Kennecott Greens Creek Mining Co.
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Kennecott Minerals

16 June 2003

Ed Emswiler
Solid Waste
Alaska Department of Environmental Conservation
410 Willoughby Avenue, Suite 303
Juneau, AK 99801-1795

RE: 2002 Tailings and Production Rock Site 23/D Annual Report
Alaska Waste Disposal Permit 0111-BA001

Dear Ed:

Attached please find two copies of the Kennecott Greens Creek Mining Company (KGCMC) 2002 Annual Report for the Tailings and Production Rock Site 23/D. This second KGCMC Annual Report is submitted in satisfaction of Sections 3.6.7, 4.1.2.4, and 6.2 of the above referenced KGCMC Waste Disposal Permit. Waste Disposal Permit 0111-BA001 was issued during this report year on 16 August 2002 to KGCMC by the Alaska Department of Environmental Conservation – Solid Waste Program, replacing the previous permit 9911-BA006.

As can be seen, this year 2002 Annual Report, comprised of over 80 pages, is some 20 pages fewer than last year's Annual Report. Due to the ADEC request to last year's Annual Report for fuller compliance monitoring data, those data and analyses are provided this year in a separate report, the KGCMC Freshwater Monitoring Program, Annual Report – Water Year 2002, two copies of which were submitted together with this 2002 Waste Disposal Annual Report document.

The Freshwater Monitoring Program (FWMP) report to the U.S. Forest Service presents data collected from around the Tailings Area and Site 23/D, as well as data from Greens Creek and other KGCMC facilities near to the mine/mill concentrator, and comprises over 400 pages. This report has been prepared to satisfy the reporting requirements in the FWMP document. The report presents data for the "Water Year 2002": 1 October 2001 through 30 September 2002. The first section of this report presents information germane to the overall sampling and reporting efforts for Water Year 2002 (Introduction, Interventions, Mid-Year Modifications, Personnel Involved, Proposed Program Modifications, and comprehensive sampling and analyses information). The subsequent sections present data specific to each of the individual sampling sites. The final section, Appendix A, contains the Alaska Department of Fish and Game prepared bio-monitoring report for 2002, Technical Report No. 03-04: April 2003.

This year’s FWMP report is the first under the revised FWMP site comparison protocol to meet ADEC site data comparison standards. Comparisons between sites now employees a non-parametric statistical methodology, replacing the previous visual comparisons of notched-box-plots. Both methods utilize data medians for their comparisons. This change in method did not result in any differing data interpretations. However, it’s finer perspective provides a higher definition detail for between-sites comparisons of some elements.

Following your initial review of the documents, please contact me to discuss scheduling of the Public Meeting presentation (permit Section 6.3) of the materials. We will arranged staff schedules to ensure the appropriate KGCMC technical staff will be in town, and available to participate in the meeting.

Should you, or other ADEC staff, have any questions in reviewing these documents, please feel free to contact me here at the mine.

Sincerely,

William F. Oelklaus
Environmental Manager

Attachments

cc. USFS – Jeff DeFreest

Kennecott Greens Creek Mining Co.
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Kennecott Minerals

16 June 2003

Jeff DeFreest
Tongass Minerals Team
Juneau Ranger District
U.S. Forest Service
8465 Old Dairy Road
Juneau, AK 99801

RE: 2002 Tailings and Production Rock Site 23/D Annual Report

Dear Jeff:

Attached please find two copies of the Kennecott Greens Creek Mining Company (KGCMC) 2002 Annual Report for the Tailings and Production Rock Site 23/D. This second KGCMC Annual Report is submitted in satisfaction of monitoring aspects contained in Appendices 3 and 11 of the General Plan of Operations for the Greens Creek Mine, as well as Sections 3.6.7, 4.1.2.4, and 6.2 of the KGCMC Waste Disposal Permit 0111-BA001 issued on 16 August 2002 to KGCMC by the Alaska Department of Environmental Conservation – Solid Waste Program. Additional aspects of GPO Appendix 11 (other production rock management area's analyses) will be presented in a subsequent addition to the materials submitted today.

As can be seen, this year 2002 Annual Report, comprised of over 80 pages, is some 20 pages fewer than last year's Annual Report. Due to the ADEC request to last year's Annual Report for fuller compliance monitoring data, those data and analyses are provided this year in a separate report, the KGCMC Freshwater Monitoring Program, Annual Report – Water Year 2002, two copies of which were submitted together with this 2002 Waste Disposal Annual Report document.

The Freshwater Monitoring Program (FWMP) report to the U.S. Forest Service satisfies conditions of Appendix 1 of the GPO, as referenced in GPO Appendices 3 and 11. The FWMP report presents data collected, for the "Water Year 2002": 1 October 2001 through 30 September 2002 from around the Tailings Area and Site 23/D, as well as data from Greens Creek and other KGCMC facilities near to the mine/mill concentrator, and comprises over 400 pages.

This year's FWMP report is the first under the revised Appendix 1 - FWMP site comparison protocol designed to meet ADEC site data comparison standards. Comparisons between sites now employees a non-parametric statistical methodology, replacing the previous visual comparisons of notched-box-plots. Both methods utilize data medians for their comparisons. This change in method did not result in any differing data interpretations. However, it's finer perspective provides a higher definition detail for between-sites comparisons of some elements.

Should you, or other Forest Service staff, have any questions in reviewing these documents, please feel free to contact me here at the mine.

Sincerely,

William F. Oelklaus
Environmental Manager

TAILINGS AND PRODUCTION ROCK SITE
2002 ANNUAL REPORT

Kennecott Greens Creek Mining Company

June 2003

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APPENDICES

1.0 Executive Summary

This annual report has been prepared by Kennecott Greens Creek Mining Company in accordance with Alaska Waste Disposal Permit 0111-BA001 and the mine's General Plan of Operations Appendices 3 and 11. The following itemized list summarizes key information and indicates where in this report the information outlined in Section 6.2 of Permit 0111-BA001 is presented:

Permit Section		Report Section
6.2.1	Closure plan summary	2.8
	No changes to closure plan in 2002	
	Precipitation	2.4, 3.4
	Mill Site 63.7" Tailings 53.5" Extreme events in August and October	
	Summary of internal monitoring and fresh water monitoring plans	2.5, 3.5
	FWMP annual report separate in 2002 as per the ADEC request for full data presentation.	
	Internal monitoring water compositions at both sites dominated by Ca, Mg, SO_4, neutral pH, high alkalinity, high zinc, low to moderate concentrations of other metals. Data are consistent with sulfide oxidation and carbonate mineral buffering. Sulfate reduction in saturated zone of tailings pile yields low concentrations of all metals. Concentration of As higher in some tailings wells due to migration of redox boundary. Seasonal compositional fluctuations are evident in most wells/drains.	
	Stability	2.3, 3.3
	No signs of instability at either the Tailings Facility or Site 23. Foundation heads consistently low at both sites except for short-lived spikes in one piezometer (north end of West Buttress) and basal wells (south end Main Pile). Target densities achieved.	
	Updated stability analyses in progress	
	Cover performance	3.8
	>85% saturation maintained, barrier layer not subject to freeze/thaw cycles. Net percolation up to 19%. Installed cutoff trench above cover plot and sealed neutron access tube contact with bentonite.	
	Pond D flow and composition	3.4
	Average flow is about 70 gpm, similar composition to dilute Site 23 finger drains (e.g 23FD-3 and 23FD-6).	
	Summary of inspections	2.3, 3.3
	Inspections confirm compliance with WDP and GPO guidelines at both sites. Southeast Tailings ditch liner flap key-in was replaced with finer-grained material.	
6.2.2	Summary of inspections	2.3, 3.3
	Summarized above	
	Monitoring results	
	Summarized above	2.3, 3.3
6.2.3	Changes to GPO in 2002	
	Change monthly internal surface water and drain sampling to quarterly.	2.5, 3.5
	Change production rock placement protocol to minimize potential for zone of low carbonate (short lag time) materials (report Section 2.6).	

	Switch from Nuclear density testing of production rock to method specification (report Section 3.3).	
6.2.4	Location and volume of materials	2.2, 3.2, A1, A2
	East Tailings and West Buttress 290,000 total tons in 2002	
	Site 23 west end and north ramps 54,000 total tons 2002	
	Compaction	2.3, 3.3
	Target densities achieved in all nuclear density tests. Change to method specification for production rock	
	Acid Base Accounting	2.5, 3.5
	Potentially acid generating tailings and Class 2 and 3 production rock	
	Neutralization potential values continue to demonstrate long lag time (buffering capacity)	
	Class 1 is significantly acid neutralizing (about 50% carbonate)	
	Only 2 of more than 80 rinse pH values less than 5.0 (D Pond berm)	
	Possible water releases	2.5
	Tailings perimeter waters: removed pyritic southern access road, removed W. Buttress tailings residue, captured NW Diversion ditch, improved ditch to N. Retention Pond, capped artesian well for non-winter months. Continue to monitor water compositions for effects related to recent activities.	
	No new signs of possible release were identified in 2002.	
6.2.5	Information regarding validity, variations and trends	various
	Full FWMP data assessment in separate report	
	Internal Monitoring Plan variations are seasonal, no deleterious trends identified	

The report is separated such that all aspects of the tailings facility are discussed first in Section 2 followed by discussion of Site 23/D in Section 3. Information that is pertinent to both sections is generally not repeated but is discussed in the most relevant section and identified by reference in the other section.

2.0 Tailings area

2.1 Introduction

Kennecott Greens Creek Mining Company (KGCMC) has prepared this section of the Annual Report in accordance with the mine's General Plan of Operations (Appendix 3) and Alaska Waste Disposal Permit 0111-BA001. A summary of all operational and monitoring activities performed in 2002 is provided. Refer to GPO Appendix 3 and permit 0111-BA001 for a detailed description of the tailings facility and associated monitoring requirements.

KGCMC operated its tailings facility continuously in 2002. Primary placement areas included the East Expansion and West Buttress (see Tailings Facility as-built in Appendix 1). KGCMC added 160,500 cubic yards of material to the Tailings Facility in 2002, bringing the total facility volume to approximately 1,665,000 cubic yards. Approximately 264,600 tons of tailings were placed at the tailings facility during this report period with a total placement of all materials at the tailings facility totaling approximately 290,700 tons as calculated from KGCMC surveyed volumes.

2.2 Placement records

Table 2.1 contains the monthly placement records for tailings, production rock and other materials (e.g ditch sediments) at the tailings facility for 2002. Surveyed volumes (cubic yards) were converted to tons using a tonnage factor of 1.8117 tons per cubic yard (134.2 pcf for tailings). Production rock used for road access and erosion control contributed approximately 17,000 tons to the facility. 9100 tons of materials such as sediments from ditch maintenance, other construction rock (crushed quarried rock) and a minor amount of treated sewage sludge were also placed at the facility in 2002. The calculated tonnage of tailings was derived by subtracting the tons of production rock and other material from the surveyed total. The pile currently contains approximately 3.02 million tons of material. Based on the survey data presented in Table 2.1 there is a remaining capacity of approximately 485,000 tons in the existing facility. Estimates of other miscellaneous materials disposed in the facility are shown in Table 2.2

Table 2.1 Tailings Placement Data

	All Materials Monthly Total	All Materials Cumulative total	All Materials Monthly Total	All Materials Cumulative Total	Prod Rock from Site 23	All Other Materials (Ditch Seds and Contruction)	Tailings
Date	survey (yd^3)	survey (yd^3)	tons(calculated)	tons (calculated)	tons (truck count)	tons (truck count)	tons(calculated)
01/31/02	13,303	1,517,881	24,101	2,749,945	135	0	23,966
2/28/2002	11,408	1,529,289	20,668	2,770,613	1770	810	18,088
3/31/2002	16,409	1,545,698	29,728	2,800,341	2580	170	26,978
4/30/2002	13,158	1,558,856	23,838	2,824,179	2430	162	21,246
5/31/2002	14,678	1,573,534	26,592	2,850,772	200	1123	25,269
6/30/2002	18,298	1,591,832	33,150	2,883,922	1734	0	31,416
7/31/2002	15,816	1,607,648	28,654	2,912,576	1016	1800	25,838
8/312/02	13,923	1,621,571	25,224	2,937,800	3510	2145	19,569
9/30/2002	9,578	1,631,149	17,352	2,955,153	45	855	16,452
10/31/2002	15,468	1,646,617	28,023	2,983,176	1879	971	25,173
11/30/2002	11,168	1,657,785	20,233	3,003,409	1395	685	18,153
12/31/2002	7,270	1,665,055	13,171	3,016,580	272	416	12,483
Totals	**160,477**	**1,665,055**	**290,736**	**3,016,580**	**16,966**	**9,137**	**264,633**
Tons calculated at 134.2 pounds per cubic foot for tailings							

Table 2.2 Miscellaneous Materials Disposal Estimates

Tailings	yds^3
Pressed Sewage Solids	50
Pressed Water Treatment Plant Sludge	500
Incinerator Ash	16
Underground	yds^3
Tires	500 ea
Sump Sediments	3640
Shop Refuse	728
Mill Refuse	312
Electrical Refuse	120

2.3 Stability

Tailings placement compaction was regularly tested throughout the year to monitor the performance goal of achieving 90 percent or greater compaction relative to a standard Proctor density. KGCMC staff utilizes a Troxler Model 3430 nuclear moisture-density gauge to measure wet density and percent moisture content of placed tailings. Typically one or more sites per active placement cell are selected on a monthly basis and a series of 1 minute replicate measurements at a 12-inch depth are taken. Dry densities are calculated and compared to laboratory measured standard Proctors.

Compaction

Summary results for 2002 are shown in Table 2.3. Standard Proctor values were measured on nine samples taken from the tailings-loadout facility at the 920 throughout the year and submitted to an outside materials testing lab, which preformed the test within the ASTM guidelines for method #D698. The mean standard Proctor value was 137.2 PCF (pounds per cubic foot), which compares closely to previous data.

Field measurement results show a high degree of achieving greater than 90% compaction with respect to an average Standard Proctor value of 137.2. Density results obtained using the Troxler procedure were compared with those from another procedure (Rubber Balloon Method ASTM D-2167) at 10 sites in 2002. The Troxler densities averaged 8 percent higher than the densities obtained via the comparative method, however the average density indicated by the rubber balloon method also exceeded the 90% target (92%).

Table 2.3 Summary statistics for 2002 tailings compaction testing data

Compaction Variable	Mean	Max	Min	Std. Dev.	n
Std. Proctor (ASTM #D698)	**137**	142	124	5.29	9
Opt. Moisture (%)	13.3%	16.1%	12.3%	1.1%	
Measured Dry Density	139	141	136	1.16	31*
Measured moisture (%)	9.8%	14.8%	4.1%	3.0%	
Rel. Compaction % **	106.9%	121.8%	92.3%	7.5%	

* n=31 represents the number of individual sites at which multiple replicates were taken.

** Percent compaction calculated with respect to corresponding monthly proctor.

Inspections

Several independent inspections are carried out at the tailings area throughout the year. Operators working at the site carry out daily visual-work place inspections. The Surface Civil Engineer and or Surface Operations Manager carry out weekly visual inspections. The environmental department carries out a monthly checklist inspection of Pond 6. No visible signs of physical instability were observed at the tailings facility during this report period.

During 2002 the USFS inspected the facility 42 times (Site inspections #92-#134) to monitor for Best Management Practices effectiveness and compliance to the General Plan of Operations. No issues of non-compliance or poor operations practices of the surface tailings facility were noted during the inspections. Concerns regarding placement of coarse rock near the tie-in for the Southeast Tailings ditch liner were addressed, and after discussion with Klohn Crippen engineers, the coarse material was replaced with finer-grained aggregate.

Well and piezometer water level data

Pneumatic piezometer and well water level data for the tailings site are presented in Figures 2.1 to 2.22. Well and piezometer locations and water level cross sections are shown on the tailing facility as-built (Appendix 1). Piezometers 43, 48, and 73 and monitoring well MW-T-B2 have been decommissioned since the last report, and replacement or redundant completions are currently in place. Water levels at several measurement points showed greater fluctuation in 2002 relative to 2001. Two periods of high precipitation (February and August through December) had measurable effects on several piezometers and wells, particularly in the western and southern portions of the pile. Instruments in the south (MW-T-00-05A, PZ-T-00-01, PZ-T-00-02, PZ-T-00-03) showed up to 5 feet of change between wet and dry periods. Piezometer 76, completed in the northern portion of the West Buttress showed approximately 10 feet of head fluctuation, however pore pressures decreased quickly to near-zero values. Routing of the Northwest Diversion Ditch into the West Buttress toe ditch in 2002 may be exerting a localized influence on hydrologic system in this area.

Section CC of the Tailings Facility as-built shows the inferred water table in the tailings pile. The maximum saturated thickness (approximately 45 feet) occurs near the center of the main portion of the pile. However, that water table level does not extend close to the down-slope toes of the pile. The foundation of the West Buttress and southern portion of the pile is well drained, as indicated by typically unsaturated conditions in the blanket drains (MW-T-00-05A, Figure 2.14) and at the base of the West Buttress (piezometers 74, 75, 76 in Figures 2.8, 2.9, 2.10). Low head elevations near the pile toe maximize the pile's geotechnical stability. The head increases observed in 2002 appear to be localized and of short duration and should not have an adverse effect on pile stability, however KGCMC will continue to monitor and evaluate these conditions closely.

The data from standpipe piezometers completed above the blanket drain (PZ-T-00-01, PZ-T-00-02, PZ-T-00-03 in Figures 2.11, 2.12, 2.13) indicate that the water perches above the unsaturated underdrains to a thickness of approximately 12 feet. This is consistent with the low permeability of the tailings and the un-capped condition of the pile. Covering the pile will help minimize the saturated zone in the pile. This was demonstrated by the 10+ foot decrease in the water table that occurred from 1995 to 1997 when the pile was covered (see Figures 2.1 to 2.7). Water levels have rebounded to, and in some cases above, 1994 elevations in most areas. Areas where water levels exceed their 1994 values are areas where the pile is considerably thicker than it was in 1994.

Water levels for four wells completed east and west of the pile are shown for comparison in Figures 2.15 to 2.18. The eastern wells, MW-T-00-3A (Figure 2.15) and MW-T-00-3B (Figure 2.16), are completed in the shallow sands 12 and 17 feet, respectively, below ground surface. The shallower well shows a water table at the surface and the deeper well indicates a water elevation about three feet below ground surface throughout 2002. The water table remained close to an elevation of 228 feet in 2002. Wells MW-T-01-03A and MW-T-01-03B are installed west of the pile. Their water levels are shown in Figures 2.21 and 2.22, respectively. MW-T-01-03A is completed in bedrock to a depth of 20 feet and MW-T-01-03B is completed in clayey silt to a depth of 12 feet. The bedrock well indicates a water elevation of 125 feet and the clayey silt well shows a water elevation of 130 feet. Figure 2.18 suggests that it may have taken approximately six months for the water level to equilibrate after it was baled dry following a slug injection test in February 2001. If this is the case it reflects the very low permeability of the clayey silt. The bedrock well shows approximately two feet of fluctuation with levels near 125 feet. The ground surface elevation is 134 feet in the proximity of the two wells.

