Kennecott Minerals

TAILINGS AND PRODUCTION ROCK SITE
2007 ANNUAL REPORT

Kennecott Greens Creek Mining Company

April 15, 2008

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FIGURES

(Data Graphs see Appendix 3; Photographs see Appendix 4)

APPENDICES

1.0 Executive Summary

This annual report has been prepared by Greens Creek Mining Company in accordance with Alaska Waste Disposal Permit 0211-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 0211-BA001 is presented:

Permit Section		Report Section
6.2.1	Closure plan summary	2.8
	Precipitation	2.4, 3.4
	Mill Site90.66" Tailings72.85"	
	The precipitation data collected in 2007 is far greater than would be expected and does not likely represent actual precipitation. The area experienced record snow levels in 2007. The rain gages were buried in snow which may have resulted in an excess of snow melt entering the rain gages during periods of melting (via a funneling effect) and produced higher than actual precipitation readings.	
	Summary of internal monitoring and fresh water monitoring plans	2.5, 3.5
	FWMP annual report separate for water year 2007 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 continues higher in some tailings wells due to migration of redox boundary. Seasonal compositional fluctuations continue evident in most wells/drains.	
	Stability	2.3, 3.3
	Stability monitoring at the Tailings Facility and Site 23 indicate that that sites meet design specifications. Foundation heads are consistently low at both sites except for short-lived spikes in one piezometer (north end of West Buttress). Target compaction densities achieved in all other than most November and December samples.	
	Cover performance	3.8
	>85% saturation maintained, barrier layer not subject to freeze/thaw cycles. Net measured "percolation" up to 19%. No effect seen of HDPE cover placed above lysimeter. Oregon State University studies initiated to better understand cover water characteristics.	
	Pond D flow and composition	3.4, 3.5
	Average flow pumped from Pond D is about 60 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.	
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 2007	2.5, 3.5
6.2.4	Location and volume of materials	2.2, 3.2, A1, A2
	East and Southeast Tailings 390,557 total tons in 2007 (tailings 334,897 and other materials 55,710 tons)	
	Site 23 82,000 total tons placed in 2007	
	Compaction	2.3, 3.3
	Target compaction densities achieved in most nuclear density tests.	
	Acid Base Accounting	2.5, 3.5
	Potentially acid generating Class 3 production rock	
	Neutralization potential values continue to demonstrate long lag time (buffering capacity)	
	Class 1 production rock is significantly acid neutralizing (about 35% carbonate)	
	Possible water releases	2.5
	Continue to monitor water compositions for effects related to 2002 remedial actions.	
	No new signs of possible release were identified in 2007.	
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 Management Permit 0211-BA001. This report provides a summary of all operational and monitoring activities performed in 2007. Refer to GPO Appendix 3 and permit 0211-BA001 for a detailed description of the tailings facility and associated monitoring requirements.

KGCMC operated its tailings facility continuously in 2007. Primary placement of tailings was in the Southeast area of the pile. In late 2007 the Northwest Expansion area became available for placement; however, placement of tailings in this area was minimal in 2007 (see Tailings Facility as-built in Appendix 1). KGCMC added 215,575 cubic yards of material to the Tailings Facility in 2007, bringing the total facility volume to approximately 2,648,482 cubic yards. These yardages convert to approximately 334,847 tons of tailings placed at the Tailings Facility during this report period with a total placement of all materials at the Tailings Facility totaling approximately 390,557 tons as calculated from KGCMC surveyed volumes and material densities.

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 2007. 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 39,425 tons to the facility. An additional 16,285 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 2007. The calculated tonnage of tailings was derived by subtracting the tons of production rock and other material from the surveyed total. The full pile currently contains approximately 4.8 million tons of material. Based on the survey data presented in Table 2.1 there is a remaining permitted capacity of approximately 4,335,890 tons in the facility. Estimates of other miscellaneous materials disposed in the facility are shown in Table 2.2.

Table 2.1 Tailings Placement Area Data

2007	All Materials Monthly Total	All Materials Cumulative Total	All Materials Monthly Total	All Materials Cumulative Total	2007 Prod Rock from Site 23	2007 All Other Materials (Ditch Seds and Construction)	2007 Tailings Tonnage
Date	Survey (yd^3)	Survey (yd^3)	tons (calculated)	tons (calculated)	tons (truck count)	tons (truck count)	tons (calculated)
1/31/2007	13,774	2,446,681	24,954	4,432,652	3,728	0	21,226
2/27/2007	16,793	2,463,474	30,424	4,463,076	3,258	0	27,166
4/2/2007	20,668	2,484,142	37,444	4,500,520	4,048	656	32,740
5/1/2007	17,480	2,501,622	31,669	4,532,188	3,924	2,979	24,766
5/31/2007	16,122	2,517,744	29,208	4,561,397	6,051	656	22,501
6/30/2007	12,974	2,530,718	23,505	4,584,902	3,040	2,464	18,001
7/31/2007	21,620	2,552,338	39,169	4,624,071	2,031	1,609	35,529
8/30/2007	15,868	2,568,206	28,748	4,652,819	2,538	0	26,210
9/30/2007	18,870	2,587,076	34,187	4,687,005	5,345	435	28,407
10/31/2007	16,628	2,603,704	30,125	4,717,130	2,890	1,993	25,242
11/30/2007	21,077	2,624,781	38,185	4,755,316	188	3,493	34,504
12/31/2007	23,701	2,648,482	42,939	4,798,255	2,384	2,000	38,555
Totals	**215,575**	**2,648,482**	**390,557**	**4,798,255**	**39,425**	**16,285**	**334,847**

Tons calculated at 134.2 pounds per cubic foot for tailings

Table 2.2 Miscellaneous 2007 Materials Disposal Estimates

Surface Tailings Facility	yds^3
Pressed Sewage Solids	50
Pressed Water Treatment Plant Sludge	500
Incinerator Ash	16
Underground	yds^3
Tires	550 ea
Sump Sediments	3640
Shop Refuse	730
Mill Refuse	310
Electrical Refuse	120

2.3 Stability

Tailings placement compaction was 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 sampled by a nuclear densometer at a 12-inch depth. Dry densities are calculated and compared to laboratory measured standard Proctors.

Compaction

Summary results for 2007 are shown in Table 2.3. Standard Proctor values were measured on samples taken from the tailings-loadout facility at the 920 and submitted to an outside materials testing lab, which performed the test within the ASTM guidelines for method #D698. The standard Proctor value was 140 pcf (pounds per cubic foot). KGCMC instituted a program at its on-site lab to determine 1-point proctors at the end of 2005. The mean dry density for twenty-two samples taken throughout the year in 2007 was 146 pcf, and the average percent moisture was 12.5%. Results to date confirm proctor and moisture data received from the outside materials testing lab.

Field measurement results show a high degree of achieving greater than 90% compaction (with respect to an average Standard Proctor value of 140). Testing done in prior years has confirmed that density results obtained using the Troxler procedure average approximately 2 percent higher than the densities obtained via other methods.

Table 2.3 Summary Statistics for 2007 Tailings Compaction Testing Data

Compaction Variable	Mean	Max	Min	Std. Dev.	n
Std. Proctor[ASTM #D698] (pcf)	**140**	**149**	**136**	**6**	4
Opt. Moisture (%)	12.5%	13.5%	1.0%	11.2%	
1-pt Proctor (pcf)	146	183	127	2.3	22
As Received Moisture (%)	12.5%	14.5%	10.5%	3.6%	
Measured Dry Density (pcf)	138	171	106	23	12
Measured moisture (%)	10.8%	14.7%	7.2%	2.4%	
Rel. Compaction % *	95.6%	114.3%	75.6%	13.7%	

* 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, which has been expanded to include the new Pond 7 constructed in 2005-2006. The ADEC inspected the site on October 11, 2007. No visible signs of physical instability were observed at the tailings facility during this report period.

During 2007 the USFS inspected the facility 30 times (Site inspections #247-#277) 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. The USFS typically noted that the facility is being developed and operated to required operations and maintenance specifications of GPO Appendix 3.

Well and Piezometer Water Level Data

Pneumatic piezometer and well water level data for the tailings site are presented in Figures 2.1 to 2.18. Well and piezometer locations and water level cross sections are shown on the tailing facility as-built (Appendix 1). Well MW-A3 was decommissioned in the summer of 2004, and MW-T-02-05 was decommissioned in 2005. Instruments in the south (PZ-T-00-01, PZ-T-00-02, PZ-T-00-03; Figures 2.11, 2.12 and 2.13) showed a 3 to 7 foot decrease in head in response to below average precipitation during the spring and summer months in 2003. Since this time, the water table elevation returned to historical levels, and varied within a two foot differential in 2004. These three instruments showed a 3 to 6 foot increase in head in 2005, likely due to problems with the pump at wet well 2. Monitoring well MW-T-00-05A showed unusual depth to water reading in 2002 and 2003 (Figure 2.14). Historical data indicate that this well's depth to water is consistent and is not influenced by seasonal or other affects. KGCMC determined that the abnormal readings were a result of the method of depth to water measurements. A sonic indicator was used at this location until it was discovered that the small amount of water in the well's casing causes problems with the reading. Beginning in June 2003, the depth to water measurements were again taken with a depth to water tape, and these head measurements again reflect historical values. In 2007 one data point for MW-T-00-05A showed a seven foot uncharacteristic increase. However, the vibrating wire did not measure the same increase which indicates there was a recording error in the measurement taken with the depth to water tape. In 2007, a vibrating wire piezometer began capturing data for this well, as well as PZ-T-00-02, and these data points are reported on Figures 2.12 and 2.14. Piezometer 76 (Figure 2.10), completed in the northern portion of the West Buttress, showed approximately 10 feet of saturation in this area in late 2002 and 2003. In 2004, anomalous readings were indicative of a broken instrument. The piezometer was replaced in the spring of 2005. Readings have been variable in 2005 and 2006, showing intermittent saturation. The 10 feet of saturation usually seen in this piezometer is consistent with the behavior of tailings elsewhere in the pile. Even when placed onto an unsaturated blanket drain, the fine-grained tailings can develop and maintain 10 to 15 feet of saturation through capillary action. Head levels are expected to continue rising as the slope length and tailings thickness of the West Buttress increase.

Section AA of the tailings facility as-built shows the inferred water table in the tailings pile. The maximum saturated thickness (approximately 35 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 foundations of the West Buttress and southern portion of the pile are well drained, as indicated by typically consistent unsaturated conditions in the blanket drains (MW-T-00-05A, Figure 2.14) and at the base of the West Buttress (piezometers 74 and PZ-T-05-08 in Figures 2.8 and 2.9). Low head elevations near the pile toe maximize the pile's geotechnical stability. Intermittent head increases are localized and of short duration and should not have an adverse effect on pile stability.

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 over 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-00-03A (Figure 2.15) and MW-T-00-03B (Figure 2.16), are completed in the shallow sands 12 and 17 feet, respectively, below ground surface. The figures for these wells show that the water elevation in shallow completions in native materials can be readily influenced by abnormal weather conditions. Wells MW-T-01-03A and MW-T-01-03B are installed west of the pile. Their water levels are shown in Figures 2.17 and 2.18, 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. These wells show similar water level fluctuations with weather conditions as the two eastern wells. However, the water level in MW-T-01-03B shows a larger differential than MW-T-01-03A because silts and clays hold more water in tension, so a small increase in water content causes a large change in head. The ground surface elevation is 134 feet in the proximity of these two wells. Both MW-T-01-03A and MW-T-01-03B were damaged, likely by wildlife, in the summer of 2006. Several attempt were made to repair the wells in 2007, but they could not be recovered. Therefore, no data were obtained from those wells in 2007. KGCMC will make another attempt to repair the wells in 2008 and if unsuccessful, will consider replacing them during a future drilling program.

2.4 Hydrology

A detailed review of the hydrology of the tailings facility was performed by Environmental Design Engineering (EDE) in 2001 (EDE 2002a) with an update in 2006 (EDE 2007). Those reports describe 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. EDE initiated work on the update to the hydrology analysis in 2006, and the final report was completed in 2007 (EDE 2007). That update made the following conclusions and recommendations:

- Bedrock exposures protruding under the northwest corner of the tailing pile may be a pathway for contact water to mix with groundwater. It is therefore practical to have the liner for the new Northwest Expansion also extend over bedrock that currently protrudes beneath the existing pile. Excavation of the northwest corner of the tailings pile will be required to expose the bedrock and tie the liner into the low permeability silt/clay glacio-marine sedimentary unit that surrounds the bedrock.
- Excavation of the northwest corner of the tailing pile will also allow installation of an underdrain to convey surface water and contact water from the northern part of the facility to the southwest. This will facilitate post-closure gravity drainage to the west.
- Excavation and lining of the northwest area is expected to lower bedrock heads, but bedrock groundwater levels may equilibrate to a level close to or slightly below the top of the fractured bedrock.
- Available data indicate that the existing placement areas are underlain either by synthetic liners or by glacio-marine sediments which act as a competent natural liner.
- Historical piezometric data were used to determine a conservative maximum tailings phreatic surface for stability analyses. Two dimensional, cross sectional flow modeling is recommended.

The 2003 Environmental Impact Statement (USFS 2003) process analyzed the incremental expansion of the tailings facility storage capacity, a continuation of which is planned between 2004 and 2008 to accommodate the projected tailings storage requirements for the mine. As part of the expansion work, Tank 6 and Pond 6 areas will be used for tailings storage. To accommodate these expansion plans and a change in the regulatory requirements for storm water retention, KGCMC constructed a new 30 acre-foot storm water pond (Pond 7) in 2005, and will reroute collection and distribution facilities to include the new Pond 7. For background and design information for Pond 7, see Klohn Crippen's 2005 report, and EDE's 2005 Pond 7 Hydrology Report.

Precipitation and temperature data are presented in Table 2.4. The precipitation data collected in 2007 is far greater than would be expected and does not likely represent actual precipitation. The area experienced record snow levels in 2007. The rain gage at the Tailings area was buried in snow which resulted in an excess of snow melt entering the rain gage (via a funneling effect) during periods of melting and produced higher than actual precipitation readings. However, precipitation measurements for months that the gage was not covered in snow (summer and fall) gave accurate precipitation data.. June was the driest month with 2.64 inches. July and August were the warmest months while February exhibited the coolest temperatures. Flow data from Wet Wells 2 and 3 for 2005 are presented with the precipitation data in Figure 2.19. The wet well flows respond relatively quickly to precipitation events, demonstrating a significant contribution of surface water. The use of the wet well flow meters has been discontinued since 2005 as part of the tailings expansion activities. KGCMC anticipates that once the Pond 7 water treatment plant construction is complete that flow monitoring will resume.

Table 2.4 Monthly Summaries of Tailings Area Climate Data

Month	Avg. Temp (°C)	Precipitation (inches)
January	-2.04	6.15
February	-4.32	2.74
March	-3.23	11.73
April	2.19	8.24
May	6.01	3.33
June	10.43	2.64
July	12.26	6.58
August	12.68	2.65
September	8.69	9.42
October	3.67	11.76
November	.43	3.31
December	-3.45	4.3
2007	3.61	72.85

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 2007 is being prepared separately and will be submitted to the Forest Service and ADEC upon completion.

Internal Monitoring

As described in Waste Management Permit Number 0211-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 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 needs of KGCMC.

The analytical results of KGCMC's internal site monitoring plan are summarized in Figures 2.20 to 2.31. Sites were distinguished between foundation wet wells (Wet Well 2 and Wet Well 3), wells completed in tailings (PZ-T-00-01, PZ-T-00-02, PZ-T-00-03, MW-T-02-5 and MW-T-02-6) and suction lysimeters (SL-T-02-4, SL-T-02-5, SL-T-02-6, and SL-T-02-7). These lysimeters are installed at various depths within the pile's vadose zone. These groups are separated on Figures 2.20 through 2.31 with the suffix a, b or c, respectively. For example, a figure number such as 2.20a would show the data for the wet wells group, 2.20b would show the data for the tailings completion wells, and 2.20c would show the data for the suction lysimeters.

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, EDE 2007, KGCMC 2002a) and the Tailings Expansion EIS (USFS 2003). The observations made under the 2007 internal monitoring plan are consistent with the findings of the EDE, KGCMC and USFS 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) from EPA.

Most values of pH remained between 6 and 8.5 for all internal monitoring site samples in 2007 (Figures 2.20a, b and c). 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 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). The suction lysimeters all have pH values between 6.87 and 8.03 with the exception of SL-T-02-06 in 2006 and 2007 which showed pHs of 8.87 and 9.3, likely a result of sulfate reduction. .

Alkalinity data are presented in Figures 2.21a, b and c. Alkalinity generally ranges between 250 and 600 mg/l $CaCO_3$ within the tailings pile waters, 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 continue to show 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) even though portions of this material have now been in place at this site for nearly 20 years.

The conductivity results from internal monitoring site waters are presented in Figures 2.22a, b, and c. The 2007 conductivity measurement were between 1,446 (wet wells) and 6,610 (suction lysimeters) μS/cm. 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 3 has a different capture area than Wet Well 2 and shows a different pattern with respect to conductivity. The changes in conductivity observed in Wet Well 3 suggest changes in the relative contributions from runoff, addition of the Northwest Diversion Ditch flow, infiltration and groundwater as the West Buttress was constructed. The increase in conductivity seen in Wet Well 2 over the past several years likely reflects an increasing contribution from contact water in the drain system and an increase in the dissolved load from migration/remobilization of oxidation products in the pile. In 2007 the suction lysimeters had conductivity values ranging from 1,398 to 6,610 μS/cm. Suction lysimeter samples are drawn from the smallest pore spaces of the unsaturated zone. Water held in these pores is often isolated from flow paths and thus has higher dissolved constituent concentrations than water from the saturated zone and foundation drains.

Hardness and sulfate concentrations remain consistent with the conductivity results. Calcium and magnesium are the primary contributors to hardness (Figures 2.23a and b) 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 Figures 2.24a, b, and c. Sulfate concentrations typically range between 500 and 5,120 mg/l in the tailings pile waters. The increase in sulfate and other constituents seen in PZ-T-00-03 likely reflects the replacement of interstitial process water with infiltrating surface water, which carries a higher dissolved load.
Arsenic data are presented in Figures 2.25a, b and c. The variability in arsenic concentrations observed in Wet Well 2, MW-T-02-06, and some suction lysimeters is related to evolving redox conditions in the pile. 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) is expected as the waters respond to the changing redox conditions. This will contribute arsenic and iron (Figures 2.30a, b and c) to the drainage water. Arsenic concentrations in the pile drainage will therefore decrease when redox conditions in the pile stabilize (e.g. with closure and capping of the pile). Sulfate reduction may also lower arsenic concentrations. This is apparent in the composition of waters from the saturated zone and in some of the SRMP test cells, which are discussed in more detail below.

Figures 2.26a, b and c show the concentration of zinc from the monitoring sites. Zinc levels from the saturated zone of the pile continue to remain low (Figure 2.26b), a result of sulfate reduction, which promotes zinc sulfide precipitation. The zinc concentration in MW-T-02-06 in 2003 and 2004, along with the lower alkalinity, suggest that sulfate reduction may not yet have been occurring in this portion of the west buttress. However, the April 2005 data showed a significant decrease in the concentration of zinc (from an average of 1,000 µg/l to less than 10 µg/l), and the zinc has continued to remain low in 2007 (42 µg/l). Placement of argillite on the outer slopes of the West Buttress has also led to higher zinc concentrations in Wet Well 3 from surface runoff flushing of this material when it was initially placed. In 2003, the zinc concentration in this wet well returned to within historical limits, and has remained between 500 – 3,500 µg/l from 2004 - 2007. The two 20 foot suction lysimeters showed zinc concentrations between 730 – 2,210 µg/l (SL-02-05, SL-02-07), and the two 40 foot lysimeters (SL-02-04, SL-02-06) had zinc concentrations less that 150 µg/l (Figure 2.26c).

The concentrations of copper and lead are considerably lower than that of zinc. Both of these metals' concentrations were generally less than 5 µg/l in water from each site in 2007 (Figures 2.27a, b and c and 2.28a, b and c), with SL-T-02-06 and SL-T-02--07 levels marginally higher, both having copper levels of 5.75 µg/l. Previous observations have shown that copper and lead mobility are greatest when the tailings are first placed, then decrease with time.

Cadmium data are shown in Figures 2.29a, b and c. With the exception of Wet Well 2 and 3, cadmium concentrations are very low (less than 0.5 µg/l). Cadmium in Wet Well 3 had a maximum value of 27 µg/l in 2002 and showed seasonal fluctuation similar that of zinc, albeit at significantly lower concentrations. In the first 2007 sample, Wet Well 2 again showed an elevated cadmium level, but the second sample was less than the detection limit Well MW-T-02-06 showed a cadmium concentration of 4.5 µg/l in June 2003; however, samples since then have all been less than the detection limit of 0.5 µg/l.

Iron and manganese data are presented in Figures 2.30 a, b and c and 2.31 a, b and c, respectively. Concentrations of iron and manganese are high in the wet wells, groundwater and most of the suction lysimeters due to oxidation/reduction and buffering reactions. Lower concentrations of iron and other metals in PZ-T-00-01, PZ-T-00-02 and PZ-T-00-03 likely indicate sulfide precipitation resulting from sulfate reduction in these waters.

In previous years, Wet Well 3 reflected surface effects while Wet Well 2 was influenced more by internal-pile contact water and foundation groundwater. However, in recent years, the compositions of Wet Well 2 and Wet Well 3 waters have become similar, reflecting a decrease in surface effects. Over the past few years MW-T-02-06 water has evolved toward compositions indicative of sulfate reduction, similar to those seen in PZ-T-00-01, PZ-T-00-02 and PZ-T-00-03.

<u>Acid Base Accounting Analyses</u>

ABA analyses of monthly composite samples were taken of tailings at the Mill filter press. These samples are representative of Mill feed and not necessarily tailings area placement. Figure 2.32 shows the monthly composite sample ABA results for 2001 through 2007. The average net neutralization potential (NNP) results for the past seven years have been -281, -197, -194, -200, -134, -123 and -156 tons $CaCO_3$/1000t, respectively. The variability from year to year is primarily due to fluctuations in acid potential (AP), which is an indication of the pyrite content of the ore. Neutralization potential (NP) values, which primarily reflect carbonate content are generally more constant.

The results of ABA analyses on 10 grid samples taken from the tailing facility in 2005 are presented in Figures 2.33 and 2.34. The grid included portions of the pile that had exposures of tailings, argillite slope armoring, road rock, and ditch sediment. Of the 10 samples, 5 were relatively pure tailings. Figure 2.33 shows the acid generation potential (AP) versus neutralization potential (NP) of all the 2005 grid samples. The pure tailings samples plot in the upper half of this figure. The average neutralization potential (NP) of the 5 tailings samples from 2005 was 326 tons $CaCO_3$/1000t, which indicates a significant remaining carbonate content in the tailings. The acid potential (AP) was determined by iron assay (assuming all iron is in the form of pyrite) and yielded an average of 440 tons $CaCO_3$/1000t. The resulting average net neutralization potential (NNP) was -114 tons $CaCO_3$/1000t, which indicates that the tailings are still potentially acid generating. These results remain consistent with previous studies of the mine's tailings. Samples of weathered tailings (after approximately 12 years of exposure) have been shown to still retain a considerable amount of neutralization potential, equivalent to approximately 20% calcium carbonate (KGCMC, 2002b). 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 adequate closure of the site (including covering the pile with a composite soil cover designed to minimize oxygen ingress). 2005 ABA Data is consistent with presious data. 2004 data is shown for reference.

Figure 2.34 shows the relationship of rinse pH to Net Neutralization Potential for the same suite of 2005 samples shown in Figure 2.33. Rinse pH is a measure of the pH of a one-to-one mixture of "as received" fines and water. The rinse pH of all of the tailings samples are above 6.0, indicating that the exposed surfaces of the tailings pile remain well buffered. Again, 2004 data is shown for reference.

Sulfate Reduction Monitoring Program (SRMP)

Following the USFS 2003 EIS Record of Decision for expansion of the tailings pile, KGCMC began a mandated 30 month study to determine the feasibility of promoting long term sulfate reduction at the facility. KGCMC assembled a team comprised of personnel from the University of Waterloo, KGCMC and independent consultants to develop and implement the investigation. The primary objective of the sulfate reduction monitoring program (SRMP) is to determine the feasibility of meeting closure objectives related to water quality by promoting in-situ microbial processes that increase alkalinity and reduce the concentration of constituents of concern.

A summary report of the 2006 data was distributed to Regulatory Agencies in 2007 . The report and submittal provided an updated schedule for completion of the study which extended beyond the originally envisioned 30 month time period. Project completion is expected by the end of 2009, however additional monitoring of the field test cells beyond that time may be warranted. A follow-up report is expected in 2008. KGCMC will also forward this report to the Regulatory Agencies for their review. ?

Field test program

Seven field test cells were constructed and instrumented in the Fall of 2004 to monitor the effects of adding different carbon sources to an unsaturated portion of the pile. Cell treatments are summarized in Table 2.5. The cells are 10 feet square and 13 feet deep. A synthetic liner was installed around the vertical sides of the excavations (Cells 2-7) to isolate the cells from lateral flow while allowing vertical flow through the cells. Pore water and core samples are taken annually from multiple depths through each cell and soil suction, moisture content and temperature profiles are also collected.

Table 2.5 SRMP Cell Treatments

	Tailings (volume %)	Peat (volume %)	Brewery Waste (volume %)	Sewage Sludge (volume %)	
Cell 1	100	0	0	0	Unexcavated
Cell 2	100	0	0	0	Excavated
Cell 3	95	5	0	0	Amended
Cell 4	95	2.5	2.5	0	Amended
Cell 5	95	2.5	0	2.5	Amended
Cell 6	95	2.5	1.25	1.25	Amended
Cell 7	90	5	2.5	2.5	Amended

The field test program results as reported in the performance report for 2006 (University of Waterloo, 2007) are summarized as follows:
Addition of organic carbon has initiated microbially mediated sulfate reduction in Cells 4 through 7. Decreases in dissolved sulfate concentrations in Cells 4 through 7 generally correspond to increases in alkalinity, depletion of ^{13}C in dissolved inorganic carbon, and enrichment of ^{34}S in pore water sulfate. Evidence for sulfate reduction was not observed in the control cells or the cell amended only with peat. Precipitation of metal-sulfide minerals is likely contributing to decreases in sulfate and metals concentrations (Fe, Zn, PB, Ni, Mn) in cells exhibiting sulfate reduction. Carbonate precipitation may also decrease the concentration of lead and manganese in some test cells. Arsenic concentrations remained elevated in carbon amended cells, however decreases in average arsenic concentrations between 2005 and 2006 were observed for Cells 4, 6 and 7. Sulfate concentrations in Cells 1, 2, 3, and 5 appear to be controlled by gypsum solubility

rather than sulfate reduction. Barium concentrations are controlled by barite solubility and have increased in cells exhibiting sulfate reduction.

Carbon amendment also resulted in increased iron reducing bacteria populations. Reductive dissolution of iron oxyhydroxides and mobilization of associated oxyanions led to corresponding increases in iron, chromium, and molybdenum concentrations. Mobilization of these elements was observed in all test cells, however higher concentrations generally correspond to cells with larger iron reducing bacteria populations.

Geochemical and microbial data suggest that ingress of oxygen is limited to the upper two feet of the test cells. Elevated populations of sulfate reducing bacteria (obligate anaerobes) and the presence of ferrous iron within 1.6 feet of the surface indicate that oxygen consumption is occurring. Sulfide oxidation is likely the dominant oxygen consuming mechanism.

Sulfate reduction and calcite and metal-sulfide precipitation appear to control the chemical composition of pore waters in Cells 4 through 7, while sulfide oxidation, dissolution of dolomite and gypsum precipitation/dissolution control the compositions of pore waters in Cell 1 through 3.

Data from field and laboratory batch tests indicates that the rate of sulfate reduction has declined in tailings amended with only biosolids. This suggests that organic carbon contributed by biosolids is rapidly consumed and may not sustain long-term sulfate reduction. In contrast, evidence for sulfate reduction was observed in Cell 4 in 2007 and this was not the case in 2006. The availability of reactive organic carbon may have been limited at the onset of the testing but increased over time due to fermentation. Addition of mixed sources of organic carbon (Cells 6 and 7) can rapidly promote and sustain active microbial sulfate reduction.

Laboratory test program

Laboratory batch tests on samples of amended tailings will continue in 2008. The batch tests include the carbon sources used in the field tests plus fish/wood compost and phosphate amended peat and brewery waste. Solid-phase samples will be collected from the batch experiments for microbial enumerations, geochemical extractions and mineralogical evaluations. Batch tests conducted in 2005 and 2007 suggest that municipal biosolids supported the highest SRB populations and rates of sulfate reduction. Measurable sulfate reduction was observed with an amendment containing only peat, which contrasts somewhat with results from the field tests. A decrease in pH associated with addition of 50 wt % dried brewery waste may have limited SRB activity. The batch test dose was more than an order of magnitude higher than that applied in the field tests.

Laboratory column tests began in 2007 and will continue in 2008 to help define the rates of nutrient consumption and determine the relative effectiveness of different carbon amendments. The results from the laboratory tests will augment the findings from the field test cells.

Pile characterization

Five sites beyond the SRMP field test cell monitoring area were sampled to characterize the tailings pile geochemistry and microbiology in 2005. The results of the sampling indicate that the pile is generally uniform in composition and has a diverse microbial population that shows no distinct vertical or horizontal trends in distribution. Microbial enumerations give an indication of the presence of various microbial groups but do not necessarily show how active the microbes are or their influence on pore water compositions. Despite the lack of apparent zoning of microbial groups, water compositions suggest that three geochemical zones exist in the pile. Oxidizing conditions are present close to the surface and decrease rapidly with depth. A thick reduced zone that does not appear to promote robust sulfate reduction is present above the water table. The bulk of the unsaturated zone lacks oxygen but may not have redox values low enough to support a large population of sulfate reducing bacteria. Below the water table where redox conditions are even lower, hydrogen sulfide, high alkalinity and low metals concentrations are evidence of significant sulfate reduction. The distribution of organic carbon is also relatively uniform and may not be the limiting factor for promoting sulfate reduction. Pore-water compositions suggest that competition for nutrients by other microbial groups such as iron reducers may also limit the rate of sulfate reduction in unamemded tailings.

Results of acid base accounting are consistent with previous studies, indicating that the tailings are potentially acid generating. The primary mineral assemblage is quartz, dolomite and pyrite.

Hydrology

A component of the SRMP is to define how pore-water passes through the tailings pile. This is necessary to determine retention times and if there is the potential for pore-water to bypass zones of effective sulfate reduction.

Measurements of moisture content, pore-water pressure, and soil suction indicate that a dynamic flow regime exists in the tailings pile. The main saturated zone in the pile exhibits a mounded shape that is thickest (about 35 feet) in the north/central part of the pile, where foundation drains do not appear to effectively dissipate buildup of pore pressures between the foundation and the pile. The mound thins to 15 feet or less toward the edges of the pile and over areas with more robust foundation drains. Tensiometer and vibrating wire piezometer data show that suction gradients fluctuate between upward during dry periods and downward during wet periods in the top 15 feet of the pile and that saturation fronts appear to migrate through the pile profile. The data suggest that though the bulk of the tailings are not 100% saturated, they are nearly so, due to their fine grain size and their relatively high moisture content.

Remaining work

- Performance monitoring of the field test cells will continue through 2008.
- Results of batch tests will be summarized in a future program update and batch experiments will continue in 2008.
- Laboratory column tests of select nutrient mixtures will continue in 2008.
- The project team will continue to refine the hydrologic model for the site, including analysis of current conditions and predicted post-closure behavior.
- Analyses to determine the geotechnical effects of carbon amendment on the tailings are planned for 2008, pending successful field and laboratory geochemical testing of the various amendments.

2.6 General Site Management

Tailings Operation and Management

The General Plan of Operations (GPO) Appendix 3 includes the general operating and management goals to achieve site stability and satisfy regulatory requirements for the KGCMC Tailings Facility In Appendix 3, Section 2.1.4, KGCMC Operations place tailings within the impoundment using specific criteria 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 2007.

KGCMC continues the use of off-highway lidded trailered trucks to transport the tailings to the surface placement area. 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 2008 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, approved in January 2004. The 2003 Stage II Tailings Expansion Environmental Impact Statement (EIS) is summarized in KGCMC Tailing and Production Rock Site 2004 Annual Report (KGCMC, 2005). In 2007, 85 percent of the tailings were placed in the Southeast Tails area, 10 percent were placed in the Northwest Expansion area and the remaining 5 percent were placed in the East Tails area.

Major tailings facility expansion project accomplishments in the Northwest and Pit 5 area in 2007 included:

- Preparation of foundation and installation of HDPE/geocomposite liner system and overlying sand drain layer extending over approximately 5.6 acres
- Installation of drainage collection and monitoring system
- Installation of surface and groundwater drains
- Extension and raising of existing low permeability walls along West Buttress and East side of Pit 5
- Installation of gravity drain pipes that transport water from Northeast area to West Buttress perimeter ditch
- Construction of retention Pond 9

Approximately 127,500 cubic yards of tailings were relocated from the northwest corner of the pile to Southeast II area or on top of the Tailings pile. In 2007 peat material was removed from the Northwest excavation area, Pond 9 excavation, and the Northwest/Pit 5 area totaling approximately 22,000 cubic yards. This material was stockpiled in the Northeast area of the tailings pile. Data from geotechnical drilling, geophysical testing and test pitting helped delineate the location of bedrock and glacio-marine sediments beneath the excavation area. Construction crews will focus on further development of the Pit 5 area, liner placement, and preparation of Pond 6 area for the 2008 construction season.

Wells and surface drainages in the vicinity of Northwest Excavation and Northwest Expansion showed a varied response to construction-related disturbances in the area. Elevated ion concentrations, notably sulfate (264 mg/l) and zinc (234 µg/l), were observed in Further Creek down-gradient from the construction area. Water quality is expected to improve following completion of the construction work and monitoring in the area will continue in 2008. If conditions warrant, a collection system will be installed along the toe of the west buttress road fill.

Co-Disposal Studies

KGCMC compared the relative costs of recountouring and covering the existing Site-E production rock pile versus consolidating it with another surface facility, and found that relocating the material to the surface tailings facility is the most economical and environmentally protective solution. The geotechncial feasibility of blending production rock with tailings was studied in 2005 (Klohn Crippen, 2005). Laboratory tests conducted in a large scale permeameter cell measured the hydraulic and strength properties of tailings only, production rock only, and various blends of production rock and tailings. Based on the results, the following main conclusions were drawn:

- The difference in permeability between compacted production rock and compacted saturated tailings is at least 33 times. Blend ratios of 2:3 (production rock to tailings by volume) and 3:2 resulted in lower values of permeability as compared to the tailings only sample. The 2:3 blend exhibited the lowest value of permeability. This behavior is mainly attributed to the elongated length of the seepage path (and reduced seepage flow area) through the tailings dominated soil matrix and around the larger rock fragments.
- Friction angle of the 2:3 blend was similar to that of the tailings only sample showing that the tailings were dominant in the blend. As expected, the friction angle improved with the addition of more production rock in the 3:2 blend. Addition of production rock generally increased the overall strength of the compacted tailings with all blend ratios.
- Relatively uniform mixing of the tailings and production rock was very easily obtained in the laboratory in all cases.

A production rock to tailings ratio of 3:2 (60% production rock by volume) with a permeability of 5×10^{-6} cm/s and a friction angle of 43° is recommended by Klohen Crippen as the limiting blend for blended codisposal of production rock and filter pressed tailings at Greens Creek.

These conclusions are based on geotechnical observations. The long term performance of the production rock and tailings blend will also depend on the geochemical performance of the blend. Therefore, KGCMC has initiated geochemical studies designed to test the geotechnical analysis recommended blend ratios for chemical stability, metal leaching, and acid generation potential.

The tailings and waste rock co-disposal evaluation continued through 2007. The laboratory geotechnical assessment findings were positive. Field trials demonstrated that the waste rock and tailings mixed well when pushed with a bulldozer. This is consistent with the findings of the laboratory mixing experiments. KGCMC began field weathering column construction in 2006, but winter conditions prevented completion of the project. Columns were completed in 2007 and monitoring began. Column modifications are planned for 2008. KGCMC will also run small scale anaerobic tests in the upcoming summer months. I

Some 7,100 cubic yards of waste rock from Site E was hauled to the tailings facility to create a stabilizing berm in the Southeast II area in 2006. A portion (1 acre) of the Site E pile was covered in the Fall of 2006. The geosynthetic cover has remained in place to reduce the moisture content of the waste rock in preparation for removal in 2008. Surface water and groundwater monitoring at the site continues.

Dust Monitoring and Abatement

Monitoring performed under the Freshwater Monitoring Program has identified lead levels in three shallow peat wells south (Site 27) and west (Site 29 and Site 32) of the tailings pile that approach or exceed freshwater quality standards (KGCMC 2008). The formation water in these wells is generally very dilute (low conductivity and hardness) and acidic (due to organic acids), which is ideal for promoting lead mobility. Dust from the tailings pile may contribute to the lead levels observed in these wells.

Visual observations and operational experience indicate that dust loss from the tailings pile occurs when dry, windy conditions persist at the site. These conditions typically occur for short periods between mid December and late February when high pressure systems produce cold, dry weather and strong northerly winds. The north-south orientation of Hawk Inlet and the Tributary Creek valley exposes the tailing pile to these winds.

Warm, dry conditions occur periodically during the spring and summer months, but wind direction and velocity are not typically as favorable for dust entrainment during these periods. Salt formation on tailings surfaces and application of water to access roads further reduces the potential for dust formation during warmer months.

Snow samples were collected just prior to the loss of snow cover in April 2007 and February 2008. Sample locations are labeled on the Tailings as-built. The objective of the sampling was to quantify the amount of tailings dust that had accumulated on the snow pack when conditions for dust loss were greatest (typically December trough February). 2007 had anomalously high snowfall and the snow cover lasted considerably longer than in 2008. The samples were analyzed for total lead concentrations, and a lead load per square meter was calculated (Table 2.5).

Table 2.6 Tails Snow Dust Loading Table

Sample Location		Date	Lead Load mg/m^2	Zinc Load mg/m^2	Feet from Pile Center E40180, N53229
1007	MW 3S, Site 29	4/14/07	30	30	825
		2/20/08	2	1	825
1008	MW 5, Site 32	4/14/07	3	2	981
		2/20/08	1	1	981
1009	Wet Well 1 75' S	4/14/07	59	79	862
		2/20/08	14	9	862
1010	MW 1S, Site 25	4/14/07	23	26	1496
		2/20/08	11	6	1496
1011	MW 2S, Site 27	4/14/07	15	10	1696
		2/20/08	14	15	1696
1012	Lease Line South	4/14/07	72	87	1213
		2/20/08	26	36	1213
1013	Main Embkmnt Toe	4/14/07	179	584	911
		2/20/08	62	153	911
1014	MW-T-02-07	4/14/07	203	396	890
		2/20/08	69	233	890
1015	MW-T-00-04A	4/14/07	404	901	875
		2/20/08	42	55	875

Figure 3.34 shows lead loading versus distance from the center of the tailings pile. The data indicate that the loading is observable up to 1600 feet from the pile and that the loading in 2008 was far less than in 2007. Several factors, including fewer dust-producing weather events, a shorter snow accumulation period and improved abatement measures, likely contributed to the reduction in calculated loading values.

Lead levels in water from the three wells do not correlate directly with lead loading values. In fact, the well with the highest lead concentration (Site 32, ~ 6.5µg/l) actually has one of the lowest lead loading values determined from the snow survey. Site 32 is downwind of the Wet Well 1 building, Outfall Shack and a stand of pine trees, which may collectively act as a dust trap, preventing accumulation of dust in the immediate vicinity of the Site 32 well. Tailings dust that settles on the peat up-gradient from Site 32 may be source of the lead observed in the well. The chemical composition of the water at Site 32 suggests that its completion zone is better suited for lead mobility than the completion zones at Site 27 and Site 29. It is the most dilute of the three waters and there is very little in the water that would cause the lead to precipitate. Complexing with organic ligands may also promote lead mobility in these peat waters.

A direct link between dust accumulation and lead concentrations in the wells has not yet been established. However the lead loading determined from snow surveys suggests that the amount of lead accumulating on the peat in the vicinity of the wells is sufficient to account for the lead values observed in the wells. This is based on the simplifying assumption that all of the lead is leached from the dust and that it is distributed evenly in a two-meter column of water (saturated peat).

KGCMC is evaluating air sampling methods that may augment the lead loading analysis. This would allow year-round monitoring, which will help quantify the temporal distribution of loading at the site. Details of the air sampling will be discussed in the next annual report.

The following measures were taken in 2007 to reduce dust loss from the tailings pile:

- Snow fence and concrete block wind breaks were installed on the crest of the tailings pile
- Snow removal was limited to only active placement areas
- Interim slopes were covered with rock
- Outer slopes were hydroseeded where appropriate

Visual observations and snow sample assays suggest that these mitigation measures have helped reduce the dispersion of dust at the tailings facility, however additional efforts are still warranted. Continued snow, water and air monitoring will determine the effectiveness of the control measures.

2.7 Site as-built

As-built drawings for the tailings facility are presented in Appendix 1. The as-built shows the 2007 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
- projected locations of piezometers from Figures 2.1 – 2.18

Photographs taken during routine site inspections in 2007 are presented in Figures 2.36 to 2.38 (Appendix 4). Figure 2.36 shows an aerial photo of the tailings area taken in September 2007. Figure 2.36 shows work on the Northwest excavation area in July. Completion of the liner at tailings is shown in Figure 2.38. The water treatment plant under construction is shown in Figures 2.39a and 2.39b.

2.8 Reclamation/Closure Plan

Reclamation Plan

In November 2001, as part of the ADEC Waste Disposal Permit requirements, KGCMC submitted a "Detail Reclamation Plan with Cost Estimates" as an attachment to the GPO Appendix 14. A Federal/State/Municipal 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 in conjunction with the approved site reclamation plan. The Detail Reclamation Plan includes all estimated costs (labor, materials, equipment, consumables, administration, 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 reclamation closure 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.

The Stage 2 Tailings Expansion process included a National Environmental Policy Act (NEPA) review through an Environmental Impact Statement (2003 EIS) to analyze the potential environmental effects of the project. As part of the tailings expansion, a reclamation review was requested to update the current General Plan of Operations (GPO) Appendix 14 – Reclamation Plan (the Plan) and the costs associated with the tailings expansion area and to revise the Plan's cost estimates to year 2003 values. The request was made in a joint letter dated October 16, 2003 from the Alaska Department of Natural Resources (ADNR), USFS, and ADEC. KGCMC submitted this cost estimate revision as Attachment A.1 to the Plan on October 22, 2003. The estimated reclamation cost detailed in this document, including the anticipated first, 5-year Tailings area expansion development phase, was approximately $26,200,000, a difference of approximately $1,800,000 from the 2001 estimate. As noted above, the Regulatory Agencies accepted this bond revision amount and KGCMC deposited the necessary funds in the Forest Service administered Federal Reserve account.

The value of the reclamation bonding fund was recalculated in 2005 for an internal Rio Tinto closure review. Based on this new estimate, KGCMC proposed an adjustment increase of $2,765,371 in the fund level from the then current $26,200,000 to $29,000,000 as discussed in the 2006 Annual Presentation Meeting and then presented in a 17 August 2006 letter to the Regulatory Agencies. The Regulatory Agencies provided their review response to KGCMC on 19 January 2007, raising 21 points for consideration and further elaboration. KGCMC fully responded to these issues with a 25 February 2007 letter.

A fully updated Reclamation Plan was submitted to regulatory agencies in April 2008. The 2008 updated Reclamation Plan fulfills a portion of the ADEC requirements for the renewal of the Waste Disposal Permit in November 2008. This updated plan is pending review by the Environmental Audit contract company, and by a multi-agency team. Upon notification of approval by the Regulatory Agencies, KGCMC will deposit any necessary additional funds in the Forest Service administered Federal Reserve account.

Reclamation Projects

KGCMC continued using past interim reclamation measures, such as hydroseeding and various erosion controls at the tailings facility, to improve and maintain established site controls. A growth medium (six inches to one foot) of native soils was placed on selected slopes of the tailings pile to promote the hydroseeded growth. KGCMC also continued the use of other sediment control measures including silt fencing, straw bales, rock check dams, solid and flexible runoff collection pipes, coarse-rock 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.

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 remains ongoing since its installation in 2000 to justify and improve closure cover technology. Extensive reviews in 2002 of the cap performance also took place during the KGCMC Stage 2 Tailings Expansion project work with the USFS (O'Kane 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. See Section 3.8 for more details on the Site 23 test cover performance

Approximately 5,000 cubic yards of material was excavated from the backslope of Site 23 during the 2005 construction season. The material was used as fill in the 960 road base and the Mill backslope road. Additional material that was removed is stored at 4.9-mile on the B road for future site reclamation activities. A spring was uncovered during the removal activities. Its flow of approximately 5 – 50 gpm was diverted into two of the existing finger drain collection system pipes (Sites 313 and 315). Flow differences between the inlet and outlet of the drains indicates a discontinuity in the piping. Though not ideal, discontinuities in perforated piping will not alter the primary function of the drains, which is to prevent water table mounding at the base of the pile. A new drain to convey water from this spring to the eastern margin of the pile was built in 2006. KGCMC plans to terminate the existing fingerdrains at their present locations and install a lateral drain system higher on the slope if conditions warrant. In 2007, approximately 8,000 cubic yards were removed from the Site 23 backslope. Approximately 4,000 cubic yards were hauled and stored at Pit 6 for Site 23 expansion. A new ramp and turnout at the 1.1 Mile B road truck wash was constructed out of 1,600 cubic yards of Site 23 backslope material and the remaining excavated material was used in various other small projects. KGCMC is cautious not to over-excavate the Site 23 backslope because of highwall safety issues due to the unconsolidated nature of the material. Any future 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.

In 2003, EDE performed mass loading calculations to test hypotheses about flow regimes at Site 23/D and to predict possible post-closure water compositions (EDE, 2004). These results compare favorably with the TDS analysis, the hydrologic analysis as well as past and present flow and water compositional data. The model was used to compare 12 potential post-closure scenarios, including removal of Site D, a range of cover percolation values and a range of annual precipitation rates. The results showed flows at Pond D ranged from 70 gpm to 176 gpm while sulfate values ranged from 24 to 233 mg/l. Cadmium appears to be the metal of greatest concern for this site with respect to meeting water quality standards at Pond D after closure. Cover percolation rates of 20% or less may be required to meet the dissolved freshwater chronic zinc standard, and rates as low as 2% may be required to meet the recently lowered cadmium standard. These predictions do not consider natural attenuation processes, such as microbial or abiotic oxidation/reduction and sorption that could occur in the system following closure of the facility. These predictions will likely require refinement as more information about the site and its final configuration becomes available.

Replacement of Pond D berm is planned but is contingent upon underground backfill capacity and progress at higher priority sites (i.e., 1350 site). The pumps at Pond D maintain the pond level very low, which creates a gradient from the berm toward the caisson, minimizing the effects of the pyritic berm material on the surrounding area.

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 Department of Environmental Conservation Waste Management Permit 0211-BA001. A summary of all operational and monitoring activities performed in 2007 is provided. Refer to GPO Appendix 11 and Permit 0211-BA001 for a detailed description of Site 23, Site D and associated monitoring requirements.

Operation of Site 23 (KGCMC's only active production rock disposal facility) continued in 2007. See the Site 23 as-built in Appendix 2 for facility layout. Approximately 82,000 tons of production rock were placed at Site 23 during this report period. KGCMC estimates the projected remaining permitted capacity at Site 23 at approximately 540,000 tons.

3.2 Placement Records

Site 23 survey data and truck count haulage information are presented in Table 3.1. Site 23 received approximately 82,000 tons of production rock in 2007 as calculated from KGCMC surveyed volumes. A tonnage factor of 1.693 tons/yd^3 was used to convert surveyed volume to tonnage. The (less than 10 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

PRODUCTION ROCK PLACED AT SITE 23					ADDITIONAL PRODUCTION ROCK HAULED					
	Surveyed (cy)		Surveyed (tons)		Hauled To Tails from Site 23 (tons)		From UG Truck Counts (tons)			
Date	Monthly	Cumulative	Monthly	Cumulative	Monthly	Cumulative	Class 1	Class 2	Class 3	Total
1/31/2007	7,389	559,470	12,508	947,065	3,728	128,950	4,350	1,890	14,585	20,825
2/28/2007	4,463	563,933	7,555	954,620	1,800	132,678	1,080	1,989	8,636	11,705
4/2/2007 *	0	563,933	0	954,620	4,048	134,478	1,800	2,663	10,021	14,484
5/1/2007 *	0	563,933	0	954,620	3,924	138,526	2,940	612	3,616	7,168
5/31/2007	7,495	571,428	12,687	967,308	6,051	142,450	4,905	1,950	9,763	16,618
6/30/2007	6,600	578,028	11,172	978,480	3,040	148,501	4,020	5,841	2,500	12,361
7/31/2007 *	0	578,028	0	978,480	2,031	151,541	1,665	1,170	4,362	7,197
8/30/2007	7,552	585,580	12,784	991,264	2,538	153,572	8,951	702	2,520	12,173
10/1/2007	3,079	588,659	5,212	996,476	5,780	156,110	9,011	4,644	4,339	17,994
10/31/2007	2,503	591,162	4,237	1,000,713	2,580	161,890	1,484	4,476	1,770	7,730
11/30/2007	4,405	595,567	7,457	1,008,170	188	164,470	2,876	1,120	325	4,321
12/31/2007	3,180	598,747	5,383	1,013,553	2,384	164,658	1,140	6,200	431	7,771
1/31/2008	1,775	600,522	3,005	1,016,558	2,598	167,042	1,440	1,180	2,984	5,604
TOTAL	**48,441**		**82,000**		**40,690**		**45,662**	**34,437**	**65,852**	**145,951**

* No survey taken due to equipment failure or excessive snow

3.3 Stability

Klohn Crippen conducted a stability assessment of Site 23 and Site D in 2003. The stratigraphy and geology were reassessed using the results from drilling programs by KGCMC and Klohn Crippen, historical drill hole data, seismic refraction data, geological mapping and piezometer data. This assessment enabled the previous stratigraphic interpretations to be revised as follows (from top to bottom): a layer of colluvium and blocky rubble about 80 feet thick; a layer of glacial till and sediment about 120 feet thick; a comparatively thin layer of weathered bedrock about 10 to 20 feet thick; and unweathered bedrock (Klohn Crippen, 2004). The blocky colluvium is interpreted to be historical (likely ancient) landslide debris.

Limit-equilibrium stability analyses and the liquefaction potential of the foundation materials were evaluated for Site 23 and Site D, using the reinterpreted geological model. Site 23 has calculated static Factors of Safety greater than 1.6 for the existing configuration, and 1.7 for the proposed final build-out geometry at 1,120 feet with 3H:1V exterior slopes. The static calculated

Factor of Safety of the backslope above Site 23 ranges from 1.0 for shallow surficial slips to 1.3 for deeper surfaces.

The excavation of the soil from the slope behind Site 23 (temporary construction condition) reduces the calculated Factor of Safety for those sections of the backslope, but this temporary reduction is not expected to cause serious backslope instability. Placement of rock fill within the excavation and construction of the final build-out geometry for the production rock site increases the calculated Factor of Safety to slightly above those for the pre-excavation condition.

Approximately 20 feet of saturated fill material identified at the base of Drill Holes DH-00-03 (north-central) and DH-02-14 (east end) at Site D was found to be potentially liquefiable under DBE and MDE loading. Liquefaction of this fill material will impact the stability of Site D, but will not reduce the stability of Site 23 to unacceptable levels.

Site D is projected to fail under a significant earthquake. In its current configuration, Site D is expected to fail under the 1/475-year magnitude design earthquake. This represents an approximate probability of failure of about 0.21% annually, or about 2% during the mine's current projected remaining operational period of about 10 years.

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 2007 the USFS inspected Site 23 approximately 32 times (Site inspections #247-#277) monitoring for Best Management Practices effectiveness and compliance to the General Plan of Operations (GPO). No issues of non-compliance or poor operations practices were noted in the inspections. In fact, the USFS inspections typically noted that Site 23 was being developed and operated to required operations and maintenance specifications of GPO Appendix 11. Also, the ADEC inspected the site on October 11, 2007.

Slope Monitoring

Slope monitoring at Site 23/D consisted of GPS monitoring of 12 survey hubs distributed across the sites. See the Site 23 as-built for hub locations. The resolution was felt sufficient to identify large potential movement and no such movements were identified.

In addition, an inclinometer was installed at Site 23 at the end of 2005 to aid with stability monitoring. The Site 23 inclinometer was measured initially in October 2006 and subsequently in February 2007 and February 2008. The measurements are presented in three forms, absolute position, incremental displacement and cumulative displacement. The view of absolute position (Figure 3.31 shows the orientation of the inclinometer casing. A positive deviation on the A axis and a negative deviation on the B axis indicate southerly (downslope) and easterly (up valley) deviations, respectively. The deviation from vertical in this view likely represents deflection of the bore hole that occurred during drilling. The displacements measured since the initial reading are too small to show up in this view and the three curves plot on top of each other. The incremental displacement chart (Figure 3.30) shows the location and magnitude of displacement since the initial 2006 reading. Displacements at the top of the hole are attributed to frost heaving, grout settling, and damage that occurred in 2007 when a bear broke the inclinometer casing. Cumulative down-hole displacement (Figure 3.32) since 2006 has been less than 0.04 feet and is essentially confined to a surface approximately 85 feet below ground level. This surface roughly corresponds to the base of the slide/colluvium unit and the top of the dense till in the foundation. The incremental displacement view shows the amount of movement in this area of interest (0.01 feet since 2006). KGCMC will increase the measurement frequency to determine if there is a seasonal influence on the movement. Given the very small rate of movement there is not an immediate cause for concern, but KGCMC will continue to monitor the situation closely.

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. Comparison of historic versus modeled flow from the finger drains and the curtain drain indicated they are performing as designed and as necessary (EDE, 2004). See 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 in Appendix 2. 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). MW-00-03 data showed an atypical drop in water elevation in August 2007. However, data collected before and after that date are within the historical data range. 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 alluvial sands (Figures 3.9 and 3.11).

The silty/clay till that underlies the colluvial unit impedes downward flow and has an upward hydrologic gradient caused by its 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.

3.4 Hydrology

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. The precipitation data collected at the Mill Site had similar issues as the Tailings Site. Due to the record amount of snowfall, rain gages were buried in snow which resulted in an excess of snow melt entering the rain gage (via a funneling effect) during periods of melting and produced higher than actual precipitation readings (eg. March 2007 showed 29.66 inches and historic values are generally between 1 and 5 inches). However, precipitation measurements for months that the gage was not covered in snow (summer and fall) gave accurate precipitation data. June was the driest month with 1.6 inches. July and August were the warmest months while February exhibited the coolest temperatures.

The production rock and colluvium units respond rapidly to hydrologic events such as snowmelt and rainfall, indicating very local recharge and discharge (EDE, 2004).

Flow data for Pond D are shown with precipitation in Figure 3.13. Pond D flow showed an overall lower and less consistent flowrate than in prior years. This is likely due to the diversion of a spring from the backslope of Site 23 in 2006. The spring was previously reporting to Pond D, but is now routed into a Site 23 ditch. A review of curtain drain and Pond D flow measurements suggest that the current Pond D flow meter readings are approximately 40% low (EDE, 2004). Piping and flow meter modifications may be required to obtain more accurate readings.

Table 3.2 Monthly Summaries of Mill Site Climate Data previous

Month	Avg Temp (°C)	Precipitation (inches)
January	-.44	5.89
February	-2.92	3.58
March	-1.95	29.66
April	3.88	17.74
May	7.53	3.34
June	11.70	1.6
July	13.14	4.35
August	13.82	2.17
September	10.05	6.46
October	5.70	8.88
November	2.44	2.67
December	-2.16	4.30
2007	5.06	90.64

3.5 Water Quality

An in-depth re-evaluation of the geochemistry and hydrology of Site 23 and Site D was performed in 2003 by Environmental Design Engineering (EDE) and KGCMC in accordance with the ADEC Waste Management Permit Section 4.1.1. In general, metal concentrations in the production rock are above crustal averages and are higher than those of the underlying till, colluvium, and alluvium units. Site contact water, therefore, has a generally higher dissolved load than background surface water and groundwater. Bruin Creek and Greens Creek have specific conductivities that range seasonally from 50 to 225 µS/cm. The lack of significant differences between upgradient and downgradient sites on these two creeks demonstrates that effects from Site 23/D are negligible.

Groundwater upgradient and downgradient of Site 23/D also varies between sites and seasonally, with specific conductivity ranging from 200 to 800 μS/cm. Compositional differences between upgradient and downgradient wells demonstrate that the slide unit hosts a series of disconnected, perched water tables of varying water qualities.

Monitoring data from surface water and groundwater sites indicate that the combination of finger drains, curtain drain, ditches and ponds is effectively collecting contact waters and that downgradient effects from Site 23/D are negligible.

Data collected from basal drains, the curtain drain and Pond D show a progressive, down-slope increase in the groundwater component of the flow. This is consistent with the hydrologic interpretation that water infiltrates through the slide material and daylights as springs near the toe of this unit. As Site 23 expands, the proportion of contact water in the flow increases, as demonstrated by the increase in the curtain drain dissolved load since 1995. While the volume of contact water has increased, the dissolved load of the contact water has not increased over time. This is a positive result because it demonstrates that acid generation is not imminent.

A dissolved load analysis based on calculated TDS was performed to determine the relative proportions of various source waters in downgradient waters. Based on this analysis, Pond D contains 12% contact water, and approximately 80% of the D Pond flow is contributed by the curtain drain.

Representative water quality analyses for the major water types are consistent with the conductivity and TDS results and help to further define the geochemical processes occurring at the site. Alkalinity and pH values from all site waters support the conclusion that carbonate minerals are effectively neutralizing acids formed by oxidation of pyrite in the production rock. Zinc, cadmium, manganese, nickel and arsenic are more mobile than other metals of interest in the drainage. Precipitation of iron oxy-hydroxides and manganese oxides controls the concentrations of iron, manganese, and arsenic. Zinc, cadmium and nickel are controlled by mixing and sorption mechanisms. Gypsum is controlling the concentration of calcium in the drainage and will slowly be removed from the system after the pile is covered.

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 2002 sampling, the first month of water year 2003. The full FWMP Annual Report for water year 2007 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 Conservation – Solid Waste Management Program. This submittal satisfied Section 2.8.3.1 of the KGCMC Waste Disposal Permit Number 0111-BA001. The provision was retained within Waste Management Permit 0211-BA001 with its issuance in November 2003.

As described in Section 2.8.3.1 of both permits, 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.

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) from EPA.

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 impractical. 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 3.26. Sites were distinguished between finger drains and groundwater. These groups are separated on the Figures 3.14 through 3.26 with the suffix a or b, respectively. For example, a figure number such as 3.14a would show the pH data for the finger drains, and 3.14b would show the pH data for the groundwater sites. 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 (Figure 3.27). Monthly sampling of the flowing drains has identified the typical range of concentrations of constituents in the drain waters. KGCMC reduced the frequency of sampling to quarterly for all internal monitoring sites starting in 2003.

Figure 3.14a shows the pH of waters collected from Site 23 Finger Drains 2 through 8, and Figure 3.14b shows the pH of 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 2007. The lower pH values (generally pH 6.0 to 7.0) 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 7.0 to 8.5). The Site 23 finger drains fluctuate at values between those of the monitoring wells. Figures 3.14a and b suggest 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.

As with pH, high alkalinity values (Figures 3.15a and b) indicate that the waters are well buffered. Fluctuations in alkalinity correlate with those of other parameters, such as hardness (Figures 3.16a and b) and conductivity (Figures 3.17a and b), and also 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 3.16a) 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 3.18a.

Conductivity results from internal monitoring site waters are presented in Figures 3.17a and b. These 2007 conductivity measurements continue to range up to 4,930 μS/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) generally have lower conductivities than the 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 serves as a barrier to downward flow; however, as discussed earlier, it occurs 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 and groundwater wells are plotted in Figures 3.18a and 3.18b and match closely the relative value patterns of conductivity.

Arsenic data are presented in Figures 3.19a and b and are generally quite low. All finger drains and MW-23-A4 experienced increases in their arsenic concentrations in September 2003, with subsequent decreases back down to historical levels in October. The flows in the finger drains positively correlate with these changes. Fluctuations in arsenic values in 23FD-2 can be attributed to changes in redox conditions. Low arsenic and iron (Figures 3.25 a and b) concentrations indicate that these metals are precipitating as oxyhydroxides on rock surfaces inside the pile.

Figures 3.20a and b shows the concentration of zinc in the 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. 23FD-2 had a zinc concentration of approximately 70 mg/l in June 2002. Although, zinc averages have fluctuated since 2002, there has been an overall decreasing trend. In 2007 zinc levels were near 6 mg/l. Zinc concentrations in the range of 20 to 70 mg/l are consistent with laboratory kinetic weathering tests 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. MW-D3 showed elevated zinc concentrations in both 2005 samples: zinc levels rose from an average of 10 µg/l in 1998-2004 to an average of 177 µg/l in 2005. Average sulfate also increased by approximately 30 mg/l in 2005 compared to average values from 2002-2004. The zinc and sulfate returned to within historical limits in 2006. The cause for the increases in 2005 is not immediately apparent; however, if it was the arrival of a contact water front, a significant increase in conductivity, sulfate, calcium and magnesium should have preceded an increase in metals such as lead and zinc.

Cadmium concentrations (Figures 3.21a and b) correlate well with those of zinc for the internal monitoring sites although at much lower values (0 to 35 µg/l).

The concentrations of copper and lead (Figures 3.22a and b and 3.23a and b) 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 Figures 3.24a and b 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. The December 2005 sample from MW-23-A2D was an order of magnitude higher than historical values and was likely an analytical error as it did not correspond with the conductivity and TDS of that sample. Also, these 2006 and 2007 metal concentrations for this site have returned within historical data values. Monitoring will continue to determine trends.

An overall increase in arsenic cadmium, copper and zinc concentrations was apparent in the majority of finger drain samples between 2005 and 2006, though the elevated levels remained within historical limits. This may be the result of capturing the flow from a spring along the site's backslope.

Manganese concentrations (Figures 3.26a and b) are generally less than 50 µg/l for MW23-A2D, MW23-A4, and three of the finger drains (23FD-3, 23FD-5 and 23FD-8). The other three finger drains (23FD-2, 23FD-6 and 23FD-7) and MW-D3 and Pond D have elevated manganese concentrations, indicative of the different redox conditions. Precipitation/dissolution of iron oxyhydroxides and manganese oxides controls the concentrations of iron and manganese in these waters.

Acid Base Accounting Data

Acid base accounting (ABA) results from 112 underground rib composites collected in 2007 are presented in Table 3.3 and Figure 3.28. Class 1 rib samples had an average neutralization potential (NP) of 417 tons $CaCO_3$/1000t, which is equivalent to 41% carbonate. The Class 1 samples had an average acid potential (AP) of 104 tons$CaCO_3$/1000t, which produced an average net neutralization potential (NNP) of 313 tons $CaCO_3$/1000t. Class 1 production rock does not have the potential to generate acid rock drainage, however KGCMC recognizes the potential for metal mobility (primarily zinc) from this argillite rock. KGCMC has long-recognized 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 rib samples had a moderate average NP value of 191 tons$CaCO_3$/1000t) and an average AP of 164 tons$CaCO_3$/1000t. The resulting average NNP for the Class 2 rib samples was 27 tons $CaCO_3$/1000t. Class 3 rib samples had an average NP, AP and NNP of 150, 344 and -194 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 rib samples produced an average NNP of -603 tons$CaCO_3$/1000t. Class 4 material is retained underground.

Figure 3.28 compares actual class designation based on ABA analyses to the results of visual designation use underground to classify the production rock. Of the 112 composites, visual classification assigned 13 sample (12%) to a lower, less conservative class. 70 (63%) of the composites were assigned to the appropriate class and 29 (26%) to a higher, more conservative class. These data represent a 88% success rate for the visual classification program.

