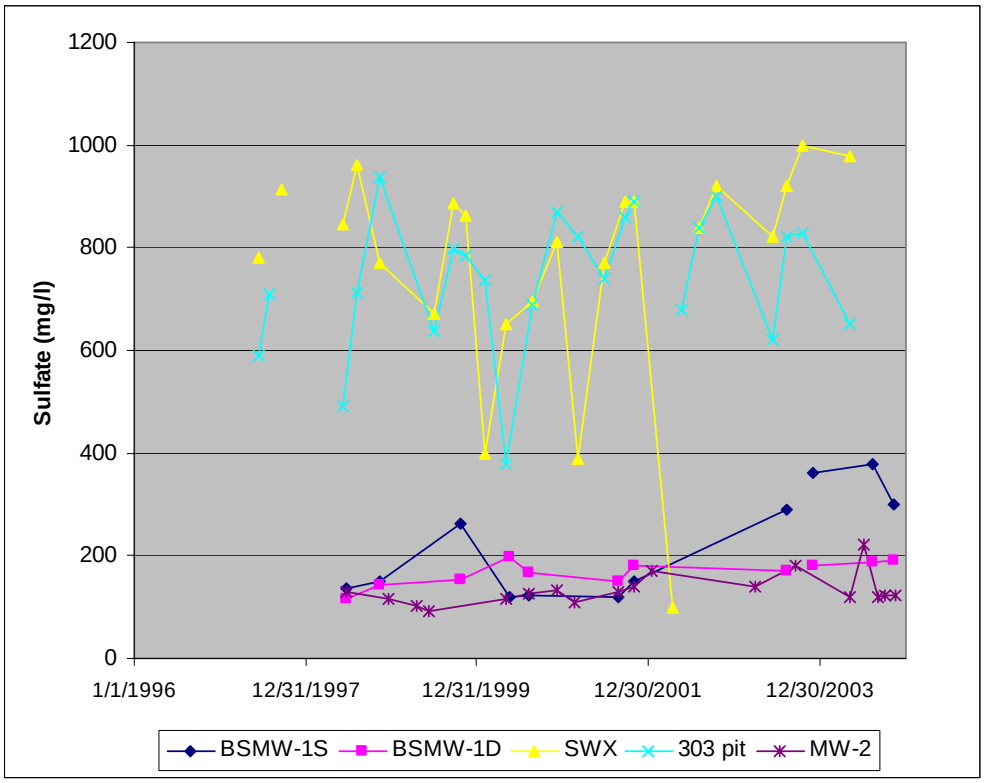

Figure 16: Graph of sulfate concentration with time at the various monitoring wells and the pit lakes.

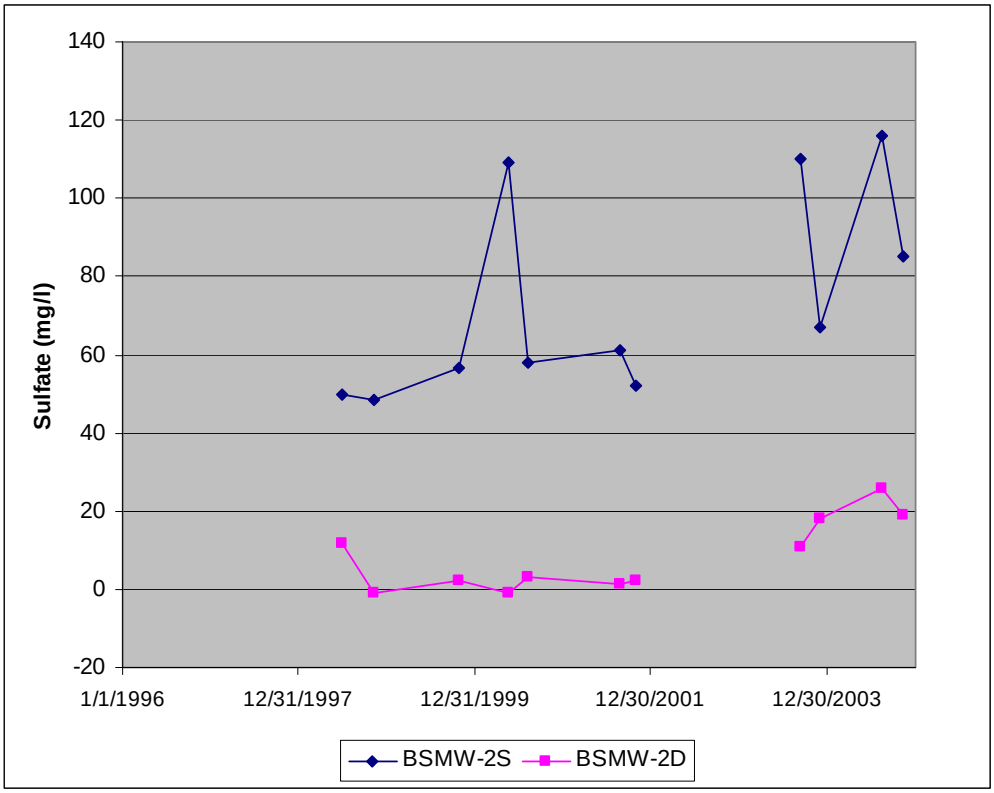

Figure 17: Graph of sulfate concentration with time at two NFHR floodplain wells.

There is an upward gradient at BSMW-1 with the water levels in the BSMW-1D being about 10 feet higher than those in BSMW-1S[1]. At BSMW-2, the depth in the shallow well is just about 6 feet below the surface and about 2 to 3 feet higher than in the deeper well. There is therefore a slight downward gradient at this point. The upward gradient at BSMW-1 is likely due to the discharge of deep groundwater into the alluvium at this point; it causes a slight artesian pressure. It suggests that groundwater quality upstream in the bedrock and changes therein may eventually affect the groundwater quality in the bedrock beneath the river and, due to the apparent upwelling, the alluvium. The presence of seeps and springs and the wet conditions in the floodplain are surface indicators of the artesian pressure that occurs here. The lack of vertical gradient at BSMW-2 indicates there is much less groundwater flow to the floodplain at this point. It is possible the springs on the terrace, documented by Exponent (1998) and discussed above, provide the discharge point for bedrock aquifers in this portion of the river. Explained differently, the river eroded the channel into the bedrock. At this point the floodplain is below the bedrock layer which receives substantial recharge from snowmelt. This would confirm the modeling results of Exponent (1998) which suggested that shallow groundwater and interflow intercepted most of the infiltrating precipitation and prevented it from becoming deep regional groundwater.

[1] Note that the annual reports used to enter the water quality data, including depth to water, appear to incorrectly list the depth to water in these two wells. Why do you say that – maybe explain a little better. The conclusions discussed here are from Figure 6 in AngloGold 2005.

The water quality at BSMW-2D differs substantially from the other wells; it also does not resemble the surface waters. As noted, sulfate concentrations are very low, but its differences are most notable in comparison with BSMW-2S. BSMW-2D has very high manganese concentrations, but these drop to close to zero for a short period in 2002 before returning to their previous high values (Figure 18, note the different scales). This coincides with a period when the pH exceeds 11.0. Arsenic concentrations also have increased about 20% providing, along with sulfate values, the only evidence of mixing with other groundwater.

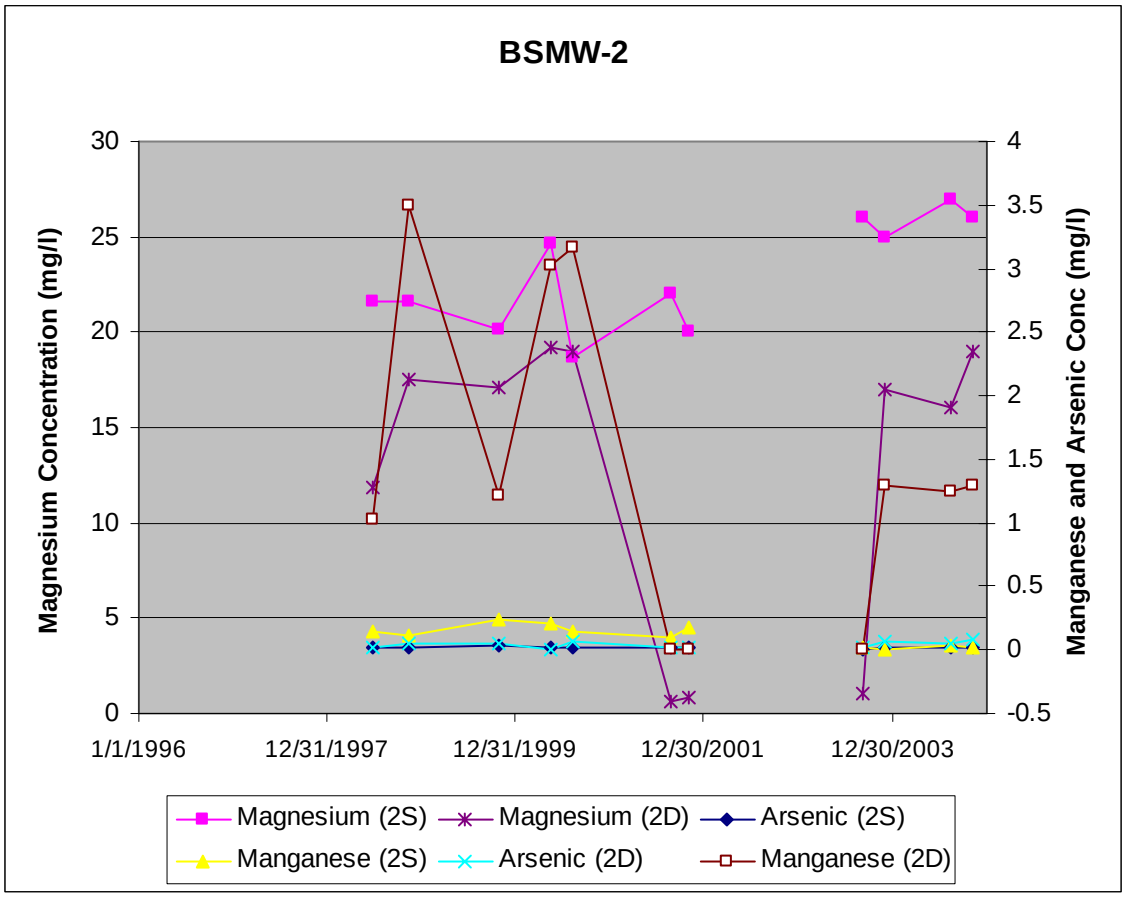

Figure 18: Graph of various contaminant concentrations at monitoring well BSMW-2. 2S mean the shallow well; 2D means the deep well.

The increasing concentrations in groundwater monitoring wells suggests that the seepage reaching the river will cause the concentrations in the river to increase. The amount of increase depends on the total load added which due to the flux to the river causing a significant flow increase between S-100 and S-140 may also be large.

Discharge to the River

The three sampling points on the tributaries are at or just above the point where the streams enter NFHR (Pictures 8 through 10). They clearly convey a discharge of waste rock seepage to the NFHR. The flow rate ranged from 247 gpm on Water Canyon to 463 gpm on Dry Canyon. As noted by IMC (1996), hydrologists expected the waste rock dumps to have seepage and increase the flows in the tributaries. As observed on Sammy Creek, the flows from above to

below the waste rock dump increases substantially; during dry periods, the waste rock dump contributes the entire flow.

As discussed above, the current purpose of MW-2 is to divert groundwater from the pit lakes. It has pumped over 2 million gallons since 2000 and discharged it to the alluvium near Sammy Creek where it seeps into Sammy Creek. This is a clear discharge to surface waters by infiltrating it into the bank next to the stream. In summary, the tributaries are a conduit for the pollution from the waste rock dumps to reach the NFHR.

Conclusion

Analysis of TDS and selenium data clearly show that there is discharge of pollutants from the Big Springs Mine to the NFHR and its tributaries and that the discharge is degrading the NFHR and tributaries. Sulfate concentrations at the monitoring points below the mine closely relate to TDS concentrations and because there were more sulfate observations and because sulfate more directly relates to mine activity due to it being a product of oxidation, they were used for time series and trend analysis.

Time series and trend analysis of sulfate concentrations indicates that the degradation began in 1992 with a substantial increase in sulfate concentrations over a few month period. The concentrations continued to trend upward until about 2000 when they leveled out in some locations and may have slightly dropped on the NFHR. On Water Canyon and Dry Canyon, the highest concentrations have occurred since 2003, so it is not possible to argue that the reclamation is making a substantial contribution to improving the water quality. The plans for reclamation suggested that the seepage would be decreased but not eliminated; the current completed reclamation is insufficient to the task of preventing seepage. The decrease observed on Sammy Creek may be due to dilution caused by the discharge of water from MW-2 which started in 2000[TJM6].

Waste rock dumps were built across the channels in the three tributaries. They clearly add substantial sulfate, and other constituent, loads to the NFHR. Sulfate loads through the mine site on the NFHR increase by an average 195 times; when considering the median increase, it is almost 700 times the inflow to the reach. This is because the concentration remains high at high flows because precipitation leaches sulfate from the waste rock. The discharge from the waste rock collects in a channel, or point source. The channel may have been a pre-existing perennial stream on Sammy Creek and Water Canyon, although Dry Canyon was likely ephemeral. The stream channels therefore serve as conduits for the waste rock seepage into the NFHR. There is a point source discharge from the waste rock into the tributaries and then into the NFHR.

These discharges clearly degrade water quality in the NFHR and tributaries for total dissolved solids and selenium. Nineteen of the 31 observations at S-140 exceed 500 mg/l and all of them are more than one-third higher than concurrent observations at S-95 or S-100. Only a few concentrations at S-150 exceed 500 mg/l, but the average there is 328 mg/l while the average at S-95 and S-100 is only 43 and 60 mg/l, respectively. The mine causes multiple violations of standards for TDS on the mainstem NFHR. On the tributaries which drain waste rock from the mines, it is also obvious that the mine causes significant increases in the concentrations and

causes the streams to violate water quality standards. Above the waste rock dump on Sammy Creek at S-101, all 42 observations were less than 200 mg/l. At S-110 below the waste rock at the confluence with the NFHR, 72 of 94 observations exceed 500 mg/l. All of the observations taken on the same day have concentrations at S-110 with an increase of greater than one-third higher than the upstream site. At the outlet from Dry Canyon (S-115) and Water Canyon (S-120), 76 of 78 and 86 of 88 observations exceed 500 mg/l.