Figure 2.1 Water Level Data for Piezometer 41

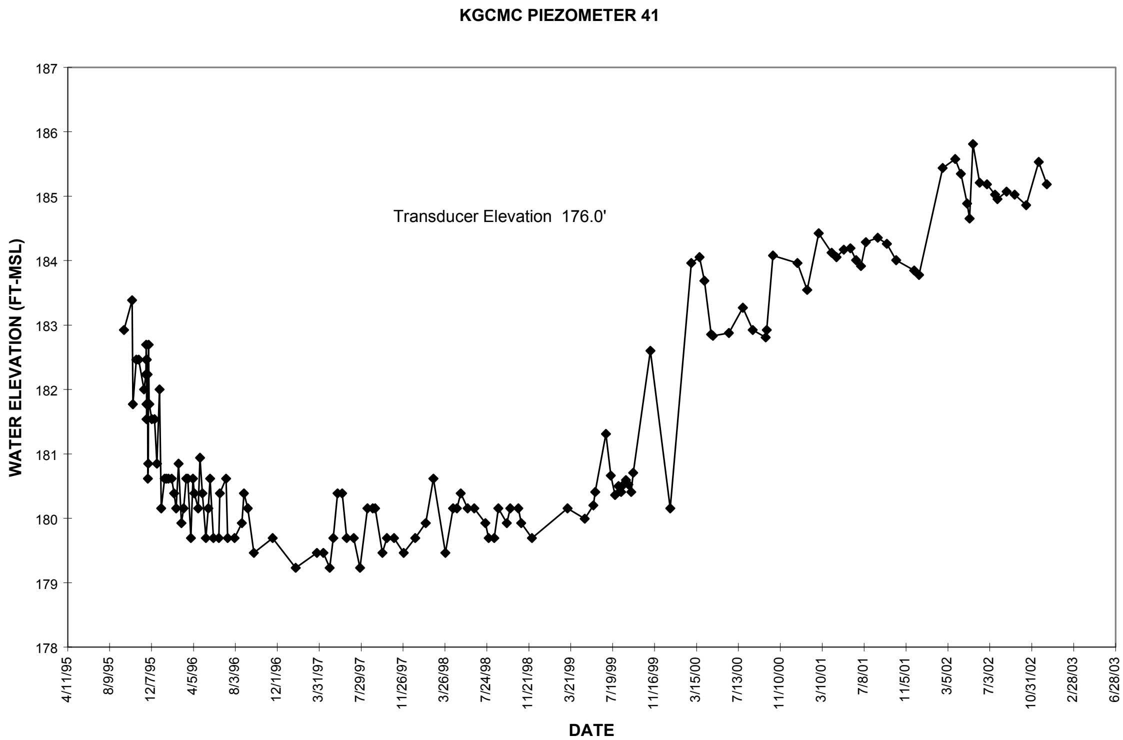


Figure 2.2 Water Level Data for Piezometer 42

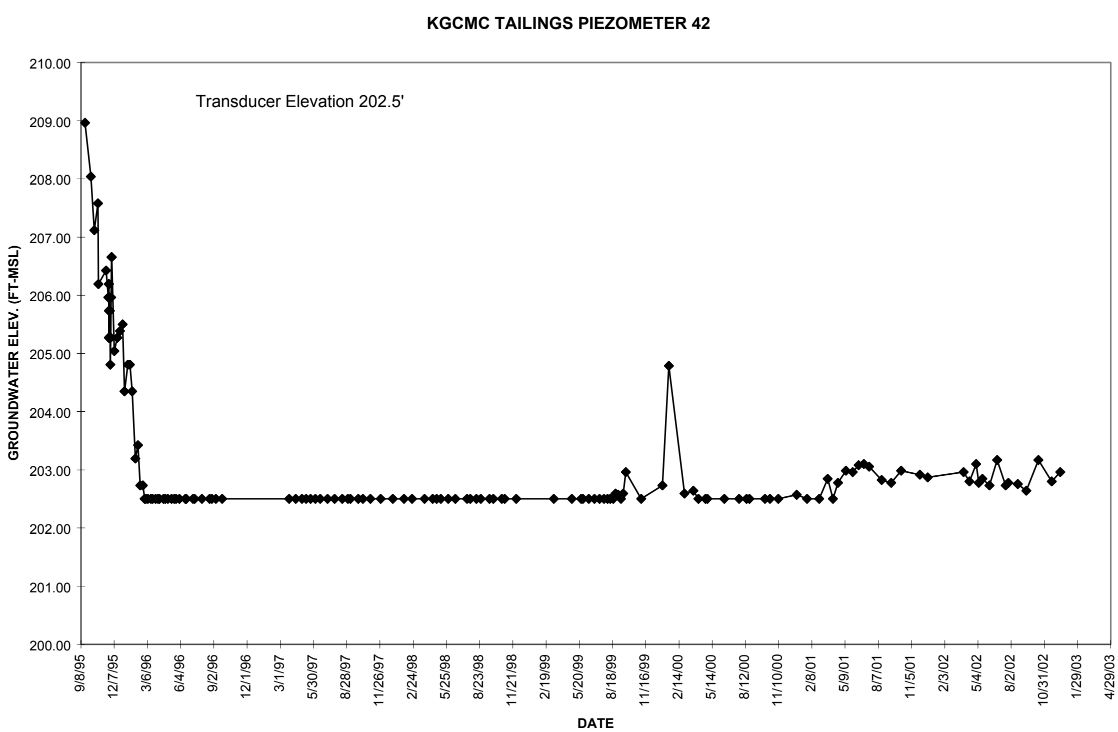


Figure 2.3 Water Level Data for Piezometer 44

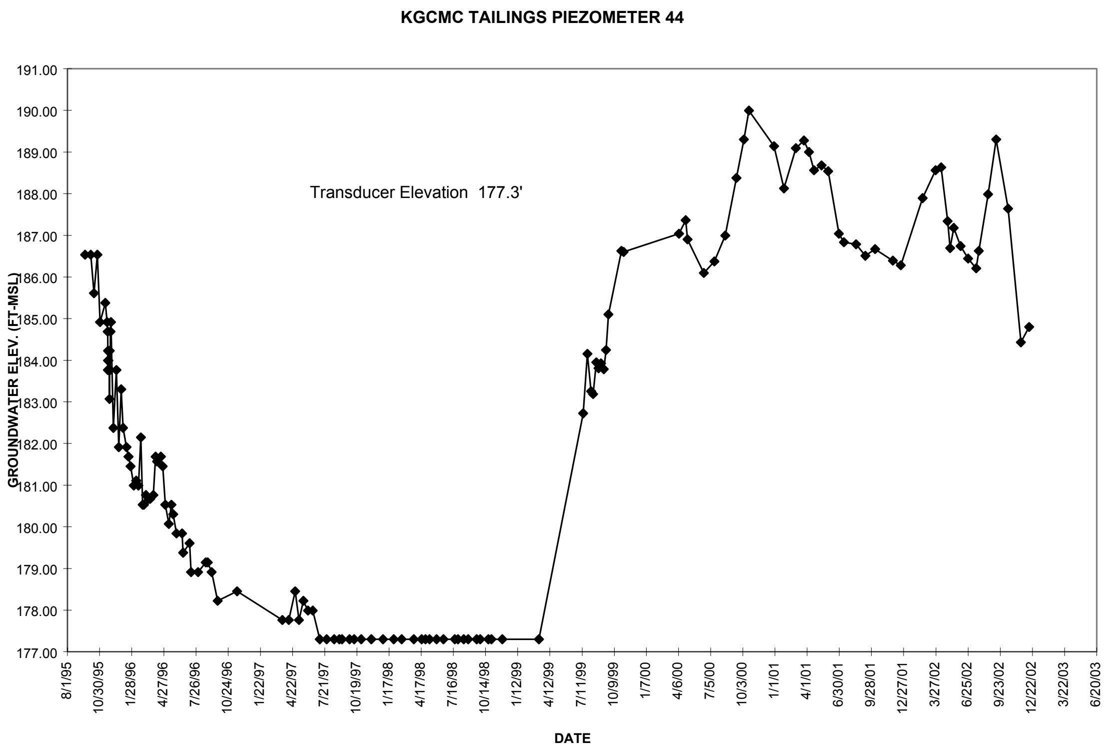


Figure 2.4 Water Level Data for Piezometer 46

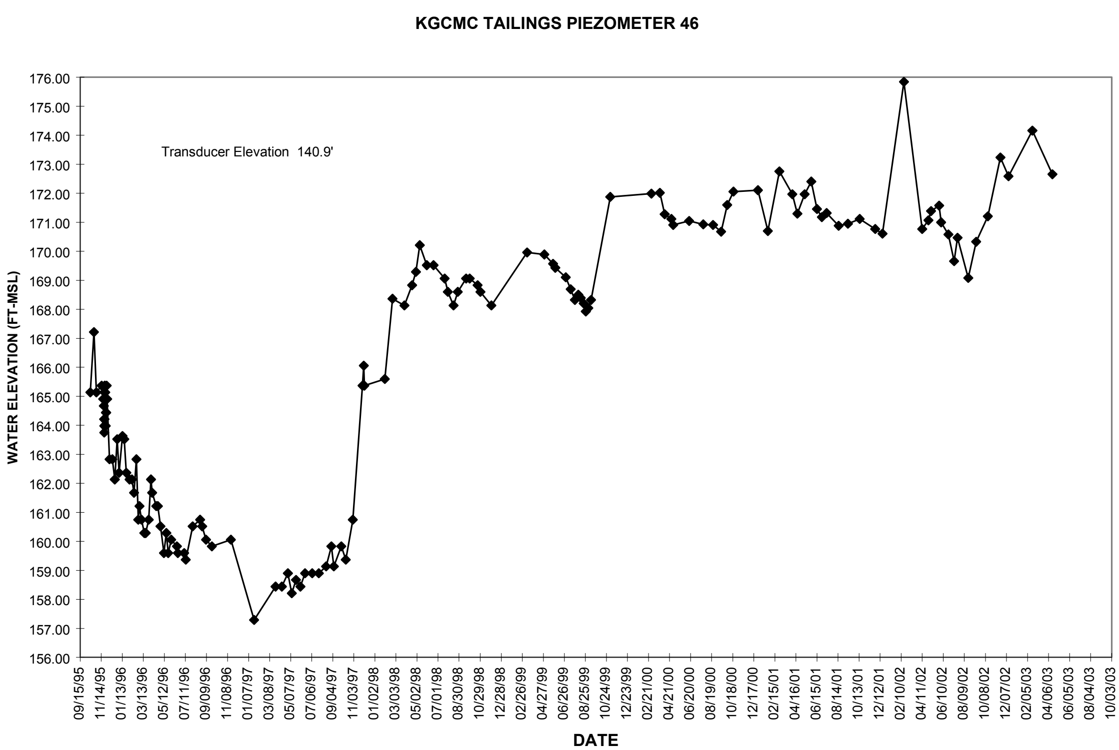


Figure 2.5 Water Level Data for Piezometer 47

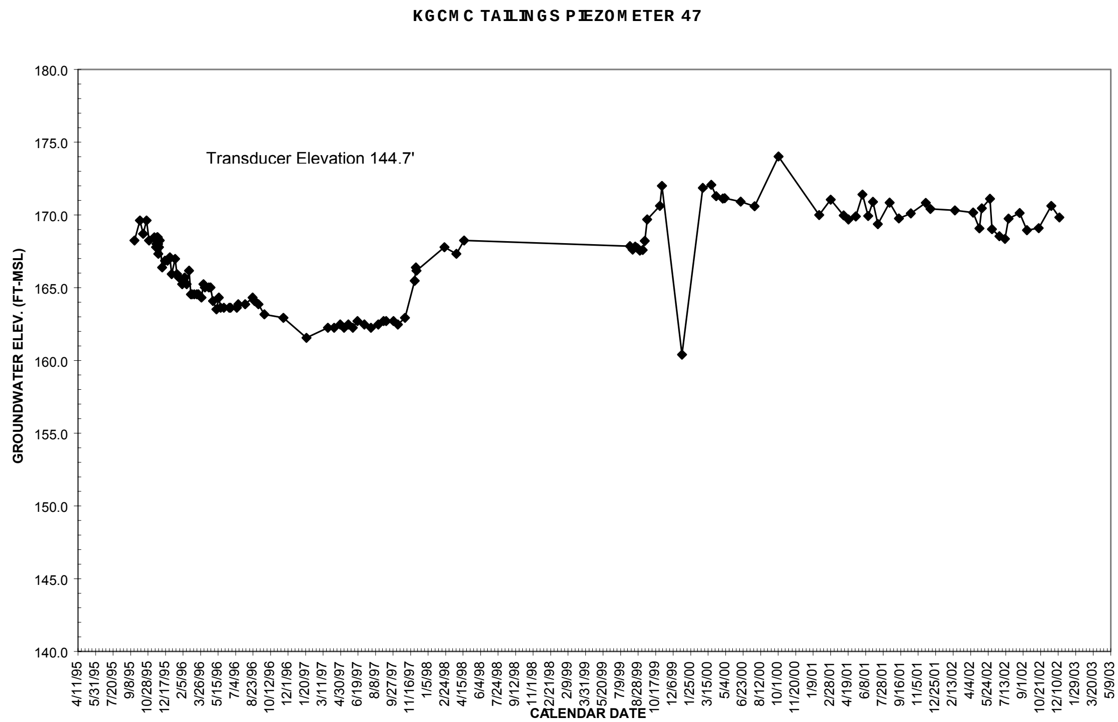


Figure 2.6 Water Level Data for Piezometer 50

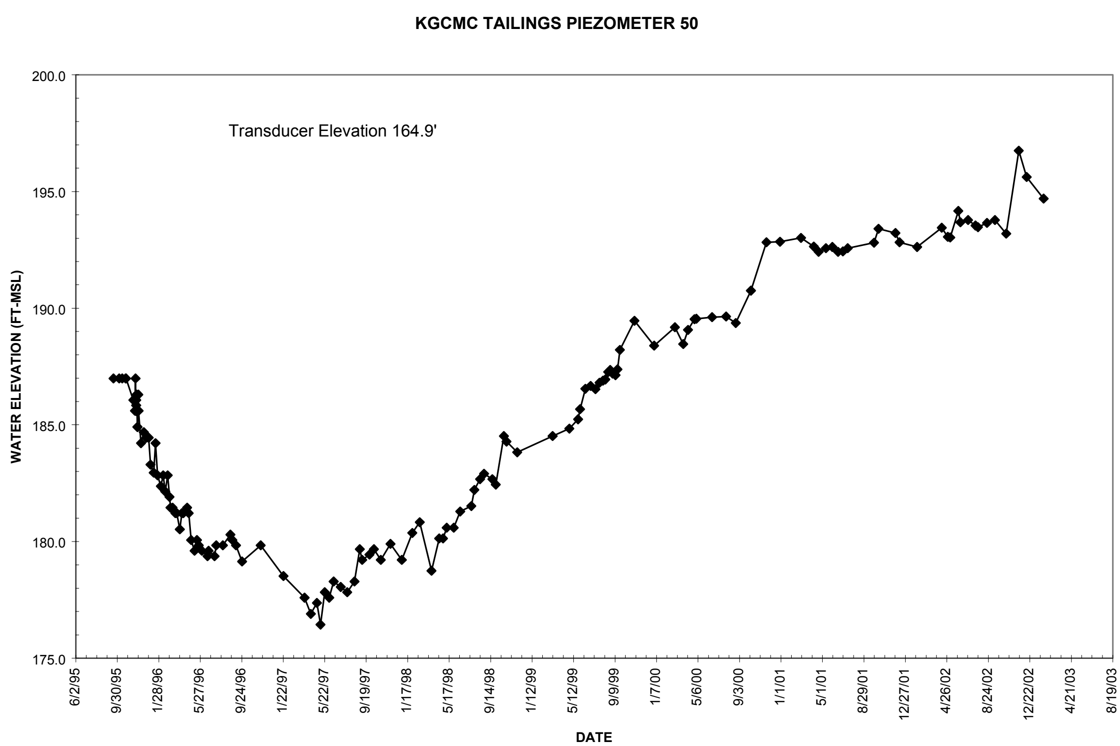


Figure 2.7 Water Level Data for Piezometer 51

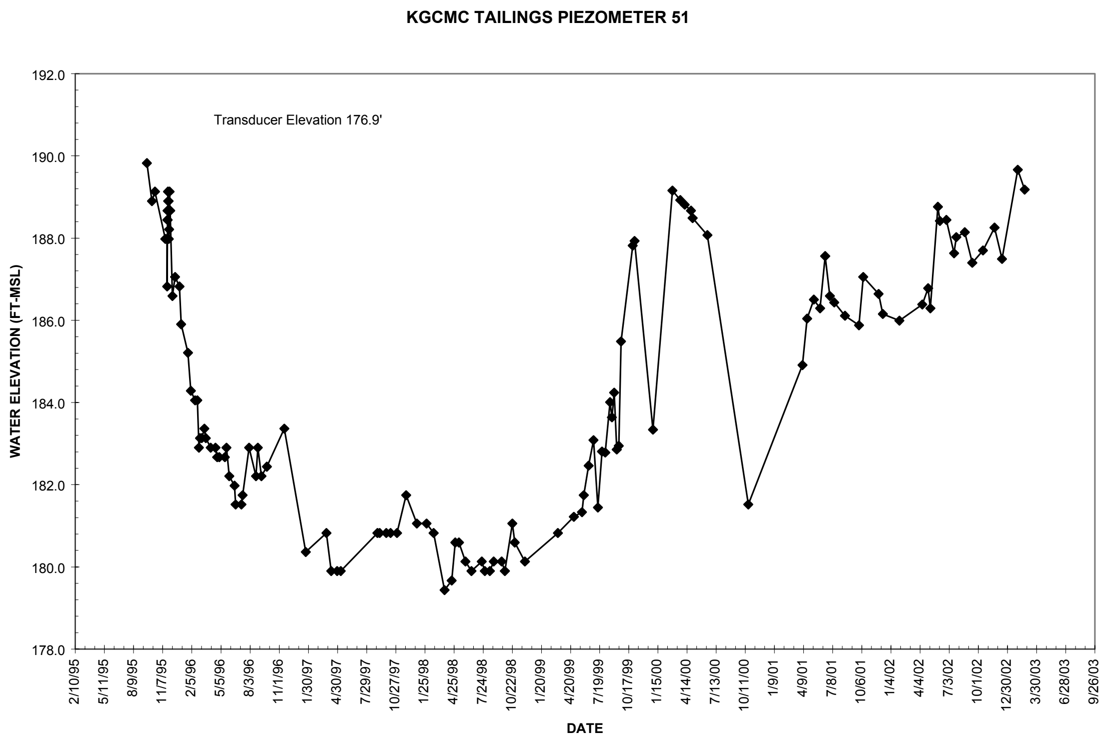


Figure 2.8 Water Level Data for Piezometer 74

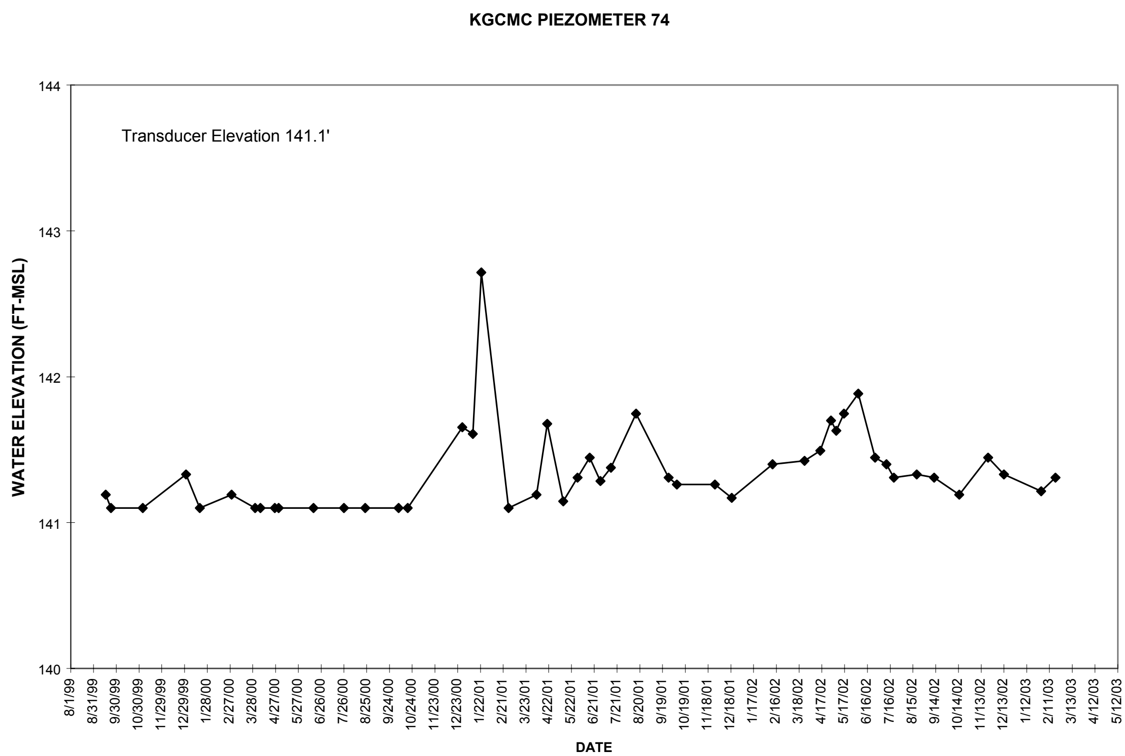


Figure 2.9 Water Level Data for Piezometer 75

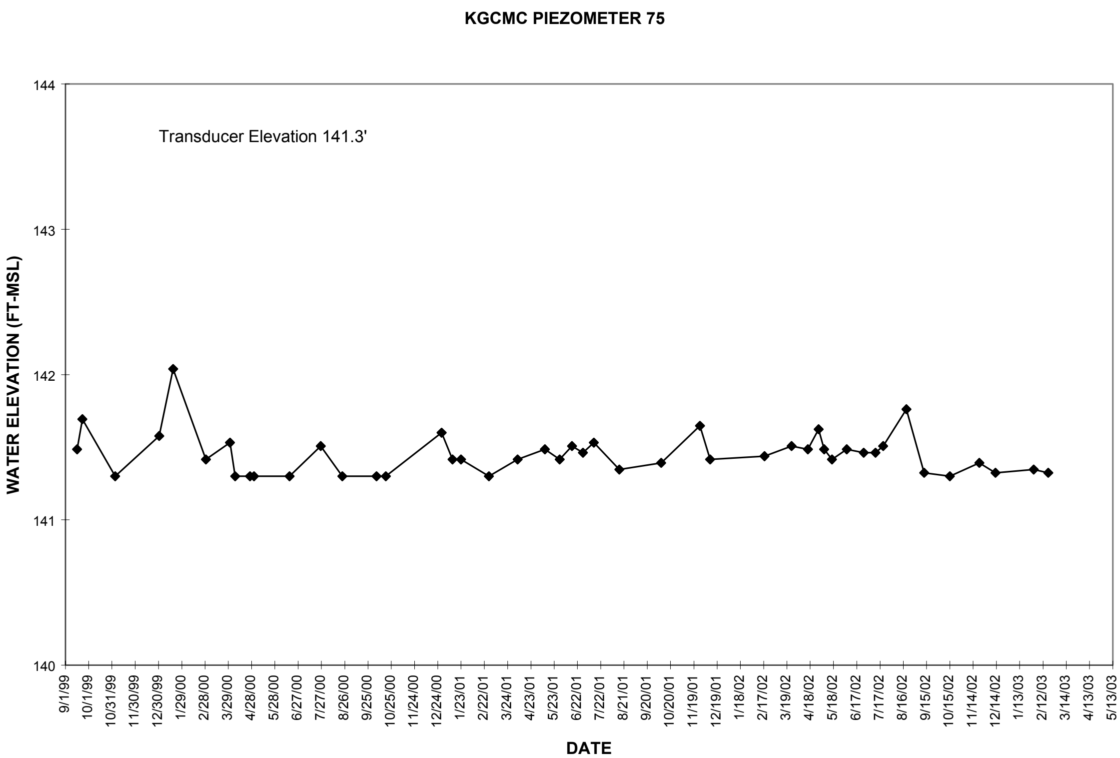


Figure 2.10 Water Level Data for Piezometer 76

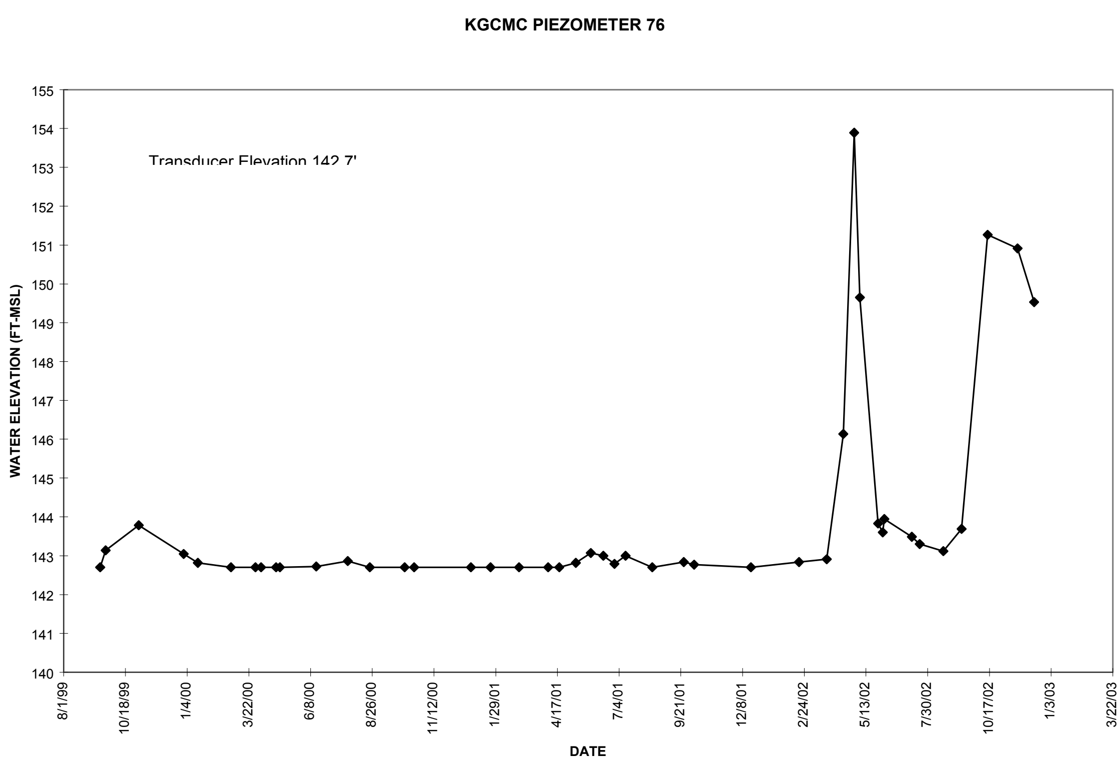


Figure 2.11 Water Level Data for Standpipe Piezometer PZ-T-00-01

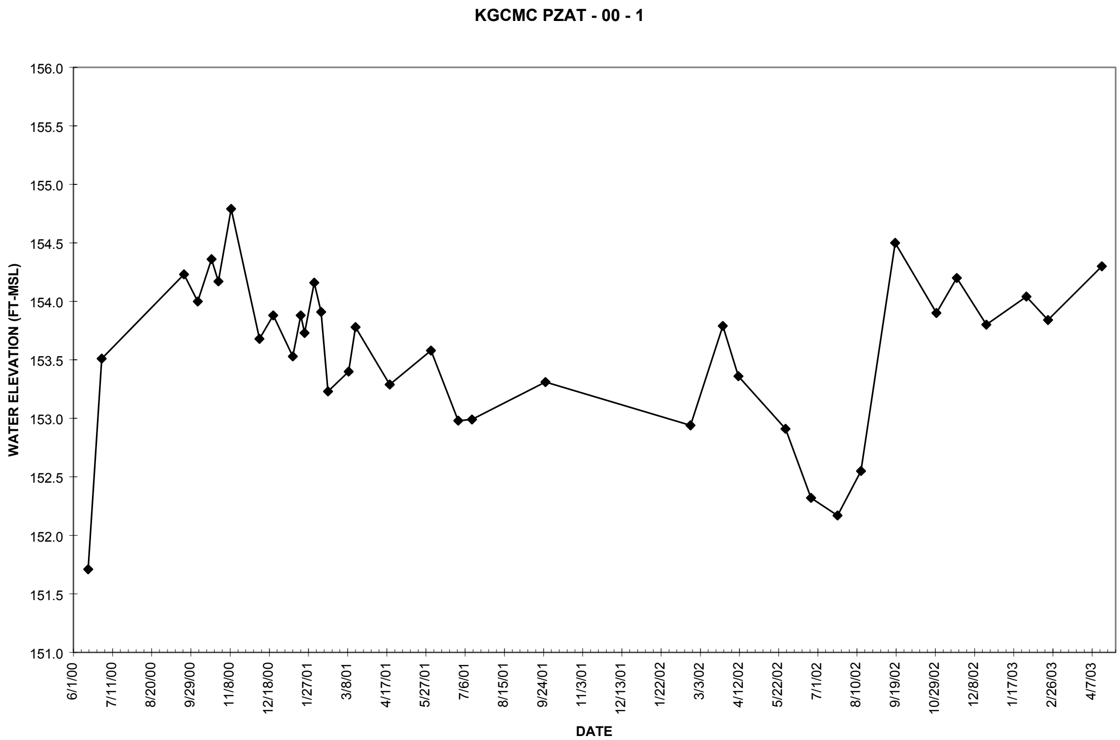


Figure 2.12 Water Level Data for Standpipe Piezometer PZ-T-00-02

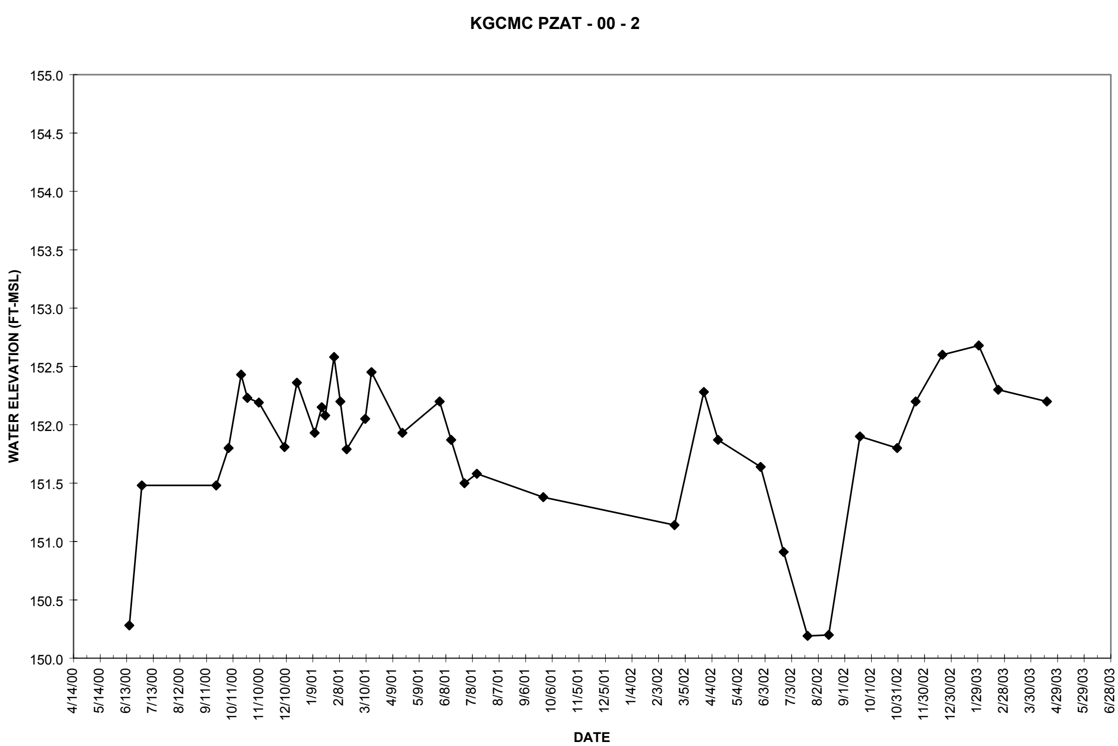


Figure 2.13 Water Level Data for Standpipe Piezometer PZ-T-00-03

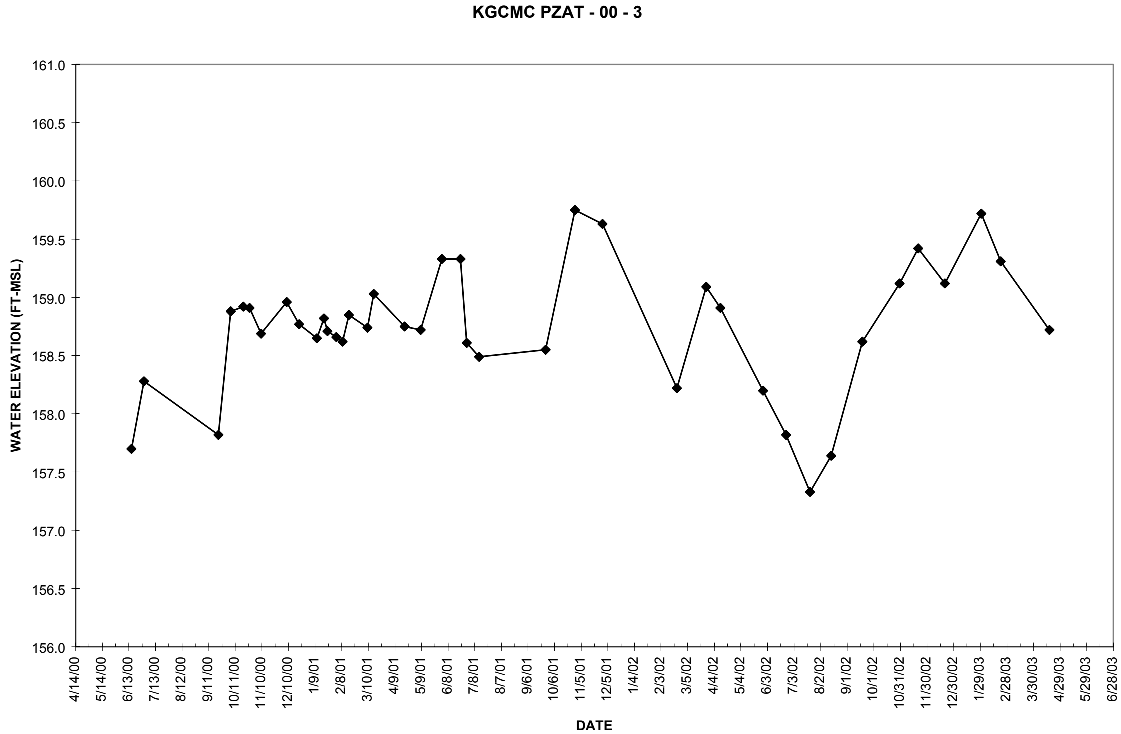


Figure 2.14 Water Level Data for Well MW-T-00-05A

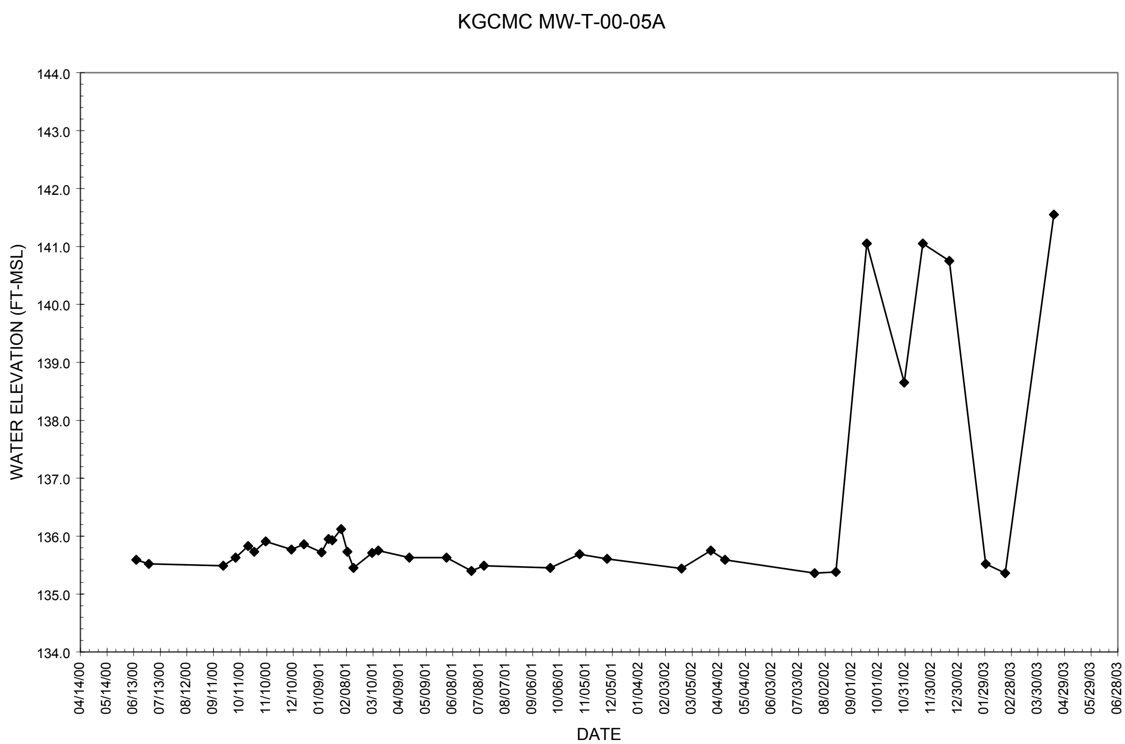


Figure 2.15 Water Level Data for Well MW-T-00-3A

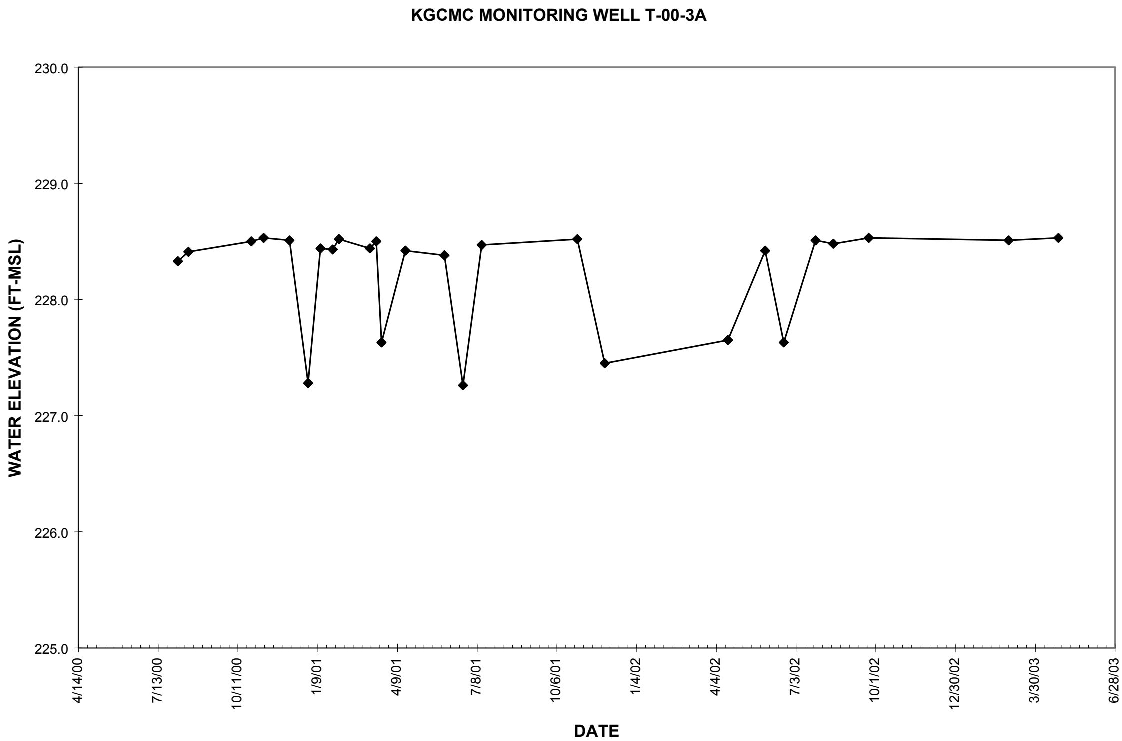


Figure 2.16 Water Level Data for Well MW-T-00-3B

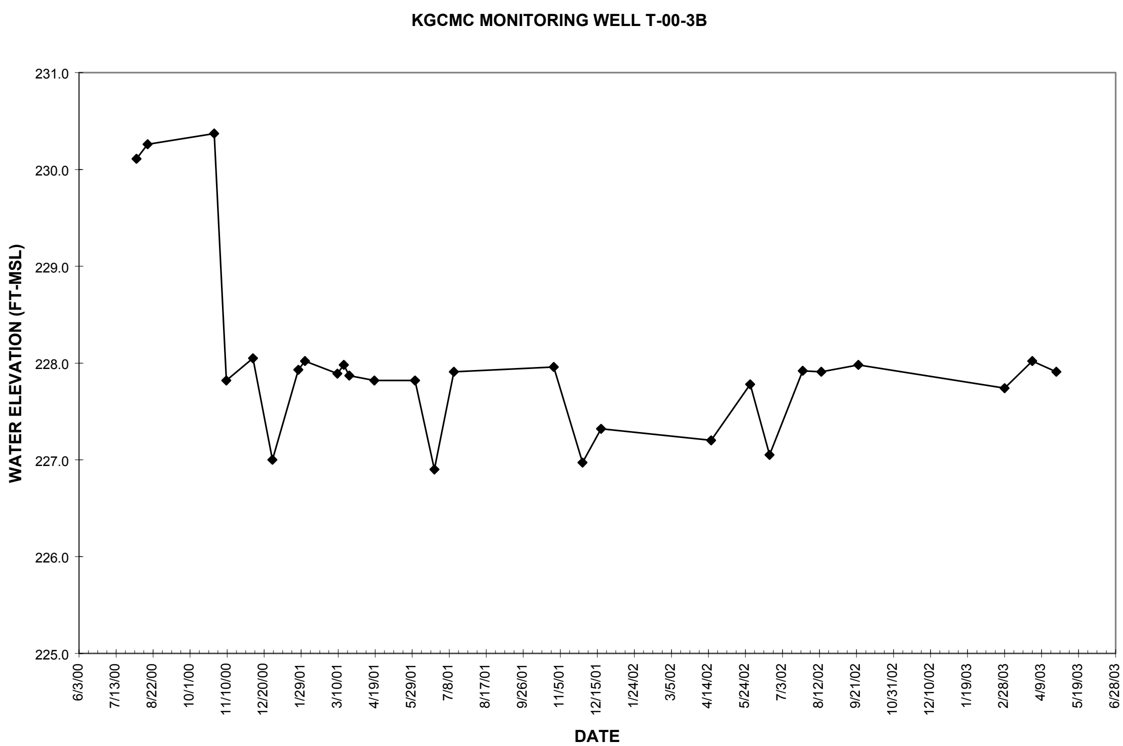


Figure 2.17 Water Level Data for Well MW-T-01-03A

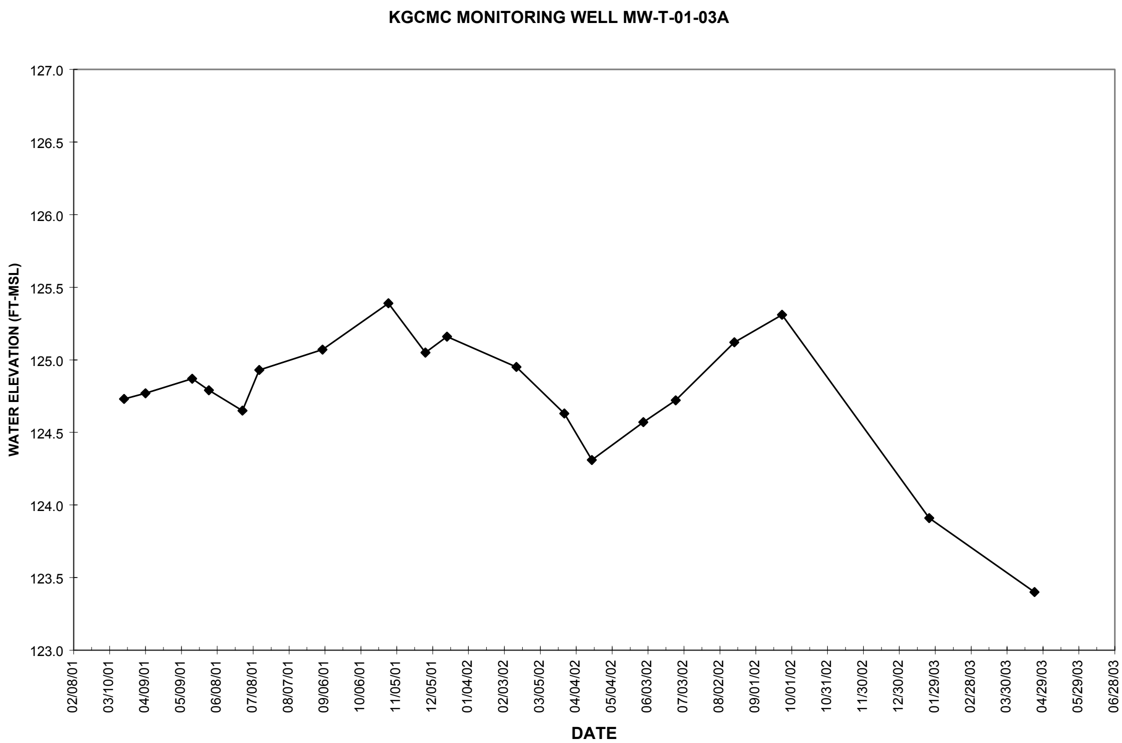
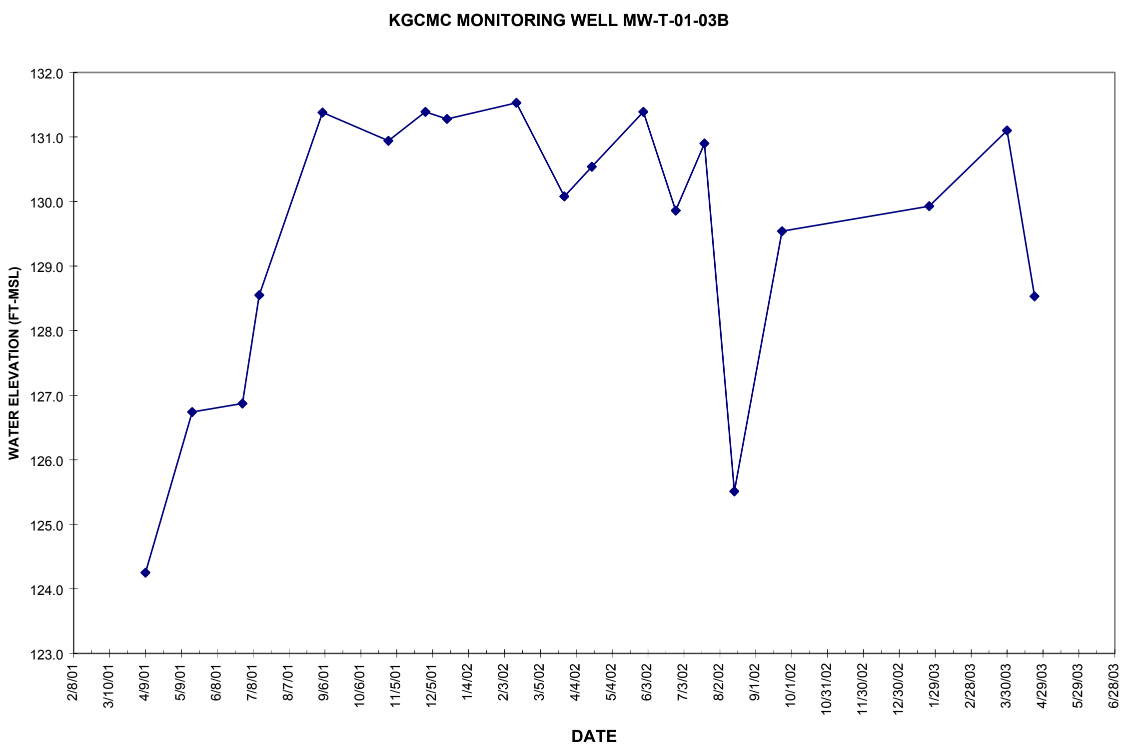


Figure 2.18 Water Level Data for Well MW-T-01-3B



2.4 Hydrology

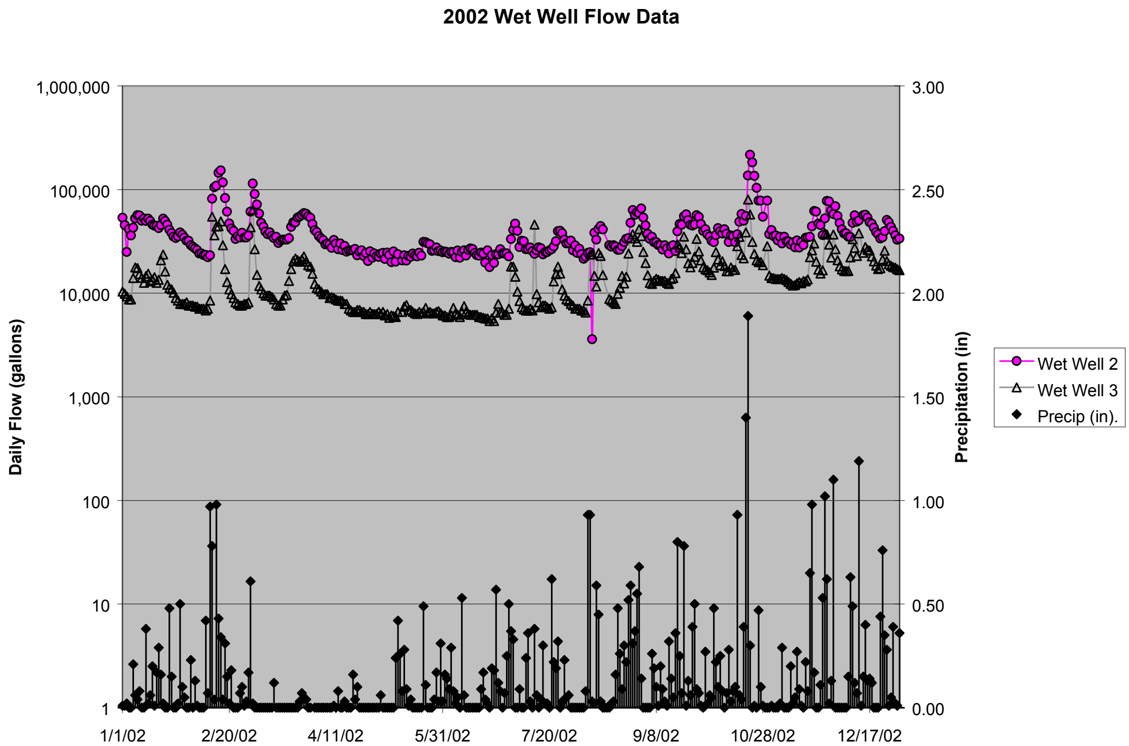
A detailed review of the hydrology of the tailings facility was performed by Environmental Design Engineering (EDE) in 2001 (EDE 2002a). The report describes the hydrogeology of the site and presents calculations of anticipated post-closure hydrologic conditions. Water management at the facility consists of a complex network of drains under the pile, bentonite slurry walls around the perimeter of the site, and ditches to divert up-slope water and collect surface runoff. See the tailings facility as-built for locations of the site's water management components. The site is underlain by a low permeability silt/clay till and other glacial/marine deposits or an engineered HDPE liner. These features minimize the potential for the downward migration of contact waters. An upward hydrologic gradient under the site further improves contact water collection.