Table 3.3 Acid Base Accounting Data Summary for Underground Rib Samples and Site 23

	Class 1		Class 2		Class 3		Class 4
	Site 23	Rib Sample	Site 23	Rib Sample	Site 23	Rib Sample	Rib Sample
NP	474	417	225	191	126	150	119
AP	67	104	270	164	333	344	722
NNP	407	313	-45	27	-208	-194	-603

Notes: Values are averages from 112 samples for rib samples and 11 samples for Site 23
ABA units are tons $CaCO_3$/1000t
NP determined by standard Sobek method
AP determined from iron assay (converted to pyrite equivalent)

Table 3.3 and Figure 3.29 show the ABA data from surface sampling at Site 23 in 2006 (2007 analyses are pending). The AP to NP distribution in the Site 23 samples is similar to the underground rib samples. Many of the samples at Site 23 were taken near the boundaries of the classification areas, and may be more representative of a mixture of classes. Therefore some of the data points may not fall neatly into the classification areas on the graph. Currently drainage from the Site 23/D area is collected and pumped either to the Mill, or to the Pit 5 water treatment facility for treatment prior to discharge to the ocean floor under the KGCMC NPDES permit AK-004320-6.

3.6 General Site Management

The construction method used at Site 23 (bottom-up construction) limits the site's complexity. Designated placement zones are marked on the active lift of the site and production rock is placed according to class. No activities other than routine monitoring occurred at Site D in 2007.

Unusually heavy snowfall during 2007 presented drainage and accessibility challenges at Site 23. In 2005 KGCMC modified placement methods to minimize the formation of permeable areas, or chimneys, between placement zones. The homogenous, planar placement surface that resulted from the new method created surface drainage challenges. KGCMC experimented with a ridge and swale pattern that appeared to improve drainage during the rainy season but was susceptible to drifting snow in the winter months. Fine tuning of methods to improve drainage and accessibility will continue in 2008.

Approximately 5,000 cubic yards of material was excavated from the backslope of Site 23 during the 2005 construction season. The material was used as fill in the 960 road base and the Mill backslope road. Additional material that was removed is stored at 4.9 on the B road for future site reclamation activities. In 2007, approximately 8,000 cubic yards were removed from this area for site development and other various projects.

3.7 Site as-built

As-built drawings for Site 23/D are presented in Appendix 2. Three drawings from the Site 23/D Hydrogeology and Geochemistry Analysis Report (EDE 2004) (Site 23/D conceptual model, Site

23/D colluvium potentiometric surface and Site 23/D cross section) are also included in Appendix 2. The drawings show 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
- fill design level

Figures 3.33 and 3.34 show photographs of Site 23. Figure 3.33 shows an aerial photo of Site 23 in May 2007.The excavation of backslope material in September 2007 is shown in Figure 3.34.

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 through 2007 include:

- The total precipitation recorded during the 2007 monitoring period was 60.4 inches, which is considerably less than the 71.3 inch average for the 2000-2007 period. Using data from the mill site station to fill in the missing Site 23 data increases the 2000 total to approximately 70 inches.
- A snow depth sensor was installed at the Site 23 meteorology station in November 2007.
- The potential evaporation estimated for 2007 was 8.3 inches, which is substantially less than the 14.8 inches estimated in 2006. This discrepancy is due to lower recorded net radiation values relative to previous years. KGCMC will try to determine if the discrepancy is due to actual weather conditions or changes to the datalogger program or the sensor itself.
- Neutron moisture probe measurements show that there has been little change in the volumetric water content of the soil profiles compared to previous years.
- The degree of saturation in the barrier layer was greater than 85% for the entire monitoring period. In fact, saturation appears to have stabilized at about 95 percent. The very low matric suction values (<10 kPa) observed in 2007 suggest that there has been no reduction in the degree of saturation in 2007. This is a positive cover performance aspect and implies that the oxygen diffusion coefficient of the barrier material was minimized, thus minimizing the ingress of atmospheric oxygen with respect to diffusion through the pore-air space.
- Approximately 11.1 inches of net percolation were recorded at the lysimeter during the 2007 monitoring period, which is approximately 16% of the precipitation recorded during the same period. This is considered a minimum value because the net percolation tipping bucket was inoperable from mid-September to mid-October.
- Late in 2002 a lined cutoff trench was installed above the cover plot and bentonite was applied around the access tube to the lysimeter. Data collected in 2003 suggest that these maintenance activities had little effect on amount of water draining from the lysimeter. In 2004 a HDPE cover was placed directly over and approximately 18 feet up-slope of the lysimeter. The cover appears to have had little effect on the recorded percolation rate, which suggests that the net percolation being recorded is from a source outside of the covered area (e.g. not direct vertical percolation through the cover profile). Efforts to

understand the processes affecting the net percolation values are ongoing (see the discussion of the Oregon State University study presented below).

- The recorded temperatures within the growth medium layer and the compacted barrier layers have been similar for the seven years of monitoring. The data show that freezing conditions have not been encountered in the compacted barrier layer, suggesting that freeze / thaw cycling is not occurring
- Vegetative cover continues dominated by the hydroseeded grass and clover plant species. However natural invasion, primarily by spruce seedlings, is evident, particularly on the western-most portion of the cover area.

In December 2006 KGCMC began collaborating with Oregon State University and M.A. O'Kane Consultants Inc. to further characterize the hydrology of the cover plot and evaluate how evolution of native forest vegetation (spruce-hemlock forest) may affect cover system performance. Field experiments and numerical modeling were conducted in 2007 and will continue through 2009. Key aspects of the Oregon State University study include:

- In May 2007 a 10-meter instrumentation trench was installed at the toe of the cover system to help quantify water flows from individual layers of the cover. Standpipe piezometers and TDR moisture probes were installed on the cover up-gradient from the trench, augmenting the existing monitoring network.
- Tracer/irrigation experiments were performed in May and November 2007.
- A shelter was constructed over the instrumentation trench in November 2007 to protect the collection system during the winter months.
- The field data were used to calibrate and test a 2D finite element model of the cover system. The model will be used to assess flow processes occurring in the existing cover and to evaluate alternative cover designs.
- Results of dye tracer experiments indicate that the vertical flow likely predominates in the growth medium and that the flow is not particularly preferential.
- The response to irrigation events of two standpipe piezometers installed above the barrier layer were used to characterize the behavior of the growth medium and upper capillary break.
- Flow data collected from the instrumentation trench shows that the system responds rapidly to irrigation and natural rain events. Lateral flow was observed in the growth medium and upper capillary break. Greater flow rates on the western side of the trench are attributed to the southwesterly tilt of the cover. The orientation of the trench relative to the tilted strata may have allowed a substantial portion of the input water to bypass the trench. The upper capillary break contributed approximately 85% of the trench flow. The remaining 15 percent of the trench flow was provided primarily by the growth medium. The barrier layer contribution was 0.2 %.
- Moisture probe measurements suggest that a greater response to irrigation events occurs near the cover surface and down-slope in the growth medium. Normal rain events had little effect on moisture contents measured using the TDR probes.
- A tracer was added to the upper capillary break approximately 9.5 meters up-slope from the trench. No tracer was observed in the discharge from the growth medium or barrier layer. The peak in tracer concentration observed in the discharge from the upper capillary break occurred approximately two hours after injection. The mean lateral subsurface velocity for transport of the tracer was calculated to be between 3.8 and 4.8 m/hr. It took two days to return to background tracer concentrations, suggesting non-ideal, dispersion-dominated transport.

- Saturated hydraulic conductivity of the growth medium was measured with a constant head permeameter. The results varied from 27 to 581 cm/day (mean 192 cm/day).
- The response in trench flow to natural rain events indicates that the lag time between peak rainfall and peak trench discharge is on the order of 6-7 hours for dry antecedent moisture conditions and 2-3 hours for wet conditions. Transient water tables perch at the interface of the upper capillary break and the barrier layer, triggering subsurface flow.
- The finite element model HYDRUS-2D/3D was used to simulate water flow in the cover system. Field and laboratory measurements of hydraulic properties of the layer materials were used in the model. Comparison of the model results with field observations indicates generally good agreement between the measured and simulated results, particularly with respect to timing and slope of rising and falling hydrograph limbs.
- A comparison between 2006 field data and the model simulation for the same time period suggests that the lysimeter at the base of the cover is providing a reasonable estimation of the vertical percolation through the barrier layer. The model supports the field measurements, indicating that the installed cover system is very efficient at conveying infiltrating waters laterally down slope without producing surface runoff and positive pressure heads in the cover system.
- Work planned for 2008 includes additional modeling of the cover system, with particular attention to flow through the barrier layer and alternative cover designs. Measurement of transpiration of undisturbed, native spruce and hemlock near Site 23 will be used to evaluate the effects of development of a mature forest on the water balance of the cover. Evaluation of natural soils and hillslopes, including the effects of vegetation will also provide information valuable to determining the long term evolution of the cover.

Reclamation Plan

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

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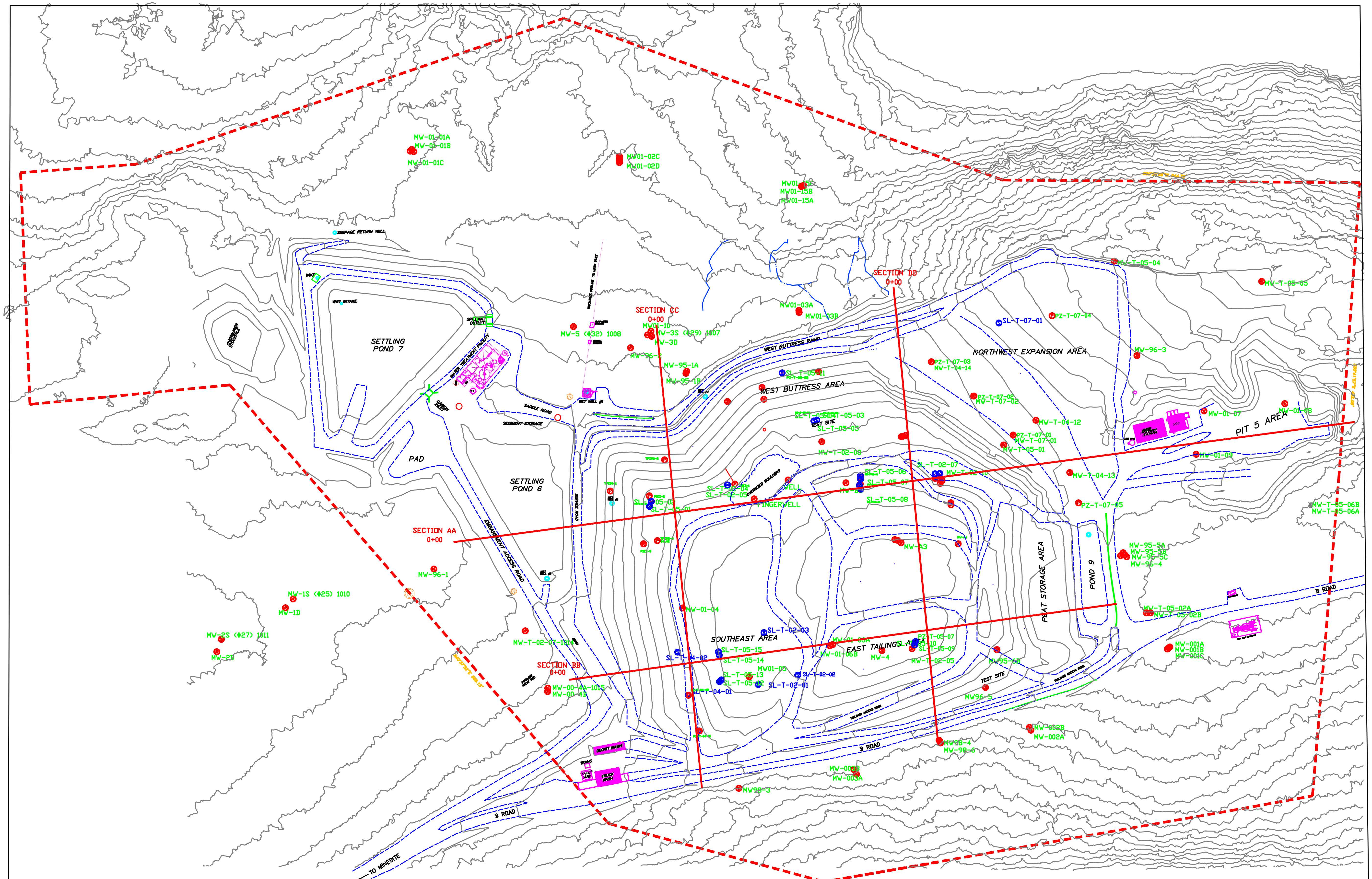
APPENDIX 1

Tailings Facility 2007 As-built and Cross Sections



LEGEND:

ROADS/DITCHES
WATER UTILS
LEASE BOUNDARY

SYMBOLS:

MONITORING WELL OR PIEZOMETER
LYSIMETER
SNOW MONITORING ISOLATED SAMPLE

KENNECOTT MINERALS

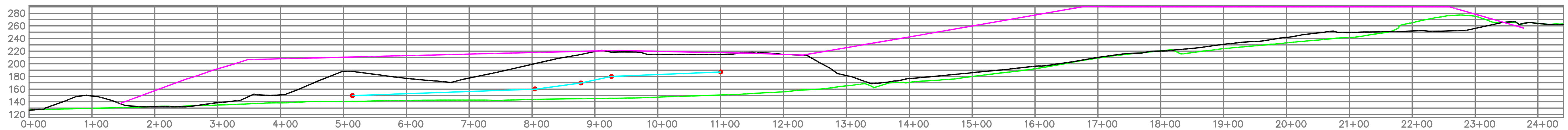
DATE: 12-31-07
DRAWING BY: Shelby Edwards
DESIGN BY: ----
REVIEWED BY: ----
PROJ OR REF. ----

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

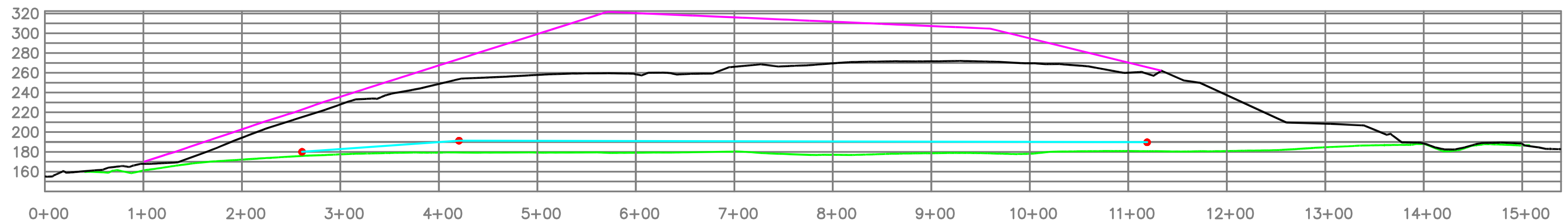
TITLE: Tailings Asbuilt

GRAPHIC SCALE: 1" = 50'

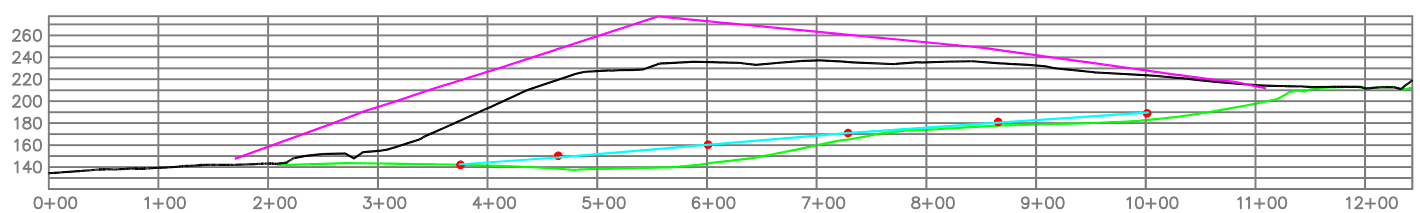
SHEET: 1 OF 1



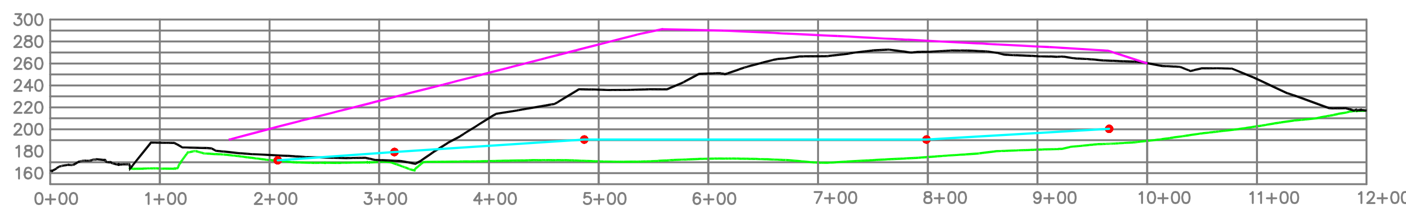
DATUM ELEV
SECTION AA



DATUM ELEV
SECTION BB



DATUM ELEV
SECTION CC



DATUM ELEV
SECTION DD

LEDGEND:
- DESIGN PLAN
- ORIGINAL GROUND
- EXISTING GROUND
- WATER LEVEL

SYMBOLS:
- FIRE HYDRANT
- MONITORING POINT
- BOLLARDS
- POWER POLES
- WATER VALVE
- CATCH BASIN

KENNECOTT MINERALS

DATE: 12-31-07
DRAWING BY: Shelby Edwards
DESIGN BY: ----
REVIEWED BY: ----
PROJ OR REF. ----

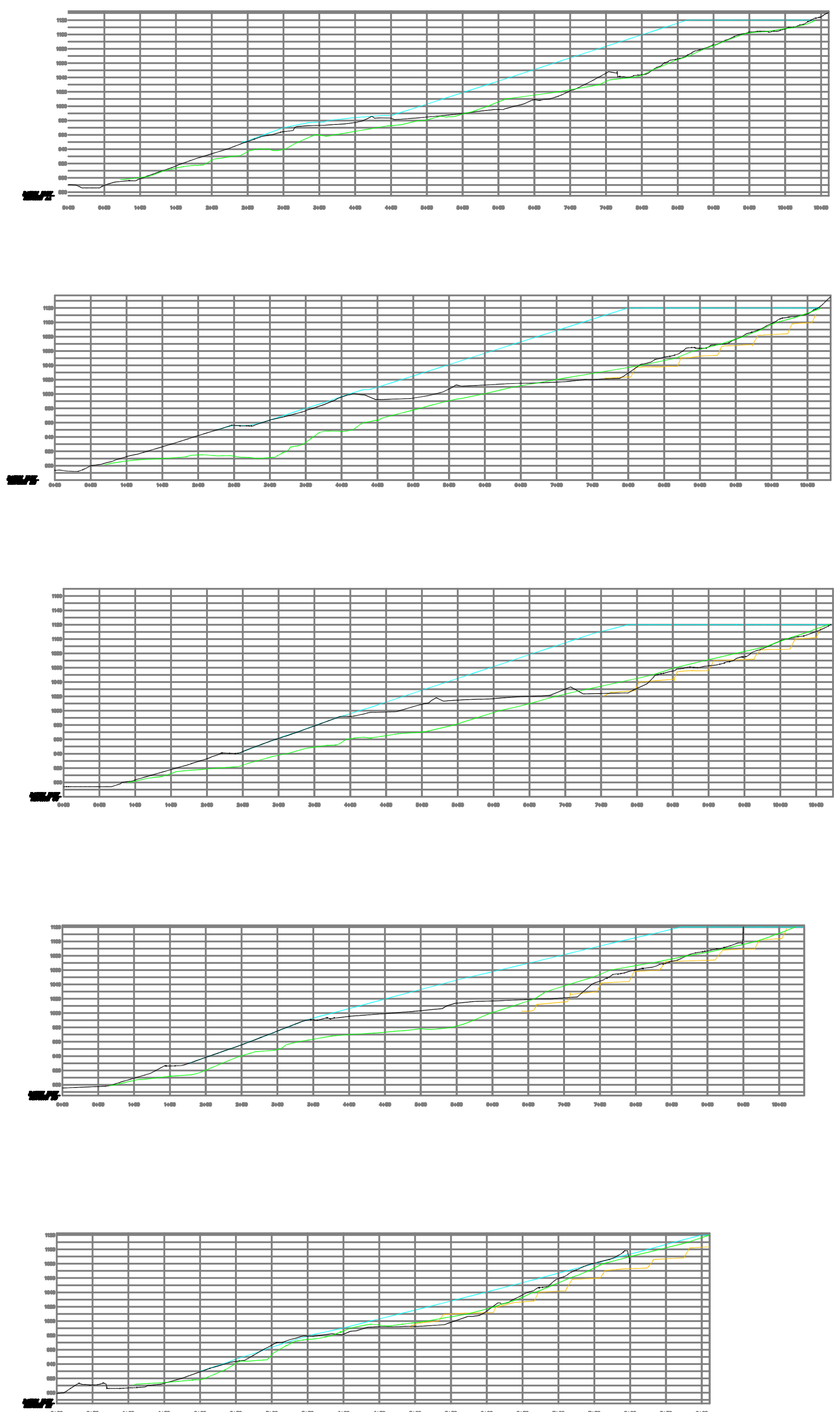
KENNECOTT GREENS CREEK MINING CO.
P.O. BOX 32199 JUNEAU, ALASKA 99803
PHONE: (907)790-8441 FAX: (907)790-8448

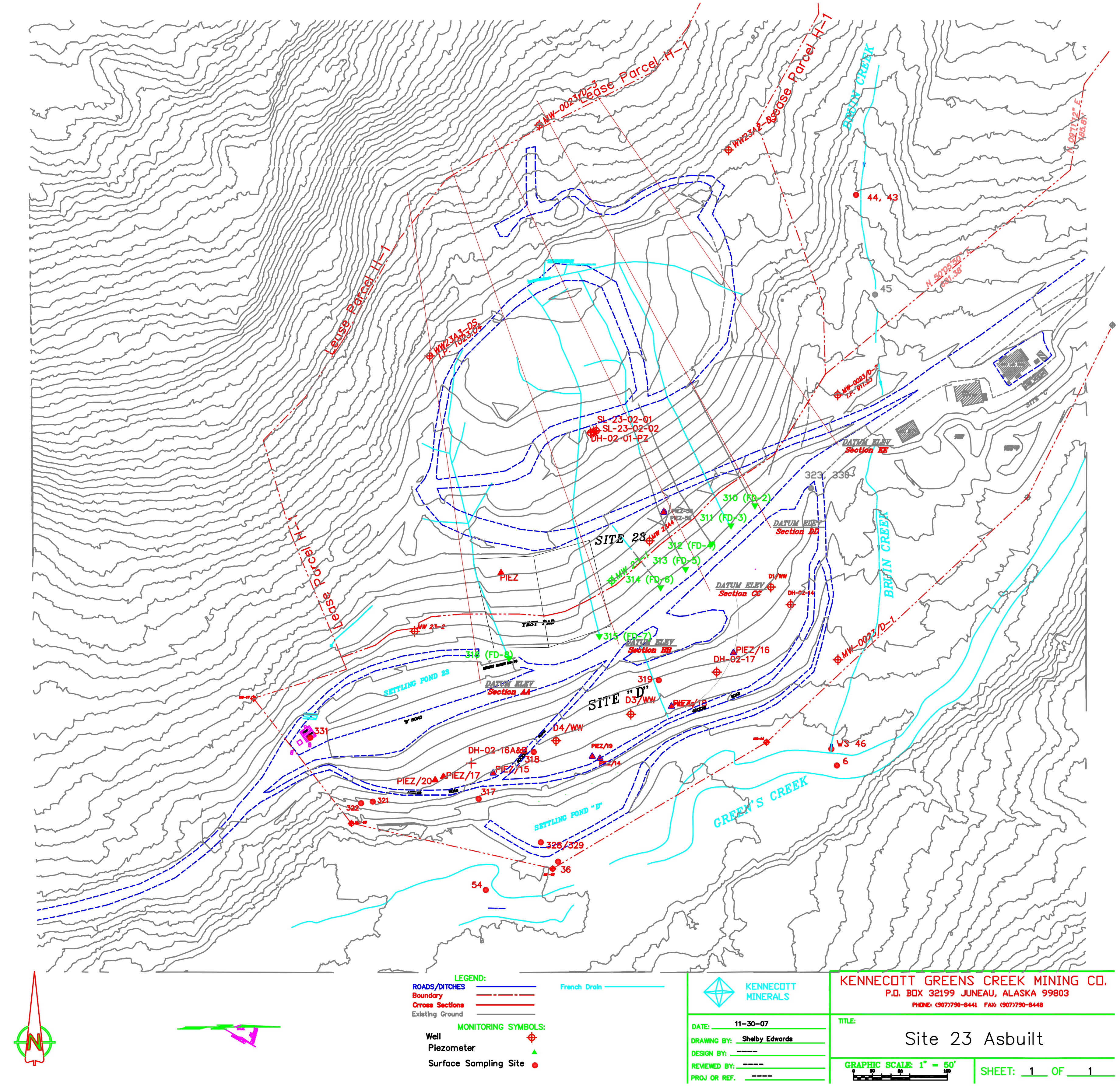
TITLE: 2007 TAILS YEAR END CROSS SECTIONS

SHEET: 1 OF 1

APPENDIX 2

Site 23/D 2007 As-built and Cross Section





Lease Parcel H-1
SITE 23
SITE "D"
SETTLING POND 23
SETTLING POND "D"
GREEN'S CREEK
BRUIN CREEK
TEST PAD
SL-23-02-01
SL-23-02-02
DH-02-01-PZ
PIEZ
PIEZ/16
PIEZ/17
PIEZ/20
PIEZ/15
DH-02-17
D3/WW
D4/WW
317
318
319
321
322
328/329
331
36
45
54
6
WS 46
44, 43
310 (FD-2)
311 (FD-3)
312 (FD-4)
313 (FD-5)
314 (FD-6)
315 (FD-7)
316 (FD-8)
DATUM ELEV Section AA
DATUM ELEV Section BB
DATUM ELEV Section CC
DATUM ELEV Section DD
DATUM ELEV Section EE
LEGEND:
ROADS/DITCHES
Boundary
Crross Sections
Existing Ground
French Drain
MONITORING SYMBOLS:
Well
Piezometer
Surface Sampling Site
KENNECOTT MINERALS
KENNECOTT GREENS CREEK MINING CO.
P.O. BOX 32199 JUNEAU, ALASKA 99803
PHONE: (907)790-8441 FAX: (907)790-8448
DATE: 11-30-07
DRAWING BY: Shelby Edwards
DESIGN BY: ----
REVIEWED BY: ----
PROJ OR REF. ----
TITLE:
Site 23 Asbuilt
GRAPHIC SCALE: 1" = 50'
SHEET: 1 OF 1

KENNECOTT MINERALS

KENNECOTT GREENS CREEK MINING CO.

DATE:	4-30-03
DRAWING BY:	TZ
DESIGN BY:	PC
REVIEWED BY:	----
PROJ OR REF.	EDE-Site 23/D Hydrology

TITLE:

SITE 23/D CONCEPTUAL GROUNDWATER FLOW

LEGEND:

- CLAY LENSES WITH PERCHED WATER
- WATER TABLE
- WATER FLOW VECTORS – FLOW RATE PROPORTIONAL
- EXISTING GROUND
- PRODUCTION ROCK FILL
- FINGER DRAINS TYPICAL
- COLLUVIUM
- ALLUVIUM
- GLACIAL TILL LAYER
- BEDROCK

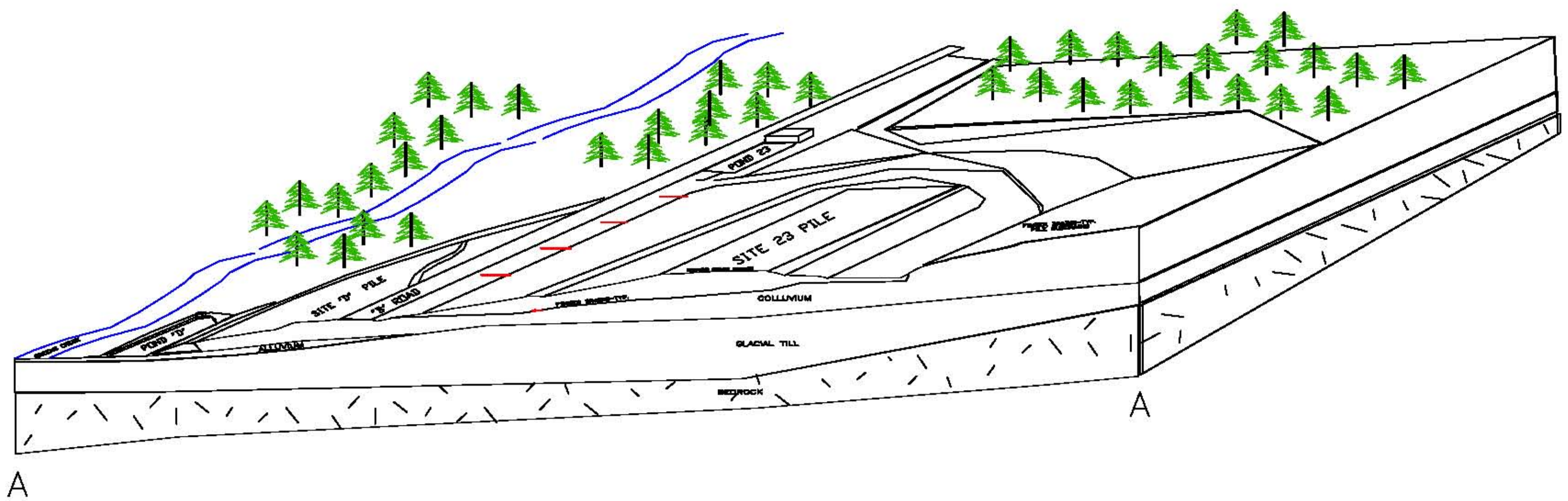
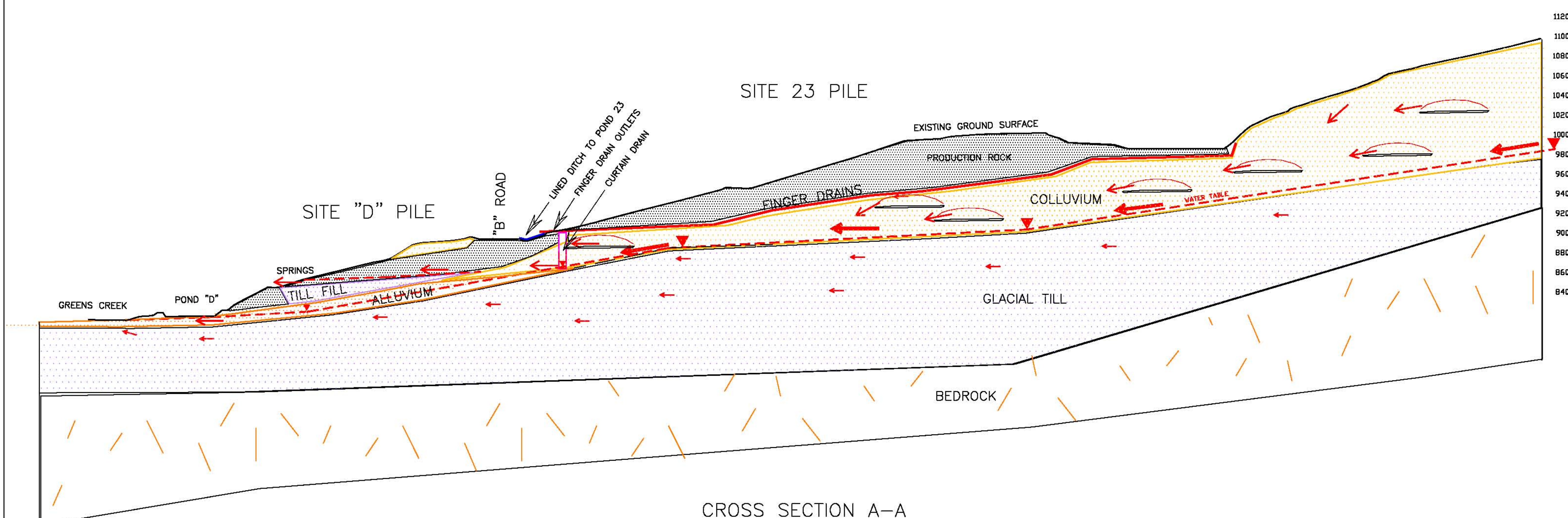


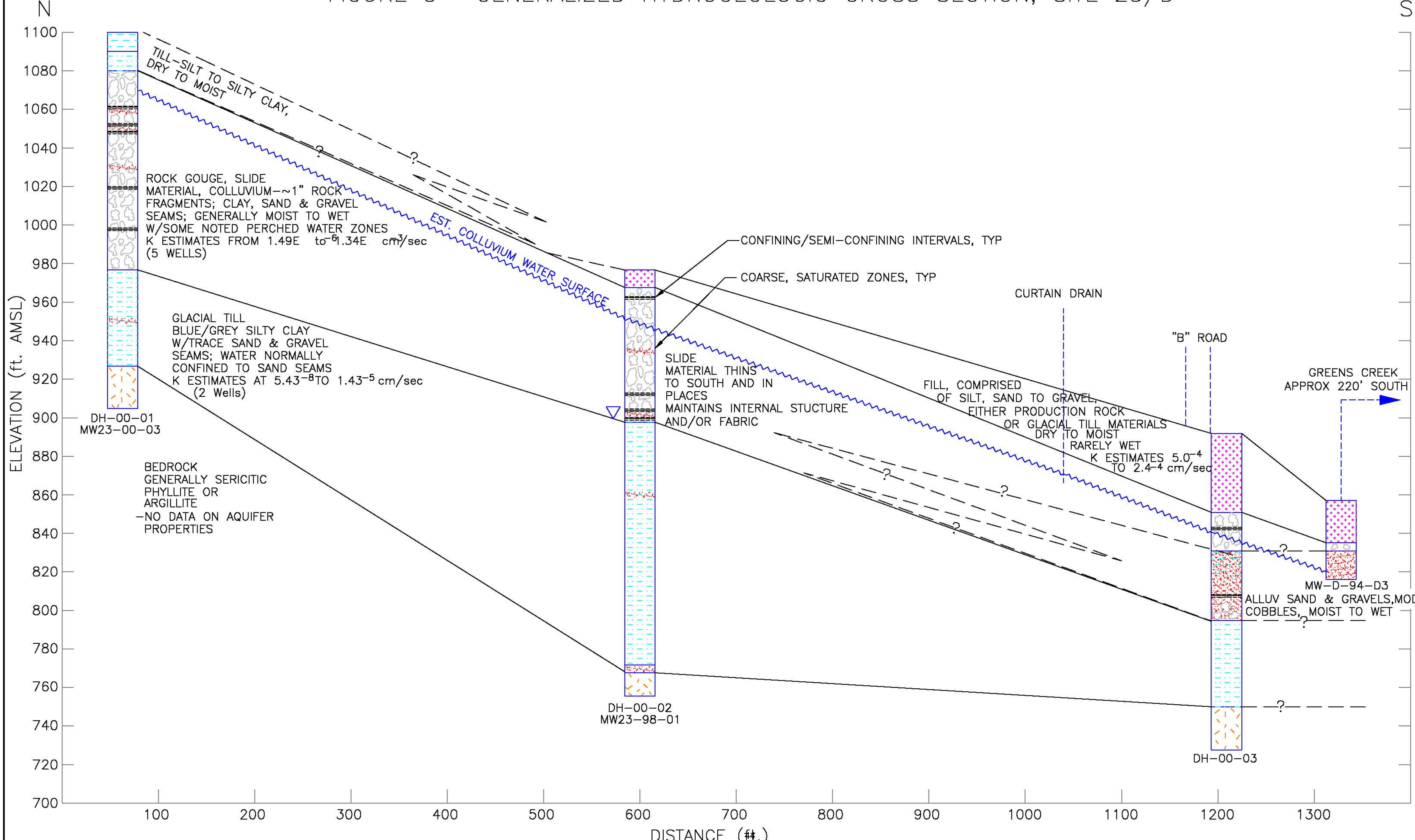
FIGURE 2

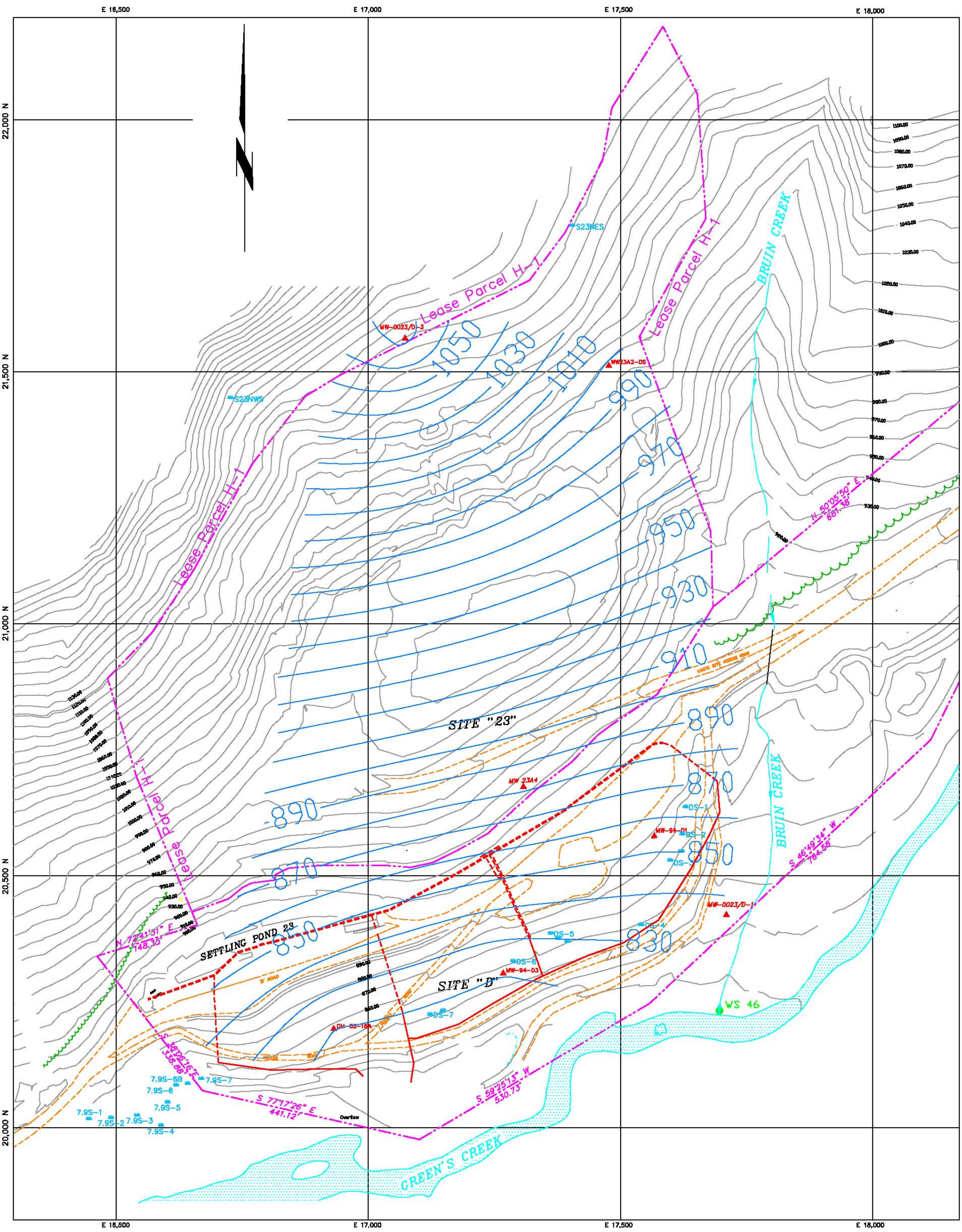


CROSS SECTION A–A

South North

FIGURE 3--GENERALIZED HYDROGEOLOGIC CROSS SECTION, SITE 23/D





LEGEND:

▲	PIEZOMETER/WELL
	LEASE BOUNDARY
	10' CONTOUR LINE
	STREAM CHANNEL
	ROAD
	CURTAIN DRAIN
	CURTAIN DRAIN OUTFALL
7.9S-4	SEEPS/SPRINGS
	COLLUVIUM POTENTIOMETRIC ISOPLETHS C.I. = 10'

FIGURE 4

KENNECOTT MINERALS **KENNECOTT GREENS CREEK MINE**
ADMIRALTY ISLAND, ALASKA

SITE 23/D
COLLUVIUM POTENTIOMETRIC
SURFACE 2003

DATE: 03/04/04
DRAWING BY: RWH
DESIGN BY: RWH
REVIEWED BY: RWH
PROJ OR REF. ----

EDE Consultants
Environmental Engineering * Hydrology * Water Resources Engineering
23 North Scott St., #23 Sheridan, WY 82801
PHONE: (307) 672-3763