Since August 1993, at S-95 and S-100, 1 of 32 and 37 observations, respectively, exceeded the aquatic standard for selenium. At the downstream stations, 31 of 67 observations at S-140 exceeded the standard. At S-150, 6 of 48 observations exceeded the standard. At the outlet from Sammy Creek, Dry Canyon, and Water Canyon, 48 of 54, 30 of 33 and 41 of 44 observations exceeded the standard. In percent terms, on the tributaries, 91% of all observations exceeded the 96-hour aquatic life standard. At S-140, just below the mine, 46% of all observations exceeded the 96-hour aquatic life standard.

Research completed in 1998 concluded that seepage from the pit lakes would reach the NFHR; the seepage rates would be about 20 to 40 gpm. Based on loading and synoptic studies, the flow increase on the river due to groundwater inflow is at least 200 gpm, therefore the pit lake contribution is small. However, if as indicated above, the seepage is primarily to Sammy Creek, 40 gpm represents at least 45 percent of the median flow in Sammy Creek. Also, in 2000 the mine began diverting groundwater from the pit lakes into Sammy Creek via an infiltration trench, but this should not decrease seepage from the pits to Sammy Creek[TJM7].

The pit lake water quality is not good because sulfate concentrations exceed 500 are close to 8000 mg/l. None of the groundwater monitoring wells reflect this high concentration, but three of the wells, MW-2, BSMW-1S and BSMW-2S all have experienced some substantial increases during the past three years. It is likely that seepage from the pit lakes or of groundwater affected by waste rock seepage would require many years to reach the river. Based on the slowly increasing concentration in alluvial wells, affected groundwater appears to be reaching the alluvium.

As long the flow downstream of the waste rock dumps has elevated sulfate concentrations, there is discharge of a pollutant to the river occurring. The drainage built under the waste rock serves as a conduit to move the pollutant to the stream beneath and downstream of the dumps.

There is no evidence of water quality improvement at this site. The fact that the highest sulfate concentrations on record occurred during the past two years and that concentrations in the groundwater are increasing suggests that it will be a very long time before the existing conditions will evolve so that natural conditions will cause remediation at the site. It is apparent that either much improved reclamation and/or active remediation efforts will be required to protect or restore water quality in the NFHR and tributaries. The following section outlines various activities which may help remediate the river or prevent future degradation.

Remediation

Remediation means the clean-up of existing conditions. For surface water, stopping the sources of pollution will usually allow the streams to naturally recover. Groundwater may require more time once the source of contamination has been determined. This section discusses the possible methods to be used to remediate the site.

Existing reclamation of the waste rock could be improved by adding a true water balance barrier over the top of the dumps to prevent seepage. Even the closure plan calculated that seepage would continue into the waste rock. Analysis presented herein proved that the current caps are not working as designed. Improved caps would decrease the seepage, but it is not possible to cap all of the surface area of the waste rock dumps. The angle of repose slopes on all dumps and 3:1 slopes on Dry Canyon dump may not be possible to further reclaim without regarding. Gorman (2005) indicated that the mine has already completed more reclamation that required when the mine was permitted.

IMC (1996) indicated that that the dumps were constructed with a drain for flow from above to flow through the dumps with as little contact with the rock as possible. Based on the observed sulfate loading, this does not appear to be working. Goodrich (1998) discussed a ditch built around dumps in the Sammy Creek drainage, but, as discussed above in the section on sulfate load, it does not appear to be working at this time either. To the extent possible, the stream flows into the waste rock must be diverted to minimize a primary source of water for oxidation and seepage.

The remaining pit lakes could be backfilled to eliminate a source of some seepage and the discharge resulting from a need to lower pit lake levels. Filled to the pre-mining groundwater level, there is little evaporation from these high elevation sites, the lakes could overtop due to seasonal run-off. If backfilled properly with a water balance barrier, most of the run-off would not seep into the backfilled pit. This should reduce seepage and by eliminating exposed pit walls it should also decrease oxidation and improve the quality of the seepage and eventually the downgradient groundwater.

Once the pits are backfilled, the diversion wells, MW-2 and MW-2a, could be plugged and the discharge to the infiltration trench on the banks of Sammy Creek ceased. This would eliminate a discharge to surface waters; even though this discharge may seep into the channel at the discharge point, the increased flow further downgradient suggests that it does reach surface water.

It would also be possible to collect the seepage and treat it passively. Systems similar to those used downstream of the Rio Tinto Mine or at Leviathan may be successful. If such a solution is chosen, it must be recognized that treatment in perpetuity will likely be required.

If the methods described above do not work, the only real solution would be to move the waste rock dumps out of the drainages. The design of such a system would require care to be certain that the waste rock is not moved to another location where the leaching of oxidation products would continue to occur and reach the surface water from a different location.

The new permit proposes to remove the monitoring at S-101. It is upstream of the waste rock on Sammy Creek and provides a baseline for flow on one of the tributaries. Concentrations at this site provide a baseline for flow on Sammy Creek; as long as concentrations downstream from the dump exceed the concentrations above the dump there is a need to maintain this station. It would be advantageous to the remediation effort to add a station upstream from the waste rock on Water Canyon[TJM8] to determine the exact load caused by dump. Alternatively, several very detailed synoptic surveys conducted in the spring during runoff and during the summer and fall could provide the data needed to better design the needed remediation. The proposed new monitoring sites will help to identify better the sources of sulfate loading.

References

AngloGold (Jerritt Canyon) Corp., 2000. Surface Mine Water Level Management Pilot Program for SWX ad 303 Surface Mines, Big Springs Project, Elko County, Nevada, (Minor Modification to Water Pollution Control Permit #NEV87001). September 15, 2000. Elko NV.

AngloGold (Nevada) Corp, 2005a. Big Spring Project, Sammy Creek Drainage: Diversion Well Performance and Water Quality Observations, Water Pollution Control Permit NEV87001. September 3, 2004. Elko NV.

AngloGold (Nevada) Corp, 2005a. Big Spring Project, Sammy Creek Drainage, Hydrogeological Observations and Diversion Well Performance, Wter Pollution Control Permit NEV87001, Updated Report, March 2005. Elko NV.

Earman, S., and R.L. Hershey, 2004. Water quality impacts from waste rock at a Carlin-type gold mine, Elko County, Nevada. Environmental Geology (2004) 45:1043-1053.

Exponent, 1998. Big Springs Mine Hydrology Evaluation. Prepared for the U.S.Forest Service, Humboldt National Forest. Boulder, CO.

Goodrich, G., 1998. Letter to Mr. Scott Bell, District Ranger, Humboldt National Forest, RE: Big Springs Mine Closure. Independence Mining Co., Elko NV.

Goodrich, G., 2000. Letter to Mr. Kurt Kolbe, Re: Big Springs Project: Surface Mine Water Level Management Pilot Program for SWX and 303 Surface Mines. AngloGold, Elko NV.

Gorman, J., 2005. Letter to Mr. Kurt Kolbe, BMRR, RE: Big Springs Water Pollution Control Permit (87001) Renewal – Responses to Great Basin Mine Watch comments. April 29, 2005. Elko NV.

Independence Mining Company (IMC), 1996. Final Closure Plan for the Big Springs Project, Water Pollution Control Permit NEV 87001, October 17, 1996. Elko, NV.

Lewis, S., 1997. Letter to Mr. Leo Drozdoff, Chief, BMRR. July 31, 1997. Independence Mining Company, Elko NV.

Schafer and Associates, 1994a. A Final Report on Surface Water Chemistry at Big Springs Mine, Independence Mining Company, Elko County, Nevada. Submitted to Humboldt National Forest on Behalf of Independence Mining Co. Bozeman, MT.

Schafer and Associates, 1994b. Final: Big Springs Mine, Geochemical Characterization Report: Samy Creek, Dry Canyon, and Water Canyon Waste Rock Dumpts and North and South Sammy Pits. Prepared for Independence Mining Company. Bozeman, MT.

Schafer and Associates, 1996. Mine Site Closure Study for Independence Mining Company, Inc., Big Springs Project, Elko County, Nevada. Prepared for Independence Mining Company, Elko, NV. Schafer and Associates, Bozeman, MT.

Tuttle, P.L., D.K. Higgins, and J.S. Foott, 2003. Preliminary Assessment of Potential Impacts of Drainage Associated with the Big Springs Mine to Aquatic Organisms in the North Fork Humboldt River, Elko County, Nevada, 1998, Final Report EC 34.12.6. US Fish and Wildlife Service, Reno.

Appendix 1

Pictures from Site Visit to Big Springs Mine

Taken by Tom Myers

Appendix 2

Data Used for Analysis

	S-95 field EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
06/20/86											
07/14/86											
08/27/86											
09/30/86											
10/22/86											
11/16/86											
12/10/86											
03/25/87											
04/28/87											
05/14/87											
06/24/87											
07/22/87											
08/12/87											
09/16/87											
11/24/87											
01/28/88											
02/17/88											
03/24/88											
04/14/88											
05/02/88											
06/06/88											
07/31/88											
08/23/88											
09/14/88											
10/12/88											
11/09/88											
04/19/89											
05/25/89											
06/08/89											
07/17/89											
08/23/89											
09/13/89											
10/17/89											
11/15/89											
12/12/89											
01/23/90											
02/13/90											
03/21/90											
04/18/90											
05/11/90											
07/20/90											
08/22/90											
09/29/90											
10/29/90											
11/09/90											
12/04/90											
01/04/91											

02/11/91								
03/27/91								
04/30/91								
05/16/91								
06/12/91								
06/19/91								
07/25/91								
08/05/91								
09/13/91								
10/23/91								
11/19/91								
12/20/91								
01/17/92								
03/12/92	85	8	30		0.004	3.6		0.01
04/22/92	60	6	1214		0.006	2.4		0.01
05/22/92	85	5			0.014	3.4		0.01
06/03/92	71				0.01	4		0.01
07/07/92								
08/05/92								
09/25/92								
10/06/92								
11/06/92	90	14			0.008	4.4	0.02	0.01
12/15/92								
01/28/93	110	9			0.006	4.5	0.01	0.01
02/18/93	90	8	300		5	4.8	0.01	0.01
03/03/93	100	9	300		0.006	4.7	0.01	0.01
03/15/93	875	8	600		0.005	4.8	0.01	0.01
04/08/93	85	5	662		0.003	3.5	0.01	0.01
04/30/93	83	5	1194		0.015	3.5	0.04	0.01
05/11/93	75	5	1876		0.11	2.9	0.01	0.01
05/27/93	49	3	3947	0.13	0.015	1.4	0.01	0.01
06/10/93	65	3	1471	0.13	0.009	2.1	0.01	0.01
06/25/93	57	4	852	0.12	0.008	2	0.01	0.01
07/09/93	55	3		0.1	0.01	2.6	0.01	0.01
07/31/93	64	9	22	0.07	0.008	3.3	0.01	0.01
08/09/93								
08/27/93								
09/08/93								
09/28/93								
10/13/93								
10/22/93								
11/12/93								
11/24/93								
12/10/93								
01/12/94								
01/12/94								
01/27/94								
01/27/94								
02/08/94								
02/28/94								

02/28/94											
03/15/94											
03/16/94											
03/28/94	60	6.94	47.1	64	6.58	0.306	0.007	3.28	-0.005	-0.005	-0.005
04/07/94	80	7.44	45.1	68	6.54	0.429	0.006	3.42	-0.005	-0.005	-0.005
04/26/94	80	3.09	30	786	7.03	0.236	0.007	2.46	-0.005	-0.005	-0.005
05/27/94	45	0.84	-10	1179	7.46	0.144	0.013	1.96	-0.005	-0.005	-0.005
06/23/94	65	5.35	42	81	7.71	0.226	0.014	3.07	-0.005	-0.005	-0.005
07/28/94											
08/30/94											
09/28/94											
10/28/94											
11/23/94											
12/21/94											
02/01/95											
04/11/95	83	4.76	45.9	824.4	7.14	0.32	0.008	3.33	-0.005	-0.005	-0.005
04/29/95	60	4.21	51.1	1045.7	6.8	0.327	0.007	3.31	-0.005	0.1	0.01
05/30/95	40	1.58	33	3823.3	6.98	0.417	0.008	1.69	0.011	-0.005	0.01
06/29/95	62	2.6	18.1	1190.2	6.89	-0.2	0.01	1.47	-0.005	-0.005	-0.005
07/26/95	80	3.41	49	4.9	6.93	0.221	0.011	2.95	-0.005	-0.005	-0.005
08/01/95											
09/01/95											
10/01/95											
11/01/95											
12/04/95	119	9.59	49	29.2	7.73	-0.075	0.008	3.69	-0.005	-0.002	-0.002
01/16/96	54.9	7.1	58		7.31	0.126	0.006	3.48	0.001	-0.002	-0.002
04/01/96											
05/07/96	64.6	-5	54		7.24	0.21	0.006	2.3	-0.01	-0.002	0.01
06/05/96	43.6	-5	32		7.67	0.35	0.012	2.1	0.01	-0.002	0.01
07/02/96	48.1	-5	35		7.77	0.22	0.012	2.1	0.01	-0.002	-0.01
07/02/96		-5	35		7.77	0.22	0.012	2.1	0.01	-0.002	-0.01
07/30/96											
08/29/96											
09/26/96											
11/04/96											
12/04/96											
04/14/97											
04/30/97	68	3	40		6.46	0.15	0.01	2.4	0.002	-0.001	0.01
05/14/97	43	1.5	28	4985							
06/16/97	50	2.4	34	2171							
06/27/97											
07/29/97	70	3.9	48	2	7.7	-0.05	0.009	3.1	0.003	-0.001	-0.01
08/26/97				0							
09/23/97				0							
01/26/98											
03/26/98											
05/25/98	52	5.8	33.9	3533	6.9	0.07	0.009	2	0.002	-0.001	0.01
06/28/98	45	2.3	53	1241							
07/27/98	66	3.6	41	53	7.32	0.02	0.009	3.1	0.004	-0.001	-0.01
08/21/98				0							