Precipitation and temperature data are presented in Table 2.4. The wettest months were October (7.69 in) and August (7.64). April was the driest month with only 0.42 inches. The area received relatively little precipitation from March through July and experienced four high precipitation periods in February, August, October and November. Flow data from Wet Wells 2 and 3 are presented with precipitation data in Figure 2.19. The wet well flows respond relatively quickly to precipitation events, demonstrating a significant contribution of surface water. The increase in Wet Well 3 flow relative to Wet Well 2 in the second half of the year seem to be a result of routing the Northwest Diversion Ditch into the West Buttress toe ditch.

Table 2.4 Monthly Summary of Tailings Area Climate Data

Month	AvgTemp (°C)	Precipitation (inches)
January	-0.33	3.04
February	-0.45	5.31
March	-1.45	1.11
April	2.77	0.42
May	7.84	2.66
June	11.53	3.2
July	12.58	4.46
August	12.95	7.64
September	9.95	5.06
October	7.36	7.69
November	5.14	6.59
December	1.05	6.27
2002	5.74	53.45

Figure 2.19 Tailings Area Wet Well Flow Data



2.5 Water Quality

Compliance Monitoring

Water sites around the surface tailings storage facility have been monitored continuously since 1988. This sampling pre-dates the placement of tailings at this facility. The FWMP Annual Report for water year 2002 is being prepared separately and will be submitted to the Forest Service and ADEC upon completion. The full FWMP report provides the additional, full data and analyses requested by ADEC in comments to last year's Tailings and Production Rock Annual Report.

Internal Monitoring

As described in Solid Waste Permit Number 0111-BA001 Section 2.8.3.1, the internal plan addressed monitoring at both the surface tailings facility and the surface production rock storage areas covered by the permit. The Internal Monitoring Plan describes monitoring within the pile areas, in contrast to the compliance monitoring (under the Fresh Water Monitoring Plan) at peripheral facility boundary sites. As such, data generated by the Internal Monitoring Plan effort are "… not for compliance purposes…" as noted in the above referenced permit Section 2.8.3.1., but provide a continuing perspective on in-pile geochemical processes.

While the Internal Monitoring Plan sets minimal monitoring standards, KGCMC generally conducts additional monitoring over and above those requirements. As the opportunity arises, or the need is seen, such additional sampling may include sampling of different media, more frequent samples from the monitoring plan-specified locations, or perhaps analyses of samples for additional constituents. Instances also arise where sampling of different locations/sites is conducted. While not required to present these additional data, KGCMC has chosen to generally include much of such extra data in this report as it is felt to help better understand conditions at the permitted areas. Collection of these extra data may or may not continue, based upon changing conditions and/or need of KGCMC.

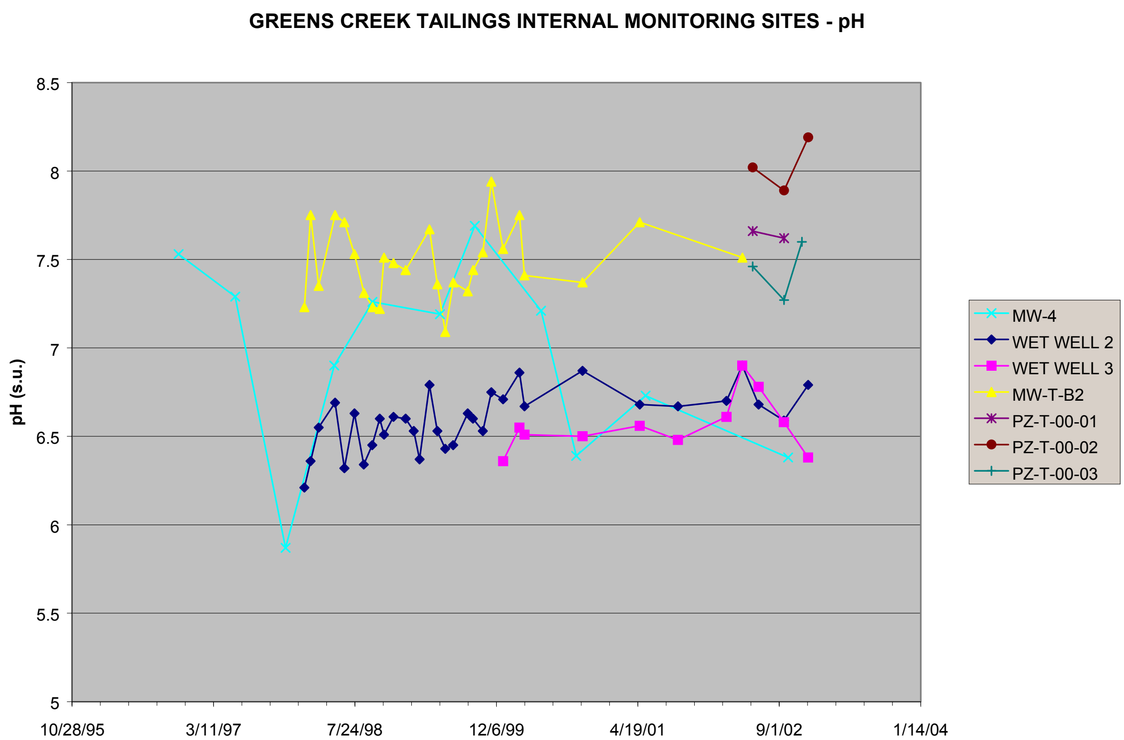
The results of KGCMC's internal site monitoring plan are summarized in Figures 2.20 to 2.29. Samples were collected from Wet Well 2, Wet Well 3, MW-T-B2, MW-4, PZ-T-00-01, PZ-T-00-02 and PZ-T-00-03 (see as-built in Appendix 1 for locations). A constriction of the well casing at depth has hindered sampling of MW-T-B2 and this well was decommissioned in 2002. Its replacement (MW-T-02-18) was drilled in 2002 and will be sampled once drilling-induced conditions around the well screen subside. Standpipe piezometers PZ-T-00-01, PZ-T-00-02 and PZ-T-00-03 are completed in a similar statigraphic position as was MW-T-B2. The data from these wells are included on this year's figures.

An in-depth evaluation of the hydrology and geochemistry of the tailings facility was performed by Environmental Design Engineering (EDE) and KGCMC in late 2001 (EDE 2002a, EDE 2002b, KGCMC 2002). The observations made under the 2002 internal monitoring plan are consistent with the findings of the EDE and KGCMC reports.

All internal monitoring waters are captured and treated prior to discharge to the ocean floor under KGCMC's National Pollutant Discharge Elimination System Permit (AK 004320-6).

Values of pH were between 6 and 8.5 for all internal monitoring site samples in 2002 (Figure 2.20). MW-T-B2, PZ-T-00-01, PZ-T-00-2 and PZ-T-00-3, which screen the lower ten feet of tailings pile, have the highest pH of the internal monitoring sites. This is likely a result of microbial sulfate reduction and equilibration with carbonate in the saturated zone of the pile. The wet wells and MW-4 produce water with slightly lower pH (generally between 6.5 and 7), reflecting minor influences from groundwater (organic acids) and oxidized surface waters (acidity from thiosalt, sulfide and iron oxidation).

Figure 2.20 Tailings Area Internal Monitoring Plan Sites - pH Data

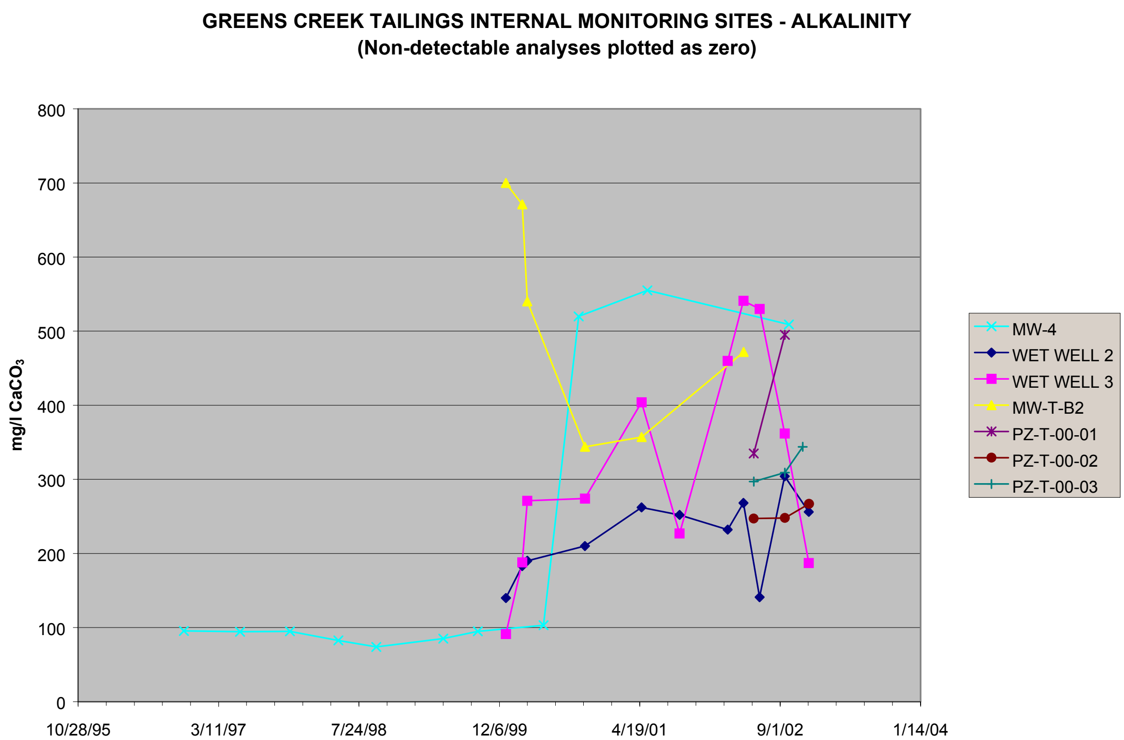


Alkalinity data are presented in Figure 2.21. Alkalinity generally ranges between 200 and 600 mg/l $CaCO_3$ within the tailings pile, consistent with buffering from carbonate minerals and the products of microbial sulfate reduction. The fact that these internal waters are near-neutral to alkaline and have substantial alkalinity indicates that the buffering capacity of the tailings is sufficient to prevent acidification of site drainage in the near-term (at least tens of years).

The conductivity results from internal monitoring site waters are presented in Figure 2.22. 2002 conductivity measurement are between 1000 and 4000 uS/cm. The significant increase in conductivity in MW-4 that occurred in 2000 is the result of advancement of the tailings pile over that shallow (peat) well's capture area. This was an anticipated response and does not reflect a failure of the site's water collection system. The silt/clay till layer that serves as a natural liner beneath the tailings pile underlies the peat and sand that the well samples.

The higher conductivity of the site contact waters reflects a larger dissolved load caused by weathering of the tailings. Pyrite oxidation and carbonate dissolution contribute dissolved ions such as sulfate, bicarbonate, calcium and magnesium to the contact waters, increasing their conductivity. Wet Well 2 generally has a lower conductivity than MW-T-B2 because it has a greater contribution from groundwater. However, both waters show similar responses to seasonal loading/flushing cycles. Wet Well 3 has a different capture area and shows a different pattern with respect to conductivity. The changes in conductivity observed in Wet Well 3 probably reflect changes in the relative contributions from runoff, addition of the Northwest Diversion Ditch flow, infiltration and groundwater as the West Buttress was constructed. Hardness and sulfate concentrations are consistent with the conductivity results.

Figure 2.21 Tailings Area Internal Monitoring Plan Sites – Alkalinity Data



Calcium and magnesium are the primary contributors to hardness (Figure 2.23) and reflect dissolution of carbonate minerals, such as calcite and dolomite. Carbonate dissolution neutralizes acidity formed by sulfide oxidation, which is also the source of sulfate shown in Figure 2.24. Sulfate concentrations range between 500 and 2000 mg/l in the tailings pile waters.

Arsenic data are presented in Figure 2.25. The data, especially for Wet Well 2 (and other sites to a lesser extent) show a distinct increasing trend. The data for MW-T-B2 appears to be cyclical. As arsenic-bearing minerals such as tetrahedrite/tennantite and to a lesser extent pyrite weather, the arsenic that is released is typically co-precipitated with iron oxy-hydroxides. As the pile grows, reducing conditions overtake areas that were once oxidizing. This was particularly true as the water table rose following removal of the temporary PVC cover that was placed on the pile in 1995 (removal began in 1997). Dissolution of oxyhydroxides (and possibly sulfates) should occur as the waters respond to the changing redox conditions. This will contribute arsenic (and iron) to the drainage water. Arsenic concentrations in the drainage will decrease when redox conditions in the pile stabilize.

Figure 2.22 Tailings Area Internal Monitoring Plan Sites – Conductivity Data

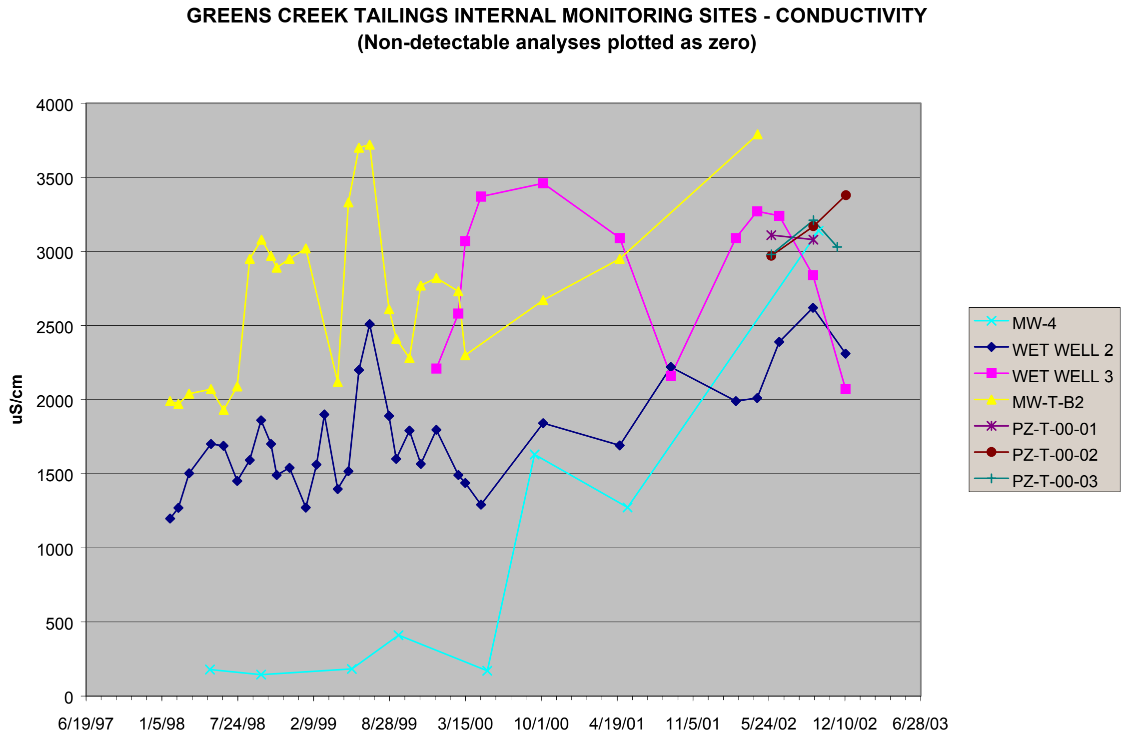


Figure 2.23 Tailings Area Internal Monitoring Plan Sites – Hardness Data

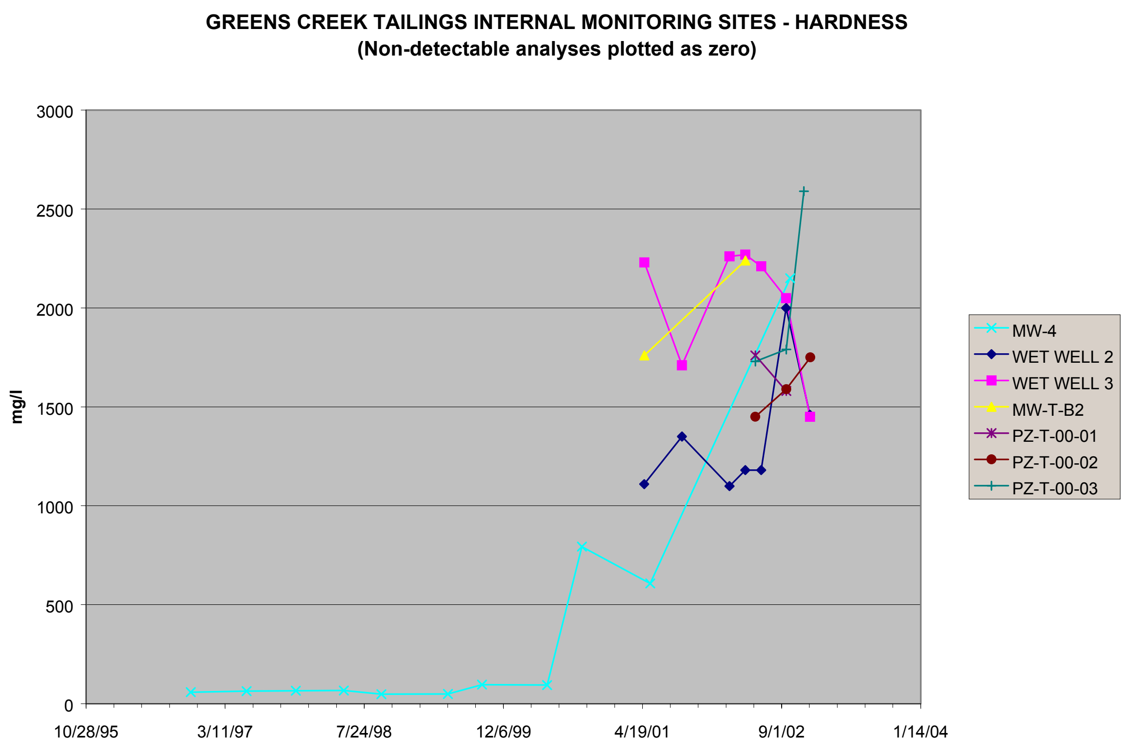


Figure 2.24 Tailings Area Internal Monitoring Plan Sites – Sulfate Data

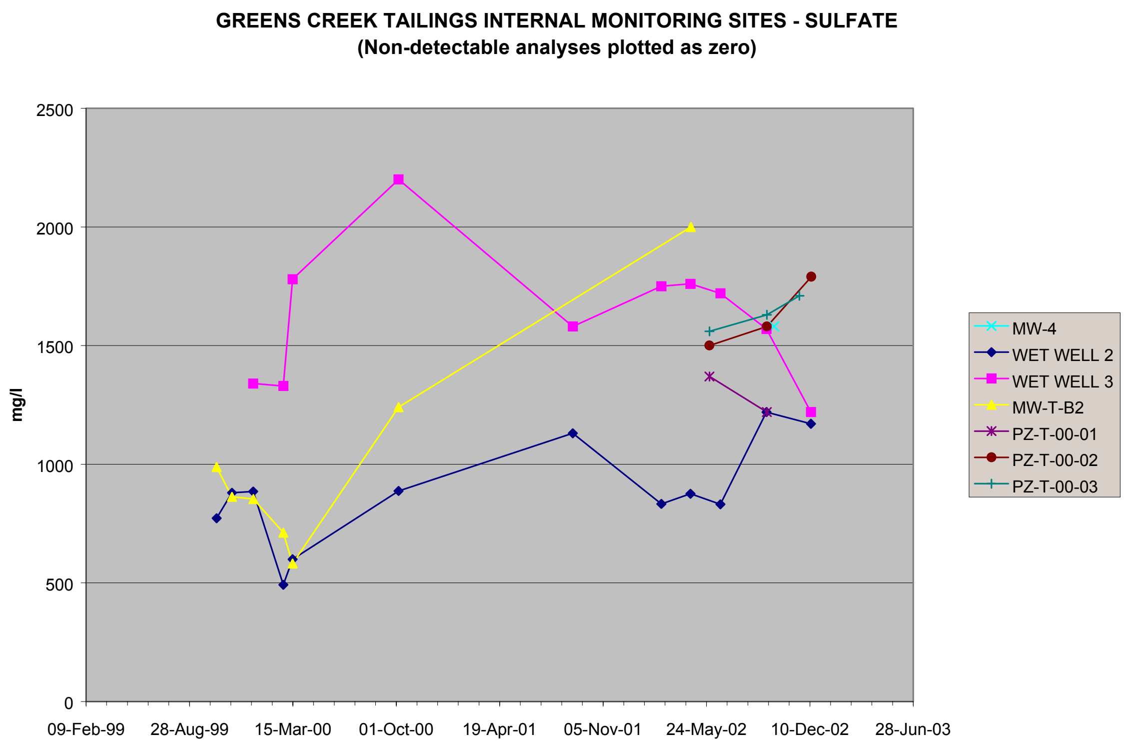


Figure 2.25 Tailings Area Internal Monitoring Plan Sites – Arsenic Data

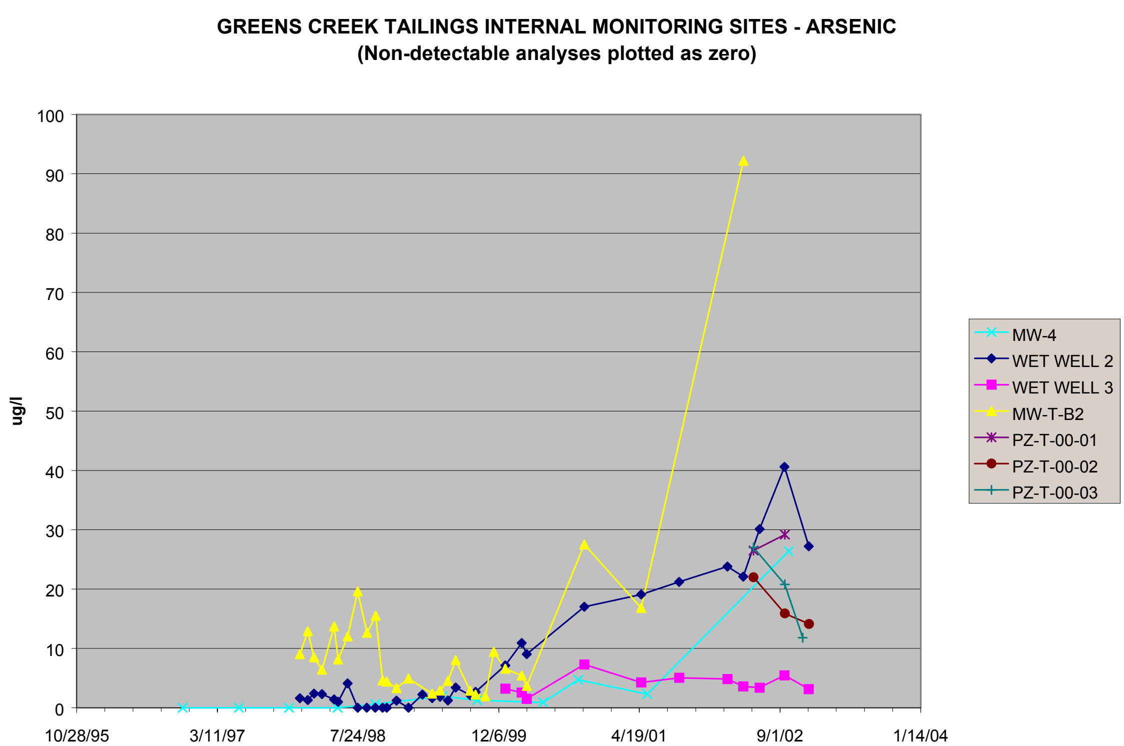


Figure 2.26 shows the concentration of zinc from the seven monitoring sites. Zinc levels from the saturated zone of the pile continue to remain low (<12 ppb); a result of sulfate reduction, which promotes zinc sulfide precipitation. Placement of argillite on the outer slopes of the West Buttress has led to higher zinc concentrations in Wet Well 3 from flushing of this newly placed material. In contrast to the saturated zone, the wet wells and MW-4 (during construction of the East Tailings area) receive a significant component of oxidized near-surface water that has higher zinc concentrations (~ 35,000 ppb).

The concentrations of copper and lead are considerably lower than that of zinc. Both of these metal's concentrations were generally less than 5 ppb in water from each site (Figures 2.27 and 2.28). The two exceptions (Wet Well 3 and MW-4) occurred in areas of active tailings placement. These observations are consistent with the observation that copper and lead mobility is greatest when the tailings are first placed, then decreases with time.

Cadmium data are shown in Figure 2.29. With the exception of Wet Well 3, cadmium concentrations are very low (less than 0.2 ppb). Cadmium in Wet Well 3 had a maximum value of 27 ppb and showed seasonal fluctuation similar that of zinc, albeit at significantly lower concentrations.

