Report on Characterization of Groundwater in the Alluvial Deposits Beneath the Floodplain of Willow Creek Below Creede

FINAL

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Introduction

Willow Creek, formed by the confluence of East and West Willow Creeks, is a tributary of the Rio Grande River near its headwaters in the San Juan Mountains in Mineral County, Colorado. Historic mining activities related to underground mining of silver and selected base metals resulted in significant water quality impairment in the 35 square mile Willow Creek watershed (zinc, cadmium and lead exceed the Colorado Table Value Standards). The State of Colorado has placed this segment of the Rio Grande River on their Clean Water Act 303(d) list. The residents of the town of Creede and the surrounding portion of Mineral County have developed a community-based effort to identify and address the most pressing environmental concerns in the Willow Creek watershed. The Willow Creek Reclamation Committee (WCRC), convened in 1999, is directing a stakeholder effort aimed at improving water quality and physical habitat in the Willow Creek watershed as part of a long-term watershed management program which will focus on restoring aquatic resources and protecting the Rio Grande from future fish kills.

From 1999 through 2003, the WCRC, with technical and financial assistance from the US Environmental Protection Agency, the United States Forest Service, the Natural Resources Conservation Service, the Colorado Division of Minerals and Geology and the Colorado Department of Public Health and Environment, has directed a variety of watershed characterization efforts. These efforts have been aimed at:

(1) Identifying sources of heavy metals
(2) Characterizing transport of heavy metals to surface waters
(3) Quantifying heavy metals loading to Willow Creek and the Rio Grande River
(4) Characterizing mine waste materials
(5) Biological assessment of aquatic resources
(6) Characterizing hydrological conditions in underground mine workings

The findings and conclusions from these characterization efforts are summarized in a series of five reports prepared by the Technical Advisory Committee of the WCRC. These reports include:

(1) Report on Surface and Groundwater Sampling and Monitoring in Willow Creek Watershed, Mineral County, CO (1999-2002)
(2) Report on Characterization of Groundwater in the Alluvial Deposits beneath the Floodplain of Willow Creek below Creede
(3) Report on Characterization of Waste Rock and Tailings Piles above Creede, Colorado
(4) Report on Characterization of Fish and Aquatic Macroinvertebrates in Willow Creek
(5) Evaluation of Metal Loading to Streams near Creede, Colorado

These reports will provide the basis for choosing the remedial actions that will be evaluated (in terms of engineering and economic feasibility) for identifying and implementing watershed restoration activities.

This report presents a discussion of the Willow Creek floodplain and the results of the groundwater sampling conducted from 1999 to 2002. The installation of monitoring wells in the floodplain and near selected mine sites provided information on groundwater quality and associations with water quality in Willow Creek and the Rio Grande.

Lower Willow Creek Floodplain and the Emperious Tailings Pile

The geology of the Willow Creek floodplain consists of Quaternary Alluvium, which is primarily sand, gravel, and cobble (USDA/SCS 1980). Throughout the history of the area, fine materials have been deposited in the floodplain due to the low gradient. These materials include tailings and waste materials washed down from mine and mill sites throughout the watershed. Periodically, the City or County uses heavy equipment to move floodplain materials. These projects are usually conducted to redirect or contain stream flow or to improve vehicular access. In the northern half of the floodplain below Creede, vegetation is sparse and consists of a few trees and clump grasses.

In the alluvial floodplain below the City of Creede, potential sources of contamination are deposited mine and mill wastes and the Emperious tailings pile (Figures 1 and 3). The Emperious Tailings Pile originated as tailings ponds for the Creede Mill. The exact date of the pond construction is not known, but the mill was built in 1937 by Creede Mills, Inc. Subsequent owner/operators of the mill and ponds included the Emperious Mining Company and Minerals Engineering Company. At maximum capacity, the Creede Mill was processing 300 tons of ore per day in 1974. The mill concentrated gold, silver, lead, zinc, copper, and cadmium, and the tailings ponds were used capture overflow from the settling units (Meeves and Darnell 1968). Mill operations ceased in October 1976.

Documented failures of the tailings pond retention or delivery structures occurred in 1963, 1971, and in 1975 (MFG 1999(b)). In August 1963, heavy rains were the probable cause of a break in the dike outlet structure of the lower tailings pond. In September 1971, the delivery ditch from the mill to the ponds failed. Both of these events were linked to fish kills in the Rio Grande River. In March 1975 the tailings dam broke, and the floodplain was inundated with contaminated water and materials. Although no fish mortalities were observed in 1975, all three of these documented failures produced extensive contamination of water and sediments in unconfined areas of the Willow Creek floodplain.

In 1988, Martin Nelson, on behalf of CoCa Mines, Inc. (Creede, CO) conducted a thorough survey of the tonnage and grade of materials in the Emperious Tailings Ponds. Maps used for the survey were dated October 1976, which would indicate that no substantial physical changes occurred to the area between the mill closure and 1988. Nelson used data from 22 new test holes (CoCa Mines, Inc. 1988), 21 survey points (Davis Engineering 1988), and 63 old test holes (Sunshine Mining Co. 1976; Minerals Engineering Co. 1973). The density of the pond materials was estimated to be 20.0 – 22.0 ft^3/ton. There were 968,014 tons of sulfides at 1.12 ounces per ton (opt) of silver and 0.004 opt of gold. There were 260,730 tons of oxides with 3.45 opt of silver and 0.009 opt of gold. Shortly after Nelson's survey, possibly in late 1988 or 1989, the tailings ponds were consolidated, regraded, and capped with alluvial materials. The current owner of the tailings pile and surrounding land is Creede Resources, a subsidiary of Hecla Mining Company.

Monitoring Well Installation and Sampling

Figures 1 and 2 show locations for the alluvial groundwater monitoring wells installed through the Willow Creek Reclamation Committee. Table 1 presents well descriptions, locations, and the agency that coordinated with the WCRC for installation. These agencies were MFG (Boulder, CO), URS Corporation (Denver, CO), and the United States Army Corps of Engineers (USACE; Albuquerque, NM). Further description of well installation and sampling is presented in the Sampling and Analysis Plan (MFG 1999); Emperious Tailing, Midwest Mine, and Solomon Mine Well Installation and Sampling (URS 2001); and the Site-Specific Addendum to Restoration of Abandoned Mine Sites (RAMS) Work Plan- Willow Creek, Creede, Colorado (USACE 2002).

MFG Well Installation

Three wells were installed in the Willow Creek floodplain from September 21-23, 1999, by MFG. Notes and boring logs are courtesy of on-site MFG supervisors (Appendix A). These wells were installed in the upper saturated portion of the alluvial aquifer. Procedures for drilling and logging are outlined in MFG SOP No. 1 : Supervision of Exploratory Borings (Appendix E of MFG 1999). Borings were drilled using a 5" Odex drilling system (air percussion drilling through advancing casing) to the depth of the alluvial aquifer. For stratigraphic logging, soil samples were collected in a minimum of 10' increments using a 2" split spoon sampler. Wells were constructed of 2" S-40 PVC, and the screened portion consisted of 0.02" factory-slotted PVC with a threaded end plug. Washed, 10/20 filter sand filled the space around the screen and extended 2-3 feet above the top of the screen. The sand was topped with a minimum of 3' of bentonite-pellet seal. A steel casing was placed around the top of the well, extending approximately 3' above and below the ground surface. This casing was fitted with a locking cap. All well construction materials were pre-cleaned and free of solvents and glues to ensure future collection of representative water samples.

URS Well Installation

Fifteen wells were installed in the floodplain below town (11), below the Solomon Mine waste piles (2), and near the Midwest Mine waste piles (2). Drilling and installation was directed by URS, and notes regarding these procedures are courtesy of their on-site scientists. Wells were installed between September 18 and 21, 2001, by ESN of Golden, Colorado. Borings were drilled using a Thunderprobe hydraulic direct push drill rig with a vibrating advance hammer. This technique did not permit collection of geologic bore descriptions. Wells were constructed of 1" S-40 PVC casing within a 2.25" diameter boring, and the screened portion consisted of 5-10' of 0.01" slotted PVC. The space around the casing was filled with natural formation that caved in during construction. The formation was topped with bentonite chips, and a steel casing was placed around the top of the well. The steel casing was secured with a concrete surface seal and topped with a locking cap. Further descriptions of the URS well installation and sampling are provided in their report (URS 2001).

USACE Well Installation

The USACE, through the Restoration of Abandoned Mine Sites (RAMS) program, installed five wells in the floodplain below Creede between October 21 and 24, 2002. The RAMS program is a regionally focused and stakeholder responsive program for the restoration of abandoned and inactive non-coal mines where water resources have been degraded by past mining practices. Drilling was accomplished using 4¼-in ID hollow-stem augers with a continuous sample barrel. The field geologist noted soil characteristics, changes in soil type, and groundwater depth for lithologic logs of each borehole.

A 1-foot thick layer of 20-40 Colorado Silica sand was poured into the borehole prior to casing placement (1-foot padding). Well casing consisted of 2-inch nominal diameter PVC pipe. The 10-foot well screens were continuous slot, wire wound, non-clogging type screen. The boring was sufficiently deep to accommodate the 1-foot padding, 10 feet of screen, and at a minimum, 7 feet of solid PVC casing below ground surface (bgs). The well screen was sealed at the bottom with a solid cap. Solid casing attached to the top of the screen extended approximately 2 ft above the ground surface. Casing components were attached by flush threaded joints or PVC collars without the use of glues.