EDE DWG site 23 base map.dwg

SCALE: 1" = 200'
SHEET: 1 OF 1

APPENDIX 3

Data Figures

Figure 2.1 Water Level Data for Piezometer 41

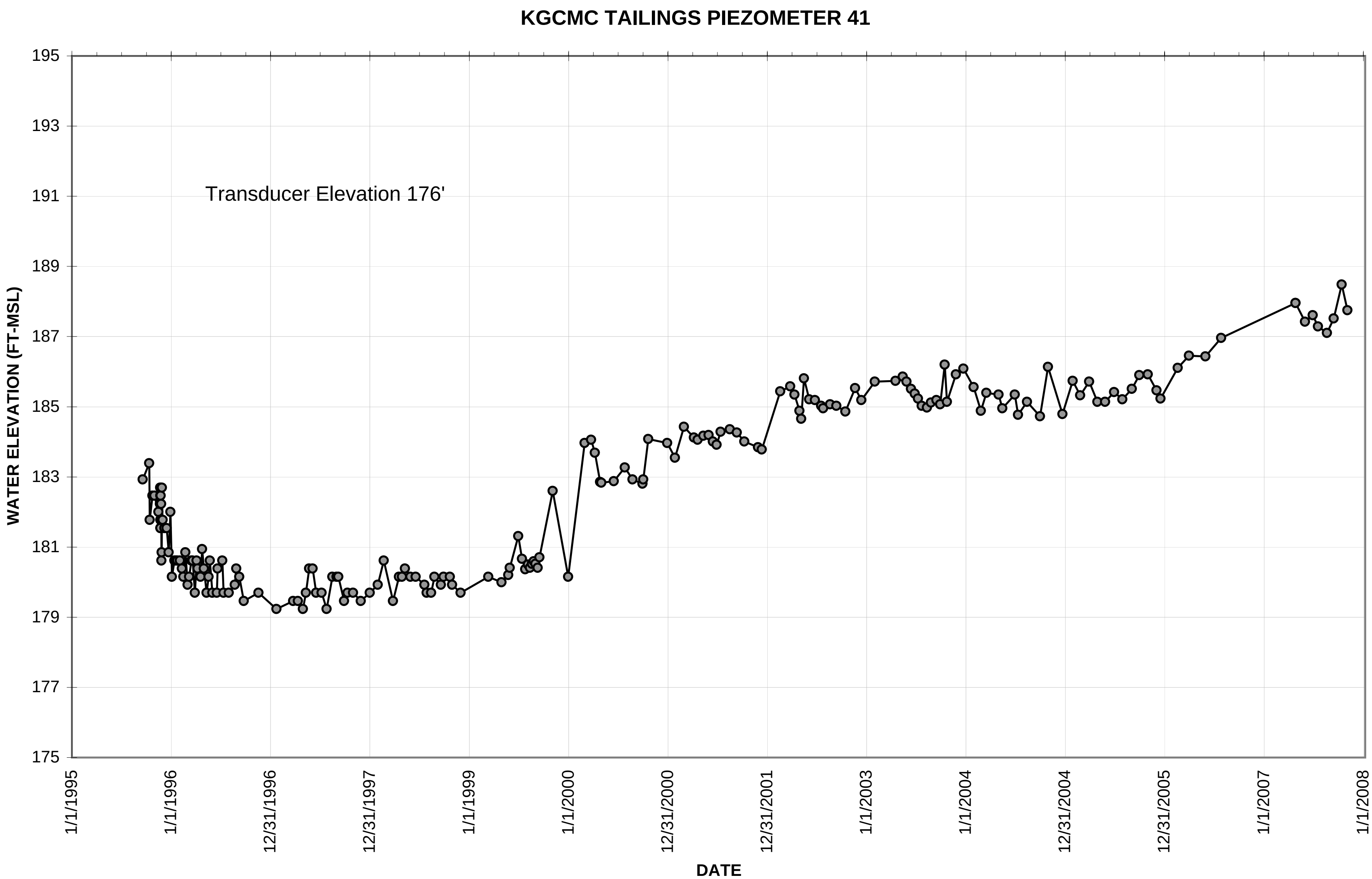


Figure 2.2 Water Level Data for Piezometer 42

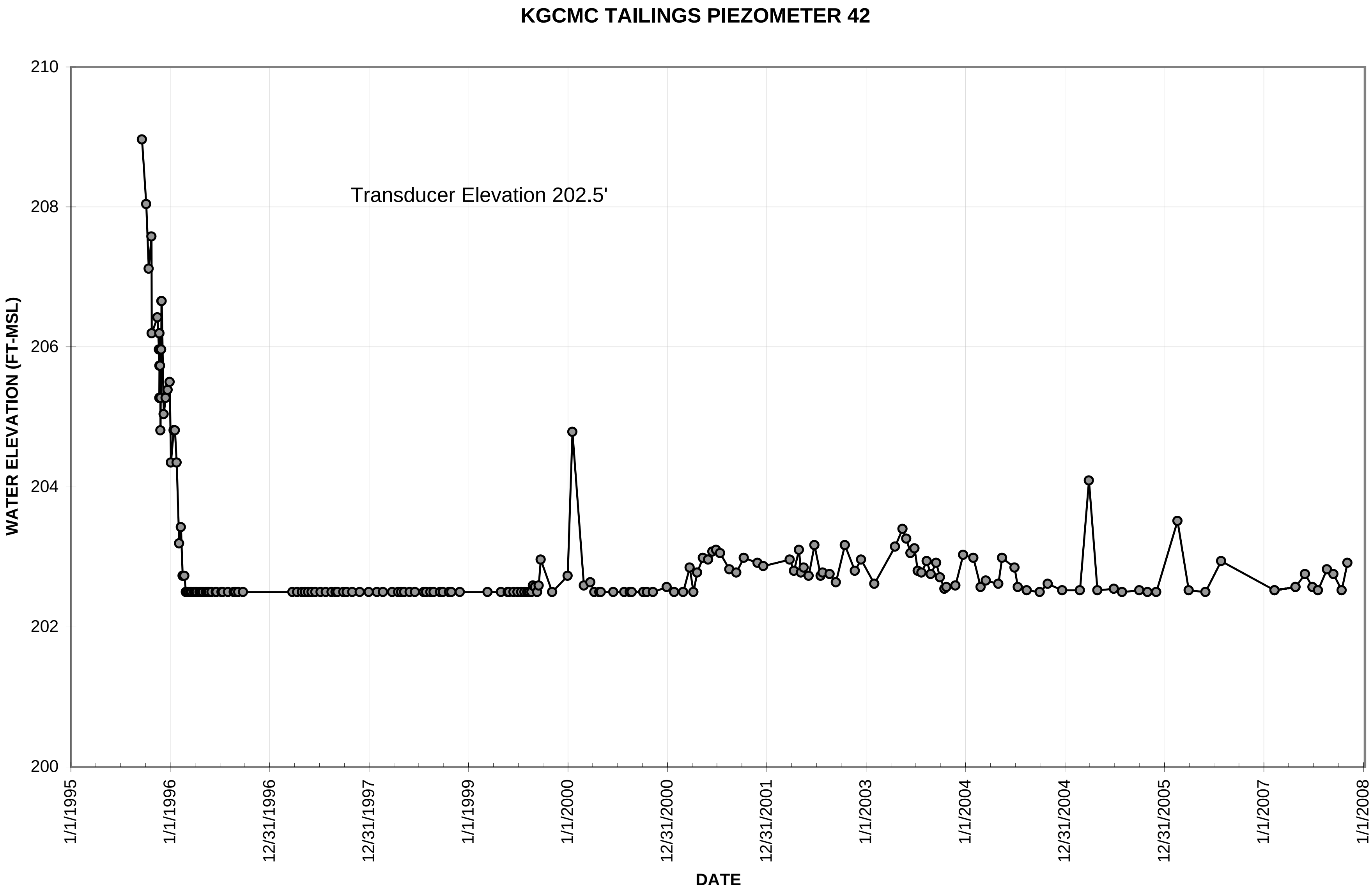


Figure 2.3 Water Level Data for Piezometer 44

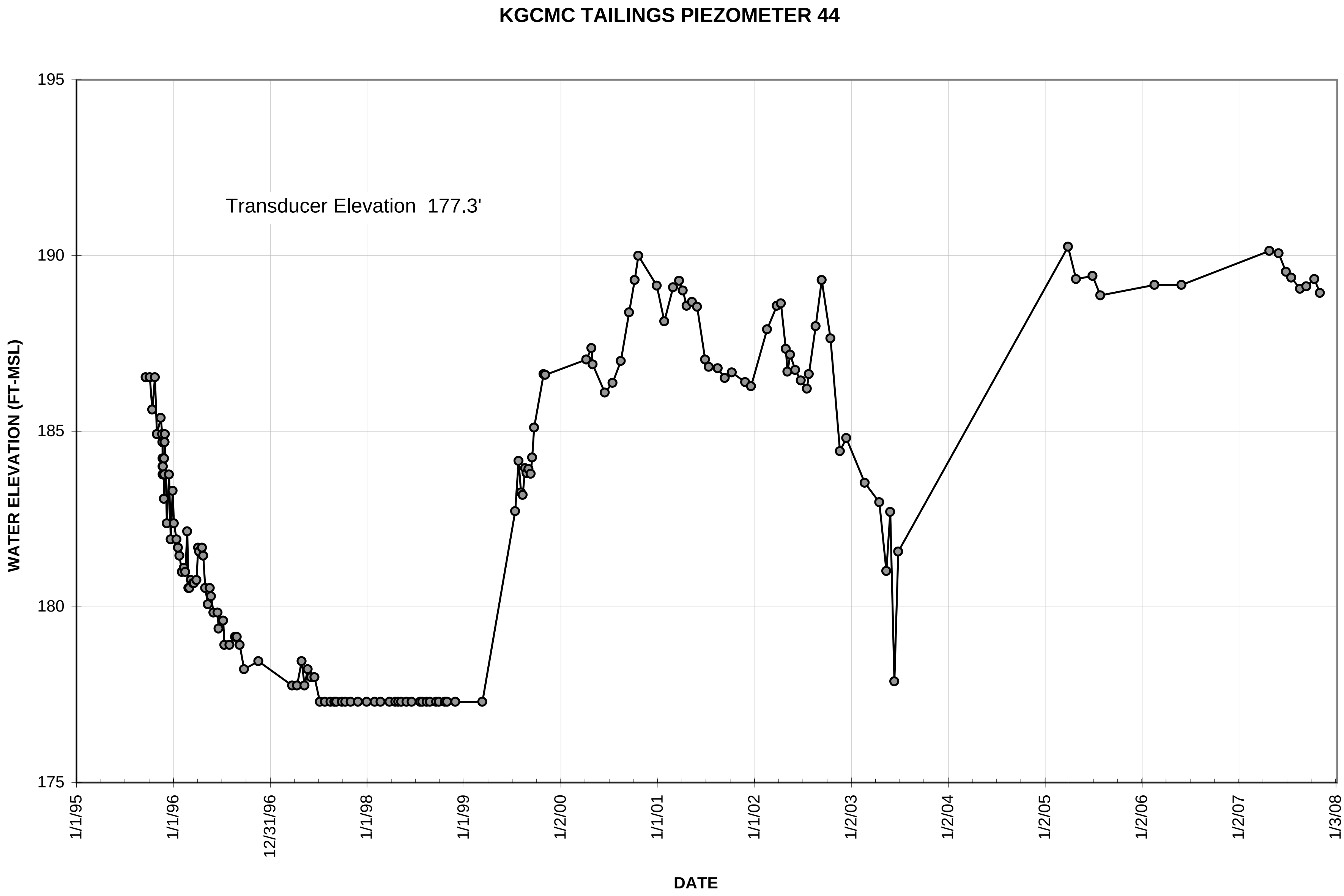


Figure 2.4 Water Level Data for Piezometer 46

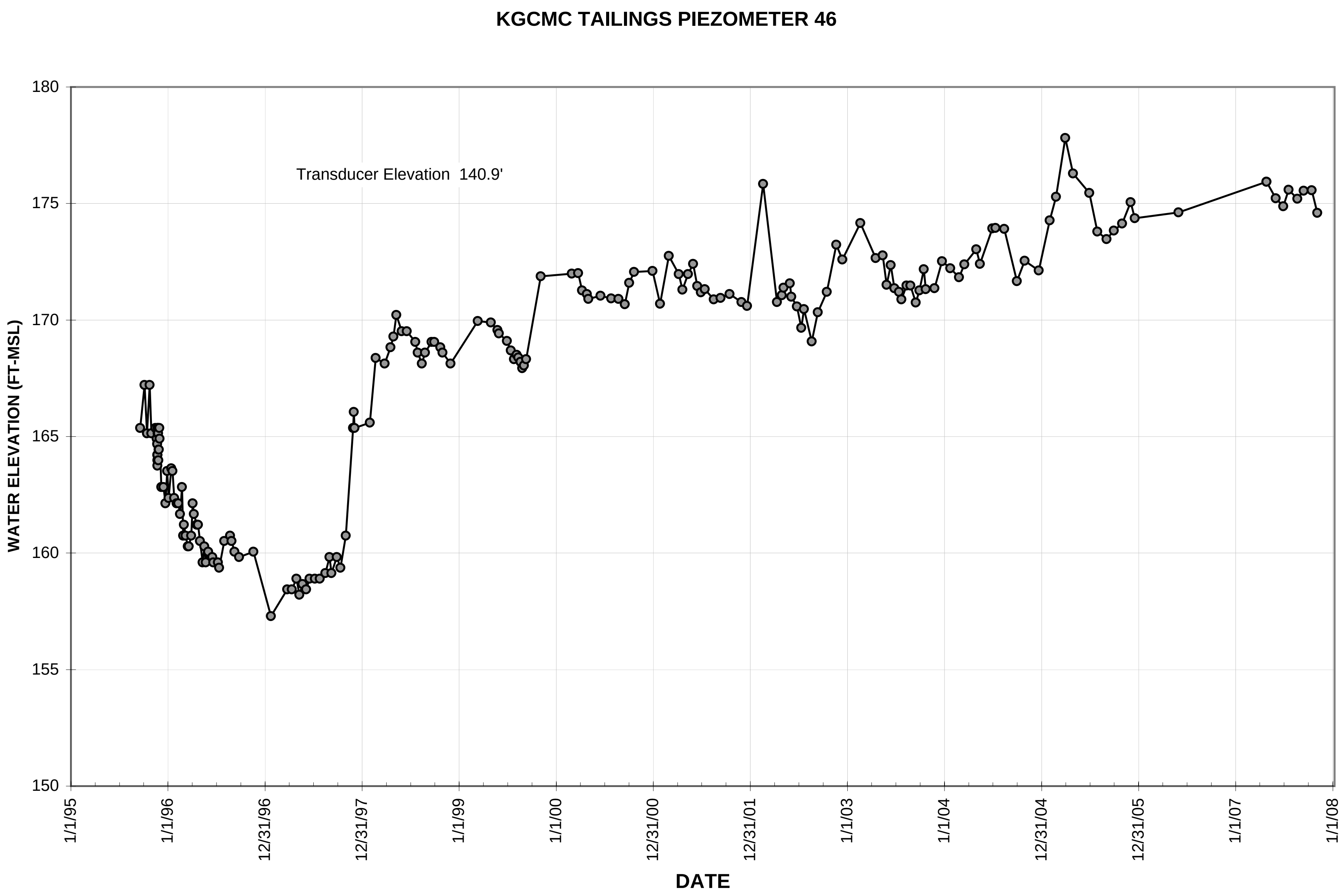


Figure 2.5 Water Level Data for Piezometer 47

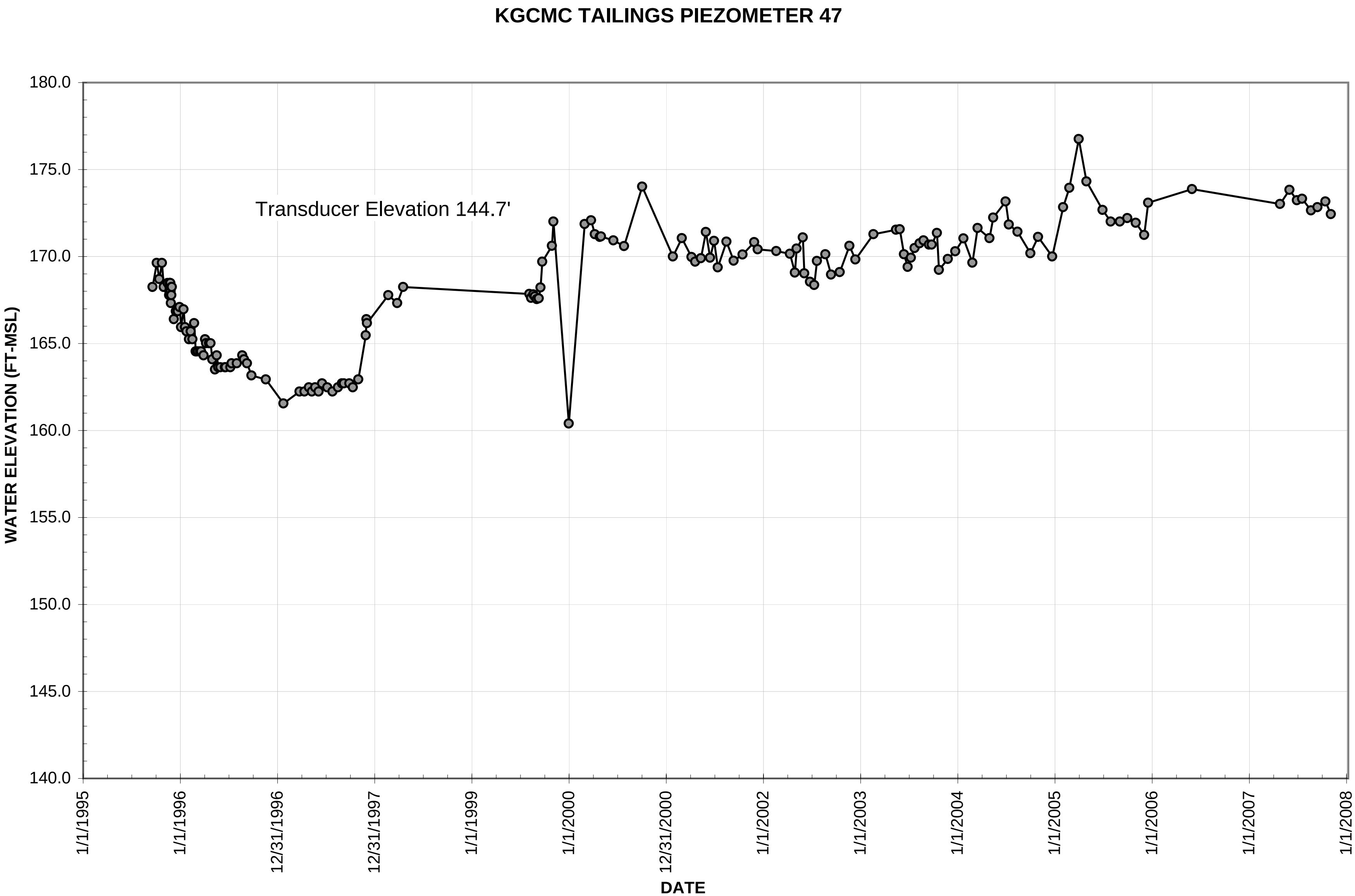


Figure 2.6 Water Level Data for Piezometer 50

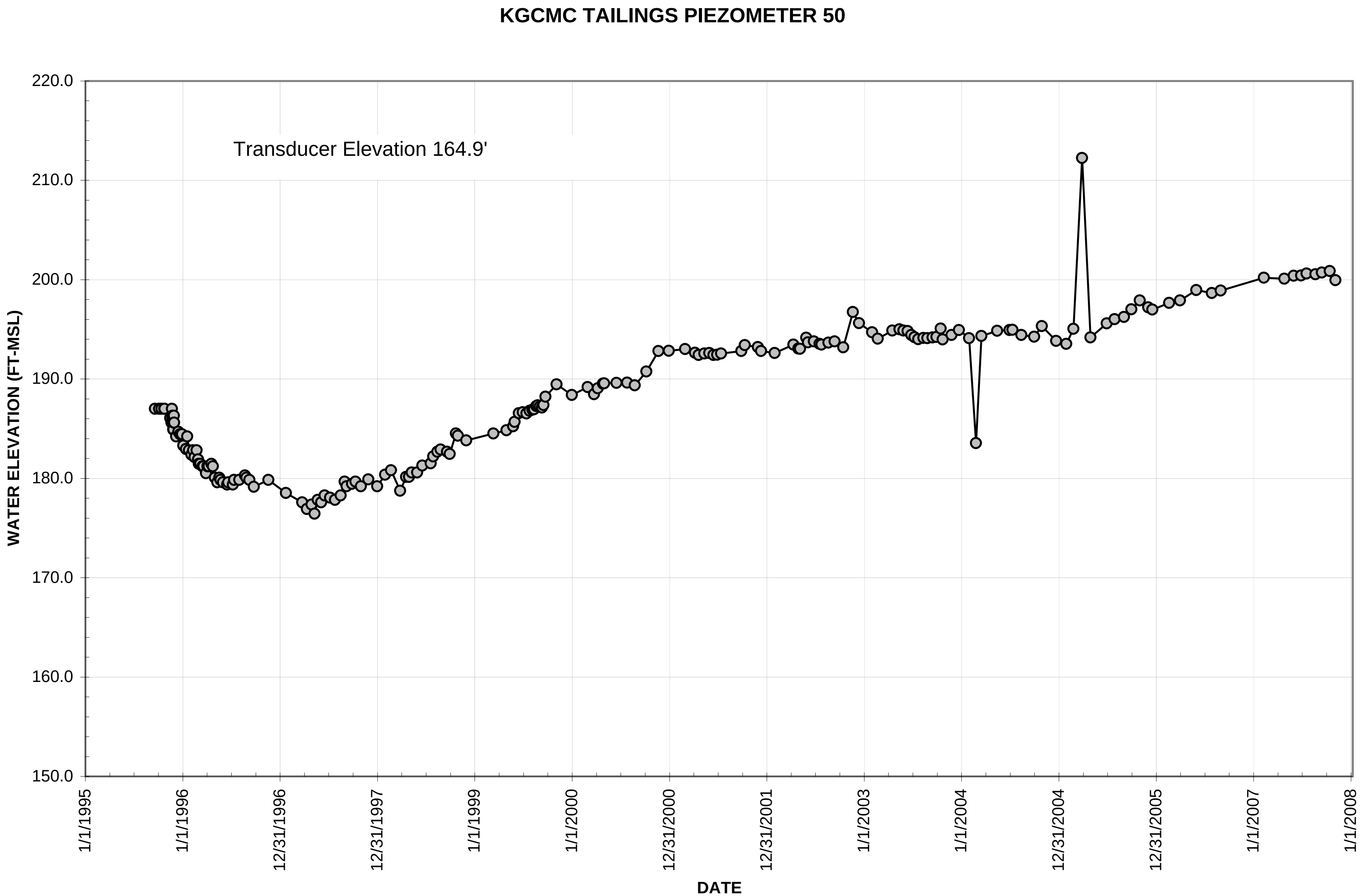


Figure 2.7 Water Level Data for Piezometer 51

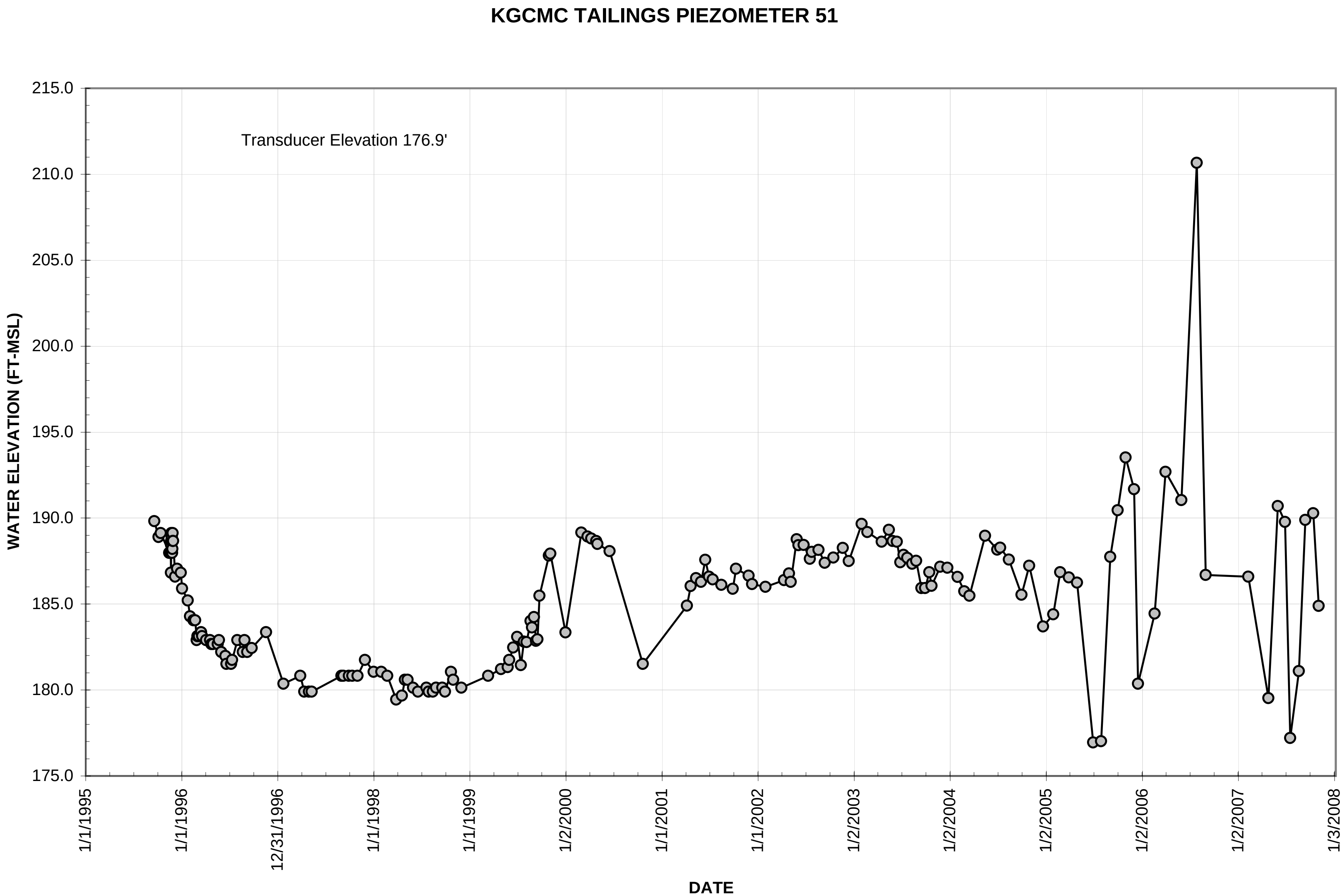


Figure 2.8 Water Level Data for Piezometer 74

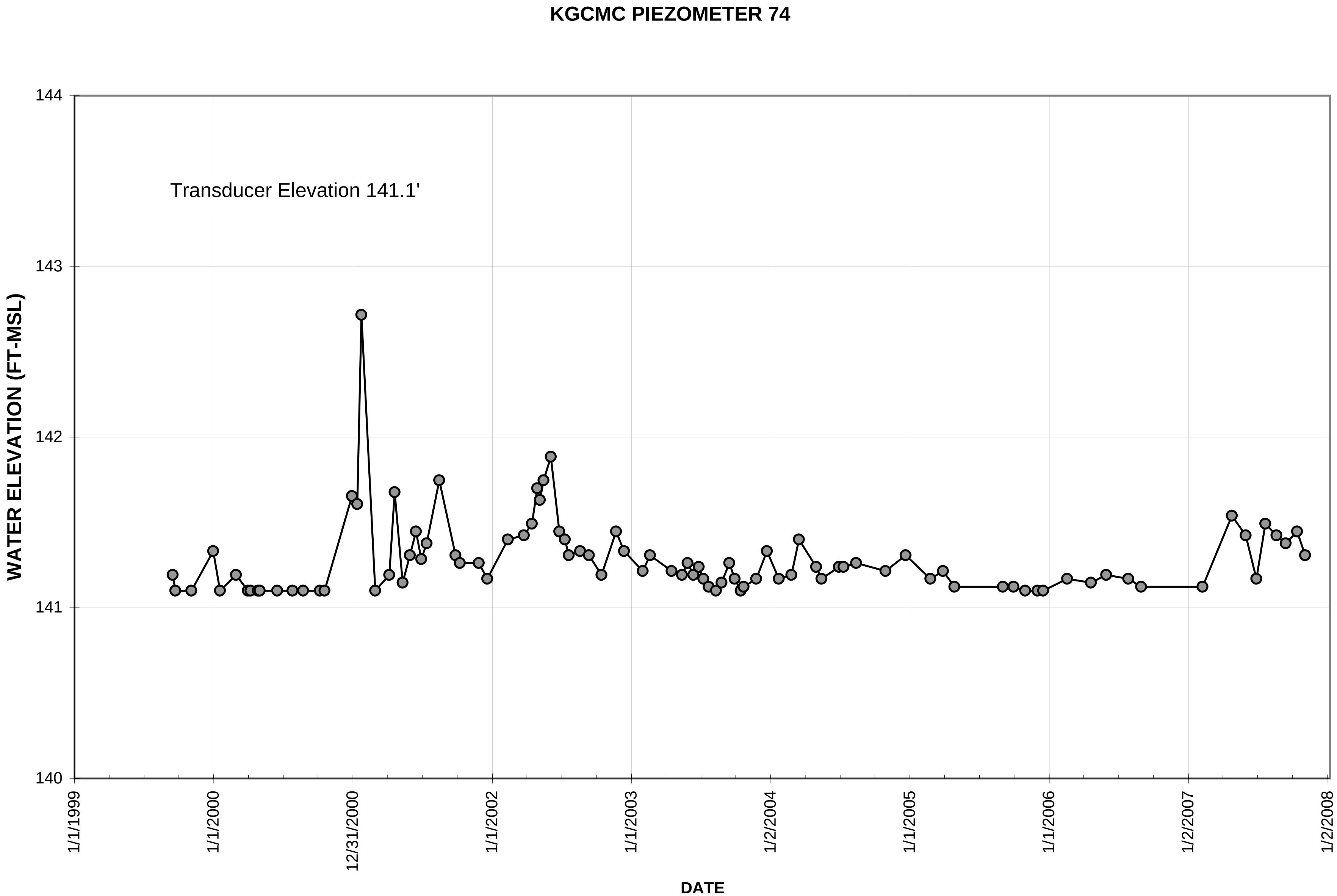


Figure 2.9 Water Level Data for Piezometer 75

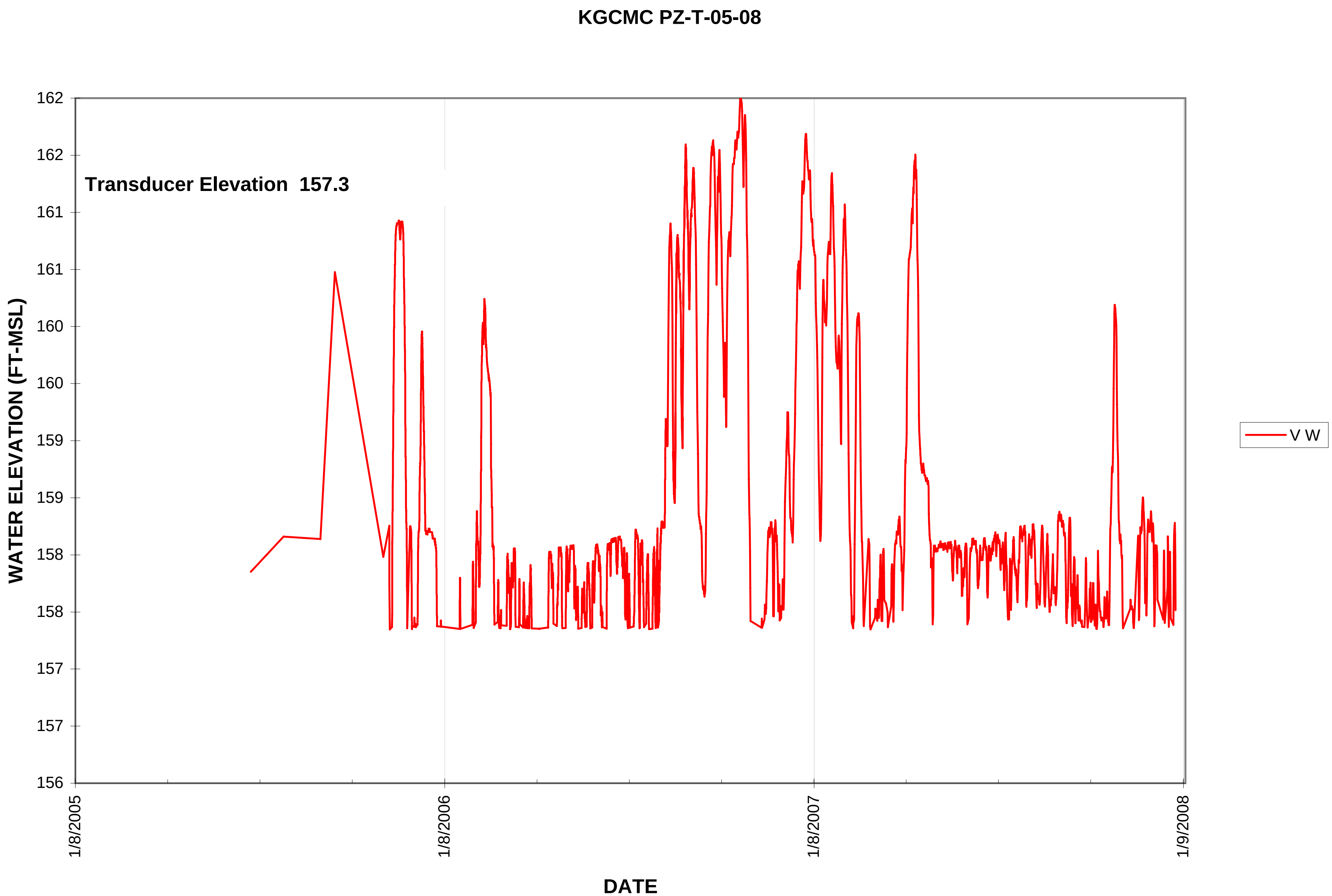


Figure 2.10 Water Level Data for Piezometer 76

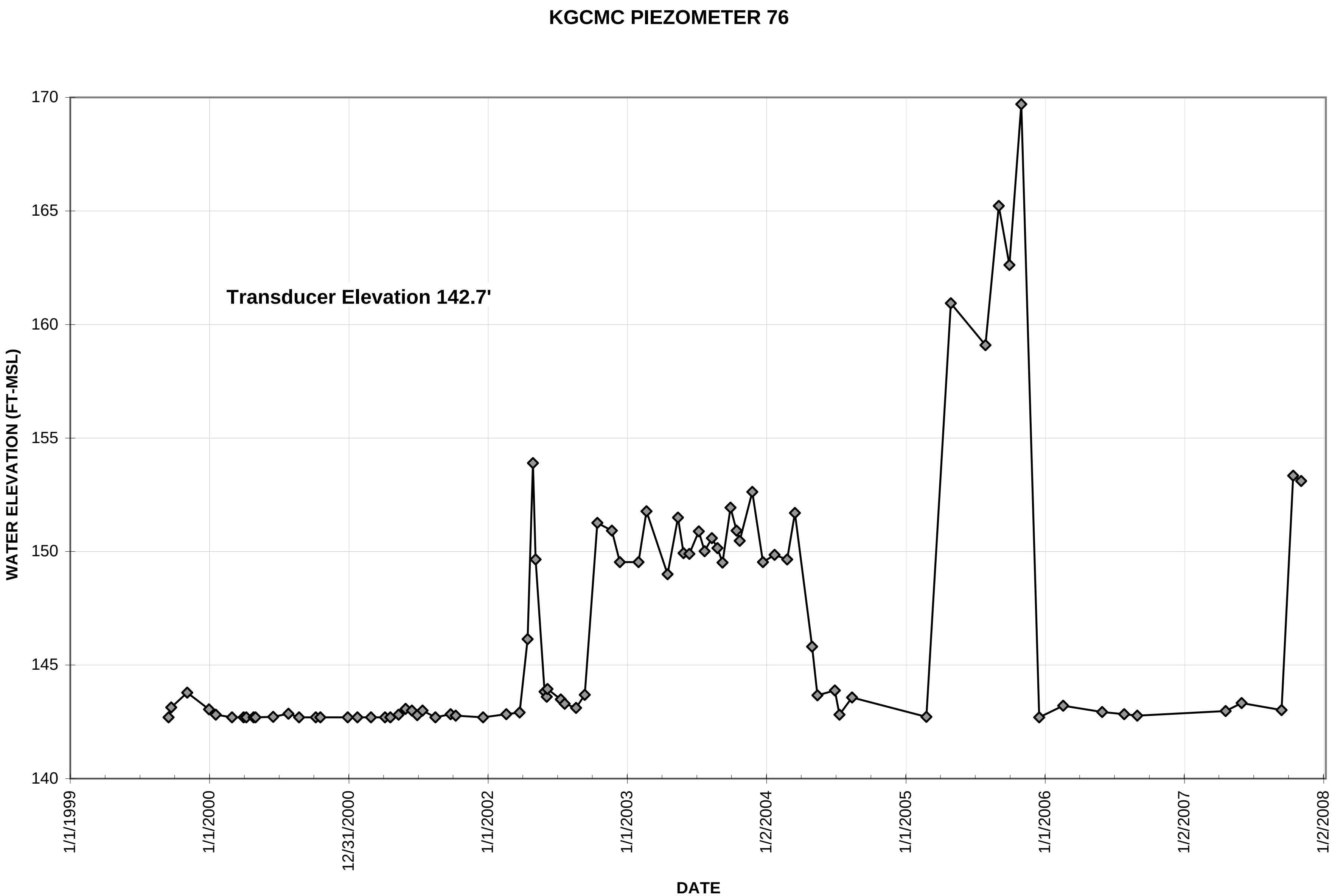


Figure 2.11 Water Level Data for Standpipe Piezometer PZ-T-00-01

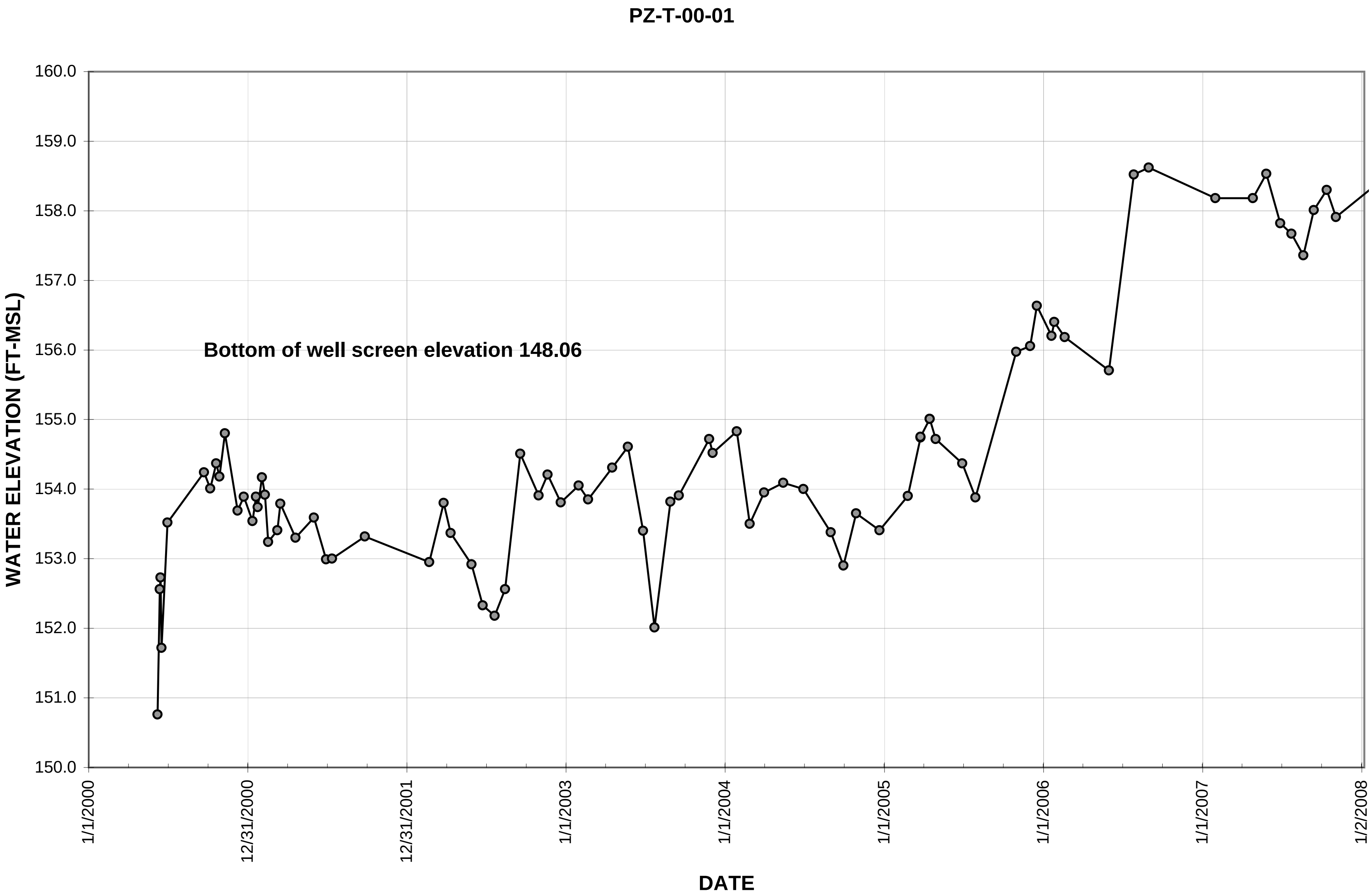


Figure 2.12 Water Level Data for Standpipe Piezometer PZ-T-00-02

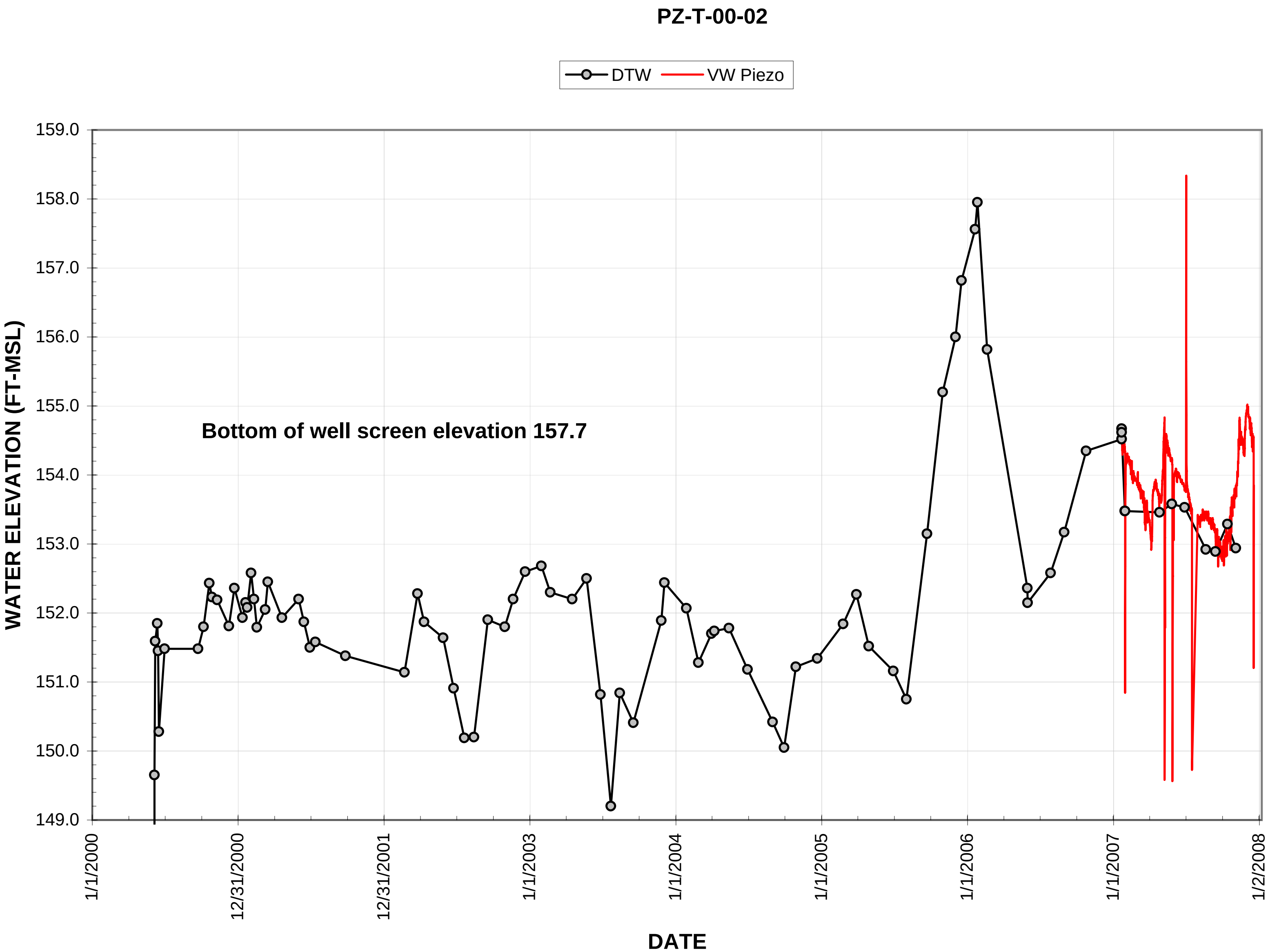


Figure 2.13 Water Level Data for Standpipe Piezometer PZ-T-00-03

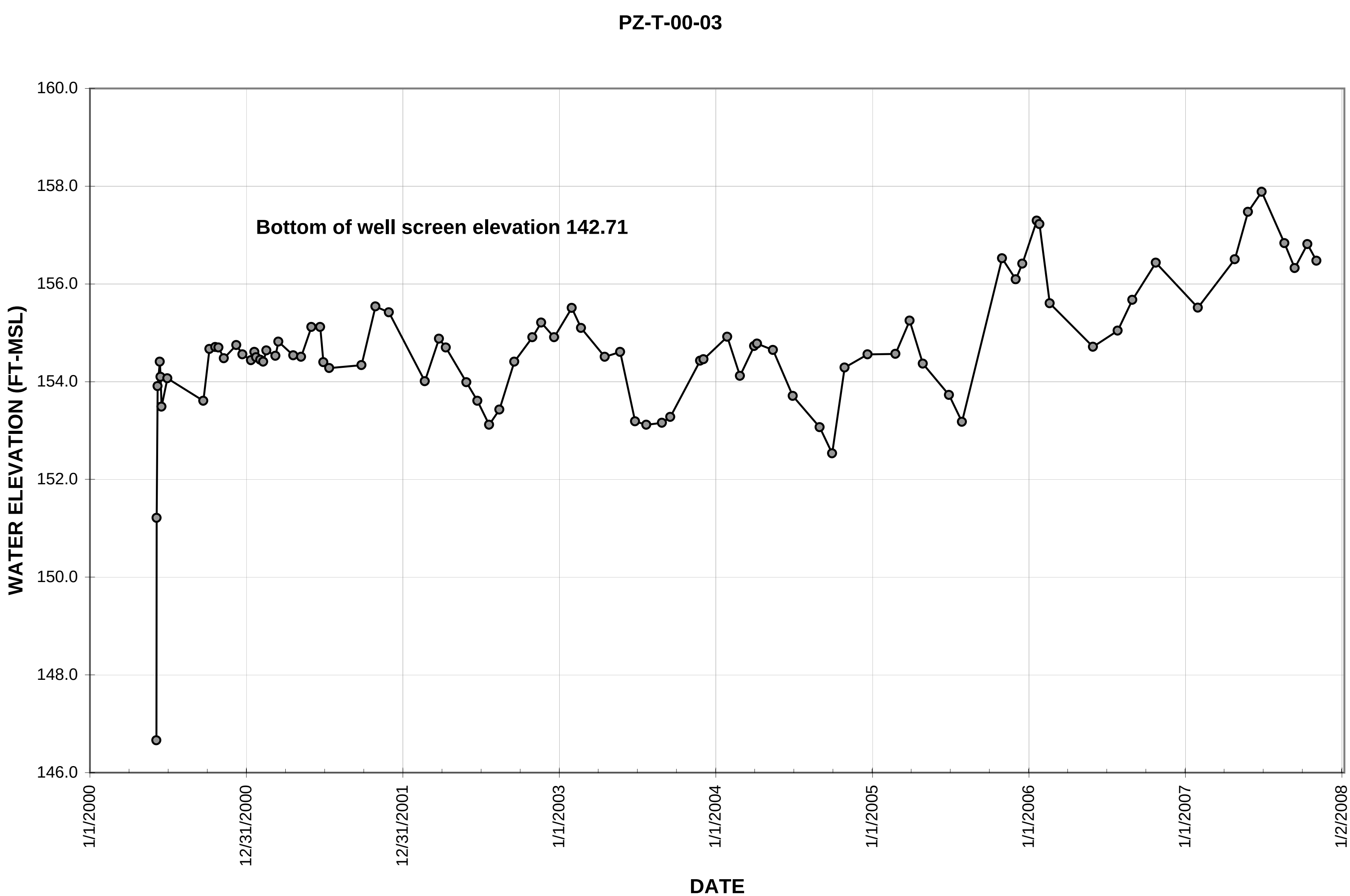


Figure 2.14 Water Level Data for Standpipe Piezometer MW-T-00-05A

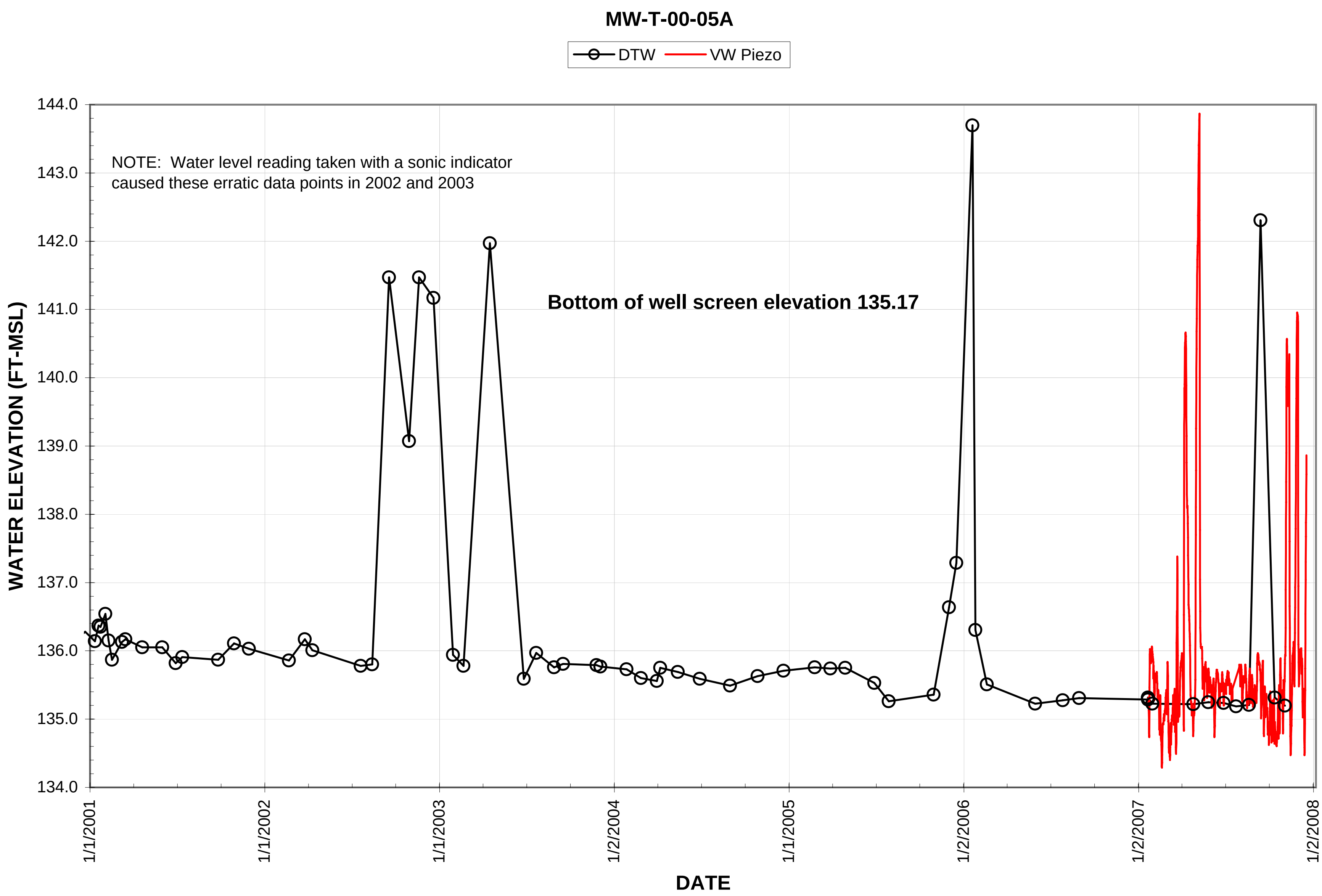


Figure 2.15 Water Level Data for Well MW-T-00-3A

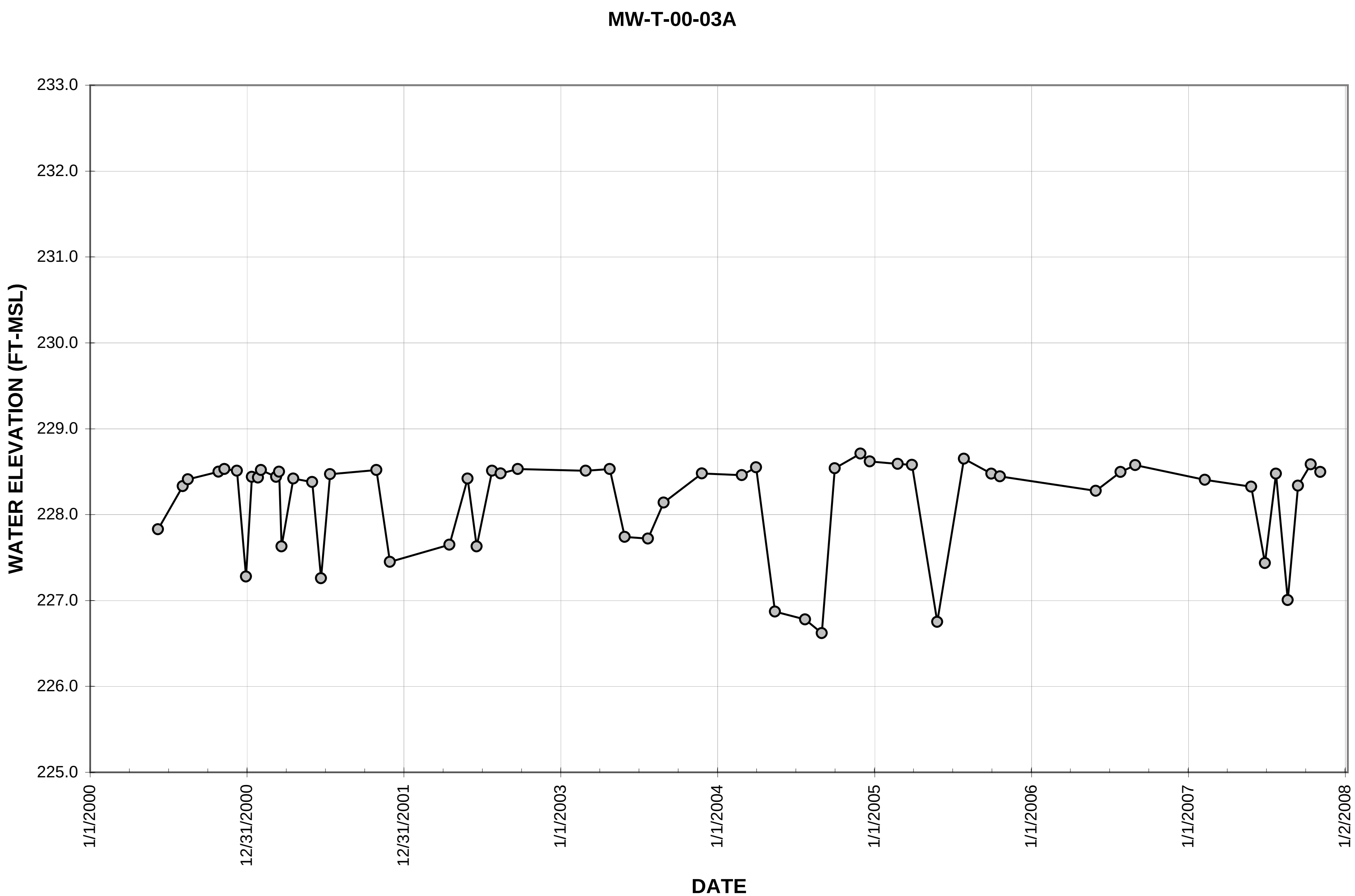


Figure 2.16 Water Level Data for Well MW-T-00-3B

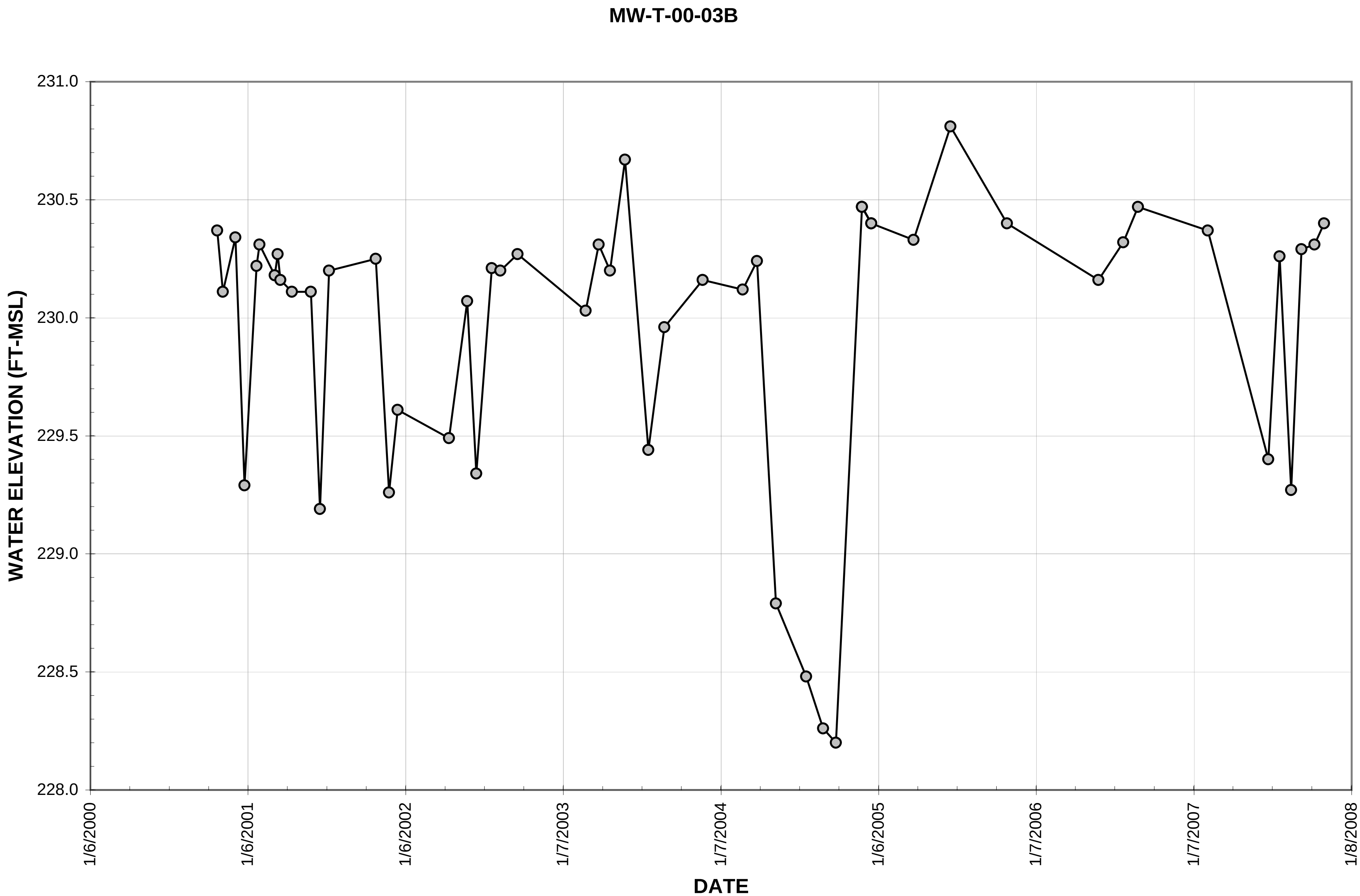


Figure 2.17 Water Level Data for Well MW-T-01-03A

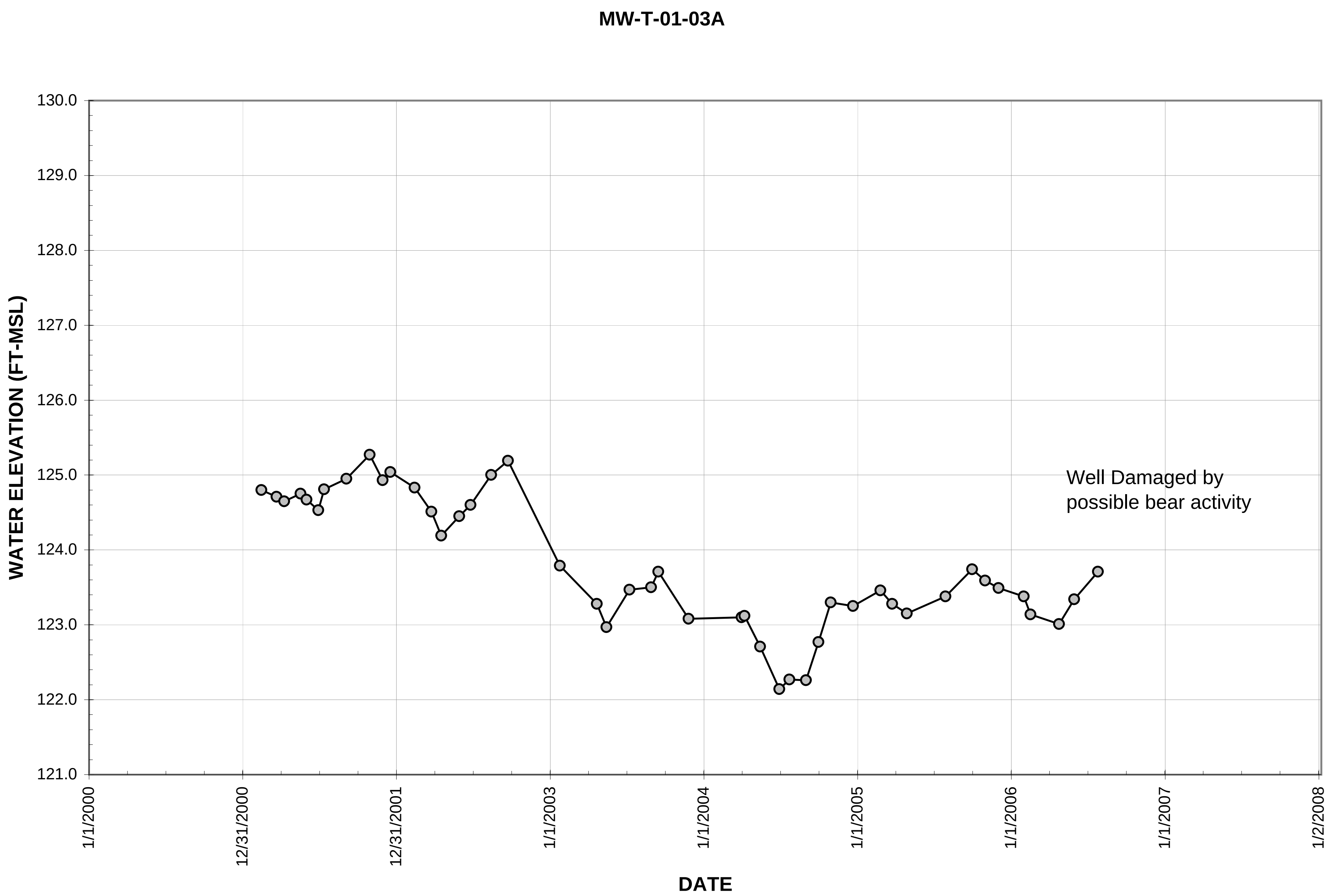


Figure 2.18 Water Level Data for Well MW-T-01-03B

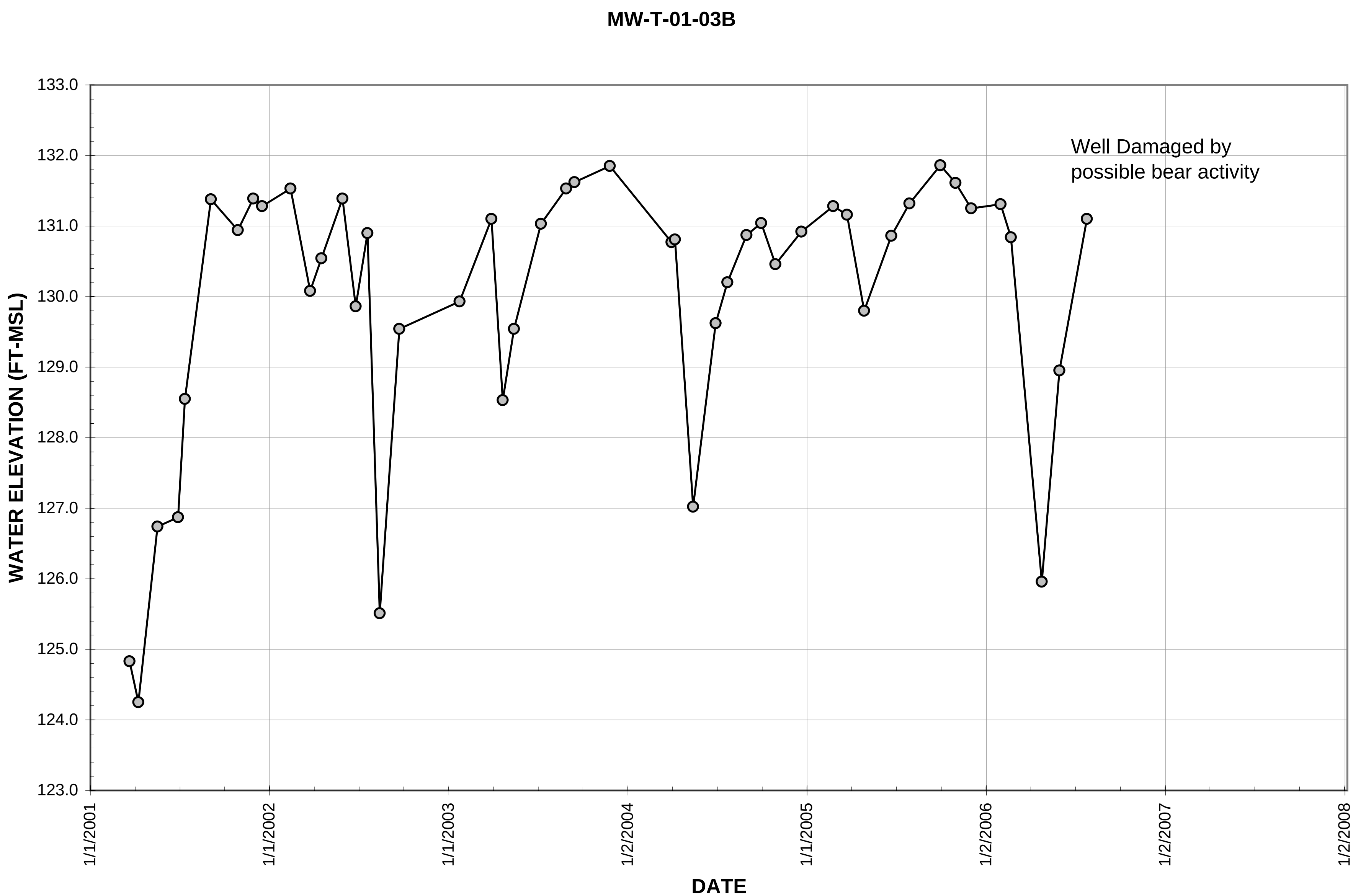


Figure 2.19 Tailings Area Wet Well Flow Data

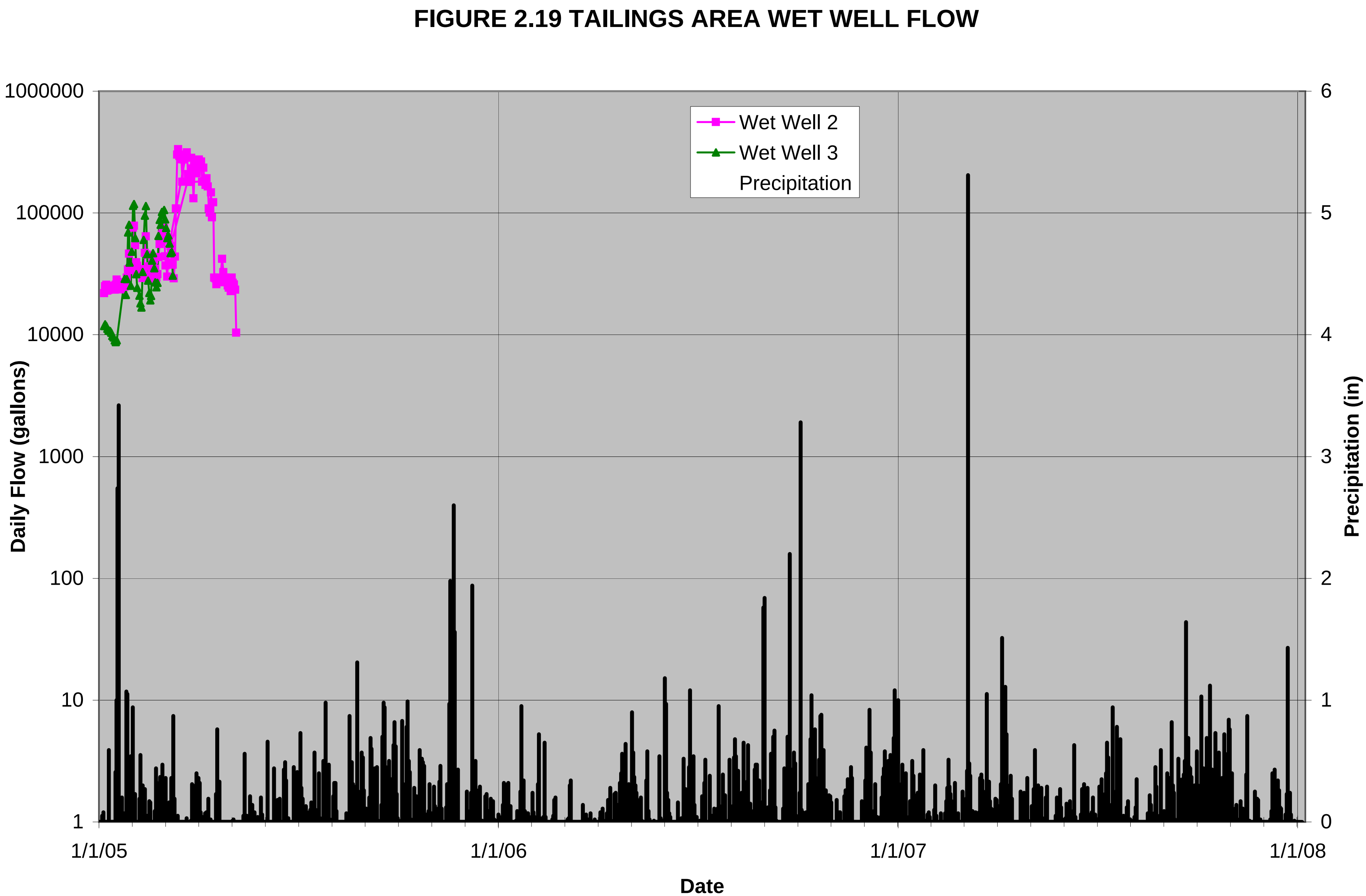


FIGURE 2.20a GREENS CREEK TAILINGS AREA INTERNAL MONITORING SITES: WET WELLS - pH DATA

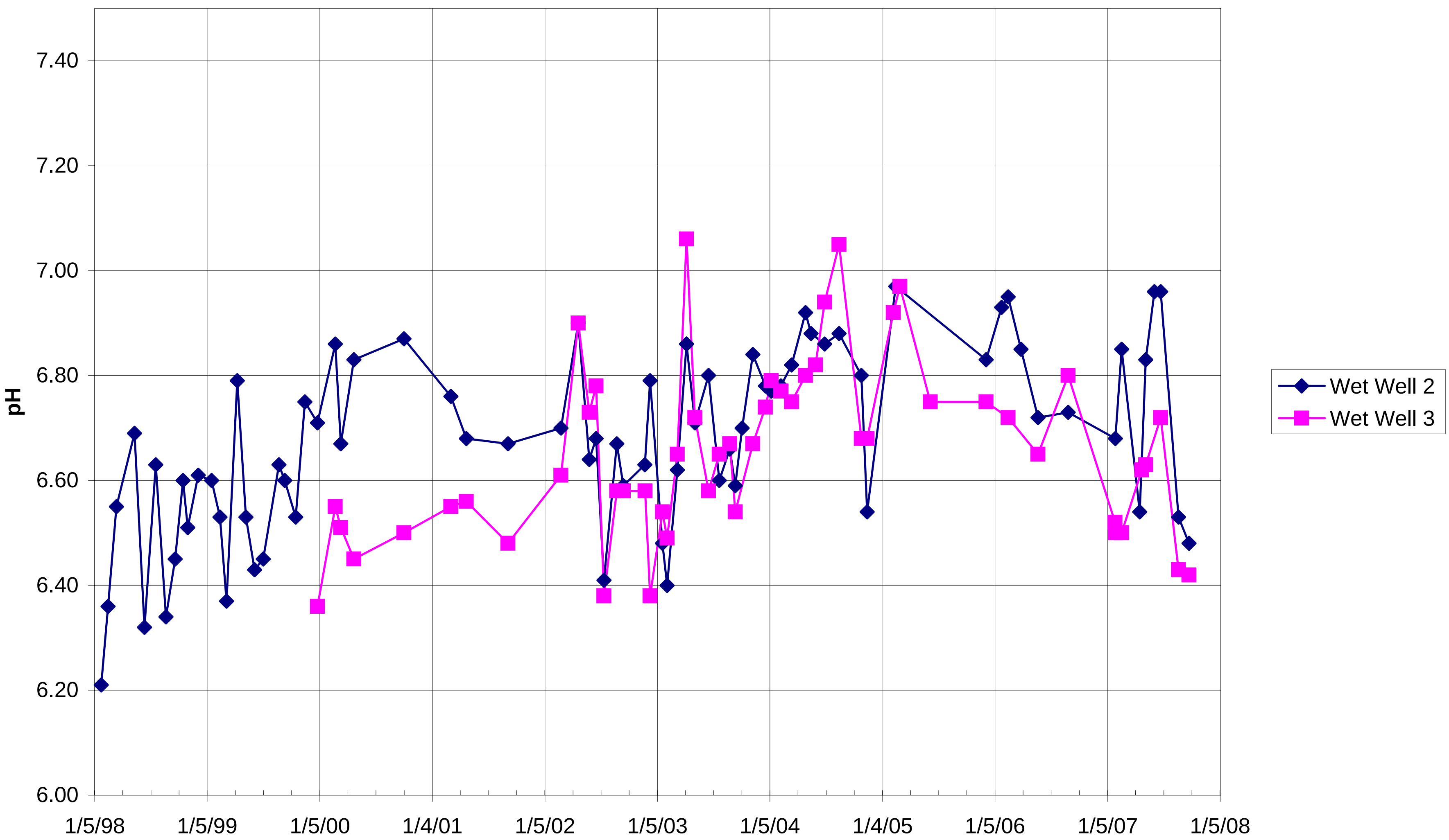


FIGURE 2.20b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - pH DATA

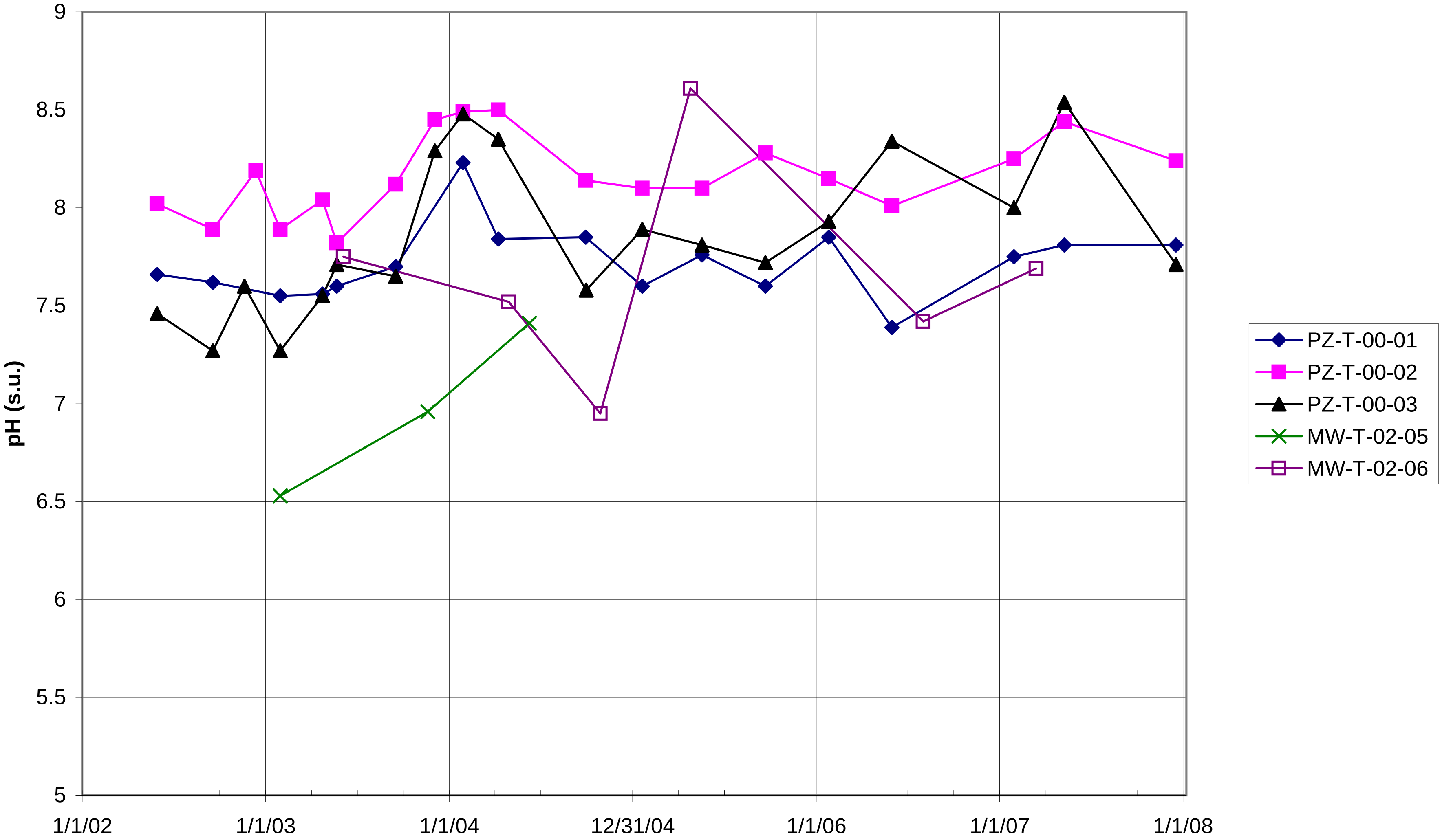


FIGURE 2.20c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - pH

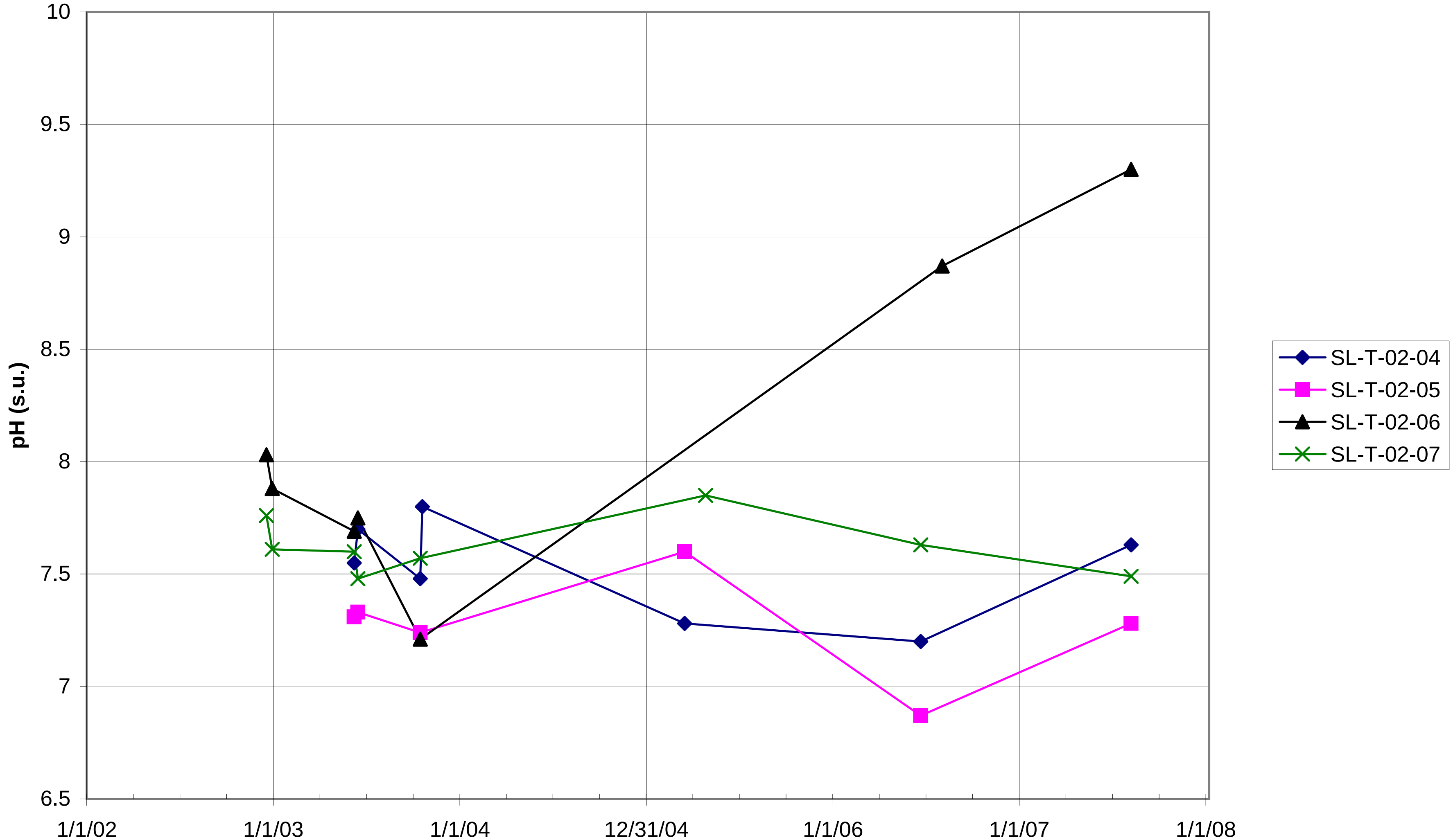


FIGURE 2.21a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - ALKALINITY (Non-detectable analyses plotted as zero)

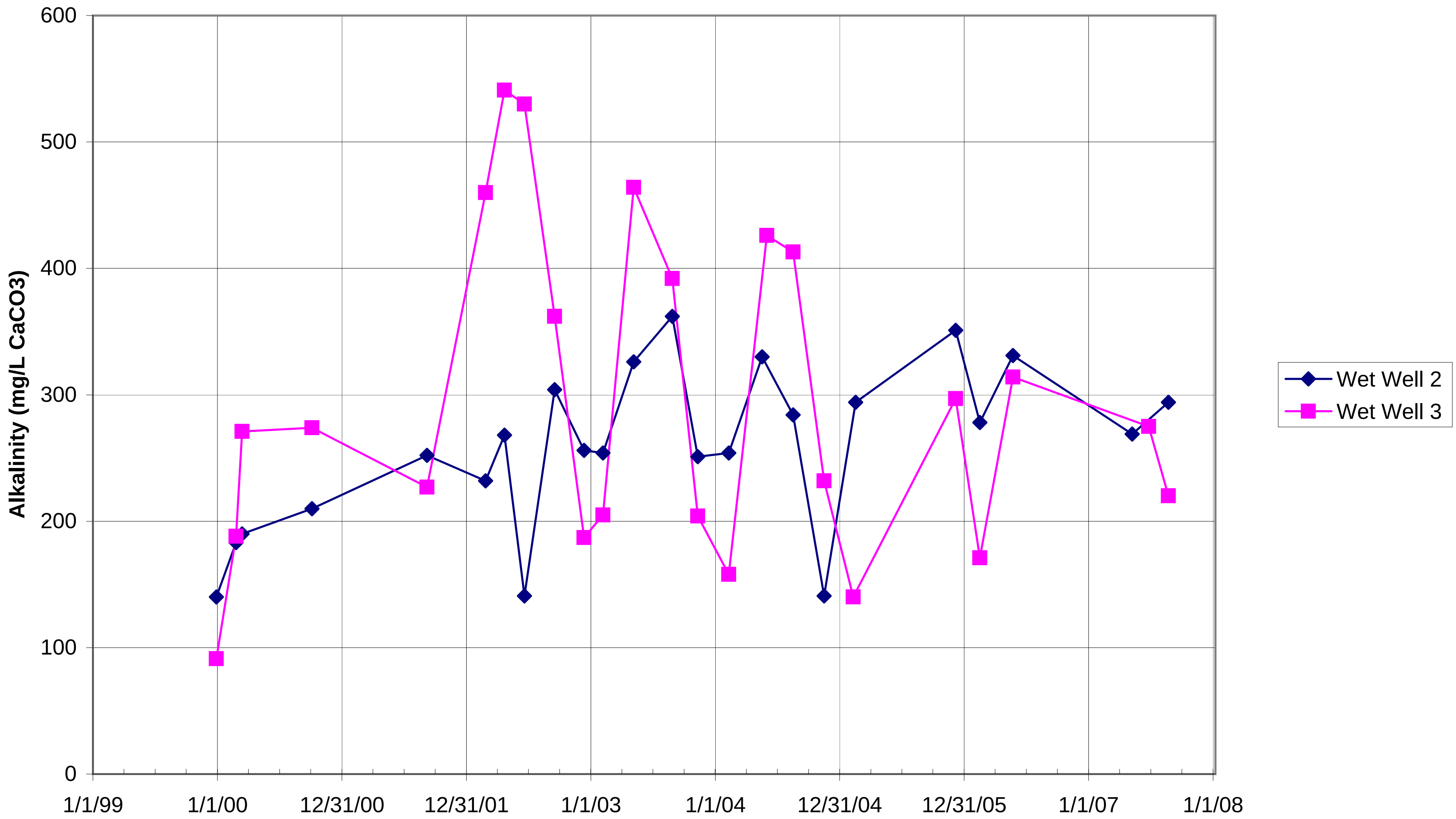


FIGURE 2.21b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - ALKALINITY DATA
(Non-detectable analyses plotted as zero)