Figure 2.26 Tailings Area Internal Monitoring Plan Sites – Zinc Data

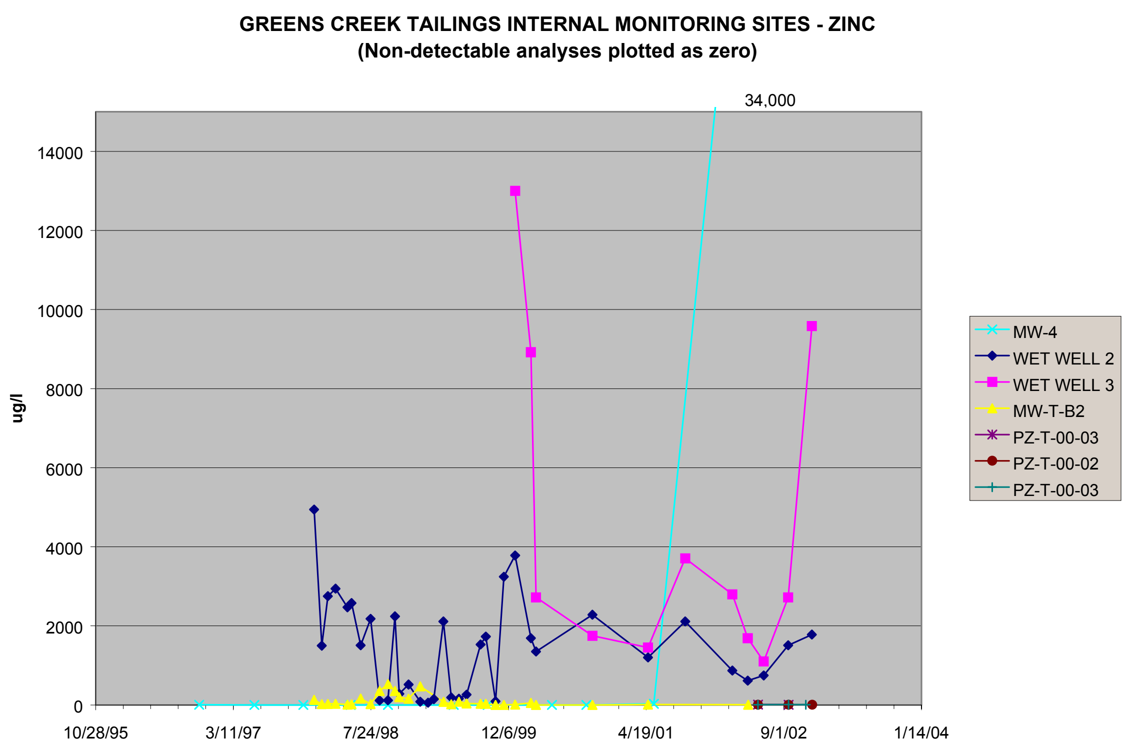


Figure 2.27 Tailings Area Internal Monitoring Plan Sites – Copper Data

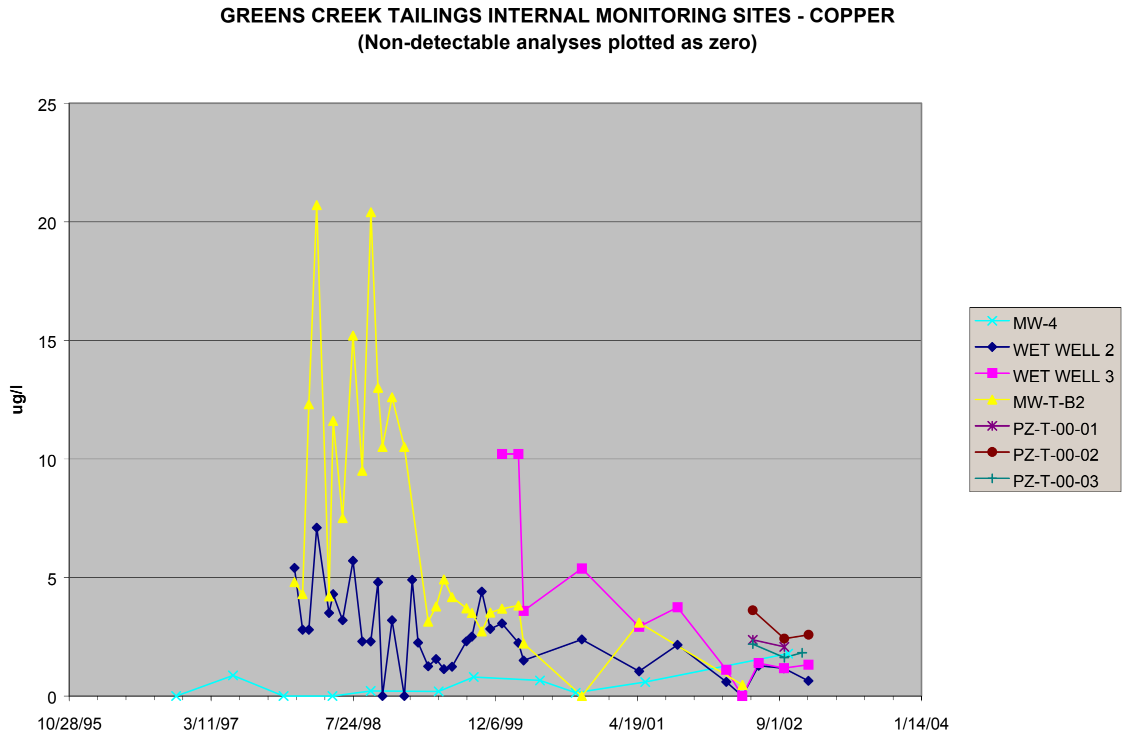


Figure 2.28 Tailings Area Internal Monitoring Plan Sites – Lead Data

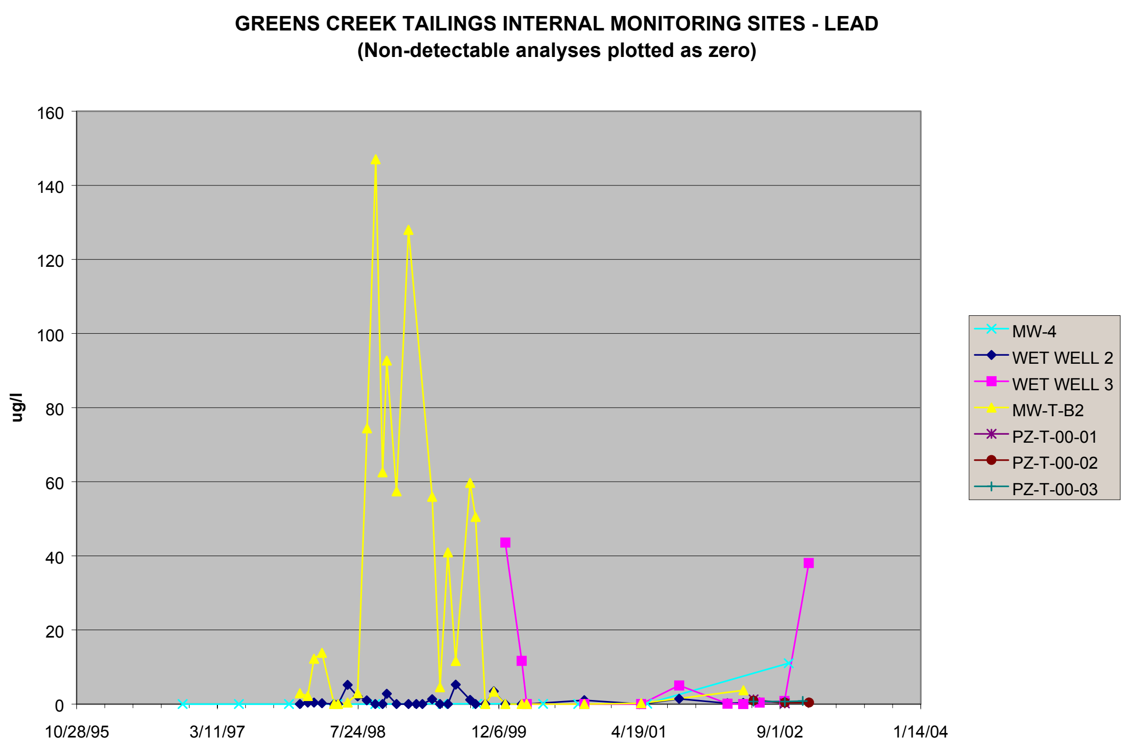
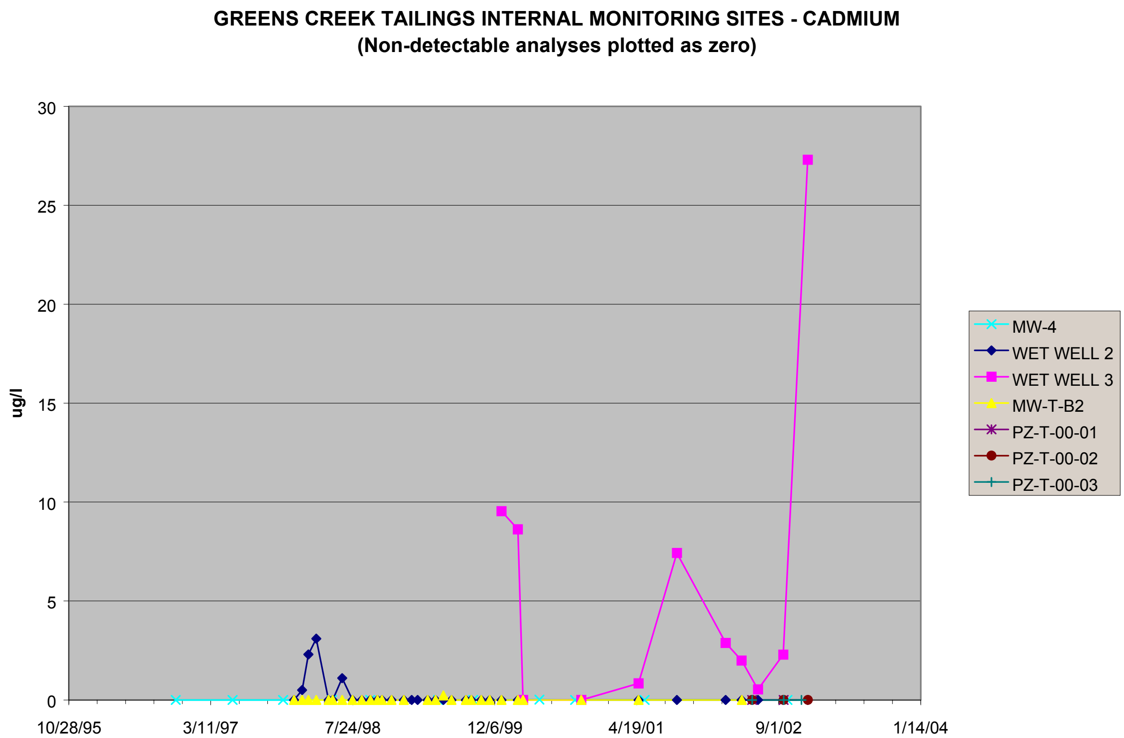


Figure 2.29 Tailings Area Internal Monitoring Plan Sites – Cadmium Data



KGCMC identified anomalous sulfate concentrations in a few areas along the perimeter of the tailings facility in 2001 and performed an in-depth evaluation of the occurrences. The findings of the investigation are presented in KGCMC, 2002. A summary of the report findings, conclusions and actions taken in 2002 follows:

Summary and conclusions

Comparison of sulfate versus combined calcium and magnesium for site waters indicates that many of the down-gradient samples have compositions consistent with background waters. However, some down-gradient samples suggest localized communication (either ongoing or past) with other sources of sulfate.

Background pH values of site waters range from acidic to alkaline. Waters with pH values as low as 4.0 are not unusual for background muskeg areas. The low pH of muskeg waters is a result of acids produced by decomposition of organic compounds in the peat. Alkaline waters derived from uplifted marine sediments yield pH values in excess of 8.5. The pH of tailings contact waters is between 6.5 and 8.5, which indicates any acidity produced by sulfide oxidation is effectively neutralized in-situ by carbonate dissolution.

Acidic drainage observed in a small area west of the tailings pile (Further Seep) was likely caused by weathering of pyritic rock in an access road on the western perimeter of the site. The road was removed during construction of the West Buttress and observations of water compositions suggest that the quality of the water is improving. The acidity of the seep (32 mg/l $CaCO_3$) is not significantly higher than the acidity of typical muskeg water (up to 25 mg/l $CaCO_3$). The maximum concentration of some metals, such as copper, lead and zinc in the seep water are equal to or above background surface water concentrations but below maximum background concentrations observed in the peat, sand, silt and bedrock near the site.

Water compositions and field observations in the area west of the pile indicate that there are other sources of dissolved loading in surface waters than those that produced Further Seep. These sources include residual contact water that existed in the area prior to slurry wall installation in 1996, pyritic construction rock and small amounts of tailings that resided inside the facility boundary but outside of primary containment structures. Water compositions suggest that contact water up-gradient of the slurry wall is not a significant contributor to dissolved loading in the western drainages.

Of the 13 wells west of the facility from which quality samples were obtained, three produced anomalous sulfate concentrations. Data from two of the three wells (both completed in shallow sand in the Further Creek drainage) are consistent with the suspected sources of dissolved loading to surface drainages. The composition of water from MW-T-01-03A, a bedrock completion, suggests two possible sources of loading. Potential sources include the knob near the northwest corner of the tailings pile and the northern terminus of West Buttress slurry wall where it keys into bedrock. The low concentrations of zinc and sulfate relative to tailings contact waters suggest that either contact water is not the source or that its contribution is small. If contact water were a significant source of the sulfate, then considerable zinc attenuation via sulfate reduction or ion exchange is required to explain the observed water compositions. In any case, the low permeability of the bedrock would preclude all but a low overall water flux.

Analysis of bedrock monitoring well data in the vicinity of Pit 5 suggests a source of sulfate loading either from Pit 5 or near the northwest corner of the tailings facility. Low zinc concentrations in the well waters are not consistent with sources such as oxidized production rock and tailings surface waters. The abundance of iron and manganese in MW-T-96-4 and MW-T-01-09 suggest that the tailings saturated zone, which has low concentrations of those elements, is not the source of the sulfate loading. In order for the saturated zone to be the source, significant mixing with an iron and manganese-rich, sulfate-deficient water would be required. The bedrock knob in the northwestern corner of the facility cannot be ruled out as a potential recharge area for down-gradient bedrock zones. However, pyritic rock fill in the Pit 5 area alone could also be the sulfate source. Low sodium and potassium concentrations suggest the contributing source rock has had time to weather. A mixture of two or more of these sources could also account for the observed water compositions.

The concentrations of sulfate and major cations in MW-T-00-07 near the Pit 5 water treatment plant appear to be consistent with those of the plant effluent, however the alkalinity of the well water is considerably higher than that of the effluent. Despite this difference, the proximity of MW-T-00-07 to the Pit 5 water treatment plant and general similarities in water compositions suggests that the water treatment plant may be the source of sulfate loading observed in the well. The sulfate concentration in MW-T-00-07 decreased from 888 mg/l to 629 mg/l between May 31, 2001 and August 21, 2002, suggesting that the well area may have received a pulse of water from a past plant upset.

Conductivity measurements in the muskeg area just north of the Pit 5 access road suggest that artesian flow of water from MW-T-96-4 is contributing sulfate to surface water in that area. The lack of sulfate in wells completed in the peat and marine/glacial units above the MW-T-96-4 bedrock well screen implies the marine/glacial units are an effective barrier to vertical flow.

Observations from these shallower wells also suggest that the slurry wall is an effective barrier to flow.

There are two areas of sulfate loading south of the tailings pile. The sulfate concentration of 78.6 mg/l observed in MW-T-00-04A is above typical background concentrations; however, all other major and trace element concentrations are consistent with background sources. Rock exposed at the Wide Corner area east of Tank 6 contains pyritic zones that could produce sulfate loading observed in MW-T-00-04A and bedrock wells MW-T-01-06A, MW-T-01-6B, MW-T-01-05. Surface or sub-surface contributions from the tailings have not been identified, and the lack of zinc, calcium and magnesium loading suggests such contributions do not exist.

Sulfate loading occurred in the muskeg area south of the Main Embankment prior to the start of tailings placement in 1989. Rock used to construct a portion of the access road below the Main Embankment contained abundant pyrite and lacked carbonate mineralization. Drainage from these road materials appears to have been the source of sulfate observed in the samples. The access road was removed in 2002.

The fact that most down-gradient waters do not show a contact water component indicates that the slurry walls and clay/silt sedimentary “natural liner” units are performing well with respect to capturing site waters. The cases where anomalous sulfate concentrations occur appear to be places where pyritic material (quarry rock, production rock or tailings) lies (or once lay) outside the capture area of the slurry walls and clay/silt “natural liner” units.

Summary of Actions Taken and Proposed Actions

The interpretations presented above are based on field observations and analysis of data collected to date. The data indicate that there have been multiple, localized sources of sulfate loading in down-gradient waters at the tailings facility. KGCMC will continue to monitor these sites to verify that the effects from the identified sources are consistent with the magnitude of the observed loading and that mitigation efforts are effective.

The following actions were taken in 2002 to verify initial interpretations and to minimize influences from confirmed sources:

- Artesian well MW-T-96-4 was capped during non-winter months to minimize contribution to surface waters.
- The NW Diversion Ditch was routed into the West Buttress Ditch.
- Accessible tailings residue was removed from the toe of the West Buttress berm.
- The access road below the Main Embankment was removed.
- Fall to the North Retention Pond was increased to improve drainage.
- A geophysical survey (NanoTEM) was performed in an attempt to image groundwater conductance. However, equipment problems and method limitations precluded obtaining useful information. Monitoring well, test pit, and surface water sampling is currently the preferred method for delineating groundwater conductivities.

The following actions are planned for 2003:

- Continue sampling and interpretation of site waters and monitor effectiveness of recent modifications.
- Route Duck Blind Drain water into discharge line. Sample these waters quarterly to document the water meets NPDES discharge requirements.

Acid Base Accounting Analyses

The results of ABA analyses on 28 grid samples from the tailing facility are presented in Figures 2.30 to 2.32. The grid included portions of the pile that had exposures of fresh tailings, weathered tailings, argillite slope armoring, road rock, and ditch sediment. Of the 28 samples, 13 were relatively pure tailings. Figure 2.30 shows the acid generation potential (AP) versus neutralization potential (NP) of all the 2002 grid samples and for reference, samples from the 1999 multi-agency review and 1994 drilling program. The pure tailings samples plot in the upper half of the figure. Argillite samples plot in the lower right quadrant and road rock and ditch sediments in the lower left quadrant. The average neutralization potential (NP) of the 13 tailings samples from 2002 was 252 tons $CaCO_3$/1000t, which indicates a significant carbonate content in the tailings (approximately 25%). The acid potential (AP) was determined by sulfide assay and yielded an average of 424 tons $CaCO_3$/1000t. The resulting average net neutralization potential (NNP) was –172 tons $CaCO_3$/1000t, which indicates that the tailings are potentially acid generating. These results are consistent with previous studies of the mine's tailings. The samples of weathered tailings (after approximately 12 years of exposure) still retain a considerable amount of neutralization potential, equivalent to approximately 20% calcium carbonate. This suggests that the potential lag time to acid generation of exposed tailings is on the order of decades. This long lag time allows time for construction and closure of the site (including covering the pile with a composite soil cover that minimizes oxygen ingress).

Figure 2.31 shows the relationship of pH to Net Neutralization Potential for the same suite of samples (except 1994 drilling) shown in Figure 2.30. Paste pH and rinse pH are both shown in the figure. Rinse pH is a measure of the pH of a one-to-one mixture of "as received" fines and water. Paste pH is the pH of the sample after it has been pulverized and moistened. Rinse pH is often lower than paste pH because pulverizing the sample exposes fresh, sometimes alkaline mineral surfaces. The rinse pH method also uses more water, which can dissolve oxidation products that lower the pH of the solution. The rinse pH and paste pH of all of the tailings samples are above 6.0, indicating that the exposed surfaces of the pile are well buffered. Figure 2.32 compares neutralization potential and acid generation potential with time of exposure, demonstrating that the rate of sulfide oxidation and carbonate consumption is slow.

Figure 2.30 Tailings Facility Acid Base Accounting Data

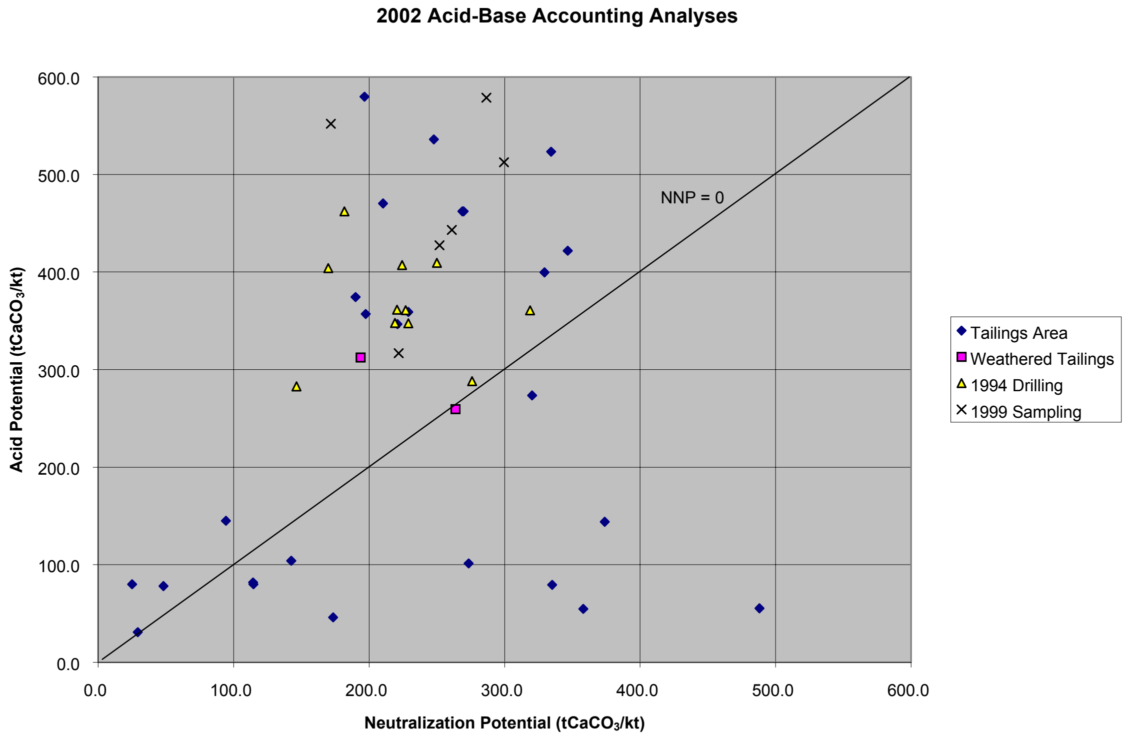


Figure 2.31 Tailings Facility pH versus Net Neutralization Potential

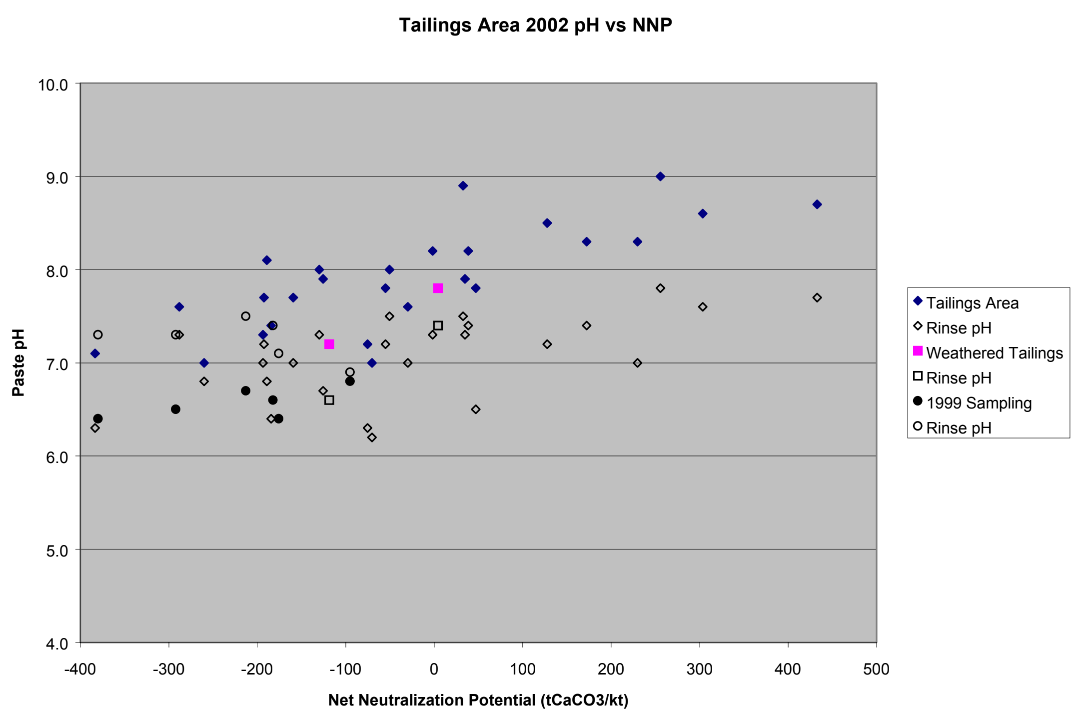
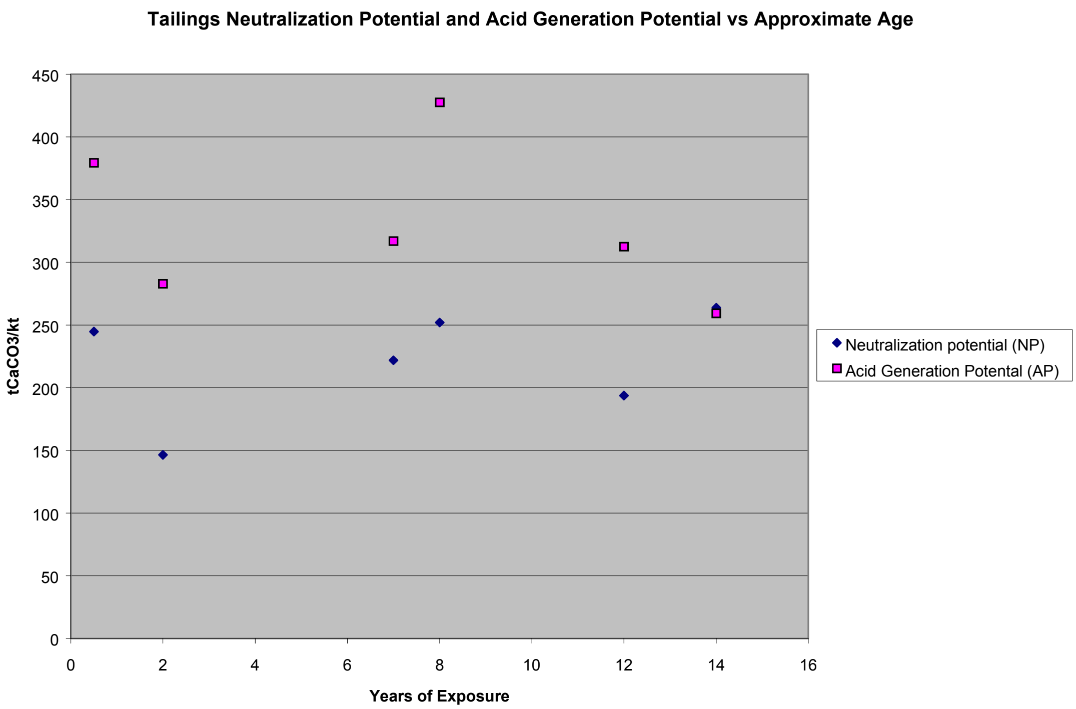


Figure 2.32 Tailings Facility ABA Data versus Years of Exposure



2.6 General Site Management

Tailings Operation and Management

In January 2001, Kennecott Greens Creek Mining Company (KGCMC) received approval for an updated General Plan of Operations – Appendix 3 Tailings Impoundment (GPO Appendix 3), dated August 2000, as part of the State of Alaska, Department of Environmental Conservation Waste Disposal Permit #0111-BA001. GPO Appendix 3 includes the general operating and management goals to achieve site stability and satisfy regulatory requirements.

As per GPO Appendix 3, Section 2.1.4, KGCMC Operations place tailings within the impoundment using specific criteria that were established by Klohn Crippen Engineering in 1999 for the placement of tailings in cellular configurations with compaction standards. KGCMC continued to place tailings in this manner through 2002.

In 2002, KGCMC's main placement area for tailings continued to be the East Side Tailings – Northeast area and the newly developed Southeast Liner area, which lies within the current lease permit boundary. The lined area was developed in May 2002 and added approximately 2 years of tailing storage capacity to the existing impoundment site. This area was developed differently from prior site development, in that an HDPE liner system was installed over the shallow fractured bedrock areas (caused by rock quarry blasting) of the wide corner quarry site. The intent is to minimize the potential for downward migration of contact waters in the area that does not have the natural aquatard (silt/clay till) layer underneath the tailing placement footprint area. A liner design plan was submitted in December 2001 with approvals granted for installation from the USFS and ADEC in early 2002. Liner installation and construction activities began in late April 2002 and completion was in late June 2002. A Southeast Expansion Construction Summary report (Klohn Crippen, November 2002) was submitted to the agencies following the construction of the Southeast Liner area.

KGCMC focused on placing in this new area after the construction and liner installation to even out the pile height with the existing north end of the pile and to give operations a broader extent of cell availability. Approximately 88% of the 2002 tailings production went into the overall East-side area. The remainder of the tailings were placed in the West Buttress area. KGCMC continues to place in this area with consideration of the purpose of the buttress installation, which is to structurally support the portion of the existing tailings pile that was constructed prior to 1994.

No changes to the methodology of tailings placement occurred in 2002, as KGCMC continues the use of off-highway lidded trailered trucks to transport the tailings to the impoundment. The material is end dumped, spread and compacted using a bulldozer, followed by a smooth-drum vibratory compactor. Regular compaction checks using a Troxler density and moisture gauge confirm the resultant performance in the placement area, as per the GPO Appendix 3. See Section 2.3 for a discussion of compaction results.

KGCMC does not expect any changes to the placement methodology in 2003 and will continue placement according to the established criteria in GPO Appendix 3. Continued development of placement areas for the remaining mine life are a part of the Stage 2 Expansion Project, currently undergoing NEPA analyses through the EIS process.

Stage 2 Tailings: Environmental Impact Statement (EIS) Update

In January 2001, KGCMC applied for an expansion of tailings surface storage capacity that can satisfy the current production requirements and reasonable anticipated reserve increases. That application initiated a National Environmental Policy Act (NEPA) process with the U.S. Forest Service as lead agency due to their land management responsibility for the proposed Stage 2 Expansion area. For the KGCMC application, the USFS established an inter-agency regulatory team (IDT) with two memoranda of understanding, which act as guides for the involvement of additional Federal, State and Local regulatory agencies. A third-party EIS contractor, Michael Baker Inc. (MB), was selected to coordinate and conduct the EIS analysis of the project proposal.

In March 2001, MB began baseline study reviews, and KGCMC started additional site investigation projects, such as surface drilling, geotechnical and hydrology studies, sensitive plant surveys, update wetland studies and detail topographic mapping. In the following month of April 2001, MB organized public project review meetings in Juneau and Angoon to establish the project issue lists, as baseline studies continued throughout the summer.

In late July 2001, in the process of investigating the surface drainages around the tailings site, KGCMC discovered water issues that initiated a report submittal to ADEC and the USFS in July 2001 per GPO and Solid Waste Permit requirements. Section 2.5 above describes the stuatus of these investigations (see “Summary and Conclusions” and “Summary of Actions Taken”) .

Final water quality at closure was identified for the Stage II Tailings Expansion EIS as a significant scoping issue surrounding the proposed tailings storage area expansion. An extensive review of historic and current water monitoring information from within and surrounding the existing tailings area was accomplished by Environmental Design Engineering (EDE). Their efforts resulted in the submittal of a hydrologic analysis report (EDE 2002a) and a geochemistry report (EDE 2002b) as baseline studies of the expansion proposal. These documents updated previous analyses, drawing on data collected in the interim to discuss the predicted water quantities and qualities as well as the conditions which influence those topics. This report process started in June 2001 and was finalized in February 2002.

In March 2002, MB initiated a significant effort to confirm the water quality results by creating a second water quality modeling exercise (see Appendix B of the DEIS published on 25 April 2003) utilizing different methodologies than used in the EDE reports. Also, final reviews of the baseline studies were completed, and comprehensive reviews of the potential alternatives, as a part of the USFS led NEPA process, resulted in a Preliminary Draft EIS (PDEIS) being issued for Regulatory Agency review in late July 2002. With publication in the Federal Register, a State of Alaska Solid Waste Permit public notice was provided for public comment to allow these related Stage II Tailings project’s permitting to proceed concurrently. In conjunction with the U.S. Army Corps of Engineers 404 wetlands permit, this will provide the Public with a comprehensive review of the project’s overall permitting.

2.7 Site as-built

An as-built for the tailings facility is presented in Appendix 1. The as-built shows the year-end topography, water management features, monitoring device locations and other significant features of the site. The as-built also includes cross sections that show the following information:

- existing topographic surface
- prepared ground upon which the pile was constructed
- water levels

Representative photographs taken during routine site inspections are presented in Figures 2.33 to 2.36.

Figure 2.33 Aerial Photograph of Tailings Facility – June 2002

Aerial view of the Tailings Facility showing the new construction area SE Liner (light color area, east, middle bottom), West Buttress (west, top), Pit 5 water treatment facility (north, right), East Tailings placement area and B Road (east, bottom right), Tank 6 (bottom left, south), and NPDES outfall pipeline (upper left, west)

Figure 2.34 Photograph of Southeast Tailings Placement Area – July 2002

Initial tailings placement in the Southeast Liner Tailings placement area. Tailings are spread in thin lifts with a bulldozer (left) and compacted with a vibratory roller (middle). Ramps (center) provide access to the wheel wash located near Tank 6 (Figure 2.33).

Figure 2.35 Photograph of West Buttress Tailings Placement Area - April 2002

This photograph is a view of the West Buttress placement looking north. Tailings are placed in cells and the 3H:1V outer slope is covered with Class 1 production rock or native materials to minimize erosion.

Figure 2.36 Photograph of Compacted West Buttress Tailings

View of compacted tailings in the West Buttress placement area. The tailings are spread and compacted in thin, inclined lifts in a cell that has an overall thickness of approximately five feet. This promotes drainage and dissipation of pore pressures that rise as the material is compacted. 12% of the overall placed tails for 2002 were put into West Buttress.

2.8 Reclamation/Closure Plan

Reclamation Plan

In November 2001, as part of the Waste Disposal Permit requirements, KGCMC submitted a "Detail Reclamation Plan with Cost Estimates" as an attachment to the GPO Appendix 14. An inter-agency team approved this attachment to Appendix 14, as the basis of current site reclamation bonding levels. Bonding levels were set for $24,400,000 as a result of the approved site reclamation plan. The Detail Reclamation Plan includes all estimated costs (labor, materials, equipment, consumables, monitoring and long term maintenance) for task specific work associated with the final closure of the property under a default scenario. KGCMC detailed a scope of work to accommodate the physical reclamation projects and the reclamation monitoring and maintenance of all site facilities by segmenting the overall project work at the mine into 7 elements:

- Roads
- Production Rock Sites
- Tailings Area
- Site General
- Water Systems
- Maintenance and Monitoring
- Administration

Each of the above elements of the Detail Reclamation Plan include narrative and cost estimates to define the closure of the property by discipline (type of work) and area. The elements of the plan encompass the entire mine site, and also include reclamation performance monitoring and facility maintenance after final closure according to the Waste Disposal Permit standards.

In 2002, there were no changes made to the site reclamation plan. Although, other ongoing reclamation planning is in progress for the Stage 2 Tailings Expansion EIS process, which will address the proposed expanded tailings footprint alternatives. Preliminary reclamation cost estimates for the tailings expansion project have been completed for this report issue, as the project is currently being processed through a National Environmental Policy Act (NEPA) review led by the United States Forest Service (USFS). The cost estimates will be included in the initiation of the State of Alaska Waste Disposal Permit process in 2003. At this time, the reclamation methodology, such as engineered soil covers, planned for the existing tailings pile final closure is anticipated to be similar for any proposed expansion of the tailings facility.

Reclamation Projects

KGCMC continued using past interim reclamation measures, such as hydroseeding and erosion control at the tailings facility, to improve and maintain established site controls. In 2002, KGCMC hydroseeded approximately 10 acres, including areas at the tailings site and Site 23/D. A growth media (six inches to one foot) of native soils was placed on selected slopes of the tailings pile to promote the hydroseed growth. KGCMC also continued the use of other sediment control measures such as silt fencing, hay bales, polymer addition, slope armoring and slope contouring throughout the site. KGCMC is committed to the continued use of site controls as the operation has consistently demonstrated the benefits of these interim reclamation programs to reduce impacts during the operational period. Housekeeping projects were also initiated at Pit 5 and Pit 7 quarries and will continue into 2003.

For Year 2002, concurrent reclamation project assessments included investigation for closure methodology, cost estimating, technical analysis and performance monitoring. Subsurface investigations at Site 23/D and the Tailings Facility are significant parts of the assessment process. In late October 2002 a geotechnical drilling program, which will result in hydrology and stability studies, was completed. At this time, a draft report for Site 23/D is in KGCMC review.

The waste disposal permit allows time to gather cover performance information for further analysis, prior to installing the covers en mass. Continued evaluation of the cover performance is ongoing to justify and improve closure capping technology. Extensive reviews in 2002 of the cap performance have also taken place during the KGCMC Stage 2 Tailings Expansion project work with the USFS (O'Kane, December 2001). KGCMC recognizes that the soil covers represent a significant part of the site reclamation plan. Therefore, KGCMC has continued to commit resources to develop and monitor the performance of the cover at Site 23.

Concurrent reclamation projects completed in 2002 included items related to the 2002 Tailings Action Plan approved by the Agency. Removal of drilling access ramps on the west side of the tailings area, and the removal of the Pond 6 seepage return structure highlighted the work, along with the addition of diversion ditches and tailings material cleanup at the northwestern rim of the tailings pile. The duck blind remediation is planned for early summer 2003, which will complete the planned work.