09/15/98	92.3	4.1	56	20							
10/21/98	92.4	15.4	82	25	7.59	0.02	0.009	3.8	0.027	-0.001	-0.01
10/22/98											
11/24/98	134.5	7.8	61	50							
12/21/98											
01/03/99											
01/29/99											
02/03/99											
02/26/99											
03/12/99											
03/24/99											
04/16/99											
04/28/99											
05/10/99	77.3	4.2	66.6	1368	7.63	0.14	0.006	3.5	0.008	-0.001	-0.01
05/25/99	52	5.8	33.9		6.9	0.07	0.009	2	0.002	-0.001	-0.01
05/26/99											
06/06/99											
06/12/99											
06/22/99	382	3	56	45							
07/22/99	72.4	4.5	26.8	15	7.39	0.05	0.009	3.9	0.017	-0.001	-0.01
08/18/99				0							
09/22/99				0							
10/28/99				0							
11/09/99	83	8.1	41	5	7.03	0.05	0.006	3.8	0.017	-0.001	0.02
12/01/99	78.1	9.6	42	15							
01/01/00											
02/04/00	78	9.3	31		7.35	0.06	0.005	3.3	0.003	-0.001	0.02
03/10/00	76.9	7.9	52								
04/21/00	61.8	3.8	39	356							
05/09/00	50.6	3.2	34.3	478	7.31	0.19	0.007	2.2	0.002	0.001	-0.01
06/21/00											
06/28/00	58.7	3.6	27	17							
07/26/00				0							
08/17/00				0							
09/14/00				0							
10/04/00				0							
11/27/00	78.6	8.4	50.6	50	7.34	0.03	0.005	3.4	0.004	-0.001	-0.01
12/07/00	64.5	10.5	31.2	30							
01/01/01											
02/16/01	77.1	8.7	50	20	7.08	-0.05	0.003	2.8	0.002	-0.001	-0.005
03/07/01	81	7.9	95	50							
04/21/01											
04/26/01											
04/30/01	58.7	3.1	22	678							
05/11/01	55	2.7	33	200							
05/24/01											
05/31/01											
06/25/01	66.6	3.7	96	20	7.07	-0.05	0.003	3	0.004	-0.001	0.007
07/30/01				0							
08/21/01				0							

09/28/01				0							
10/22/01				0							
11/01/01											
01/01/02											
02/01/02											
03/01/02											
04/02/02											
04/12/02											
04/19/02											
05/04/02	67	3.7	68		7.28	0.22	0	3	0.003	-0.001	-0.005
05/14/02											
05/29/02											
06/04/02											
06/14/02											
06/21/02	15.5	2.9	22								
07/10/02											
08/01/02				0							
08/07/02											
09/11/02				0							
10/18/02				0							
10/30/02				0							
11/07/02				0							
12/02/02				0							
01/01/03											
02/06/03											
03/05/03											
03/30/03											
04/13/03											
04/23/03											
05/03/03	70	3.6	56		7.93	0.24	0.004	3.1	0.002	-0.001	-0.015
06/15/03		2.3	29								
07/14/03											
07/25/03				0							
08/29/03											
09/16/03				0							
10/19/03				0							
11/30/03											
12/05/03											
12/23/03											
01/01/04											
02/01/04											
03/07/04											
03/21/04											
04/09/04											
05/07/04											
05/27/04											
06/02/04											
06/09/04											
06/28/04	**42**	2	35		7.66	0.06	0.008	2	0.009	-0.01	-0.01
07/01/04	42	2	10								

08/01/04
09/01/04

	S-100										
	EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
06/20/86											
07/14/86											
08/27/86							0.008				
09/30/86											
10/22/86							0.006				
11/16/86							0.005				
12/10/86											
03/25/87											
04/28/87	53	4					0.012	1.9			
05/14/87	47	3					0.012	1.6			
06/24/87	75	5					0.008	2.7			
07/22/87	75	4					0.006	3			
08/12/87											
09/16/87											
11/24/87		11					0.004	3.2			
01/28/88											
02/17/88											
03/24/88											
04/14/88	85	7					0.009	2.6			
05/02/88	74	5					0.008	2			
06/06/88	53	2					0.009	1.7			
07/31/88	130	6					0.012	5.1			
08/23/88											
09/14/88											
10/12/88	141	10					0.007	5.2			
11/09/88	145	20					0.037	5.1			
04/19/89	80	5					0.017	2			
05/25/89	59	1					0.011	1.4			
06/08/89	45	3					0.002	1.3			
07/17/89	95	3					0.003	3.2			
08/23/89	250	18					0.003	88			
09/13/89											
10/17/89	290	18					0.006	10.3			
11/15/89	170	18					0.016	6.8			
12/12/89											
01/23/90											
02/13/90											
03/21/90											
04/18/90	74	0					0.009	1.5			
05/11/90	60	0					0.01	1.9			
07/20/90	110	18		122			0.014	5.1			
08/22/90	455	136					0.021	23			
09/29/90	700	26					0.007	26			
10/29/90	410	19					0.006	15.4			

11/09/90	350	17	0.013	13.7
12/04/90	395	18	0.005	14.3
01/04/91	270	17	0.009	10.8
02/11/91	295	24	0.009	11.4
03/27/91		11	0.005	4.1
04/30/91	130	10	0.013	3
05/16/91	75	1	0.015	2
06/12/91	48	0.5	0.01	2
06/19/91				
07/25/91	304	25	0.005	10.6
08/05/91	477	34	0.007	16.6
09/13/91	650	47	0.013	26
10/23/91	350	28	0.008	15.4
11/19/91	165	13	0.001	6.4
12/20/91	300	65	0.006	15
01/17/92	150	17	0.008	7
03/12/92	140	15	0.006	6.1
04/22/92				
05/22/92				
06/03/92				
07/07/92				
08/05/92				
09/25/92				
10/06/92				
11/06/92				
12/15/92				
01/28/93				
02/18/93				
03/03/93				
03/15/93				
04/08/93				
04/30/93				
05/11/93				
05/27/93				
06/10/93				
06/25/93				
07/09/93				
07/31/93				
08/09/93				
08/27/93				
09/08/93				
09/28/93				
10/13/93				
10/22/93				
11/12/93				
11/24/93				
12/10/93				
01/12/94				
01/12/94				
01/27/94				

01/27/94	100	14.9	60	20	7.25	0.278	0.009	4.79	-0.005	-0.005	-0.005
02/08/94											
02/28/94											
02/28/94											
03/15/94	110	16.6	78	157	6.64	0.722	0.011	4.69	0.013	-0.005	0.026
03/16/94											
03/28/94	90	17.4	69	119	6.73	0.316	0.012	4.59	0.012	-0.005	0.009
04/07/94	90	13.3	58	148	6.76	0.389	0.007	4.22	-0.005	-0.005	0.006
04/26/94	80	9.47	44	671	7.23	0.277	0.01	3.12	0.007	-0.005	-0.005
05/27/94	50	4.92	49	1563	7.44	0.259	0.016	2.12	-0.005	-0.005	0.011
06/23/94		14	63	47	7.59	0.143	0.019	4.6	0.007	-0.005	0.009
07/28/94											
08/30/94											
09/28/94											
10/28/94											
11/23/94											
12/21/94											
02/01/95											
04/11/95											
04/29/95	91	7.35	43	671	7.2	0.266	0.009	3.44	-0.005	-0.005	-0.005
05/30/95				4248.8	6.3						
06/29/95	73			1649.8	7.56						
07/26/95	90	11.6	68	73.2	7.24	0.215	0.037	4.05	0.007	-0.005	-0.005
08/01/95	130			0.5	7.44						
09/01/95	120			10	6.88						
10/01/95	75	18	82.1	8.5	6.98	-0.075	0.006	5.14	0.006	0.003	0.008
11/01/95											
12/04/95				46.7	7.57						
01/16/96	89.3	15.1	69		7.54	0.283	0.006	4.4	0.006	-0.002	-0.002
04/01/96											
05/07/96											
06/05/96	47.8	5	48		7.55	0.35	0.016	1.8	0.02	-0.002	0.01
07/02/96											
07/02/96											
07/30/96		20	80		7.81	-0.05	0.009	5.81	0.015	-0.002	-0.01
08/29/96											
09/26/96											
11/04/96		22	102		7.5	-0.05	0.008	6.1	0.016	-0.001	22
12/04/96											
04/14/97											
04/30/97	95	6.5	50								
05/14/97	62	3.9	30	5724							
06/16/97	68	5.1	39	1933							
06/27/97	64	5.6	31	1933	7.43	0.13	0.008	2.6	0.002	-0.001	0.05
07/29/97	100	17	68	24	7.8	-0.05	0.009	5.2	0.011	-0.001	-0.01
08/26/97				0							
09/23/97	182	36.7	105	15							
01/26/98											
03/26/98											
05/25/98	107	12.3	39	4055	6.82	0.06	0.008	2.6	0.004	-0.001	-0.01

06/28/98	53	3.9	65	1117							
07/27/98	82	9.4	51	131							
08/21/98	131	12.1	75	3	7.57	0.04	0.008	3.5	0.025	-0.001	-0.01
09/15/98	163	24.1	98	20							
10/21/98	124	23.6	95	45	7.68	-0.01	0.006	5.4	0.017	-0.0005	-0.01
10/22/98	83	8					0.006	5			
11/24/98	212	14.1	63	50							
12/21/98											
01/03/99											
01/29/99											
02/03/99											
02/26/99											
03/12/99											
03/24/99											
04/16/99	93	7.7	57.8	50							
04/28/99											
05/10/99	82.4	7.3	52.6	1820	7.59	0.17	0.007	3.8	0.01	-0.001	-0.01
05/25/99	107	12.3	39		6.82	0.06	0.008	2.6	0.004	-0.001	-0.01
05/26/99											
06/06/99											
06/12/99											
06/22/99	42.9	6.5	56	1115							
07/22/99	97.4	12.7	42.8	20	7.5	0.03	0.01	4.9	0.01	-0.001	-0.01
08/18/99				0							
09/22/99	181	28	101	15							
10/28/99	151	19.5	75	45							
11/09/99	118	14	70	20	7.57	0.02	0.006	5.5	0.012	-0.001	0.01
12/01/99	114	15.4	61	25							
01/01/00											
02/04/00											
03/10/00											
04/21/00	77.5	8.8	56	362							
05/09/00	64.8	8	68.8	600	8.16	0.09	0.007	2.8	0.004	-0.001	-0.01
06/21/00	74.4	7.3	45	21							
06/28/00											
07/26/00	144.6	19.9	81	5							
08/17/00	161	26.5	93.2	5	7.39	0.23	0.017	6.9	0.058	-0.001	-0.01
09/14/00				0							
10/04/00		22.6		20							
11/27/00	112	15.8	74.2	60	7.54	0.04	0.012	5	0.02	-0.001	-0.01
12/07/00	87.2	17.4	47	30							
01/01/01											
02/16/01	82.1	13	46		6.95	-0.05	0.005	3.5	0.006	-0.001	-0.005
03/07/01	85	11	66								
04/21/01											
04/26/01											
04/30/01	69.6	7.3	38	796							
05/11/01											
05/24/01											
05/31/01	59	4.3	28	250							

06/25/01	87.2	10	33	25	7.67	-0.05	0.007	4	0.008	-0.001	0.007
07/30/01				0							
08/21/01				0							
09/28/01				0							
10/22/01				0							
11/01/01											
01/01/02											
02/01/02											
03/01/02											
04/02/02											
04/12/02											
04/19/02	90	7.1	30	300							
05/04/02											
05/14/02											
05/29/02											
06/04/02	50	3.8	34	500	7.22	0.1	0.008	1.8	0.005	-0.001	-0.01
06/14/02											
06/21/02											
07/10/02		5.7	44								
08/01/02	125	19	55	40	7.54	-0.05	0.007	5.7	0.014	-0.001	-0.005
08/07/02											
09/11/02				0							
10/18/02	176	23	59								
10/30/02											
11/07/02											
12/02/02		14	69	50						0.001	
01/01/03											
02/06/03	86	11	60		7.37	-0.05	0.006	3	0.002	-0.001	-0.03
03/05/03											
03/30/03	50	8.6	40	450							
04/13/03											
04/23/03											
05/03/03	80	5.6	54		7.92	0.2	0.005	3.6	0.003	-0.001	-0.015
06/15/03		3.9	37								
07/14/03											
07/25/03											
08/29/03											
09/16/03	160	25	100	5	7.81	-0.05	0.005	7.7	0.043	-0.001	0.02
10/19/03	**140**	1.4	73	10	7.72	0.05	0.008	6	0.046	-0.005	-0.02
11/30/03											
12/05/03	115.6	13	56	50							
12/23/03											
01/01/04											
02/01/04											
03/07/04											
03/21/04											
04/09/04											
05/07/04											
05/27/04	48	3.2	49		7.8	0.5	0.011	2	0.03	-0.005	0.01
06/02/04											

06/09/04											
06/28/04											
07/01/04	100	8.6	54	50							
08/01/04		9.1	98	50	7.47	-0.05	0.006	5.1	0.009	-0.005	0.018
09/01/04	130	11	44	20							

S-101

	EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
05/27/94	55	6.41	50	609	7.18	0.292	0.046	2.67	-0.005	-0.005	0.007
06/23/94		8.16	50	75		0.137	0.055	3.89	-0.005	-0.005	-0.005
07/28/94											
08/30/94											
09/28/94											
10/28/94											
11/23/94											
12/21/94											
02/01/95											
04/11/95											
04/29/95											
05/30/95											
06/29/95	56	8.92	49.8	1107.6	7.31	0.676	0.104	3.92	-0.01	-0.01	-0.01
07/26/95	80	7.31	58.1	200.1	7	-0.2	0.043	3.88	-0.005	-0.005	-0.005
08/01/95	150	23.9	118	10	7.72	-0.2	0.052	10	-0.005	-0.005	-0.005
09/01/95											
10/01/95	122	24.3	122	2	6.81	-0.075	0.05	10.3	-0.004	0.003	0.004
11/01/95											
12/04/95											
01/16/96											
04/01/96											
05/07/96											
06/05/96	59.1	6	48		7.5	0.36	0.061	2.8	0.023	-0.002	-0.01
07/02/96	67.4	6	70		7.75	0.11	0.048	2.8	-0.01	-0.002	-0.01
07/02/96											
07/30/96		15	82		8.01	0.09	0.048	7.63	-0.01	-0.002	-0.01
08/29/96											
09/26/96											
11/04/96											
12/04/96											
04/14/97											
04/30/97											
05/14/97											
06/16/97	55	4.8	42	913	7.74	0.14	0.045	2.4	0.002	-0.001	0.03
06/27/97											
07/29/97	110	14	81	14	8	-0.05	0.059	7.4	-0.001	-0.001	-0.01
08/26/97	233	23.4	129	10							
09/23/97	213	22.6	182	5							
01/26/98											
03/26/98											
05/25/98											