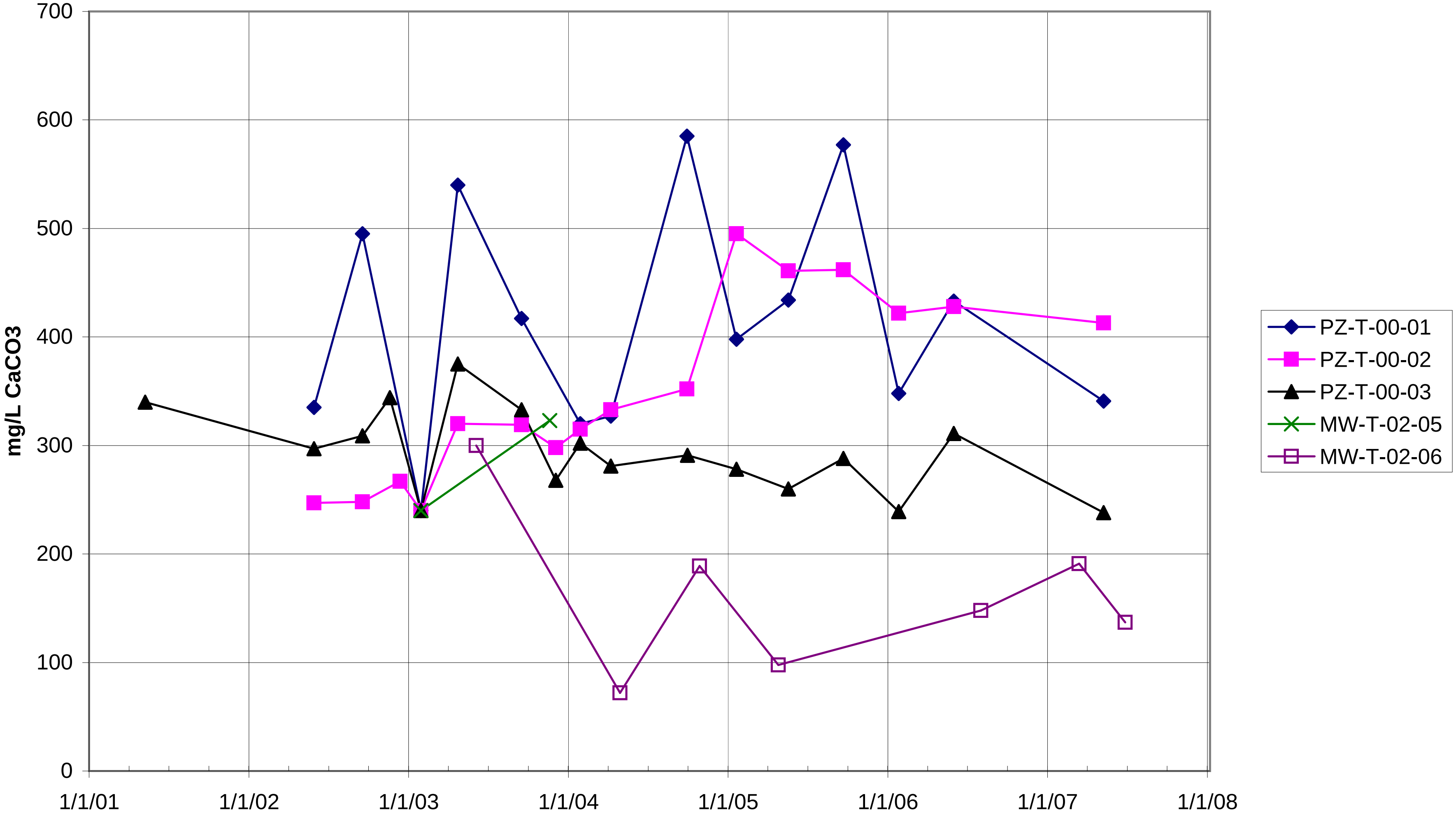


FIGURE 2.21c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - FIELD ALKALINITY

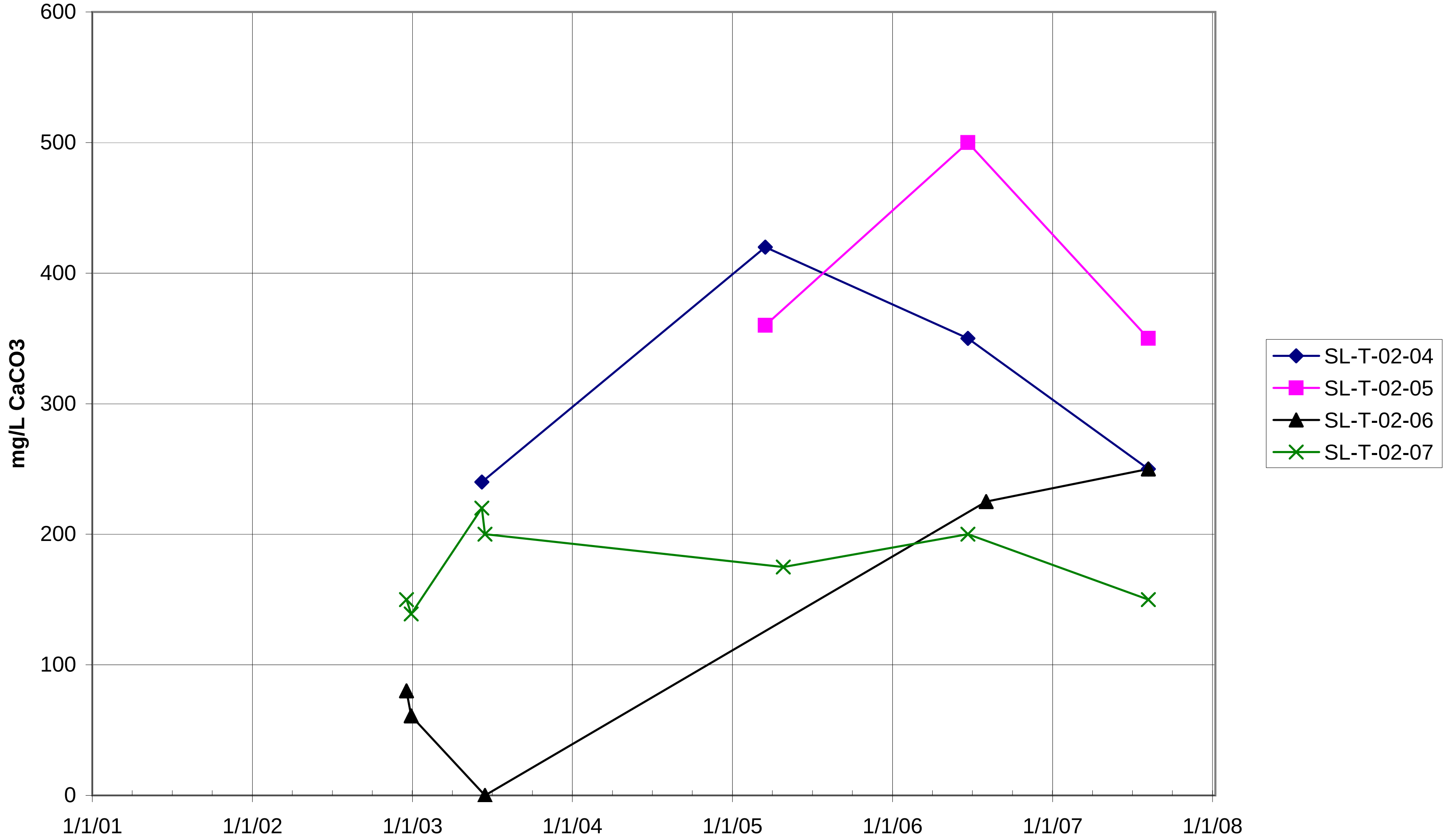


FIGURE 2.22a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - CONDUCTIVITY DATA

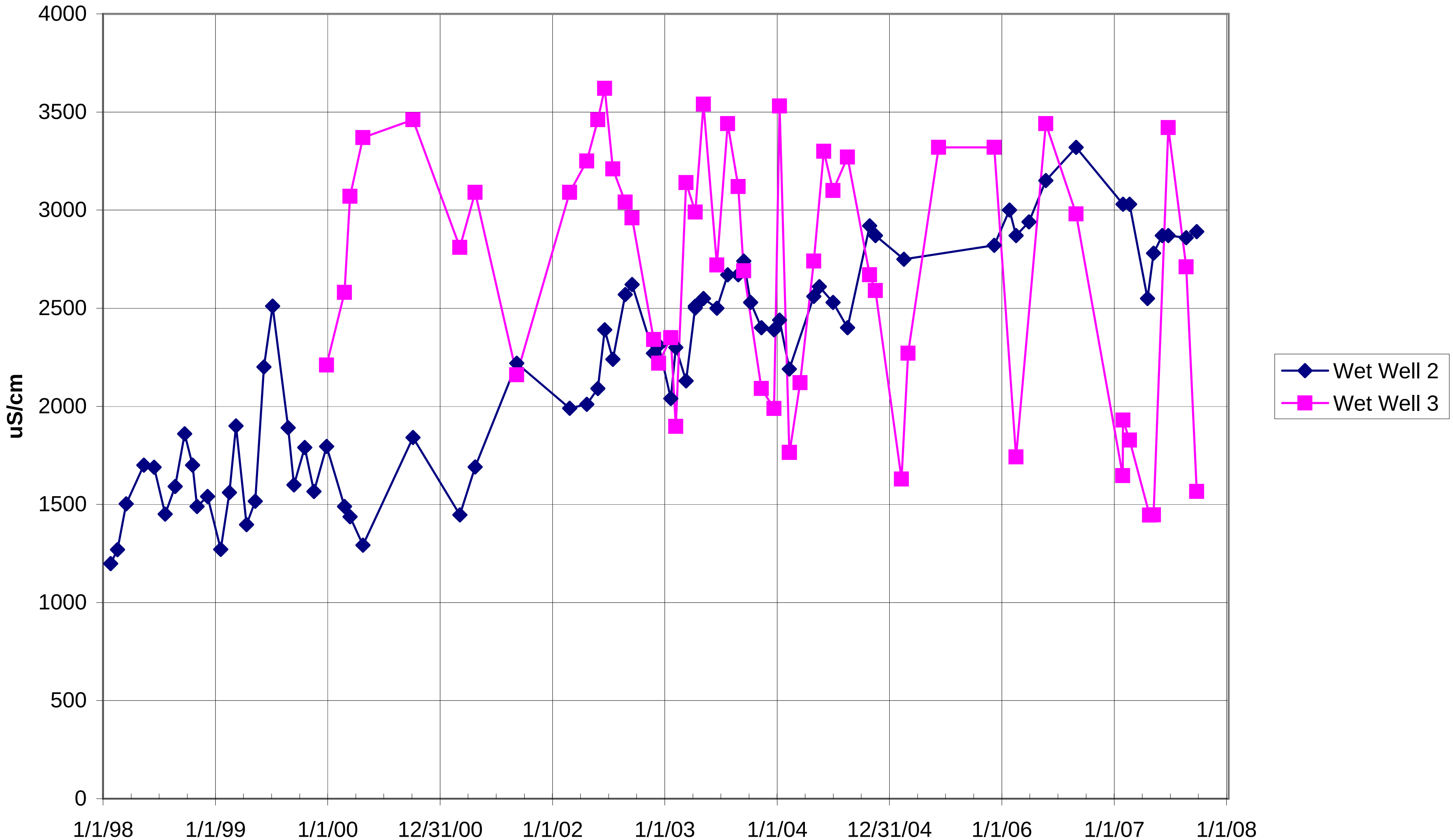


FIGURE 2.22b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - CONDUCTIVITY DATA

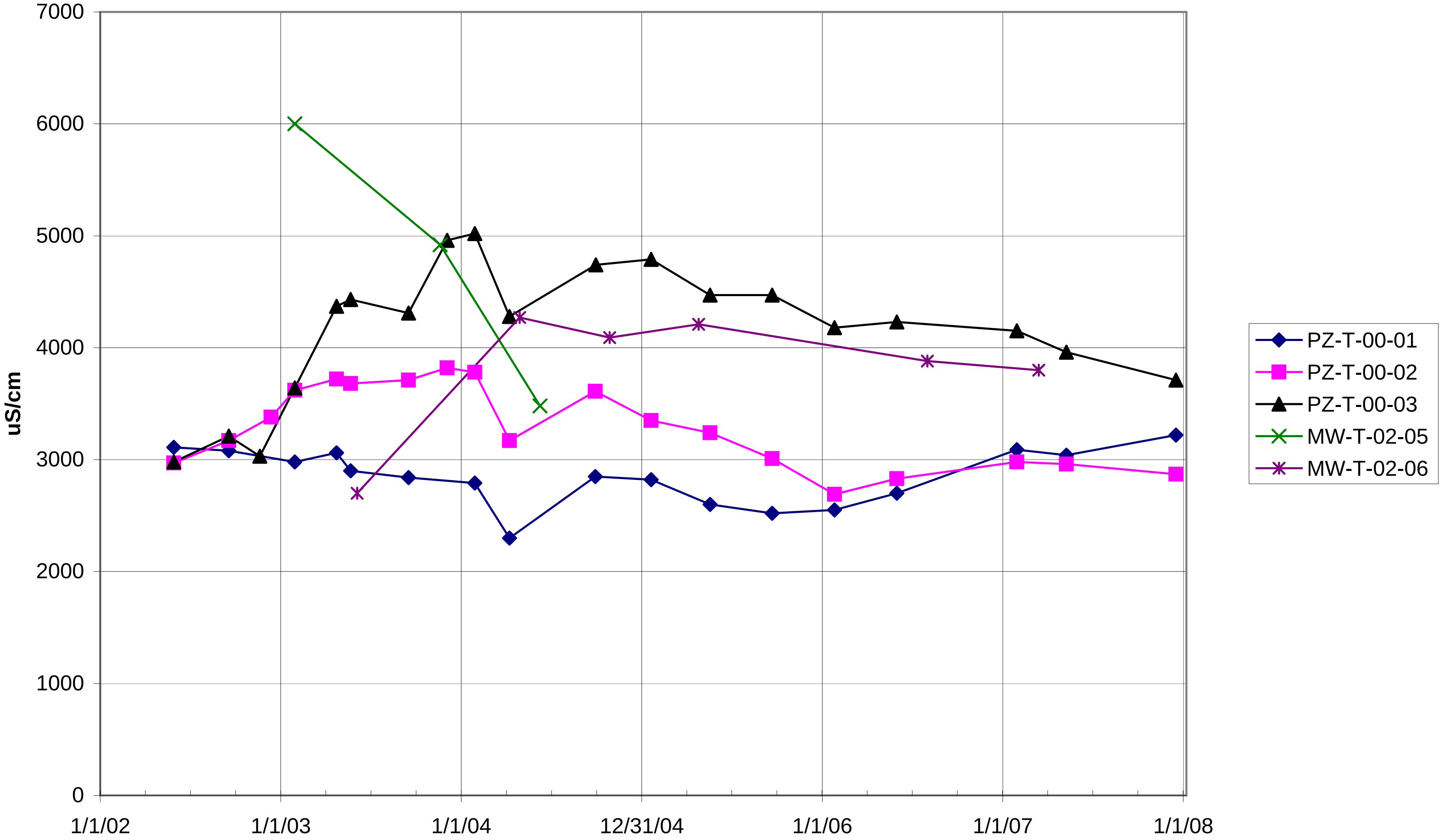


FIGURE 2.22c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - CONDUCTIVITY

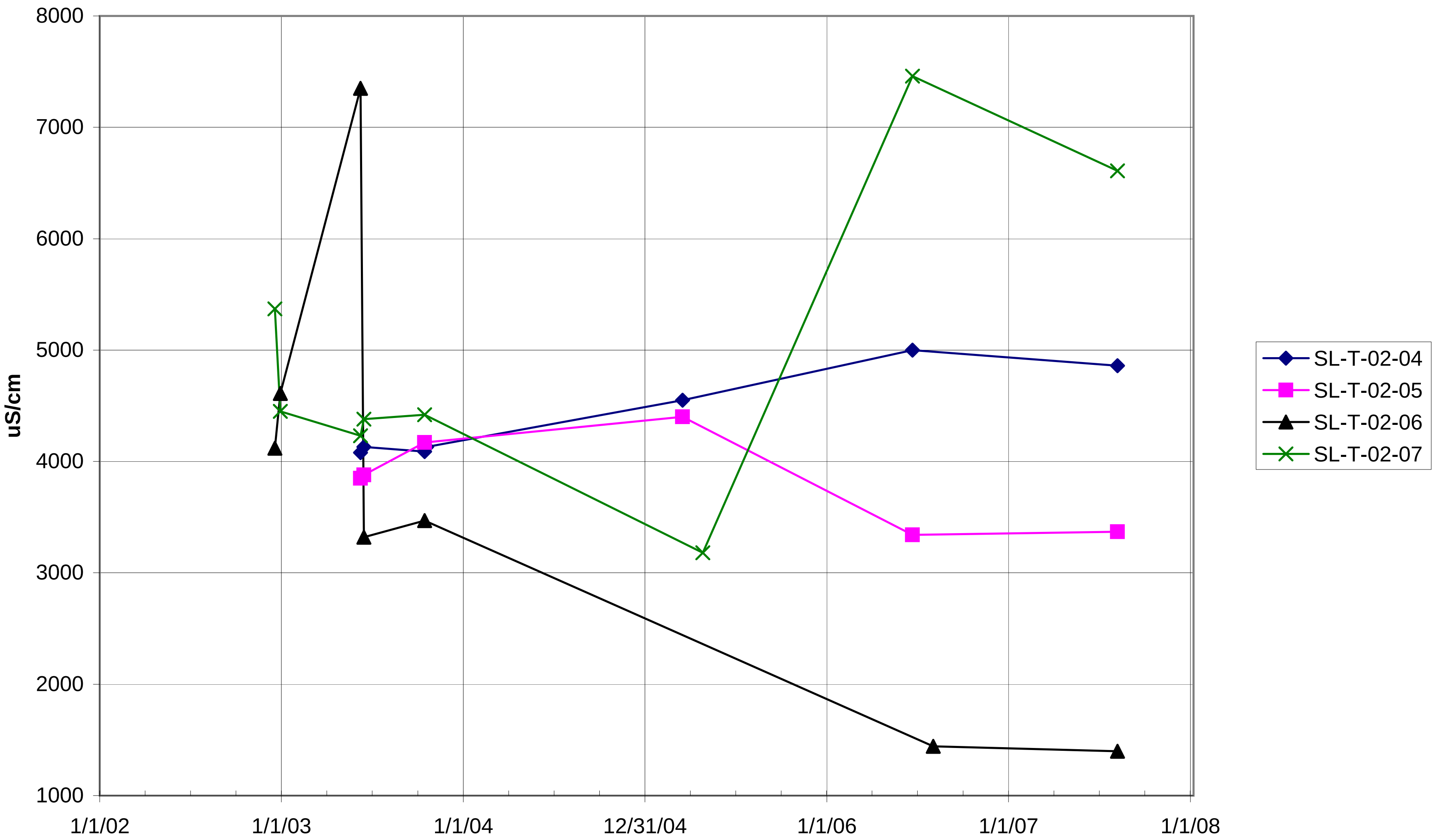


FIGURE 2.23a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - HARDNESS DATA (Non-detectable analyses plotted as zero)

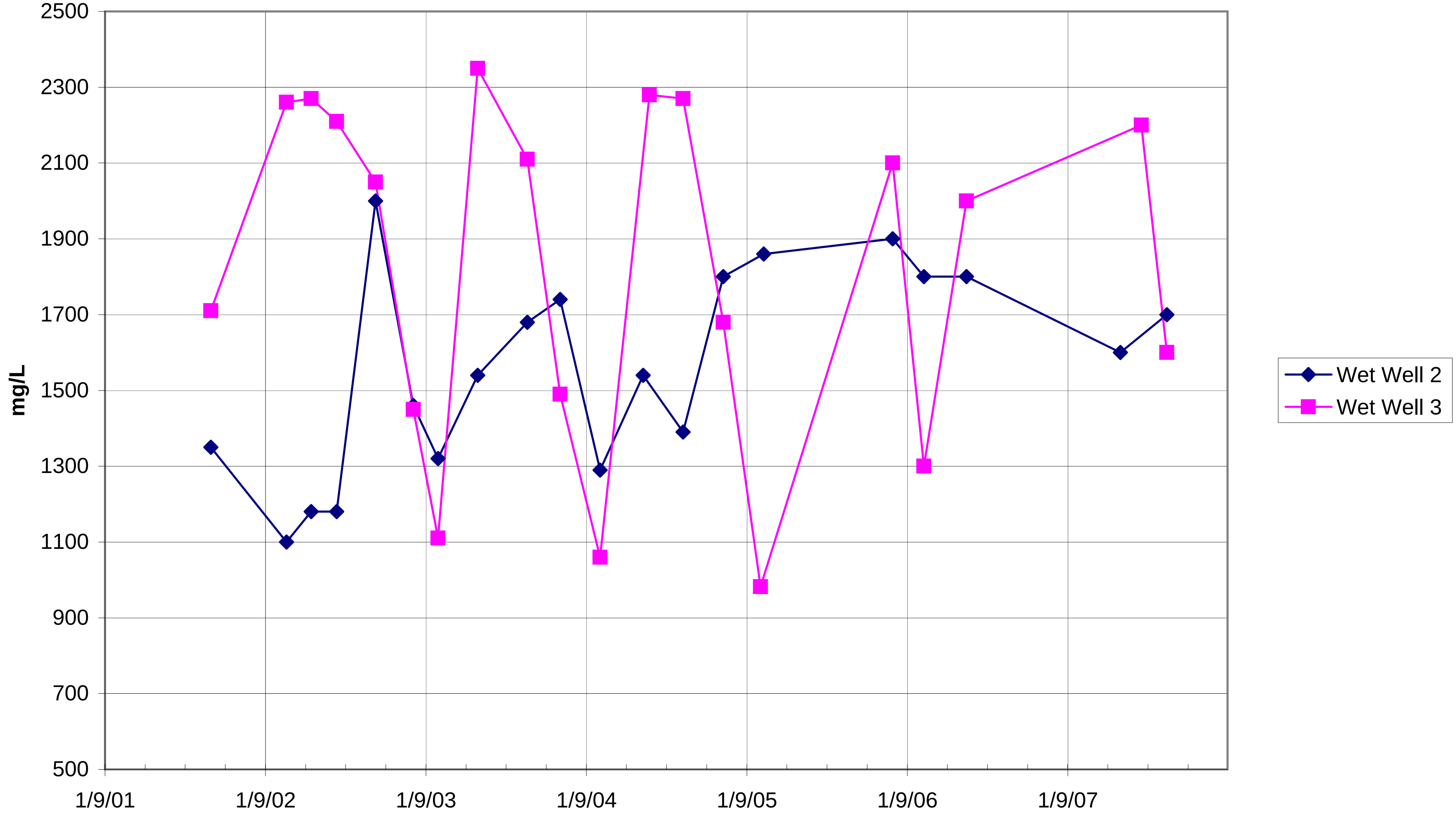


FIGURE 2.23b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - HARDNESS DATA (Non-detectable analyses plotted as zero)

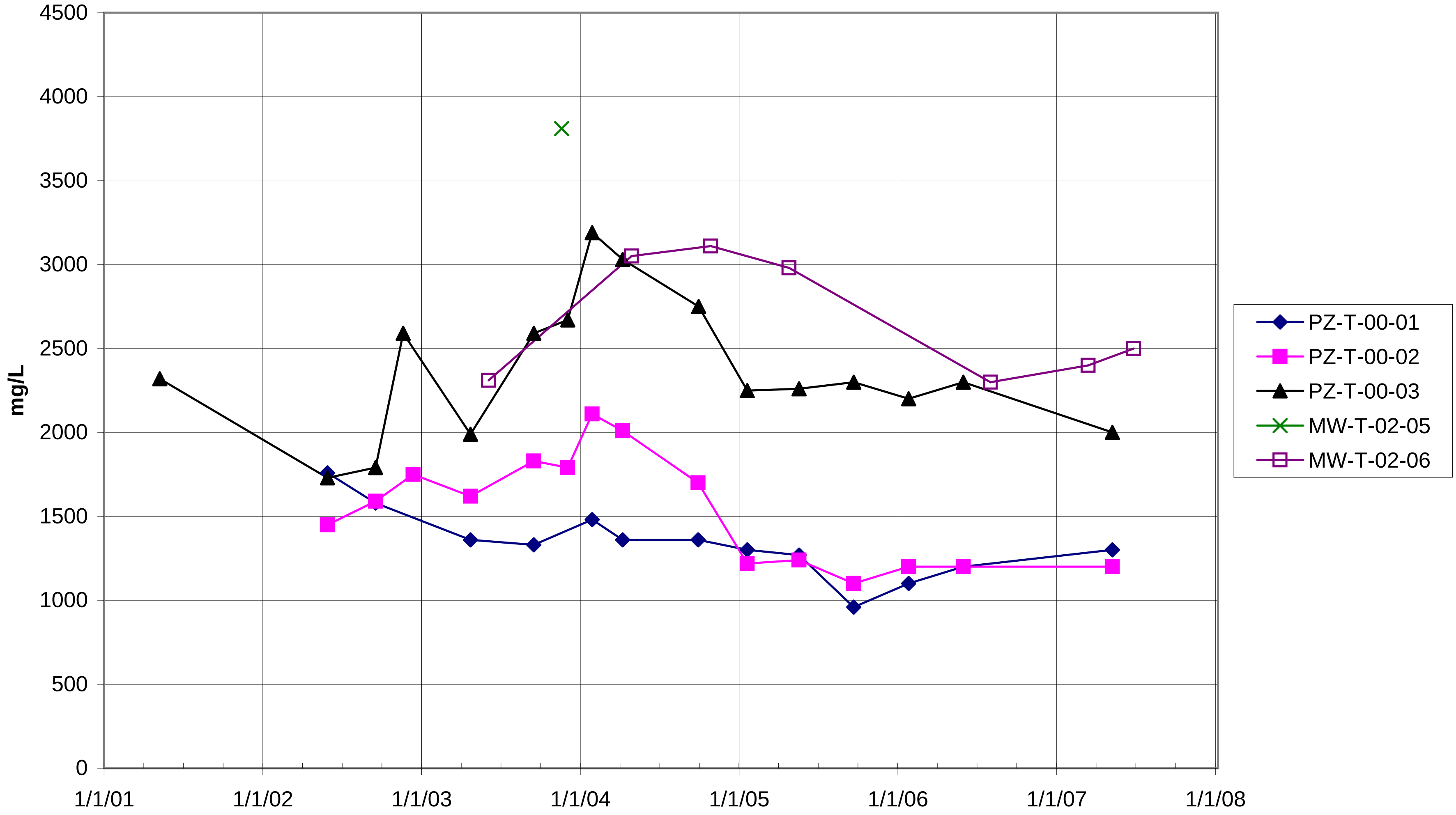


FIGURE 2.24a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - SULFATE DATA
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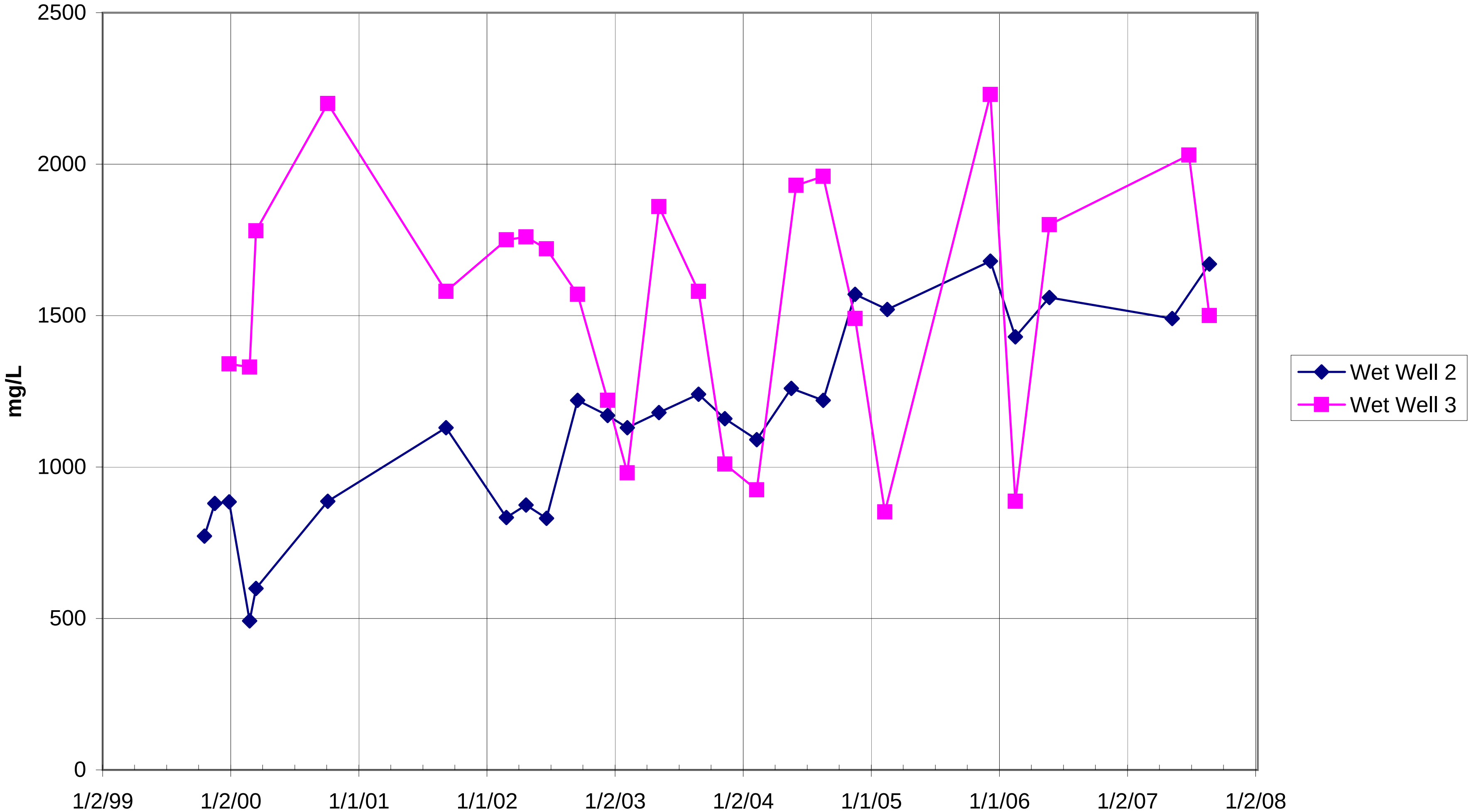


FIGURE 2.24b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - SULFATE DATA (Non-detectable analyses plotted as zero)

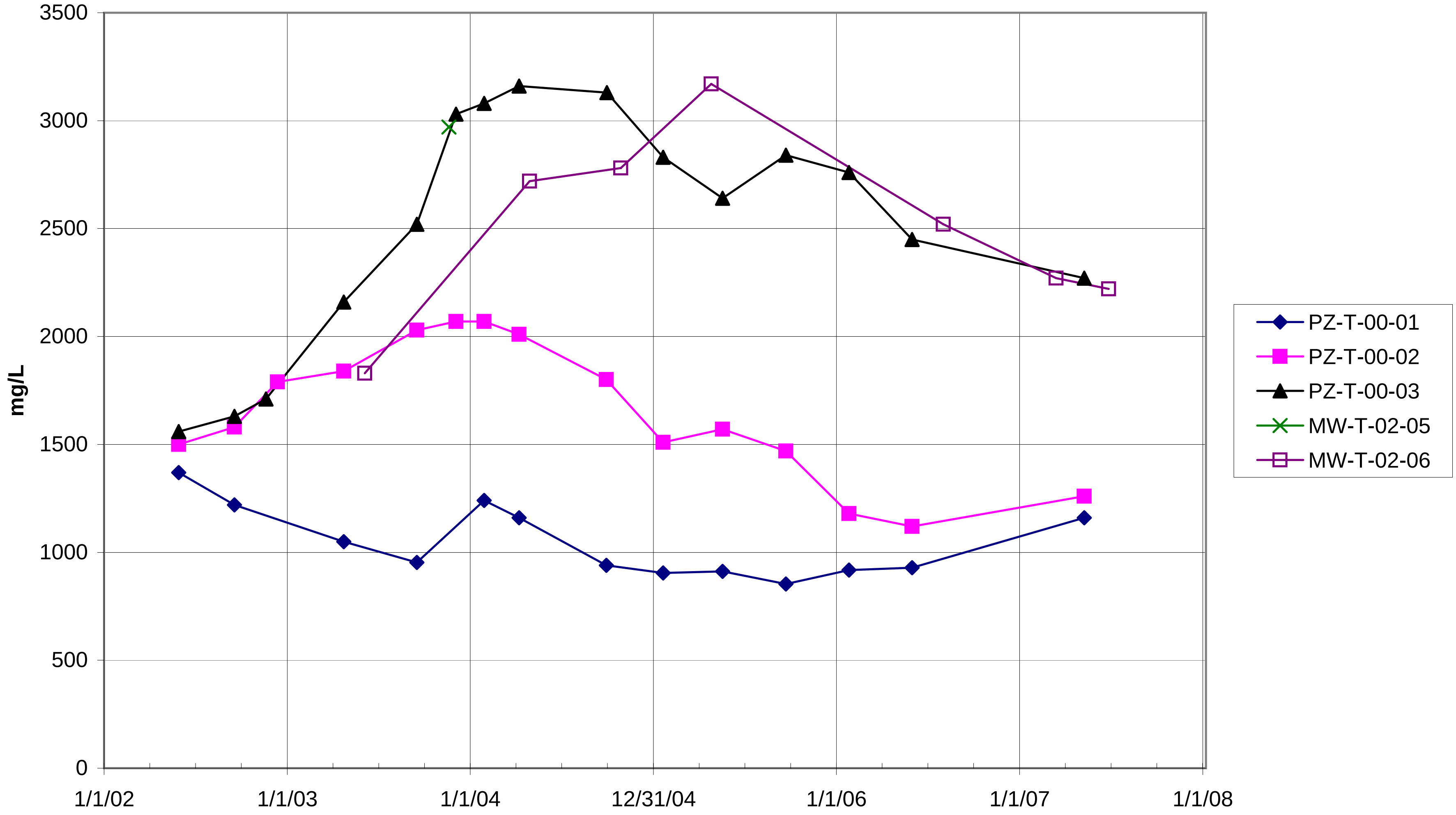


FIGURE 2.24c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS- SULFATE DATA (Non-detectable analyses plotted as zero)

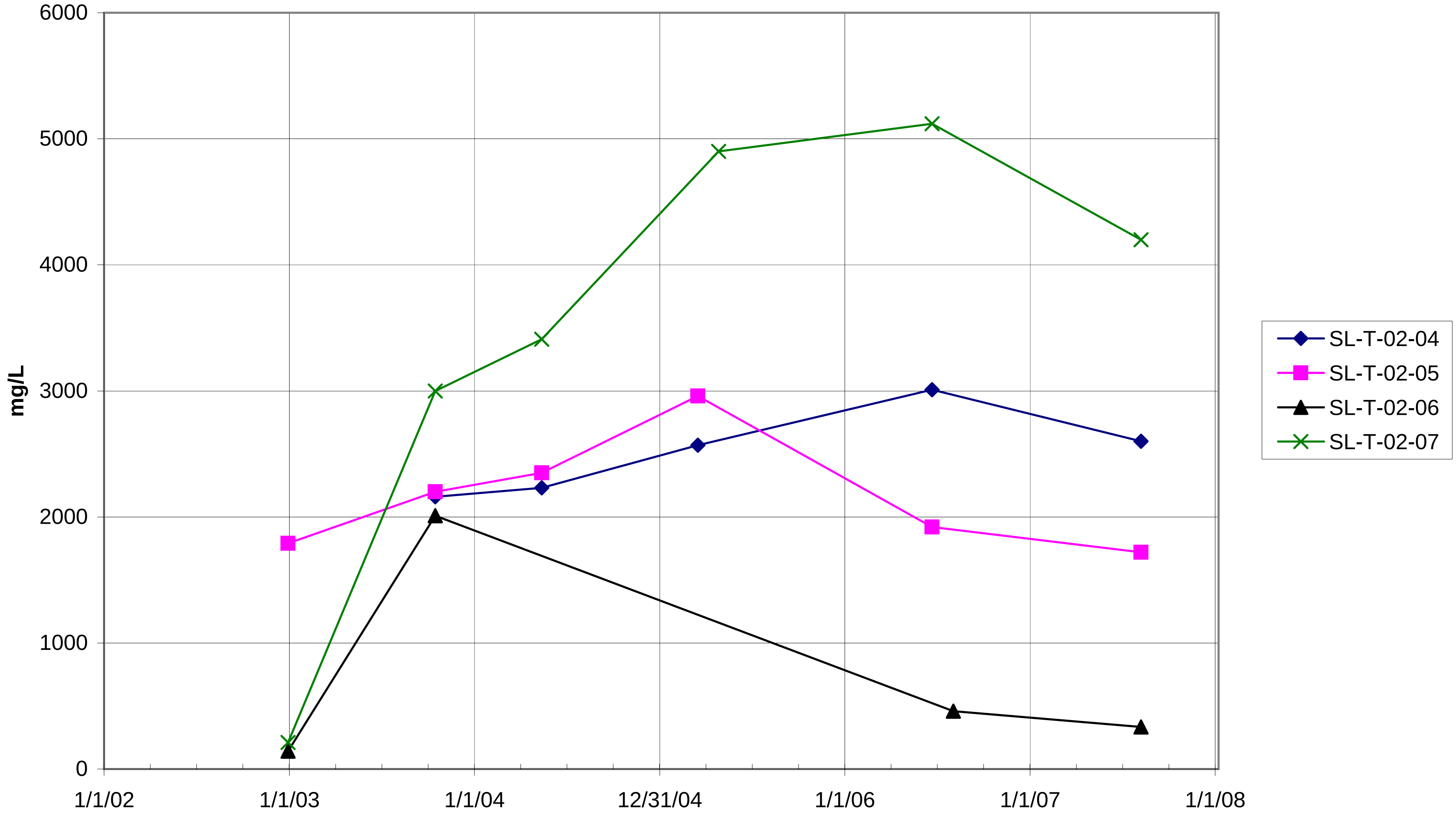


FIGURE 2.25a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS- ARSENIC DATA (Non-detectable analyses plotted as zero)

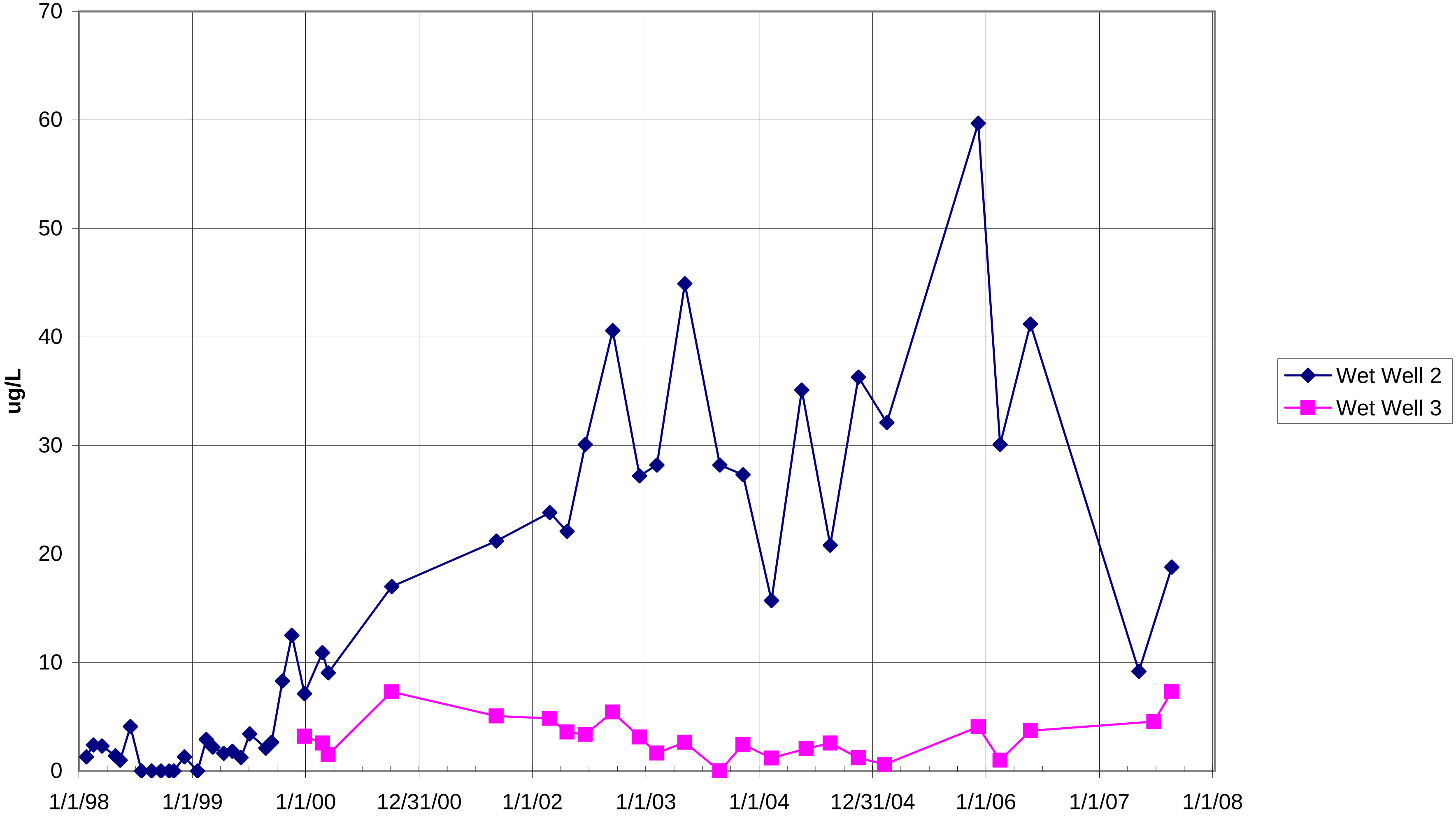


FIGURE 2.25b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - ARSENIC DATA (Non-detectable analyses plotted as zero)

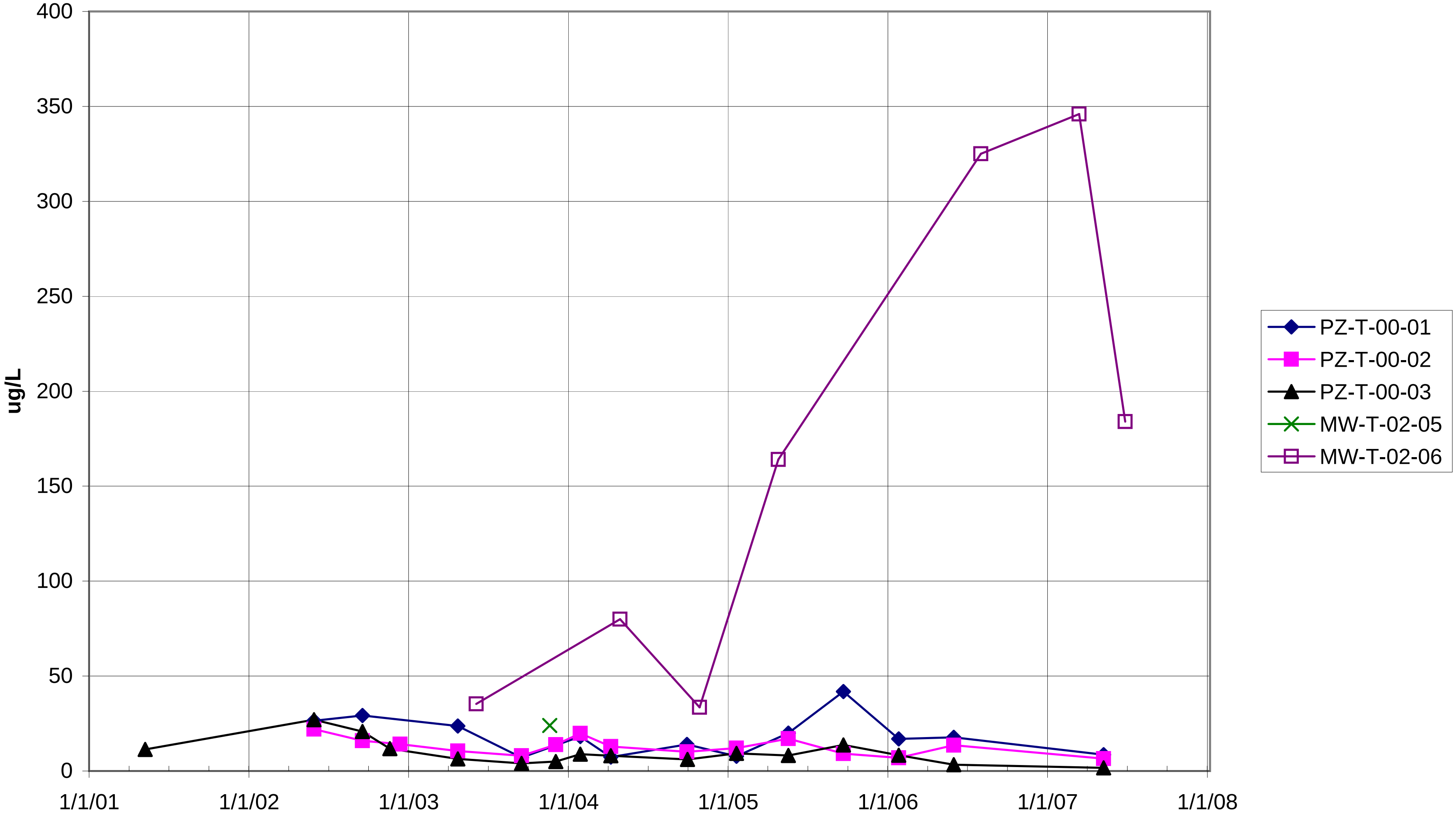


FIGURE 2.25c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - ARSENIC DATA (Non-detectable analyses plotted as zero)

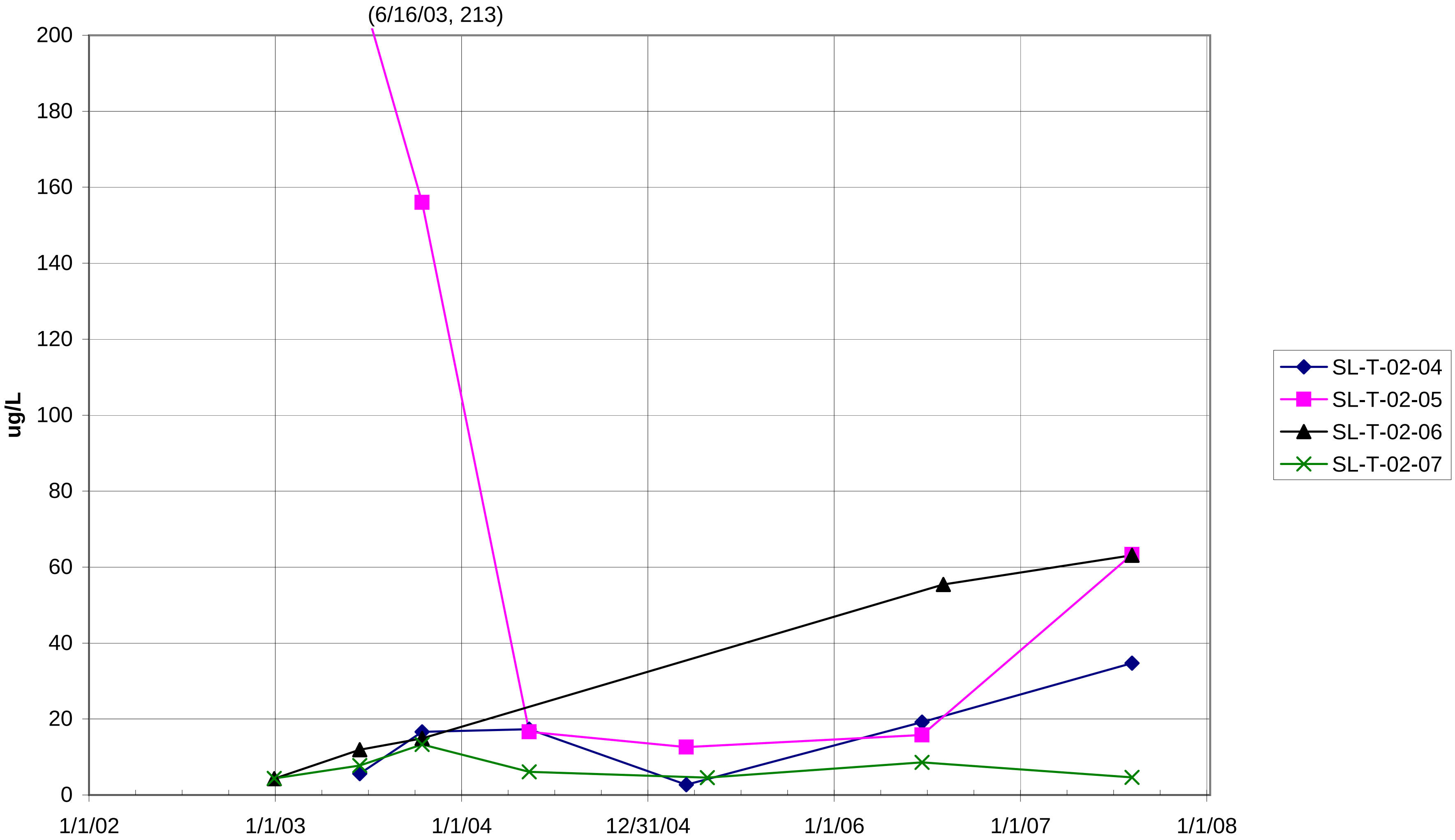


FIGURE 2.26a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - ZINC DATA (Non-detectable analyses plotted as zero)

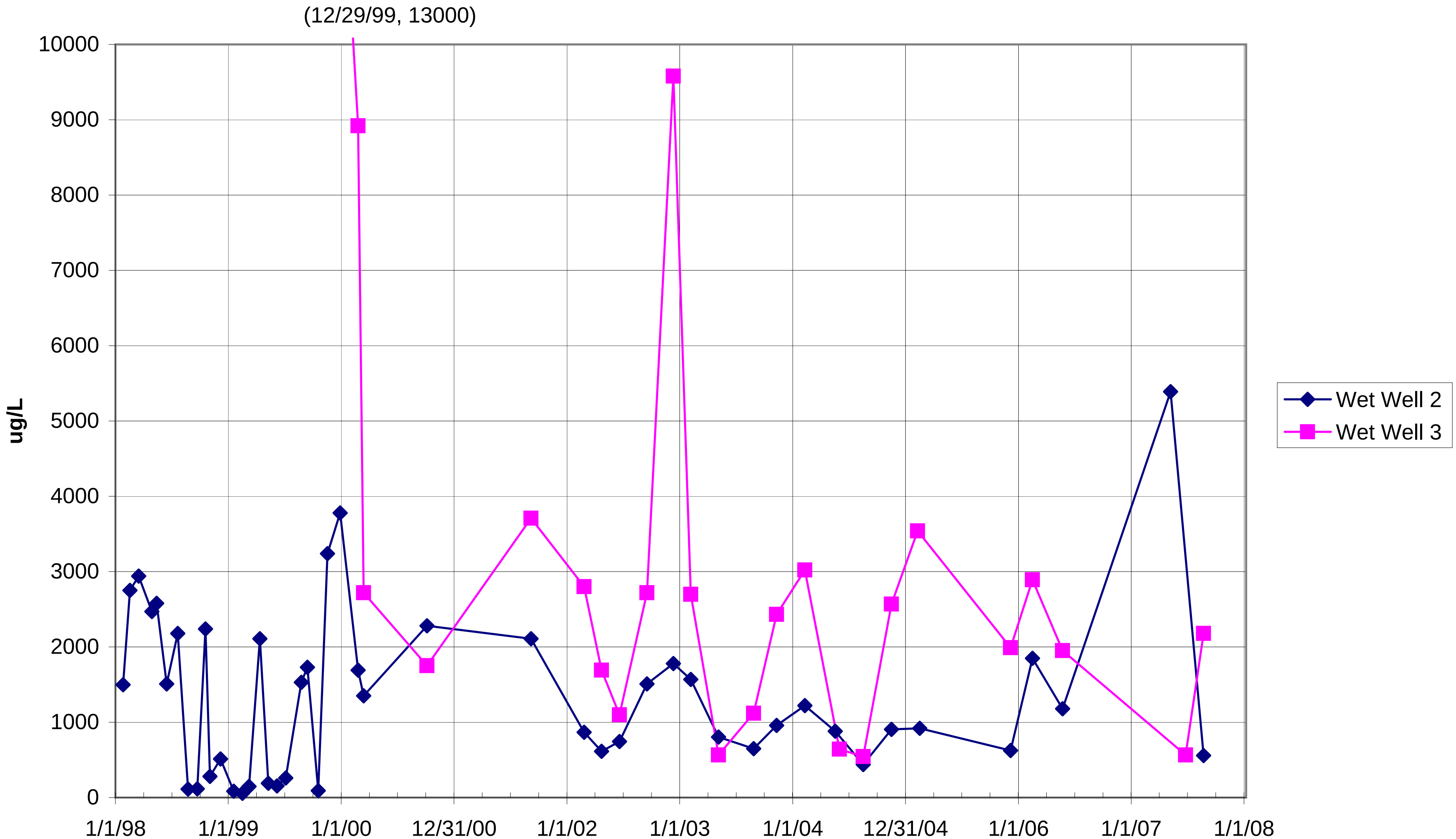


FIGURE 2.26b GREENS CREEK TAILINGS INTERNAL MONITORING SITES:
TAILINGS COMPLETIONS - ZINC DATA
(Non-detectable analyses plotted as zero)

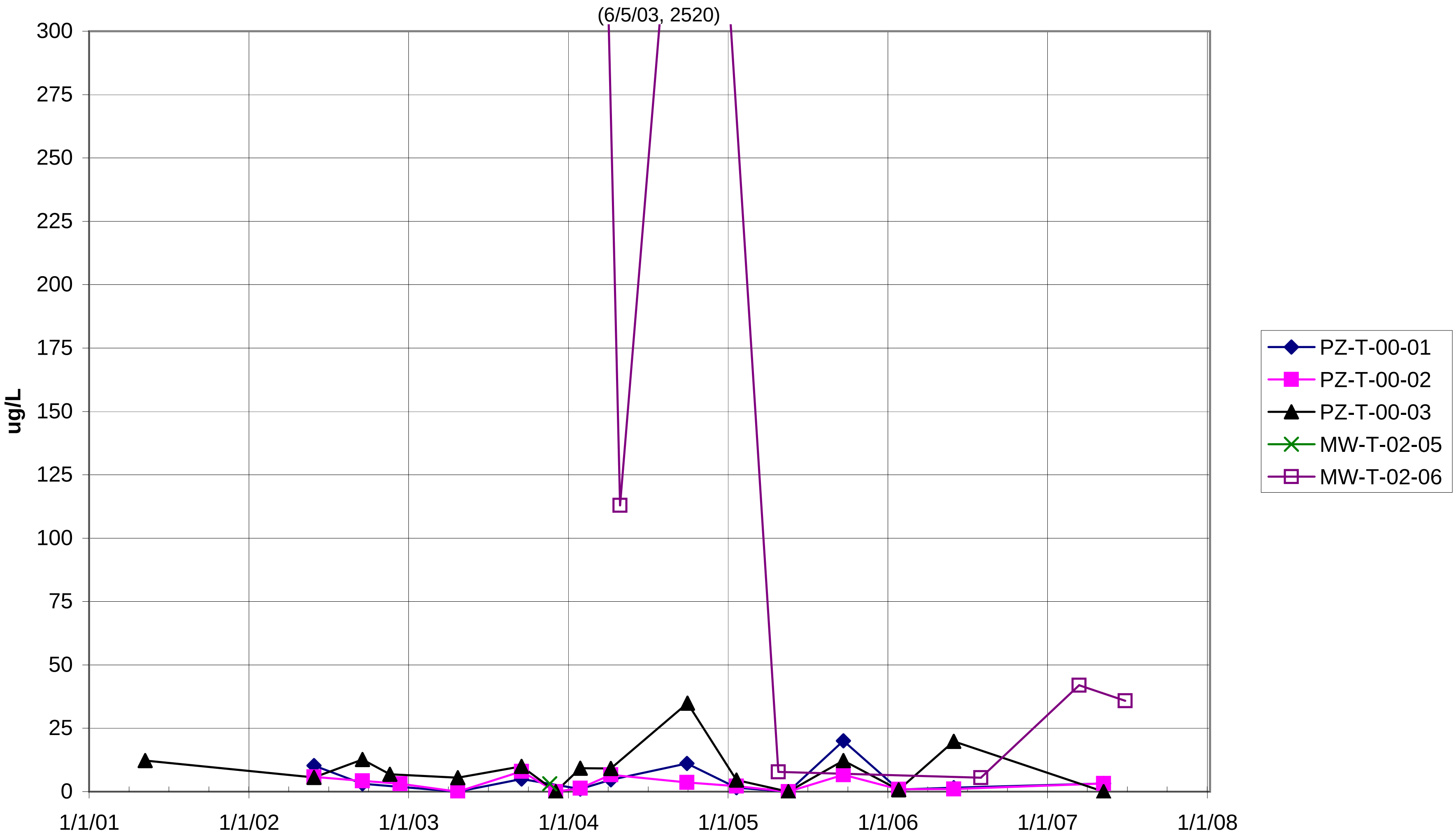


FIGURE 2.26c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - ZINC DATA (Primary and secondary y axis: Non-detectable analyses plotted as zero)

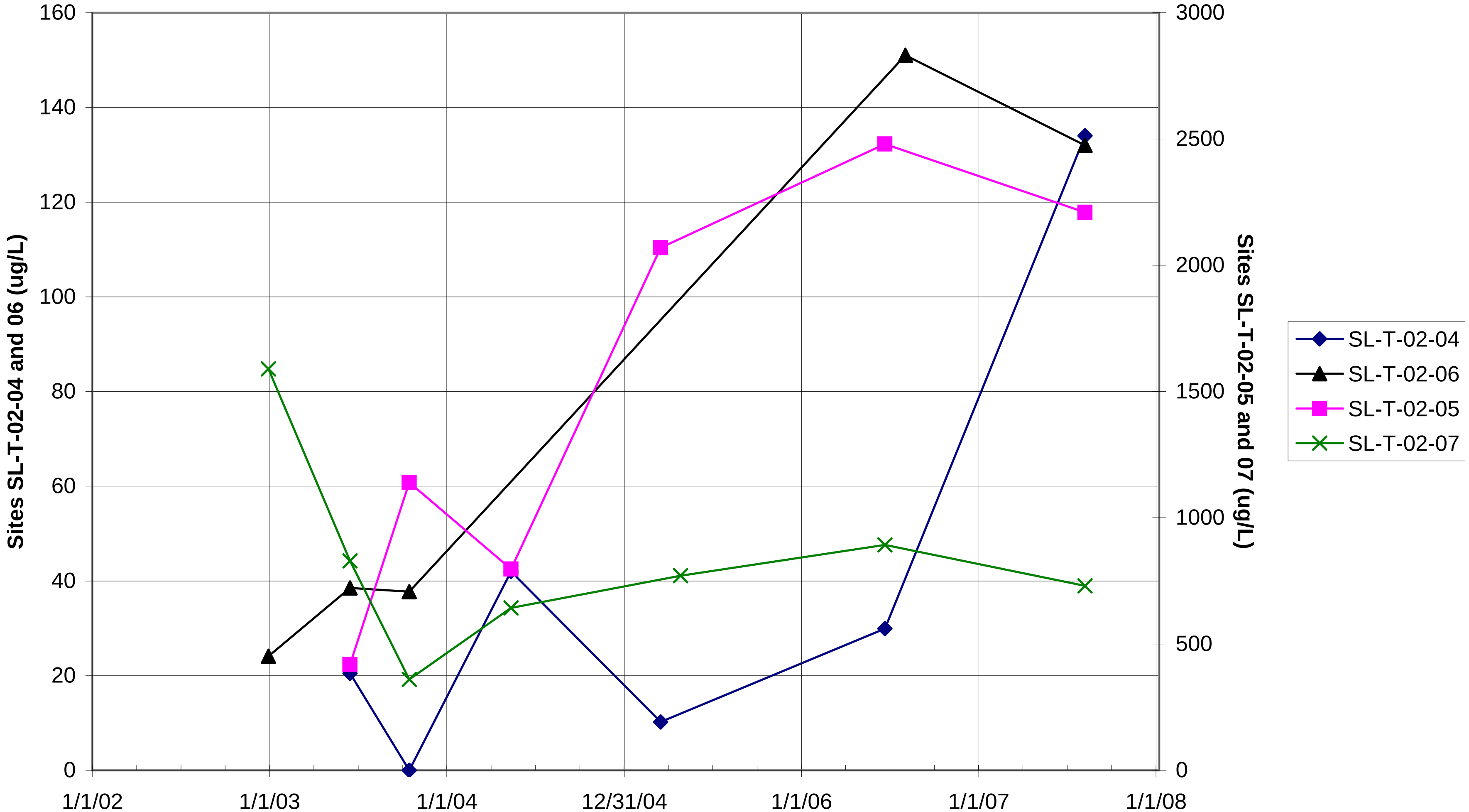


FIGURE 2.27a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - COPPER DATA (Non-detectable analyses plotted as zero)

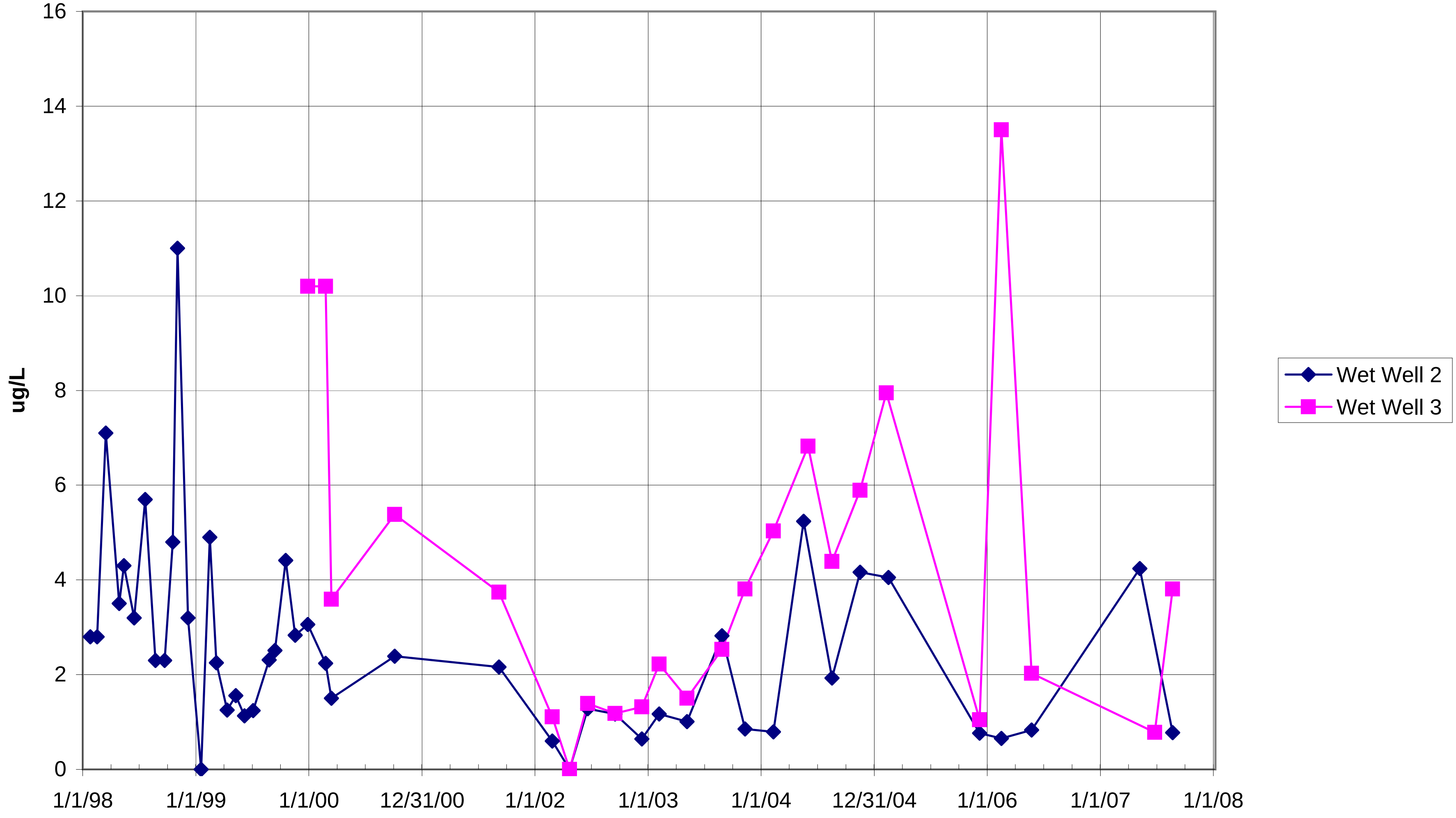


FIGURE 2.27b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - COPPER DATA (Non-detectable analyses plotted as zero)