Well completion following casing placement consisted of installing the filter pack, bentonite pellet plug, and protective steel casing with locking cap. The top of the filter pack was approximately 1 foot above the top of the well screen. The bentonite plug was placed above the filter pack and hydrated. A 4-inch square by 4-foot long steel protective casing equipped with locking cap was placed into the plug to a depth of approximately 2 feet bgs. Due to concerns over the potential for frost heave, the well pads were constructed using crushed gravel. The well pads were approximately 4 feet in diameter, up to 3-inches thick adjacent to the well, and gently sloped away from the well. Further descriptions of the USACE well installation and sampling are provided in their report (USACE 2003).

Water Sampling

Methods for well water collection were as described in the Sampling and Analysis Plan for Surface Water, Groundwater, and Biological Community Monitoring (MFG 1999). Water samples were collected from the three MFG wells September 18-23, 1999 (following installation); July 16, 2000; March 13, 2001; April 26, 2001; May 22, 2001; and September 27, 2001. Water samples were collected from MFG and URS wells on November 15-17, 2001, and April 24-25, 2002. All lower floodplain wells (MFG, URS, and USACE) were sampled on November 18, 2002. Water samples from the USACE wells were analyzed at USACE laboratories, with two splits analyzed at Sangre de Cristo Lab (Alamosa, CO). Wells were also sampled on April 29, 2003 and the results are included as Appendix B.

Parameters measured in the field included: water level (100' Solinst), temperature, pH, and conductivity (WTW Multiline P4). Field data sheets were used to record pertinent information. Water level and casing diameter were used to calculate well volume, and at least three volumes were purged before samples were collected. During this purging, temperature, pH, and conductivity were recorded to ensure that there was < 10% variation in these parameters at the time of sample collection. Wells were purged with bailers or a peristaltic pump fitted with flexible polyethylene (PE) tubing. A new bailer or PE tubing was used at each site. The internal pump tubing was not changed at each site, but was thoroughly rinsed with deionized and sample water. All sampling equipment was pre-cleaned with a nitric acid solution and/or rinsed with deionized and sample water. If wells were known to be high in metals, they were sampled last to prevent potential contamination.

A description of sample bottle types and parameters analyzed is presented in Table 2. Filtered samples were collected using a syringe filter (0.45 μm membrane filter) or an in-line filter housing on the peristaltic pump tubing. Filtering equipment was pre-rinsed with nitric acid and deionized water, and approximately 10mL of sample was filtered onto the ground before bottles were filled. In April 2002, filtering was difficult due to high levels of sediments in the samples. In addition, winds and blowing dust may have compromised the integrity of filtered samples. In November 2002, it was decided that in order to ensure representative samples, filtering would be conducted by the laboratory. Unfiltered samples were delivered to the lab within 24 hours. Bottles were kept on ice or refrigerated until analyzed by River Watch (RW, Denver, CO), Sangre de Cristo Lab (SDC, Alamosa, CO), ACZ Labs (ACZ, Steamboat Springs, CO), or USACE Labs (Omaha, NE).

As indicated in the SAP (1999), the number of blanks and duplicates was 10% of the total number of samples collected, and the sites for these QAQC samples were randomly chosen. Field duplicates are shown in Table 3 with the percent difference. In 1999, duplicates were analyzed at the same lab, whether ACZ or RW. Duplication in 1999 was good, with differences less than or equal to 5%. In 2001, duplicates and blanks were sent to separate laboratories (ACZ and SDC). Duplicate samples in 2001 indicated some quality control problems, and 8 out of 32 duplicated parameters differed by more than the acceptable 30%. In some cases, values from the same site differed by as much as a factor of ten. Due to analysis at two laboratories, it is not clear if the quality problem was due to inconsistencies in the field or in the laboratory. In April 2002, all samples were analyzed at SDC, and duplication was good, with 3 out of 34 duplicated parameters exceeding 30% difference. In November 2002, duplication among samples analyzed at SDC was good, with none exceeding 30%. This precision indicated that filtration by the lab might have helped to ensure the quality of the filtered samples. Splits that were analyzed at USACE and SDC differed substantially, with at least 9 out of 24 pairs differing by more than 30%. Reasons for poor duplication are unclear. Duplication among samples analyzed at USACE was good. Overall, data suggest that these samples may easily be contaminated, and that care is needed in the field and in the laboratory to ensure that representative values are obtained.

Results from field blanks (Table 4 Section A) were generally near or below the limits of detection, and overall did not indicate a substantial contamination problem. The exception was the blank collected at MW11 in November 2002, which had elevated levels of several constituents. This may have been because, due to a small amount of available deionized water, the internal pump tubing was not flushed thoroughly. Further investigations are warranted to determine if proper flushing of the internal tubing reduces blank contamination. Laboratory detection limits are presented in Table 4 Section B. At ACZ Labs, the range between the Method Detection Limit and the Practical Quantitation Limit represents values which may be obtained by the methods used, but which are reasonably questionable. Limits reported by ACZ are based on the dilutions used. Values presented in the table are from analyses with no dilutions, and therefore should not be applied as standards for all analyses conducted.

Results and Discussion

Water Sampling

Table 5 Sections A through R give data collected for the individual wells. Wells MW6 and NCC2 have been dry since installation and no samples have been collected.

Data from floodplain wells collected in November 2001, April 2002, and November 2002 are shown in Figures 3-9. Due to discrepancies in the splits in November 2002, only the USACE data are shown for wells MW16 through MW20. Overall, the data indicate that zinc, magnesium, cadmium, and aluminum might have been elevated in some of the wells in November 2002 relative to the other sampling dates. From the data, it is evident that elevated metals concentrations are present in wells MW8, MW9, MW10, MW11, MW16, MW18, MW19, and MW20, hereafter referred to as the contaminated wells. Figure 3 shows the relative locations of the wells, Willow Creek, and the Emperious Tailings Pile, along with the pH, conductivity, and total dissolved solids from the November 2002 sampling event. In Figures 4, 6, 8, and 9, two graphs are shown for each constituent to allow for the change in scale necessary to display the non-contaminated and contaminated wells.

Zinc levels in the non-contaminated wells ranged from 70 µg/L in MW1 to 26,600 µg/L in MW17 (Figure 4). Wells MW1, MW2, MW3, and MW15 consistently showed the lowest levels of zinc (<2,800 µg/L), potentially due to their distance from potential contamination sources such as the creek and the Emperious tailings pile. In the contaminated wells, zinc ranged from 51,500 to 679,250 µg/L. Although the 51,500 µg/L found in MW8 was one-fifth levels found in the other contaminated wells in April 2002, the value was substantiated by duplication with <1% difference. Zinc in most wells, both non-contaminated and contaminated, was substantially greater in November 2002 than in the other sampling events. The reasons for the increase were not clear, as water levels and conductivities were similar to previous events. In general, zinc in the contaminated wells was greater than in the non-contaminated wells by two orders of magnitude. The contaminated wells are proximal to each other, which indicates that they are likely tapping into a contaminated water source that, for reasons undetermined, is isolated from the other existing wells and likely from Willow Creek. Figure 5 shows zinc concentrations using triangulated irregular networks (TINs) to represent a surface (ArcView 3D Analyst 1999). Due to their relatively low levels and distance from the others, the MFG wells (MW1, 2, and 3) were not included in the diagrams. This figure shows the hot spot centered around MW8, 9, 10, and 20. The additional data provided by MW18 in November 2002 indicate that the contaminated groundwater may be oriented to the southeast, away from Willow Creek. The low zinc contours indicated on the northeast side of the diagram are likely skewed by the low levels in MW15, which is above the tailings pile.

Manganese in non-contaminated wells ranged from below the limit of detection (10 µg/L) to 2,375 µg/L (MW3), though this maximum was ten times the average (Figure 4). Manganese in contaminated wells ranged from 31,600 to 254,350 µg/L. Magnesium levels ranged from 1,400 to 6,620 µg/L in the non-contaminated wells and from 14,600 to 947,300 µg/L in the contaminated wells. Magnesium in the contaminated wells was substantially greater in November 2002 than on previous dates, sometimes by up to an order of magnitude. As with zinc, the reasons for this increase are not clear.

Iron was highly variable among wells, potentially indicating site-specific influences or solution reactions (Figure 6). Iron in non-contaminated wells ranged from below the limit of detection (10 µg/L) to 565 µg/L (MW13). Iron from the contaminated wells varied by more than three orders of magnitude (range: 140µg/L in MW19 to 920,000 µg/L in MW9). The low range values in MW18 (160 µg/L) and MW19 (140 µg/L) were atypical for the contaminated wells, and all other iron values were more than two orders of magnitude greater than the non-contaminated wells. Copper in non-contaminated wells ranged from below the limit of detection (1 µg/L) to 159 µg/L (MW12), though most values were below 10 µg/L. Copper concentrations in contaminated well MW9 (50, 101, and 34 µg/L) were similar to those in non-contaminated wells. In the other contaminated wells, copper was between 176 and 4,180 µg/L. Cadmium levels in the non-contaminated wells ranged from below the limit of detection (0.1 µg/L) to 154.2 µg/L (MW14). In the contaminated wells, cadmium levels were substantially lower in April (avg. = 83 µg/L) than in November 2001 (avg. = 905 µg/L) or November 2002 (avg. =983 µg/L). The average for November 2001 excludes MW9 (0.3µg/L), which was not substantially different from the non-contaminated wells. As with zinc, TINs were created to view cadmium concentrations (Figure 7). Due to the relatively low levels in April 2001, no contours were distinguishable. Cadmium hotspots followed a path from northwest near MW16 to southeast near MW18. Again, these TINs indicate a plume orientation away from the other wells and Willow Creek.