Site 23 has limited area available for continued cap installation, because the available space on the lower western slope continues to be affected by ramp development above the area. As the access ramp is raised past this area, KGCMC will have approximately an acre of available final outside slope for cap installation. This project area may become available in 2004. Therefore, no significant Site 23 backslope excavation is planned in the Year 2003 unless a need to develop additional production rock placement area or to accumulate additional native soils for reclamation becomes necessary. Excavation estimates between 30,000-40,000cy of backslope material could be taken in the northeastern portion of the site, as these projects commence. KGCMC can not over-excavate the Site 23 backslope because of highwall safety issues. The planned removals are dependent on several factors, such as production rock availability for Site 23 excavation fill, weather and potential reclamation sites being ready for soil capping. At this time, the concurrent reclamation plan has a flexible schedule and is addressed in the Detail Reclamation Plan - Cost Estimates document in Section 5.

3.0 Site 23/D

3.1 Introduction

Kennecott Greens Creek Mining Company (KGCMC) has prepared this report in accordance with the mine's General Plan of Operations (Appendix 11) and Alaska Waste Disposal Permit 0111-BA001. A summary of all operational and monitoring activities performed in 2002 is provided. Refer to GPO Appendix 11 and permit 0111-BA001 for a detailed description of Site 23, Site D and associated monitoring requirements.

KGCMC operated Site 23 (its only active production rock disposal facility) continuously in 2002. See the Site 23 as-built in Appendix 2 for facility layout. Approximately 54,000 tons of production rock were placed at the tailings facility during this report period. The projected remaining capacity at Site 23 is approximately 850,000 tons.

3.2 Placement records

Site 23 survey data and truck count haulage information are presented in Table 3.1. Site 23 received approximately 53,814 tons of production rock in 2002 as calculated from KGCMC surveyed volumes. A tonnage factor of 1.693 tons/yd^3 was used to convert surveyed volume to tonnage. Class 1 production rock comprised 46% percent of the total placement at the site. Class 2 and Class 3 production rock comprised just over 18 and 36 percent respectively. The small (less than 3 percent) difference between truck count totals and calculated totals based on survey data reflects variations in tonnage factors, small differences in load capacities and double handling of materials. The surveyed volume reported in cubic yards has the least uncertainty relative to other quantities reported in Table 3.1. The acid base accounting data presented in Section 3.5 indicate that KGCMC continues to conservatively classify its production rock. Some of the phyllite that is visually classified as Class 3 is actually chemically Class 2 (i.e. laboratory testing demonstrates a NNP between 100 and –100 tons $CaCO_3$/1000t).

Table 3.1 Production Rock Placement Data

Date	Production Rock Placed At Site 23				Production Rock Hauled (truck count, tons)					
	Monthly survey (yd^3)	Cumulative survey (yd^3)	Monthly calc. (tons)	Cumulative calc. (tons)	Class 1 To Site 23	Class 2 To Site 23	Class 3 To Site 23	Total	Class 1 To Tailings	Total (less tails haul)
1/31/02	3,667	398,989	6,209	675,404	2,460	750	3,000	6,210	135	6,075
2/28/02	4,194	403,183	7,101	682,505	5691	180	3090	8,961	1,770	7,191
4/1/02	1,577	404,760	2,670	685,175	2280	2250	720	5,250	2,580	2,670
5/1/02	1,150	405,910	1,947	687,122	1320	780	41	2,141	2,430	-289
5/30/02	1,416	407,326	2,397	689,519	1260	1170	1740	4,170	200	3,970
7/1/02	3,045	410,372	5,156	694,675	1800	390	4749	6,939	1,734	5,205
8/1/02	3,286	413,658	5,564	700,239	6210	960	3180	10,350	1,016	9,334
9/5/02	2,197	415,855	3,719	703,958	6245	0	270	6,515	3,510	3,005
9/30/02	2,963	418,818	5,016	708,974	5790	720	420	6,930	45	6,885
10/31/02	3,100	421,918	5,248	714,222	3824	600	390	4,814	1,879	2,935
12/2/02	3,643	425,560	6,167	720,389	4710	900	1620	7,230	1,395	5,835
1/3/03	1,548	427,111	2,620	723,009	750	1350	480	2,580	272	2,308
Totals	31,786	427,111	53,814	723,009	42,340	10,050	19,700	72,090	16,966	55,124
					25,374	Class 1 placement (total minus fraction hauled to tailings)				
		Placement percentage by class:			46%	18%	36%			

3.3 Stability

Compaction

Historically, KGCMC has utilized the nuclear density method described in Section 2.3 to monitor compaction of production rock at Site 23. Following recommendations by Klohn Crippen, KGCMC has terminated nuclear density measurements, because the grain size distribution of the production rock in not suited to the nuclear method. Klohn Crippen recommends that KGCMC follow a method specification to ensure adequate compaction of the production rock. The method specification detailed in the Klohn Crippen report (provided in Appendix 3) is as follows:

- The material should be placed in and spread to a maximum lift thickness of 24 inches and initially compacted with one complete pass using a bulldozer.

- KGCMC should further compact the material with a minimum of four complete passes (two cycles) over each layer of production rock using a Caterpiller CS 563 or equivalent self propelled vibratory compactor.

KGCMC has adopted the method specification and will continue to employ it in the future. Klohn Crippen is finalizing a stability assessment of Site 23 and Site D, which should be completed by July 2003.

Inspections

Several independent inspections are carried out at Site 23 throughout the year. Operators working at the site carry out daily visual-work place inspections. The Surface Civil Engineer and or Surface Operations Manager carry out weekly visual inspections. The environmental department carries out a monthly checklist inspection. No visible signs of physical instability were observed at Site 23 during this report period.

During 2002 the USFS inspected Site 23 approximately 42 times (Site inspections #92-#134) monitoring for Best Management Practices effectiveness and compliance to the General Plan of Operations. No issues of non-compliance or poor operations practices were noted in the inspections. In fact, the USFS inspections typically noted that Site 23 is being developed and operated to required operations and maintenance specifications of GPO Appendix 11.

Slope monitoring

Slope monitoring at Site 23/D consisted of GPS monitoring of 14 survey hubs distributed across the sites. See the Site 23 as-built for hub locations. The resolution was sufficient to identify large potential movement and no such movements were identified.

Well and piezometer water level data

Well and piezometer water level data are provided in Figures 3.1 to 3.12. The lack of significant pressure in piezometers installed close to the base of Site 23 (piezometers 52-55, Figures 3.1 to 3.4) demonstrates that the pile remains free draining. This is consistent with the construction of a network of finger drains under the pile and a blanket drain at the pile toe. See the Site 23 as-built (Appendix 2) for piezometer and finger drain locations. The lack of pore pressure at the toe indicates that pile stability has been maximized. Water levels from several monitoring locations are shown on Section CC of the as-built. The inferred water table is 30 to 60 feet below the base of the production rock pile material up-slope of the Site 23 active placement area and 5 to 20 feet below the base of material placed in Site D and the toe of Site 23, respectively (see also, Figures 3.5 to 3.12). Observations from wells completed in the colluvium below the sites indicate that perched water tables and braided flow paths exist beneath the site (e.g compare Figure 3.6 and 3.7). This unit also shows large (up to 10 feet) fluctuations in head levels, which are consistent with perched, confined conditions and channel-like flow. There is a distinct seasonal pattern to the water level fluctuations beneath Site 23/D, particularly in the colluvial unit (Figure 3.9) and the alluvial sands (Figure 3.11).

The silty/clay till that underlies the colluvial unit impedes downward flow and has an upward hydrologic gradient caused by confining the more permeable bedrock below it. MW-23-98-01 (Figure 3.8) is completed in the till unit and indicates a water table near the top of the till, which is approximately 100 feet below the existing topographic surface. Alluvial sands occur between the colluvial unit and the silt/clay till near the toe of Site 23 and under Site D. Data from MW-23-A4 and MW-D-94-D3 (Figures 3.9 and 3.11) indicate that the sands are saturated. A curtain drain installed in between Site D and Site 23 in 1994 collects water that flows at the base of the colluvial unit and the top of the alluvial sands (see as-built and Section CC for locations). This drain helps reduce pore pressures in the foundation of Site D, as well as capturing infiltration waters from Site 23.