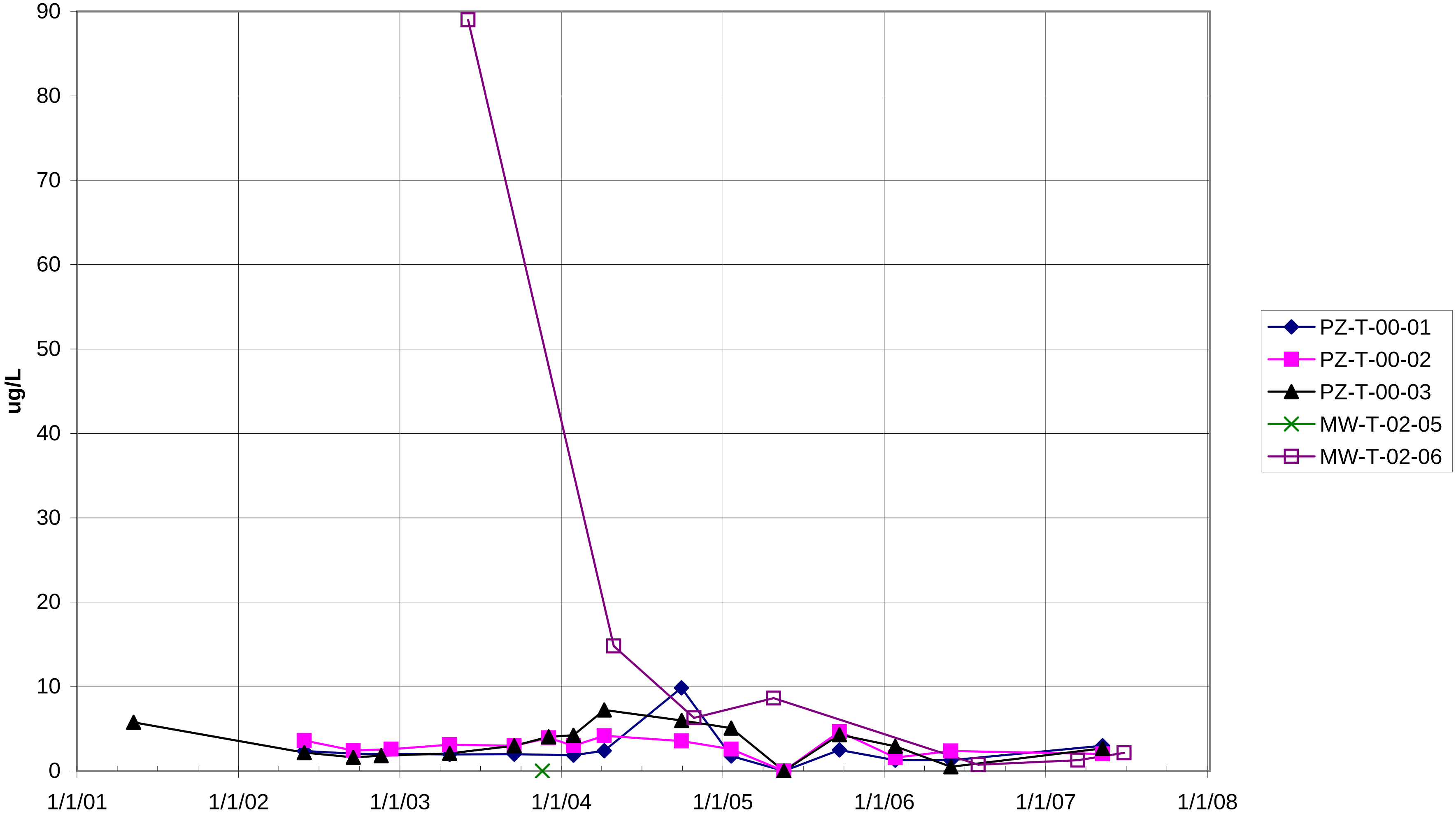


FIGURE 2.27c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - COPPER DATA (Non-detectable analyses plotted as zero)

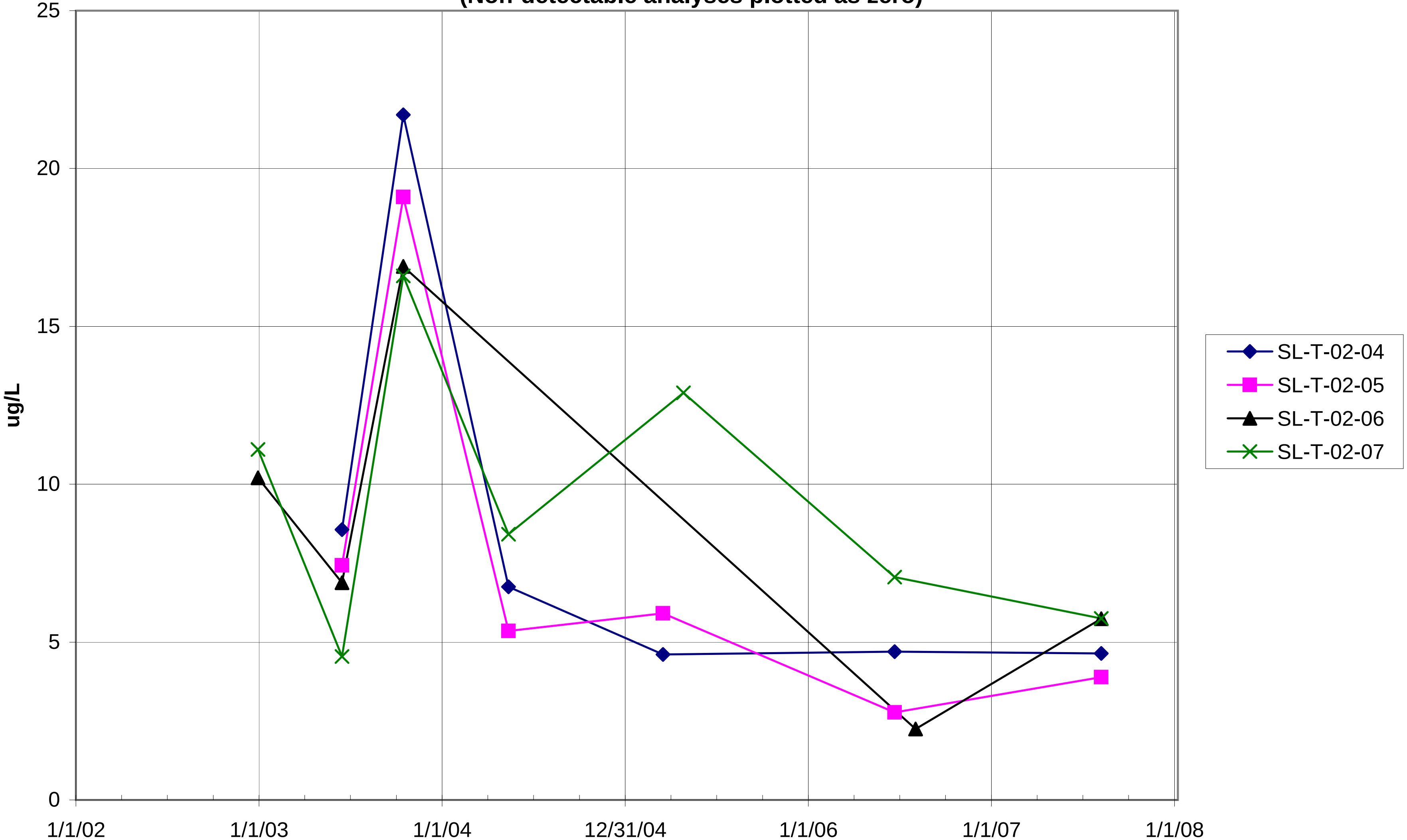


FIGURE 2.28a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - LEAD DATA (Non-detectable analyses plotted as zero)

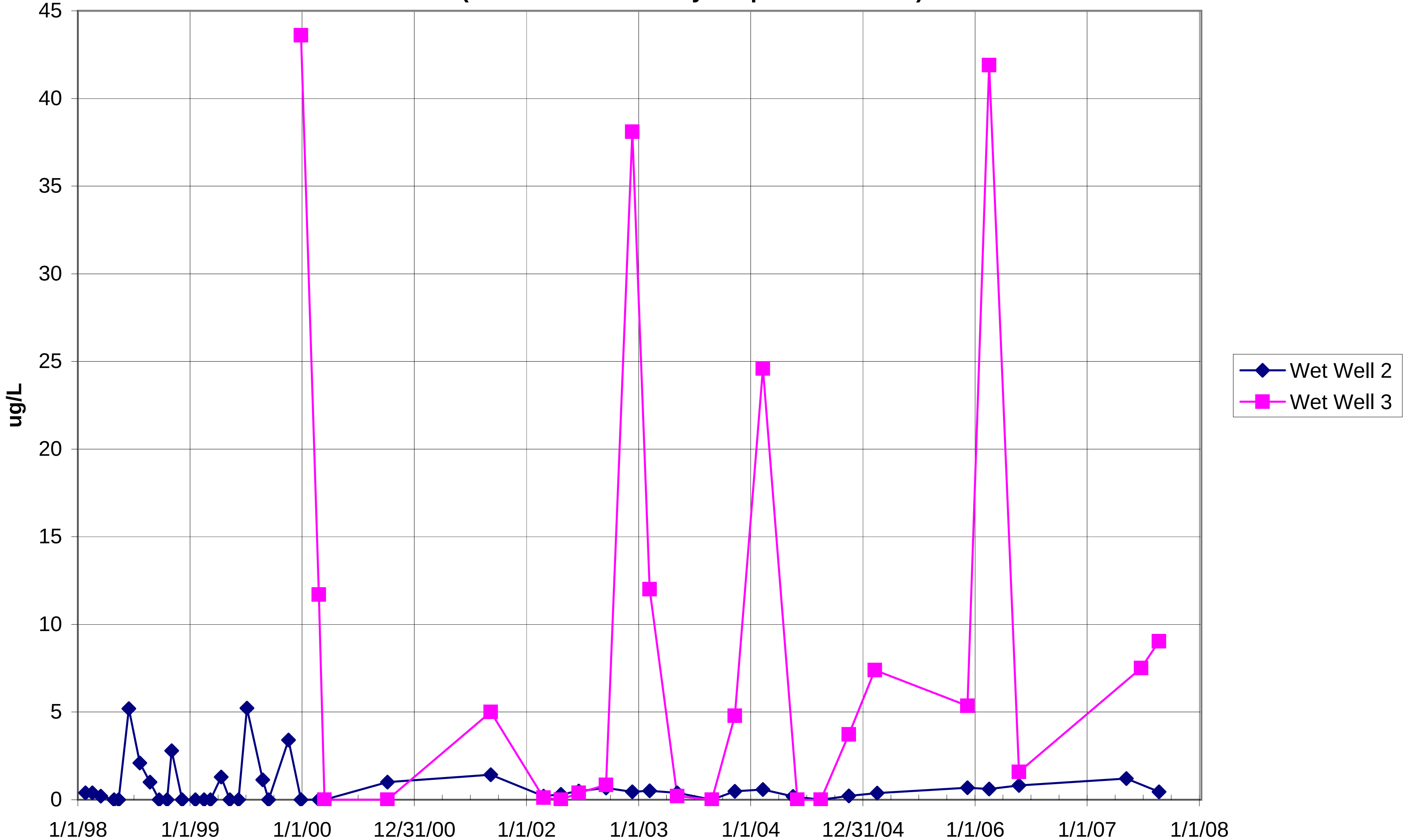


FIGURE 2.28b GREENS CREEK TAILINGS INTERNAL MONITORING SITES:
TAILINGS COMPLETIONS - LEAD DATA
(Non-detectable analyses plotted as zero)

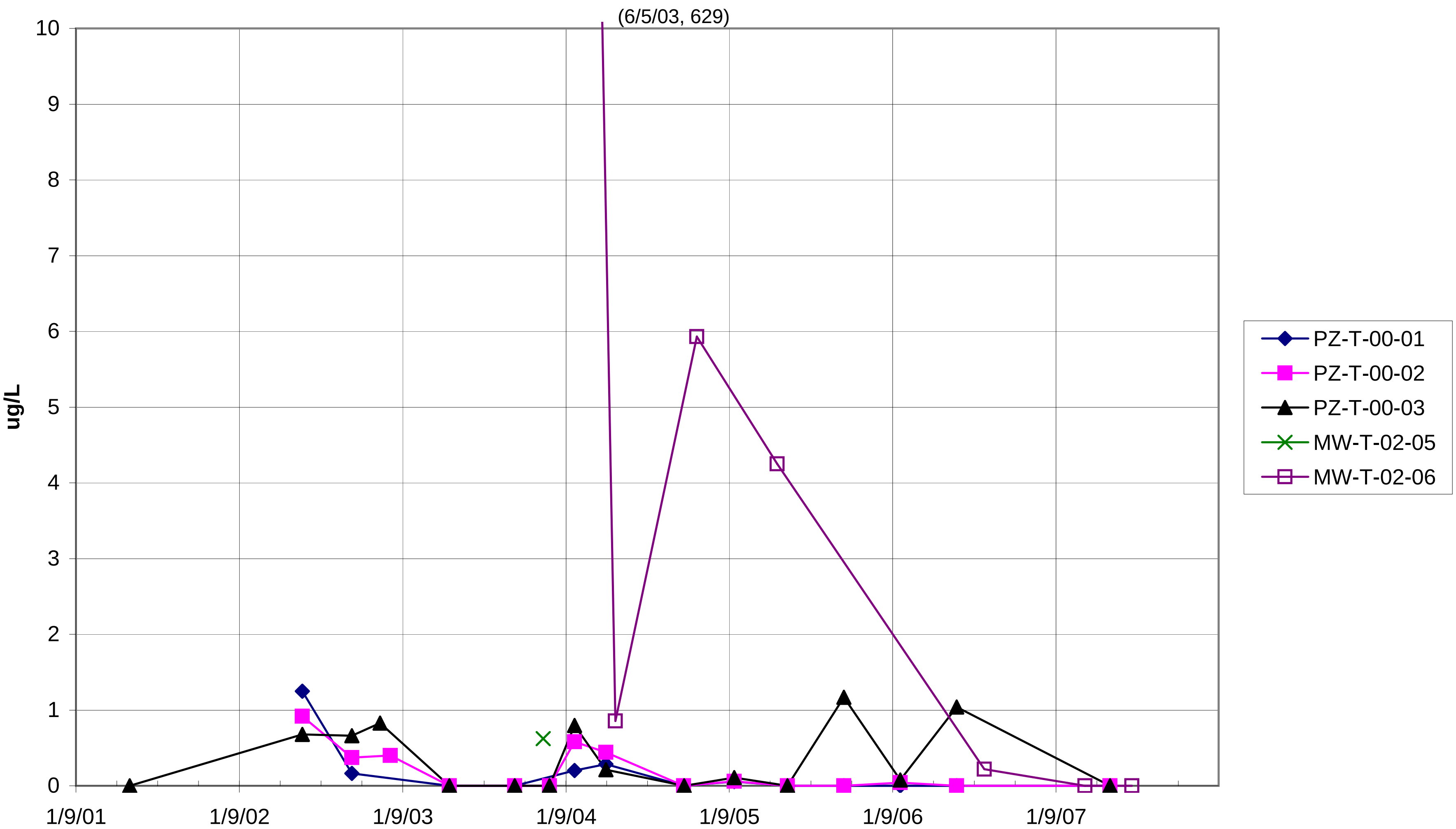


FIGURE 2.28c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - LEAD DATA (Non-detectable analyses plotted as zero)

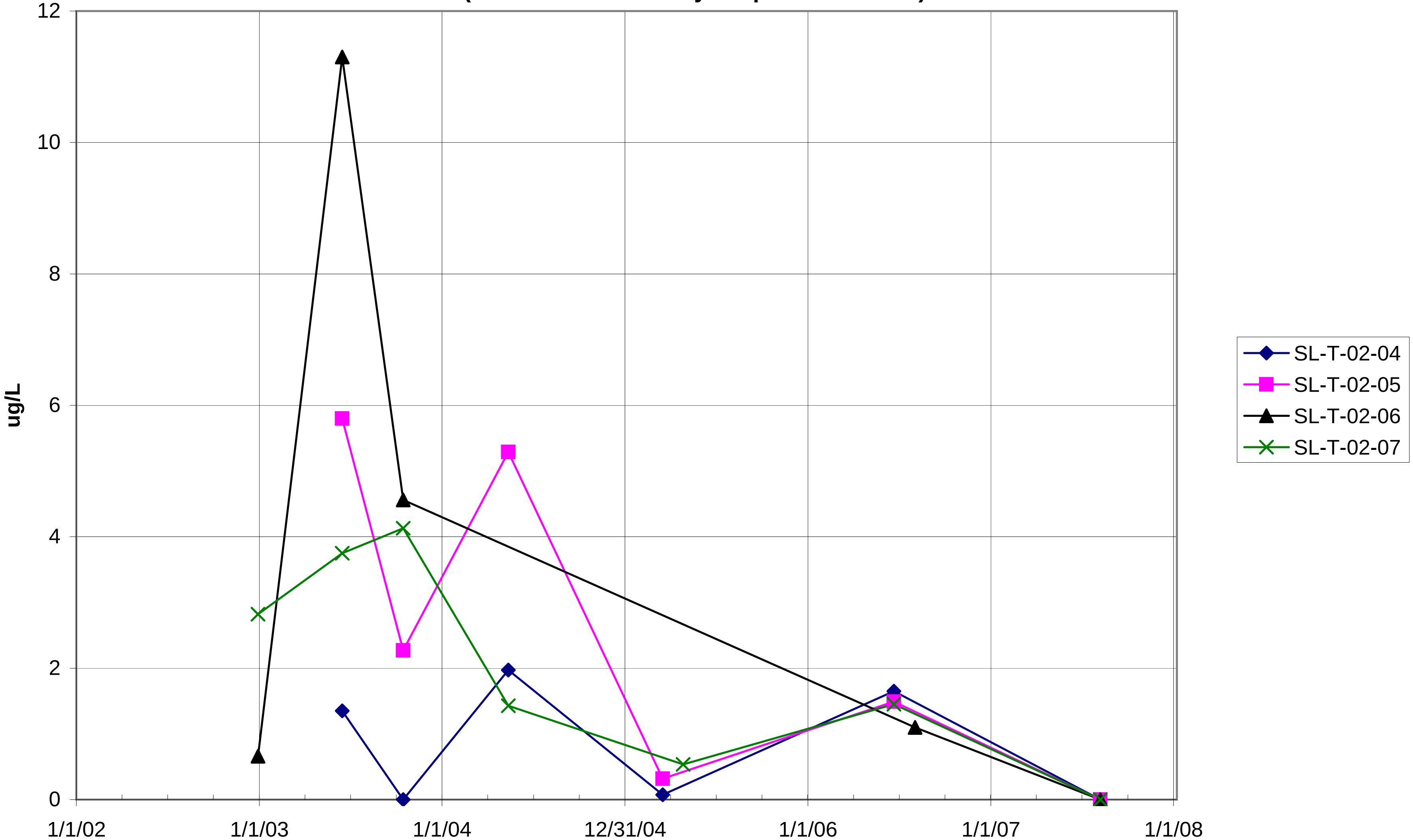


FIGURE 2.29a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - CADMIUM DATA (Non-detectable analyses plotted as zero)

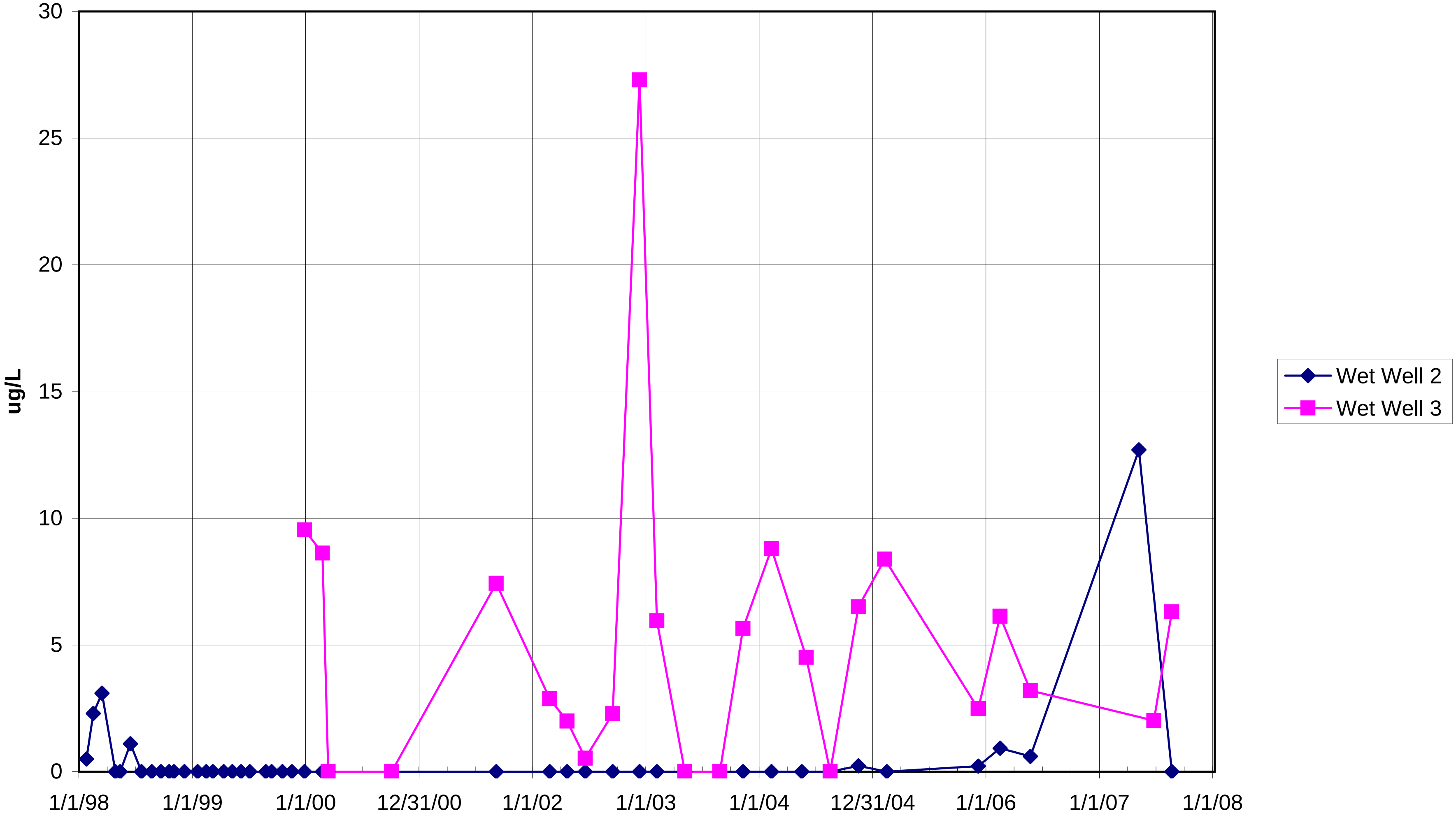


FIGURE 2.29b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - CADMIUM DATA (Non-detectable analyses plotted as zero)

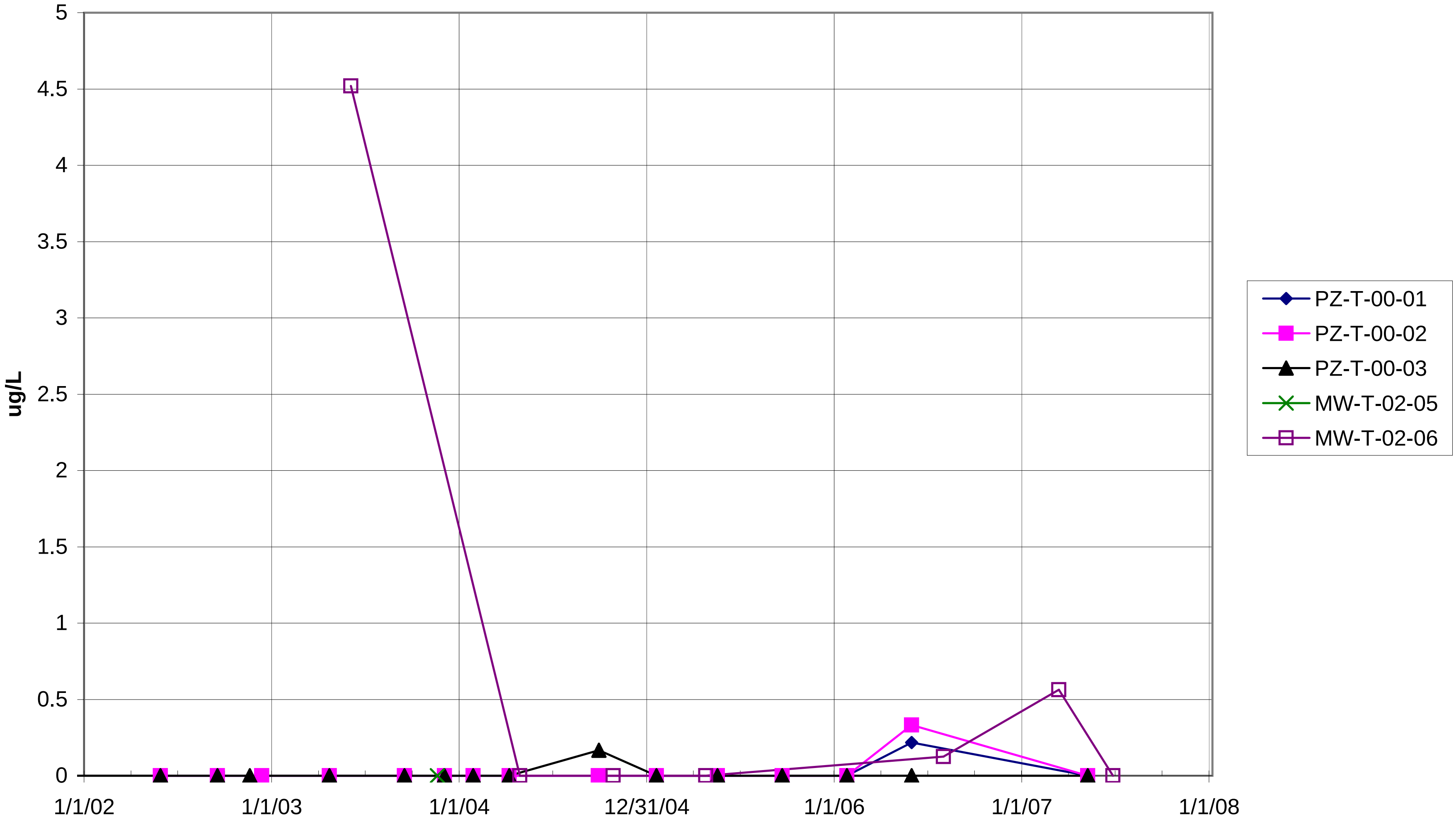


FIGURE 2.29c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - CADMIUM DATA (Non-detectable analyses plotted as zero)

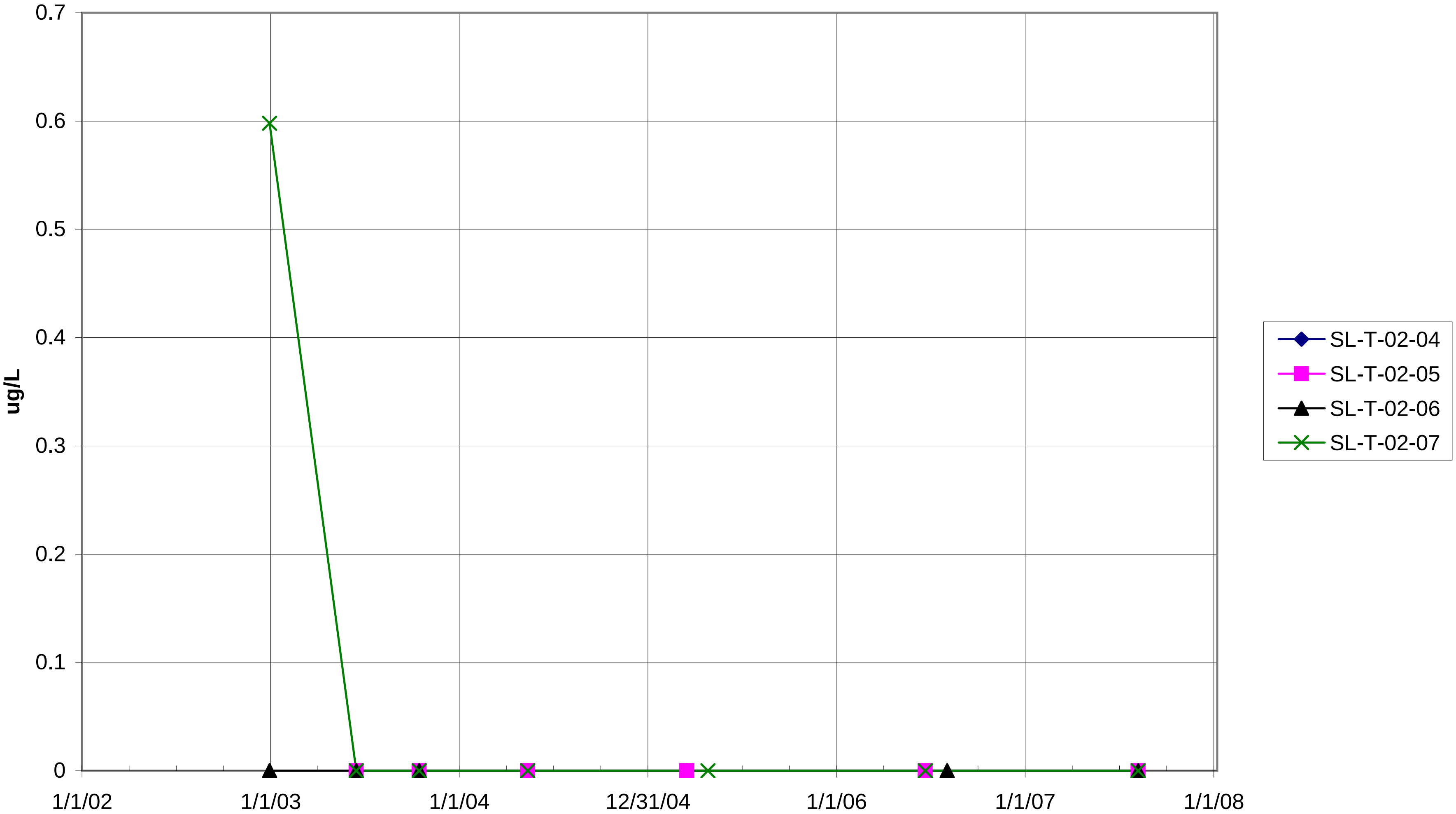


FIGURE 2.30a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - IRON DATA (Non-detectable analyses plotted as zero)

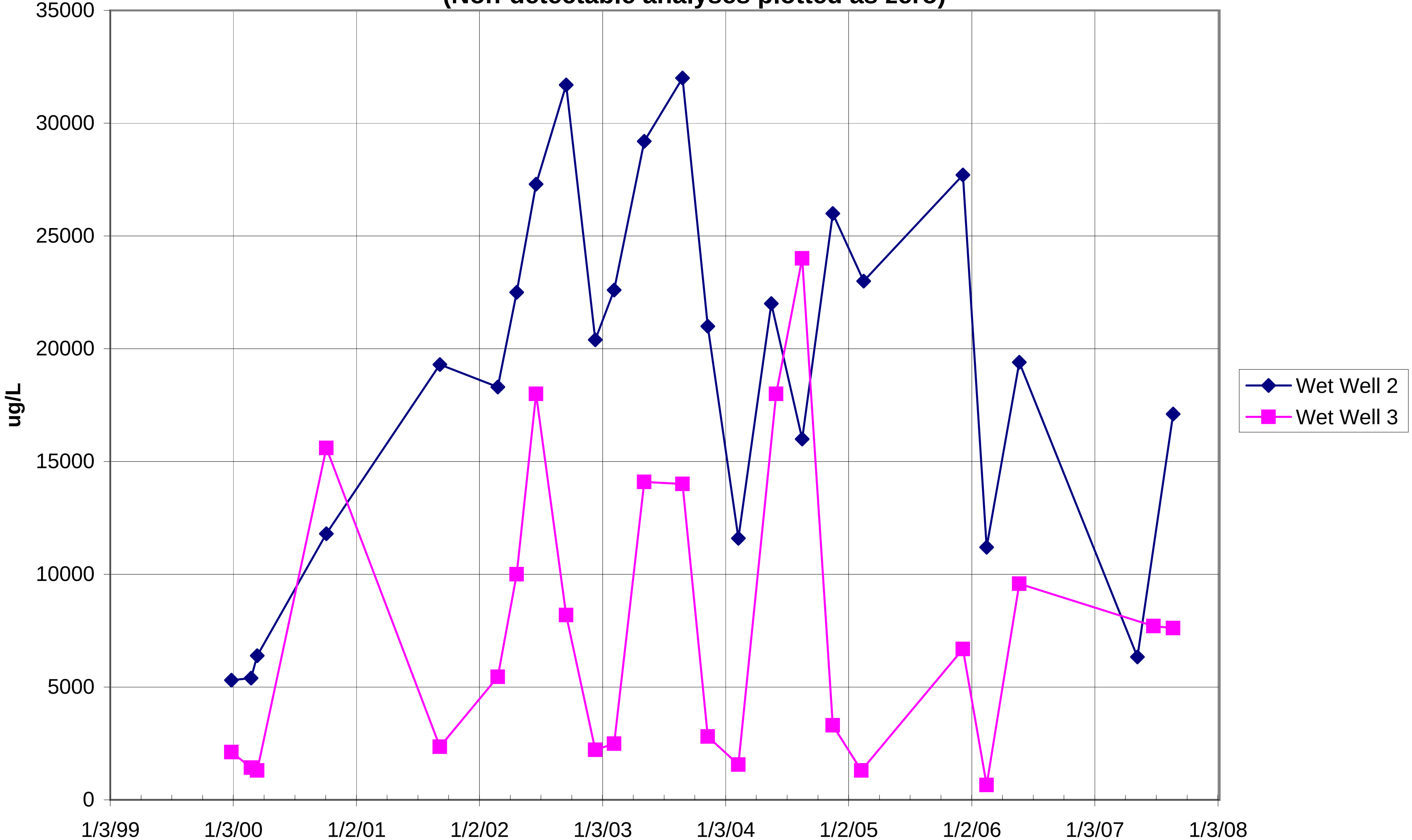


FIGURE 2.30b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - IRON DATA (Non-detectable analyses plotted as zero)

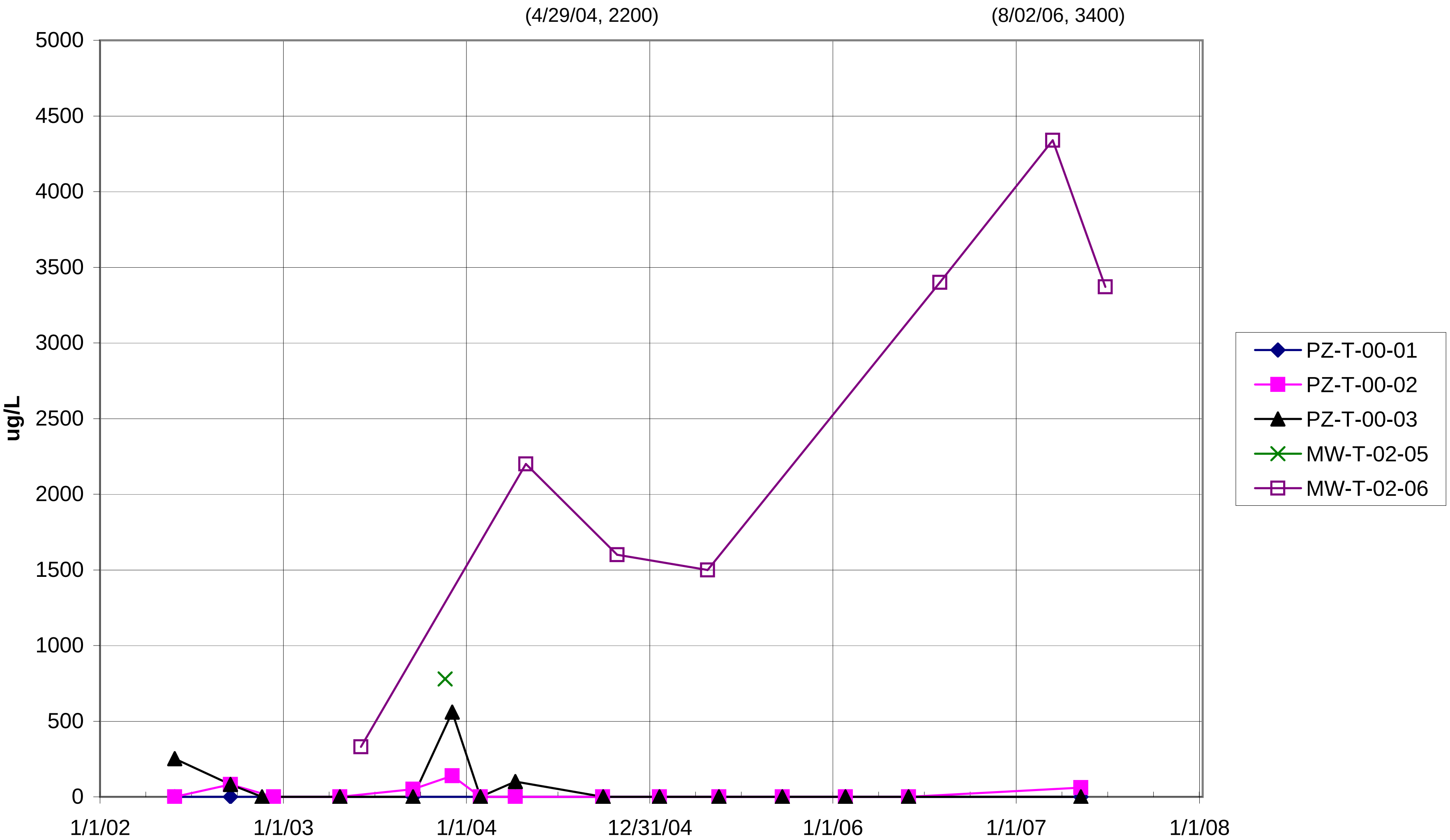


FIGURE 2.30c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - IRON DATA (Non-detectable analyses plotted as zero)

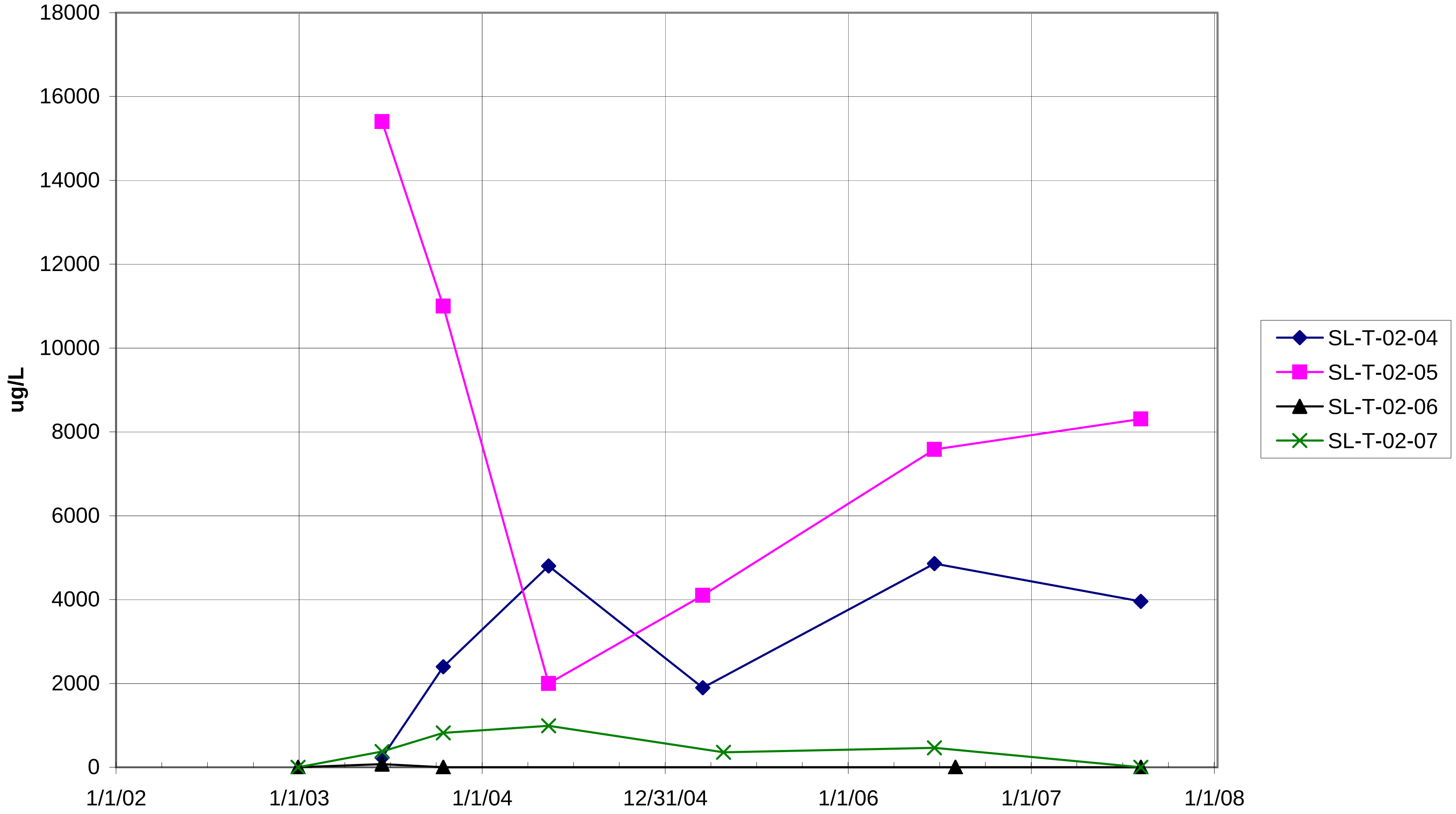


FIGURE 2.31a GREENS CREEK TAILINGS INTERNAL MONITORING SITES: WET WELLS - MANGANESE DATA (Non-detectable analyses plotted as zero)

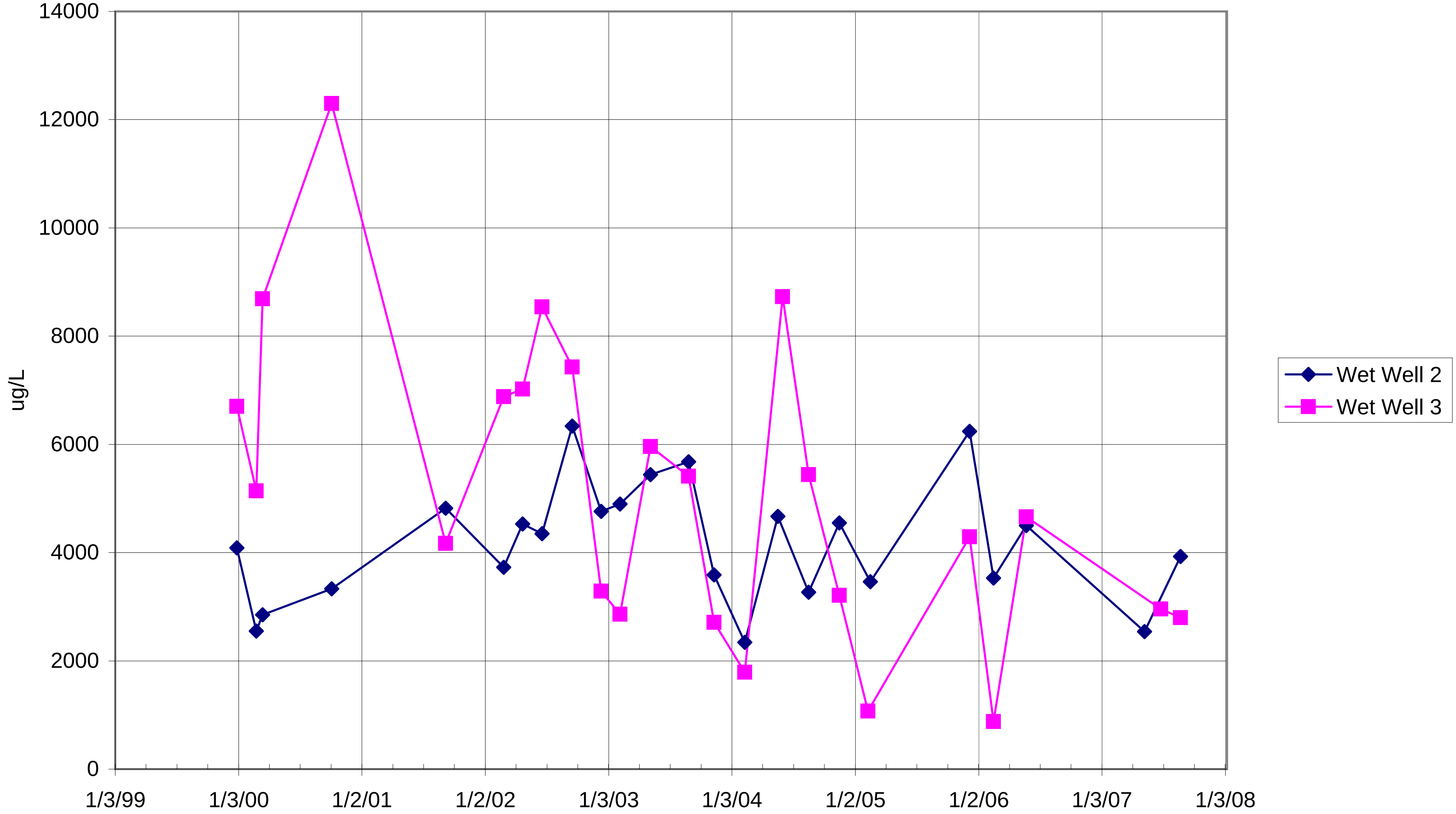


FIGURE 2.31b GREENS CREEK TAILINGS INTERNAL MONITORING SITES: TAILINGS COMPLETIONS - MANGANESE DATA (Non-detectable analyses plotted as zero)

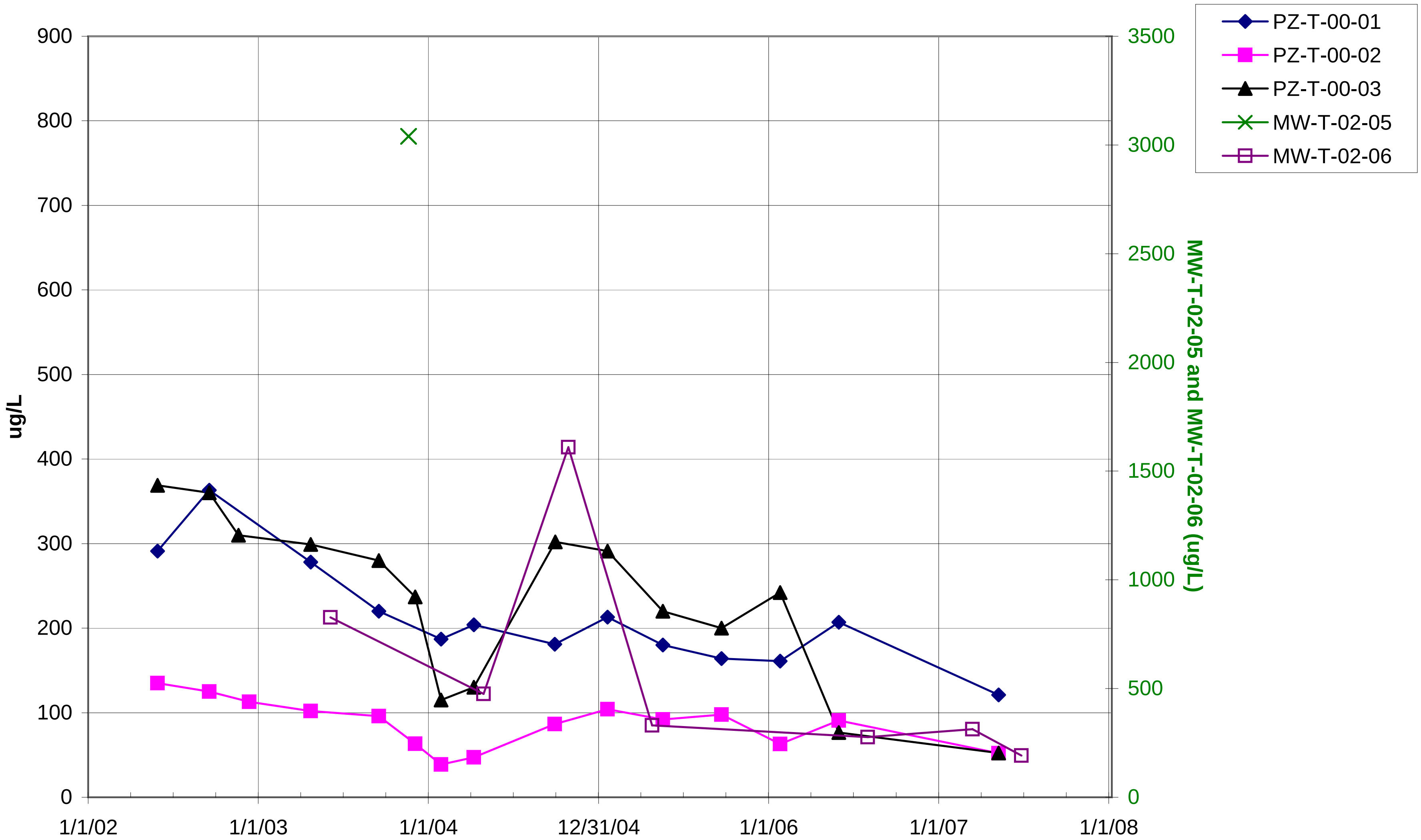


FIGURE 2.31c GREENS CREEK TAILINGS INTERNAL MONITORING SITES: SUCTION LYSIMETERS - MANGANESE DATA (Non-detectable analyses plotted as zero)