06/28/98	52	5	49	1129	7.61	0.08	0.046	2.4	-0.001	-0.001	-0.01
07/27/98	100	8.7	51	176	7.58	0.01	0.051	5.1	-0.001	-0.001	-0.01
08/21/98				0							
09/15/98	199	20.8	102	50							
10/21/98	258	34.6	160	45	7.53	0.03	0.09	13.9	-0.001	0.075	-0.01
10/22/98											
11/24/98											
12/21/98											
01/03/99											
01/29/99											
02/03/99											
02/26/99											
03/12/99											
03/24/99											
04/16/99											
04/28/99											
05/10/99											
05/25/99	100	8.7	51		7.58	0.01	0.051	5.1	-0.001	-0.001	-0.01
05/26/99	285	74.9	178	100	7.49	0.2	0.057	13.8	0.001	0.03	-0.03
06/06/99	98.7	6.9	19.7	100							
06/12/99											
06/22/99											
07/22/99	162	20.9	71.8	75	7.84	0.06	0.062	8.2	0.005	0.004	-0.01
08/18/99	217	24.9	111	50							
09/22/99	282	38.3	163	50							
10/28/99	289	45.3	164	75							
11/09/99	263	37.5	156	75	8.03	0.03	0.088	14.9	0.002	0.005	0.01
12/01/99											
01/01/00											
02/04/00											
03/10/00											
04/21/00											
05/09/00	193	31.8	120	100	7.66	0.06	0.071	9.6	-0.001	0.011	-0.01
06/21/00											
06/28/00	115	11.6	55	35							
07/26/00	255	32.5	136	25							
08/17/00	268	37.1	160	50	7.92	0.25	0.118	14.1	0.003	0.006	-0.01
09/14/00	278	38.7	136	25							
10/04/00		34.4		20							
11/27/00											
12/07/00											
01/01/01											
02/16/01											
03/07/01											
04/21/01											
04/26/01											
04/30/01											
05/11/01											
05/24/01	50.6	4.8	34	168							
05/31/01											

06/25/01	90.8	9.3	25	40	8.08	-0.05	0.04	5	-0.001	-0.001	-0.01
07/30/01	220	30	120	5							
08/21/01				0							
09/28/01				0							
10/22/01				0							
11/01/01											
01/01/02											
02/01/02											
03/01/02											
04/02/02											
04/12/02											
04/19/02											
05/04/02											
05/14/02											
05/29/02											
06/04/02											
06/14/02	54	4.3	34	500	7.57	0.16	0.043	2.4	0.001	-0.001	-0.005
06/21/02											
07/10/02											
08/01/02	152	17	79	25	7.91	-0.05	0.048	8.6	0.001	0.001	0.006
08/07/02											
09/11/02	210	24	120	2.5							
10/18/02											
10/30/02	**250**	42	140	80	7.85	0.12	0.091	14	0.001	0.007	-0.02
11/07/02											
12/02/02											
01/01/03											
02/06/03											
03/05/03											
03/30/03											
04/13/03											
04/23/03											
05/03/03											
06/15/03											
07/14/03	120	13	72	50	7.73	-0.05	0.039	6.8	-0.001	-0.001	-0.02
07/25/03											
08/29/03											
09/16/03	280	46	160	30	8.22	-0.05	0.075	15	-0.001	0.008	0.017
10/19/03											
11/30/03											
12/05/03											
12/23/03											
01/01/04											
02/01/04											
03/07/04											
03/21/04											
04/09/04											
05/07/04											
05/27/04	96	13	58		7.6		0.054	4.1		-0.01	
06/02/04											

06/09/04		9.3	36								
06/28/04											
07/01/04	71	8.7		763							
08/01/04											
09/01/04	282	49	140				0.066				

	SC-101.5 EC	Sulfate	TDS	Q	pH	Al	As	Mg	Mn	Se	Zn
05/27/94	385	172	277	1425	6.81	1.26	0.042	29.4	0.294	0.014	0.108
06/23/94		158	266	181		0.532	0.043	28.2	0.107	0.01	0.037
07/28/94	800	386	642	36	7.56	0.519	0.033	76.3	0.132	0.022	0.041
08/30/94	850	429	700	6	8.49	0.439	0.028	82.5	0.055	0.024	0.009
09/28/94	700	400		10	8.32	0.573	0.027	84	0.045	0.021	0.013
10/28/94	550	315	525	27	8.52	0.296	0.034	65.2	0.021	0.016	-0.005
11/23/94											
12/21/94											
02/01/95											
04/11/95											
04/29/95											
05/30/95	550	557	792	2268.2	6.15	3.69	0.069	91.2	1.05	0.024	0.301
06/29/95	332	101	162	2477.8	7.02	0.828	0.03	17.5	0.164	-0.005	0.052
07/26/95	320	171	306	617.5	6.79	1.01	0.044	33.5	0.19	0.013	0.054
08/01/95	685	459	663	38.1	7.87	0.556	0.029	82	0.205	0.018	0.045
09/01/95	610	400	690	15.2	8.06	0.512	0.018	86.4	0.183	0.021	0.041
10/01/95	465	348	571	20.6	7.94	0.38	0.028	67.6	0.102	0.019	0.021
11/01/95											
12/04/95	983	442	714	11.2	8.01	0.419	0.036	87.4	0.093	0.021	0.028
01/16/96											
04/01/96											
05/07/96											
06/05/96	412	183	316		6.8	1.47	0.04	29.8	0.37	-0.002	0.13
07/02/96	275	95	185		7.3	0.52	0.031	17	0.11	0.005	0.04
07/02/96											
07/30/96		240	410		7.98	0.65	0.03	54.9	0.019	0.011	-0.01
08/29/96		320	584		7.79	0.36	0.015	72	0.18	0.001	0.04
09/26/96		330	516		7.79	0.54	0.008	76	0.17	0.003	0.04
11/04/96		280	442		7.36	0.13	0.011	61	0.088	0.017	0.03
12/04/96											

	S-102 EC	Sulfate	TDS	Q	pH	Al	As	Mg	Mn	Se	Zn
03/12/92	470	190			7.59		0.012	29.2			
04/22/92											
05/22/92											
06/03/92											
07/07/92											
08/05/92											
09/25/92											
10/06/92											

11/06/92											
12/15/92											
01/28/93											
02/18/93											
03/03/93											
03/15/93											
04/08/93											
04/30/93											
05/11/93											
05/27/93											
06/10/93											
06/25/93											
07/09/93											
07/31/93											
08/09/93											
08/27/93											
09/08/93											
09/28/93											
10/13/93											
10/22/93											
11/12/93											
11/24/93											
12/10/93											
01/12/94											
01/12/94											
01/27/94											
01/27/94											
02/08/94											
02/28/94											
02/28/94											
03/15/94											
03/16/94											
03/28/94											
04/07/94											
04/26/94	790	346	556	306	7.32	0.541	0.048	50.3	0.104	0.025	0.012
05/27/94	420	180	326	1374	6.97	1.08	0.031	31.2	0.237	0.018	0.086
06/23/94		181	362	148		0.288	0.021	34.7	0.037	0.014	0.009
07/28/94	750	359	614	22	7.7	-0.2	0.016	55.6	-0.005	0.033	-0.005
08/30/94	900	426	711	17	7.38	0.27	0.016	59	-0.005	0.028	0.008
09/28/94	7.25	419	687	10	7.7	0.254	0.016	63	0.007	0.023	0.009
10/28/94	650	405	668	10	7.62	-0.2	0.01	60.7	0.011	0.023	0.007
11/23/94											
12/21/94											
02/01/95											
04/11/95	825	335	555	414.2	7.3	0.49	0.042	54	0.026	0.018	0.016
04/29/95	550	437	712	540.8	6.76	0.872	0.077	78.1	0.123	-0.1	0.049
05/30/95	550	448	676	3092.7	6.96	3.3	0.071	70.4	0.676	0.017	0.199
06/29/95	367	132	214	3250.7	7.04	0.734	0.03	20.5	0.137	-0.005	0.044
07/26/95	420	222	388	323.1	6.87	0.39	0.026	38.1	0.097	0.016	0.021
08/01/95	600	462	684	26.9	7.83	-0.2	0.018	65.7	0.011	0.02	0.005

09/01/95	600	429	698	58.8	7.61	0.2	0.011	68.3	-0.005	0.021	0.008
10/01/95	500	386	643	25.1	7.04	0.18	0.015	58.6	0.008	0.023	0.01
11/01/95											
12/04/95	771	326	549	81.2	7.93	-0.075	0.015	49	0.003	0.021	0.005
01/16/96											
04/01/96											
05/07/96	1370	706	1060		6.71	4.06	0.025	129	1.55	0.004	0.36
06/05/96	466	177	396		7.33	1.95	0.033	35	0.33	-0.002	0.11
07/02/96	411	152	255		7.75	0.37	0.022	24.9	0.07	0.007	0.02
07/02/96											
07/30/96		344	570		8.1	-0.05	0.017	60.7	0.025	0.015	0.02
08/29/96		417	642		7.68	-0.02	0.006	68	-0.01	0.004	-0.02
09/26/96		400	668		7.63	0.1	0.005	68	-0.01	0.003	-0.02
11/04/96		360	584		7.33	-0.05	0.012	61	0.008	0.025	0.01
12/04/96											

S-110

	EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
06/20/86							0.035				
07/14/86											
08/27/86							0.03				
09/30/86											
10/22/86											
11/16/86							0.023				
12/10/86							0.024				
03/25/87											
04/28/87	87	5					0.028	4			
05/14/87	67	6					0.036	3			
06/24/87	114	8					0.037	5			
07/22/87	135	11					0.05	6			
08/12/87	435	50					0.069	23			
09/16/87	350	46					0.033	20			
11/24/87		23					0.021	10			
01/28/88											
02/17/88											
03/24/88											
04/14/88	130	14					0.031	5			
05/02/88	133	16					0.026	5			
06/06/88	105	12					0.04	4			
07/31/88	340	18					0.034	13			
08/23/88	300	20					0.033	12			
09/14/88	275	18					0.033	12			
10/12/88	280	24					0.032	11			
11/09/88	490	36					0.019	22			
04/19/89	440	100					0.059	18			
05/25/89	390	93					0.048	12			
06/08/89	150	45					0.005	6			
07/17/89	198	40					0.004	10			

08/23/89	310	31		0.005	14
09/13/89	290	33		0.002	14
10/17/89	300	34		0.016	13
11/15/89	280	48		0.018	6
12/12/89					
01/23/90					
02/13/90					
03/21/90					
04/18/90	410	105		0.031	
05/11/90	350	86		0.033	
07/20/90	420	143		0.023	21
08/22/90	470	35		0.01	17
09/29/90	440			0.032	
10/29/90	370	88		0.022	
11/09/90	380	84		0.022	
12/04/90	345	77		0.026	
01/04/91	407	72		0.024	19
02/11/91	525	71		0.021	24
03/27/91					
04/30/91					
05/16/91	650	258		0.057	47
06/12/91	1022	539			54
06/19/91					
07/25/91	513	197		0.01	27
08/05/91	627	241		0.015	31
09/13/91	640	233		0.015	39
10/23/91	550	231		0.011	36
11/19/91	550	200		0.01	33
12/20/91	1240	79		0.006	15
01/17/92	500	190		0.013	33
03/12/92	460	140	7.79	0.019	27.5
04/22/92					
05/22/92					
06/03/92					
07/07/92					
08/05/92					
09/25/92					
10/06/92					
11/06/92					
12/15/92					
01/28/93					
02/18/93					
03/03/93					
03/15/93					
04/08/93					
04/30/93					
05/11/93					
05/27/93					
06/10/93					
06/25/93					

07/09/93											
07/31/93											
08/09/93											
08/27/93											
09/08/93											
09/28/93											
10/13/93											
10/22/93											
11/12/93											
11/24/93											
12/10/93											
01/12/94											
01/12/94	430	190	423	50	7.54	0.274	0.017	35.4	-0.0005	0.008	0.007
01/27/94											
01/27/94	570	192	408	28	7.72	0.291	0.017	35.3	-0.0005	0.013	0.009
02/08/94											
02/28/94											
02/28/94											
03/15/94											
03/16/94											
03/28/94	660	242	521	5	7.48	0.197	0.047	38.5	0.034	0.006	-0.005
04/07/94	500	198	372	66	7.12	0.117	0.011	32.9	0.007	0.013	0.011
04/26/94	740	309	505	584	7.34	0.367	0.04	44	0.076	0.02	0.007
05/27/94	410	185	309	1691	7.03	0.912	0.045	28.1	0.2	0.012	0.076
06/23/94	490	205	360	268	7.87	0.202	0.024	33.7	0.022	0.015	0.009
07/28/94	750	353	580	24	7.54	-0.2	0.021	50.6	0.01	0.033	0.012
08/30/94		337	655	10	7.56	0.28	0.019	55.5	-0.005	0.02	0.007
09/28/94	725	370	644	19	7.71	0.252	0.013	57.3	-0.005	0.023	0.007
10/28/94	625	360	618	5	7.54	-0.2	0.009	55.6	0.007	0.015	0.008
11/23/94											
12/21/94											
02/01/95											
04/11/95	795	326	505	253.1	7.71	-0.2	0.019	50.2	0.015	0.021	0.021
04/29/95	448	347	582	473.9	7.71	0.413	0.038	61.1	0.059	-0.1	0.033
05/30/95		394	635	5943.5	7	3.12	0.057	82.9	0.749	0.02	0.216
06/29/95	358	124	227	3079.2	7.52	0.719	0.027	22.1	0.139	0.007	0.044
07/26/95	395	219	379	273.3	7.83	-0.2	0.018	37.5	0.079	0.014	0.019
08/01/95	550	378	658	32.8	7.98	0.2	0.016	61.5	0.012	0.04	0.008
09/01/95	410	357	631	56.5	7.99	0.2	12	60.7	-0.005	0.016	0.009
10/01/95	410	337	602	58	7.76	0.075	0.014	54.8	-0.004	0.025	0.007
11/01/95											
12/04/95	739	239	517	110	8.06	0.079	0.014	45.4	0.01	0.014	0.017
01/16/96	560	312	580		7.82	0.099	0.013	29.3	0.004	0.016	-0.002
04/01/96											
05/07/96	1310	694	1330		7.32	3.17	0.022	121	1.38	0.003	0.33
06/05/96	449	191	360		7.42	1.07	0.024	31.3	0.24	-0.002	0.08
07/02/96	506	198	340		7.9	0.24	0.019	33.5	0.06	0.007	0.02
07/02/96											
07/30/96		421	702		8.4	0.06	0.02	74.6	0.029	0.01	0.014
08/29/96		528	804		7.95	0.03	0.006	89	0.01	-0.001	-0.02