Figure 3.1 Pressure Data for Piezometer 52

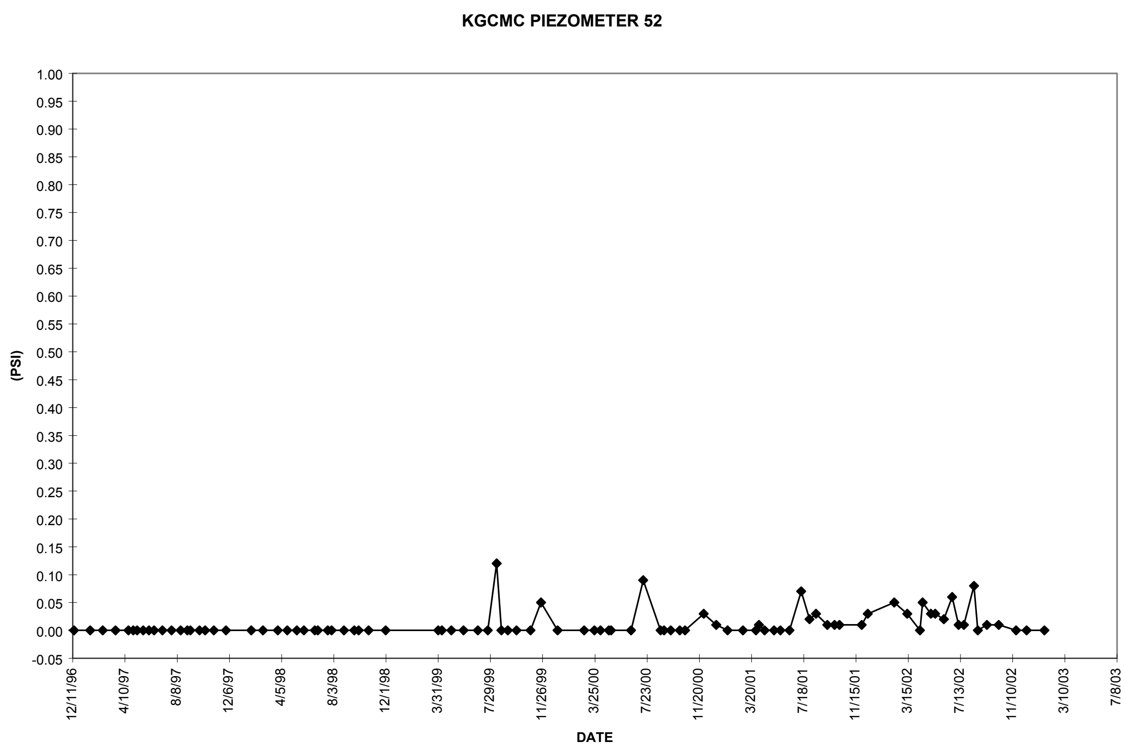


Figure 3.2 Pressure Data for Piezometer 53

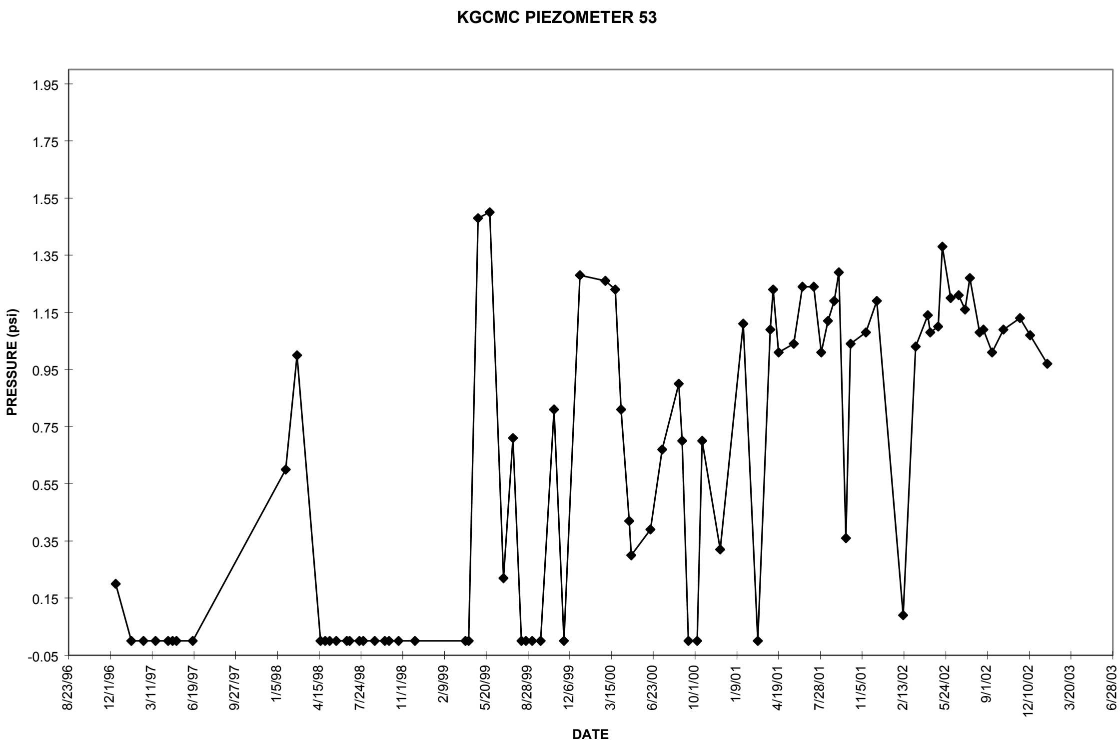


Figure 3.3 Pressure Data for Piezometer 54

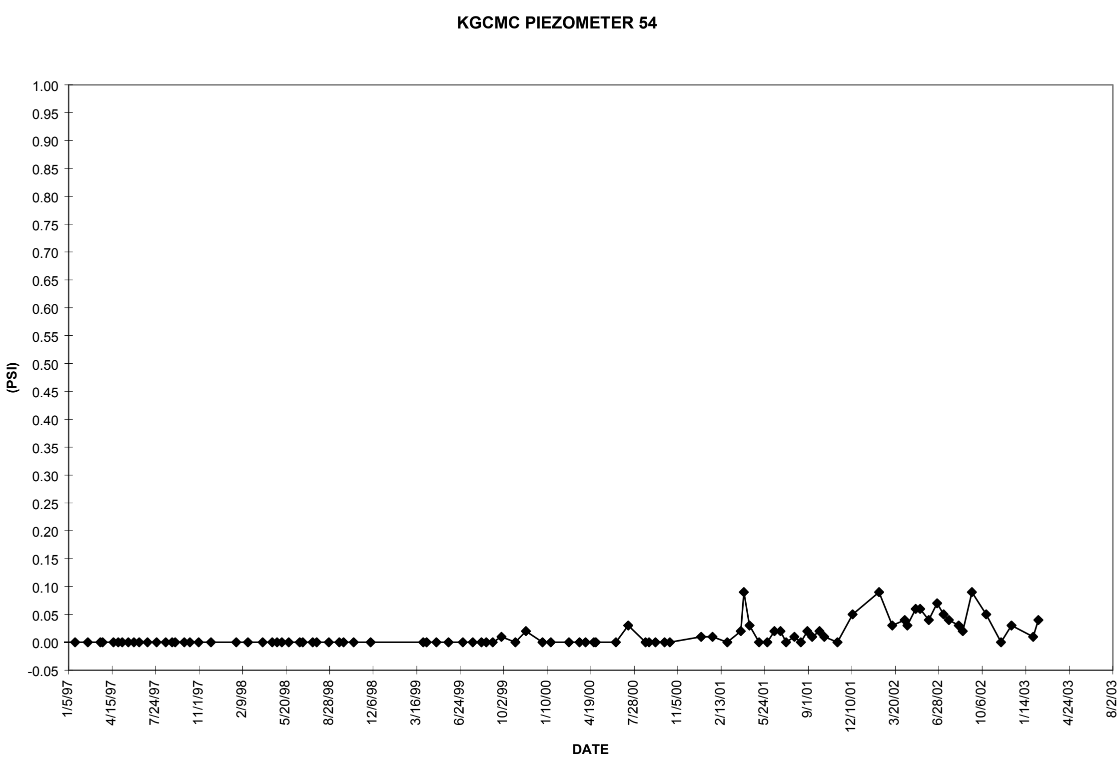


Figure 3.4 Pressure Data for Piezometer 55

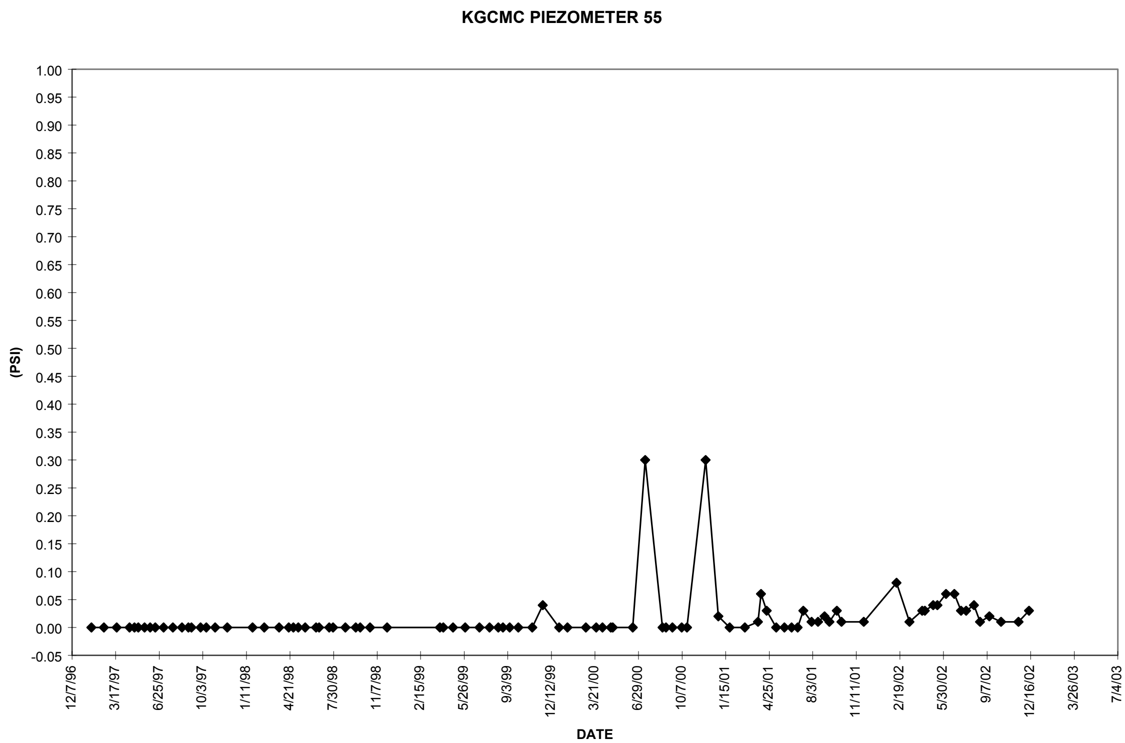


Figure 3.5 Water Level Data for Well MW-23/D-00-03

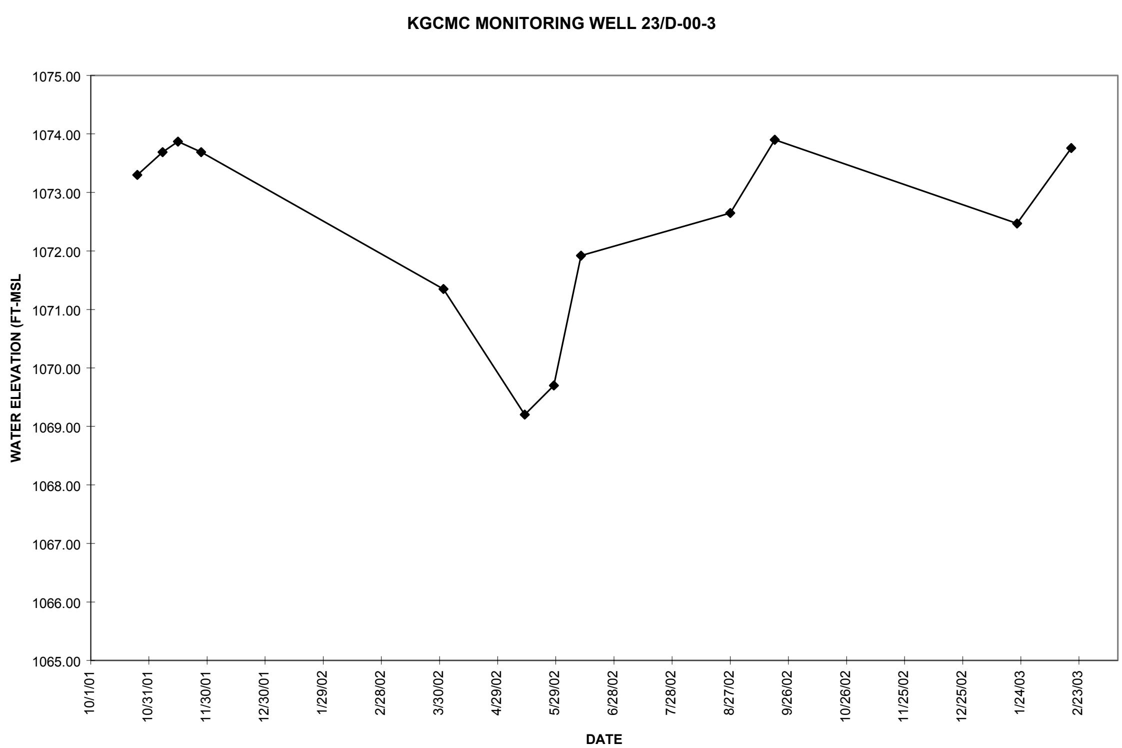


Figure 3.6 Water Level Data for Well MW-23-A2D

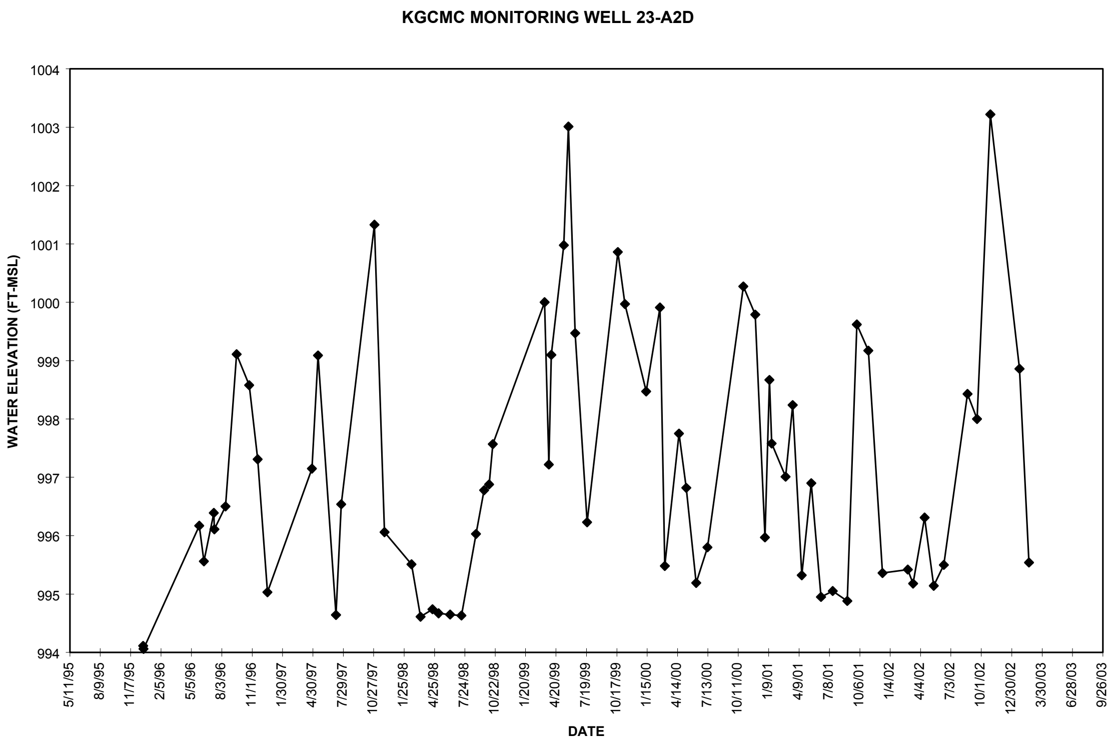


Figure 3.7 Water Level Data for Well MW-23-A2S

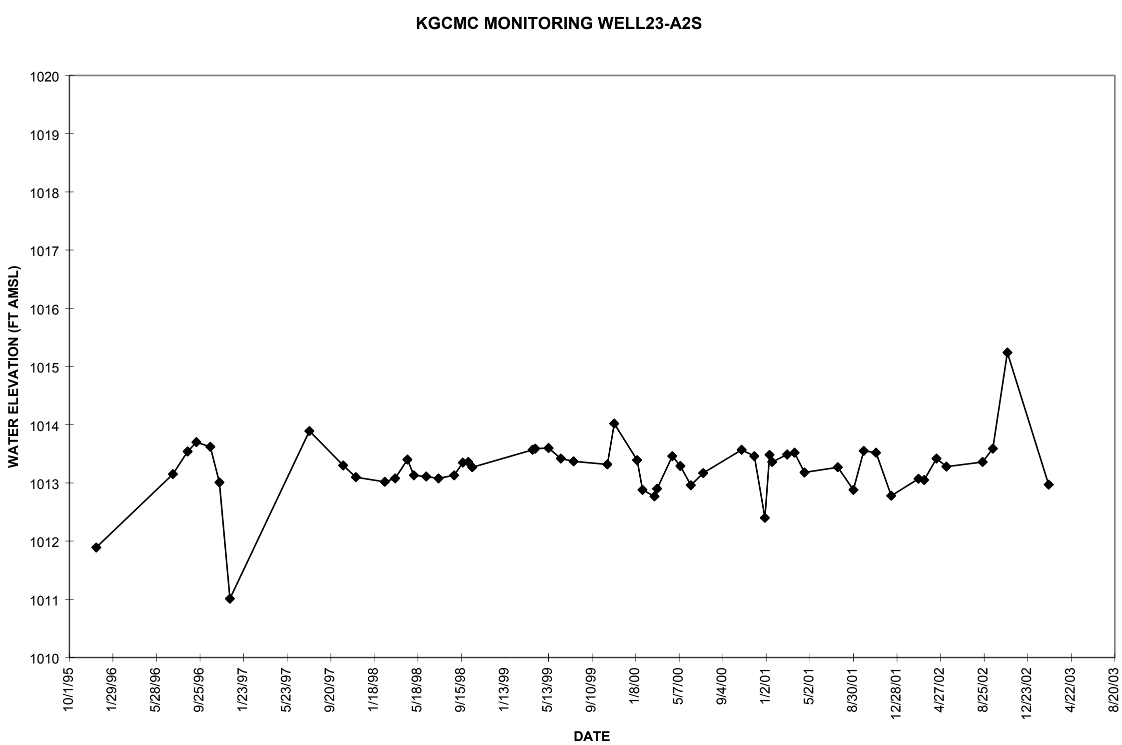


Figure 3.8 Water Level Data for Well MW-23-98-01

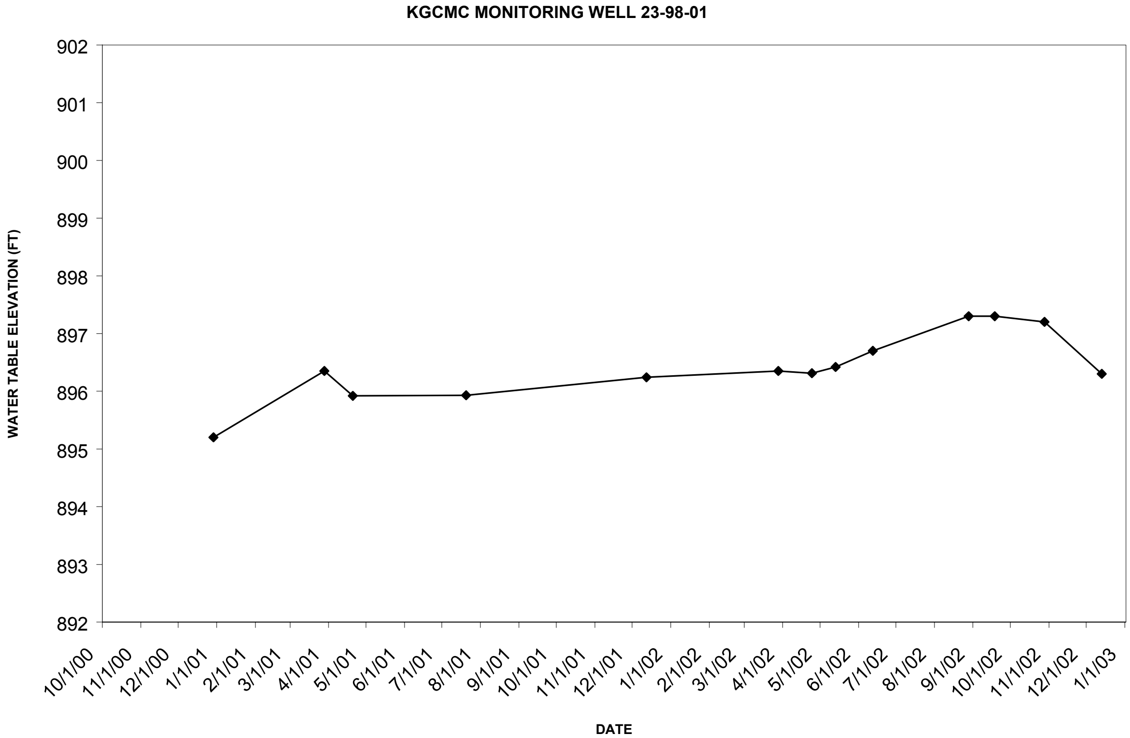


Figure 3.9 Water Level Data for Well MW-23-A4

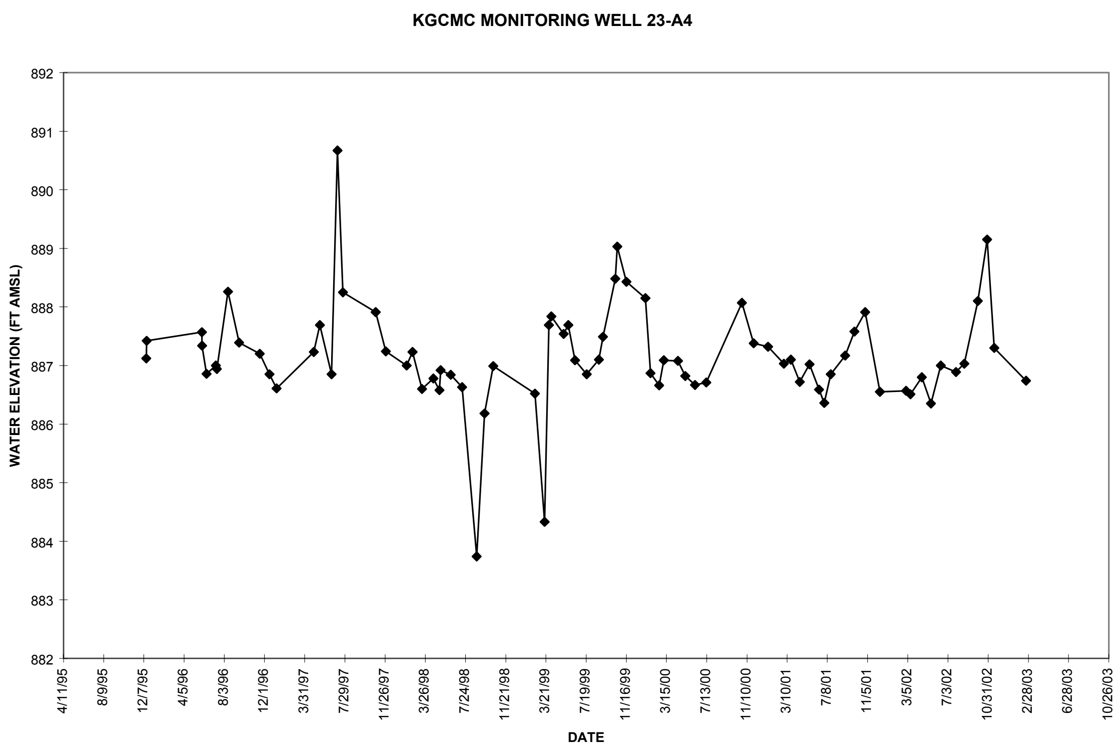


Figure 3.10 Water Level Data for Well MW-23/D-00-01

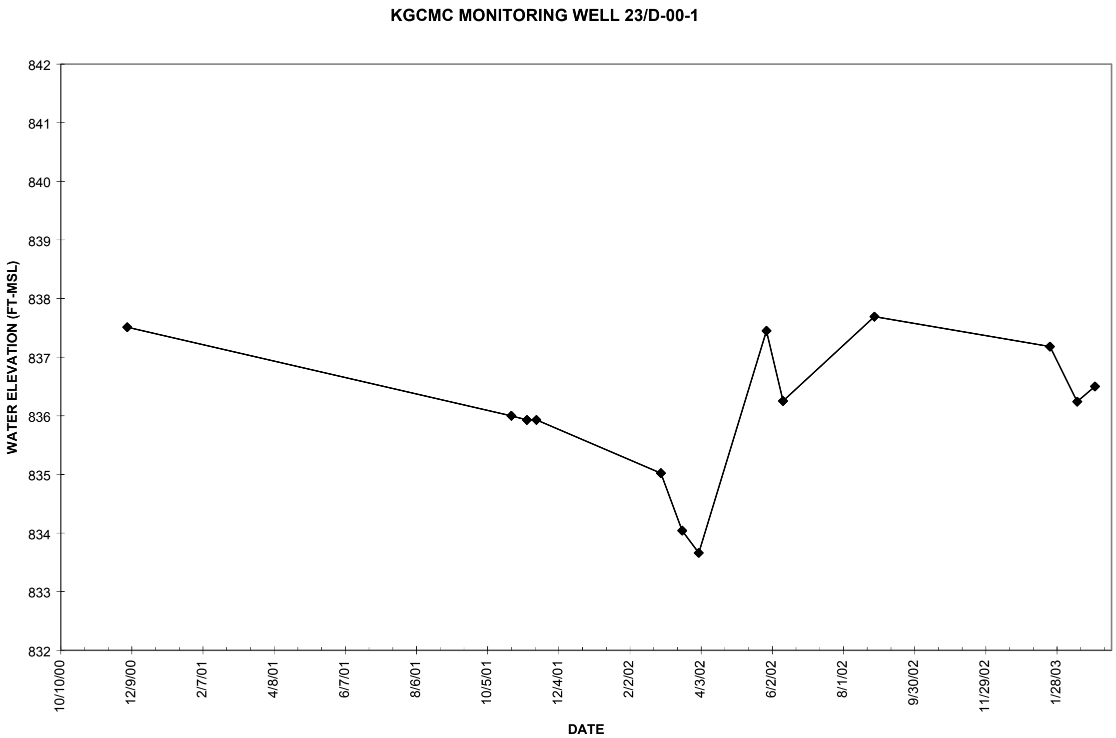


Figure 3.11 Water Level Data for Well MW-D-94-D3

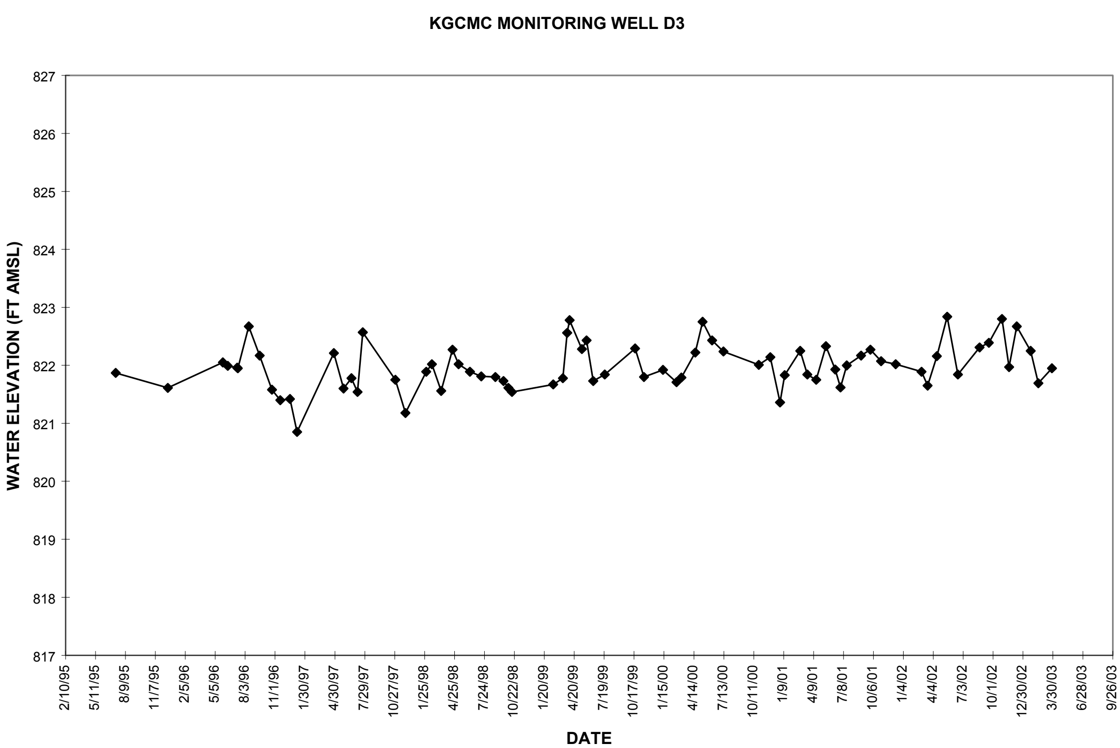
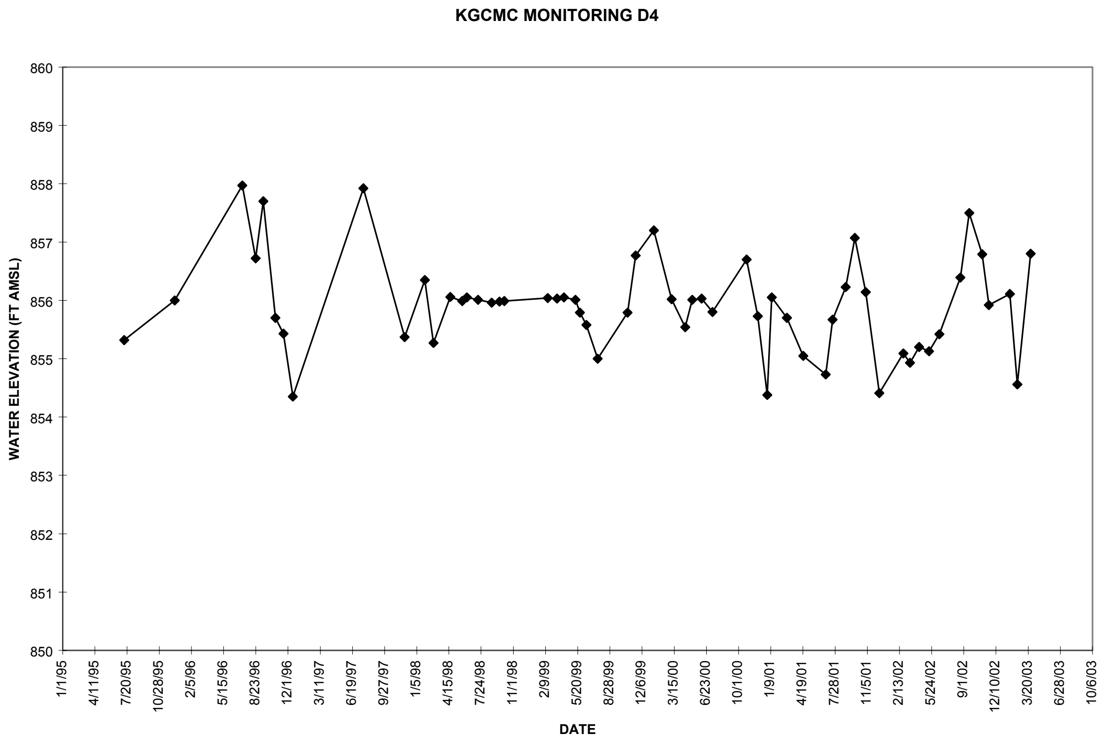


Figure 3.12 Water Level Data for Well MW-D-94-D4



3.4 Hydrology

A general description of the hydrogeology of Site 23/D is provided above. Environmental Design Engineering and KGCMC are performing a hydrological and geochemical re-analysis of Site 23/D. This investigation will provide a more detailed understanding of the existing and future hydrologic and geochemical conditions at the site.

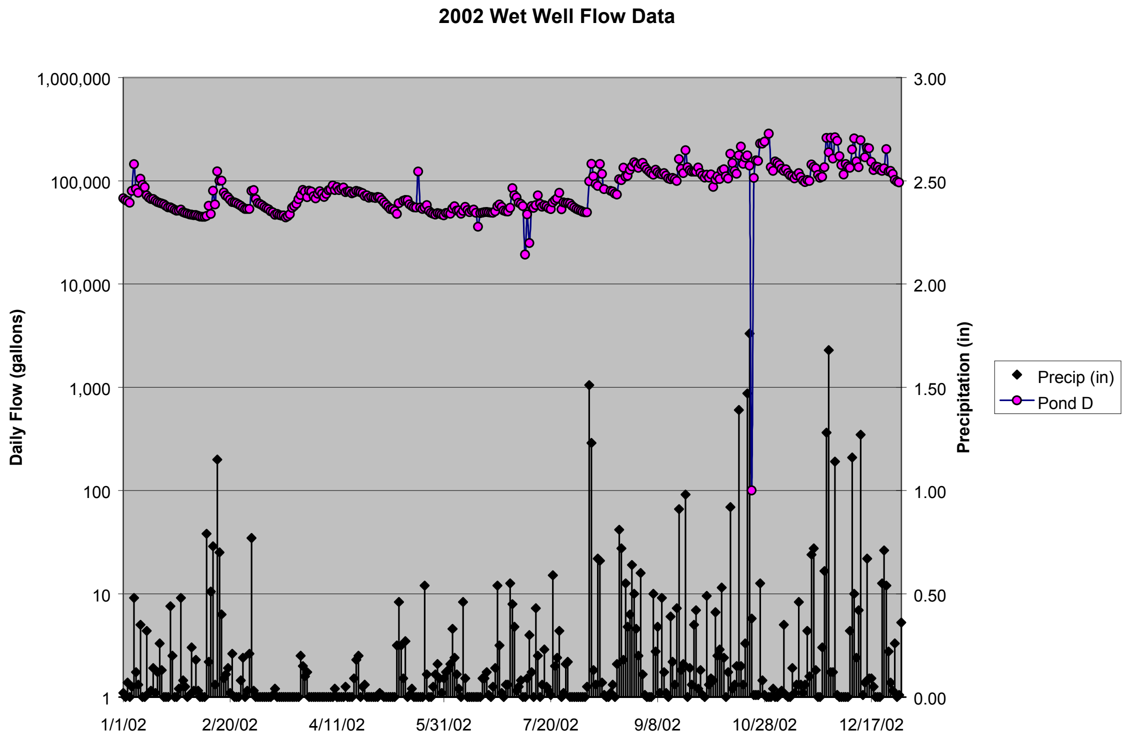
Surface and groundwater are managed using a network of drains, ditches and sediment ponds at both Site D and Site 23. See the Site 23 as-built for locations of these features. Water that is collected in the finger drains beneath Site 23 is routed to Pond 23 along with Site 23 runoff via a lined ditch. Pond 23 also periodically receives stormwater via pipeline from the 920 area. A curtain drain below the toe of Site 23 captures groundwater from the colluvial unit beneath the site and reports to the Pond D wet well via pipelines. Pond D also captures surface water and drainage from seeps near the toe of Site D. Pond D water is returned to the Pond 23 pump station where it is either sent to the mill or down to the Pit 5 water treatment facility.

Monthly temperature and precipitation data are provided in Table 3.2. A total of 63.7 inches of precipitation fell in 2002. The wettest months were August and October with 9.87 and 9.71 inches of precipitation, respectively. The driest month was April (0.67 in). Flow data for Pond D are shown with precipitation in Figure 3.13. The single low flow measurement in October occurred when the pumps were turned off to reduce the surge at Pond 6 during an extreme storm event. That event had consumed the full capacity of Pond 6.

Table 3.2 Monthly Summary of Mill Site Climate Data

Month	AvgTemp (°C)	Precipitation (inches)
January	-1.74	3.48
February	-2.37	5.87
March	-3.69	1.63
April	0.69	0.67
May	6.41	2.56
June	10.55	3.07
July	11.36	4.62
August	11.89	9.87
September	8.71	6.2
October	6.05	9.71
November	3.68	8.42
December	-0.48	7.6
2002	4.25	63.70

Figure 3.13 Pond D Flow Data



3.5 Water quality

Compliance Monitoring

Water sites around the Site 23/D production rock storage area have been monitored for various periods. Sites have been added and deleted over time as rock storage area development required. Monitoring under the revised FWMP schedule and sites began with October 2001 sampling, the first month of water year 2002. The full FWMP Annual Report for water year 2002 is being prepared separately and will be submitted to the Forest Service and ADEC upon completion.

Internal Monitoring

In May 2001 Kennecott Greens Creek Mining Company (KGCMC) submitted an Internal Monitoring Plan to the Alaska Department of Environmental Quality – Solid Waste Management Program. This submittal satisfied Section 2.8.3.1 of the KGCMC Waste Disposal Permit Number 0111-BA001.

As described in permit Section 2.8.3.1, the internal plan addressed monitoring at both the surface tailings facility and the surface production rock storage areas covered by the permit. The Internal Monitoring Plan describes monitoring within the pile areas, in contrast to the compliance monitoring (under the Fresh Water Monitoring Plan) at peripheral facility boundary sites. As such, data generated by the Internal Monitoring Plan effort are "… not for compliance purposes…" as noted in the above referenced permit Section 2.8.3.1.

Operationally for KGCMC, the production rock Site 23 and the adjacent production rock Site D are treated as a single entity, primarily due to their conterminous positions making isolation from one another unpractical. Consequently, they are operated and referred to as Site 23/D in this report.

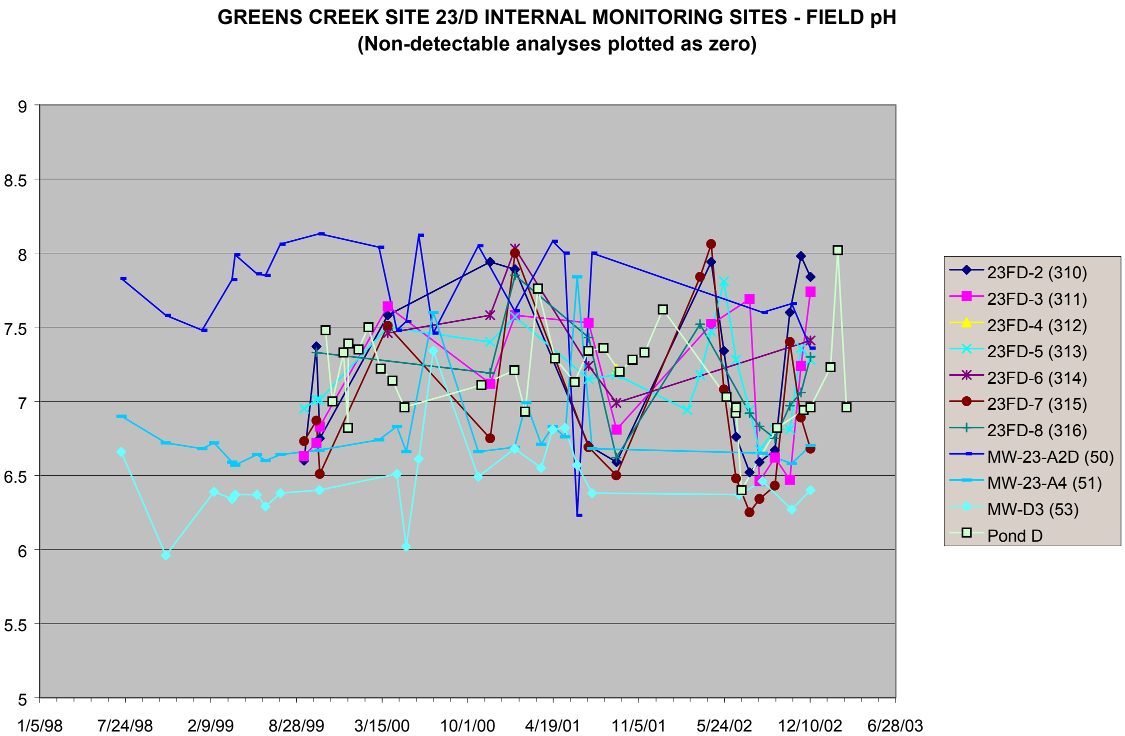
The results of KGCMC's Site 23/D internal site monitoring plan are summarized in Figures 3.14 to 3.25. Sample collection from the Site 23 finger drains is dependent upon their flow. Flow from several of these finger drains is very irregular, responding directly to precipitation-induced infiltration and groundwater fluctuations. Monthly sampling of the flowing drains has identified the typical range of concentrations of constituents in the drain waters. KGCMC believes that reducing the frequency of sampling to quarterly will still fulfill the intent of the monitoring program and proposes quarterly sampling for all internal monitoring sites starting in 2003.

An in-depth re-evaluation of the geochemistry and hydrology of Site 23 and Site D is currently being performed by Environmental Design Engineering (EDE) and KGCMC in accordance with Waste Disposal Permit Section 4.1.1. The observations made under the internal monitoring plan are an initial phase and will help define the scope of the study. Completion of the study is anticipated by December 2003.

Waters represented by the internal monitoring sites are captured, routed to the mill or tailings facility and treated prior to discharge to the ocean floor under KGCMC's National Pollutant Discharge Elimination System Permit (AK 004320-6).

Figure 3.14 shows the pH of waters collected from Site 23 Finger Drains 2 through 8, monitoring wells MW-23-A2D, MW-23-A4, MW-D3 and Pond D (see as-built in Appendix 2 for locations). Values of pH were between 6 and 8.5 for all internal monitoring site samples in 2002. The lower pH values (generally pH 6 to 7) were recorded in MW-23-A4 and MW-D3, both of which are completed in alluvial sands beneath Site 23 and Site D, respectively. MW-23-A2D, which screens colluvium up-gradient of Site 23 typically has the highest pH (generally pH 7.5 to 8). The Site 23 finger drains fluctuate at values between those of the monitoring wells. Albeit chaotic, Figure 3.14 suggests that waters from different foundation units have different pH values and that Site 23 and Site D contact waters and the materials with which they are in contact exhibit sufficient buffering capacity to prevent acidification of site drainage in the near term. Seasonal fluctuations are apparent in the finger drains with highest pH values occurring in winter months and lower pH in mid to late summer.

Figure 3.14 Site 23/D Internal Monitoring Plan Sites – pH Data



As with pH, high alkalinity values (Figure 3.15) indicate that the waters are well buffered. Fluctuations in alkalinity correlate with those of other parameters, such as hardness (Figure 3.16) and conductivity (Figure 3.17), and appear to be seasonal. Carbonate minerals in the production rock contribute to the high alkalinity of the drainage from the finger drains. Alkalinity is lowest in samples with the highest groundwater component (e.g. the monitoring wells, D Pond, 23FD-5 and 23FD-7). Calcium and magnesium are the primary contributors to hardness (Figure 3.16) and reflect dissolution of carbonate minerals, such as calcite and dolomite. Carbonate dissolution neutralizes acidity formed by sulfide oxidation, which is also the source of sulfate shown in Figure 3.18.

Figure 3.15 Site 23/D Internal Monitoring Plan Sites – Alkalinity Data

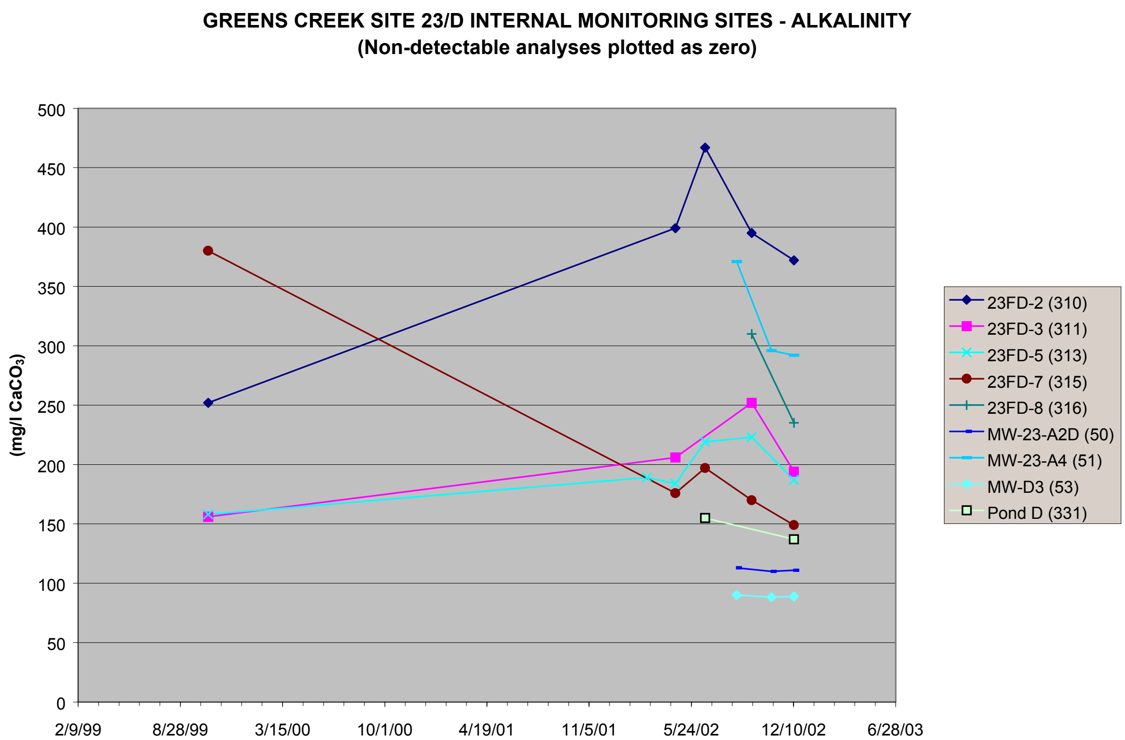
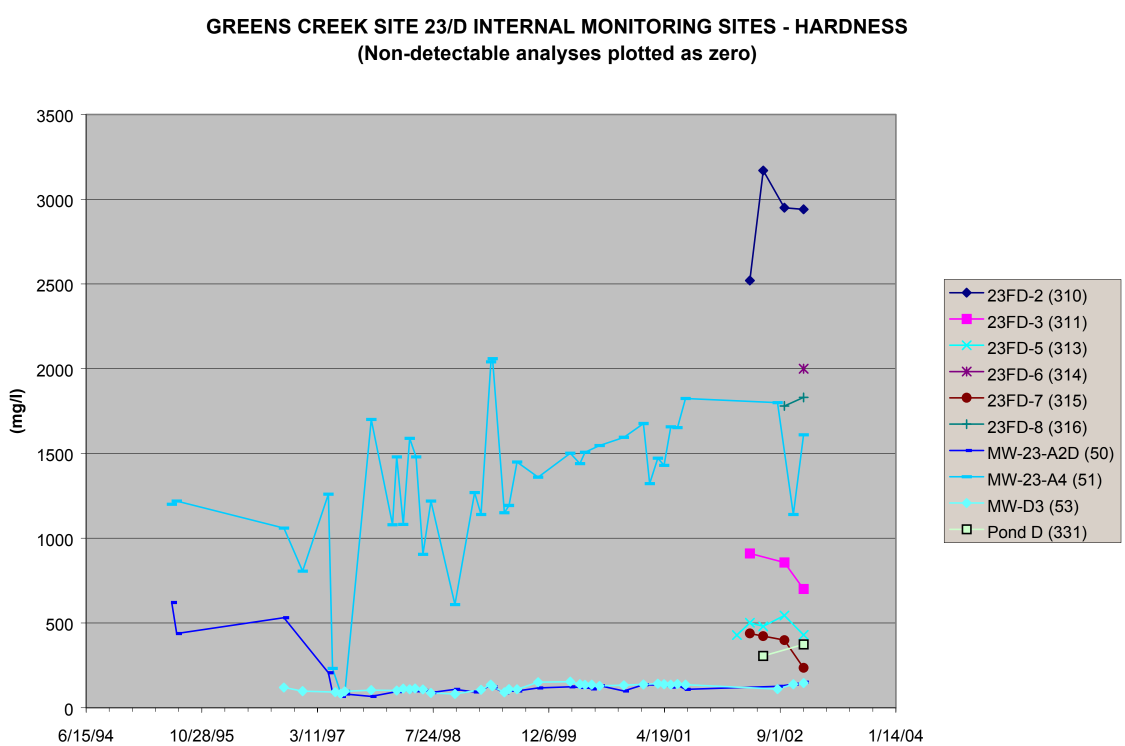


Figure 3.16 Site 23/D Internal Monitoring Plan Sites – Hardness Data



Conductivity results from internal monitoring site waters are presented in Figure 3.17. 2002 conductivity measurements range up to 5270 uS/cm. MW-23-A2D and MW-D3 have the lowest conductivity. MW-D3 is completed in alluvial sands below the fill placed at Site D. The finger drains with the highest flow (e.g. 23FD-5, which directly drains an excavated spring) have the lower conductivities than drains with lower flow. This reflects a larger contribution from groundwater to the high-flow drains relative to a higher proportion of site contact water in the other finger drains. The significant decrease in conductivity in 23FD-7 that occurred in 2000 is probably the result of incorporation of groundwater collected in the upper portion of the drain above the active placement area. The presence of contact water in the alluvial sand below Site 23 (as seen in MW-23-A4) is not surprising given the permeable nature of the colluvium that lies immediately beneath the site. A clay till layer underlies the colluvium and alluvial sands beneath the site. The clay till acts as a barrier to downward flow, however it is well below the base of both piles.

The fact that MW-D3 does not show signs of a contribution from contact water suggests that an upward hydrologic gradient may exist beneath Site D. Finger Drain 23FD-2 has the highest conductivity but consistently low flow, suggesting no significant influence from groundwater. This drain may also be influenced by runoff that infiltrates along the access ramp to the site. The higher conductivity of the site contact waters reflects a larger dissolved load caused by weathering of the production rock. As with tailings, pyrite oxidation and carbonate dissolution contribute dissolved ions such as sulfate, bicarbonate, calcium and magnesium to the contact waters, increasing their conductivity. Sulfate concentrations for the finger drains are plotted in Figure 3.18 and match closely the relative value patterns of conductivity.

Figure 3.17 Site 23/D Internal Monitoring Plan Sites – Conductivity Data

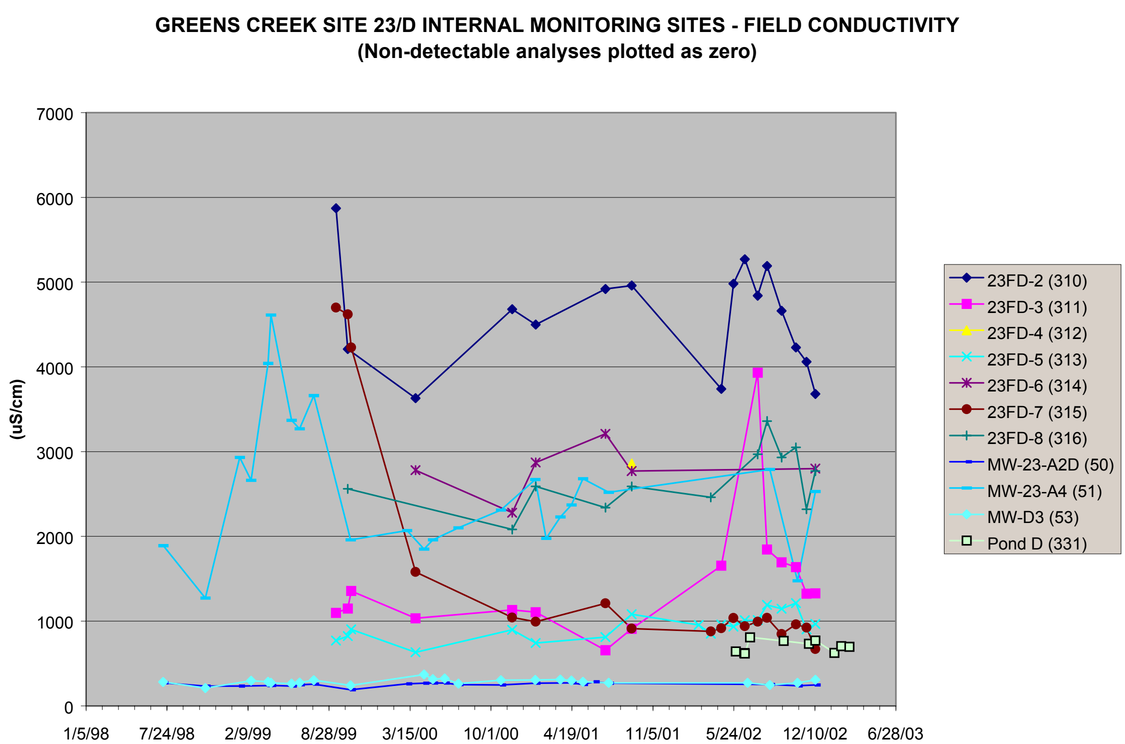
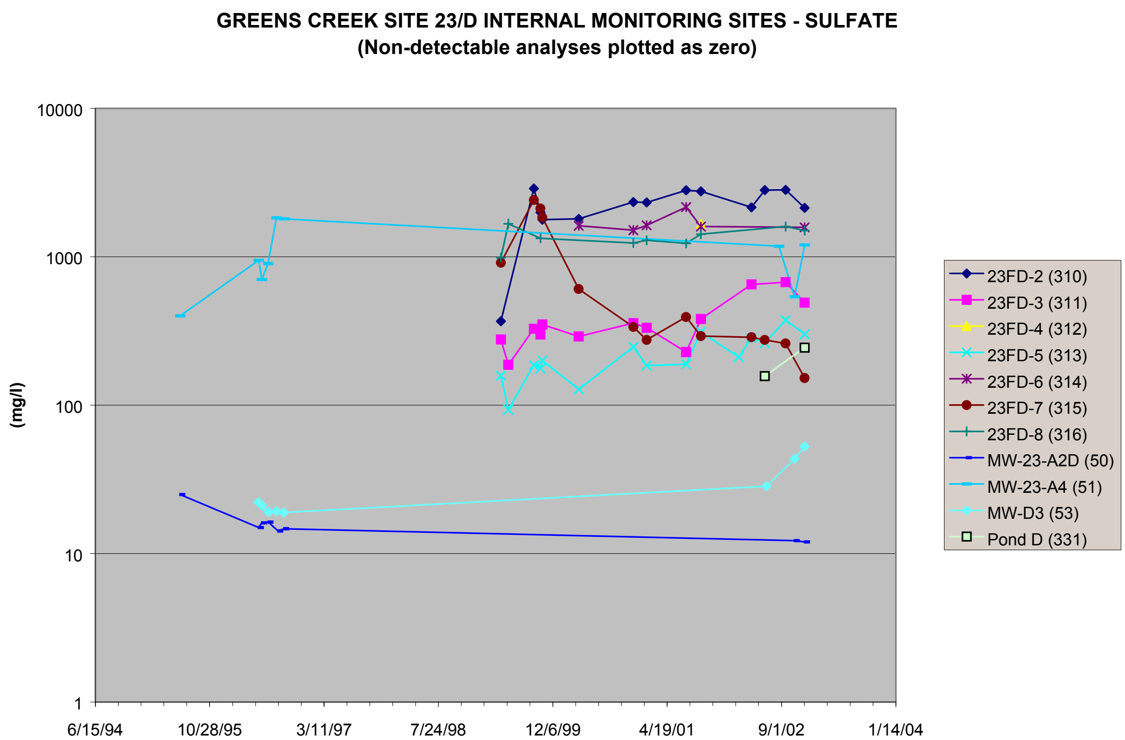


Figure 3.18 Site 23/D Internal Monitoring Plan Sites – Sulfate Data



Arsenic data are presented in Figure 3.19 and are generally quite low (less than 4.5 ppb in 2002). Fluctuations in arsenic values in 23FD-2 are likely due to changes in redox conditions. Low arsenic and iron concentrations indicate that these metals are precipitating as oxyhydroxides on rock surfaces inside the pile.

Figure 3.20 shows the concentration of zinc in the 11 internal monitoring locations at Site 23/D. Zinc levels appear to be controlled by seasonal conditions. The changes in zinc concentrations mimic those for conductivity and sulfate. Although 23FD-2 shows an increasing trend for zinc and other metals, zinc concentrations in the range of 20 to 70 mg/l are consistent with kinetic weathering test performed on samples of argillite and serpentinite (Vos 1993). The zinc concentrations recorded for Pond D are generally below 0.7 mg/l and reflect contributions from several source waters. Pond D receives water from Site D surface runoff, seeps on the slope and at the toe of the site and the effluent from the curtain drain that KGCMC installed between Site D and Site 23.

Cadmium concentrations (Figure 3.21) correlate well with those of zinc for the internal monitoring sites although at much lower values (0 to 35 ppb).

The concentrations of copper and lead (Figures 3.22 and 3.23) are considerably lower than that of zinc in the Site 23/D internal monitoring sites. Both of these metals show the same general trends as zinc with the exception of one anomalous lead result in a sample from 23FD-2 in 1999. The nickel concentrations presented in Figure 3.24 support the observation that the drainage from 23FD-2 is different than that of other drainages. It is possible that the material that supplies water to this drain has a greater proportion of serpentinite, which was shown to produce higher zinc and nickel concentrations than other rock types such as argillite and phyllite (Vos 1993). What appeared to be a linear increase in nickel concentrations in 23FD-2 prior to 2002 now appears to be decreasing or at least cyclical.