Calcium in groundwater (Figure 8) ranged from 1,200 µg/L (MW5) to 64,100 µg/L (MW13) in non-contaminated wells and from 59,400 µg/L (MW19) to 528,000 µg/L (MW18) in contaminated wells. Aluminum levels at all non-contaminated sites were lower in April (range: <3 - 109 µg/L) than in November 2001 (range: 39 – 1,215µg/L) or November 2002 (range: 30 – 2775 µg/L). In the contaminated wells, aluminum levels were between 1,741 (MW10) and 5,211 µg/L (MW11) in November 2001 and April 2002; however, in November 2002, aluminum ranged from 17,200 µg/L in MW18 to 194,800 µg/L in MW10. A possible explanation for the high values in November 2002 might be that substantial solution reactions occurred in the unfiltered samples in transit to the laboratory.

Figure 9 shows the total dissolved solids, specific conductance, and pH for the wells. The field parameters proved to be good indicators of contamination, as the contaminated wells exhibited high specific conductance and low pH relative to the non-contaminated wells. In these parameters, values show some consistency with date, especially in the contaminated wells. Dissolved solids in the non-contaminated wells were between 152 mg/L (MW15) and 783 mg/L (MW3), and in the contaminated wells ranged from 3,603 mg/L (MW11) to 7,190 mg/L (MW9). In the non-contaminated wells, specific conductance values were between 163 µS/cm (MW2) and 520 µS/cm (MW2). Conductance ranged from 1,116 µS/cm (MW19) to 5,000 µS/cm (MW9) at the contaminated sites. Values of pH indicated that the groundwater was acidic. Field values for pH were used because samples exceeded the holding times for lab pH. Samples from the contaminated wells (range: 3.0 – 5.1) were substantially more acidic than the non-contaminated sites (range: 5.4 – 7.1), with the exception of MW17 (2.9). This pH value for MW17 was derived by USACE with no duplication by WCRC. The pH from April 2003 (5.4; see Appendix B) does not support the low pH findings; however, further sampling is needed to determine whether or not MW17 has pH levels comparable to the other non-contaminated sites.

Data from the wells near the Solomon and Midwest Mines indicate that metal concentrations were similar or lower than those in the non-contaminated floodplain wells. Constituents in the Solomon wells were not substantially different from each other and therefore are likely tapping into the same groundwater source.

Emperious Tailings Pile Core

With permission from Creede Resources, the Willow Creek Reclamation Committee contracted with the United States Army Corps of Engineers on October 23, 2002 to collect a core of the tailings pile (see Figure 1). This coring was concurrent with the well drilling, and was conducted under the supervision of a representative of Creede Resources. Soil samples were collected using a 4 ½“ auger with a continuous sampler. Samples were collected at 5 inches, and at 3, 7, 10, and 15 feet (total depth of core). At 10.2 feet, a 4.2 foot silty-clay layer was encountered. The material below the silty-clay layer was dark, organic soil considered to be native soil. The sample collected at 15 feet was of this native soil. At no time during drilling was water encountered. Abandonment included placing a 5.2 foot bentonite pellet plug, which extended from the bottom of the borehole to 0.4 feet above the surface of the clay layer. The remainder of the borehole was filled with cuttings (USACE 2002). Data from the samples are presented in Table 6. These data indicate that the 15’ sample had the greatest concentrations of cadmium (2560 mg/kg), magnesium (2570 mg/kg), manganese (247 mg/kg), and zinc (2320 mg/kg). Because the 15’ sample appeared to be native soil, these data show that either the native materials have been contaminated by leaching from the pile, or potentially that the pile was placed on materials that were already contaminated. Relatively high levels of aluminum (3630 mg/kg), iron (14100 mg/kg), lead (3170 mg/kg), and manganese (210 mg/kg) at the 5” layer indicate that the cap from 1989 has either eroded or been contaminated.

Conclusion

The groundwater wells installed in 1999, 2001, and 2002 have provided a good indication of water quality. Wells near the Solomon and Midwest Mine sites will be used to monitor changes in groundwater quality following planned reclamation activities at those sites. Based on three sampling events, it is clear that floodplain wells MW8, MW9, MW10, MW11, MW16, MW18, MW19 and MW20 are associated with a source of contaminated water. Further studies are needed to determine the pathways and velocity of contaminated groundwater in the Willow Creek floodplain. Although the core collected in 2002 might not be representative of the entire pile, it gives some indication of the depth to native soil and the degree of contamination within and below the pile.

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Tables

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Table 1. Well locations and descriptions. Depth of well based on boring logs and represents depth from ground surface to bottom of PVC screen. Locations for lower floodplain wells constructed by MFG, URS, and USACE are in UTM. Some well locations and elevations approximated(~) from 7.5 min USGS San Luis Quadrangle.

Well name	Installed by	Depth of well (ft.)	Northing	Easting	Elevation (ft.)
MW1	MFG	25.5	4187917.06	332109.41	8616.265
MW2	MFG	23.5	4188628.13	331728.65	8657.605
MW3	MFG	13.5	4188406.38	331361.16	8652.747
MW5	URS	14.4	4188904.00	331361.00	8681.643
MW6	URS	8.8	4189091.23	331217.08	8692.163
MW7	URS	15.9	4189180.53	331233.35	8698.722
MW8	URS	13.9	4189358.13	331138.08	8697.023
MW9	URS	17.1	4189339.54	331076.00	8718.465
MW10	URS	12.2	4189490.09	331026.53	8714.224
MW11	URS	14.8	4189594.66	330916.99	8728.557
MW12	URS	11.4	4189796.99	330784.86	8733.356
MW13	URS	13.8	4189928.28	330820.71	8748.614
MW14	URS	13.7	4190082.82	330884.78	8758.389
MW15	URS	14.9	4189620.22	330953.83	8768.682
MW16	USACE	17.0	4188874.45	331493.94	~8732
MW17	USACE	22.6	4189016.70	331441.16	~8689
MW18	USACE	15.4	4189127.41	331201.48	~8692
MW19	USACE	14.0	4189362.45	331136.42	~8699
MW20	USACE	17.5	4188564	331050	~8718
MWNCC1	URS	8.5	~4195540	~330340	~10240
MWNCC2	URS	13.8	~4195610	~330340	~10240
MWEW1	URS	13.6	~4193490	~331350	~9200
MWEW2	URS	9.07	~4193530	~331350	~9200

Table 2. Bottle types and parameters analyzed for well samples. One of each bottle was collected per site. In November 2002 samples were filtered and acidified by the laboratory.

Volume	Type	Filtered/Unfiltered	Preservative	Parameters
500 mL	plastic	unfiltered	none	total dissolved solids, alkalinity
500 mL	plastic	filtered	nitric acid	dissolved metals
500 mL	plastic	filtered	none	chloride and sulfate
25 mL	glass	filtered	sulfuric acid	dissolved organic carbon

Table 3. Field duplicates collected during groundwater sampling in November 2001, April 2002, and November 2002. Values in bold were below the Practical Quantitative Limit and if shown with "<" were less than the Method Detection Limit. The percent difference for duplicates was not calculated if one or both values were below the Method Detection Limit.

Field Duplicates

Date	Station	Lab	tALK (mg/L)	% diff.	dAl (ug/L)	% diff.	dCa (ug/L)	% diff.	dCd (ug/L)	% diff.	dCu (ug/L)	% diff.	dFe (ug/L)	% diff.	dMg (ug/L)	% diff.	dMn (ug/L)	% diff.	dPb (ug/L)	% diff.
9/23/99	MW1	RW, ACZ																		
		RW,ACZ																		
11/16/01	MWEW2	SDC	18	8	46		8800	39	8.3	9	2		123	85	1300	10	**<10**		101	0
		ACZ	21		**<30**		20200		**10**		**<10**		**10**		1600		467		**100**	
11/17/01	MW10	SDC	**<1**	**0**	4700	91	268000	34	1040	33	1500	4	268000	1	80000	28	127900	6	**<1**	**0**
		ACZ	**<2**		95600		132000		2060		1390		264000		45000		113000		**<200**	
4/24/02	MW12	SDC	11	11	80	80	29200	6	45.1	2	14	8	14		2400	12	**<10**	**0**	13	20
		SDC	9		713		26100		43.4		12		**<10**		1900		**<10**		9	
4/24/02	MW8	SDC	**<1**	**0**	2300	11	327000	0	84.2	1	815	0	41700	2	32000	7	149900	0	8	14
		SDC	**<1**		1839		324000		85.1		814		40200		28000		150000		6	
11/18/02	MW15	SDC	45	1	123	2	22600	7	8.8	1	**<1**	**0**	174	2	2400	0	**<10**		**<2**	
		SDC	46		128		26100		8.6		**<1**		181		2400		**<10**		**<2**	
11/18/02	MW16	SDC	**<1**	**0**	602000	55	**<1000**		1539.0	2	6293	20	214000	32	**<500**		151500	24	6	69
		ACE	**0**		174000		71300		1490.0		4180		110000		41200		92800		30	
11/18/02	MW20	SDC	**<1**		55970		**<1000**		497.0		270		700000		500		182800		13	
		ACE	56		38200	18	197000		834.0	21	271	2	619000	6	53900	66	144000	11	36	36
		ACE	54		38200		201000		840.0		261		618000		54700		143000		35	

Table 3 (cont.)