09/26/96		500	848		7.92	-0.04	-0.005	83	0.01	0.002	-0.02
11/04/96		430	716		7.84	-0.05	0.019	71	0.012	0.015	0.01
12/04/96											
04/14/97											
04/30/97	887	430	662		7.31	0.9	0.02	73	0.32	0.016	0.09
05/14/97	693	280	491	5148							
06/16/97	419	170	285	1788							
06/27/97											
07/29/97	790	490	790	269	8	-0.05	0.019	86	0.051	0.013	0.01
08/26/97	1370	674	1150	32							
09/23/97	1020	581	933	105							
01/26/98											
03/26/98											
05/25/98	732	345	626	4001	7.35	0.04	0.005	59.3	0.223	0.012	0.06
06/28/98	430	172	367	2493							
07/27/98	863	402	672	360							
08/21/98	1070	509	791	160	8	0.05	0.021	79	0.028	0.011	-0.01
09/15/98	542	516	882	290							
10/21/98	1110	498	924	120	7.84	-0.01	0.016	84.2	0.016	0.01	0.01
10/22/98	300	31					0.033	18			
11/24/98	1275	419	736	124							
12/21/98	937	420	683	120							
01/03/99		388	681	50							
01/29/99											
02/03/99	882	375	630	50	8.02	-0.01	0.021	60.5	0.026	0.008	0.02
02/26/99	826	319	596	50							
03/12/99	763	316	535	50							
03/24/99											
04/16/99	705	289	500	50							
04/28/99											
05/10/99	660	283	536	1009	7.84	0.18	0.019	49.2	0.058	0.01	0.03
05/25/99	732	345	626		7.35	0.04	0.005	59.3	0.223	0.012	0.06
05/26/99											
06/06/99											
06/12/99											
06/22/99	330	140	254	2045							
07/22/99	830	361	582	286	7.95	0.07	0.026	57	0.078	0.012	-0.01
08/18/99	936	400	688	200							
09/22/99	973	381		142							
10/28/99	903	413	670	120							
11/09/99	878	391	672	50	8.02	0.02	0.024	65.7	0.005	0.01	0.02
12/01/99	867	383	655	75							
01/01/00											
02/04/00	923	384	683		7.95	0.02	0.018	63	0.011	0.009	0.02
03/10/00	890	409	663								
04/21/00	680	281	501	219							
05/09/00	684	287	506	302	7.62	0.48	0.03	51.3	0.15	0.011	0.06
06/21/00											
06/28/00	731	310	539	89							
07/26/00	911	470	767	29							

08/17/00	1063	457	830	19	8	0.05	0.033	77.2	0.011	0.011	0.04
09/14/00	1070	501	823	20							
10/04/00		403		30							
11/27/00	978	419	747	65	7.98	-0.01	0.016	71.9	0.003	0.009	-0.01
12/07/00	757	462	722	50							
01/01/01											
02/16/01	761	300	530	50	7.64	-0.05	0.016	48	0.008	0.006	0.008
03/07/01	630	270	500	25							
04/21/01											
04/26/01	360	300	380	75							
04/30/01											
05/11/01	510	250	400	500							
05/24/01											
05/31/01											
06/25/01	712	380	560	25	8.17	-0.05	0.021	68	0.034	0.011	0.018
07/30/01	870	380	640	40							
08/21/01	716	350	610	15	8.17	-0.05	0.029	70	0.011	0.005	0.014
09/28/01	870	370	660	30							
10/22/01	1000	500	800	25							
11/01/01											
01/01/02											
02/01/02											
03/01/02											
04/02/02											
04/12/02	720	340	540	150							
04/19/02											
05/04/02											
05/14/02		270	460								
05/29/02											
06/04/02	356	130	230		7.6	0.28	0.024	24	0.043	0.007	0.023
06/14/02	372	170	280								
06/21/02											
07/10/02		230	400								
08/01/02	846	390	630	250	8.03	-0.05	0.024	69	0.011	0.007	0.013
08/07/02											
09/11/02	781	360	640	50							
10/18/02		460	660								
10/30/02											
11/07/02	790	360	590	75	7.64	0.11	0.019	61	0.005	0.005	-0.02
12/02/02	771	350	370	100							
01/01/03											
02/06/03	770	340	600		7.79	-0.05	0.017	45	0.013	0.007	0.033
03/05/03											
03/30/03	630	320	520	75							
04/13/03	700	370	590	450							
04/23/03											
05/03/03		290					0.017	51		0.007	
06/15/03		220	370								
07/14/03											
07/25/03	980	550	800	65							

08/29/03	1000	500	840		8.12	0.13	0.03	79	0.041	0.009	0.035
09/16/03	990	480	810	35							
10/19/03	1100	560	910	26	7.99	-0.05	0.019	78	0.005	0.009	0.03
11/30/03											
12/05/03	1092	500	780	25							
12/23/03											
01/01/04											
02/01/04											
03/07/04											
03/21/04											
04/09/04	706	320	500								
05/07/04	636	280	440								
05/27/04	660	320	500		7.8	0.05	0.011	52	0.026	0.009	0.05
06/02/04	400	160	300								
06/09/04											
06/28/04											
07/01/04	647	290	430	305							
08/01/04		500	1000	25	8.05	-0.05	0.022	78	0.004	0.012	0.026
09/01/04	1064	540	850	50							

S-112

	EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
03/15/94	640	319	518	286	6.54	0.256	-0.005	54.5	0.014	0.017	0.014
03/16/94											
03/28/94	910	513	817	128	7.07	0.103	-0.005	87.4	0.096	0.023	0.011
04/07/94	1180	694	1070	110	7	0.063	-0.005	112	0.098	0.027	0.016
04/26/94	1870	1090	1580	953	6.92	-0.05	-0.005	180	0.531	0.062	0.059
05/27/94	820	438	681	860	6.83	0.28	0.01	76.1	0.233	0.025	0.043
06/23/94	165	1150	1700	74	7.15	0.096	0.006	198	0.053	0.068	0.027
07/28/94	2750	1920	**2960**	30	7.2	0.231	0.006	318	0.008	0.196	0.015
08/30/94				0							
09/28/94				0							
10/28/94	2225	1900	**48.2**	5	7.15	-0.2	-0.005	324	-0.005	0.169	-0.005
11/23/94											
12/21/94											
02/01/95											
04/11/95											
04/29/95	1390	809	1140	695.6	7.14	-0.2	0.008	150	0.245	0.036	0.029
05/30/95				3753.8							
06/29/95				952.8							
07/26/95	1910	1270	1910	152.1	7.17	0.2	-5	232	0.079	0.052	0.023
08/01/95											
09/01/95				60							
10/01/95	2880	2170	3350	20	7.05	-0.075	-0.005	435	-0.004	0.085	0.004
11/01/95											
12/04/95				62							
01/16/96											
04/01/96											
05/07/96											

06/05/96	1040	538	884		7.12	0.27	0.009	107	0.25	-0.002	0.03
07/02/96											
07/02/96											
07/30/96		1590	2360		7.53	-0.05	0.008	334	0.061	0.03	0.038
08/29/96											
09/26/96											
11/04/96		2200	3174		7.35	-0.05	-0.001	470	0.007	0.068	0.02

s-115

	EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
10/23/91	870	408			7.2		0.013	34			
11/19/91	800	320			7.4		0.004	41			
12/20/91											
01/17/92											
03/12/92	440	150			7.24		0.003	25.3			
04/22/92											
05/22/92											
06/03/92											
07/07/92											
08/05/92											
09/25/92											
10/06/92											
11/06/92											
12/15/92											
01/28/93											
02/18/93											
03/03/93											
03/15/93											
04/08/93											
04/30/93											
05/11/93											
05/27/93											
06/10/93											
06/25/93											
07/09/93											
07/31/93											
08/09/93											
08/27/93											
09/08/93											
09/28/93											
10/13/93											
10/22/93											
11/12/93											
11/24/93											
12/10/93											
01/12/94											
01/12/94											
01/27/94											

01/27/94											
02/08/94											
02/28/94											
02/28/94											
03/15/94											
03/16/94											
03/28/94											
04/07/94											
04/26/94											
05/27/94											
06/23/94											
07/28/94											
08/30/94											
09/28/94											
10/28/94											
11/23/94											
12/21/94											
02/01/95											
04/11/95											
04/29/95	1450	840	1320	920	7.3	-0.2	0.005	152	0.228	0.034	0.027
05/30/95				3700	6.9						
06/29/95				900	7.22						
07/26/95	1550	935	1470	150	8.22	0.2	0.007	168	0.125	0.042	0.006
08/01/95				0	8.37						
09/01/95				60	7.75						
10/01/95	3140	2500	3660	20	7.56	0.093	0.007	448	0.028	0.108	0.012
11/01/95											
12/04/95				62	7.51						
01/16/96											
04/01/96											
05/07/96											
06/05/96	1050	538	916		7.34	0.27	0.008	107	0.23	-0.002	0.03
07/02/96											
07/02/96											
07/30/96		1160	1780		8.76	-0.05	0.014	254	0.084	0.028	0.014
08/29/96											
09/26/96											
11/04/96		2400	3513		6.82	-0.05	0.005	480	0.019	0.089	0.02
12/04/96											
04/14/97											
04/30/97	1276	700	1074		6.86	0.2	0.006	140	0.38	0.018	0.05
05/14/97	1137	600	929	3000							
06/16/97	774	440	592	1436							
06/27/97											
07/29/97	1520	1100	1630	78	9.2	-0.1	0.005	210	0.059	0.026	-0.02
08/26/97	2600	1680	2580	9							
09/23/97	2720	2170	3170	10							
01/26/98	509	175	344	758	8.05	0.02	0.002	35.2	0.009	0.004	-0.01
03/26/98											
05/25/98	1330	727	1130	3162	7.5	0.03	0.002	152	0.117	0.007	0.04

06/28/98	1060	565	943	1222							
07/27/98	1670	965	1520	192							
08/21/98	2540	1620	2400	75	8.71	0.06	0.012	351	0.065	-0.0005	-0.01
09/15/98	3130	2140	3290	100							
10/21/98	3320	2200	3570	100	8.8	-0.01	0.014	480	0.016	0.041	-0.01
10/22/98											
11/24/98	2570	1580	2450	50							
12/21/98	1750	1020	1500	75							
01/03/99											
01/29/99											
02/03/99											
02/26/99											
03/12/99	1480	860	1200	125	7.84	-0.01	0.003	180	0.049	0.015	0.03
03/24/99											
04/16/99	754	329	514	809							
04/28/99											
05/10/99	967	510	794	4288	7.77	0.18	0.004	97.5	0.117	0.01	0.03
05/25/99	1330	727	1130		7.5	0.03	0.002	152	0.117	0.007	0.04
05/26/99											
06/06/99											
06/12/99											
06/22/99	831	447	734	1107							
07/22/99	1980	1150	1700	35	9.07	0.04	0.006	241	0.048	0.022	-0.01
08/18/99											
09/22/99	3880	2800	4100	45							
10/28/99	3810	2980	4180	100							
11/09/99	3790	2730	4030	15	7.96	0.02	0.005	536	0.021	0.042	0.01
12/01/99	3440	2360	3400	50							
01/01/00											
02/04/00	1910	1050	1630		7.69	0.01	0.001	248	0.012	0.016	0.02
03/10/00	1135	604	884								
04/21/00	1320	671	1080	570							
05/09/00	1548	839	1340	514	7.72	0.12	0.005	170	0.227	0.015	0.03
06/21/00											
06/28/00	588	260	401	39							
07/26/00	1110	1670	2520	15							
08/17/00	3310	1980	3420	15	8.64	0.04	0.009	77.2	0.043	0.034	-0.01
09/14/00	3780	2520	3820	15							
10/04/00		2600		15							
11/27/00	2490	1450	2300	45	7.5	-0.01	0.002	326	0.02	0.019	-0.01
12/07/00	1825	1540	2260	10							
01/01/01											
02/16/01	1588	950	1300	25	7.07	-0.05	-0.001	180	0.005	0.009	0.007
03/07/01	1100	710	1100	86							
04/21/01	930	500	750	866	7.45	-0.05	0.005	110	0.097	0.008	0.014
04/26/01	750	41	530	866							
04/30/01											
05/11/01	1200	750	1100	616							
05/24/01											
05/31/01											

06/25/01	2278	1500	2100	60							
07/30/01	3600	2900	3900	25							
08/21/01	3677	3200	4100	20	9.35	-0.05	-0.005	660	0.03	0.04	-0.025
09/28/01	4000	3300	4700	10							
10/22/01	4300	3600	4900	15							
11/01/01											
01/01/02											
02/01/02											
03/01/02											
04/02/02											
04/12/02	1200	670	1000								
04/19/02											
05/04/02											
05/14/02	1100	570	900								
05/29/02											
06/04/02	1005	490	730		7.34	-0.05	0.003	100	-0.001	0.007	0.023
06/14/02	1087	660	920								
06/21/02											
07/10/02		570	810								
08/01/02											
08/07/02	2600	1900	2600	200	7.87	-0.05	0.002	400	0.031	0.028	0.015
09/11/02	3490	2600	3900	50							
10/18/02	3870	2900	4000								
10/30/02											
11/07/02	3700	2800	3900	100	7.52	0.31	0.002	570	0.14	0.035	0.03
12/02/02		2800	3500								
01/01/03											
02/06/03	1300	760	1200	200	7.51	-0.05	0.003	120	0.083	0.008	0.031
03/05/03											
03/30/03	1032	670	930	750							
04/13/03	864	540	770	1100							
04/23/03	1000	460	740		7.79	0.37	0.005	110	0.15	0.008	0.04
05/03/03											
06/15/03		820	1300								
07/14/03											
07/25/03	3900	3800	4500	38							
08/29/03	4600	3600	5200	25	7.77	-0.1	0.007	650	0.13	0.049	-0.13
09/16/03	4500	3700	5100	20							
10/19/03	4770	4000	5300	27	7.91	-0.1	-0.002	770	0.018	0.04	-0.04
11/30/03	2890	1800	2500	30							
12/05/03											
12/23/03											
01/01/04											
02/01/04											
03/07/04											
03/21/04											
04/09/04	1310	770	1000								
05/07/04	1005	610	850								
05/27/04	1200	770	1000		7.42	-0.05	0.003	130	0.2	0.015	0.07
06/02/04	849	440	790								