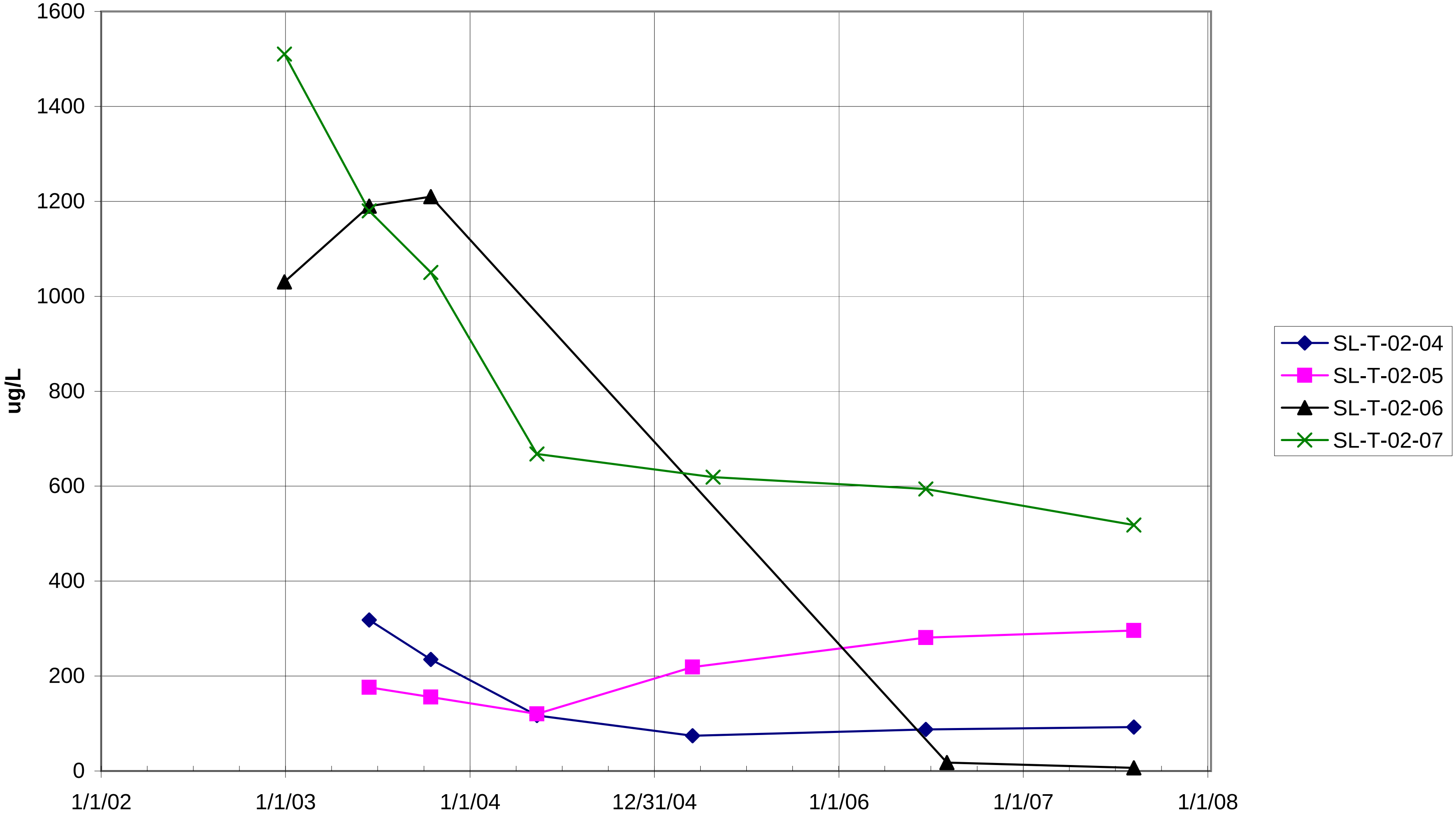


FIGURE 2.32 TAILINGS MONTHLY COMPOSITE ABA RESULTS

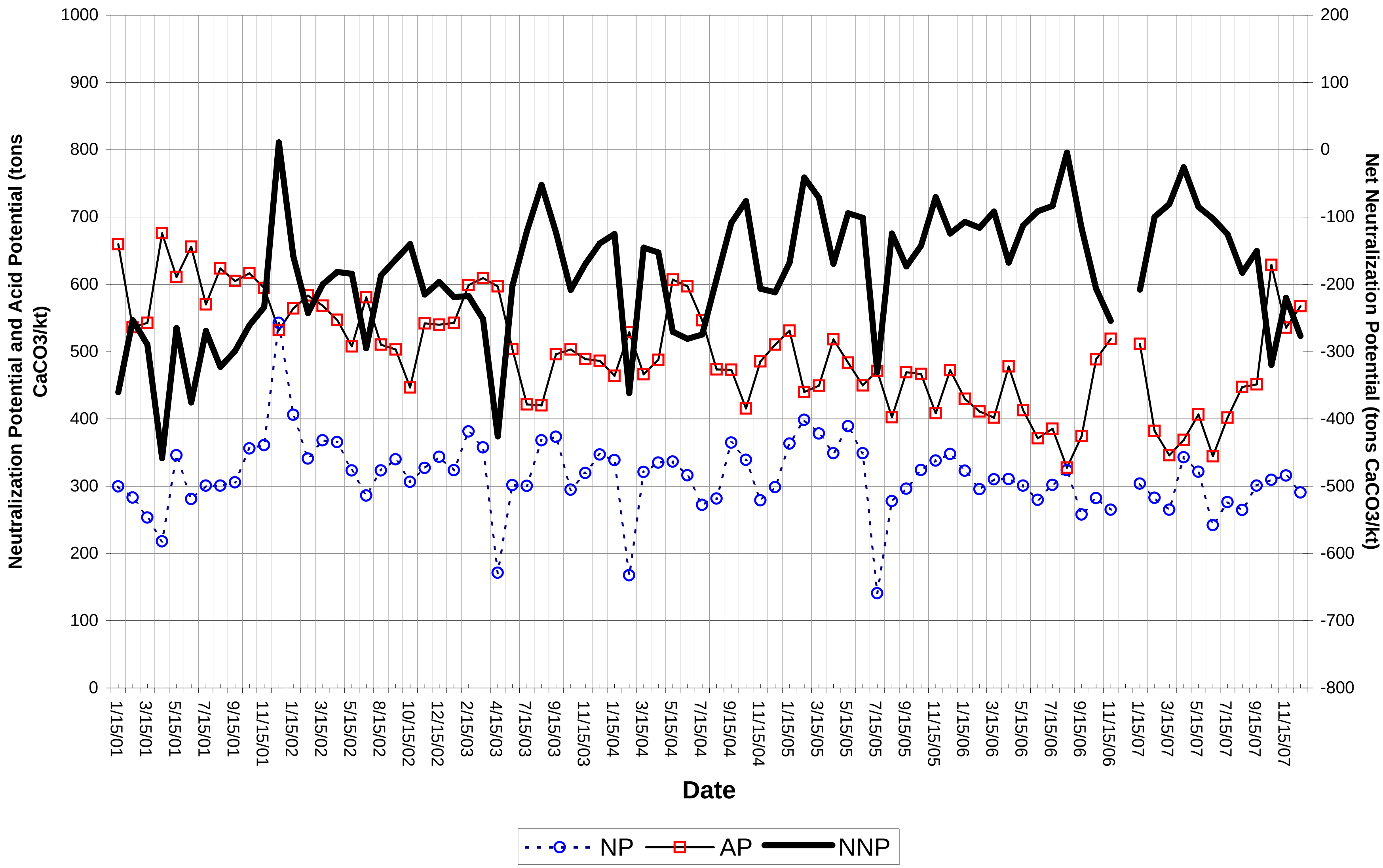


FIGURE 2.33 TAILINGS FACILITY 2004 and 2005 ACID BASE ACCOUNTNG DATA

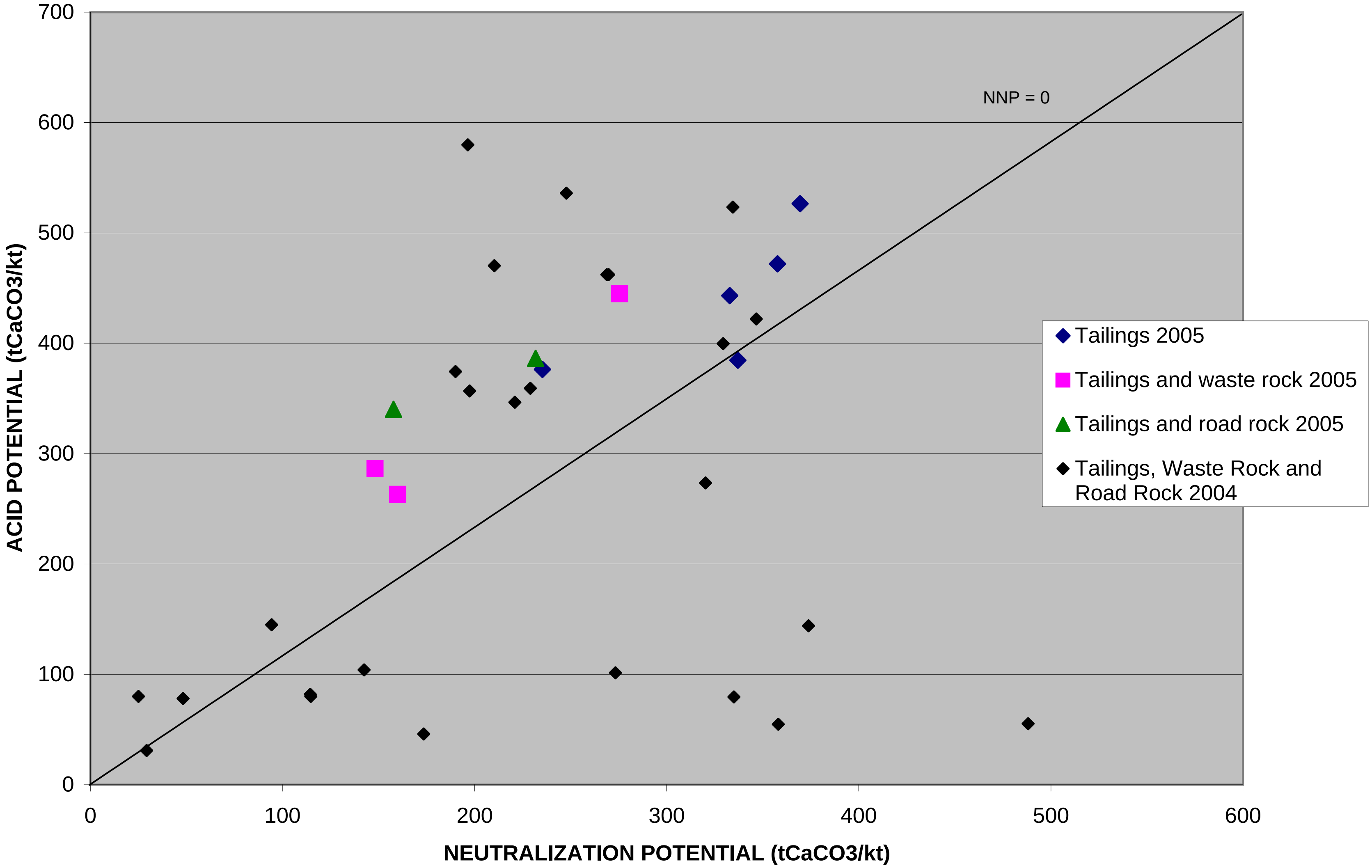


FIGURE 2.34 TAILINGS FACILITY PH VERSUS NET NEUTRALIZATION POTENTIAL

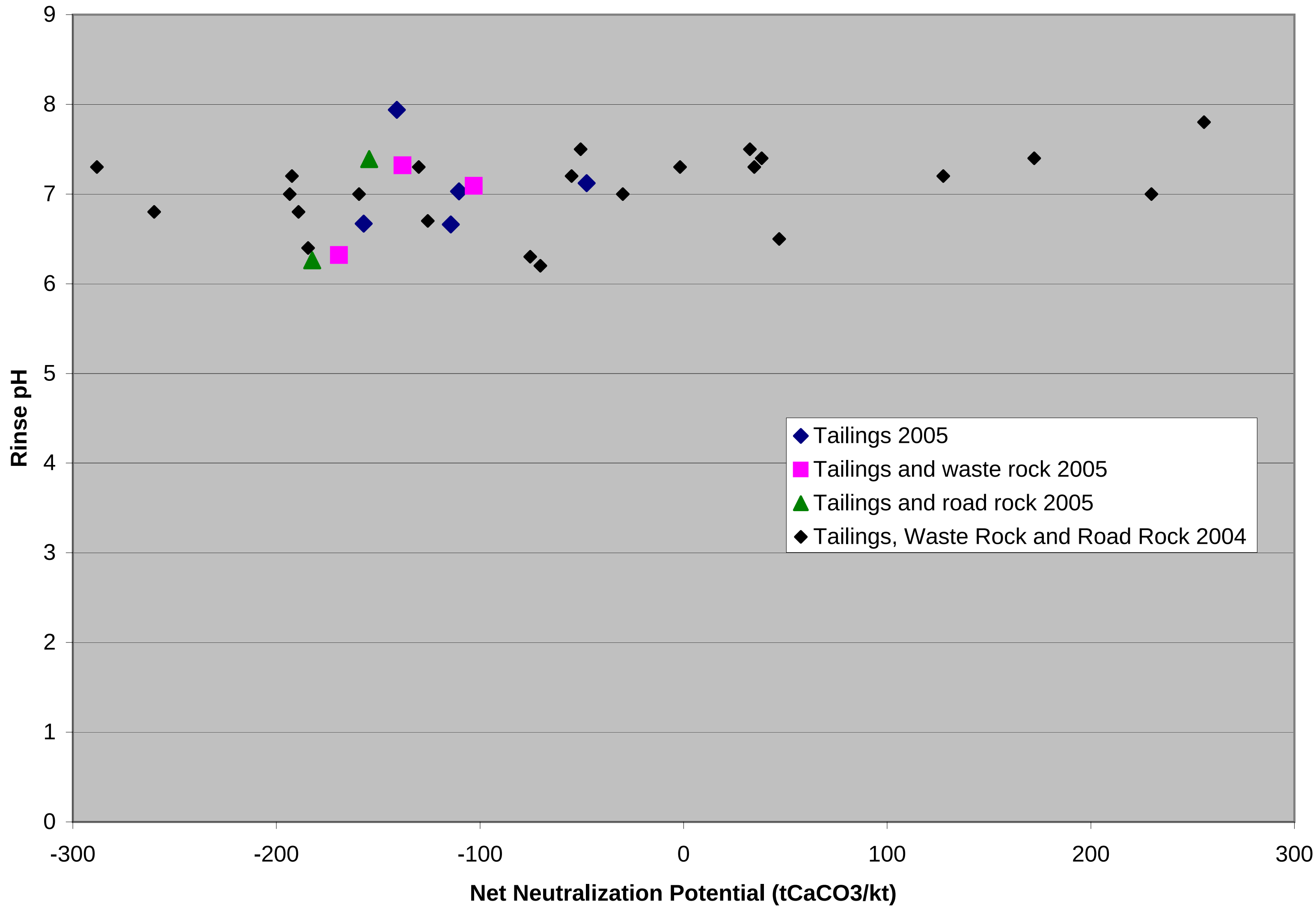


Figure 3.1 Pressure Data for Piezometer 52

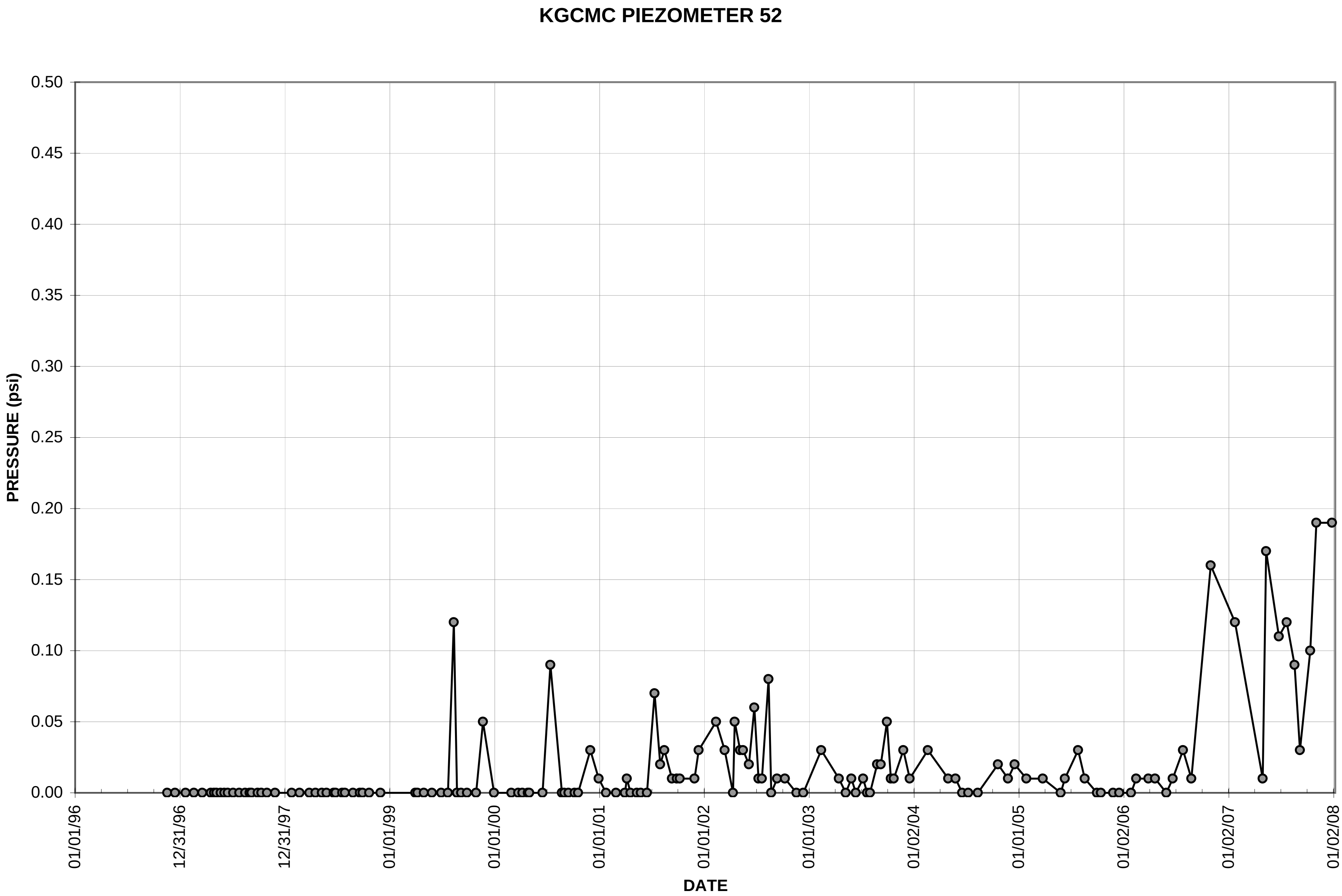


Figure 3.2 Pressure Data for Piezometer 53

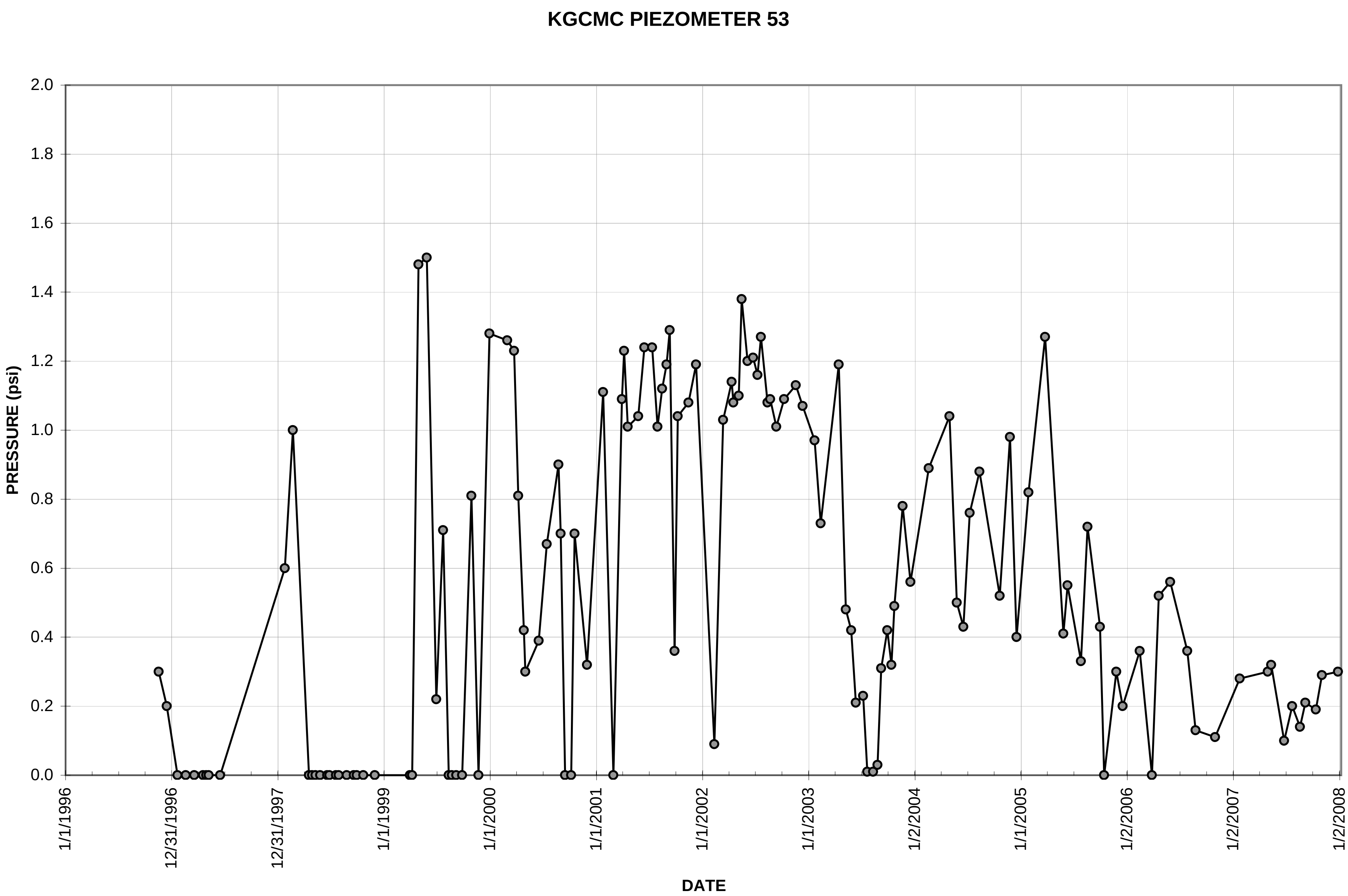


Figure 3.3 Pressure Data for Piezometer 54

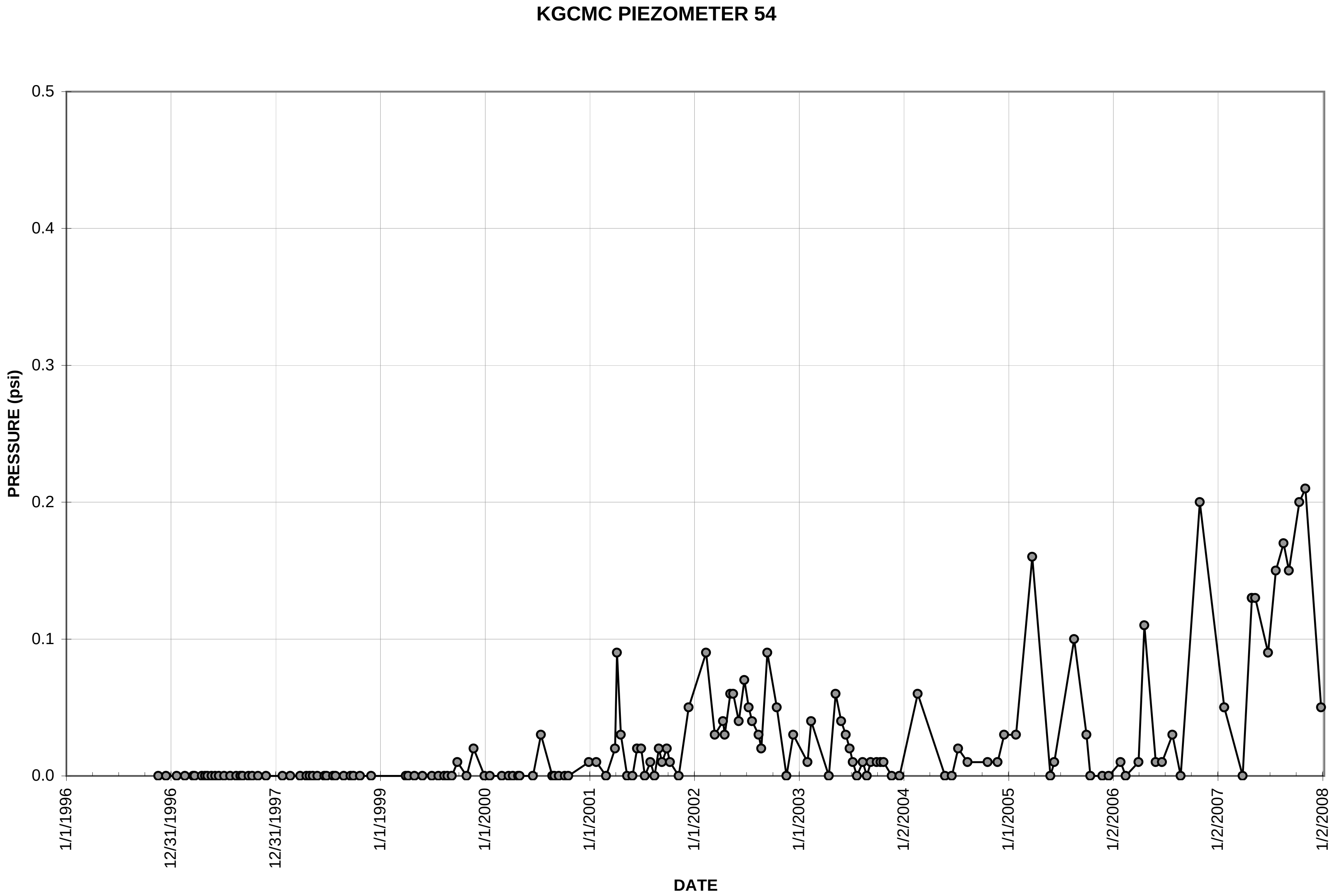


Figure 3.4 Pressure Data for Piezometer 55

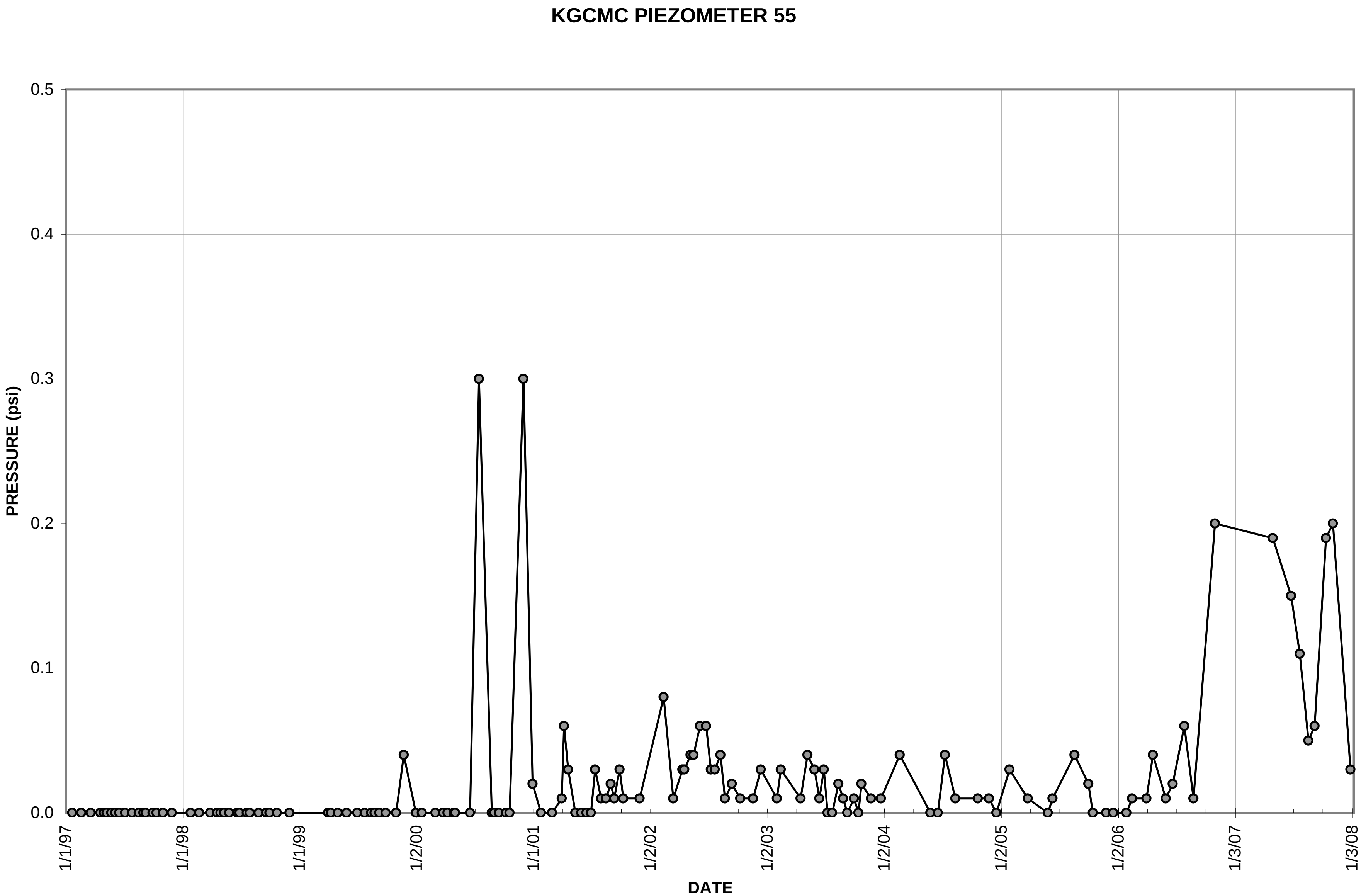


Figure 3.5 Water Level Data for Well MW-23/D-00-03

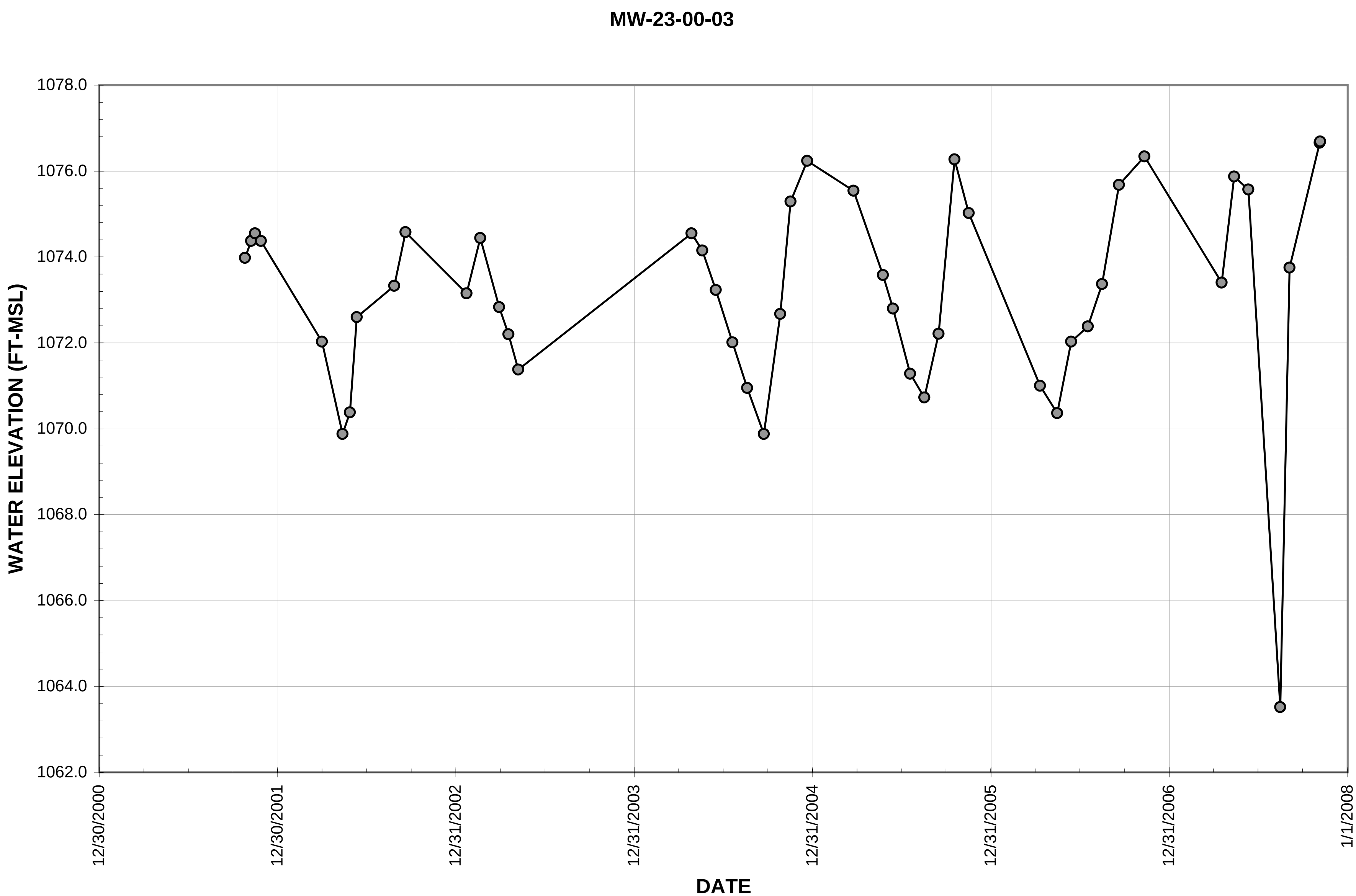


Figure 3.6 Water Level Data for Well MW-23-A2D

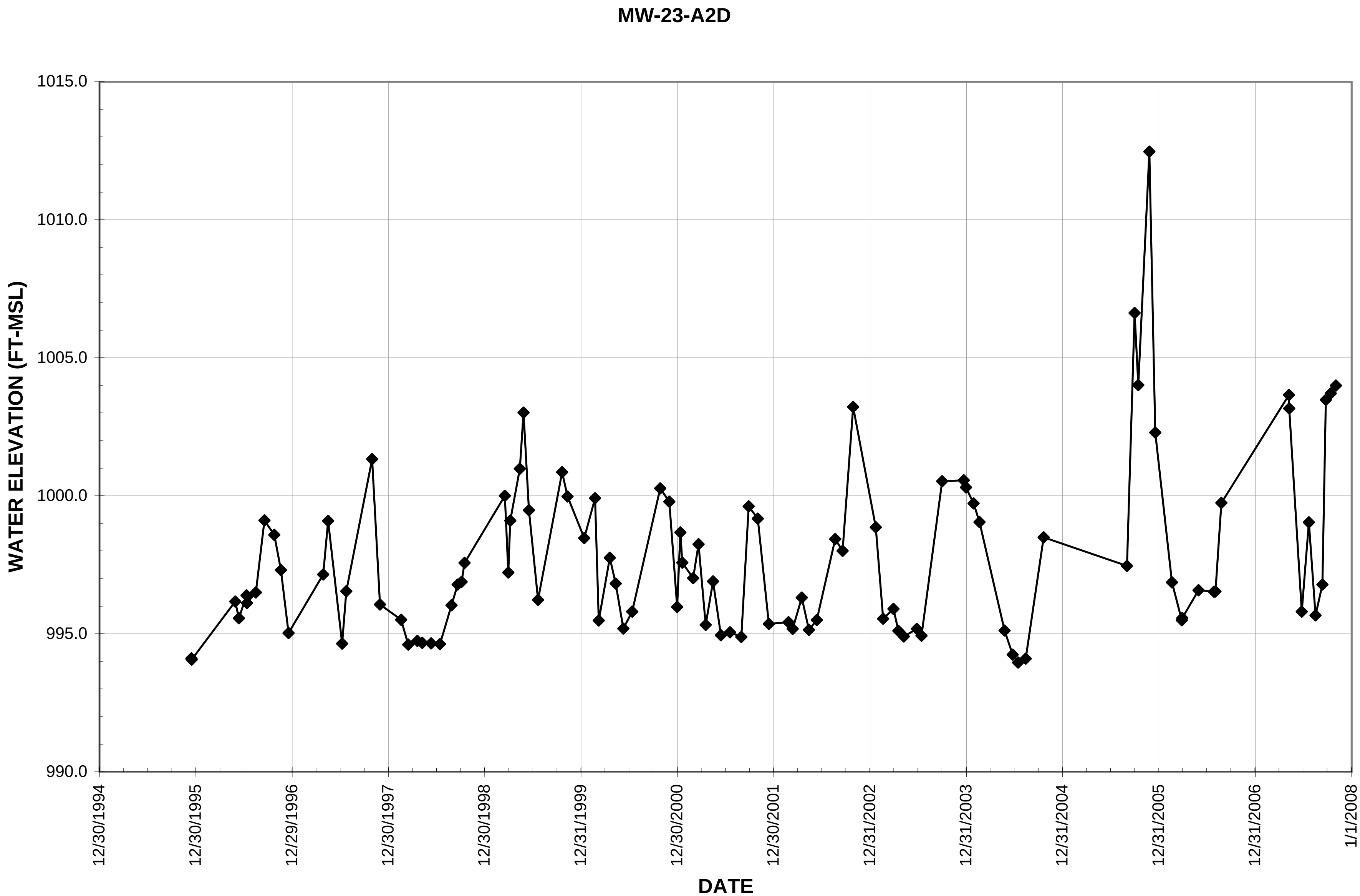


Figure 3.7 Water Level Data for Well MW-23-A2S

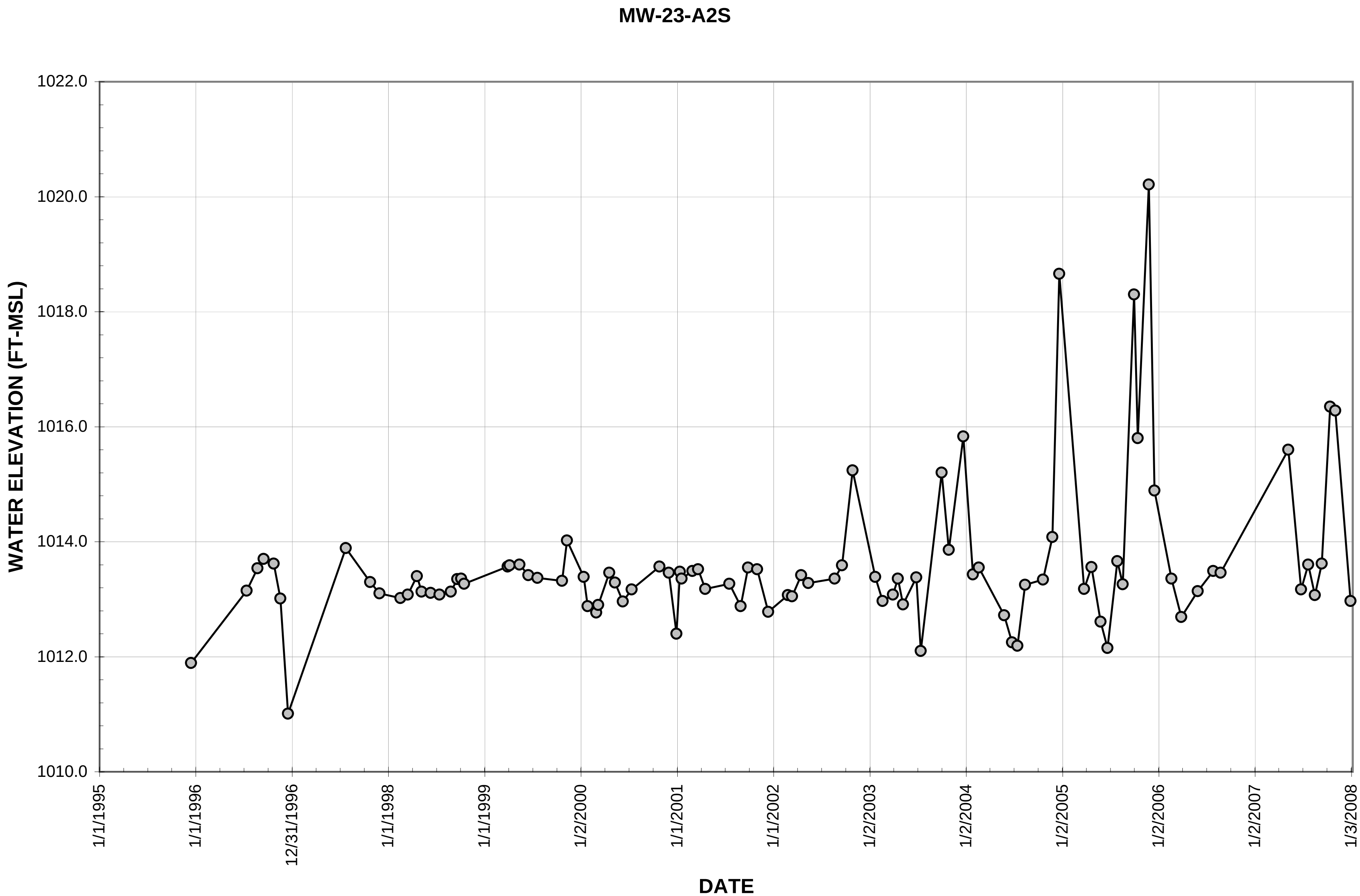


Figure 3.8 Water Level Data for Well MW-23-98-01

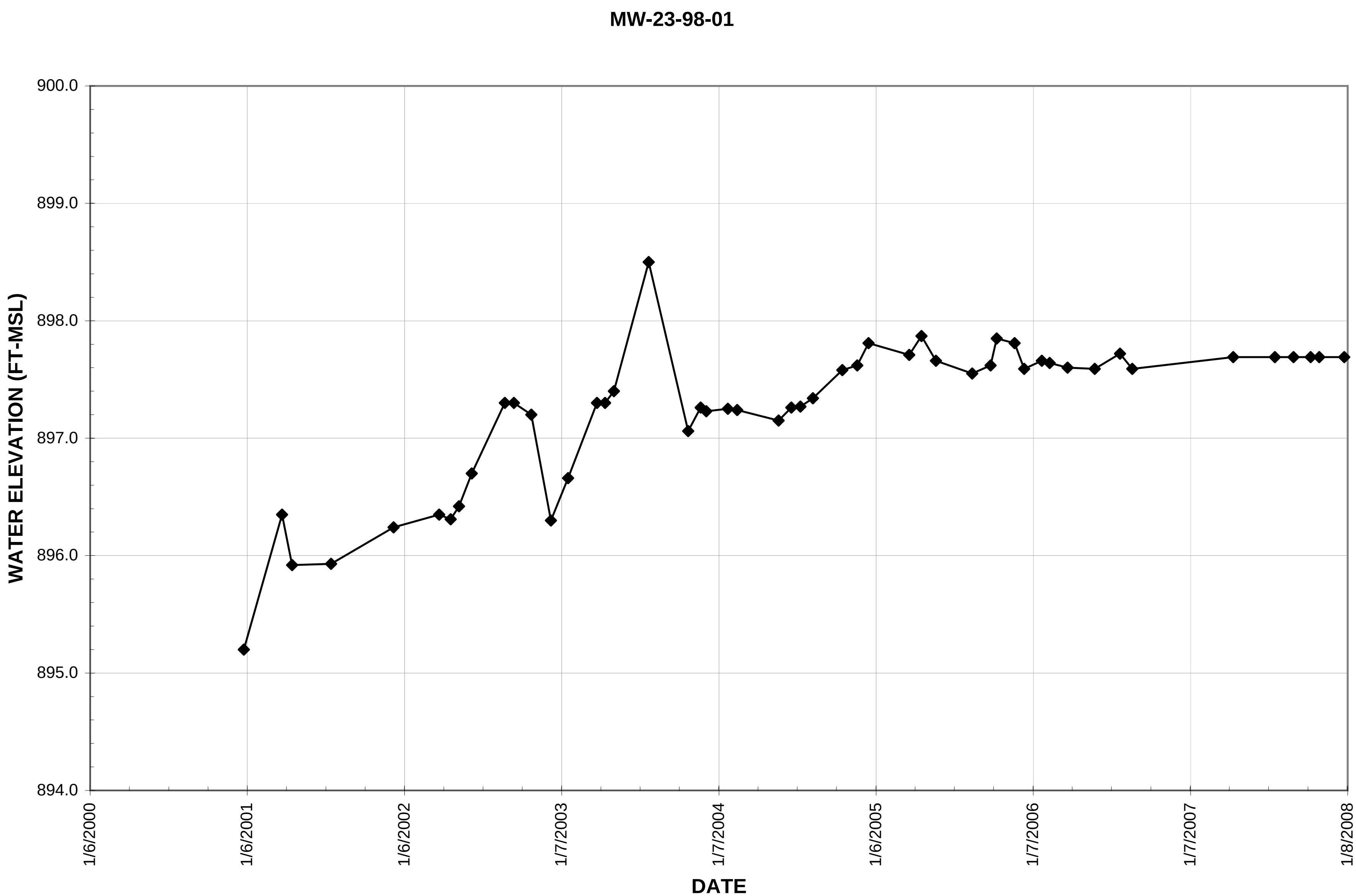


Figure 3.9 Water Level Data for Well MW-23-A4

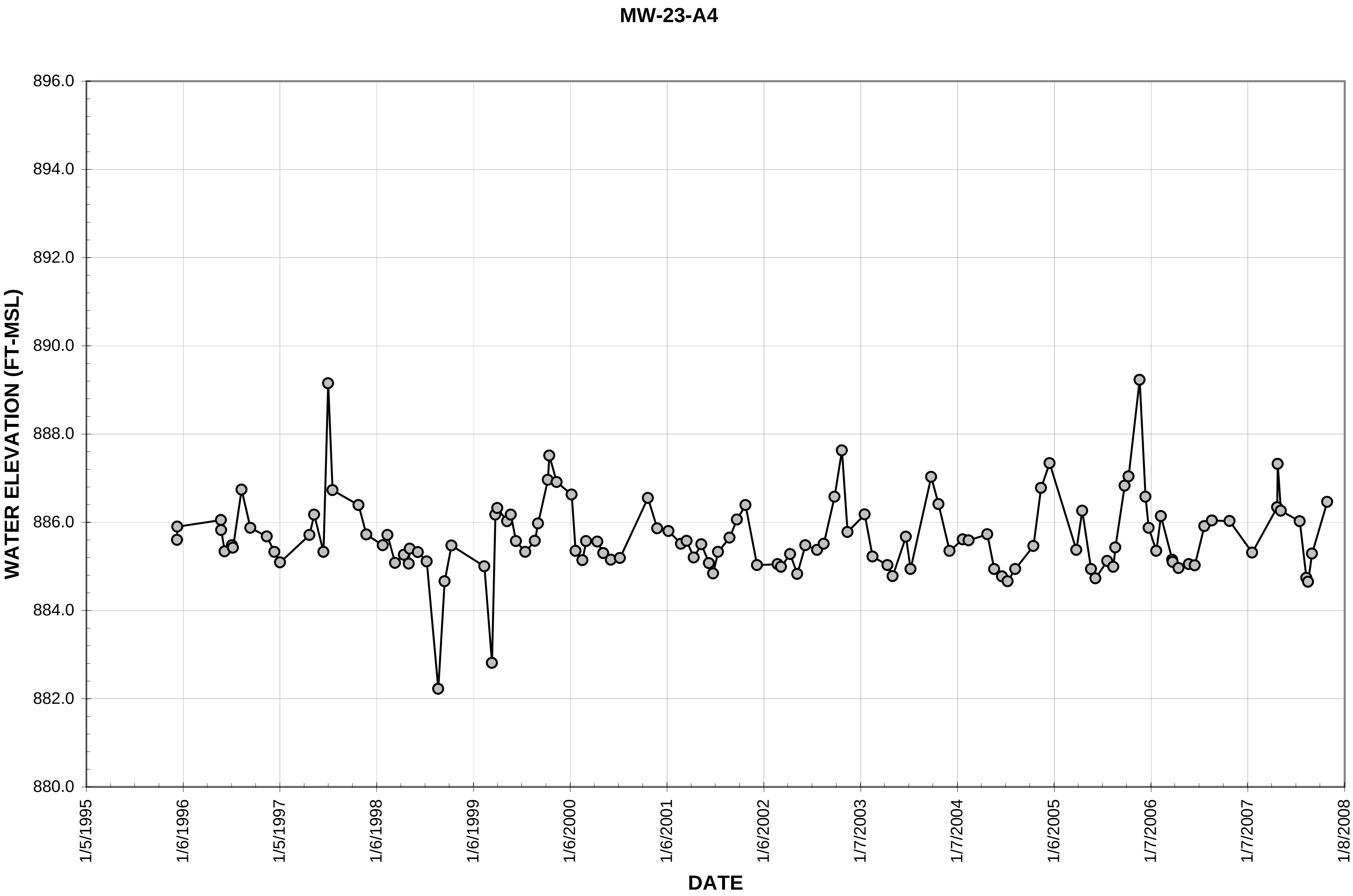


Figure 3.10 Water Level Data for Well MW-23/D-00-01

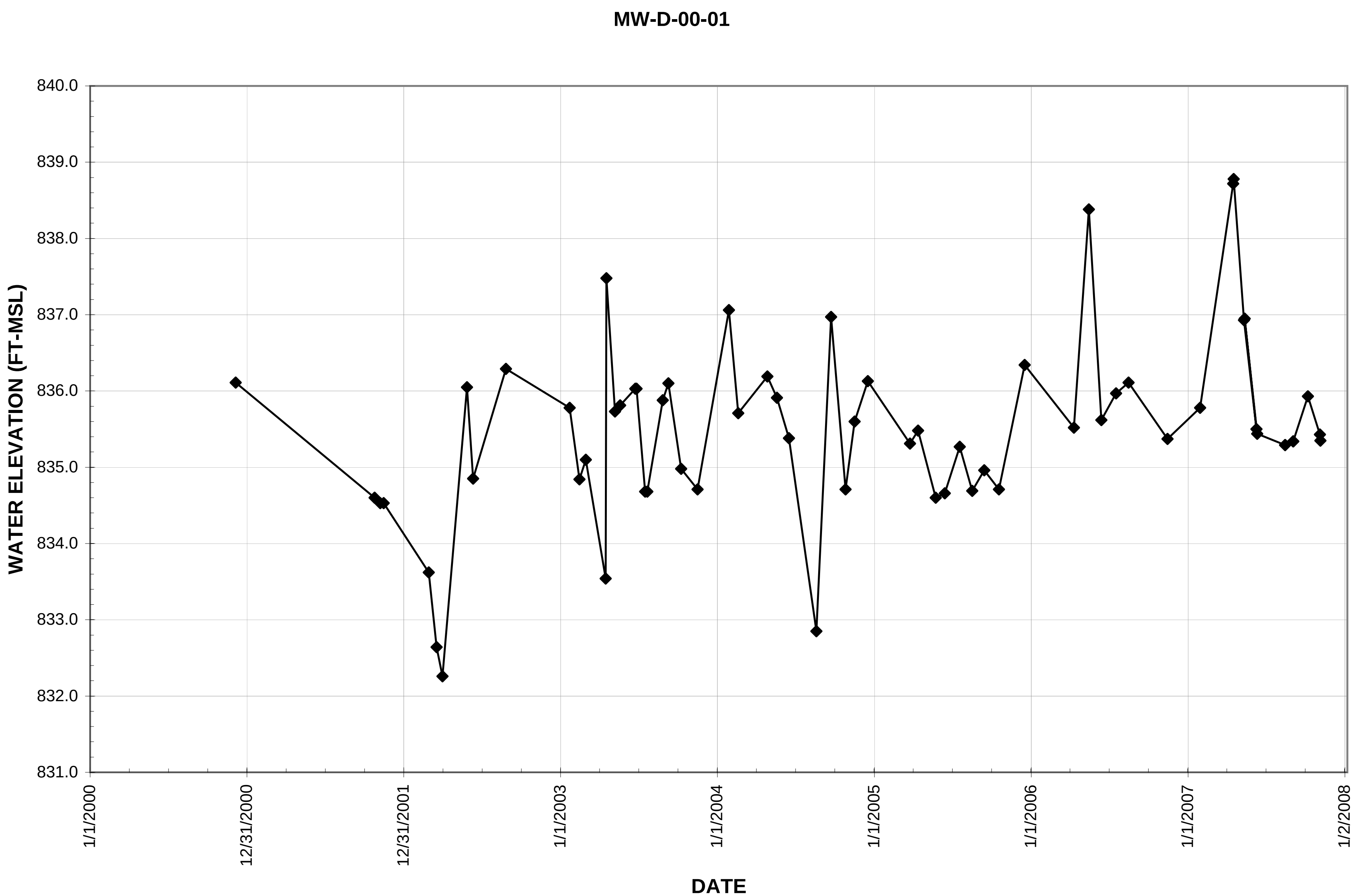


Figure 3.11 Water Level Data for Well MW-D-94-D3

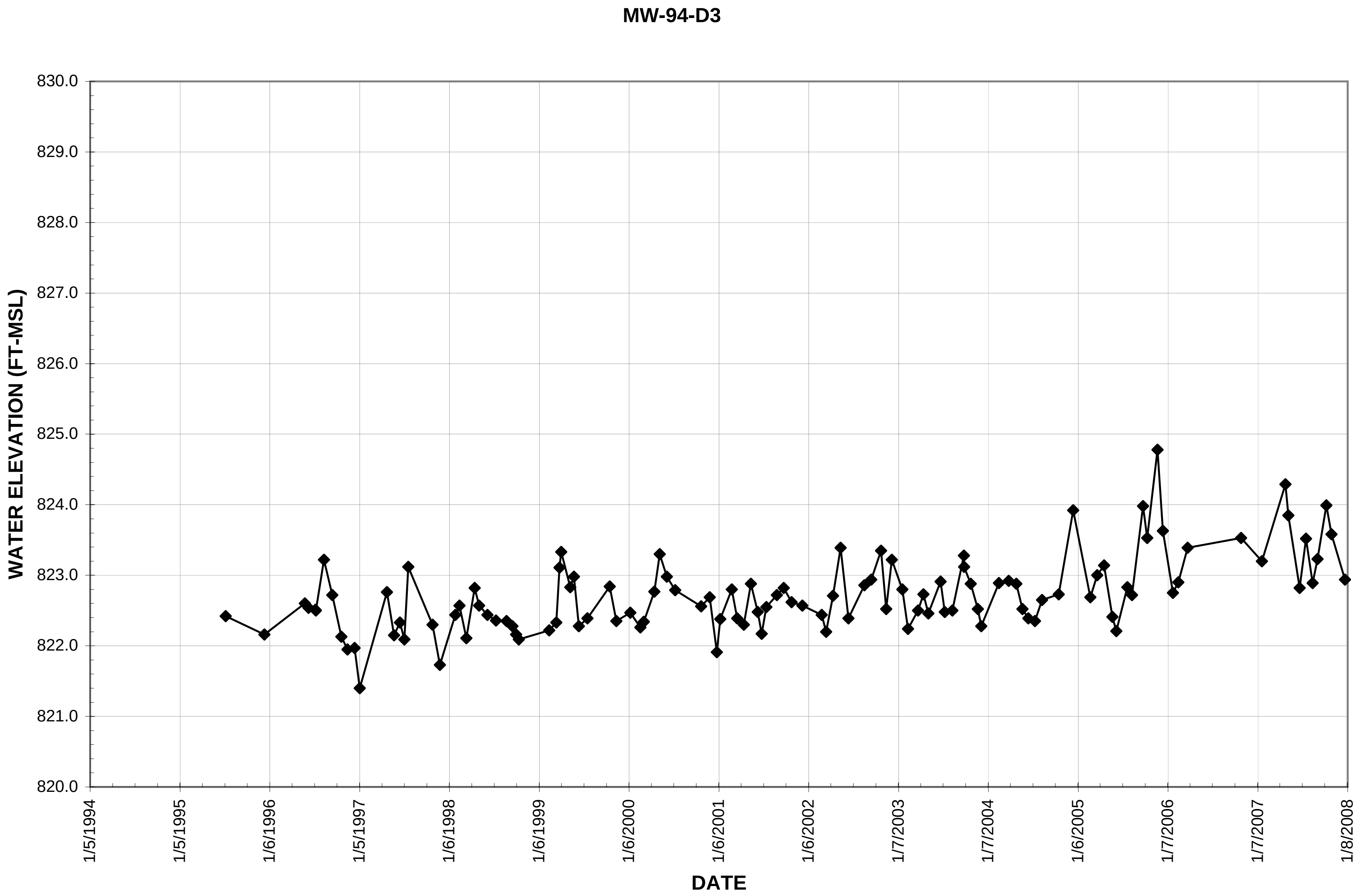


Figure 3.12 Water Level Data for Well MW-D-94-D4

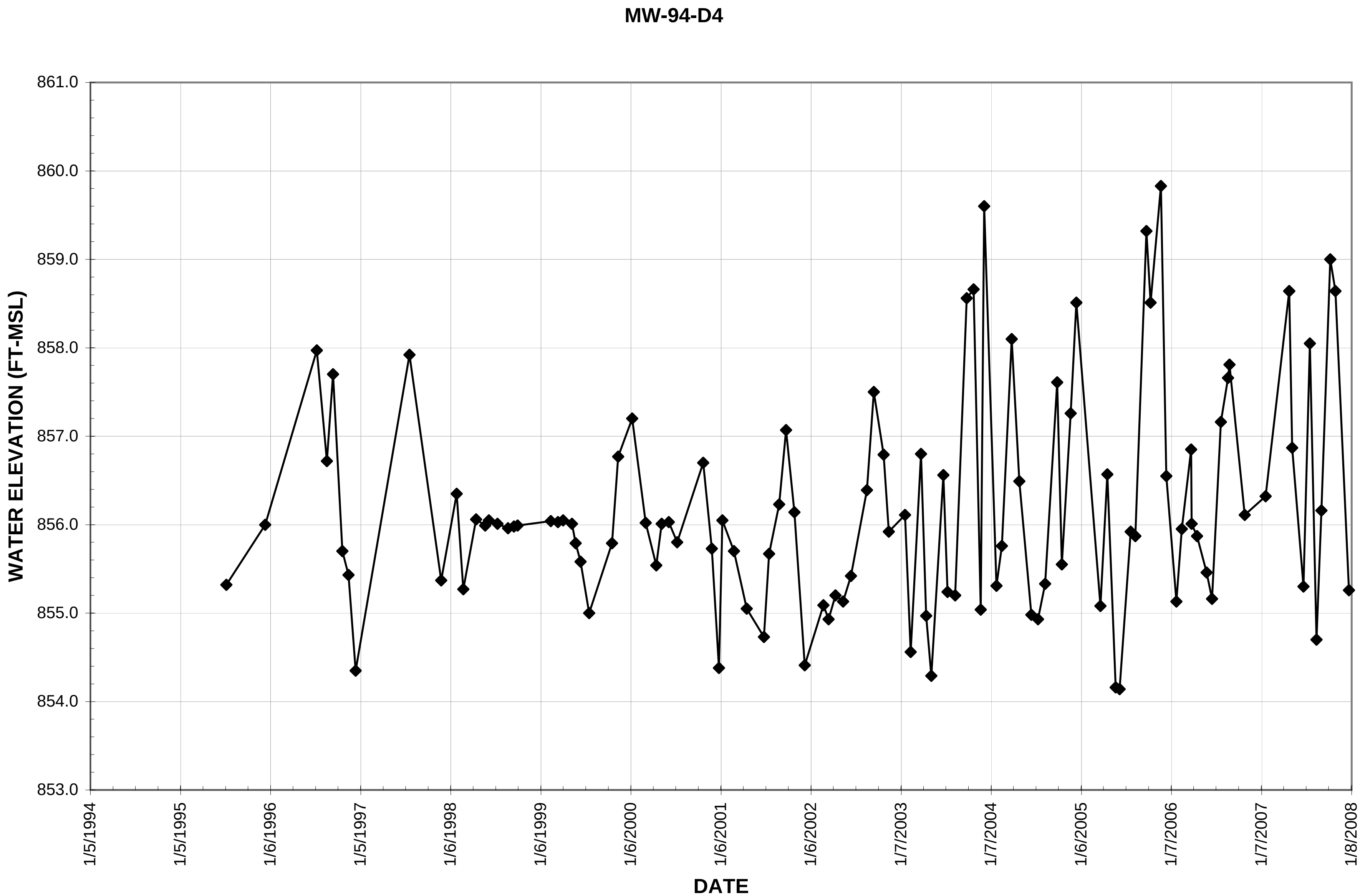


Figure 3.13 Pond D Flow Data

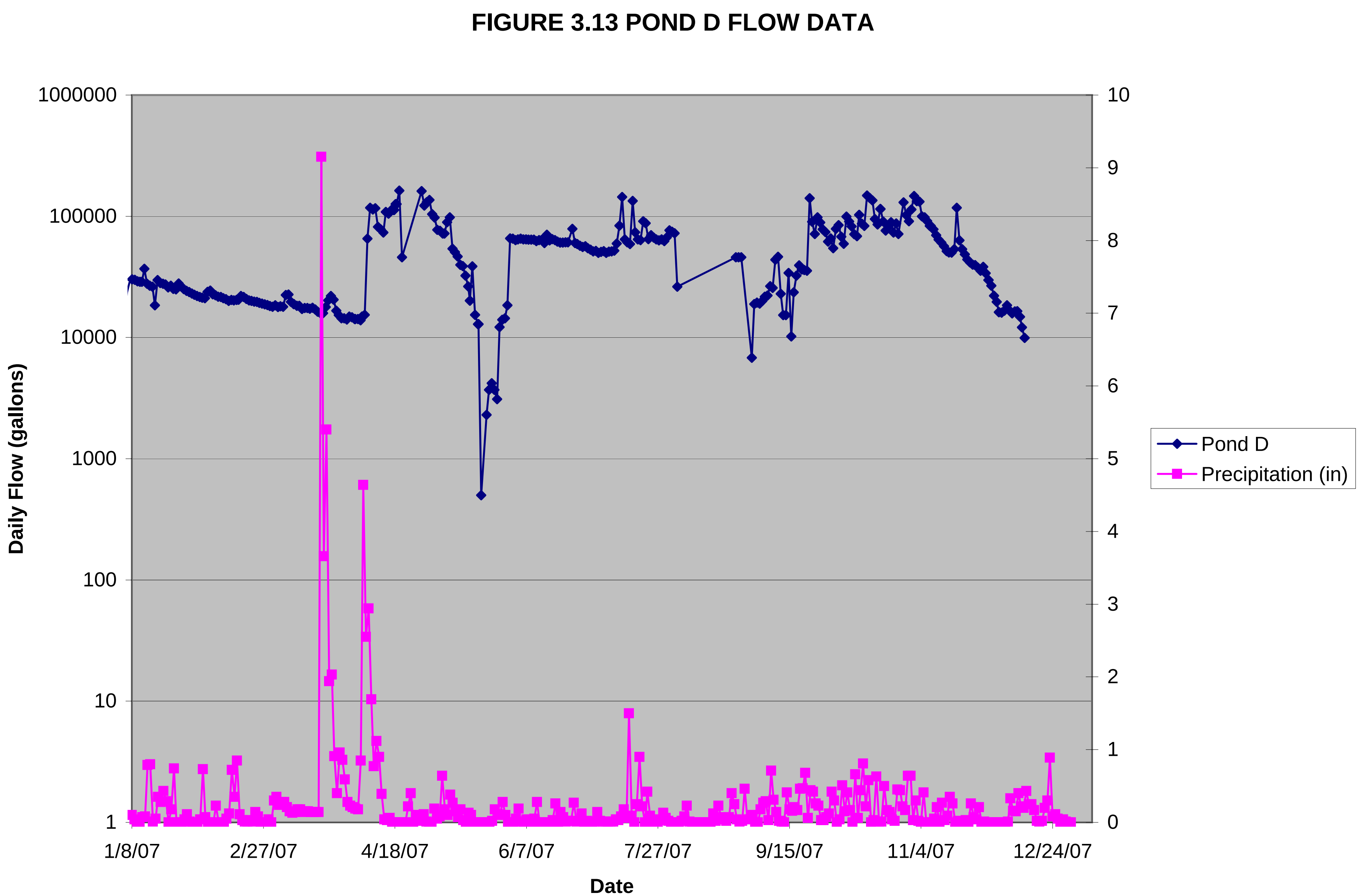


FIGURE 3.14a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - pH DATA

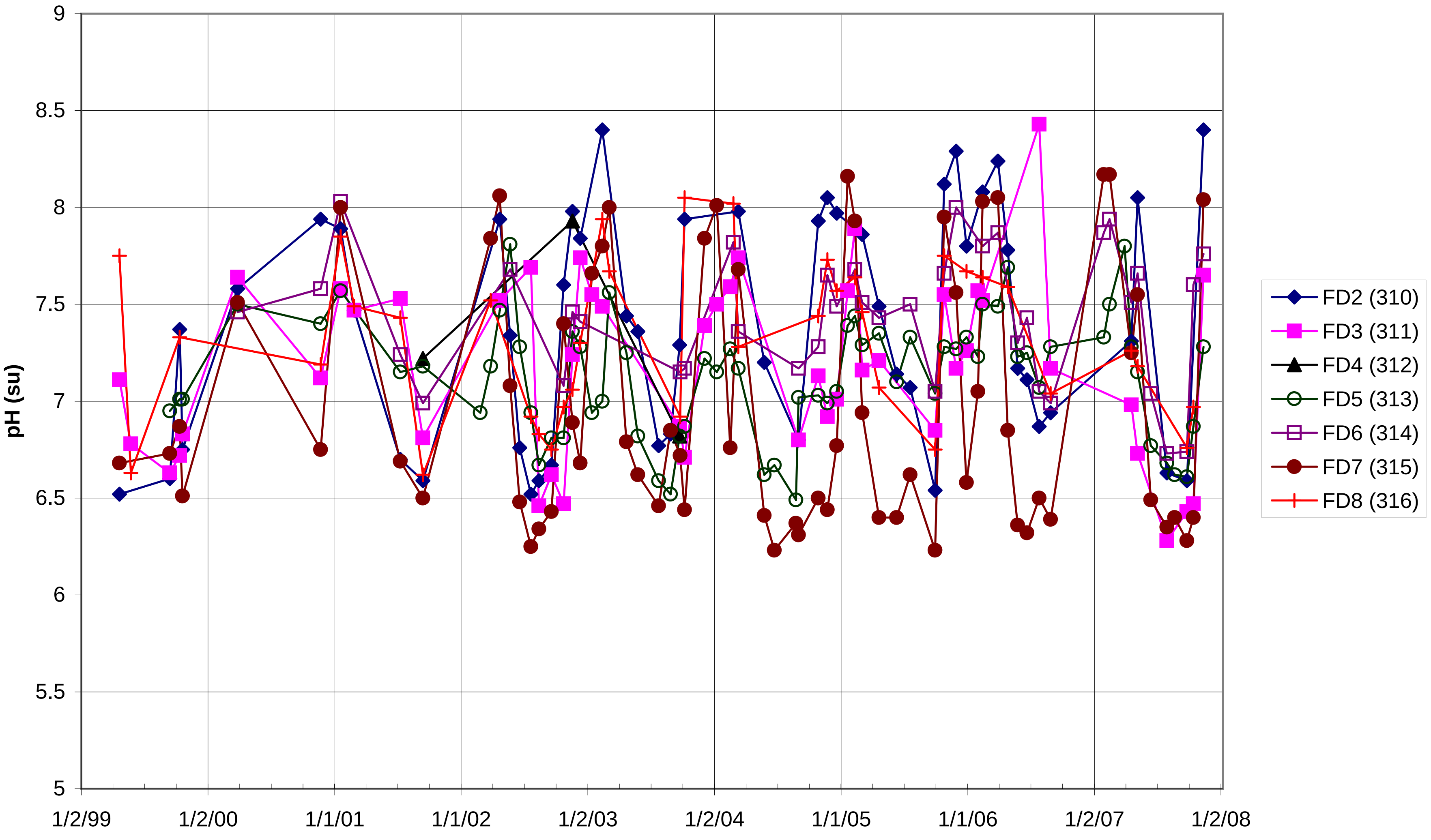


FIGURE 3.14b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - pH DATA

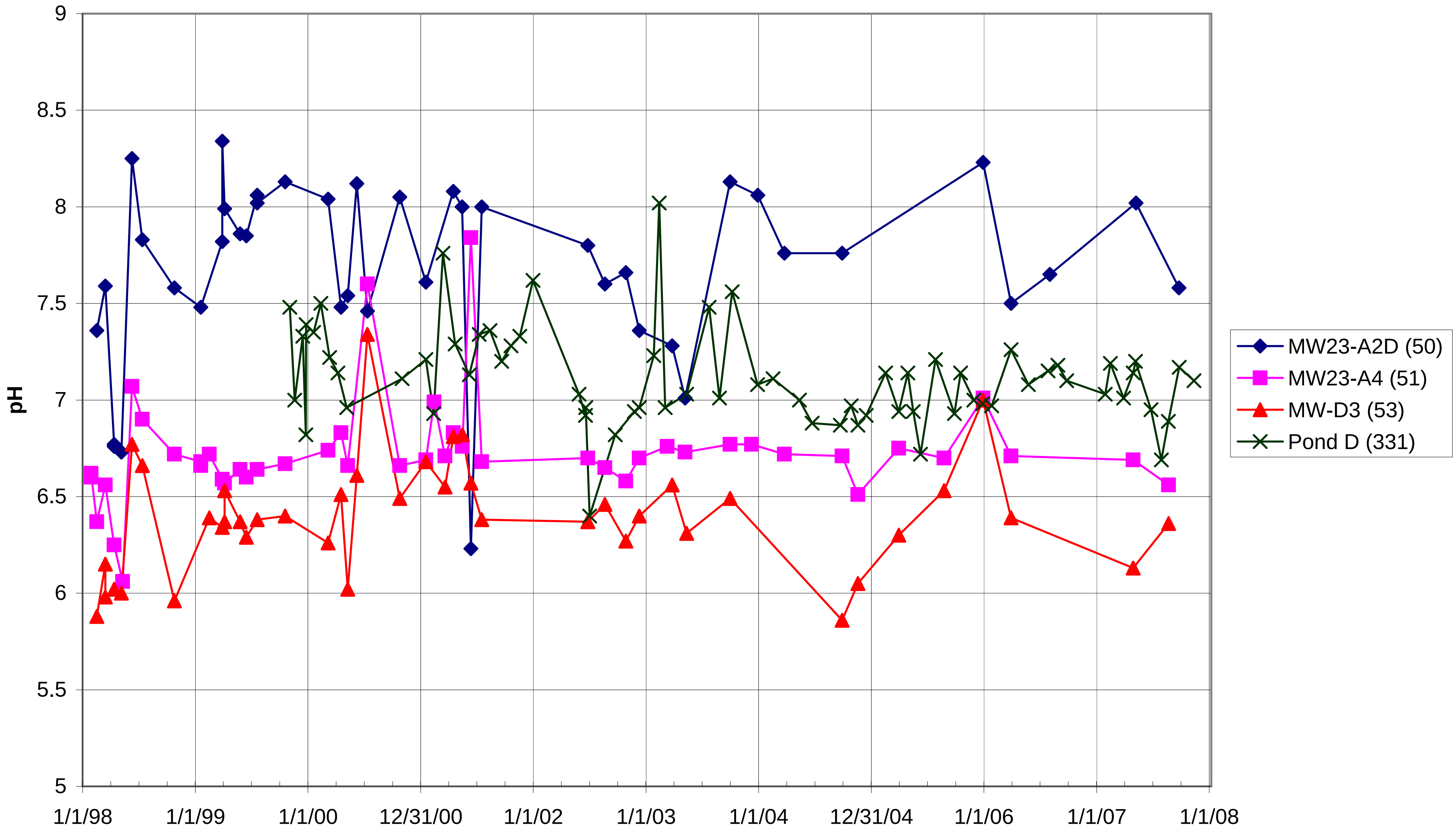


FIGURE 3.15a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES:
FINGER DRAINS - ALKALINITY DATA
(Non-detectable analyses plotted as zero)

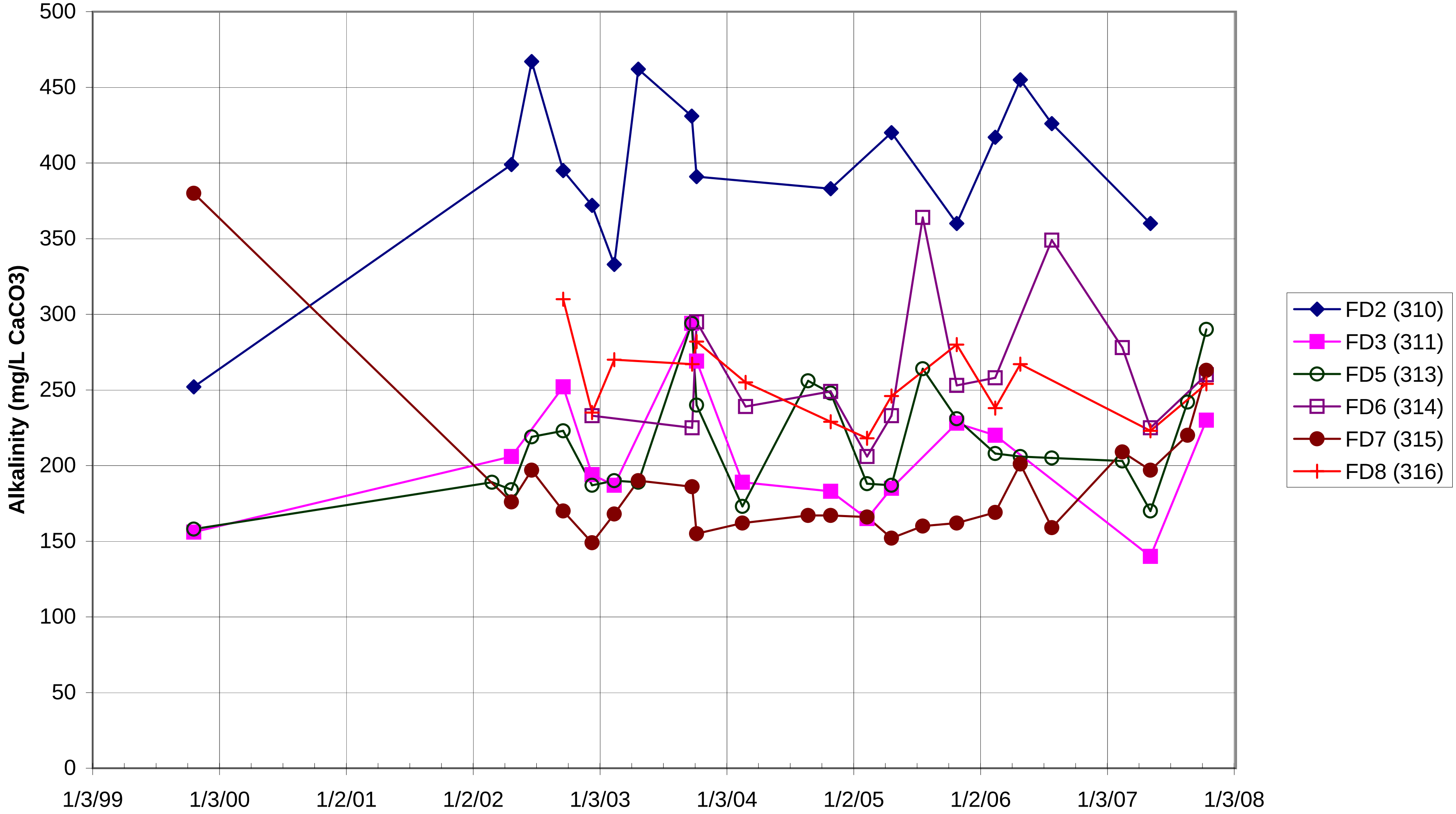


FIGURE 3.15b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES:
GROUND WATER - ALKALINITY DATA
(Non-detectable analyses plotted as zero)