Date	Station	Lab	dZn		SO4		Cl		TDS		dSi		dK		DOC		Na	
			(ug/L)	% diff.	(mg/L)	% diff.	(mg/L)	% diff.	(mg/L)	% diff.	(mg/L)	% diff.	(mg/L)	% diff.	(mg/L)	% diff.	(mg/L)	% diff.
9/23/99	MW1	RW, ACZ			247	1	10	5	530	3	25.7	0	2.8	2	**2**			
		RW,ACZ			240		9		500		25.8		2.7		**2**			
11/16/01	MWEW2	SDC	1960	7	21	31	**<1**		115	18	16.2	14	1.4	17			2.6	14
		ACZ	2240		40		**1**		80		21.6		**1**				3.4	
11/17/01	MW10	SDC	323600	13	2195	10	65	81	3950	1	59.4	22	46.0	77			3.0	67
		ACZ	417000		2660		7		4000		93.0		6				15.0	
4/24/02	MW12	SDC	5183	1	117	3	7	4	222	3	62.3	46	2.1	59	44	28	8.4	1
		SDC	5061		110		6		208		167.3		8.2		78		8.2	
4/24/02	MW8	SDC	51500	0	2910	4	33	3	5083	0	176.0	0	38.0	7	58	2	69.5	1
		SDC	51280		3121		35		5107		176.0		33.0		56		68.0	
11/18/02	MW15	SDC	1678	1	42	3	3	0	152	2	19.0	2	4.9	5	**<1**	**0**	6.2	0
		SDC	1637		39		3		157		19.6		4.4		**<1**		6.2	
11/18/02	MW16	SDC	923800	46	3534	1	42.8	83										
		ACE	339000		3600		4											
11/18/02	MW20	SDC	949300	37	3128	3	41.8	101										
		ACE	458000		3300		4											
		ACE	425000		3380		4											

Table 4. A) Field blanks collected during well sampling in November 2001, April 2002, and November 2002. Values in bold were below the Practical Quantitation Limit and if shown with "<" were less than the Method Detection Limit. B) Laboratory detection limits for ACZ and SDC labs. Limits from ACZ are based on dilutions and therefore may vary between samples. The values presented for ACZ are based on zero dilutions. The Practical Quantitation Limit represents a level below which values are reasonably questionable.

A) **Field Blanks**

Date	Station	Lab	tALK (mg/L)	dAl (ug/L)	dCa (ug/L)	dCd (ug/L)	dCu (ug/L)	dFe (ug/L)	dMg (ug/L)	dMn (ug/L)	dPb (ug/L)	dZn (ug/L)	SO4 (mg/L)	Cl (mg/L)	TDS (mg/L)	dSi (mg/L)	dK (mg/L)	DOC (mg/L)	Na (mg/L)
9/23/99	MW1	RW, ACZ		**<15**	**<100**	**<0.15**	**<1**	**<10**	**<100**	**<10**	**<3**	**<1**	1.9	2.0					
11/17/01	MW8	ACZ	**5**	**<30**	**<200**	**<3**	**<10**	**20**	**<200**	**7**	**<40**	**20**	**<10**	**3**	30	1.2	**<0.3**		3.6
4/24/02	MW15	SDC	**<1**	**<3**	**<1000**	**<0.1**	**<1**	**<10**	**<500**	**<10**	2	**<5**	2	**<1**	**<1**	0.2	**<0.5**	**<1**	**<1**
11/18/02	MW11	SDC	**<1**	73.7	**<1000**	1.0	4	**<10**	700	19.7	**<2**	178	16	2	**<1**	**<0.2**	**<0.5**	17	**<1**
11/18/02	DI blank	SDC		**<3**		**<0.1**	**<1**	**<10**		**<10**	**<2**	**<5**							

B) **Laboratory Detection Limits**

Lab	Level	tALK (mg/L)	dAl (ug/L)	dCa (ug/L)	dCd (ug/L)	dCu (ug/L)	dFe (ug/L)	dMg (ug/L)	dMn (ug/L)	dPb (ug/L)	dZn (ug/L)	SO4 (mg/L)	Cl (mg/L)	TDS (mg/L)	dSi (mg/L)	dK (mg/L)	DOC (mg/L)	Na (mg/L)
ACZ	Method Detection Limit	2	30	200	3	10	10	200	5	40	10	10	1	10	0.2	0.3		0.3
	Practical Quantitation Limit	10	200	1000	20	50	50	1000	30	200	50	20	5	20	0.5	1		1
SDC	Method Detection Limit	1	3	1000	0.1	1	10	500	10	1	5	1	1	1	0.5	0.5	1	0.5
RW	Method Detection Limit		15	100	0.15	1	10	100	10	3	1							

Table 5. A) through W) Data tables for groundwater samples. Data are grouped by site and presented in chronological order.

A) **MW1**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
9/23/99			6.6	11.3	132	340	614	5.1		247.0	10.0	220	530	104	25.70	53.30	2.8	4.4	2		
7/16/00	17.74	28.70	7.5	10.5	30	54	174	7.6		41.0	<1		103	76	20.13	22.03	2.2			4.40	
3/13/01	21.34	28.92	7.1	7.4	2	92	195	5.7		58.8											
4/2/01	20.61	28.78	7.0	6.8	20	78	183	8.0		55.9											
5/23/01			7.2	8.3	12	86		8.2	<50	73.0	2.0										
11/16/01	20.30	28.17	6.5	9.0	20		190			51.2	1.1		155		20.95		2.0		26	4.83	
4/24/02	21.20	28.40	7.1	7.9	13		193			63.9	1.7		534		4.40		2.0		46	4.90	
11/18/02	21.50	28.38	6.4	9.2	9		214			67.0	2.0		164		23.00		1.8		<1	5.10	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
9/23/99	17	3466	0	17		127843	126359	15.1	16.4	4	10.5	29	3948	11295	11541	64	447	0	16.6	4691.4	4817
7/16/00	1131	1961	5	8		24200		0.3	0.3	4	5	561	989	1420		67	133	4	7	14	15
3/13/01		761		15	1583	27000			3.0		19		8230	3030			1125		50		1310
4/2/01	1680		13		182	27700		0.3		17		2440		3840		383		34		155	
5/23/01	0	133	0	0		26228	26212	0.0	0.0	0	0	0	90	2862	2878	0	0	0	0	0	0
11/16/01	39					22400		<0.1		1		146		2570		<10		<1		100	
4/24/02	<3					24500		0.2		2.3		<10		3800		<10		8.2		70.8	
11/18/02	2775					28000		0.1		<1		565		<500		<10		<2		57.5	

Table 5. (cont.)

B) **MW2**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
9/23/99			6.6	8.5	16	37	94	8.6		30.0	4.0	209	60	40	22.50	33.60	1.3	1.9	1		
7/16/00	13.15	25.50	7.3	10.6	12	68	198	7.4		70.0	<1		126	433	19.33	22.35	1.7			5.60	
3/13/01	12.00	25.70	6.9	3.8	1	116	302	9.5		122.5											
4/2/01	10.52	25.37	6.7	2.8	12	112	294	9.8		108.5											
5/23/01			6.9	5.0	14	100		9.2	<50	78.0	1.0										
11/17/01	14.80	25.11	5.5	9.0	8		163			52.4	1.0		140		15.73		1.9		29	4.33	
4/24/02	12.05	25.32	6.5	4.8	7		241			172.9	1.2		711		33.80		1.2		53	5.30	
11/18/02	12.53	25.47	6.2	9.1	6		253			94.7	2.0		188		24.00		1.8		5	5.80	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
9/23/99	115	3107	0	0		13481	13719	0.0	0.2	0	3.3	37	1497	1476	1892	0	100	0	4.1	574	605
7/16/00	1662	2158	7	13		28800		0.7	0.8	10	19	1080	8550	1180		197	778	16	28	1083	1169
3/13/01		573		13	1110	44300			0.4		3		1640	3460			232		12		1420
4/2/01	1298		6		163	42300		0.5		12		2550		2690		268		16		1223	
5/23/01	0	2325	0	0		29460	30713	0.2	0.2	0	8.1	0	2407	3510	4171	0	158	0	12.1	708	726
11/17/01	215					18800		2.7		8		<10		2050		<10		<1		930	
4/24/02	6					54000		0.4		2		62		3700		<10		12		1286	
11/18/02	236					32100		0.5		<1		73		3100		<10		<2		1357	

Table 5. (cont.)