06/09/04											
06/28/04											
07/01/04	1312	740	1100	500							
08/01/04		3200	3600	75	7.7	-0.05	0.002	570	0.015	0.038	0.032
09/01/04	3770	3000	3800	50							

	SC-118 EC	Sulfate	TDS	Q	pH	Al	As	Mg	Mn	Se	Zn
03/12/92	350	110			7.41		0.013	17.8			
04/22/92											
05/22/92											
06/03/92											
07/07/92											
08/05/92											
09/25/92											
10/06/92											
11/06/92											
12/15/92											
01/28/93											
02/18/93											
03/03/93											
03/15/93											
04/08/93											
04/30/93											
05/11/93											
05/27/93											
06/10/93											
06/25/93											
07/09/93											
07/31/93											
08/09/93											
08/27/93											
09/08/93											
09/28/93											
10/13/93											
10/22/93											
11/12/93											
11/24/93											
12/10/93											
01/12/94											
01/12/94	810	517	824	355	7.69	0.381	0.014	65.5	0.022	0.099	0.009
01/27/94											34361
01/27/94	930	465	803	202	7.94	0.25	0.012	66.7	0.012	-0.005	0.007
02/08/94	880	452	754	274	8.06	0.297	0.011	61.2	0.008	-0.005	0.006
02/28/94											34393
02/28/94	870	473	791	110	7.41	0.262	0.011	63	0.009	-0.005	0.005
03/15/94	530	237	411	30	7.46	0.07	0.013	36	-0.005	0.02	-0.005
03/16/94											34409

03/28/94	530	350	578	42	7.3	0.076	0.014	52.6	-0.005	0.026	0.005
04/07/94	780	389	654	49	7.59	0.145	0.014	61.1	0.011	0.029	-0.005
04/26/94	1810	924	1310	356	7.49	0.334	0.016	115	0.326	0.027	0.013
05/27/94	925	491	871	391	7.43	0.186	0.019	72.7	0.031	0.024	0.016
06/23/94	78	372	663	329	7.89	0.149	0.028	60.3	0.017	0.014	-0.005
07/28/94	975	446	749	381	7.81	0.292	0.015	66	0.02	0.012	0.005
08/30/94	900	415	724	391	8.14	0.259	0.016	61.7	0.016	-0.005	-0.005
09/28/94	795	410	738	190	8.39	0.264	0.012	65.7	0.011	-0.005	-0.005
10/28/94	425	200	370	49	7.58	-0.2	0.012	33.5	0.007	0.01	-0.005
11/23/94											
12/21/94											
02/01/95											
04/11/95	1593	781	1250	629.7	7.58	-0.2	0.018	136	0.055	0.043	-0.005
04/29/95	750	831	1250	278.3	7.32	-0.2	0.017	139	0.084	-0.1	0.02
05/30/95	1200	1040	1690	944.3	7.66	-0.1	0.025	220	0.414	0.058	0.067
06/29/95	1041	504	764	448.4	7.28	-0.2	0.016	76.3	0.039	0.019	0.007
07/26/95	600	434	707	309	7.28	-2	0.014	67.4	0.023	0.021	-0.005
08/01/95	500	376	621	122.1	7.62	-0.2	0.016	57.7	0.008	0.023	-0.005
09/01/95	495	305	571	245.9	7.19	-0.2	0.014	62	-0.005	0.015	0.01
10/01/95	440	326	531	93.8	7	-0.075	0.015	56.9	-0.004	0.017	-0.02
11/01/95											
12/04/95	704	282	475	57	7.9	-0.075	0.015	48.9	-0.001	0.018	0.009
01/16/96	635	395	675		7.9	0.156	0.012	70.4	0.003	0.021	-0.002
04/01/96											
05/07/96	2330	1300	2010		7.6	0.32	0.01	233	0.27	-0.002	0.06
06/05/96	1580	794	1430		7.76	1.06	0.025	151	0.19	-0.002	0.06
07/02/96	1180	582	945		7.87	-0.05	0.016	96.1	0.02	0.015	0.01
07/02/96											
07/30/96		536	868		8	-0.05	0.018	103	0.015	0.016	0.017
08/29/96		584	843		7.75	-0.02	-0.005	100	-0.01	-0.001	-0.02
09/26/96		490	776		7.56	0.05	0.007	94	-0.01	0.003	-0.02
11/04/96		450	688		7.57	-0.05	0.014	83	0.002	0.022	0.01
12/04/96		420	630		7.68	-0.05	0.013	73	-0.001	0.022	-0.02

S-120

	EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
06/20/86											
07/14/86											
08/27/86											
09/30/86											
10/22/86											
11/16/86											
12/10/86											
03/25/87											
04/28/87	69	5					0.019	2.6			
05/14/87	64	5					0.024	2.5			
06/24/87	72	8					0.064	3.4			
07/22/87	86	5					0.03	3.3			

08/12/87	111	6		0.03	4.1
09/16/87	108	5		0.024	4.4
11/24/87		6		0.008	4.6
01/28/88					
02/17/88					
03/24/88					
04/14/88	83	4		0.019	2.3
05/02/88	89	6		0.025	
06/06/88	77	4		0.022	2.3
07/31/88	100	5		0.03	4
08/23/88	90	7		0.028	3.6
09/14/88	100	8		0.03	4
10/12/88	125	7		0.021	4.6
11/09/88	175	9		0.011	8.9
04/19/89	130	20		0.061	
05/25/89	127	21		0.043	3.1
06/08/89	104	14		0.003	2.9
07/17/89	95	12		0.003	3
08/23/89	105	10		0.004	3.2
09/13/89	105	21		0.003	3.9
10/17/89	150	28		0.033	4.8
11/15/89	120	19		0.022	5.6
12/12/89	150	17		0.027	5.1
01/23/90					
02/13/90					
03/21/90					
04/18/90					
05/11/90	180	45		0.021	6.5
07/20/90	115	25		0.06	4
08/22/90	225	39		0.032	7.6
09/29/90	200	40		0.045	6.3
10/29/90	180	39		0.027	7.1
11/09/90	340	52		0.017	11.8
12/04/90	150	34		0.02	6.3
01/04/91	165	27		0.023	6.8
02/11/91					
03/27/91					
04/30/91	458	140		0.032	20
05/16/91	370	163		0.053	23
06/12/91	213	55		0.027	9
06/19/91					
07/25/91	149	37		0.016	5.1
08/05/91	268	55		0.022	8
09/13/91	780	322		0.017	31
10/23/91	290	85	7.1	0.029	13
11/19/91	470	140	7.7	0.017	22
12/20/91	260	75	7.6	0.017	12
01/17/92	200	45	7.7	0.022	10
03/12/92	450	130	7.35	0.015	22.4
04/22/92					

05/22/92											
06/03/92											
07/07/92											
08/05/92											
09/25/92											
10/06/92											
11/06/92											
12/15/92											
01/28/93											
02/18/93											
03/03/93											
03/15/93											
04/08/93											
04/30/93											
05/11/93											
05/27/93											
06/10/93											
06/25/93											
07/09/93											
07/31/93											
08/09/93											
08/27/93											
09/08/93											
09/28/93											
10/13/93											
10/22/93											
11/12/93											
11/24/93											
12/10/93											
01/12/94											
01/12/94	760	476	809	233	7.62	0.33	0.015	62.5	0.026	0.01	0.013
01/27/94											
01/27/94	920	474	790	254	7.94	0.28	0.016	65.2	0.024	-0.005	0.01
02/08/94	870	462	756	202	8.02	0.294	0.014	59.9	0.016	0.007	0.008
02/28/94											
02/28/94	850	461	772	205	7.85	0.401	0.018	62.5	0.019	-0.005	0.006
03/15/94	460	188	350	19	7.58	0.393	0.032	28.7	0.07	0.012	0.024
03/16/94											
03/28/94	500	314	534	49	7.29	0.151	0.023	47.5	0.037	0.02	0.01
04/07/94	790	388	648	47	7.12	0.228	0.02	57.8	0.035	0.026	0.009
04/26/94	1620	805	1140	352	7.59	0.501	0.032	98.1	0.313	0.021	0.011
05/27/94	970	503	850	356	7.63	0.27	0.016	71.2	0.038	0.018	0.019
06/23/94	75	424	660	365	8.04	0.176	0.025	59.2	0.03	0.011	0.008
07/28/94	900	439	743	181	7.82	0.375	0.034	63	0.067	0.01	0.008
08/30/94	900			256	8.08						
09/28/94	700			161	7.82						
10/28/94	400	202	374	9	7.72	0.2	0.022	34.3	0.037	0.015	0.016
11/23/94											
12/21/94											
02/01/95											

04/11/95											
04/29/95	1190	643	1010	183.6	7.7	0.41	0.025	106	0.079	0.033	
05/30/95				1026.4							
06/29/95				1030.9							
07/26/95	861	451	701	643.6	7.68	-0.2	0.013	65.7	0.025	0.022	0.01
08/01/95				128.2							
09/01/95				155.7							
10/01/95	697	324	525	114.9	7.72	-0.075	0.016	57.2	-0.004	0.017	0.006
11/01/95											
12/04/95				130							
01/16/96	631	388	652		7.8	-0.075	0.01	67	0.013	0.02	-0.002
04/01/96											
05/07/96											
06/05/96	1570	844	1470		7.83	0.91	0.016	141	0.16	-0.002	0.04
07/02/96											
07/02/96											
07/30/96		546	862		7.96	0.06	0.02	103	0.028	0.014	0.02
08/29/96											
09/26/96											
11/04/96		460	736		7.6	-0.05	0.016	81	0.022	0.021	-0.01
12/04/96											
04/14/97											
04/30/97	1500	800	1208	100	7.67	-0.05	0.02	150	0.006	0.012	0.02
05/14/97	1993	1100	1827	1282							
06/16/97	1248	770	1146	1153							
06/27/97											
07/29/97	960	660	1040	478	7.5	-0.05	0.013	110	0.046	0.016	-0.02
08/26/97	1230	648	1010	218							
09/23/97	1020	587	890	342							
01/26/98											
03/26/98											
05/25/98	1860	1100	1760	1484	7.59	0.03	0.009	210	0.173	0.03	0.05
06/28/98	1660	940	1610	1484							
07/27/98	1330	703	1180	462							
08/21/98	1320	712	1090	187	7.77	0.03	0.013	110	0.026	0.015	0.02
09/15/98	1329	666	1100	157							
10/21/98	1260	615	1100	109	7.67	-0.01	0.012	107	0.023	0.015	0.01
10/22/98	111	6					0.014	4.9			
11/24/98	1451	613	954	113							
12/21/98	906	457	657	120							
01/03/99		593	909	75							
01/29/99											
02/03/99											
02/26/99											
03/12/99											
03/24/99	1170	604	930	40							
04/16/99	1291	694	1040	40							
04/28/99											
05/10/99	1630	952	1510	203	7.83	0.03	0.013	166	0.009	0.025	0.03
05/25/99	1860	1100	1760		7.59	0.03	0.009	210	0.173	0.03	0.05

05/26/99											
06/06/99	1350	1210	1740	100							
06/12/99											
06/22/99											
07/22/99	1390	720	1130	380	7.76	0.04	0.013	112	0.03	0.016	0.02
08/18/99											
09/22/99	1400	735	1170	50							
10/28/99											
11/09/99	1280	699	1060	70	7.79	-0.01	0.011	119	0.003	0.016	0.01
12/01/99	1290	758	1020	100							
01/01/00											
02/04/00	1170	572	905		7.72	0.02	0.013	99	0.007	0.015	0.03
03/10/00	1215	653	983								
04/21/00	1900	1010	1660	47							
05/09/00	2040	1170	1890	92	7.68	0.18	0.014	228	0.165	0.025	0.04
06/21/00											
06/28/00	1402	751	1150	144							
07/26/00	1162	721	1080	51							
08/17/00	1273	602	1050	45	7.75	0.03	0.016	104	0.011	0.015	0.02
09/14/00	1260	672	985	45							
10/04/00		527		45							
11/27/00	1154	553	913	50	7.81	-0.01	0.012	101	0.003	0.013	-0.01
12/07/00	886	614	882	45							
01/01/01											
02/16/01	1121	570	850	10	7.37	-0.05	0.01	91	0.007	0.011	0.007
03/07/01	940	550	870	20							
04/21/01		910	1400	50							
04/26/01											
04/30/01											
05/11/01	1800	1300	1700	60							
05/24/01											
05/31/01											
06/25/01	1335	770	1000	60	7.91	-0.05	0.012	140	0.012	0.014	0.029
07/30/01	1400	760	1100	60							
08/21/01	1293	760	1100	55	7.76	-0.05	0.012	140	0.009	0.012	0.017
09/28/01	1300	690	1100	40							
10/22/01	1200	760	1100	25							
11/01/01											
01/01/02											
02/01/02											
03/01/02											
04/02/02	110	550	850								
04/12/02											
04/19/02											
05/04/02											
05/14/02		1200	1700								
05/29/02											
06/04/02	1714	940	1400		7.73	0.24	0.013	180	0.25	0.015	0.042
06/14/02	1545	1000	1400								
06/21/02											