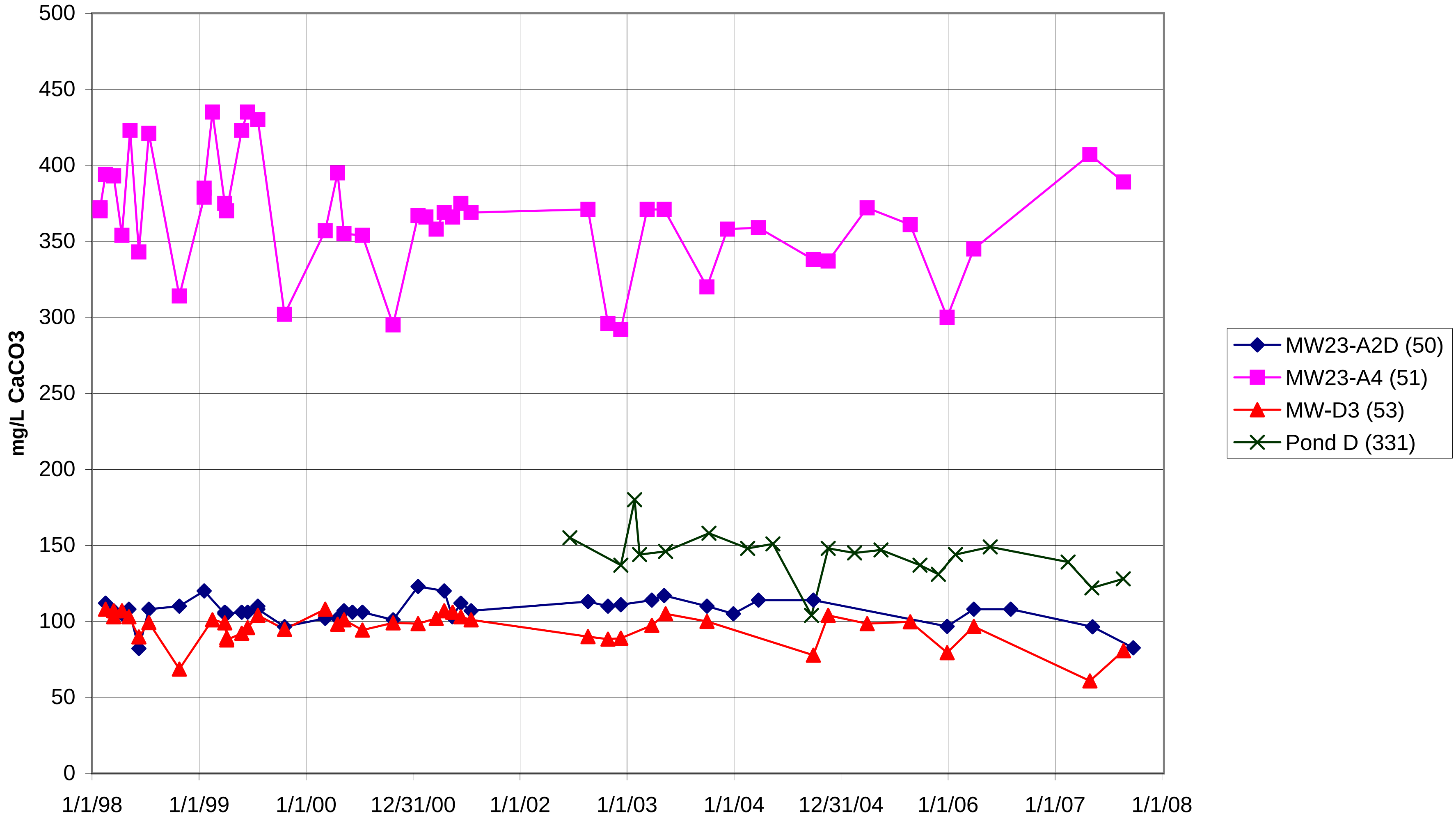


FIGURE 3.16a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - HARDNESS DATA (Non-detectable analyses plotted as zero)

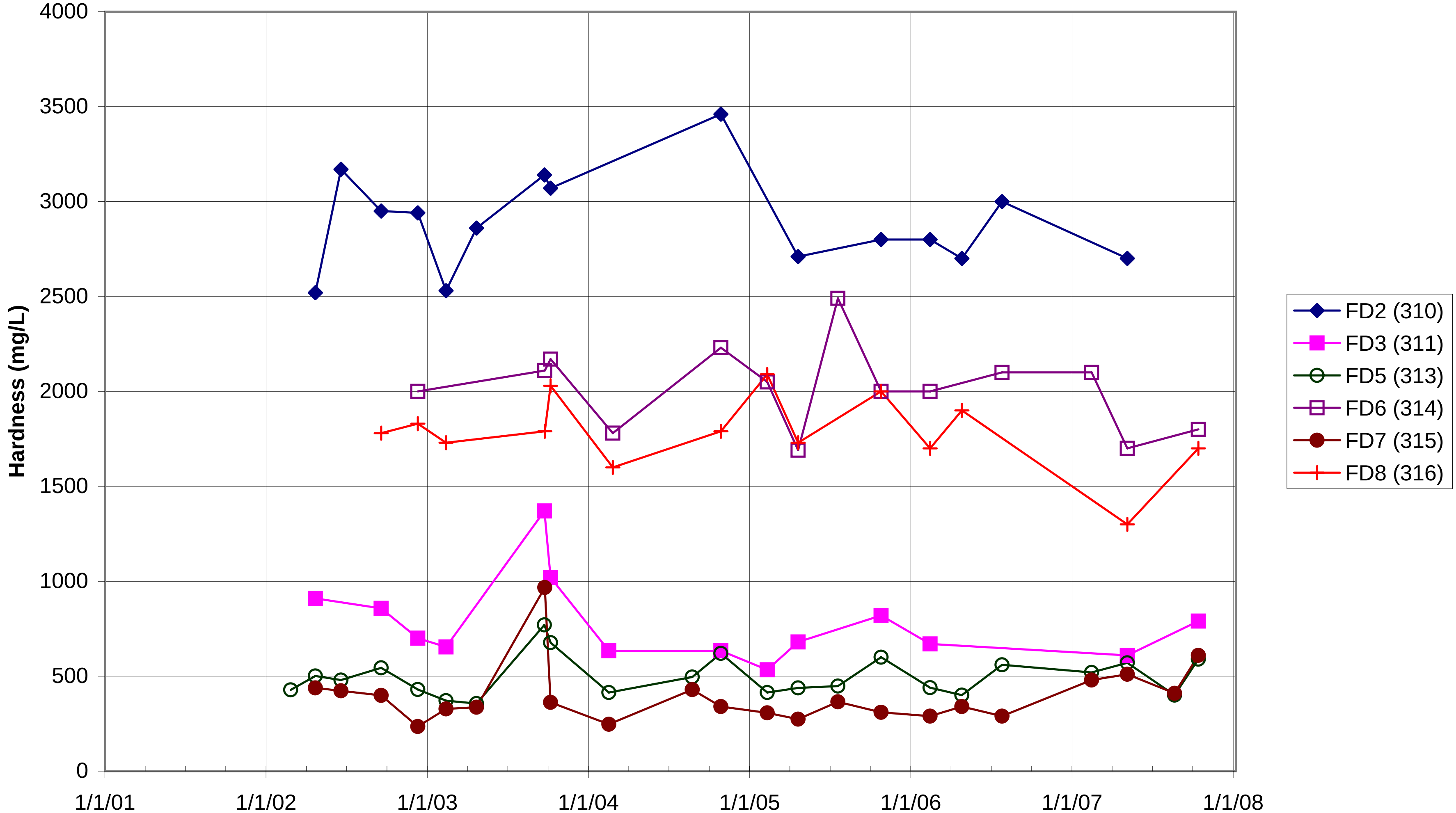


FIGURE 3.16b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES:
GROUND WATER - HARDNESS DATA
(Non-detectable analyses plotted as zero)

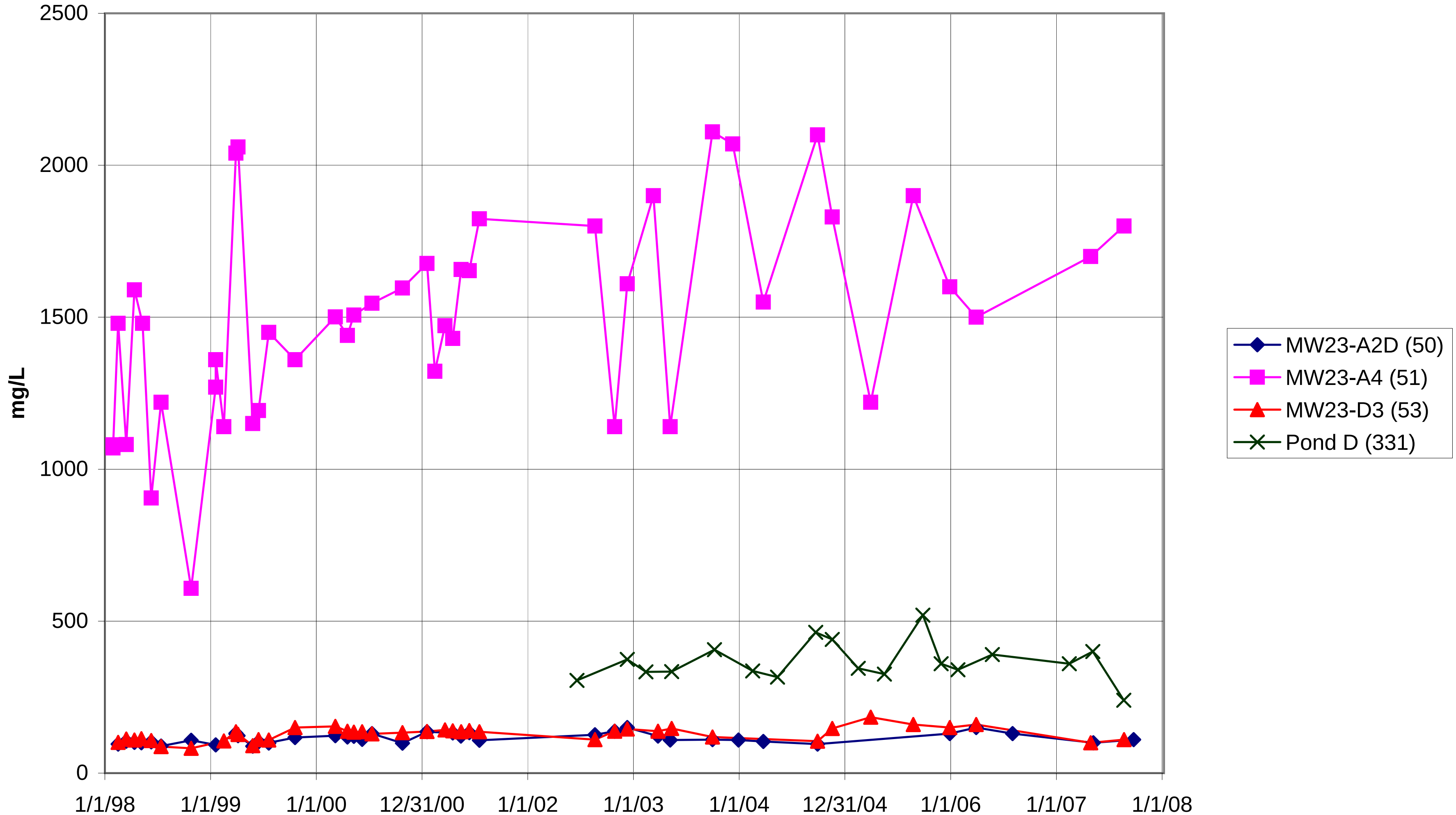


FIGURE 3.17a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - CONDUCTIVITY DATA

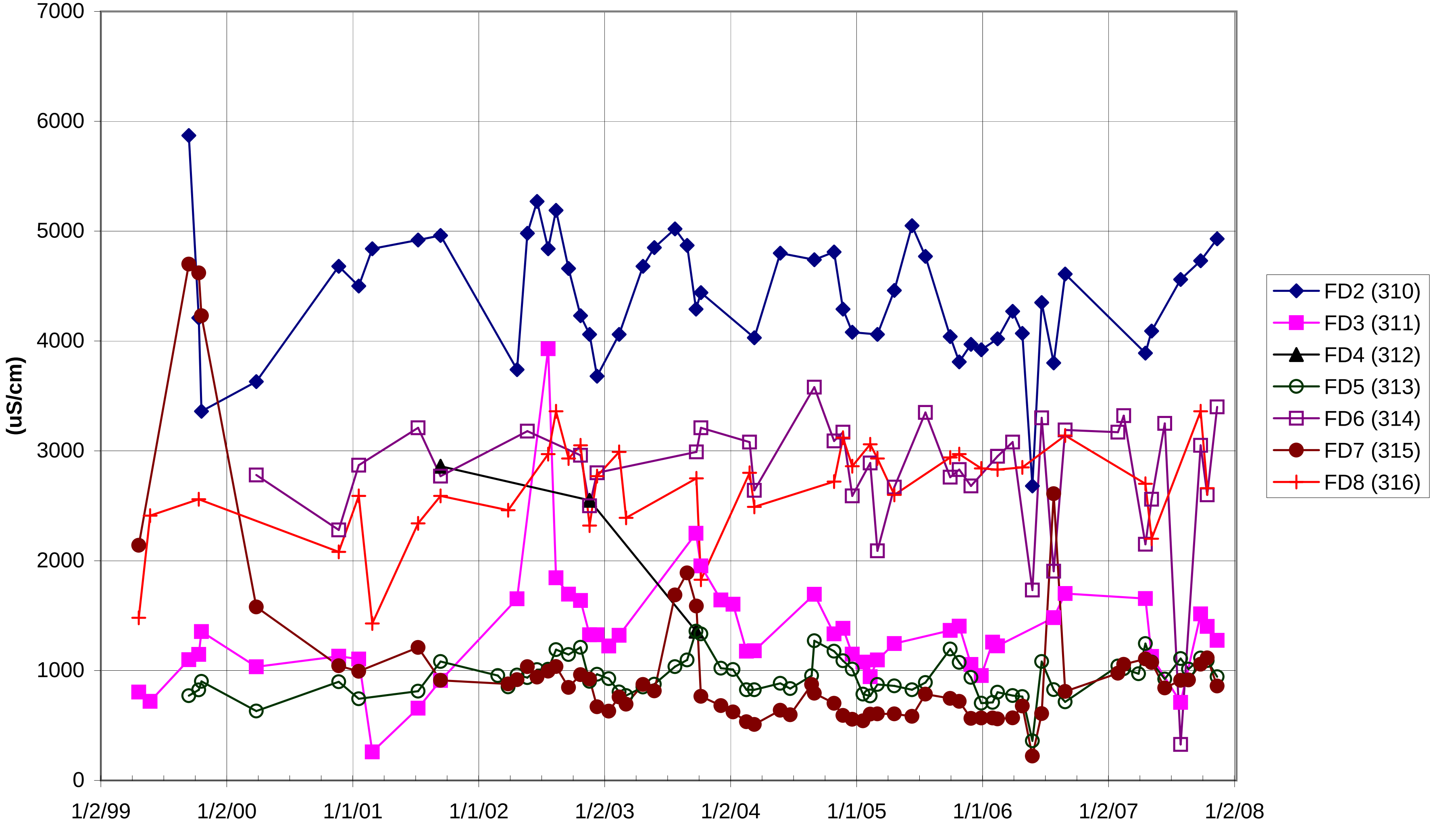


FIGURE 3.17b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - CONDUCTIVITY DATA

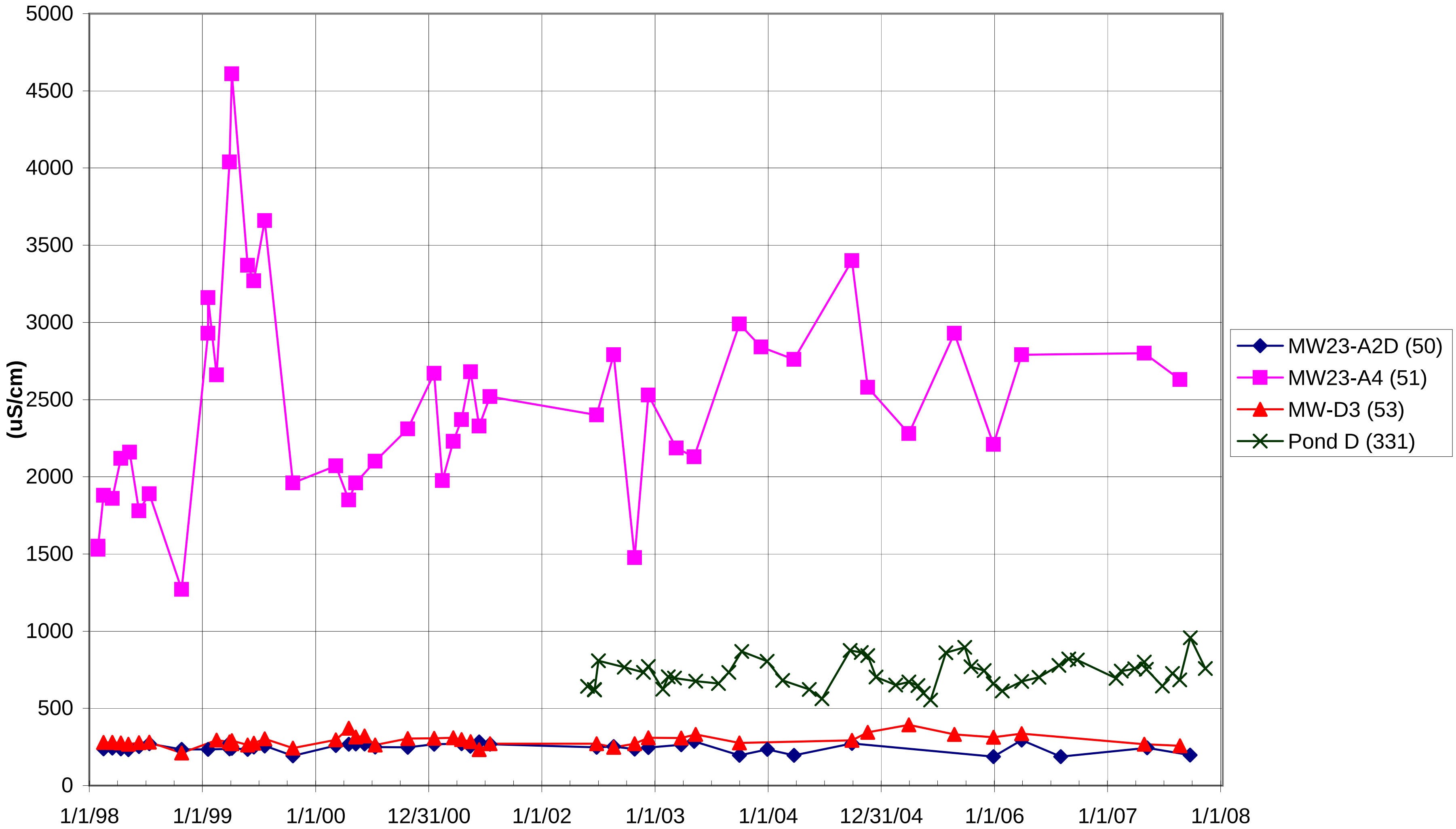


FIGURE 3.18a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES:
FINGER DRAINS - SULFATE DATA
(Non-detectable analyses plotted as zero)

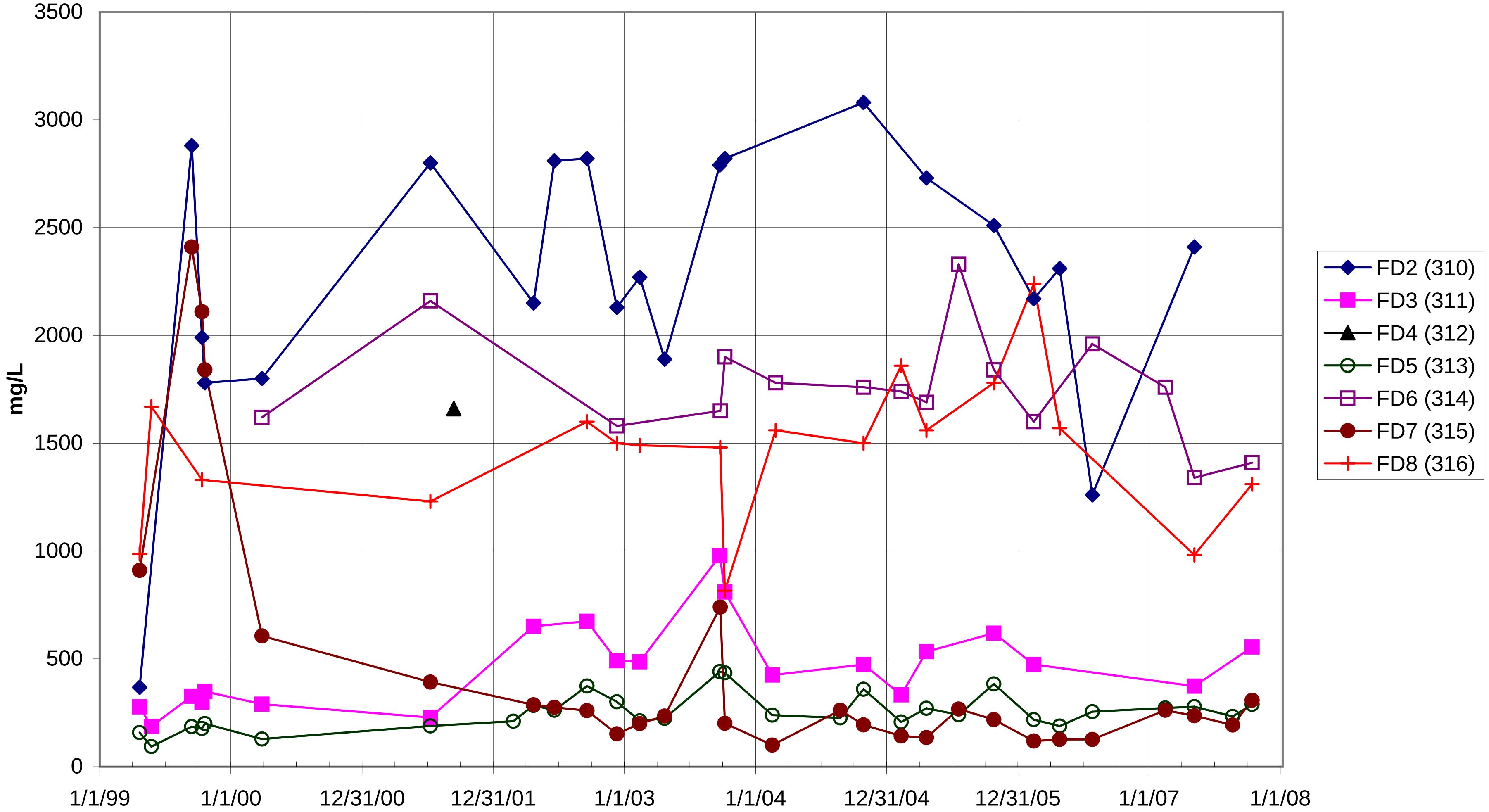


FIGURE 3.18b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - SULFATE
(Non-detectable analyses plotted as zero)

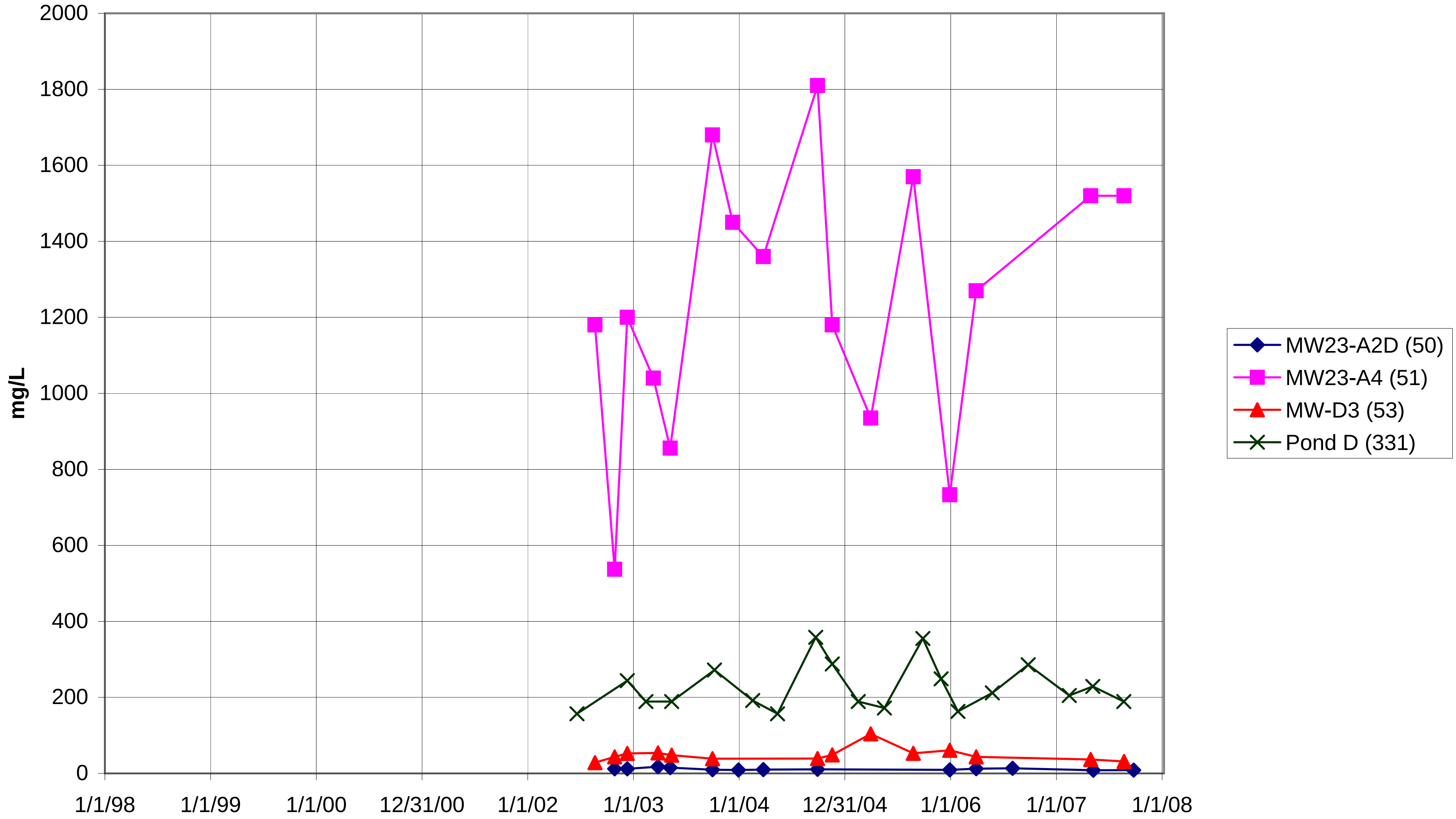


FIGURE 3.19a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - ARSENIC DATA
(Non-detectable analyses plotted as zero)

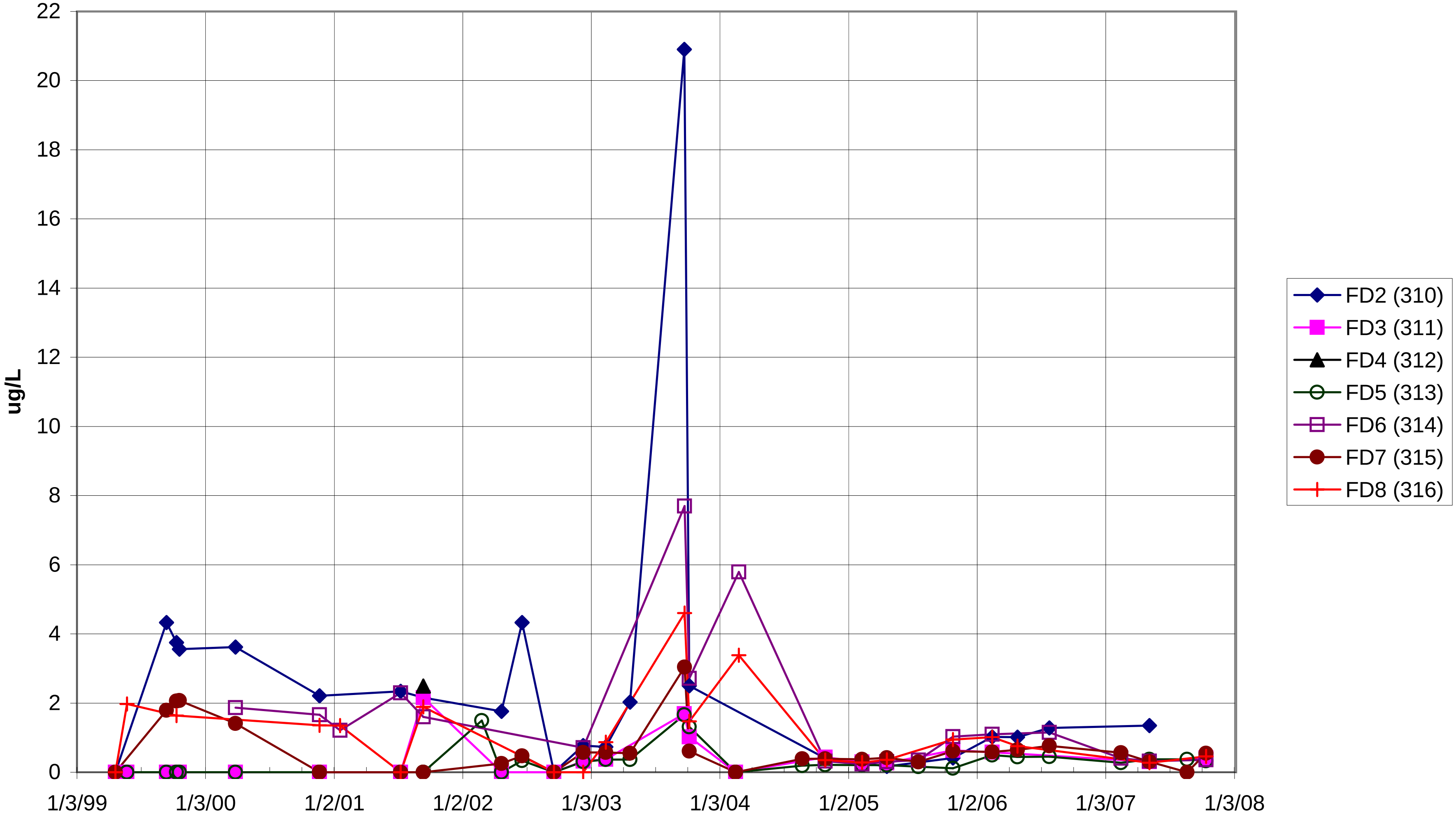


FIGURE 3.19b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - ARSENIC DATA (Non-detectable analyses plotted as zero)

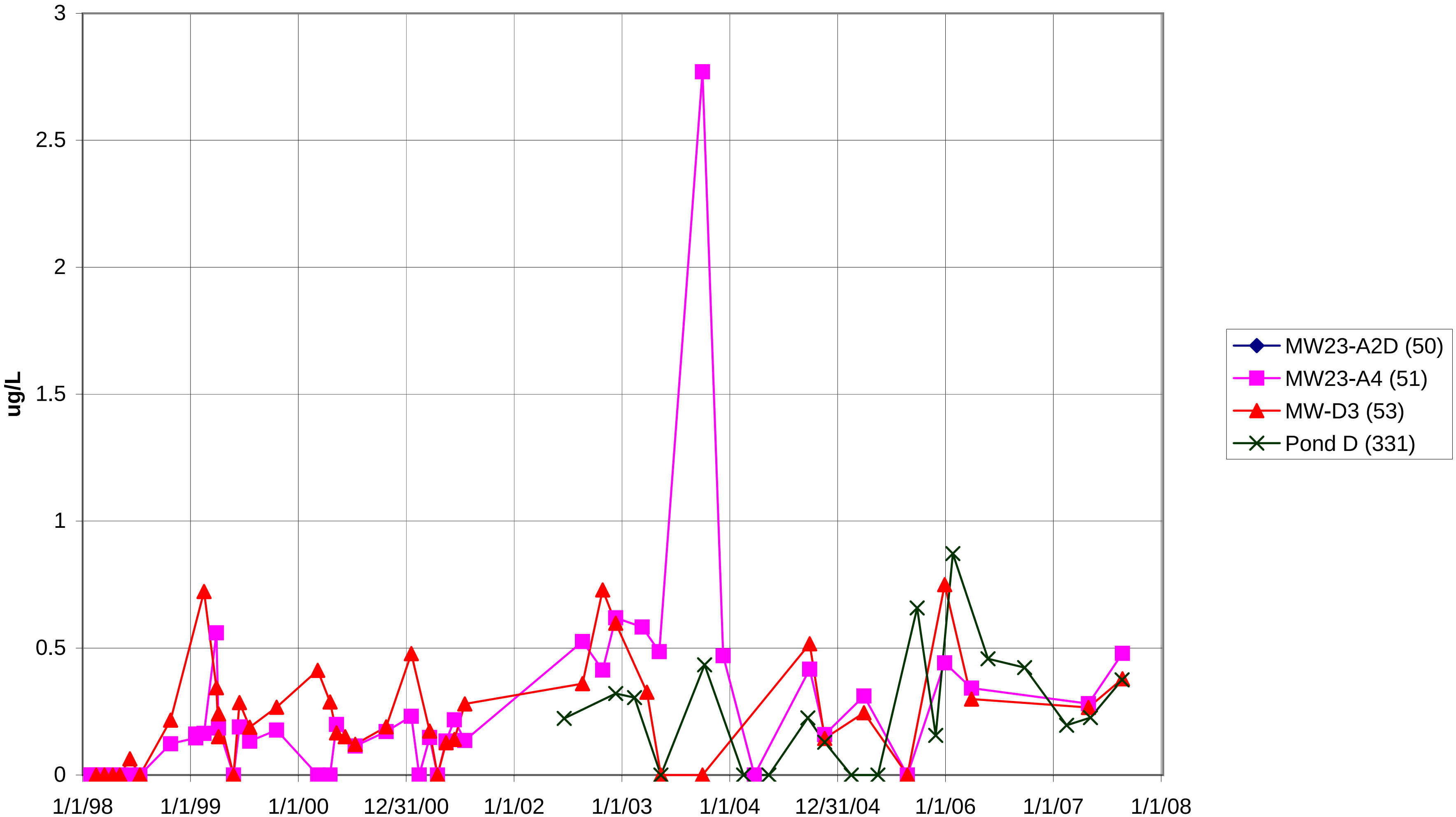


FIGURE 3.20a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - ZINC DATA (Non-detectable analyses plotted as zero)

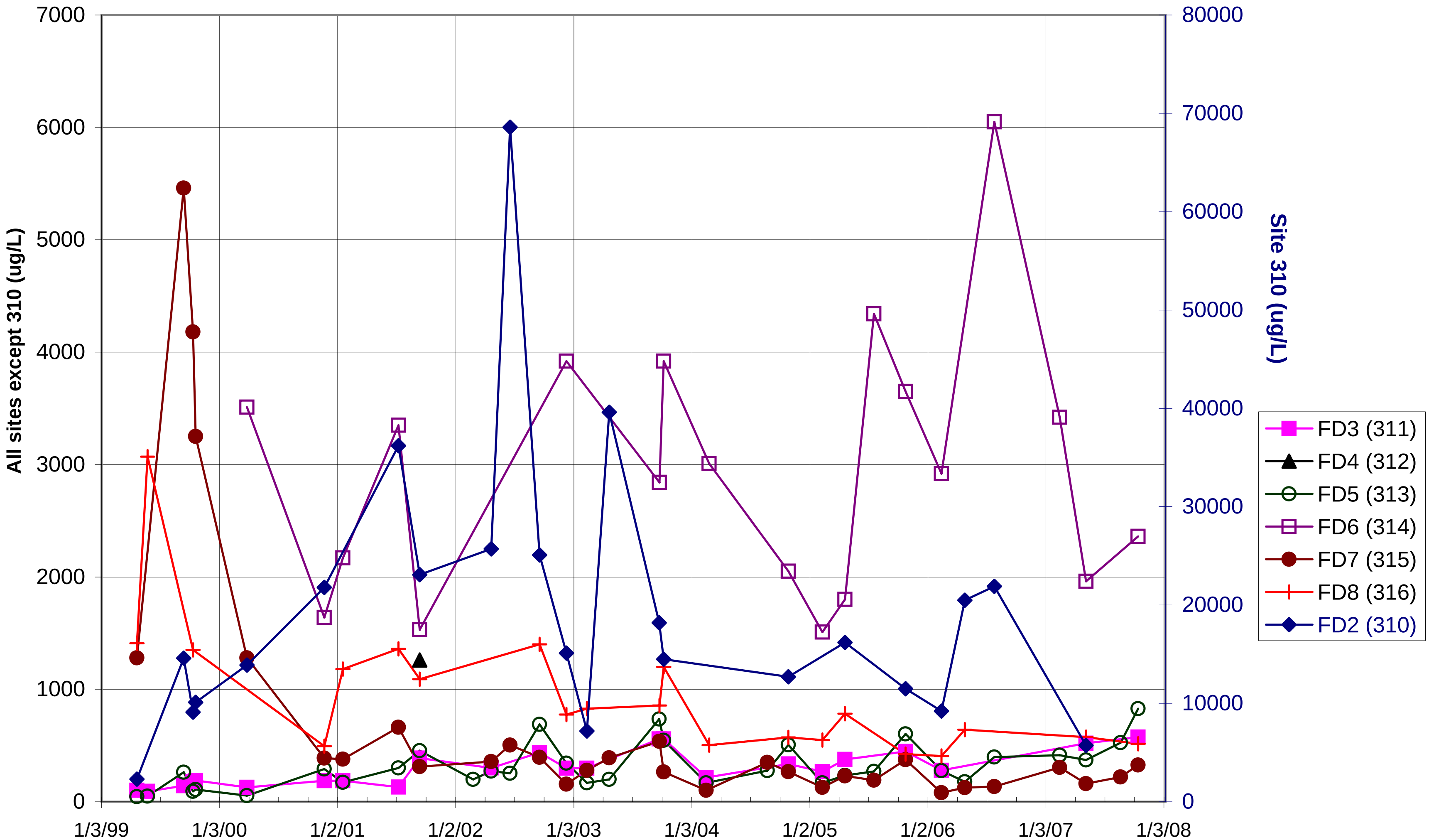


FIGURE 3.20b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - ZINC DATA
(Non-detectable analyses plotted as zero)

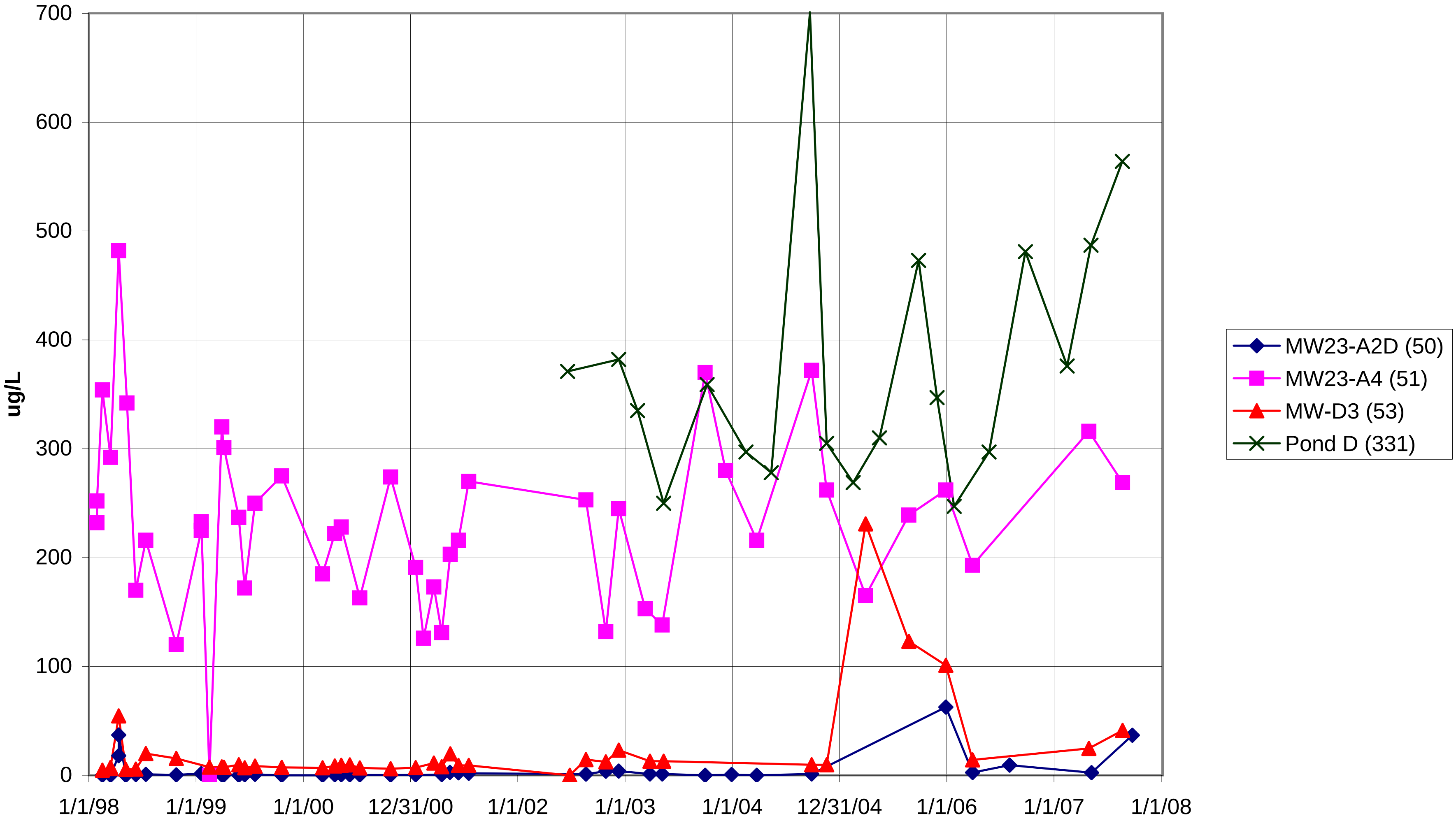


FIGURE 3.21a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - CADMIUM DATA
(Non-detectable analyses plotted as zero)

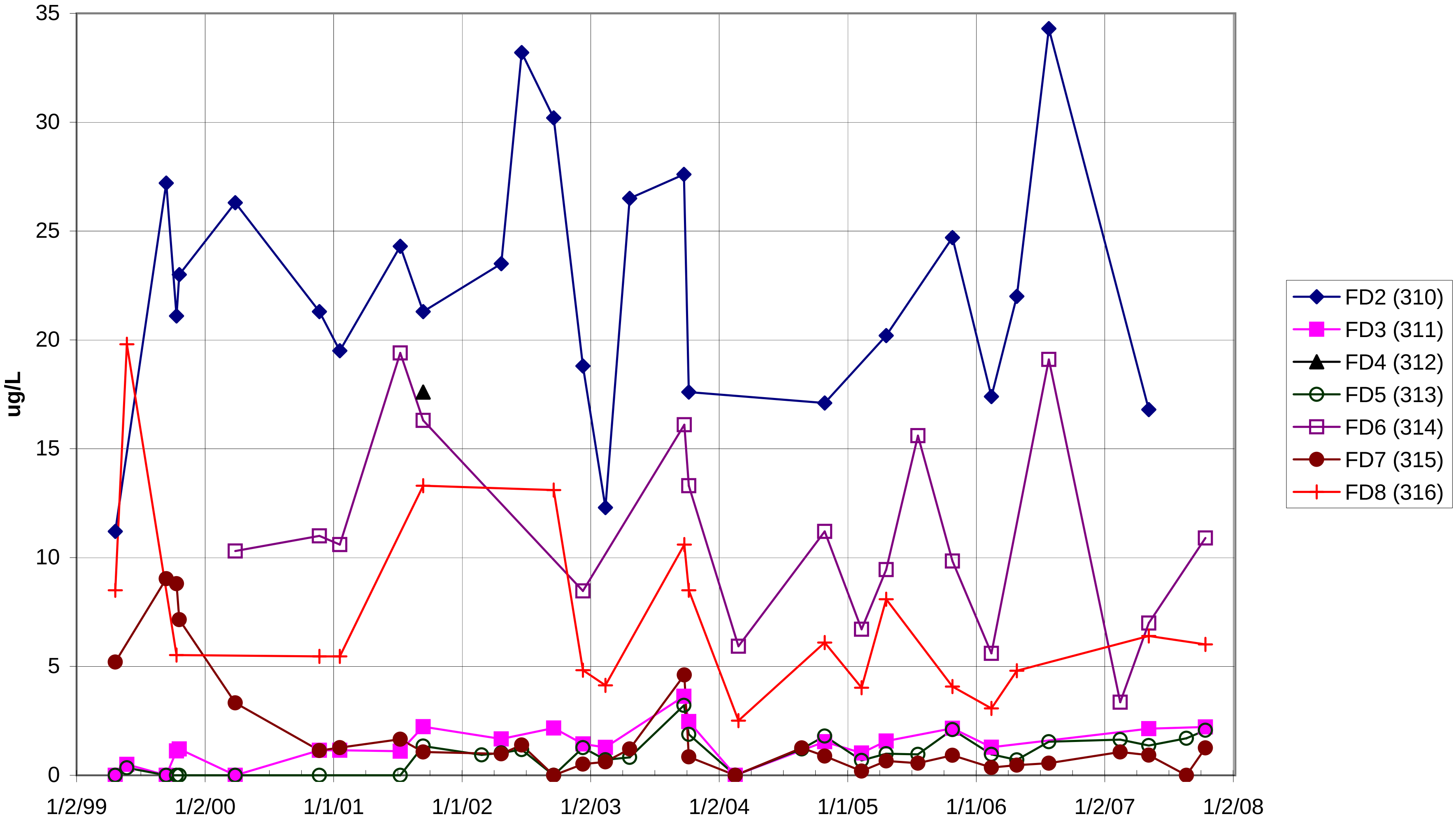


FIGURE 3.21b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - CADMIUM DATA (Non-detectable analyses plotted as zero)

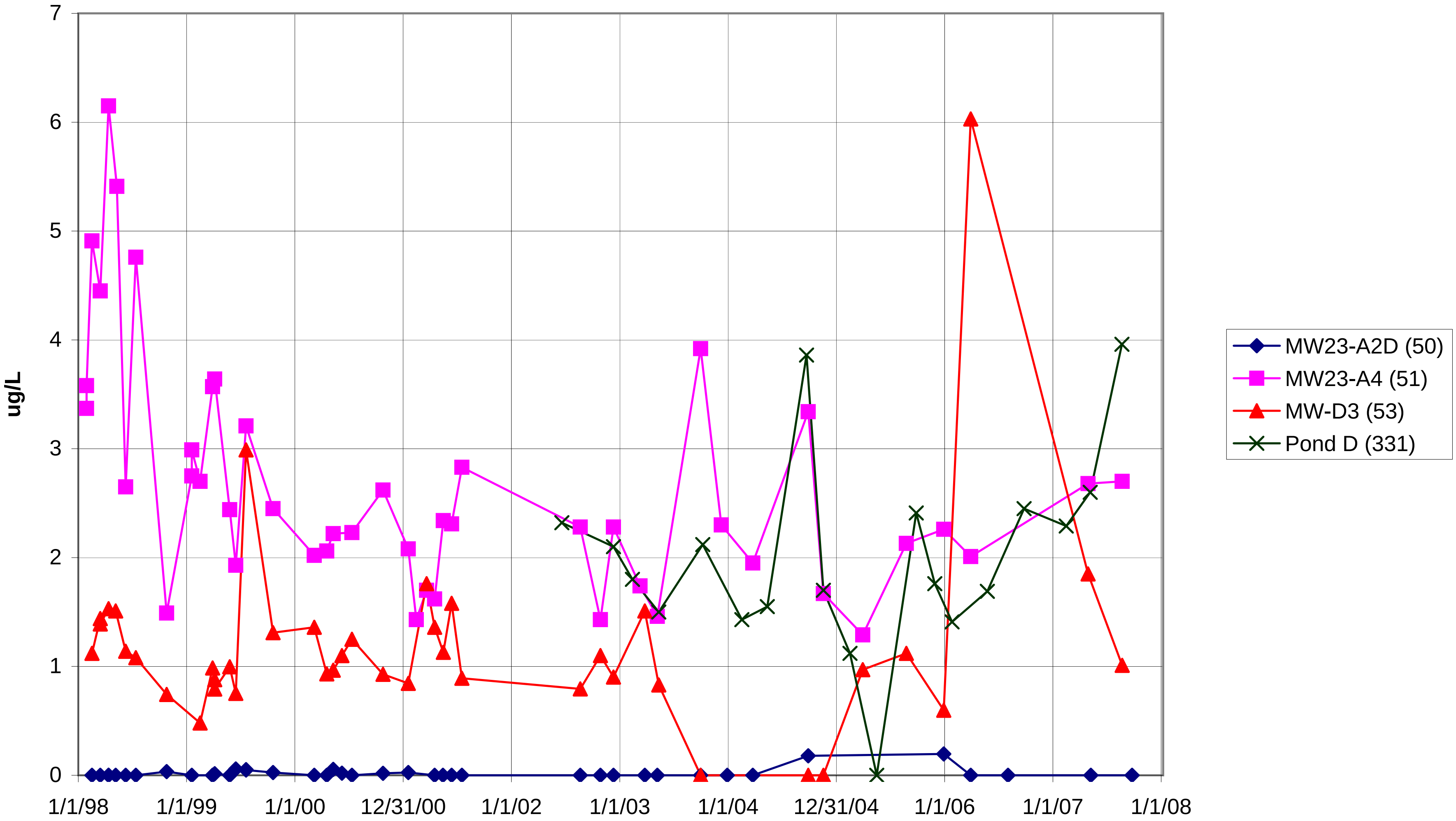


FIGURE 3.22a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES:
FINGER DRAINS - COPPER DATA
(Non-detectable analyses plotted as zero)

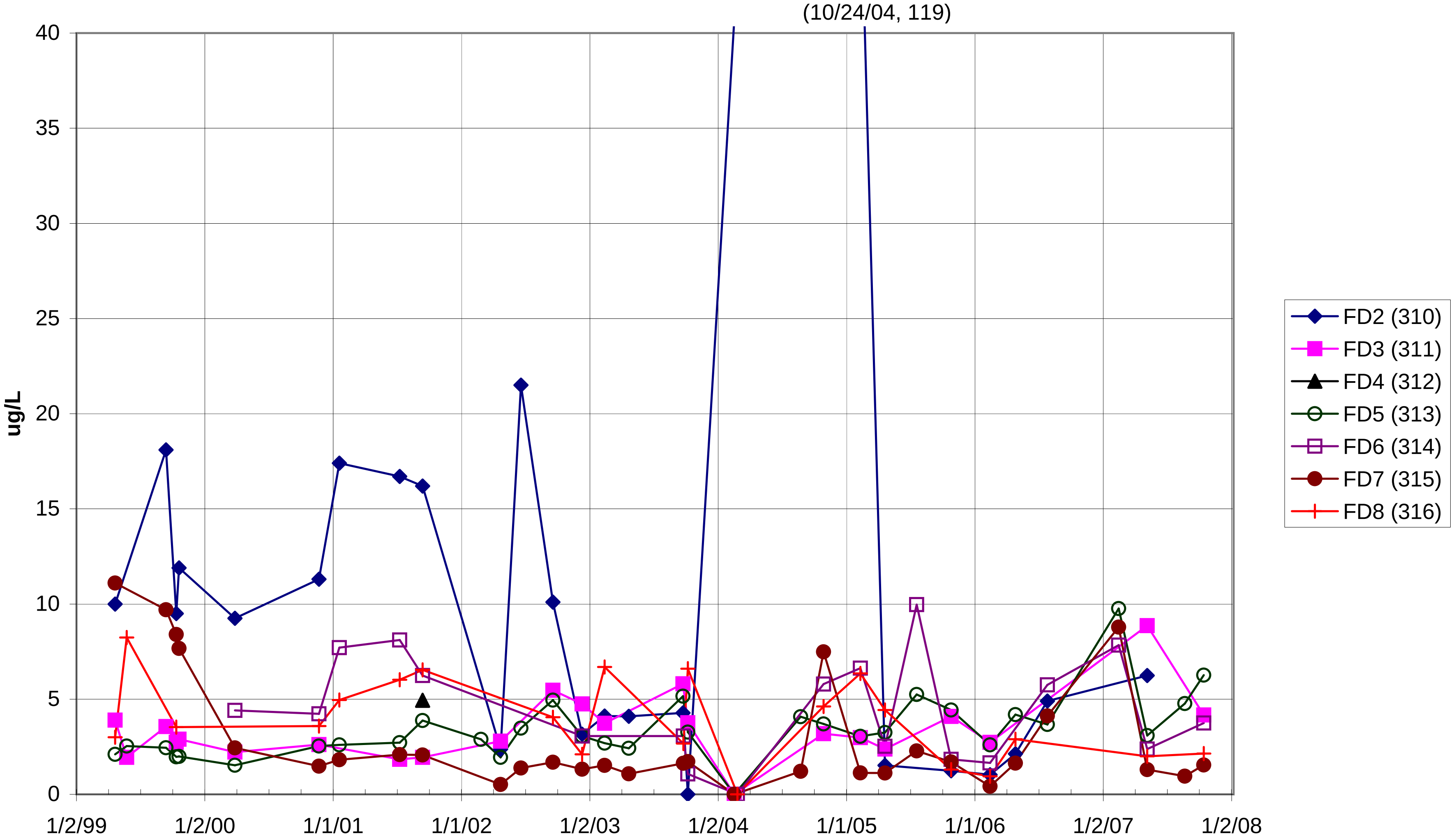


FIGURE 3.22b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - COPPER DATA (Non-detectable analyses plotted as zero)

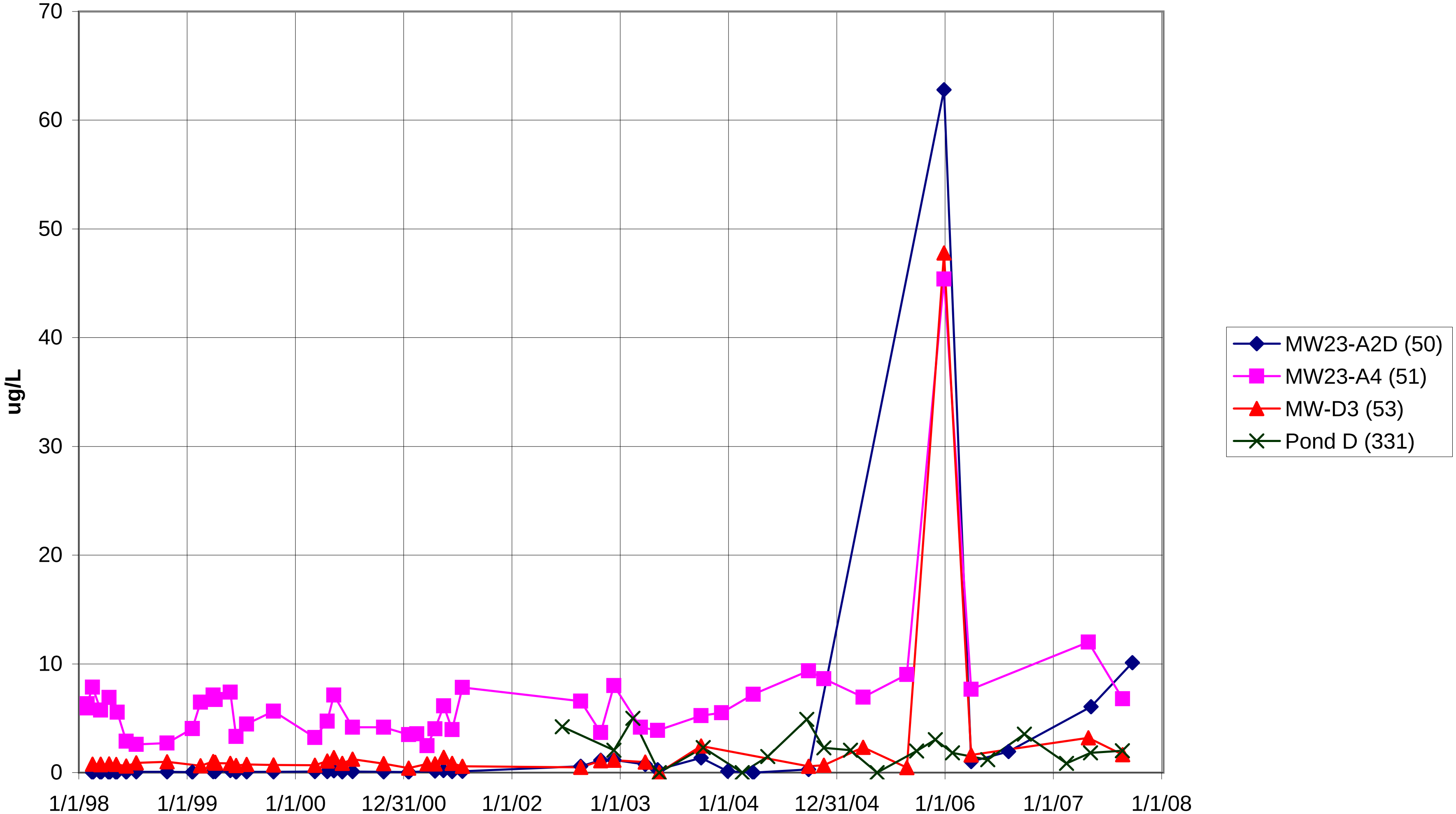


FIGURE 3.23a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - LEAD DATA (Non-detectable analyses plotted as zero)

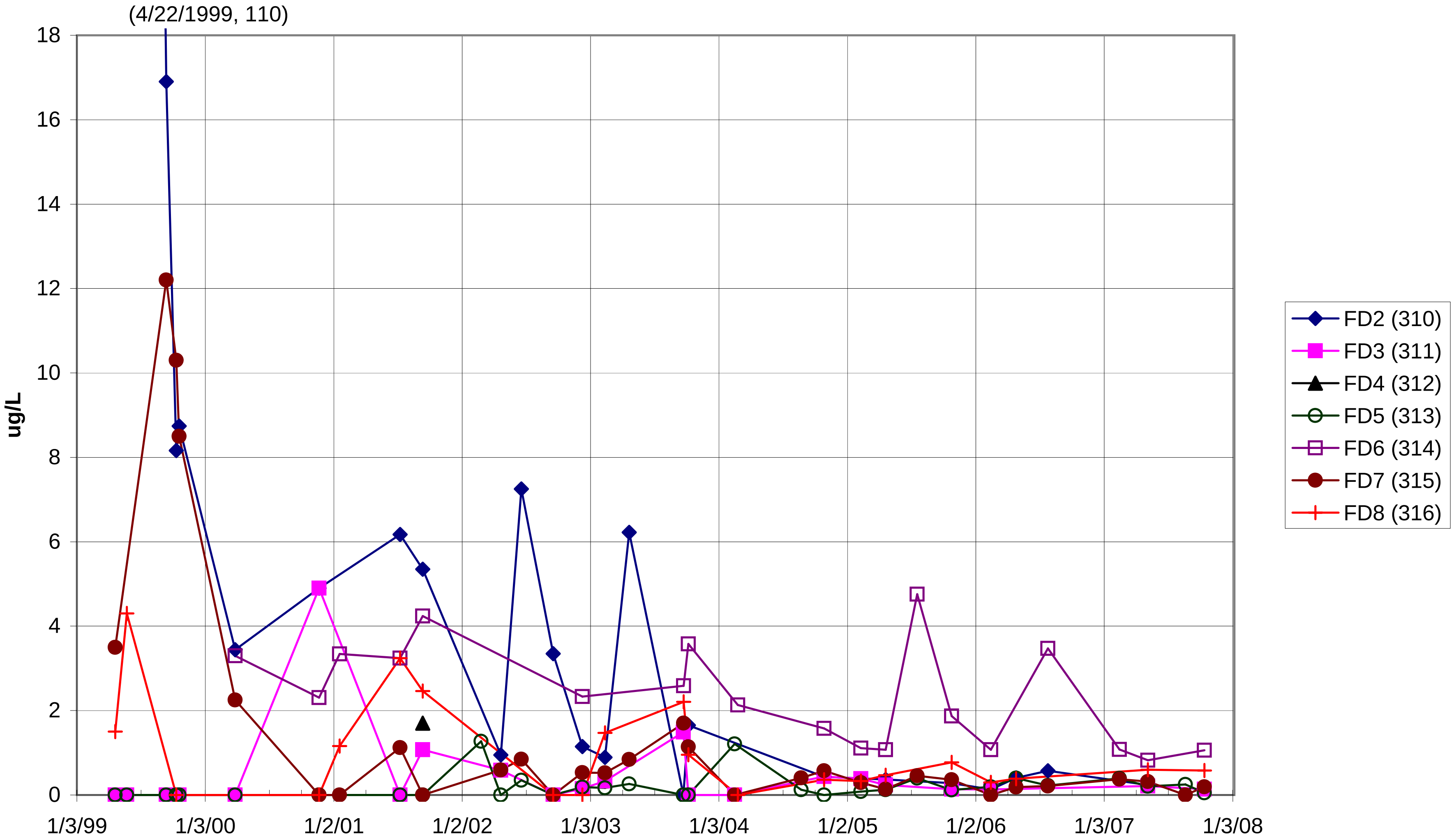


FIGURE 3.23b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - LEAD DATA
(Non-detectable analyses plotted as zero)

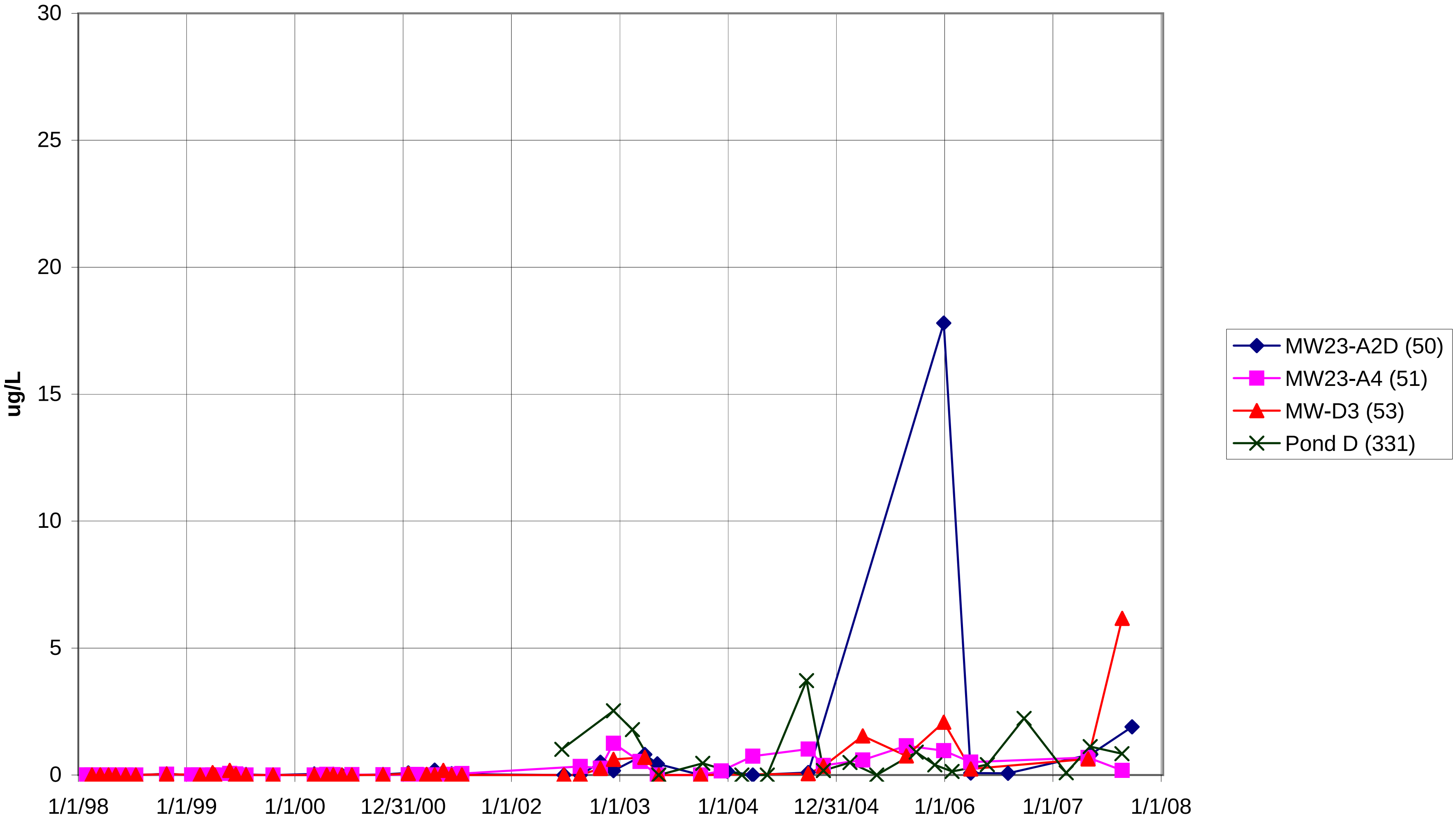


FIGURE 3.24a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES:
FINGER DRAINS - NICKEL DATA
(Non-detectable analyses plotted as zero)