C) **MW3**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
9/23/99			6.7	10.3	39	71	151	8.0		34.0	3.0	201	110	20	24.20	34.90	2.2	2.6	1		
7/16/00	5.17	15.45	6.8	13.0	127	174	446	2.3		79.9	8.9		254	463	22.25	26.28	2.1			16.70	
5/23/01			7.1	8.7	106	402			<50	289.0	20.0										
11/17/01	5.30	15.07	6.4	6.4	63		366			49.3	12.9		264		12.78		1.9		29	17.17	
4/24/02	5.30	15.30	6.7	4.6	137		520			111.8	10.6		783		143.20		4.2		44	18.30	
11/18/02	5.12	15.42	6.4	3.1	92		444			100.0	2.1		278		25.60		2.0		5	25.70	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
9/23/99	63	1991	0	0		25656	25977	0.0	0.0	0	3.4	24	937	2726	2932	0	35	0	0	0	15
7/16/00	837	1663	9	34		68400		13.0	15.0	33	34	1200	3600	2510		153	325	44	69	3020	3611
5/23/01	0	1774	0	20		112202	125109	15.2	15.0	2.9	10.3	0	3228	11021	11229	14	278	0	25.2	5425	5981
11/17/01	1215					46200		6.6		27		11		3490		98		<1		1980	
4/24/02	<3					60400		8.8		7.1		<10		5200		225		3		2269	
11/18/02	74					49400		14.2		4.3		<10		4300		2375		<2		2703	

D) **MW5**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/16/01	8.36	13.80	6.4	9.7	8		221			78.9	<1.0		179		17.43		2.2		25	4.71	
4/24/02	5.80	14.10	6.5	5.4	9		217			84.7	1.1		149		127.00		1.3		69	5.00	
11/18/02	6.80	14.10	6.3	8.1	14		276			100.0	2.1		196		20.00		2.9		10	6.70	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/16/01	115					1200		9.3		6		138		2210		320		<1		4120	
4/24/02	<3					25200		21.4		1.2		<10		2500		<10		7.9		4726	
11/18/02	29.9					25500		24.2		<1		<10		3000		<10		<2		6034	

Table 5. (cont.)

E) **MW6**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/16/01	dry																				
4/24/02	dry																				
11/18/02	dry																				

F) **MW7**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/16/01	9.35	15.73	6.4	8.5	4		237			80.9	<1.0		205		19.38		1.8		23	5.41	
4/24/02	8.80	16.00	6.3	5.4	9		212			86.3	1.0		205		158.40		1.0		71	5.10	
11/18/02	8.85	16.05	6.2	7.1	9		273			98.6	2.0		191		20.00		1.4		<1	6.70	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/16/01	237					3100		9.8		8		101		3050		146		<1		4340	
4/24/02	109					20900		17.3		<1		<10		1700		<10		10.8		4936	
11/18/02	283					22000		24.9		<1		91.3		2600		<10		<2		9738	

G) **MW8**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/17/01	4.43	13.85	4.2	8.5	<1		3850			3032.9	6.3		5348		30.65		18.0		33	4.00	
4/24/02	4.10	13.95	3.2	6.7	<1		4040			2909.7	33.2		5083		176.00		38.0		58	69.50	
11/18/02	3.52	14.00	3.3	6.2	<1		3950			2575.0	42.2		4830		98.00		34.5		<1	54.30	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/17/01	4700					267000		890.0		1100		119000		63000		222500		13		399600	
4/24/02	2300					327000		84.2		815		41700		32000		149900		8		51500	
11/18/02	137100					337900		1026.6		373		35300		425800		181300		<2		503500	

Table 5. (cont.)

H) **MW9**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/15/01	7.60	17.12	4.3	11.2	<1		4890			4291.2	6.4		7190		25.03		35.0		4	5.00	
4/24/02	7.50	17.20	4.4	6.7	<1		5000			4065.4	36.2		7188		170.50		9.5		3	52.50	
11/18/02	7.84	17.20	4.4	10.0	<1		4560			3486.0	41.8		6279		29.60		44.5		<1	35.00	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/15/01	4240					267000		0.3		101		744000		63000		207200		19		394300	
4/24/02	3876					358500		63.9		50.5		920000		53000		254350		14.1		253750	
11/18/02	52570					232000		443.8		34.1		707000		947300		191200		5.2		679250	

I) **MW10**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/17/01	3.64	12.18	3.2	9.8	<1		3220			2194.9	65.1		3950		59.40		46.0		16	3.00	
4/24/02	3.50	12.30	3.2	6.3	<1		4030			3027.7	38.3		5222		150.40		10.0		56	44.00	
11/18/02	3.58	12.29	3.2	8.6	<1		3690			2906.0	22.8		4610		48.20		23.8		<1	49.00	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/17/01	4700					268000		1040.0		1500		268000		80000		127900		<1		323600	
4/24/02	1741					251500		92.5		2124		466500		30500		204250		11.9		250350	
11/18/02	194800					147300		1536.3		799.5		292000		218300		148600		<2		586200	

J) **MW11**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/15/01	6.77	14.83	3.9	9.4	<1		2900			2299.3	5.0		3603		34.75		48.5		<1	24.33	
4/24/02	6.55	14.80	3.9	8.9	<1		3150			2305.9	20.3		4110		172.80		28.5		29	45.00	
11/18/02	7.10	14.98	3.8	8.4	<1		3090			1953.0	40.8		3858		23.70		34.5		<1	75.30	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/15/01	4660					113500		785.1		462		346000		51000		113500		12		294700	
4/24/02	5211					227000		91.3		1002		56000		23000		157350		14.2		246450	
11/18/02	124900					171300		1223.1		176.3		412000		189500		116100		4		510500	

Table 5. (cont.)

K) **MW12**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/16/01	2.72	11.44	5.9	8.9	8		262			80.7	7.7		212		18.05		3.0		41	8.12	
4/24/02	4.00	11.50	5.9	7.4	11		289			117.3	6.9		222		62.30		2.1		44	8.40	
11/18/02	2.62	11.53	6.2	6.4	6		256			84.7	4.8		178		19.60		2.4		<1	9.00	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/16/01	150					4200		26.8		159		33		2010		45		12		4450	
4/24/02	80					29200		45.1		13.5		13.5		2400		<10		12.8		5183	
11/18/02	203					17200		39.3		9.2		42.7		2200		<10		<2		12640	

L) **MW13**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/15/01	3.61	13.78	6.5	9.9	88		449			102.0	6.7		343		20.35		4.2		28	14.42	
4/24/02	3.30	13.90	6.4	5.6	103		422			98.1	5.6		469		38.90		2.7		20	10.70	
11/18/02	3.57	13.77	6.8	7.5	80		372			80.7	4.3		263		14.20		3.6		<1	11.00	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/15/01	1077					64100		3.6		18		167		6620		1864		<1		1350	
4/24/02	52.4					55800		19.9		3.1		<10		5300		<10		19		3352	
11/18/02	193.5					49600		20.2		1.1		142		4300		15		18		3137	

M) **MW14**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/15/01	3.85	13.70	5.4	9.1	32		288			81.2	11.0		223		14.50		3.0		<1	8.97	
4/24/02	2.90	13.40	5.8	6.7	22		306			102.1	4.3		348		25.50		2.6		18	8.60	
11/18/02	3.80	13.40	6.4	7.9	32		273			66.8	5.6		191		19.10		2.6		<1	8.70	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/15/01	950					7600		154.2		3		<10		1400		140		3		4500	
4/24/02	<3					30100		52.1		1.4		10.8		1900		<10		9.5		5183	
11/18/02	142					17500		62.6		<1		184		2000		<10		<2		14950	

Table 5. (cont.)

N) **MW15**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/16/01	7.08	14.93	6.2	9.6	52		216			35.3	2.4		168		22.40		4.3		9	5.58	
4/24/02	6.25	15.00	6.5	7.1	36		202			45.0	3.1		170		36.90		3.7		36	5.90	
11/18/02	7.29	14.95	6.3	9.6	45		212			41.9	3.3		152		19.00		4.9		<1	6.20	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/16/01	167					21600		3.3		10		<10		2240		91		<1		1640	
4/24/02	75.1					21800		6.7		2.5		64.1		2600		<10		3.6		1599	
11/18/02	123.2					22600		8.8		<1		174		2400		<10		<2		1678	

O) **MW16**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/18/02	8.96		3.0	10.3	0		4380			3600.0	4.0										

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/18/02	174000					71300		1490.0		4180		110000		41200		92800		30		339000	

P) **MW17**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/18/02	13.24		2.9	10.2	0		380			170.0	0.0										

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/18/02	1120					41900		37.1		5		40		4680		275		0		26600	

Q) **MW18**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/18/02	8.07		5.1	8.6	58		3240			2300.0	7.7										

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/18/02	17200					528000		723.0		700		160		57000		132000		4		366000	

Table 5. (cont.)

R) **MW19**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/18/02	7.67		3.9	10.8	0		1116			690.0	2.0										

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/18/02	28200					59400		586.0		488		140		14600		31600		7		132000	

S) **MW20**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
11/18/02	8.27		4.2	9.3	56		4230			3300.0	4.0										

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
11/18/02	38200					197000		834.0		271		619000		53900		144000		36		458000	

T) **MWNCC1**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
9/27/01			5.8	10.8			124	6.2		37.6	1.1										
11/16/01	5.91	9.15	6.8	6.1	20		115			21.0	<1.0		108		13.25		1.0		28	2.65	
4/24/02	8.80	9.10	5.7	4.7	22		49			7.6	<1		95		14.30		0.8		50	1.70	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	dBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
9/27/01	742		417		376	15400		0.3		73		13240		1880		638		35		182	
11/16/01	221					9700		<0.1		4		207		1330		36		26		<5	
4/24/02	19.9					4500		0.4		7		18		1000		138		<2		<10	

U) **MWNCC2**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
9/27/01	dry																				
11/16/01	dry																				
4/24/02	dry																				

Table 5. (cont.)