07/10/02		880	1300								
08/01/02											
08/07/02	1300	760	1100	150	7.68	-0.05	0.012	130	0.009	0.012	0.015
09/11/02	1189	750	1100	150							
10/18/02	1228	730	930								
10/30/02											
11/07/02	1200	680	950	200	7.55	0.1	0.012	120	0.004	0.012	0.02
12/02/02	1130	680	1000								
01/01/03											
02/06/03	1200	680	900		7.76	-0.05	0.012	89	0.004	0.01	0.032
03/05/03											
03/30/03	1170	760	1100	100							
04/13/03	1213	790	1100	350							
04/23/03	1600	970	1300		7.94	0.25	0.021	180	0.022	0.014	0.03
05/03/03											
06/15/03		1100	1600								
07/14/03											
07/25/03	1500	1000	1400	42							
08/29/03	1600	960	1400		7.92	-0.05		0.014	0.008	0.015	0.04
09/16/03	1500	950	1300	90							
10/19/03	1622	960	1300	72	7.7	-0.05	0.012	160	0.003	0.014	0.03
11/30/03	1584	860	1300	70							
12/05/03											
12/23/03											
01/01/04											
02/01/04											
03/07/04											
03/21/04											
04/09/04	2330	1400	1900								
05/07/04	2410	1500	1900								
05/27/04	2350	1500	2000		7.42		0.01	250	0.13	0.025	0.07
06/02/04	1580	1100	1600								
06/09/04											
06/28/04											
07/01/04	1644	990		703							
08/01/04		920	1500	500	7.8	-0.05	0.013	140	0.002	0.017	0.034
09/01/04	1483	870	1200	350							

	S-140										
	EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
06/20/86											
07/14/86											
08/27/86											
09/30/86											
10/22/86											
11/16/86											
12/10/86											
03/25/87											

04/28/87	66	4		0.015	2.6
05/14/87	73	5		0.02	2.8
06/24/87	103	5		0.029	4.2
07/22/87	121	7		0.01	5.1
08/12/87	190	19		0.016	8.2
09/16/87	178	13		0.013	8.1
11/24/87		15		0.021	6.9
01/28/88	140	15		0.006	5.6
02/17/88	160	17		0.006	5.6
03/24/88	115	16		0.014	4
04/14/88	102	7		0.016	3
05/02/88	99	6		0.013	3
06/06/88	93	6		0.021	3.1
07/31/88	140	5		0.017	5
08/23/88	150	7	103.67	0.015	5.9
09/14/88	160	9	80.78	0.01	6.4
10/12/88	164	17		0.012	7.3
11/09/88	320	23	83.48	0.006	11.5
04/19/89	150	40	13123.81	0.032	4.9
05/25/89	88	17	6983.33	0.002	4.2
06/08/89	109	15	8310.43	0.003	3.3
07/17/89	170	13	1068.14	0.003	4.7
08/23/89	162	11	266.14	0.003	5.8
09/13/89	167	16	217.67	0.002	6.8
10/17/89	225	19	173.69	0.008	8.1
11/15/89	210	23	358.59	0.01	8.6
12/12/89	220	24		0.009	8.5
01/23/90	210	26		0.009	7.9
02/13/90	220	23		0.006	7.7
03/21/90	170	25	1357.62	0.011	6.8
04/18/90	190	47	3584.57	0.014	8
05/11/90	170	35	2855.27	0.013	6.7
07/20/90	177	29		0.021	7
08/22/90	250	35		0.015	11
09/29/90	275	36		0.015	10
10/29/90	240	35		0.01	11
11/09/90	250	35		0.009	11
12/04/90	240	36		0.008	11
01/04/91	264	38		0.006	12
02/11/91	262	35.3		0.006	12
03/27/91	230	41		0.006	10
04/30/91	307	22		0.012	13
05/16/91	345	106		0.025	19
06/12/91	394	154		0.086	22
06/19/91		49		0.018	8.2
07/25/91	235	53.4		0.011	8.8
08/05/91	324	74		0.017	18
09/13/91	510	140		0.006	19
10/23/91	310	80		0.01	16.1
11/19/91	450	130	798.9	0.006	21

12/20/91	300	65					0.005	16			
01/17/92	340	92		368			0.005	18			
03/12/92	310	79		786.3			0.005	15.6			
04/22/92	420	154					0.009	24			
05/22/92	250	69		1709			0.014	13.4			
06/03/92	240			887.3			0.015	13.6		0.001	
07/07/92	340	74					0.017	16.9		0.001	
08/05/92	280	41		92			0.03	14.9		0.001	
09/25/92	400	59		232			0.012	22.6	0.08	0.001	0.02
10/06/92	360	71		205.1			0.014	19.3	0.08	0.001	0.02
11/06/92	640	284		425			0.007	38.8	0.2	0.001	0.02
12/15/92	490	160					0.005	24.6	0.06	0.001	0.02
01/28/93	445	132					0.008	24	0.06	0.001	0.02
02/18/93	420	155		1500		0.01	0.15	25	0.03	0.001	0.02
03/03/93	420	158		1500			0.005	23	0.03	0.001	0.02
03/15/93	340	113		1800			0.008	20	0.06	0.001	0.02
04/08/93	700	261		2275.4			0.09	52	0.2	0.001	0.02
04/30/93	550	239		4724.5			0.036	38	0.21	0.001	0.03
05/11/93	550	192		13058			0.14	35	0.49	0.002	0.07
05/27/93	400	151		16946		0.36	0.036	26	0.19	0.001	0.03
06/10/93	290	138		7103.2		0.19	0.14	25	0.11	0.002	0.02
06/25/93	300	104		3624.1		0.16	0.16	18	0.05	0.001	0.02
07/09/93	330	109				0.12	0.014	19	0.04	0.001	0.02
07/31/93	390	119				0.28	0.035	26	0.01	0.001	0.02
08/09/93	400	115		704.6		0.17	0.02	22	0.05	0.001	0.02
08/27/93	430	136		494.1		0.17	0.015	22	0.06	0.001	0.02
09/08/93	430	138		312.4		0.15	0.013	24	0.07	0.001	0.04
09/28/93	480	154		275.6		0.14	0.008	27	0.06	0.001	0.02
10/13/93	494	160		409.8		0.39	0.05	28	0.06	0.05	0.01
10/22/93	512	176		357.2		0.4	0.015	28	0.05	0.05	0.01
11/12/93	921	438		433.1		0.16	0.005	59	0.1	0.007	0.01
11/24/93	762	326		357		0.27	0.005	46	0.06	0.009	0.01
12/10/93	580	209		326.7		0.28	0.006	31	0.05	0.005	0.01
01/12/94	600	306		200		0.33	0.005	44	0.04	0.005	0.01
01/12/94	600	306	544	200	7.61	0.332	-0.005	44.3	0.037	-0.005	-0.005
01/27/94	680	301		607		0.29	0.008	47	0.04	0.007	0.01
01/27/94	680	301	544	607	7.81	0.288	0.008	47.3	0.043	0.007	-0.005
02/08/94											
02/28/94	610	299		377		0.31	0.009	42	0.04	0.005	0.01
02/28/94	610	299	480	377	7.77	0.312	0.009	42.3	0.042	-0.005	-0.005
03/15/94	360	151	292	920	7.6	0.151	0.008	25.3	0.03	0.006	0.016
03/16/94	360	151		920		0.15	0.008	25	0.03	0.006	0.01
03/28/94	290	173	313	846	7.32	0.113	-0.005	28.3	0.02	-0.005	-0.005
04/07/94	500	200	362	1293	7.55	0.128	0.006	31.7	0.02	0.01	-0.005
04/26/94	980	420	619	3310	7.66	0.06	0.011	59.6	0.079	0.02	-0.005
05/27/94	400	171	286	5555	7.38	0.342	0.025	27.1	0.046	0.01	0.015
06/23/94	50	201	377	931	7.87	0.449	0.032	34.7	0.109	0.007	0.009
07/28/94	680	294	529	430	7.69	0.681	0.025	47.7	0.103	-0.005	0.009
08/30/94	750	338	595	246	7.73	0.347	0.016	50	0.064	-0.005	0.006
09/28/94	700	341	607	349	7.48	0.326	0.011	54.8	0.076	-0.005	-0.005

10/28/94	460	293	502	160	7.78	-0.2	0.008	31.1	0.06	-0.005	-0.005
11/23/94											
12/21/94											
02/01/95	808	339	545	1500	7.33	0.032	-0.005	56.1	0.036	0.02	-0.003
04/11/95	751	305	540	2803.2	8.05	-0.2	0.01	56.9	0.029	0.015	0.006
04/29/95	435	288	491	4246.5	7.56	0.2	0.012	53.4	0.042	-0.1	0.011
05/30/95		252	437	15059	7.6	0.753	0.027	34.6	0.144	0.007	0.041
06/29/95	240	71.8	131	10959.2	7.62	1.66	0.06	13.8	0.099	-0.005	0.038
07/26/95	450	223	383	1636.3	7.4	-0.2	0.017	39.9	0.075	0.009	0.015
08/01/95	500	297	514	415.6	7.64	0.998	0.036	52.6	0.214	0.023	0.016
09/01/95	490	295	526	346.9	7.21	0.235	0.011	54	0.055	-0.005	-0.005
10/01/95	460	366	601	230.2	7.24	0.165	0.009	61.9	0.049	0.007	-0.002
11/01/95											
12/04/95	896	394	668	825	7.46	0.095	0.009	64.9	0.051	0.008	-0.002
01/16/96	647	421	677		7.68	0.124	-0.005	71.8	0.041	0.008	-0.002
04/01/96											
05/07/96											
06/05/96	376	130	168		7.81	0.53	0.034	26.2	0.08	-0.002	0.02
07/02/96	599	256	430		7.98	0.13	0.017	42.2	0.05	0.007	-0.01
07/02/96											
07/30/96		344	588		8.43	0.09	0.024	69.1	0.063	0.006	-0.01
08/29/96		421	641		7.95	-0.02	-0.005	77	0.05	-0.001	-0.02
09/26/96		390	663		7.8	-0.04	-0.005	76	0.05	0.001	-0.02
11/04/96		510	766		7.73	-0.05	0.008	86	0.078	0.008	-0.01
12/04/96		480	710		7.72	-0.05	0.005	80	0.066	0.01	-0.02
04/14/97											
04/30/97											
05/14/97											
06/16/97											
06/27/97					8.1		0.015			0.003	0.04
07/29/97					7.79		0.012			0.005	-0.02
08/26/97											
09/23/97											
01/26/98											
03/26/98											
05/25/98					7.51		0.012			0.008	0.02
06/28/98											
07/27/98					7.75		0.012			0.007	-0.01
08/21/98											
09/15/98											
10/21/98					7.83	.	0.009			0.007	-0.01
10/22/98	169	13					0.01	8.2			
11/24/98											
12/21/98											
01/03/99											
01/29/99											
02/03/99											
02/26/99											
03/12/99											
03/24/99					7.94		0.01			0.005	0.01

04/16/99				
04/28/99	7.66	0.007	0.006	0.03
05/10/99				
05/25/99				
05/26/99				
06/06/99				
06/12/99				
06/22/99				
07/22/99				
08/18/99				
09/22/99	8.09	0.01	0.005	0.01
10/28/99				
11/09/99	8	0.006	0.005	0.02
12/01/99				
01/01/00				
02/04/00	7.87	0.006	0.005	0.02
03/10/00				
04/21/00				
05/09/00	7.72	0.01	0.008	0.02
06/21/00				
06/28/00				
07/26/00				
08/17/00	7.92	0.013	0.007	-0.01
09/14/00				
10/04/00				
11/27/00	7.93	0.009	0.003	0.01
12/07/00				
01/01/01				
02/16/01	7.5	0.003	0.003	-0.005
03/07/01				
04/21/01	7.93	0.007	0.004	-0.005
04/26/01				
04/30/01				
05/11/01				
05/24/01				
05/31/01				
06/25/01				
07/30/01				
08/21/01	8.03	0.009	0.003	0.007
09/28/01				
10/22/01	7.85			
11/01/01				
01/01/02				
02/01/02				
03/01/02				
04/02/02				
04/12/02				
04/19/02				
05/04/02				
05/14/02				

05/29/02											
06/04/02					7.22		0.022			0.004	-0.01
06/14/02											
06/21/02											
07/10/02											
08/01/02					7.6		0.011			0.005	0.006
08/07/02											
09/11/02											
10/18/02											
10/30/02											
11/07/02					7.63		0.005			-0.003	-0.015
12/02/02											
01/01/03											
02/06/03					7.73		0.005			0.003	-0.02
03/05/03											
03/30/03											
04/13/03											
04/23/03					7.95		0.007			0.004	-0.02
05/03/03											
06/15/03											
07/14/03											
07/25/03											
08/29/03					8.03		0.011			0.005	0.026
09/16/03											
10/19/03					7.87		0.007			-0.005	-0.02
11/30/03											
12/05/03											
12/23/03											
01/01/04											
02/01/04											
03/07/04											
03/21/04											
04/09/04					7.79		0.006			0.007	0.04
05/07/04											
05/27/04											
06/02/04											
06/09/04											
06/28/04											
07/01/04					7.87		0.011			-0.005	0.035
08/01/04											
09/01/04											

	s-150										
	EC	Sulfate	TDS	Q	field pH	Al	As	Mg	Mn	Se	Zn
06/20/86							0.012				
07/14/86							0.008				
08/27/86							0.007				

09/30/86				
10/22/86			0.006	
11/16/86			0.005	
12/10/86			0.007	
03/25/87	142	10	0.004	
04/28/87	88	4	0.007	2.9
05/14/87				
06/24/87	156	7	0.01	5.7
07/22/87	200	10	0.008	7.8
08/12/87	270	14	0.005	9.7
09/16/87	250	15	0.005	11
11/24/87		15	0.003	9.3
01/28/88	160	13	0.003	6.2
02/17/88	220	13	0.003	6.5
03/24/88	125	12	0.005	4
04/14/88	110	7	0.01	2.8
05/02/88	114	7	0.007	3.1
06/06/88	113	7	0.013	3.5
07/31/88	260	10	0.008	9
08/23/88	320	15	0.005	10.4
09/14/88	330	17	0.004	11.4
10/12/88	320	27	0.004	10.4
11/09/88	340	15	0.029	10.8
04/19/89	130	8	0.01	3.8
05/25/89	135	18	0.013	4.2
06/08/89	122	12	0.002	3.6
07/17/89	185	14	0.002	7
08/23/89	270	14	0.001	9.5
09/13/89	260	16	0.001	10
10/17/89	300	14	0.004	10
11/15/89	250	19	0.04	9.8
12/12/89	250	17	0.005	8.3
01/23/90	210	17	0.004	7.6
02/13/90	210	15	0.004	7.2
03/21/90	130	14	0.005	4.8
04/18/90	140	20	0.003	2.3
05/11/90	150	26	0.008	5.3
07/20/90	210	23	0.009	8
08/22/90	250	23	0.006	10
09/29/90	300	21	0.006	10.6
10/29/90	260	30	0.004	10.8
11/09/90	250	27	0.004	9.7
12/04/90	260	27	0.003	10.9
01/04/91	269	23	0.003	11.4
02/11/91	224	23	0.003	10
03/27/91	165	28	0.005	6.6
04/30/91	158	72	0.004	5.1
05/16/91	195	46	0.021	9
06/12/91	411	157	0.059	21
06/19/91			0.012	8