Figure 3.19 Site 23/D Internal Monitoring Plan Sites – Arsenic Data

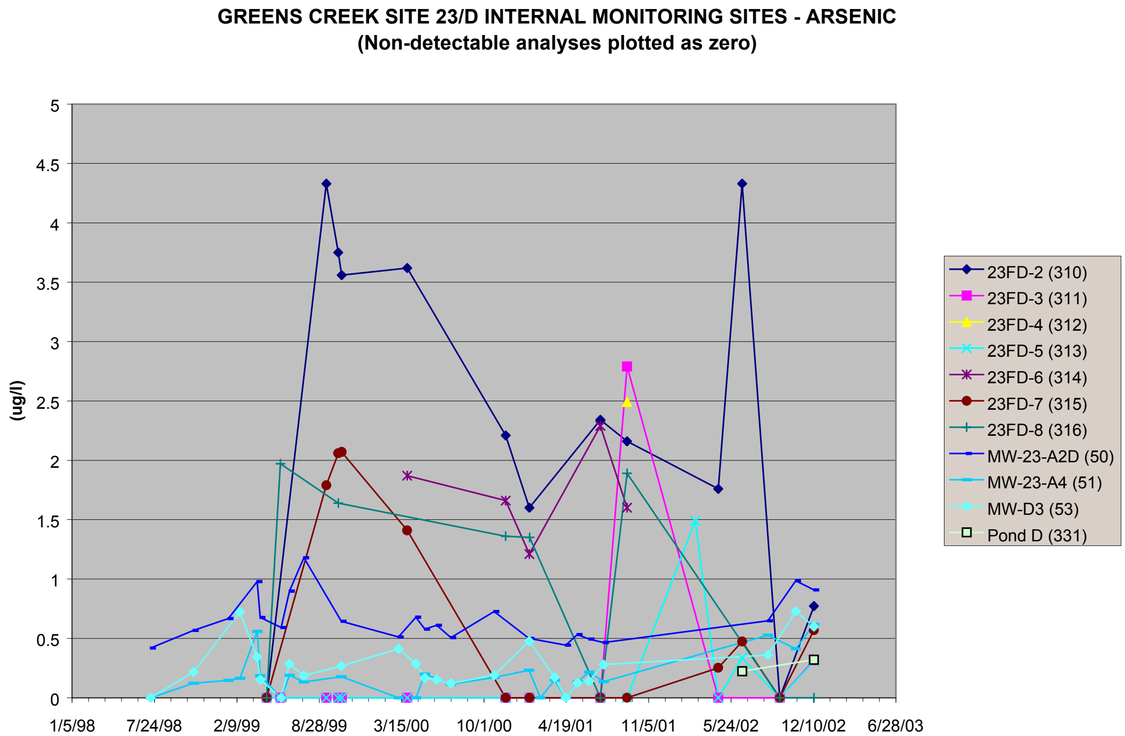


Figure 3.20 Site 23/D Internal Monitoring Plan Sites – Zinc Data

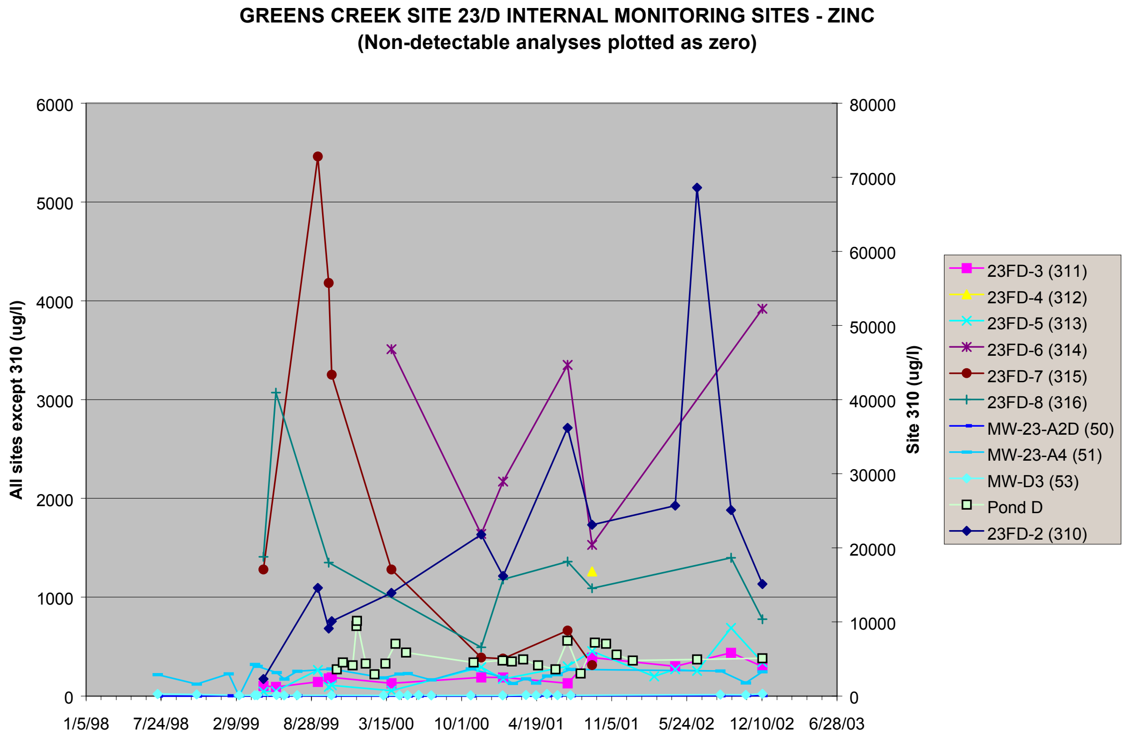


Figure 3.21 Site 23/D Internal Monitoring Plan Sites – Cadmium Data

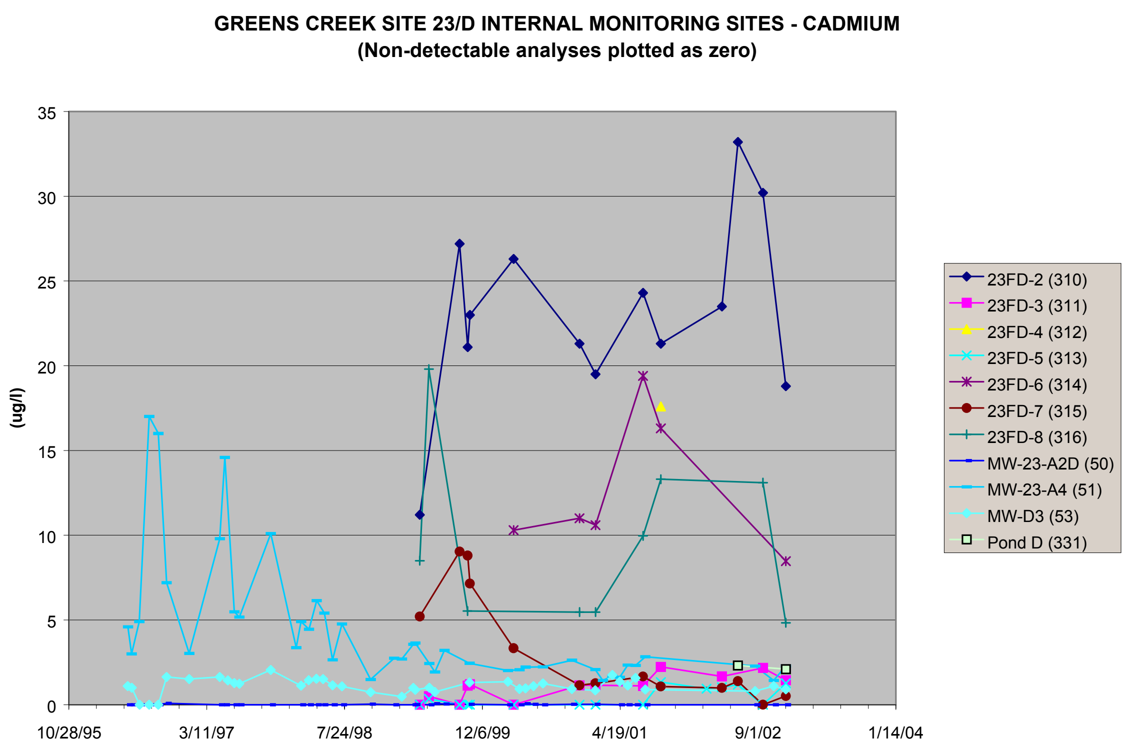


Figure 3.22 Site 23/D Internal Monitoring Plan Sites – Copper Data

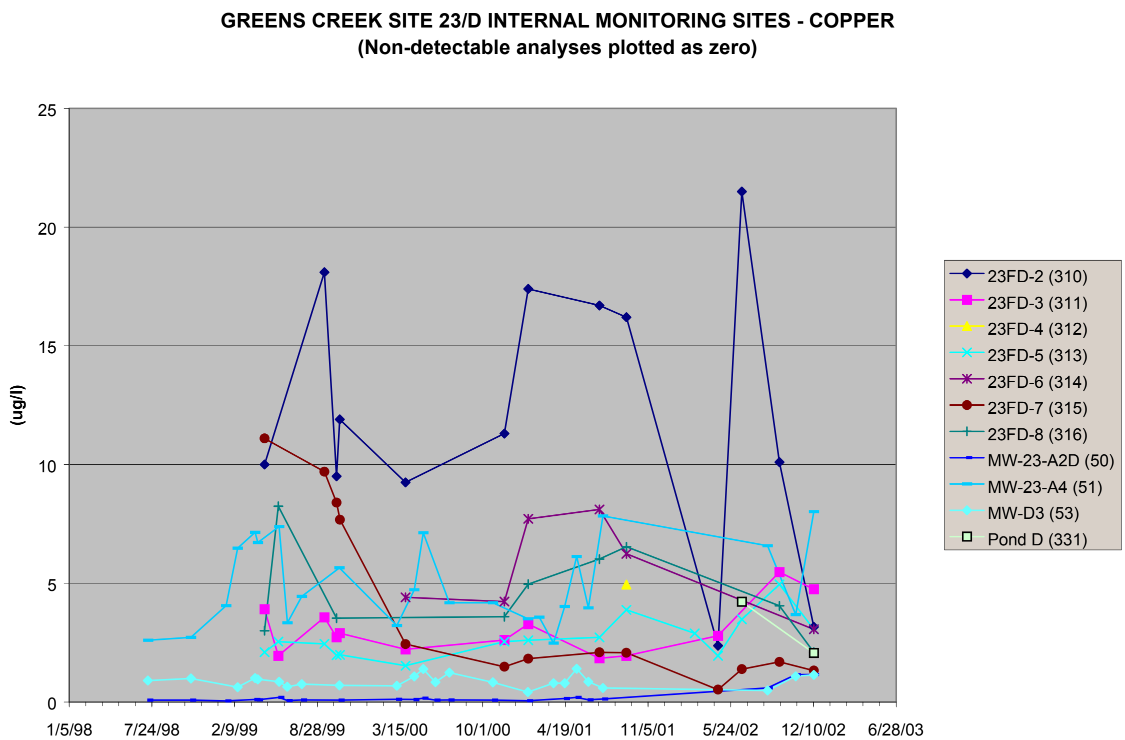


Figure 3.23 Site 23/D Internal Monitoring Plan Sites – Lead Data

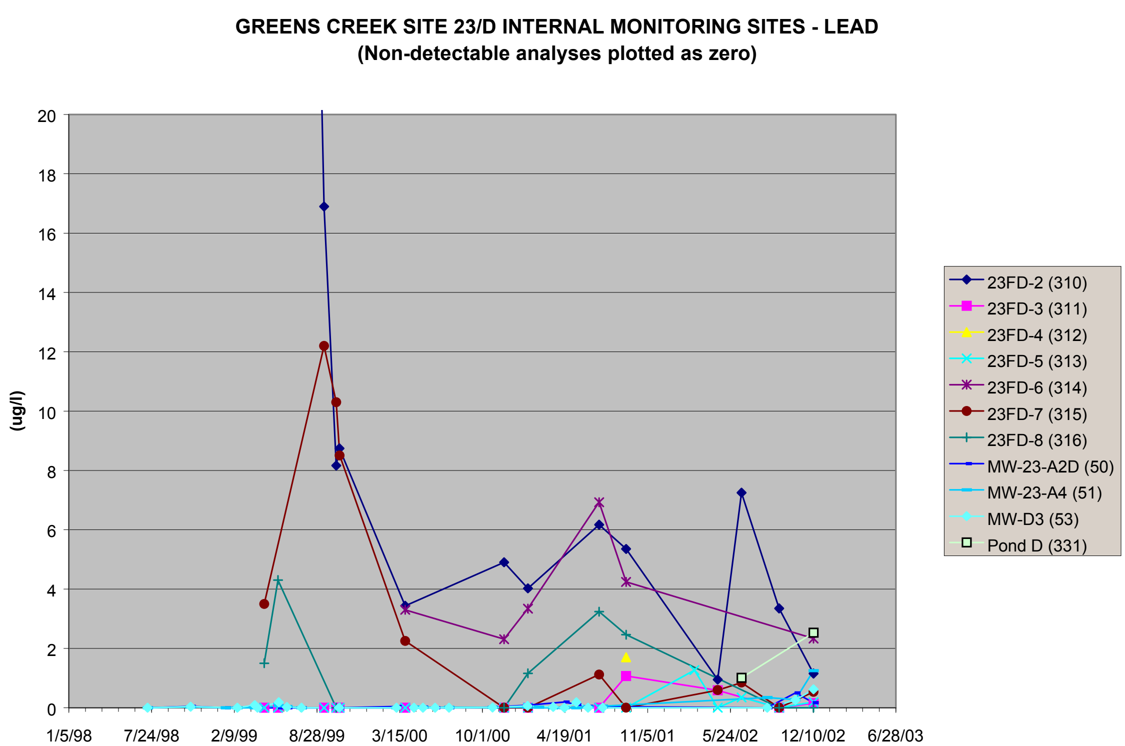


Figure 3.24 Site 23/D Internal Monitoring Plan Sites – Nickel Data

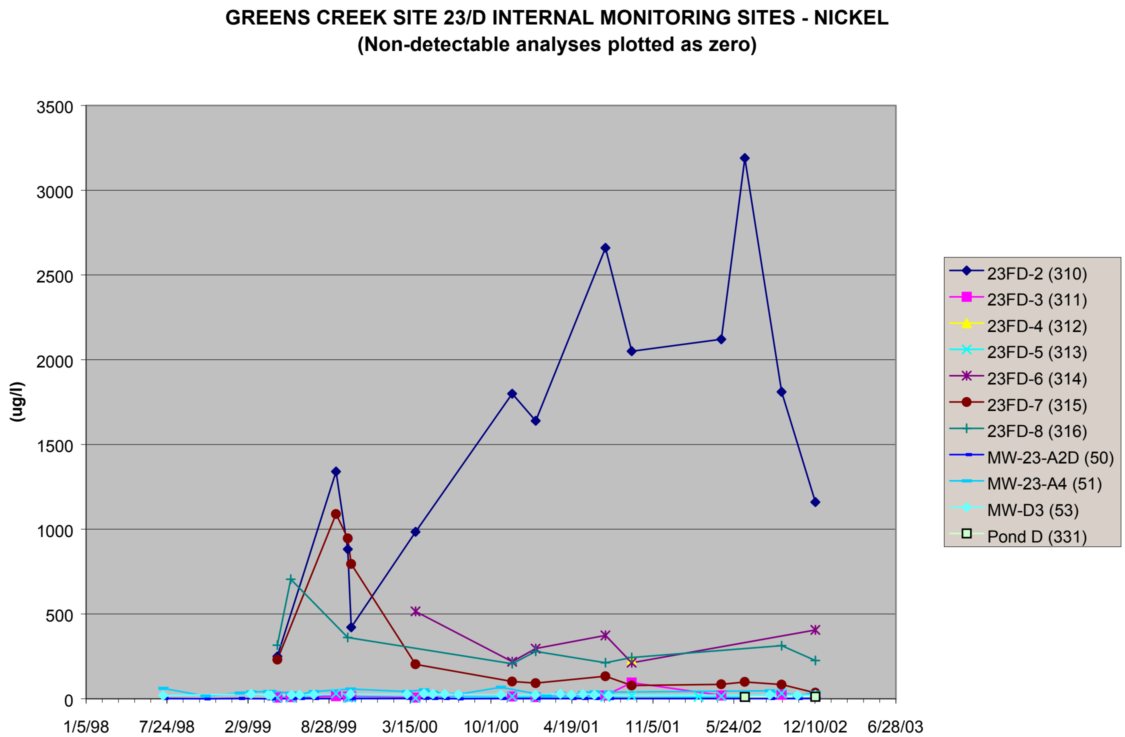
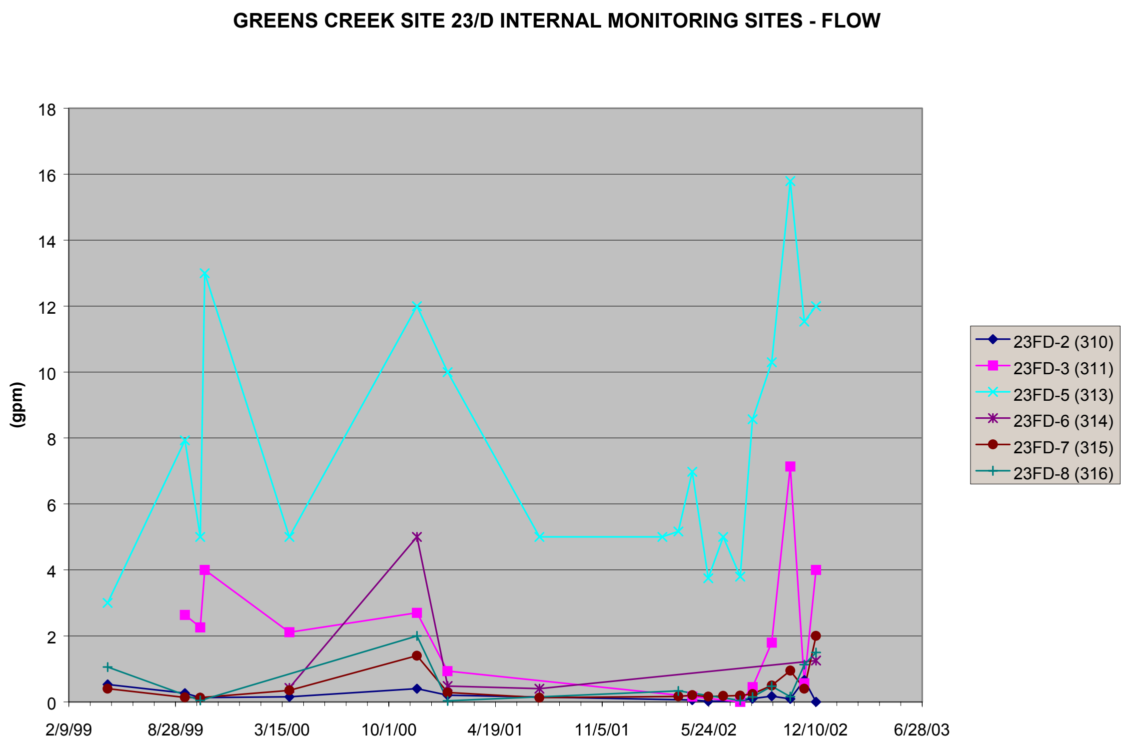


Figure 3.25 Site 23/D Internal Monitoring Plan Sites – Flow Data



<u>Acid Base Accounting Data</u>

Acid base accounting (ABA) results from 52 underground composites are presented in Table 3.3 and Figure 3.26. Class 1 samples had an average neutralization potential (NP) of 484 tons $CaCO_3$/1000t, which is equivalent to almost 50% carbonate. The Class 1 samples had an average acid potential (AP) of 66 tons$CaCO_3$/1000t, which produced an average net neutralization potential (NNP) of 418 tons $CaCO_3$/1000t. Class 1 production rock does not have the potential to generate acid rock drainage, however the potential for metal mobility (primarily zinc) for argillite does exist. KGCMC recognizes this characteristic of Class 1 production rock and handles the material accordingly by placing it in controlled facilities, such as Site 23 and the tailings area.

Class 2 production rock samples had a moderate average NP value (201 tons$CaCO_3$/1000t) and an average AP of 243 tons$CaCO_3$/1000t. The resulting average NNP for the Class 2 samples was -42. Class 3 samples had an average NP, AP and NNP of 128, 292 and -164 tons$CaCO_3$/1000t, respectively. Negative values for NNP indicate that the materials are potentially acid generating, thus requiring appropriate ARD control measures. Carbonate in the Class 2 and Class 3 production rock prevents ARD formation in the short term, allowing time for placement of a composite soil cover to be constructed during reclamation. The soil cover is designed to inhibit ARD formation by minimizing oxygen and water infiltration into the underlying production rock. Class 4 samples produced an average NNP of -287 tons$CaCO_3$/1000t, which is just inside the cutoff for Class 3 material (-300 tons$CaCO_3$/1000t). Class 4 material is retained underground.

Figure 3.26 compares actual class designation based on ABA analyses to the results of visual designation use underground to classify the production rock. Of the 52 composites, visual classification assigned only 2 samples (4%) to a lower, less conservative class. 45 (86%) of the composites were assigned to the appropriate class and 6 (10%) to a higher, more conservative class. These data represent a 96% success rate for the visual classification program.

Table 3.3 Acid Base Accounting Data Summary for Underground Rib Samples

Class #	NP	AP	NNP
1	484	66	418
2	201	243	-42
3	128	292	-164
4	131	418	-287

Notes:
Values are averages from 52 samples
ABA units are tons $CaCO_3$/1000t
NP determined by standard Sobek method
AP determined from iron assay (converted to pyrite equivalent)

Figure 3.27 shows the ABA data from surface sampling at Site 23 and Site D. Grid samples were obtained from the outer slopes of both piles and the active placement zones of Site 23. The AP to NP distribution is similar, albeit with lower AP values, to the underground rib sampling. The data indicate full compliance with designated placement zones. The outer slope samples that plot near the origin are native soils placed over production rock as interim reclamation in some areas. These samples of native soils also have relatively low pH values (down to 5.0), which is typical for coniferous forest soils.

During the grid sampling of Site 23 and Site D, 41 pH measurements were taken. Excluding the native soil values discussed above, two of the 41 measurements had pH values of less than 5.0. The two low pH values are related to pyritic rock used to construct the berm that encloses D Pond. Removal of this pyritic rock will be included as a component of the reclamation activities planned for Site D. Currently drainage from this area is collected and pumped to the Pit 5 water treatment facility. The distribution of pH and NNP (Figure 3.28) illustrates that alkaline conditions persist at both sites, despite these two anomalous pH values. As discussed in Section 2.5, the difference between paste pH and rinse pH is due to different preparation methods. The paste pH is typically higher than rinse pH because the sample is pulverized, which tends to expose fresh mineral surfaces. The rinse pH method uses more water, which can dissolve oxidation products and lower the test solution pH.

Figure 3.26 ABA Data from Underground Rib Sampling

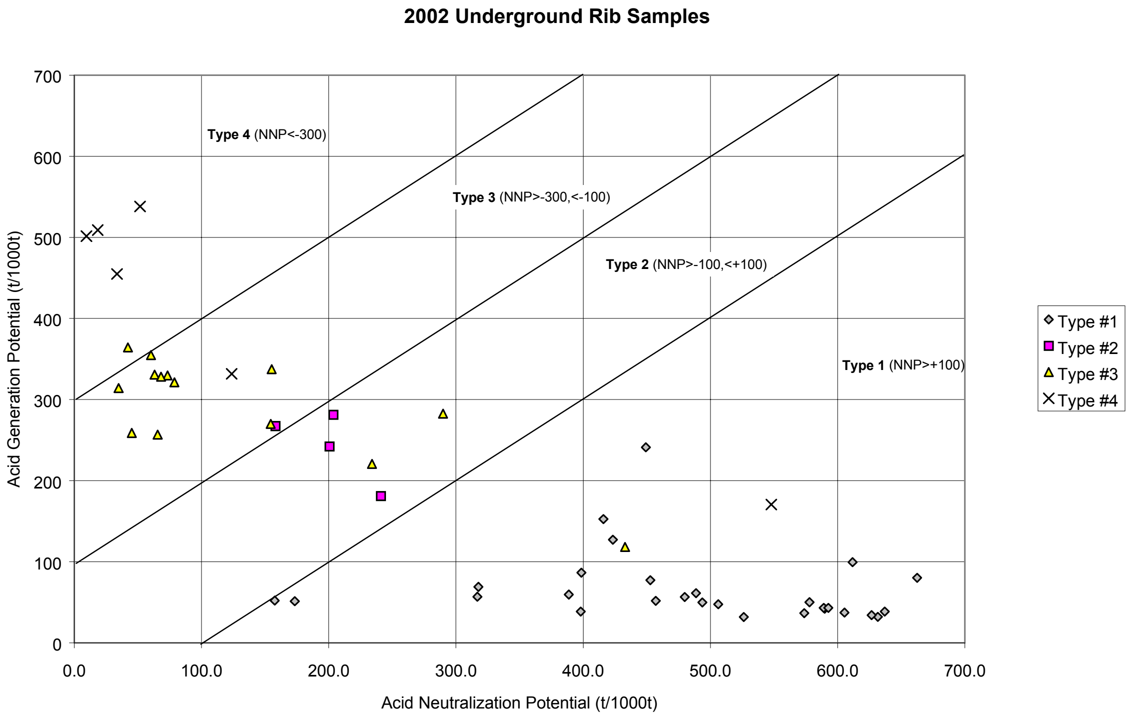

2002 Underground Rib Samples
Type 4 (NNP<-300)
Type 3 (NNP>-300,<-100)
Type 2 (NNP>-100,<+100)
Type 1 (NNP>+100)
Acid Generation Potential (t/1000t)
Acid Neutralization Potential (t/1000t)
Type #1
Type #2
Type #3
Type #4
0
100
200
300
400
500
600
700
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0

Figure 3.27 ABA Data from Surface Sampling

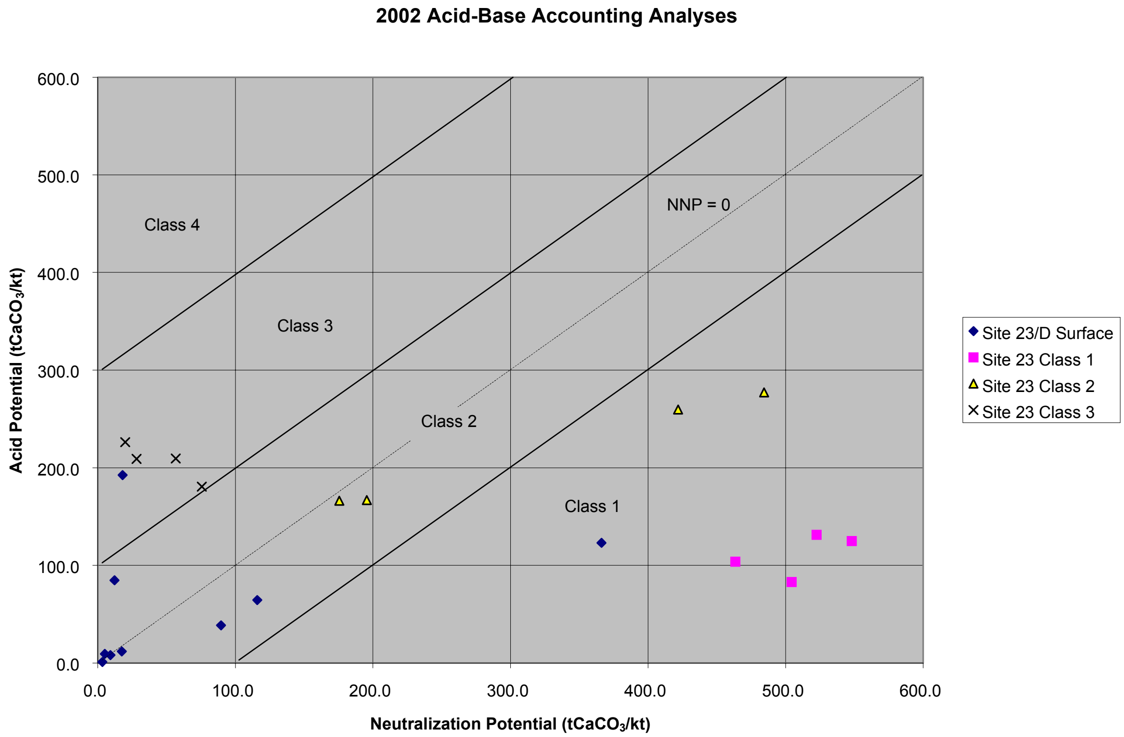
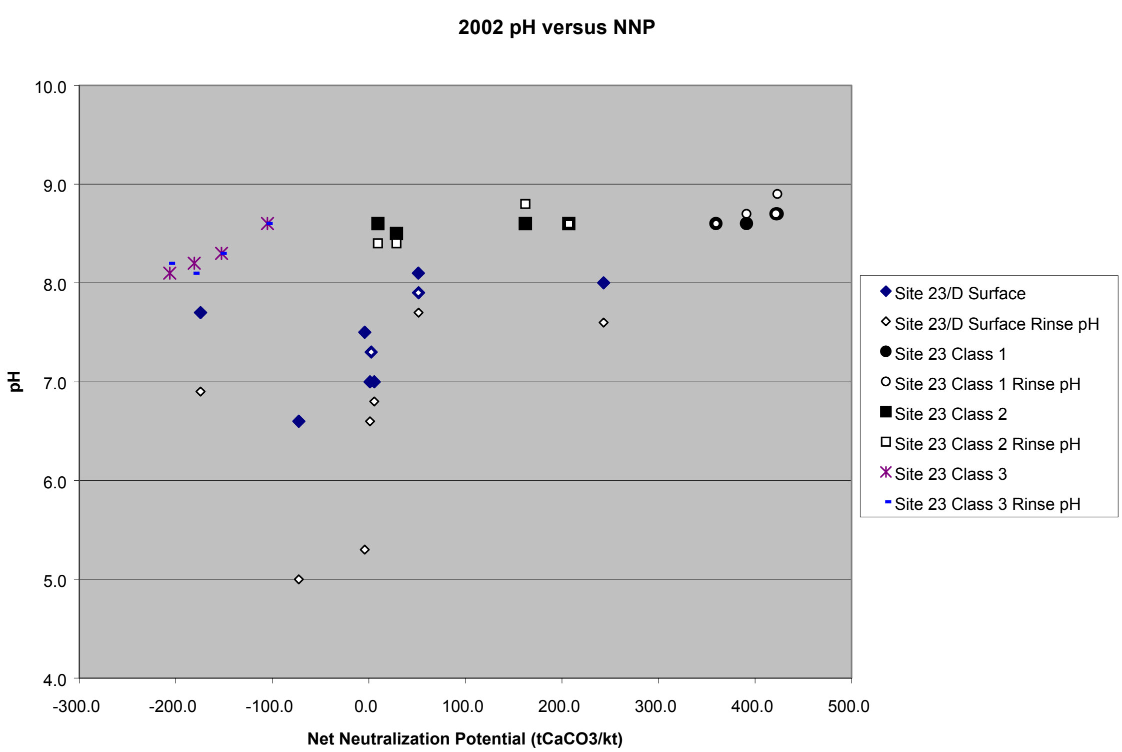


Figure 3.28 pH versus Net Neutralization Potential Data from Surface Sampling



3.6 General site management

The construction method used at Site 23 (bottom-up construction) limits the site's complexity. All placement activity in 2002 occurred between the 960 and 990 levels of the pile. Designated placement zones are marked on the active lift of the site and production rock is placed according to class. Class 2 and Class 3 materials are placed five and ten feet, respectively, from the outer edges of the pile. Class 1 can be place anywhere in the pile but is most often used to provide the thickness required to maintain the five-foot zone between the outer surface and the Class 1-2 placement zone interface. See Section 3.7 for photographs of designated placement zones.

In 2002 KGCMC continued to raise the west portion of the pile where the access ramp reaches the active placement surface. This will facilitate construction of a switchback in the access ramp, which would allow a reasonable grade access route to the crest of the pile design capacity.

No significant changes to the slope above Site 23 were made in 2002, and routine inspections revealed no problems associated with management of the site.

Consideration of advancements in the understanding of ARD processes at Greens Creek and the current mine production rock forecast has led KGCMC to assess its classification and placement procedures. Significant points related to the assessment are as follows:

- Groundwater cannot enter Site 23 from below because the pile's foundation is free-draining. Therefore groundwater does not pose an ARD/metals leaching risk to the site.

- Layering of alkaline material in or below acid generating rock is not effective at preventing or mitigating ARD. Therefore placing argillite (Class 1) at the base of Site 23 is not a beneficial use of this material. For the same reason the basal layer of Class 2 provides no additional benefit. It would be more appropriate to blend this material as much as possible with low carbonate lithologies to extend the buffering capacity of the pile core.

- The purpose of placing argillite on the outer surface of the pile is not to add alkalinity to the pile. Its intended purpose is to create distance between the potentially acid generating rock and the atmosphere. It also has the potential to act as an oxygen sink, because it contains small amounts of oxygen-consuming sulfide. However, compaction and oxygen consumption by sulfide-rich rocks have a much greater control on oxygen transport in the pile. During pile construction, placement of argillite on the outer slopes likely has minimal impact on oxidation processes. Instead, the lack of significant air convection and the presence of carbonate minerals in the Class 2 and Class 3 rock are the primary factors preventing ARD formation. Covering the pile with a composite soil cover during reclamation is the long term ARD prevention measure. After cover construction, the presence of two-feet of argillite acting as an oxygen sink beneath the cover would be beneficial.

- Carbonate content, more so than sulfide content controls the lag time to acid generation in Greens Creek production rock. In order to minimize the likelihood of developing acidic conditions prior to constructing the soil cover, it is important to avoid creating low carbonate zones in the pile. Achieving a homogeneous carbonate content would be more beneficial than segregating different types of potentially acid generating lithologies based on NNP.

- The current mine production rock forecast calls for less annual tonnage than in previous years. Since lower underground tonnages would reduce the rate at which production rock accumulates, isolation of the pyritic core would be slower. This would place a higher priority on limiting the occurrence of low carbonate, pyritic zones in the upper portion of the pile.

KGCMC proposes the following modifications to its production rock placement practices in order to improve its ARD prevention strategy:

- Achieve a more homogeneous carbonate distribution by discontinuing segregation of Class 2 and Class 3 rock types in the pile. If excess Class 1 rock is available beyond what is needed for erosion control at the tailings facility and creating a two-foot oxygen sink layer at Site 23, blend with Class 2 and Class 3 material. Minimize zones with a NP less than 100 $tCaCO_3/kt$ and a NP/AP ratio less than 0.4.

- Eliminate the layering of Class 1 and Class 2 to provide additional rock for blending and armoring of outer slopes.