V) **MWEW1**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
9/27/01	5.75	13.76	6.1	8.8			102			24.2	<1										
11/16/01	5.96	13.45	6.7	5.8	20		97			21.6	<1.0		95		12.43		<0.5		20	<0.5	
4/24/02	6.08	13.75	5.7	4.0	20		66			11.7	<1		57		35.30		0.9		13	2.70	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	tBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
9/27/01		138		3	<2	10400			7.2		<1		45	1600			<10		120		2237
11/16/01	43					<1000		4.0		1		145		<500		<10		101		2030	
4/24/02	75.1					5700		7.6		3		<10		1300		<10		98		1505	

W) **MWEW2**

Date	Depth to water (ft)	Depth of well (ft)	pH	Temp (C)	tALK (mg/L)	tHARD (mg/L)	Cond (uS/cm)	DO (mg/L)	NH4 (ug/L)	SO4 (mg/L)	Cl (mg/L)	ORP (mV)	TDS (mg/L)	TSS (mg/L)	dSi (mg/L)	tSi (mg/L)	dK (mg/L)	tK (mg/L)	DOC (mg/L)	Na (mg/L)	
9/27/01	6.80	9.10	6.4	8.4			99			24.6	<1										
11/16/01	6.85	8.80	6.7	5.9	18		96			21.1	<1		115		16.23		1.4		10	2.55	
4/24/02	6.90	9.10	5.8	3.4	18		65			11.4	<1		61		59.60		1.4		48	2.60	

Date	dAl (ug/L)	tAl (ug/L)	dAs (ug/L)	tAs (ug/L)	tBa (ug/L)	dCa (ug/L)	tCa (ug/L)	dCd (ug/L)	tCd (ug/L)	dCu (ug/L)	tCu (ug/L)	dFe (ug/L)	tFe (ug/L)	dMg (ug/L)	tMg (ug/L)	dMn (ug/L)	tMn (ug/L)	dPb (ug/L)	tPb (ug/L)	dZn (ug/L)	tZn (ug/L)
9/27/01		348		2	<2	10300			7.8		1		20	1400			<10		133		2088
11/16/01	46					8800		8.3		2		123		1300		<10		101		1960	
4/24/02	54.2					6200		7.3		4		<10		700		<10		107		1433	

Table 6. Metal, pH, and conductivity data from the USACE Emperious Tailings Pile core. Samples were collected at 5 inches, and at 3, 7, 10, and 15 feet. The sample collected at 15 feet was in native soil. A duplicate sample was collected at 3 feet. All metal concentrations are reported in mg/kg.

	Soil Samples					
Analyte	5"	3'	7'	10'	15' (native soil)	3' (duplicate)
Aluminum	3630	635	1220	1100	1100	614
Cadmium	2	9.49	4	13.4	2560	11
Calcium	911	190	230	570	1430	72
Copper	123	78.1	33.8	157	18	86.8
Iron	14100	6490	15300	16400	10500	7430
Lead	3170	3460	6260	4190	314	3690
Magnesium	917	20 J	37	38	2570	20 J
Manganese	210	9.77	10.3	11	247	9.47
Zinc	517	1620 B	622 B	2960 B	3920 B	1860 B
pH	8.45	3.74	2.75	3.25	3.97	3.34
Conductivity (umho/cm)	93.9	249	1400	914	2320	330

Note: B = Analyte also detected in method blank; J = Estimated concentration below laboratory limit; all values reported in milligrams per kilogram (mg/Kg)

Figures

List of Figures

Floodplain Wells and Emperious Pile Core Sites
Below Creede, Colorado

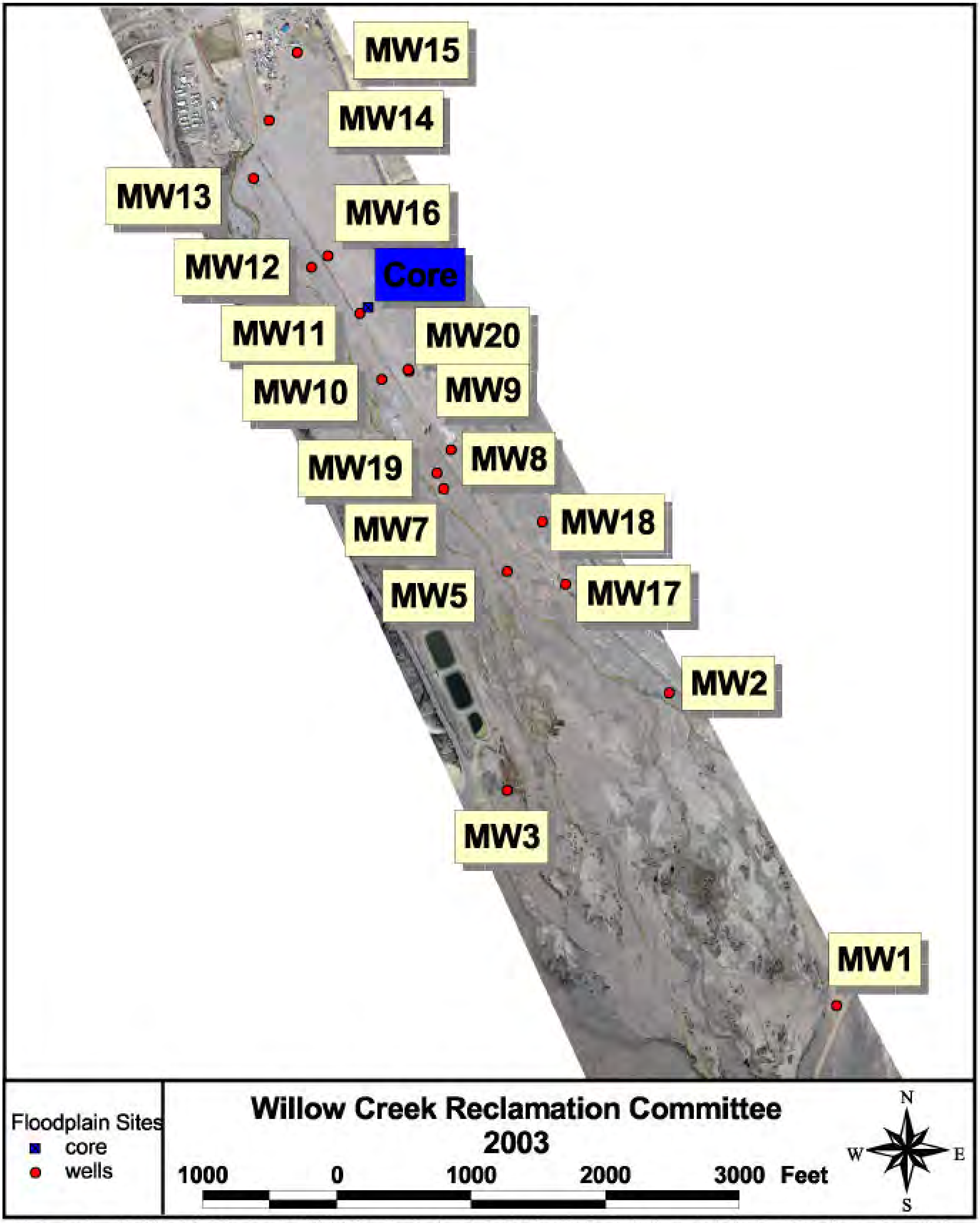


Figure 1. MFG, URS, and USACE wells in the Willow Creek floodplain below Creede, CO. The site of the Emperious tailings pile core is presented in blue.

Alluvial Groundwater Wells at the Midwest Mine and Below the Solomon Mine Area

Figure 2. URS wells above Creede, Colorado. Wells associated with the Midwest Mine area are MWNCC1 and MWNCC2. Wells below the Solomon area are MWEW1 and MWEW2.