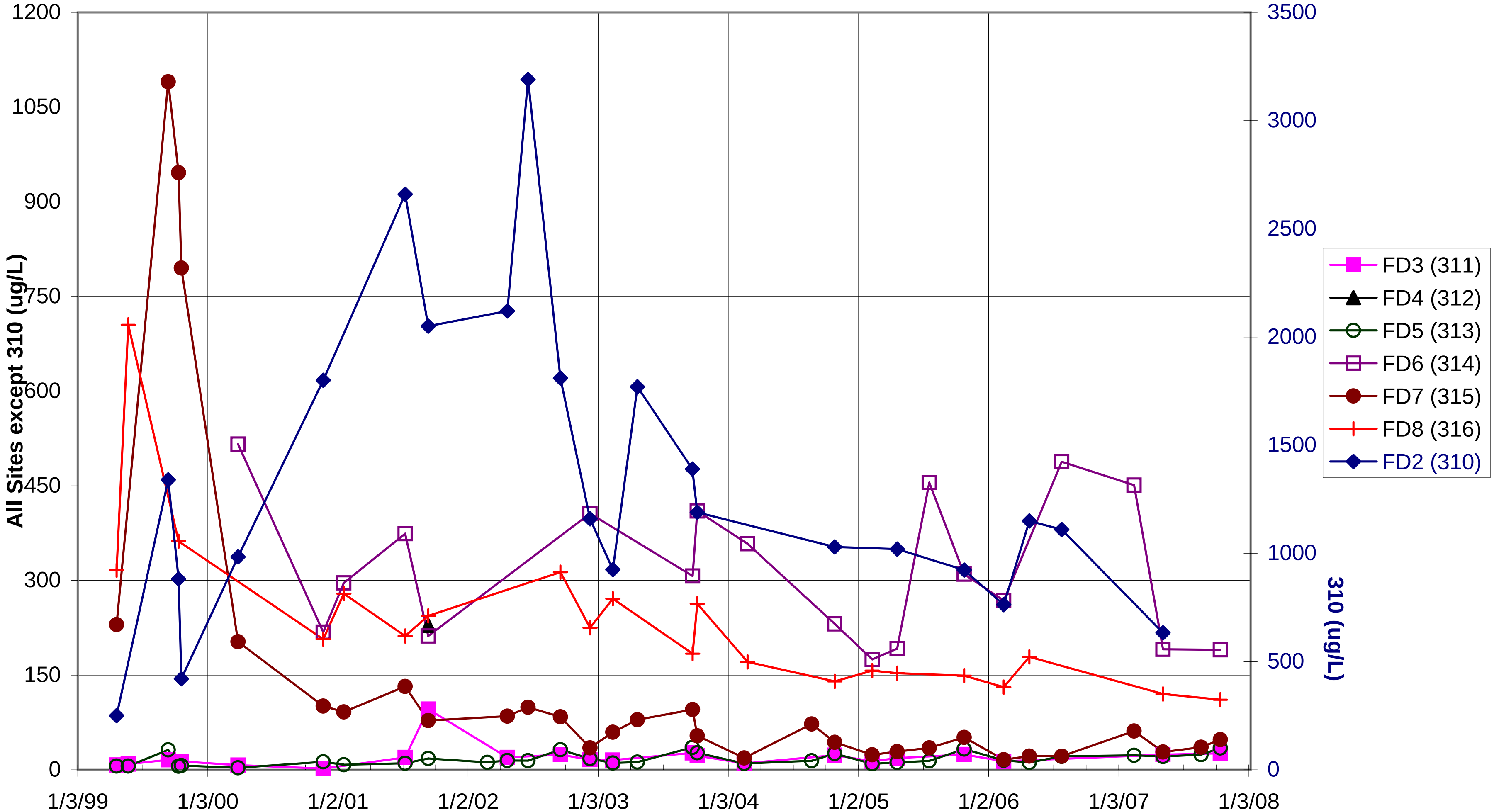


FIGURE 3.24b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - NICKEL DATA (Non-detectable analyses plotted as zero)

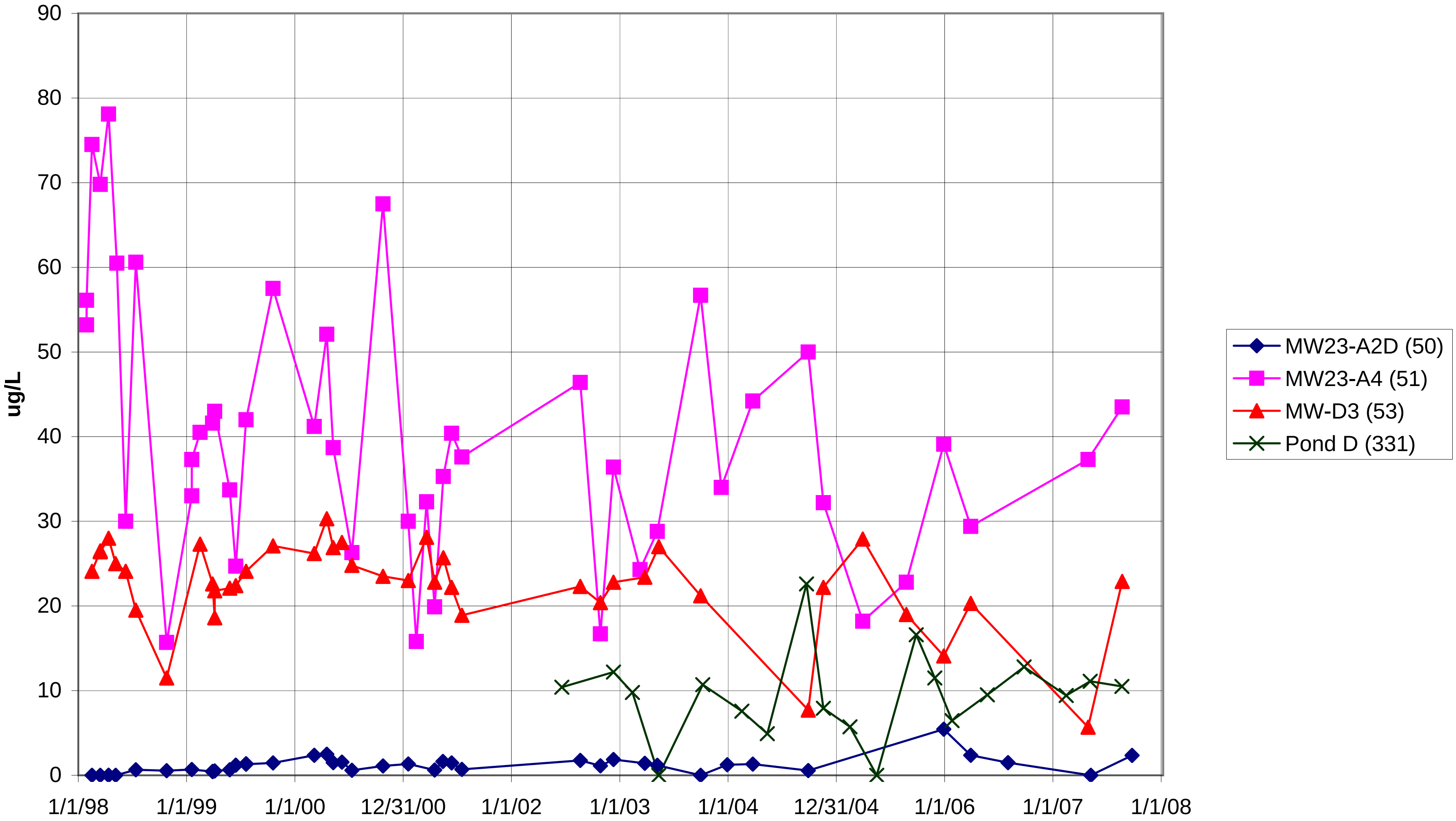


FIGURE 3.25a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - IRON DATA (Non-detectable analyses plotted as zero)

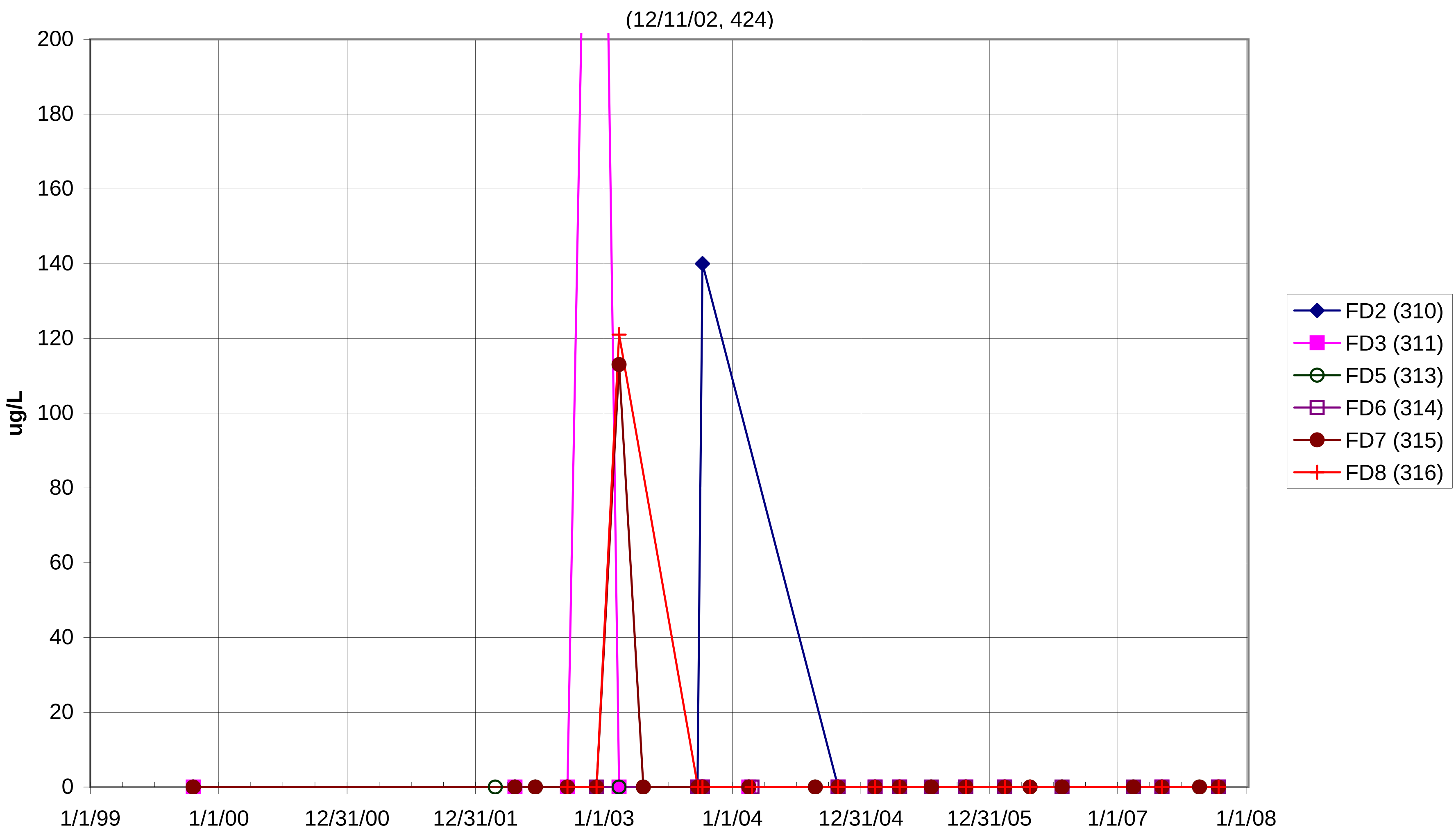


FIGURE 3.25b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - IRON DATA
(Non-detectable analyses plotted as zero)

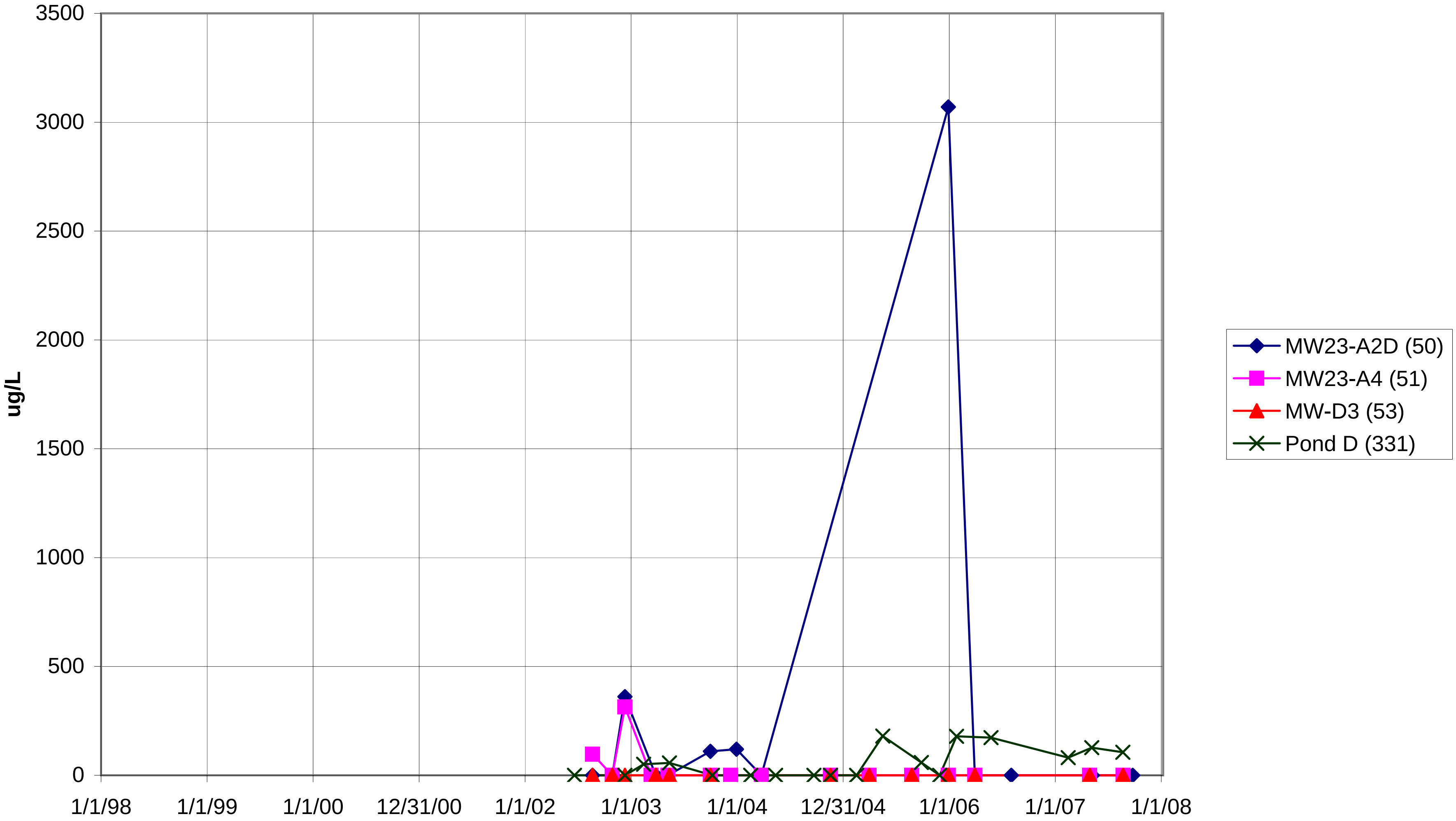


FIGURE 3.26a GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - MANGANESE DATA
(Non-detectable analyses plotted as zero)

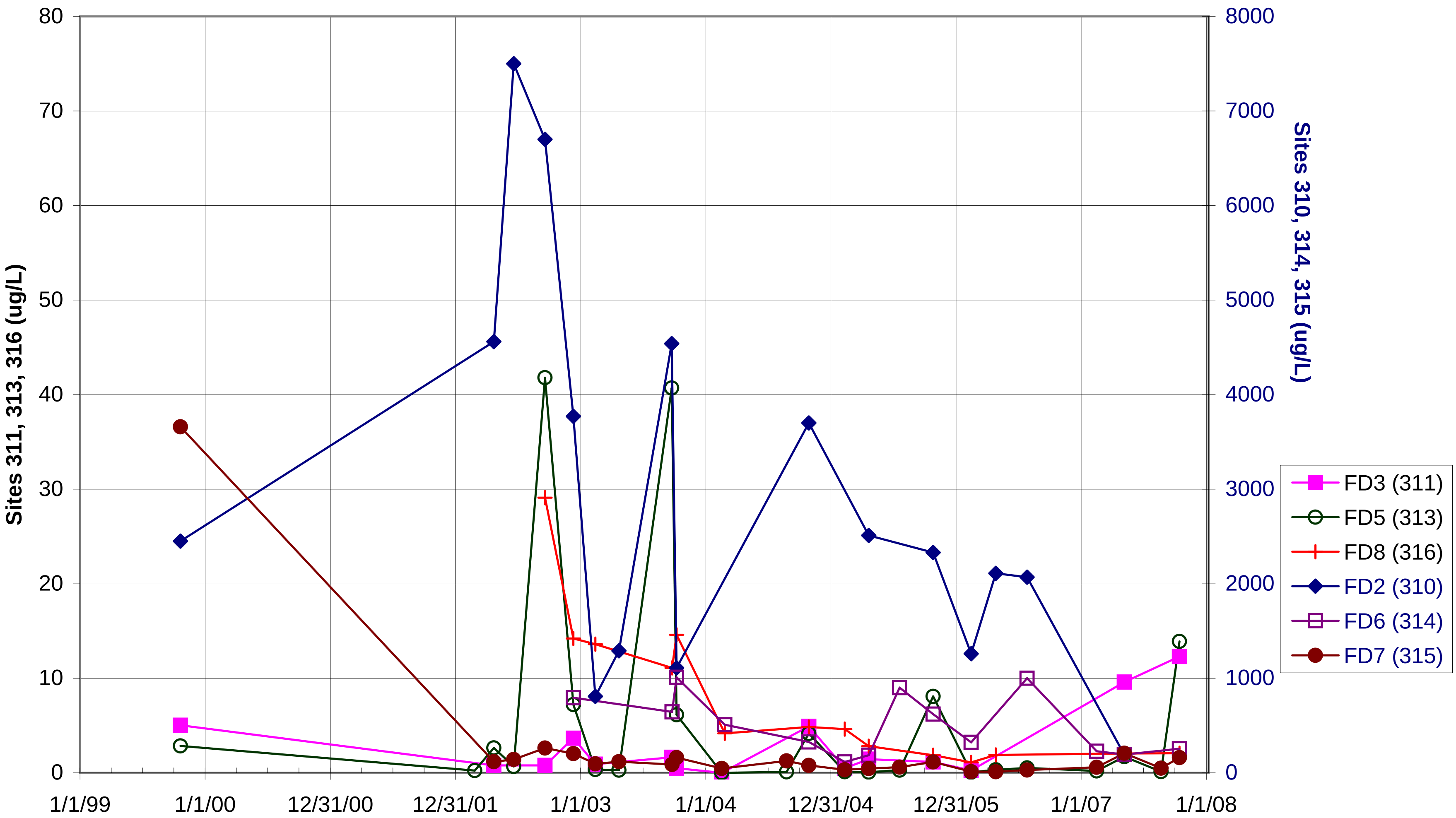


FIGURE 3.26b GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: GROUND WATER - MANGANESE DATA (Non-detectable analyses plotted as zero)

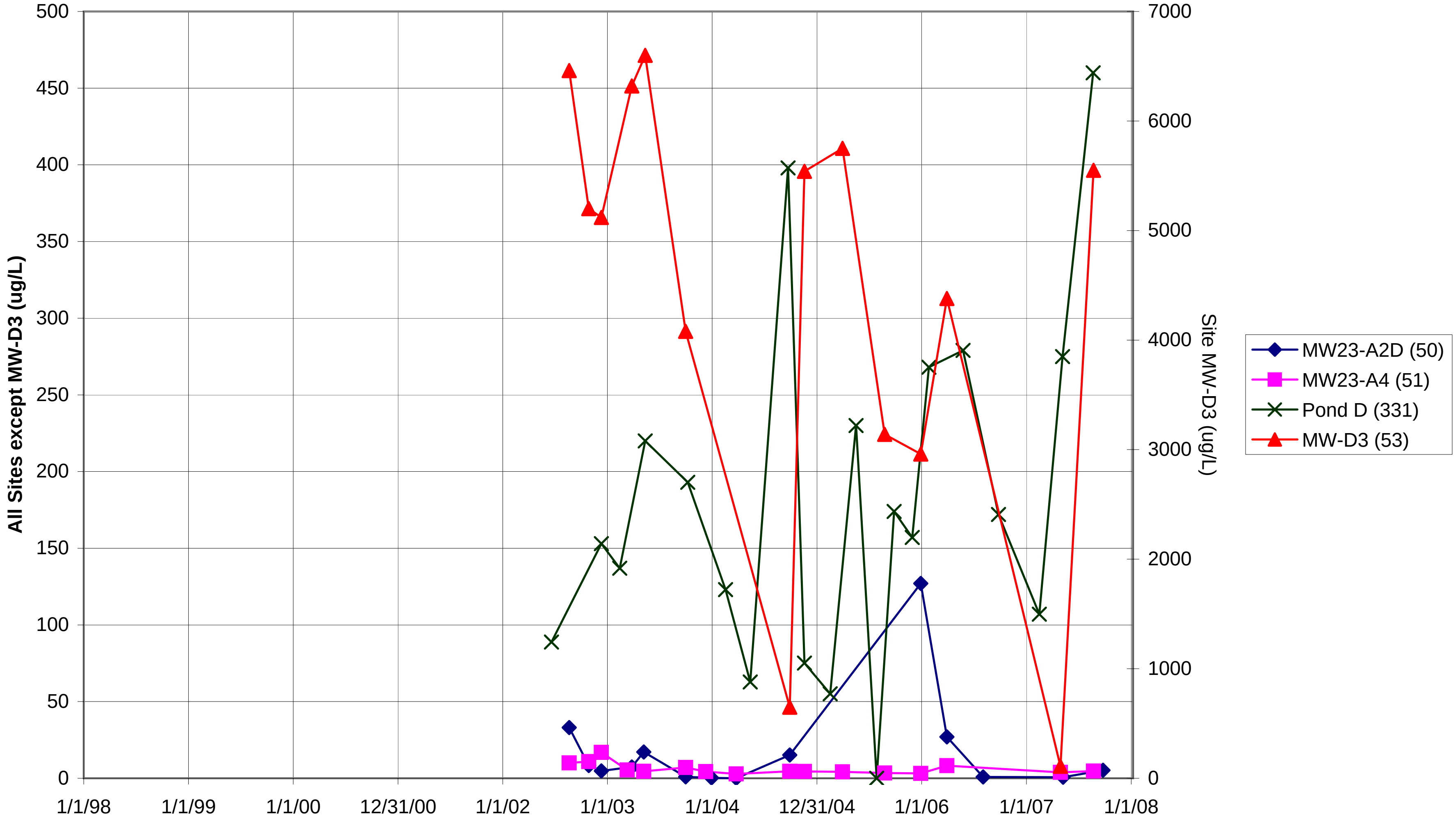


FIGURE 3.27 GREENS CREEK SITE 23/D INTERNAL MONITORING SITES: FINGER DRAINS - FLOW

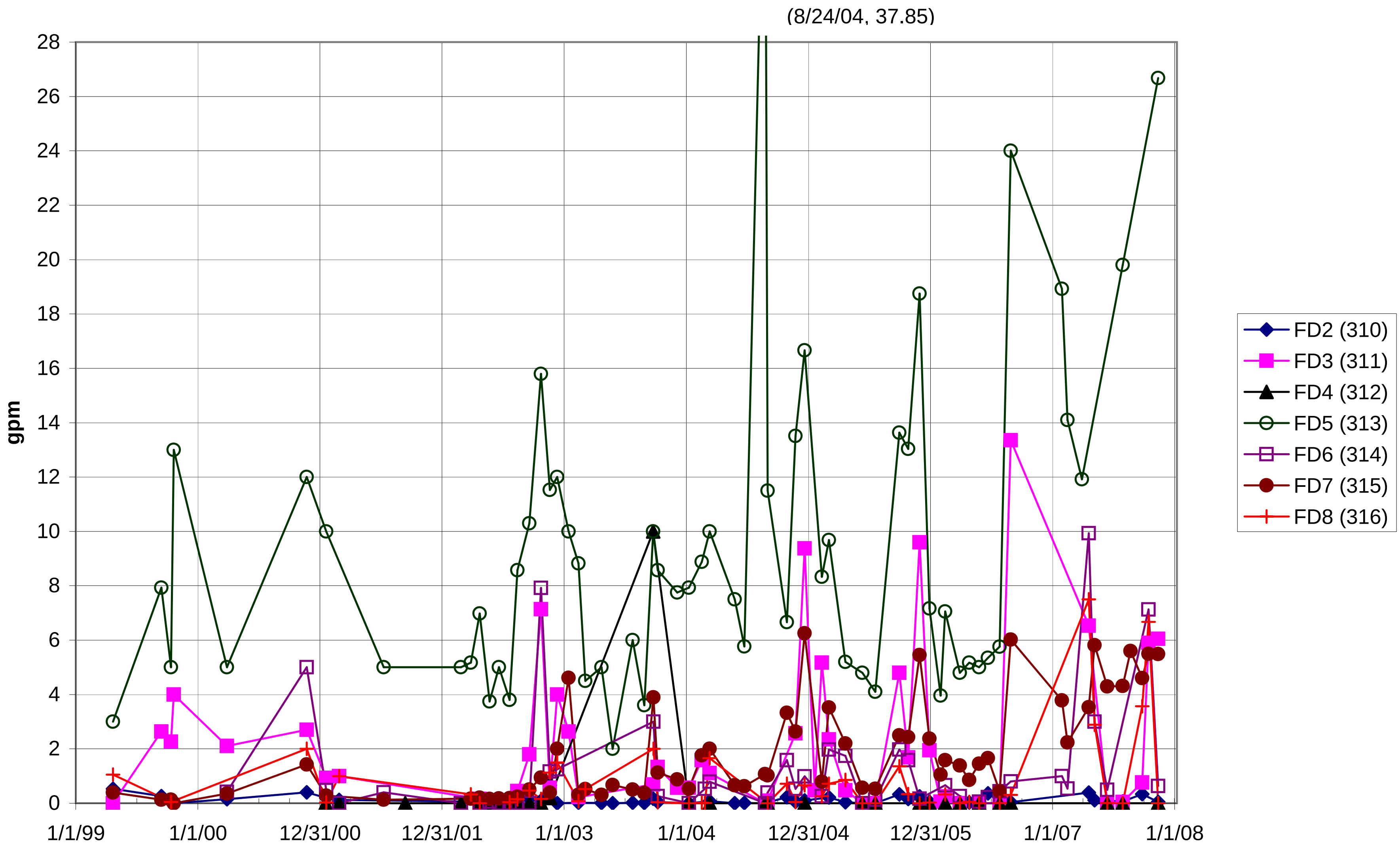


FIGURE 3.28 2007 and 2006 ABA DATA FROM UNDERGROUND RIB SAMPLES

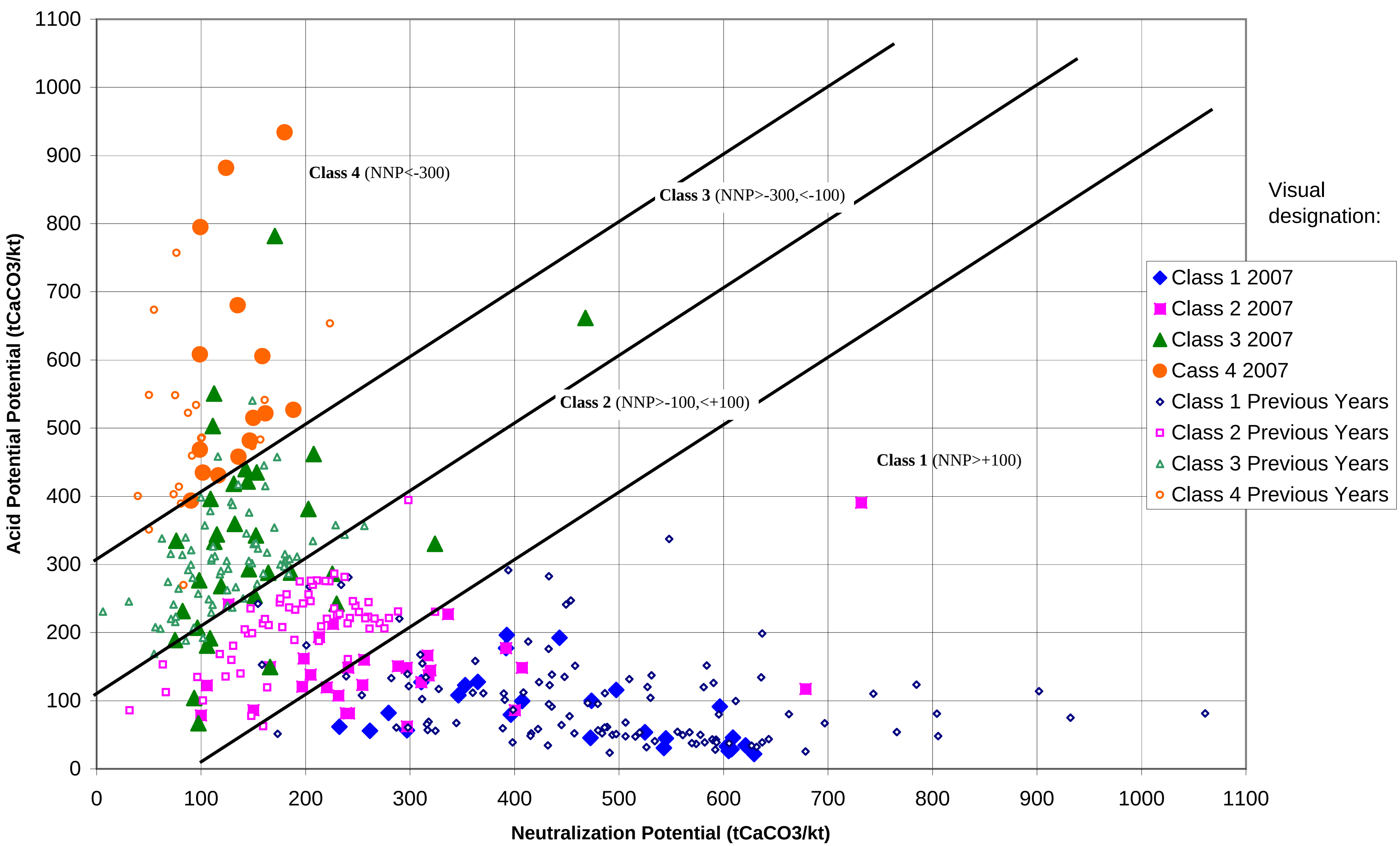
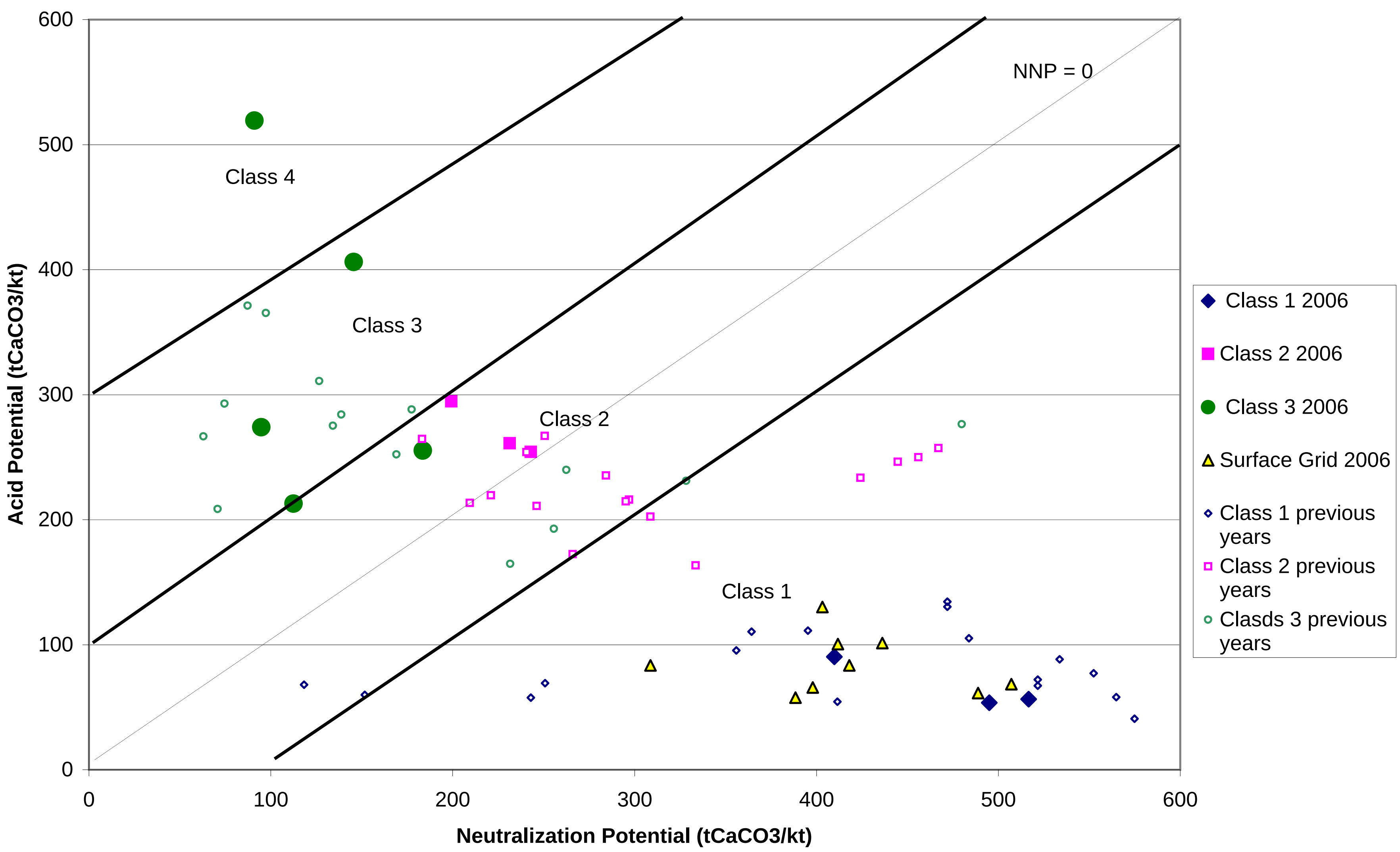


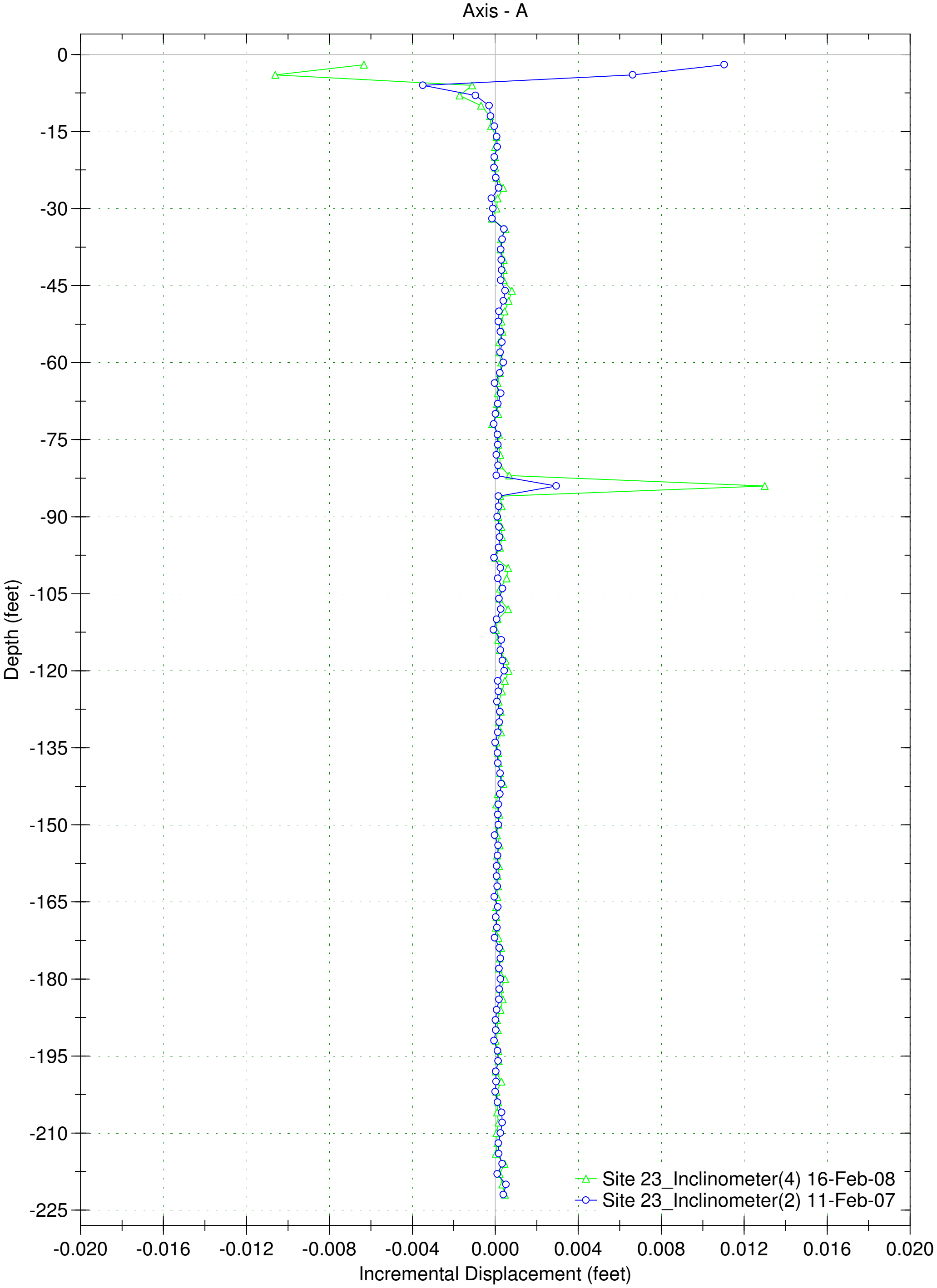
FIGURE 3.29 ACID-BASE ACCOUNTING DATA FOR SURFACE SITE 23

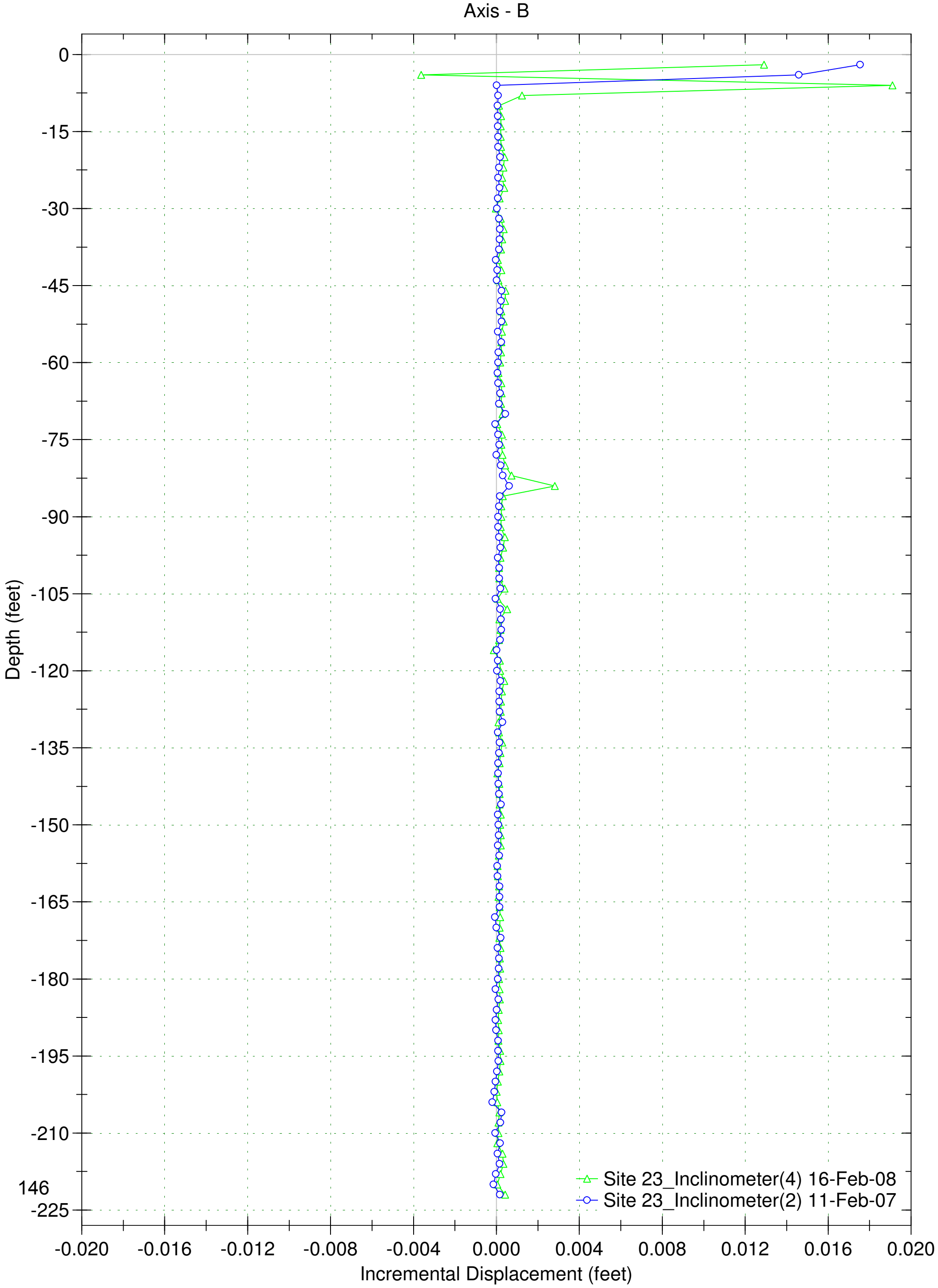


RST Instruments Ltd. | INCREMENTAL DISPLACEMENT | Inclinalysis

Borehole : Inclinometer
Project : Site 23
Location :
Northing :
Easting :

Spiral Correction : N/A
Collar Elevation :
Borehole Total Depth : 222.0 feet
North Groove Azimuth :
Base Reading : 2006 Oct 07 10:28





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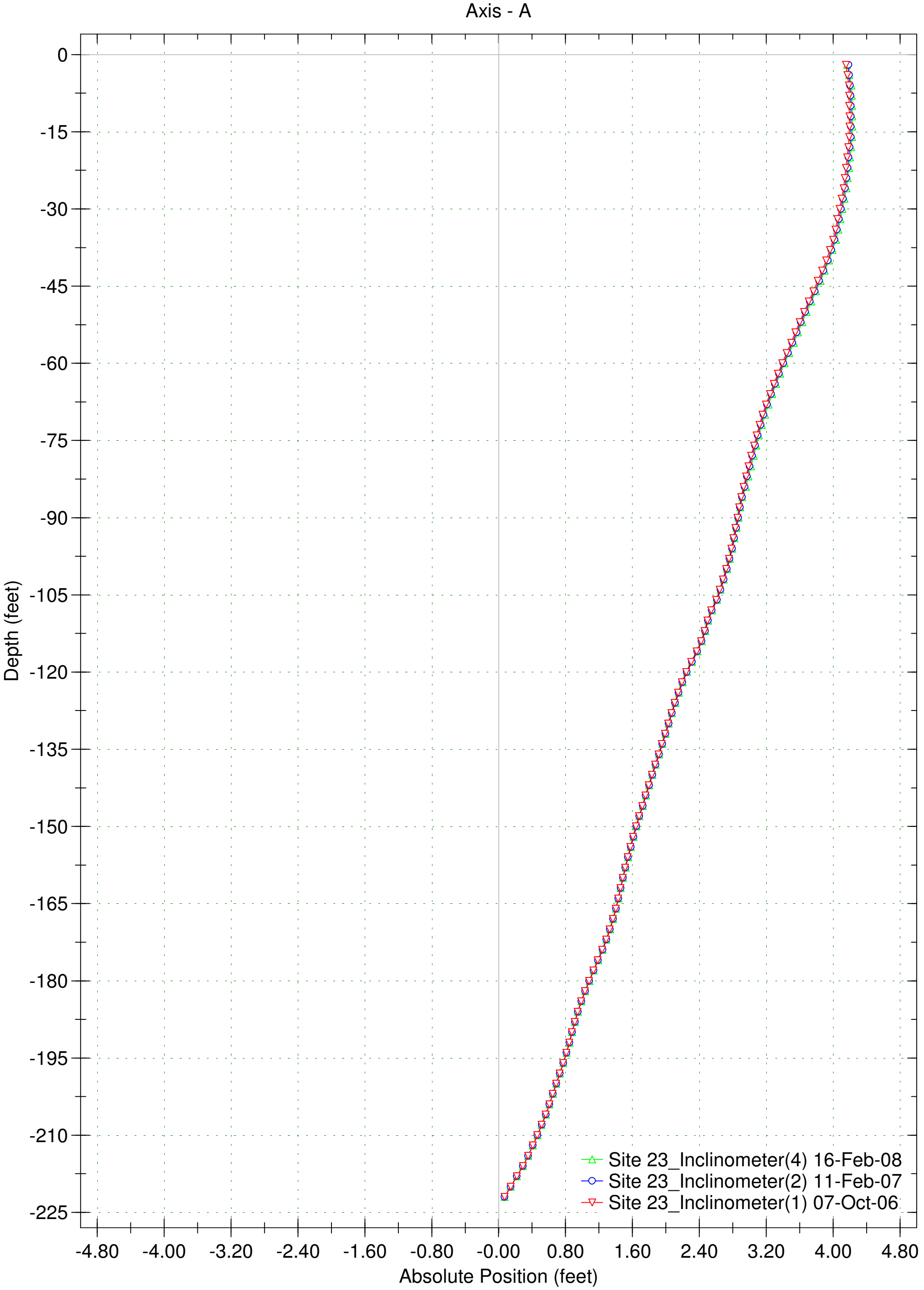
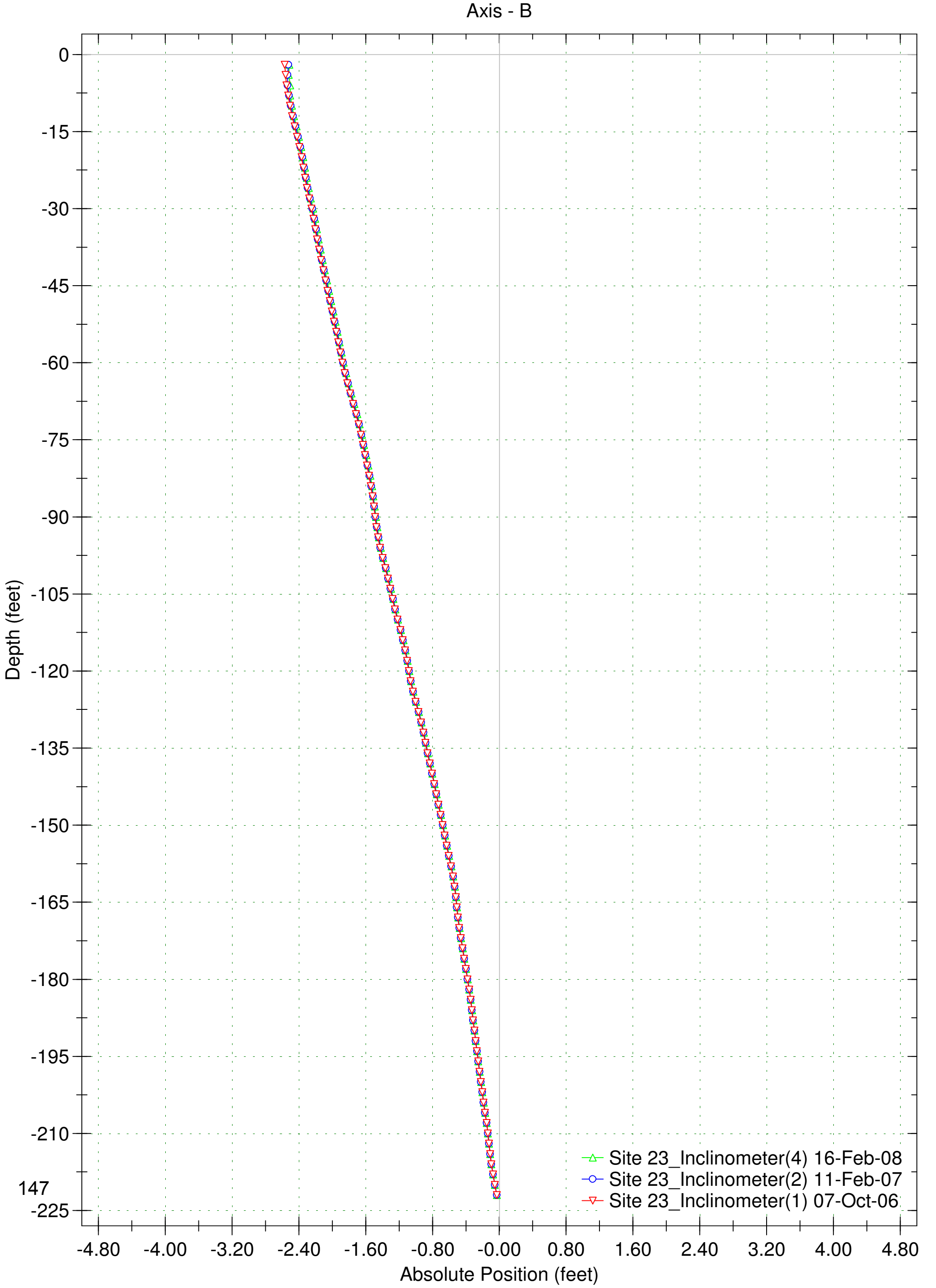
ABSOLUTE POSITION

Inclinalysis

Borehole : Inclinometer
Project : Site 23
Location :
Northing :
Easting :

Spiral Correction : N/A
Collar Elevation :
Borehole Total Depth : 222.0 feet
North Groove Azimuth :
Base Reading : 2006 Oct 07 10:28





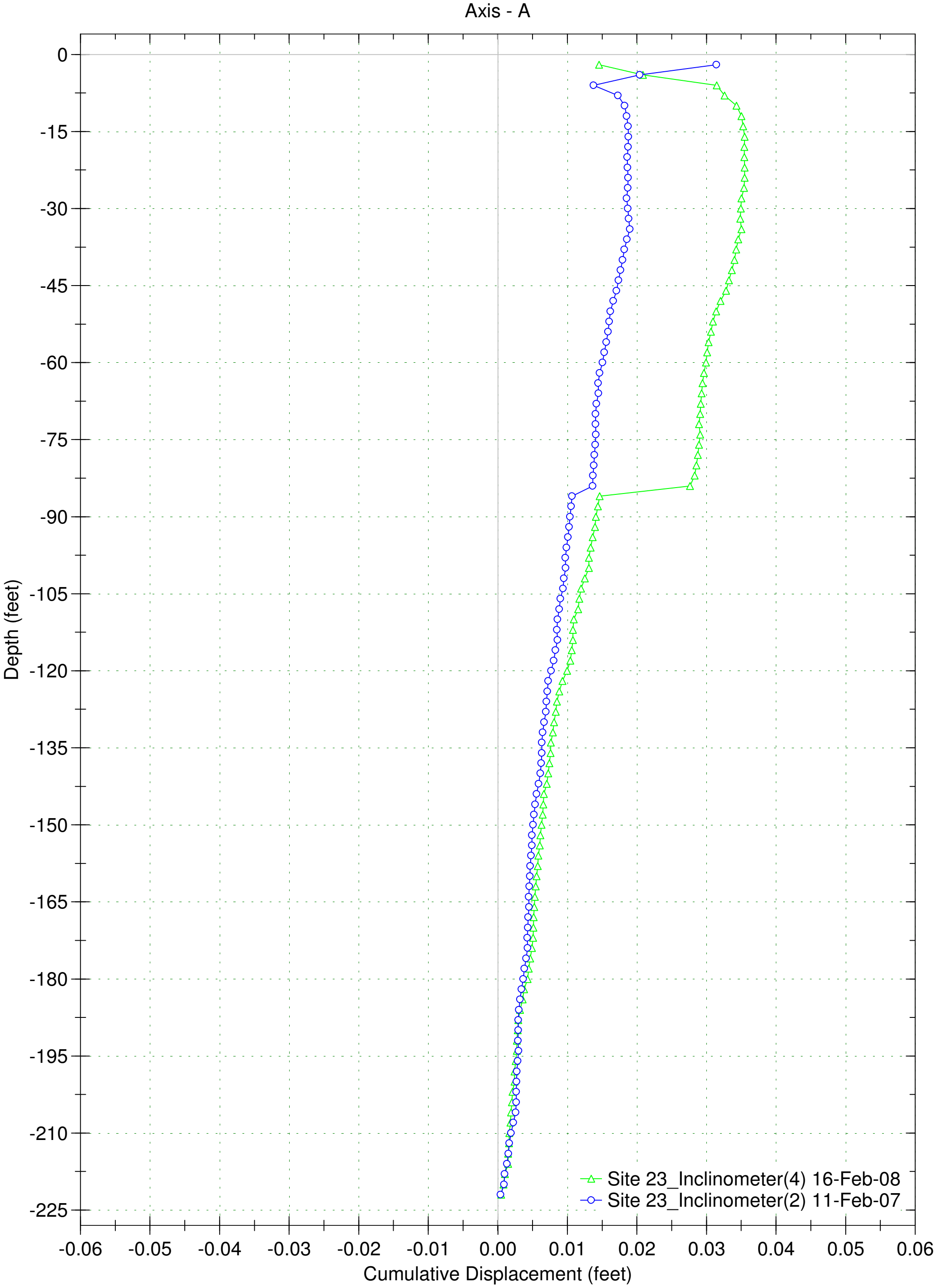
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis

Borehole : Inclinometer
Project : Site 23
Location :
Northing :
Easting :

Spiral Correction : N/A
Collar Elevation :
Borehole Total Depth : 222.0 feet
North Groove Azimuth :
Base Reading : 2006 Oct 07 10:28



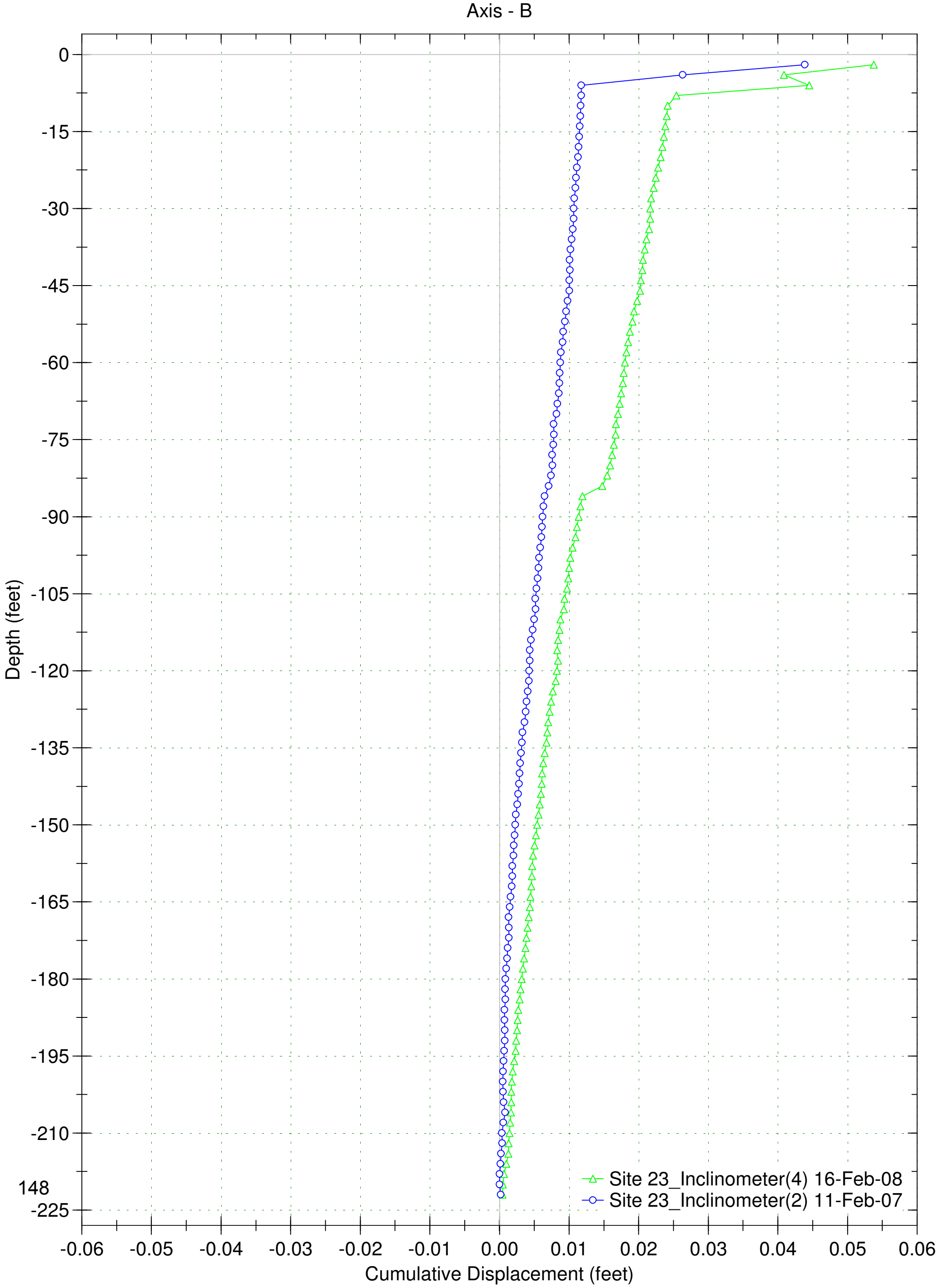
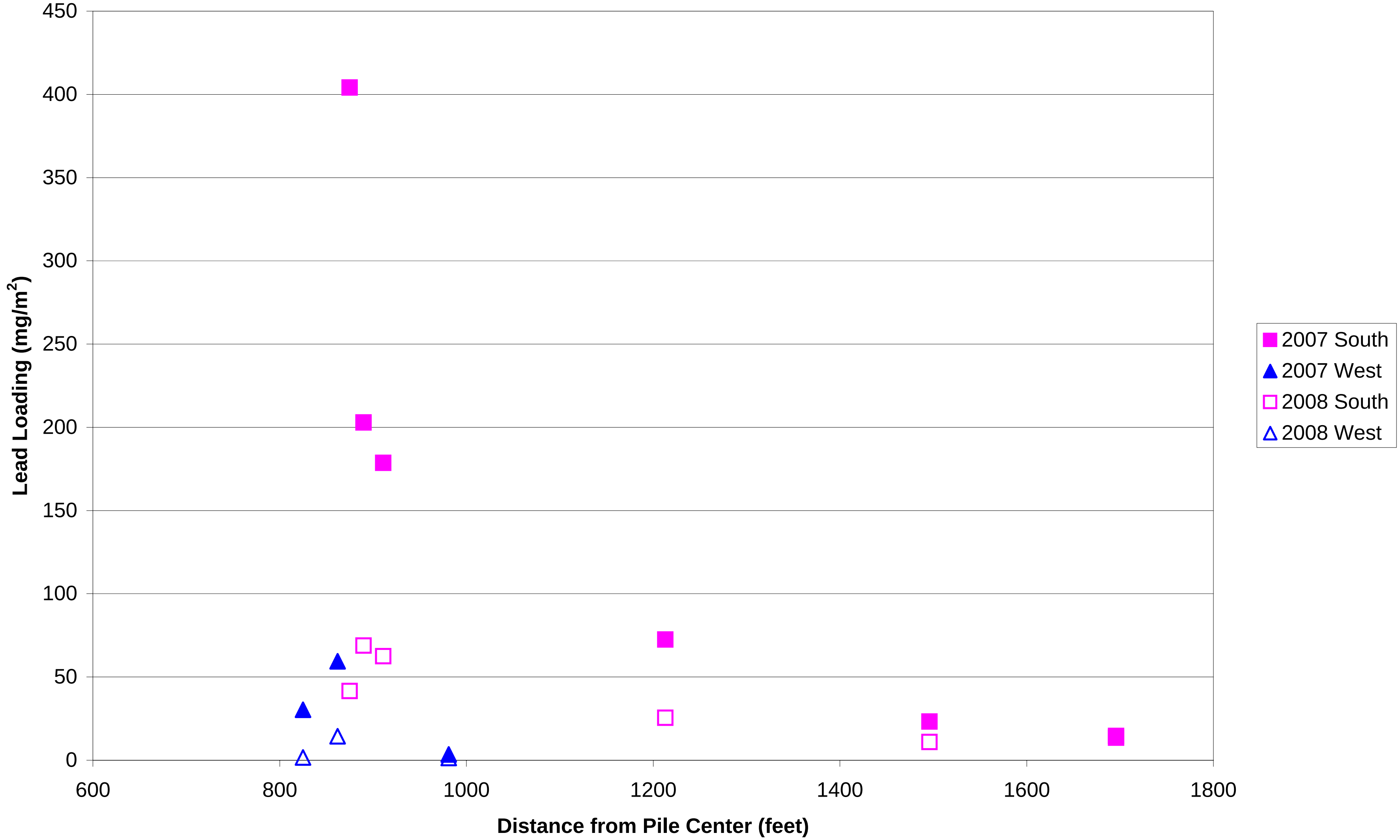


Fig. 2.35 Snow Survey Analysis - Lead Loading vs Distance from Pile Center



APPENDIX 4

Site Photographs

Fig 2.36 Aerial Photo of Tailings Area September 2007

Fig. 2.37 Northwest Excavation July 2007

Fig 2.38 Tailings Northwest Expansion and Northwest Excavation Liner September 2007

Fig. 2.39a New Pond 7 Water Treatment Plant September 2007

Fig 2.39bNew Pond 7 Water Treatment Plant December 2007

Fig. 3.33 Site 23 May 2007

Fig. 3.34 Site 23 Backslope Excavation September 2007