3.7 Site as-built

An as-built for Site 23/D is presented in Appendix 2. The as-built shows the year-end topography, water management features, monitoring device locations, and other significant features of the site. The as-built also includes cross sections that show the following information:

- existing topographic surface
- prepared ground upon which the pile was constructed
- original unprepared ground
- water levels
- designated placement zones for the three production rock classes

Figure 3.29 Aerial Photograph of Site 23/D

This photograph shows Site 23 (foreground) and Site D (separated from Site 23 by the B Road). The composite soil cover plot (green) is visible on the lower slope of Site 23. Pond 23 and Pond D are visible on the southwest (right) perimeters of their respective sites. Reclamation materials have been removed from the slope above Site 23 (below tree line, forground).

Figure 3.30 Photograph of Site 23 Composite Soil Cover Plot

The photograph shows the recently seeded composite soil cover placed on the lower slope of Site 23. A portion of the lower capillary break is visible below the seeded growth layer. The B Road and lined ditch that brings surface waters to Pond 23 are visible in the foreground.

Figure 3.31 Photograph of Site 23 Designated Placement Zones

The photograph shows the designated placement zones (Class 1, left; Class 2, center; Class 3, right). Marks from the grid roller are visible on the recently spread and compacted production rock surface. The view is looking east.

Figure 3.32 Photograph of Site 23 Foundation Preparation

This photograph shows construction of the pile base. Native rock and sediments are removed from the back slope and stockpiled for use in future reclamation projects. Continuation of finger drains (not visible) extend over the prepared surface and a five-foot thickness of Class 1 production rock is placed prior to placement of other classes.

Figure 3.33 Photograph of Site 23 Backslope and Designated Placement Zones

The three designated placement zones are visible in the lower half of the photograph. Class 3 in the foreground, Class 2 at center and Class 1 at base of backslope. Safety berms are left between the placement zones. Excavated material from the backlope (upper half of photo) will be used for site reclamation. Monitoring well MW-23-98-01 is visible in the foreground (right). The view is oriented north.

3.8 Reclamation

KGCMC has monitored the performance of a one-acre composite soil cover plot on Site 23 since September 2000 (see Site 23 as-built in Appendix 2 for plot location). Key performance aspects of the cover system include:

- The monitoring indicates that the primary objective of maintaining at least 85% saturation in the compacted barrier layer of the cover has been met. In fact, saturation appears to have stabilized at about 95 percent. This is significant because maintaining water saturation in the barrier layer minimizes oxygen transport into the underlying production rock.

- Of the 157 inches of precipitation that fell since the lysimeter collection system was installed, approximately 30 inches of percolation into the lysimeter has been recorded. The cover system appears to have allowed approximately 19 percent of the incident precipitation into the lysimeter. This represents an approximate 8 percent increase relative to 2001. It is possible that water from the access ramp above the cover plot and/or preferential flow down the neutron probe access tube is affecting the net percolation results. Late in 2002 a lined cutoff trench was installed above the cover plot and bentonite was applied around the access tube to the lysimeter. Subsequent monitoring will determine if these maintenance activities reduce the apparent net percolation rate.

- The temperature in the barrier layer throughout this monitoring period has again remained above 32°F, which implies that the barrier layer is not subjected to freeze/thaw cycles.

- Data capture from the 14 monitoring instruments has been nearly 100%. All components of the field monitoring system are functioning properly. The tipping bucket rain gauge was taken off-line for repair during the fourth quarter. Adjusted Mill Site precipitation data was used for the period that the gauge was off-line.

- Despite experiencing a measurable earthquake and intense rain, the cover showed no signs of erosion or slope instability, and thus no repair costs were incurred. The reclamation plan however does allow for cover maintenance, which to date has not been required. This is a positive result with respect to the structural integrity of the cover, which currently does not have a buttressed toe. Full-scale cover placement will include toe support.

<u>Reclamation Plan</u>

The KGCMC Reclamation Plan, as well as its implementation is discussed above in Section 2.8 Tailings of this report. Please refer to that discussion for aspects relevant to Site 23/D area reclamation.

4.0 References

Environmental Design Engineering (EDE), 2002a Kennecott Greens Creek Mining Company Stage II Tailings Expansion Hydrologic Analysis, February 5, 2002.

Environmental Design Engineering (EDE), 2002b Kennecott Greens Creek Mining Company Stage II Tailings Expansion Geochemistry Report, February 5, 2002.

Kennecott Greens Creek Mining Company (KGCMC), 2002 Update of Information and Action Plan on Seeps West of the Current Tailings Disposal Facility, January 2002.

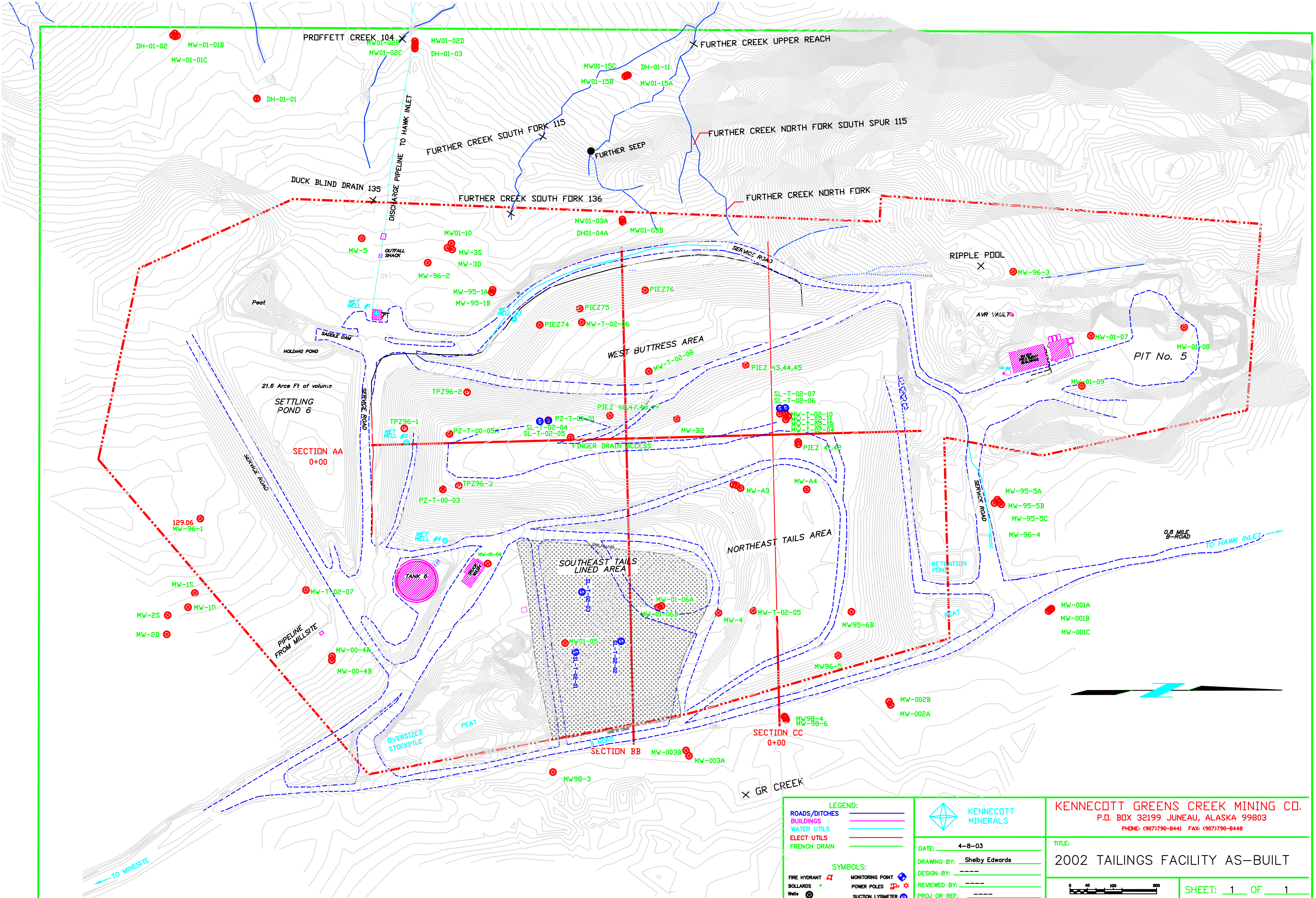
Klohn Crippen, 2002, Existing Tailings Facility Southeast Expansion Construction Summary, November, 2002.

O’Kane Consultants Inc. (O’Kane), 2001, Cover System Performance at the Kennecott Greens Creek Mine, Report # 678-01, December, 2001.

Vos, R.J., 1993, Weathering Characteristics of Waste Rock From Admiralty Island Deposit (23 Month Report, B.C. Research Inc., July 1993.

APPENDIX 1

Tailings Facility 2002 As-built and Cross Sections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FURTHER CREEK UPPER REACH
FURTHER CREEK SOUTH FORK 115
FURTHER SEEP
FURTHER CREEK NORTH FORK SOUTH SPUR 115
DUCK BLIND DRAIN 135
FURTHER CREEK SOUTH FORK 136
FURTHER CREEK NORTH FORK
DISCHARGE PIPELINE TO HAWK INLET
RIPPLE POOL
WEST BUTTRESS AREA
PIT No. 5
SETTLING POND 6
21.6 Acre Ft of volume
HOLDING POND
SADDLE DAM
Peat
SECTION AA
0+00
FINGER DRAIN ACCESS
NORTHEAST TAILS AREA
SOUTHEAST TAILS LINED AREA
TANK 6
PIPELINE FROM MILLSITE
OVERSIZED STOCKPILE
PEAT
RETENTION POND
SECTION BB
SECTION CC
0+00
GR CREEK
TO MINESITE
TO HAWK INLET
0.8 MILE B-ROAD
SERVICE ROAD
DH-01-02
MW-01-01B
MW-01-01C
DH-01-01
MW01-02D
DH-01-03
MW01-02C
MW01-15C
MW01-15B
DH-01-11
MW01-15A
MW01-03A
DH01-04A
MW01-03B
MW01-10
MW-5
MW-3S
MW-3D
MW-96-2
MW-95-1A
MW-95-1B
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PIEZ75
PIEZ74
MW-T-02-06
MW-T-02-08
PIEZ 43,44,45
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TPZ96-1
PZ-T-00-05A
PZ-T-00-01
SL-T-02-04
SL-T-02-05
SL-T-02-07
SL-T-02-06
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PIEZ 41,42
TPZ96-3
PZ-T-00-03
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MW-A4
MW-96-3
MW-01-07
MW-01-08
MW-01-09
MW-95-5A
MW-95-5B
MW-95-5C
MW-96-4
129.06
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MW-1S
MW-1D
MW-2S
MW-2D
MW-T-02-07
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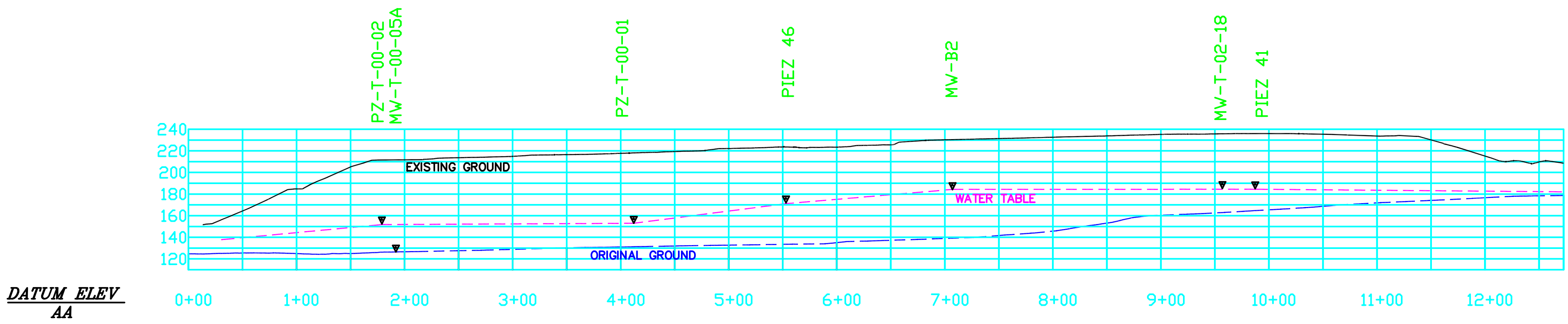
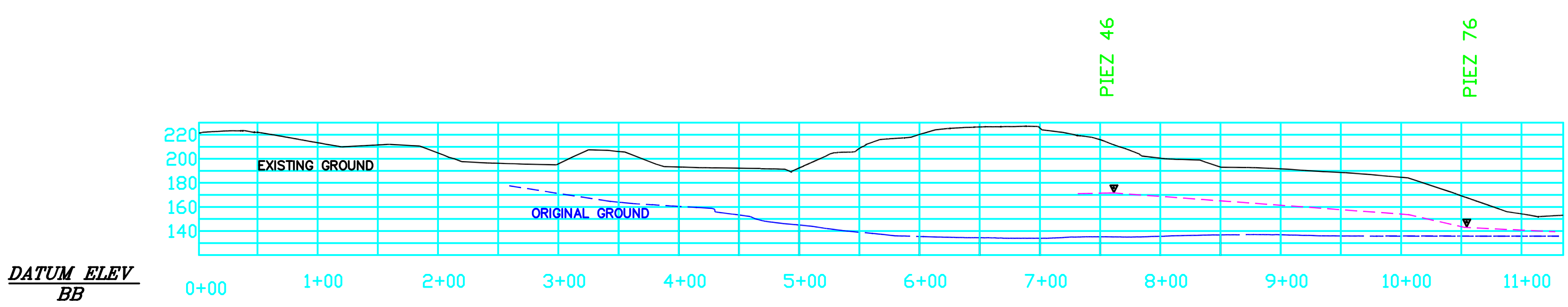
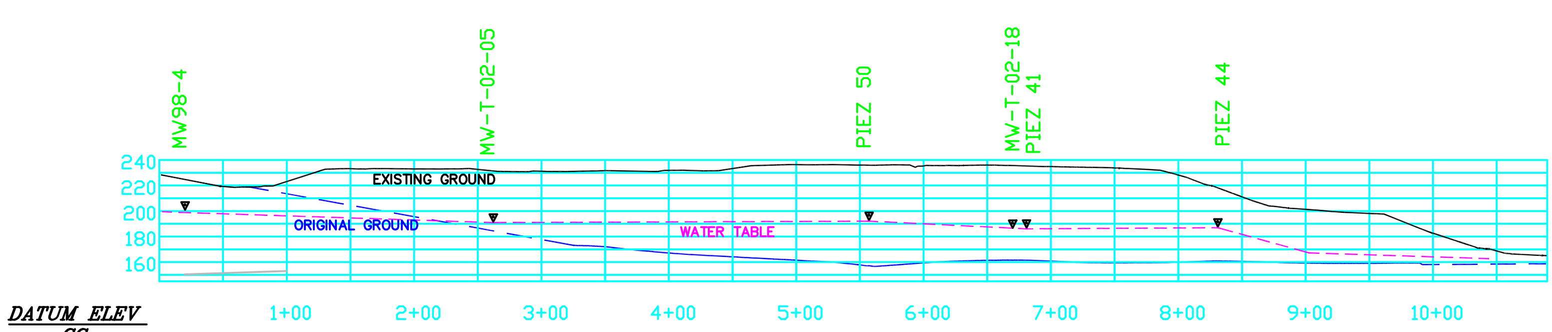
MW-00-4B
MW-01-06A
MW-01-06B
MW01-05
MW-4
MW-T-02-05
MW95-6B
MW-001A
MW-001B
MW-001C
MW96-5
MW-002B
MW-002A
MW98-4
MW98-6
MW-003B
MW-003A
MW98-3
LEGEND:
ROADS/DITCHES
BUILDINGS
WATER UTILS
ELECT UTILS
FRENCH DRAIN
SYMBOLS:
FIRE HYDRANT
BOLLARDS
Wells
MONITORING POINT
POWER POLES
SUCTION LYSIMETER
KENNECOTT MINERALS
KENNECOTT GREENS CREEK MINING CO.
P.O. BOX 32199 JUNEAU, ALASKA 99803
PHONE: (907)790-8441 FAX: (907)790-8448
DATE: 4-8-03
DRAWING BY: Shelby Edwards
DESIGN BY: ----
REVIEWED BY: ----
PROJ OR REF. ----
TITLE:
2002 TAILINGS FACILITY AS-BUILT
0 40 100 200
SHEET: 1 OF 1







EXISTING GROUND

ORIGINAL GROUND

WATER TABLE

KENNECOTT GREENS CREEK MINE

ADMIRALTY ISLAND, ALASKA

2002 TAILINGS FACILITY AS-BUILT

CROSS SECTIONS

DATE: 4-8-03

DRAWING BY: Shelby Edwards

DESIGN BY: ----

REVIEWED BY: ----

PROJ OR REF. ----

PREPARED BY:

GREENS CREEK MINING CO.

JUNEAU, ALASKA

PHONE: (907)790-8441 FAX: (907)789-8448

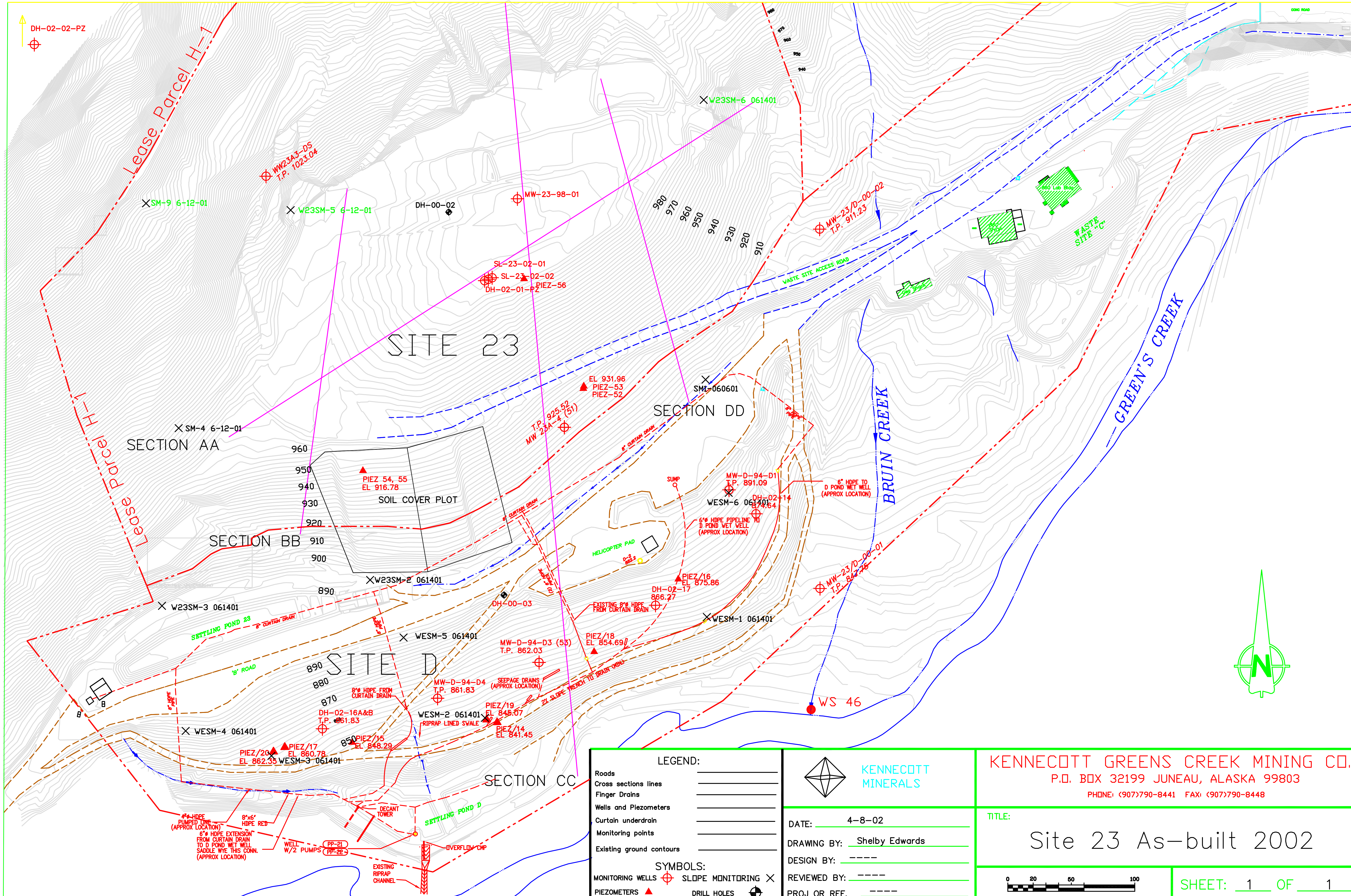
GCMC DWG #

SCALE: IN FEET

SHEET:

APPENDIX 2

Site 23/D 2002 As-built and Cross Sections



SITE 23
SITE D
SECTION AA
SECTION BB
SECTION CC
SECTION DD
SOIL COVER PLOT
Lease Parcel H-1
Lease Parcel H-1
BRUIN CREEK
GREEN'S CREEK
WASTE SITE "C"
WASTE SITE ACCESS ROAD
HELICOPTER PAD
SETTLING POND 23
SETTLING POND D
WS 46
DH-02-02-PZ
WW23A3-DS T.P. 1023.04
SM-9 6-12-01
W23SM-5 6-12-01
DH-00-02
MW-23-98-01
W23SM-6 061401
SL-23-02-01
SL-23-02-02
DH-02-01-PZ
PIEZ-56
MW-23/D-00-02 T.P. 911.23
EL 931.96 PIEZ-53 PIEZ-52
T.P. 925.52 MW 23A-4 (51)
SMI-060601
SM-4 6-12-01
PIEZ 54, 55 EL 916.78
MW-D-94-D1 T.P. 891.09
WESM-6 061401
DH-02-14 864.64
6" HDPE TO D POND WET WELL (APPROX LOCATION)
6"Ø HDPE PIPELINE D POND WET WELL (APPROX LOCATION)
SUMP
W23SM-2 061401
W23SM-3 061401
PIEZ/16 EL 875.86
DH-02-17 866.27
DH-00-03
EXISTING 8"Ø HDPE FROM CURTAIN DRAIN
WESM-1 061401
MW-23/D-00-01 T.P. 847.75
WESM-5 061401
MW-D-94-D3 (53) T.P. 862.03
PIEZ/18 EL 854.69
MW-D-94-D4 T.P. 861.83
SEEPAGE DRAINS (APPROX LOCATION)
8"Ø HDPE FROM CURTAIN DRAIN
2% SLOPE TRENCH TO DRAIN
DH-02-16A&B T.P. 861.83
WESM-2 061401
RIPRAP LINED SWALE
PIEZ/19 EL 845.07
PIEZ/14 EL 841.45
WESM-4 061401
PIEZ/15 EL 848.29
PIEZ/17 EL 860.78
PIEZ/20 EL 862.35
WESM-3 061401
DECANT TOWER
OVERFLOW CMP
EXISTING RIPRAP CHANNEL
WELL W/2 PUMPS
PP-21
PP-22
8"x6" HDPE RED
4"Ø HDPE PUMPED LINE (APPROX LOCATION)
6"Ø HDPE EXTENSION FROM CURTAIN DRAIN TO D POND WET WELL SADDLE WYE THIS CONN. (APPROX LOCATION)
LEGEND:
Roads
Cross sections lines
Finger Drains
Wells and Piezometers
Curtain underdrain
Monitoring points
Existing ground contours
SYMBOLS:
MONITORING WELLS
SLOPE MONITORING
PIEZOMETERS
DRILL HOLES
KENNECOTT MINERALS
KENNECOTT GREENS CREEK MINING CO.
P.O. BOX 32199 JUNEAU, ALASKA 99803
PHONE: (907)790-8441 FAX: (907)790-8448
DATE: 4-8-02
DRAWING BY: Shelby Edwards
DESIGN BY: ----
REVIEWED BY: ----
PROJ OR REF. ----
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SHEET: 1 OF 1
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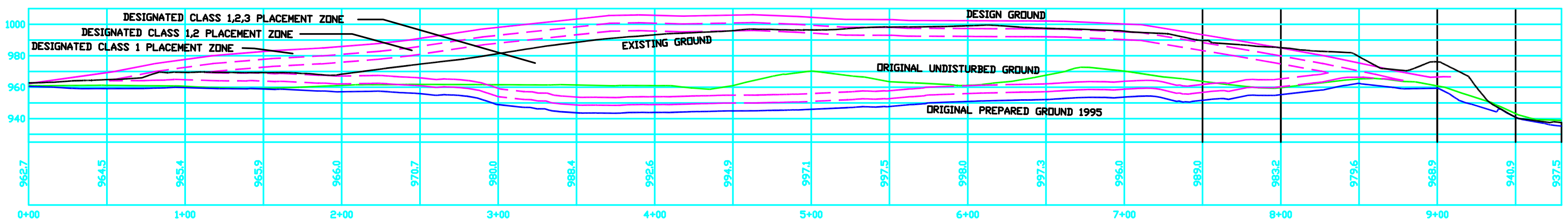

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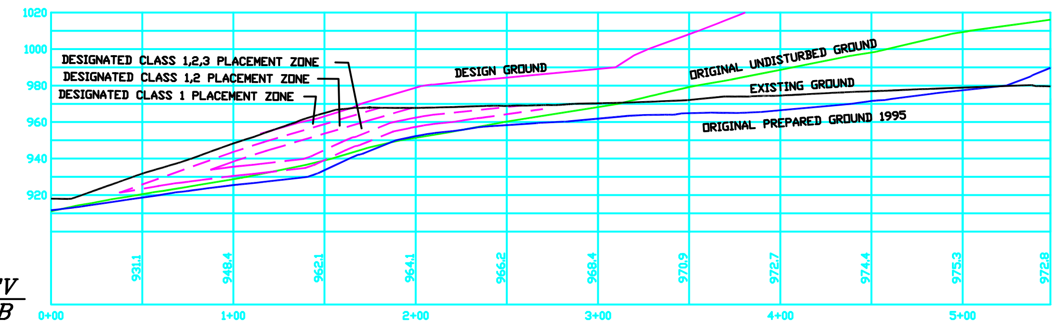
SECTION AA



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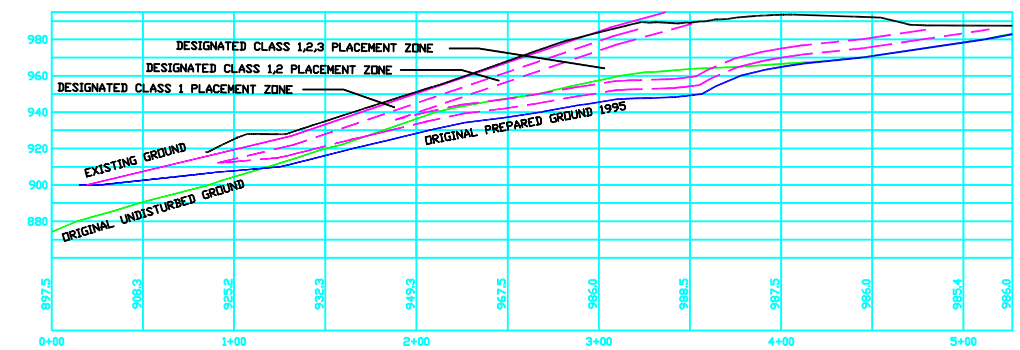

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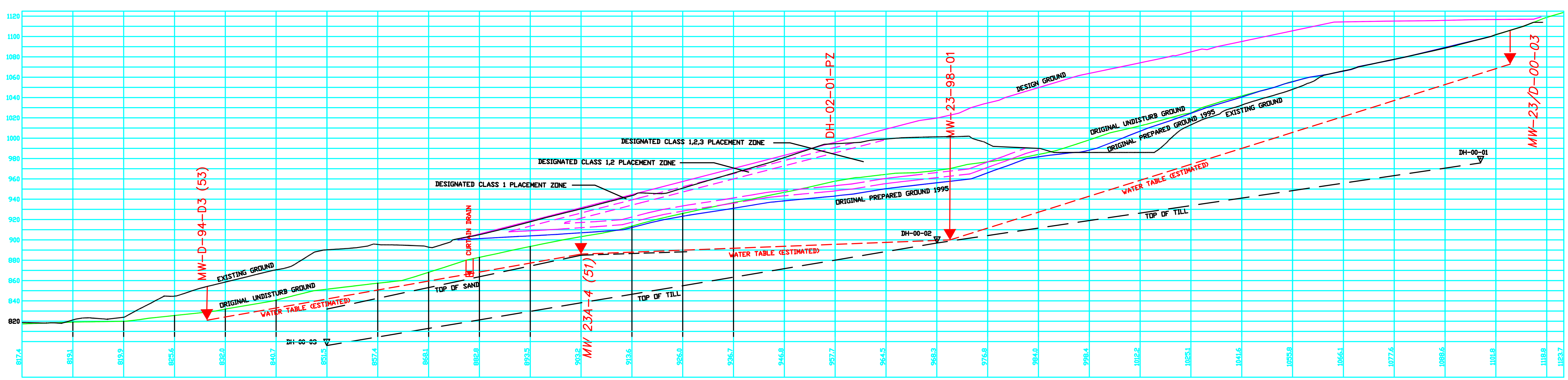
SECTION DD



DATUM ELEV
SECTION CC

LEGEND:

- ORIGINAL PREPARED GROUND 1995
- DESIGN GROUND
- PLACEMENT ZONES
- WATER TABLE (ESTIMATED)
- TILL AND SAND LAYER
- ORIGINAL UNDISTURBED GROUND
- EXISTING GROUND

SYMBOLS:

- WELL DATA
- DRILL HOLE DATA

KENNECOTT MINERALS

KENNECOTT GREENS CREEK MINING CO.
P.O. BOX 32199 JUNEAU, ALASKA 99803
PHONE: (907)790-8441 FAX: (907)790-8448

DATE: 4-9-03
DRAWING BY: Shelby Edwards
DESIGN BY: ----
REVIEWED BY: ----
PROJ OR REF. ----

TITLE:

Site 23 Cross Sections 2002

0 20 50 100

SHEET: 1 OF 1

APPENDIX 3

Klohn Crippen Letter Regarding Production Rock Compaction

April 7, 2003

Kennecott Greens Creek Mining Company
P.O. Box 32199
Juneau, Alaska
99803-2199

Mr. Tom Zimmer
Environmental Coordinator

Dear Mr. Zimmer:

Kennecott Greens Creek Mining Company
Production Rock Site 23 Compaction Methodology – Final

The current specification for compaction of Production Rock (waste rock) at the Kennecott Greens Creek Mining Company (KGCMC) Site 23 as outlined in the General Plan of Operations:

"KGCMC's goal is to reduce water infiltration into Site 23 as much as possible. To meet this goal, KGCMC will target a compaction specification of 90 percent of the site material's Proctor density for production rock placed on the site. Compaction effort will be in accordance with the following procedural method developed from compaction/infiltration tests on mine production rock. After placement and initial compaction with the bulldozer when the material is spread, KGCMC will make a minimum of two passes over each layer of production rock using a Caterpillar CS 563 or equivalent self propelled vibratory compactor."

Currently, there is no practical ASTM standard procedure to determine the Proctor density for the material being stockpiled at Production Rock Site 23. The gradation of the waste rock for Site 23 is enclosed. The ASTM specifications D698-00a (Standard Proctor Test) and D1557-00 (Modified Proctor Test) describe the test method to determine the moisture-density relationship of soils. ASTM specifies that both tests cannot be completed on material where greater than 30% is retained on the ¾ in. sieve. The material at Site 23 is outside of these gradation specifications.

The ASTM specification D1556-90 (Sand Cone Method) describes the test method to determine the in-place density of soils using a sand cone. ASTM specifies that test D1556-90 cannot be completed on material where there is an appreciable amount of particles larger than 1½ in. The material at Site 23 is outside of these gradation specifications.

Density of coarse material in place can be determined using ASTM specifications D4253-00 (Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table) and D5030-89 (Standard Test Method for Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit). The normal procedure for assessing the field achieved density is by comparison with the Density Ratio determined from maximum and minimum density tests conducted in the laboratory for minus 3 inch material ASTM D4253/4-00. These tests are very time consuming to perform and are generally used to establish a method specification for placement (lift thickness, number of passes etc.).

The standards for design and construction of waste material dumps generally used by KC is "Waste Dump Design Guidelines for Mines in British Colombia" prepared by Piteau Associates Ltd. for the Ministry of Energy, Mines and Petroleum Resources. This document states, "Due to the coarse nature of the waste, laboratory compaction testing is difficult, and results are generally not representative."

Based on the above we recommend that the current specification for controlling the compaction of waste rock at Production Rock Site 23 be changed to a method specification with lift thickness and compaction requirements. We propose the following:

- KGCMC compact the waste material at Site 23 in accordance with a method specification.
- The material should be placed and spread to a maximum lift thickness of 24 inches and initially compacted with one complete pass using a bulldozer.
- KGCMC should further compact the material with a minimum of four complete passes (two cycles) over each layer of production rock using a Caterpillar CS 563 or equivalent self propelled vibratory compactor.

It may be possible to increase the lift thickness and or reduce the number of machine passes if the material placed to the method specification is tested for example using the ASTM D5030-89 field test and the results compared to the relative density ratio derived from the maximum and minimum dry density/unit weight laboratory test D4253/4-00. The ASTM specification D5030-89 covers the determination of the in-place density of coarse rock using water to fill a lined test pit. The density ratio is not directly correlated to Proctor density but 90% (modified) proctor is likely in the range of 60% to 70% relative density[1].

[1] Sherard, James L., Woodward, Richard J., Gizienski, Stanley F., Clevenger, William A., John Wiley and Sons, Inc. *Earth and Earth-Rock Dams*. 1963.

Please contact us if you have any comments or questions.

Yours truly,

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Attachment: Site 23 Gradations