URS and USACE Wells
pH, Conductivity, and Total Dissolved Solids
November 2002

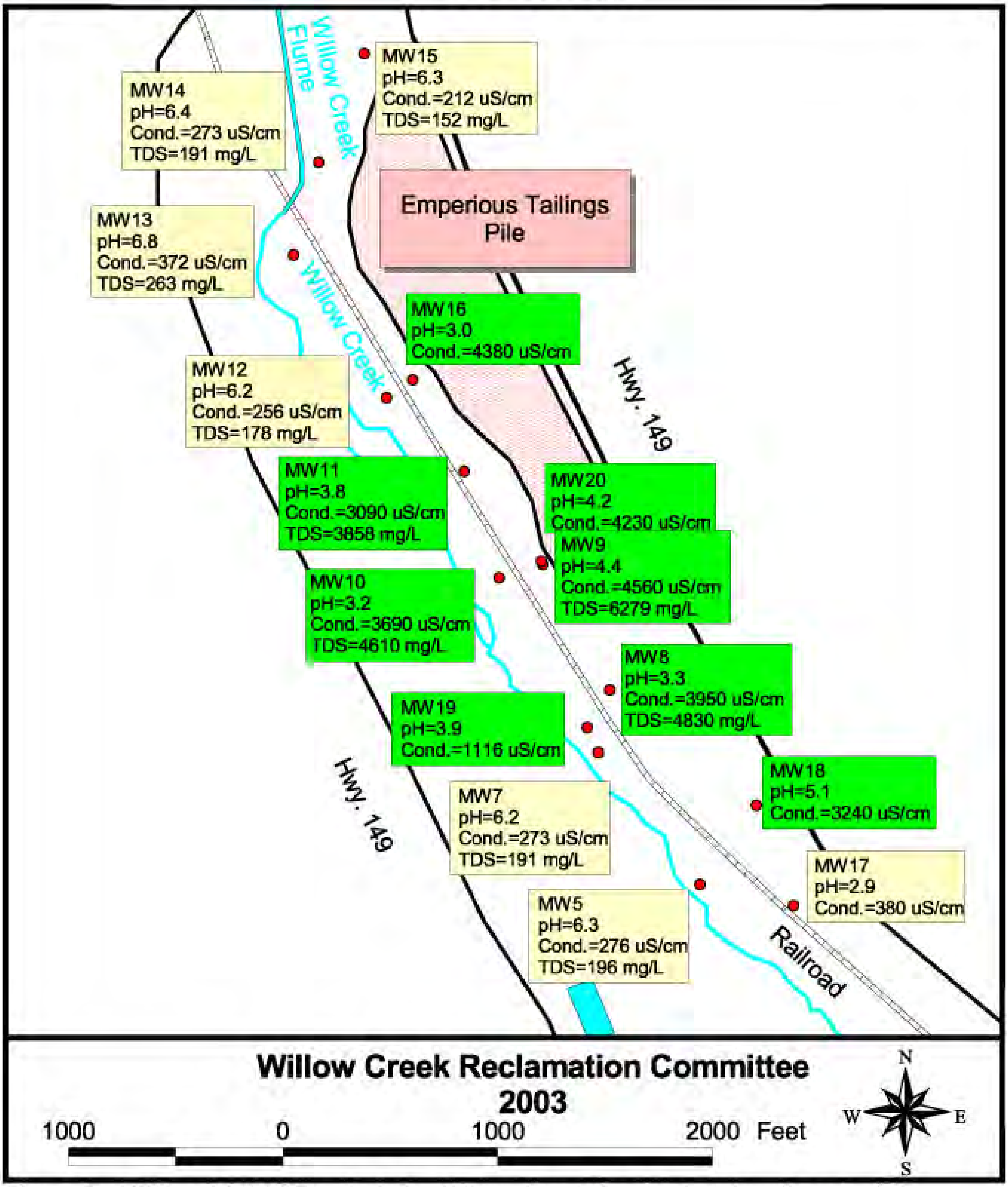


Figure 3. URS and USACE wells in the Willow Creek floodplain below Creede, CO. Well and tailings pile locations and dimensions are approximated from aerial photo. Data values are from November 2002 samples. Green shading indicates wells referred to as contaminated.

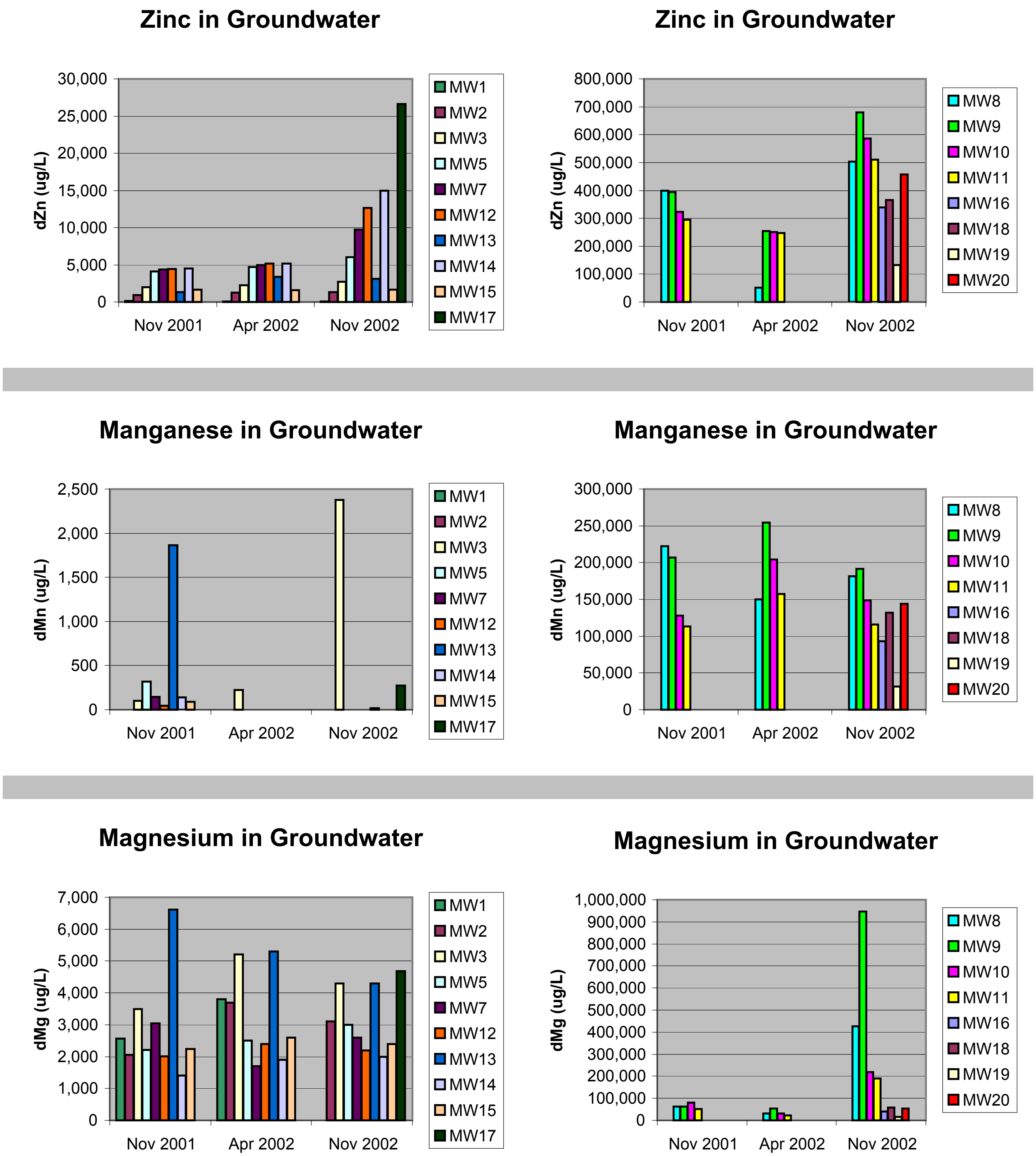


Figure 4. Zinc, manganese, and magnesium concentrations in groundwater samples collected in November 2001, April 2002, and November 2002. Data are presented as two graphs for each constituent to allow for scale changes.

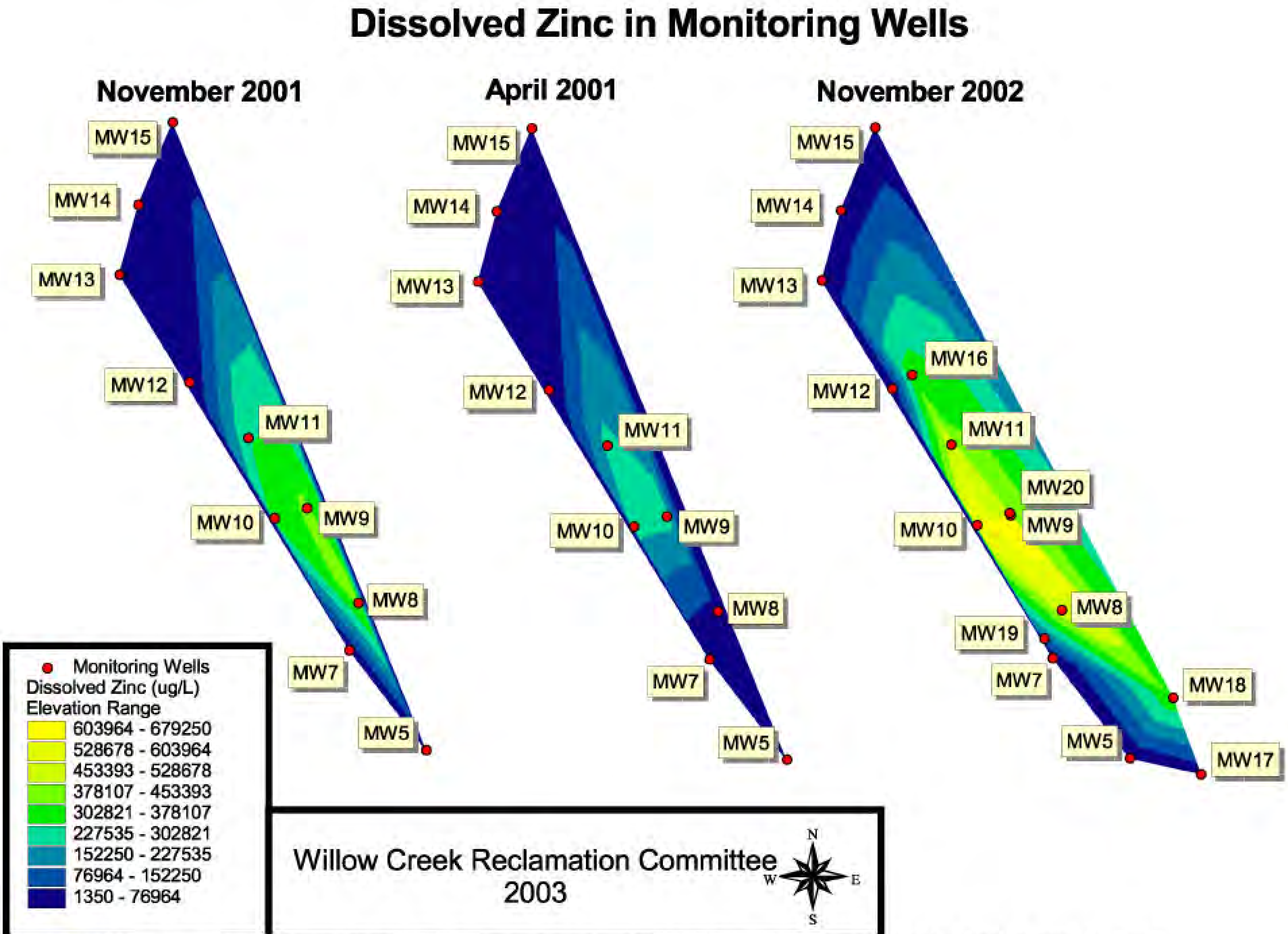


Figure 5. Dissolved zinc concentration (ug/L) diagrams for the URS (MW5-MW15) and USACE (MW16-MW20) wells.