07/25/91	270	42					0.008	9.8			
08/05/91	330	38					0.008	12			
09/13/91	500	124					0	20			
10/23/91	340	65					0.004	16			
11/19/91	300	69					0.003	12			
12/20/91	22	54					0.016	10			
01/17/92	250	38					0.003	11			
03/12/92	200	27			7.89		0.003	7.8			
04/22/92											
05/22/92											
06/03/92											
07/07/92											
08/05/92											
09/25/92											
10/06/92											
11/06/92											
12/15/92											
01/28/93											
02/18/93											
03/03/93											
03/15/93											
04/08/93											
04/30/93											
05/11/93											
05/27/93											
06/10/93											
06/25/93											
07/09/93											
07/31/93	274			1000	6.78						
08/09/93											
08/27/93											
09/08/93											
09/28/93											
10/13/93											
10/22/93											
11/12/93											
11/24/93											
12/10/93											
01/12/94											
01/12/94	490	162	325	826	7.69	0.36	-0.005	26.1	-0.005	-0.005	-0.005
01/27/94											
01/27/94	460	166	337	933	7.84	0.232	-0.005	27.9	0.006	-0.005	-0.005
02/08/94	470	171	345	332	7.84	0.281	-0.005	27.5	0.006	-0.005	-0.005
02/28/94											
02/28/94	370	144	280	2065	7.83	0.567	-0.005	22.5	0.032	-0.005	-0.005
03/15/94	210	57.3	149	2669	7.74	0.248	-0.005	11.1	0.023	-0.005	0.018
03/16/94											
03/28/94	170	59.4	155	2335	7.53	0.164	-0.005	11.7	0.013	-0.005	-0.005
04/07/94	250	69.4	159	2965	7.78	0.171	-0.005	12.8	0.013	-0.005	0.008
04/26/94	480	159	262	8404	7.86	0.124	-0.005	24.7	0.031	0.008	-0.005

05/27/94	350	134	251	8044	7.54	0.299	0.013	21.9	0.026	0.008	0.013
06/23/94	425	152	287	1489	8.2	0.143	0.012	26.6	0.017	-0.005	-0.005
07/28/94	495	144	334	504	8.1	-0.2	0.007	27.9	0.008	0.008	0.007
08/30/94	550			186	8.26						
09/28/94	475			280	7.61						
10/28/94	350	170	380	140	7.96	-0.2	-0.005	31.1	0.006	-0.005	-0.005
11/23/94				100							
12/21/94	270			200	8.05						
02/01/95	304			3000	7.72						
04/11/95	388	110	214	5850.6	8.37	-0.2	0.006	22	0.017	-0.005	-0.005
04/29/95	322	92.7	195	8571.6	7.69	0.302	-0.005	18.1	0.018	0.006	-0.005
05/30/95				30000	7.34						
06/29/95	30			16064.8	8.02						
07/26/95	440	136	276	2222	8.07	-0.2	0.01	26.9	0.035	0.014	-0.005
08/01/95	360			486.9	8.29						
09/01/95	345			768.3	8.18						
10/01/95	325	172	385	588.8	7.74	-0.075	-0.005	34.9	-0.004	0.003	-0.002
11/01/95											
12/04/95	543			1836	8.07						
01/16/96	365	144	287		7.57	0.23	-0.005	27.4	0.02	0.003	-0.002
04/01/96	273	68	164		8.25	0.2	-0.005	14.5	0.017	0.002	0.009
05/07/96											
06/05/96											
07/02/96	468	156	320		8.35	0.08	0.009	28.2	0.03	0.003	-0.01
07/02/96											
07/30/96		190	412		8.65	-0.05	0.01	38.2	0.017	0.004	-0.01
08/29/96											
09/26/96		190	393		8.3	-0.04	-0.005	36	-0.01	0.001	-0.02
11/04/96		250	483		7.98	-0.05	0.004	49	0.009	0.005	0.01
12/04/96											
04/14/97											
04/30/97	330	100	186	12500	8.28	0.1	0.006	20	0.014	0.002	0.02
05/14/97	402	140	262	35435							
06/16/97	326	110	209	17027							
06/27/97											
07/29/97	530	230	404	1693	7.9	-0.05	0.005	44	0.026	0.006	-0.01
08/26/97	587	176	404	668							
09/23/97	602	225	452	595							
01/26/98											
03/26/98	267	78.6	166	14582							
05/25/98	416	153	298	37920	7.64	0.03	0.007	31.1	0.074	0.004	-0.01
06/28/98	485	175	368	12215							
07/27/98	606	214	385	3012							
08/21/98	625	220	443	1444	8.21	0.06	0.009	42.8	0.006	-0.0005	-0.01
09/15/98	771	274	531	1118							
10/21/98	765	281	582	601	8.05	-0.01	0.008	51.7	0.009	0.003	-0.01
10/22/98	268	15					0.003	11.8			
11/24/98	1103	209	358	2161							
12/21/98	602	212	409	1016							
01/03/99											

01/29/99	544	157	337	6000	8.06						
02/03/99											
02/26/99	474	155	310	5000							
03/12/99	431	118	293	6903							
03/24/99						0.25	0.005	17.5	0.039	0.002	0.04
04/16/99											
04/28/99	297	93.5	179	9576	7.7	0.12	0.003	20.6	0.02	0.002	0.06
05/10/99											
05/25/99	416										
05/26/99											
06/06/99											
06/12/99	447	162	295	16560							
06/22/99											
07/22/99	652	228	415	3495							
08/18/99											
09/22/99	742	284	502	638	8.11	0.02	0.004	49.4	0.004	0.005	0.03
10/28/99	866	370	639	1887							
11/09/99	743	298	547	1657	8.09	0.01	0.003	54.7	0.007	0.005	0.02
12/01/99	781	317	563	2000							
01/01/00											
02/04/00	518	159	328		8.07	0.02	0.002	31.9	0.006	0.003	0.01
03/10/00	380	111	258	6500							
04/21/00	353	117	228	3692							
05/09/00	519	208	374	3109	7.82	0.12	0.005	41.6	0.033	0.004	-0.01
06/21/00	577	196	367	591							
06/28/00											
07/26/00	511	147	347	249							
08/17/00	480	99.4	309	140	8.14	-0.01	0.004	26.5	0.008	0.005	0.03
09/14/00	529	130	319	129							
10/04/00		215		150							
11/27/00	654	218	446	200	8.11	0.01	0.002	43.8	0.009	0.003	-0.01
12/07/00	580	135	326	150							
01/01/01											
02/16/01	547	170	310	500	7.76	-0.05	-0.001	31	0.006	0.002	-0.005
03/07/01	380	130	290	882							
04/21/01											
04/26/01	143	73	110	2000							
04/30/01											
05/11/01	440	190	320	3000							
05/24/01											
05/31/01											
06/25/01	434.2	200	360	750	8.12	-0.05	0.004	44	0.023	0.003	0.008
07/30/01	500	130	320	150							
08/21/01	387.5	110	260	120	8.05	-0.05	0.003	28	0.022	0.002	-0.005
09/28/01	550	140	340	150							
10/22/01	620	220	490	180							
11/01/01											
01/01/02	550	230	390	150							
02/01/02											
03/01/02											

Date	SWX EC	Sulfate	TDS	field	Al	As	Mg	Mn	Se	Zn
04/02/02										
04/12/02										
04/19/02	320	110	190							
05/04/02										
05/14/02	355	130	230							
05/29/02										
06/04/02	385	140	240		7.64	0.16	0.01	26	0.033	0.004	-0.01
06/14/02	361	130	280							
06/21/02										
07/10/02		230	430							
08/01/02										
08/07/02	480	140	300	750	7.83	-0.05	0.003	30	0.015	0.003	0.006
09/11/02	460	130	320	500						
10/18/02	457	140	300							
10/30/02										
11/07/02	540	160	370		7.89	-0.05	0.003	32	0.012	-0.003	-0.015
12/02/02	557	190	410	750						
01/01/03										
02/06/03	360	120	220		7.65	0.31	0.004	21	0.039	0.001	0.02
03/05/03	383	150	300	2000						
03/30/03										
04/13/03	190	79	170							
04/23/03	260	77	180		8.06	0.18	0.004	17	0.036	0.004	-0.02
05/03/03										
06/15/03		230	420							
07/14/03										
07/25/03	580	250	410	1431						
08/29/03	520	150	360		8.19	-0.05	0.002	27	0.004	0.002	0.028
09/16/03	510	140	330	552						
10/19/03	573	160	370	691	8.05	-0.05	0.001	31	0.005	-0.005	0.02
11/30/03	847	270	490	700						
12/05/03										
12/23/03		230	420	750						
01/01/04										
02/01/04										
03/07/04	465	140	150	1621						
03/21/04	230	71	150		7.98	0.49	0.004	14	0.041	-0.005	-0.02
04/09/04	319	120	210							
05/07/04	416	160	280							
05/27/04		150	280				0.007	33	0.027	0.005	0.01
06/02/04										
06/09/04										
06/28/04		170								
07/01/04	550	220	410	550						
08/01/04		160	530	500	8.15	-0.05	0.002	29	-0.001	-0.005	0.017
09/01/04	533	150	350	500						

				pH						
06/13/97	1356	780	1209	7.88	-0.1	0.008	150	0.29	0.01	0.03
07/29/97										
09/18/97	1310	914	1390	8.31	0.002	0.009	147	0.179	0.007	0.043
02/01/98										
06/08/98	1580	845	1390	8	-0.01	0.004	144	0.577	0.008	0.05
08/05/98	1710	963	1520	8.16	0.01	0.01	177	0.328	0.007	0.03
11/11/98	1530	770	1250	8.2	-0.01	0.007	109	0.017	0.009	0.01
06/29/99	1340	670	1130	8.22	-0.01	0.008	128	0.26	0.009	0.02
09/23/99	1620	888	1320	8.25	0.01	0.006	160	0.126	0.003	0.02
11/11/99	1540	861	1380	8.17	0.02	0.013	155	0.182	0.004	0.02
02/04/00	1050	400	780	7.85	0.01	0.009	76	0.258	0.004	0.03
05/01/00	1327	651	1070	8.06	0.02	0.009	115	0.28	0.006	0.03
08/22/00	1528	696	1270	8.14	-0.01	0.012	129	0.071	0.007	0.04
12/08/00	1543	810	1230	7.92	-0.01	0.02	152	0.146	0.003	-0.01

03/07/01	855	390	720	7.35	-0.05	0.023	68	0.47	-0.001	0.078
06/25/01	1427	770	1200	8.43	-0.05	0.004	150	0.12	0.004	0.01
09/27/01		890	1200	8.06	-0.05	0.012	170	0.082	0.006	0.014
10/29/01		890	1300	7.92	-0.05	0.006	160	0.19	0.006	0.018
04/12/02	260	100	170	7.56	-0.05	0.004	12	0.034	-0.006	-0.01
05/20/02										
08/05/02	1460	840	1300	8.17	-0.05	0.02	150	0.1	0.006	0.012
10/18/02	1500	920	1300	7.97	-0.05	0.009	160	0.081	0.005	-0.03
06/15/03	1500	820	1300	8.27	-0.05	0.01	150	0.2	0.009	0.04
08/11/03	1700	920	1500	8.18	-0.05	0.007	170	0.11	0.006	0.048
10/21/03	1800	1000	1600	7.95	-0.05	0.008	170	0.17	-0.01	0.03

05/05/04	1500	980	1400	8.13	-0.1	0.014	160	0.15	-0.01	0.03

	303 pit EC	Sulfate	TDS	field pH	Al	As	Mg	Mn	Se	Zn
06/13/97	1141	590	970	8.2	-0.1	0.006	98	0.025	0.011	-0.02
07/29/97	1277	710	1134	8.01	-0.1	0.006	110	0.018	0.007	0.02
09/18/97										
02/01/98										
06/08/98	1030	491	826	7.92	-0.01	0.005	74.4	0.021	0.008	-0.01
08/05/98	1360	714	1140	8.19	0.01	0.009	103	0.01	0.008	-0.01
11/11/98	1750	936	1480	7.9	-0.01	0.006	148	0.275	0.007	0.03
06/29/99	1260	638	1040	8.24	-0.01	0.009	101	0.011	0.01	0.01
09/23/99	1490	799	1200	8.3	0.02	0.012	107	0.007	0.008	0.01
11/11/99	1430	785	1270	8.2	-0.01	0.01	113	0.006	0.007	0.01

02/04/00	1570	737	1270	8.12	-0.01	0.013	107	0.002	0.007	0.02
05/01/00	823	380	621	7.98	0.01	0.008	58	0.01	0.006	-0.01
08/22/00	1509	690	1280	8.09	-0.01	0.017	109	0.011	0.01	0.04
12/08/00	1628	868	1320	8.04	-0.01	-0.001	137	0.025	0.007	-0.01
03/07/01	1076	820	1300	8.14	-0.05	0.033	120	0.04	0.006	0.035
06/25/01	1390	740	1200	8.48	-0.05	0.018	110	0.008	0.004	0.012
09/27/01		860	1200	8.16	0.1	0.022	140	0.016	0.01	-0.01
10/29/01		890	1300	7.94	0.07	0.02	140	0.27	0.008	0.014
04/12/02										
05/20/02	1200	680	1200	8.13	0.56	0.092	95	0.16	0.006	0.014
08/05/02	1500	840	1200	8.08	-0.05	0.023	120	0.059	0.008	-0.01
10/18/02	1400	900	1300	8.07	0.06	0.027	130	0.052	0.007	-0.03

06/15/03	1200	620	1000	8.36	-0.05	0.015	95	0.031	0.011	0.038
08/11/03	1500	820	1300	8.33	-0.05	0.02	120	0.022	0.008	-0.04
10/21/03	1600	830	1300	8.59	-0.05	0.028	130	0.025	-0.01	-0.04
05/05/04	1200	650	1000	8.23	-0.1	0.022	98	0.022	0.01	0.03