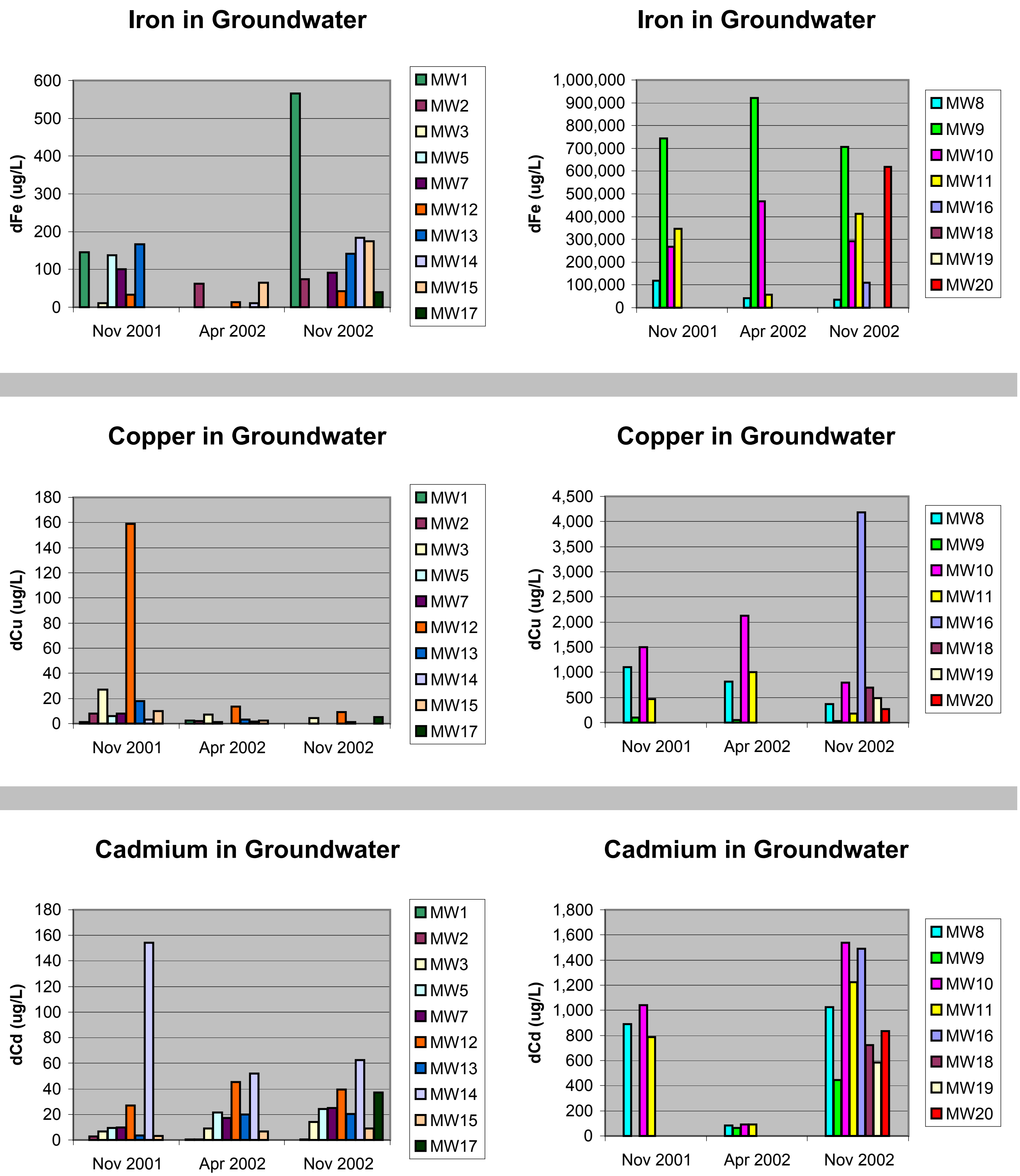


Figure 6. Iron, copper, and cadmium concentrations in groundwater samples collected in November 2001, April 2002, and November 2002. Data are presented as two graphs for each constituent to allow for scale changes for contaminated wells MW8, MW9, MW10, and MW11.

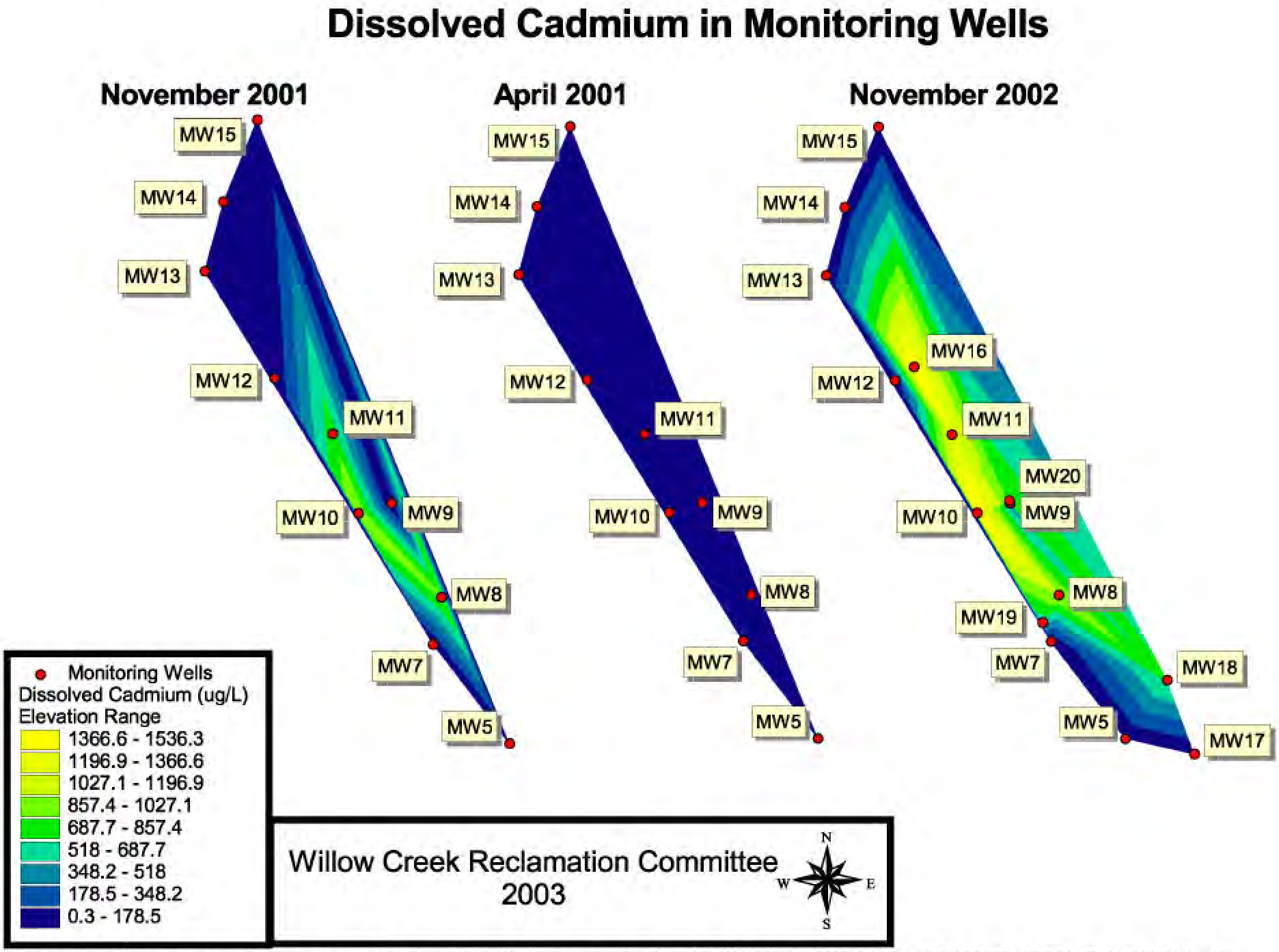


Figure 7. Dissolved cadmium concentration (ug/L) diagrams for the URS (MW5-MW15) and USACE (MW16-MW20) wells.

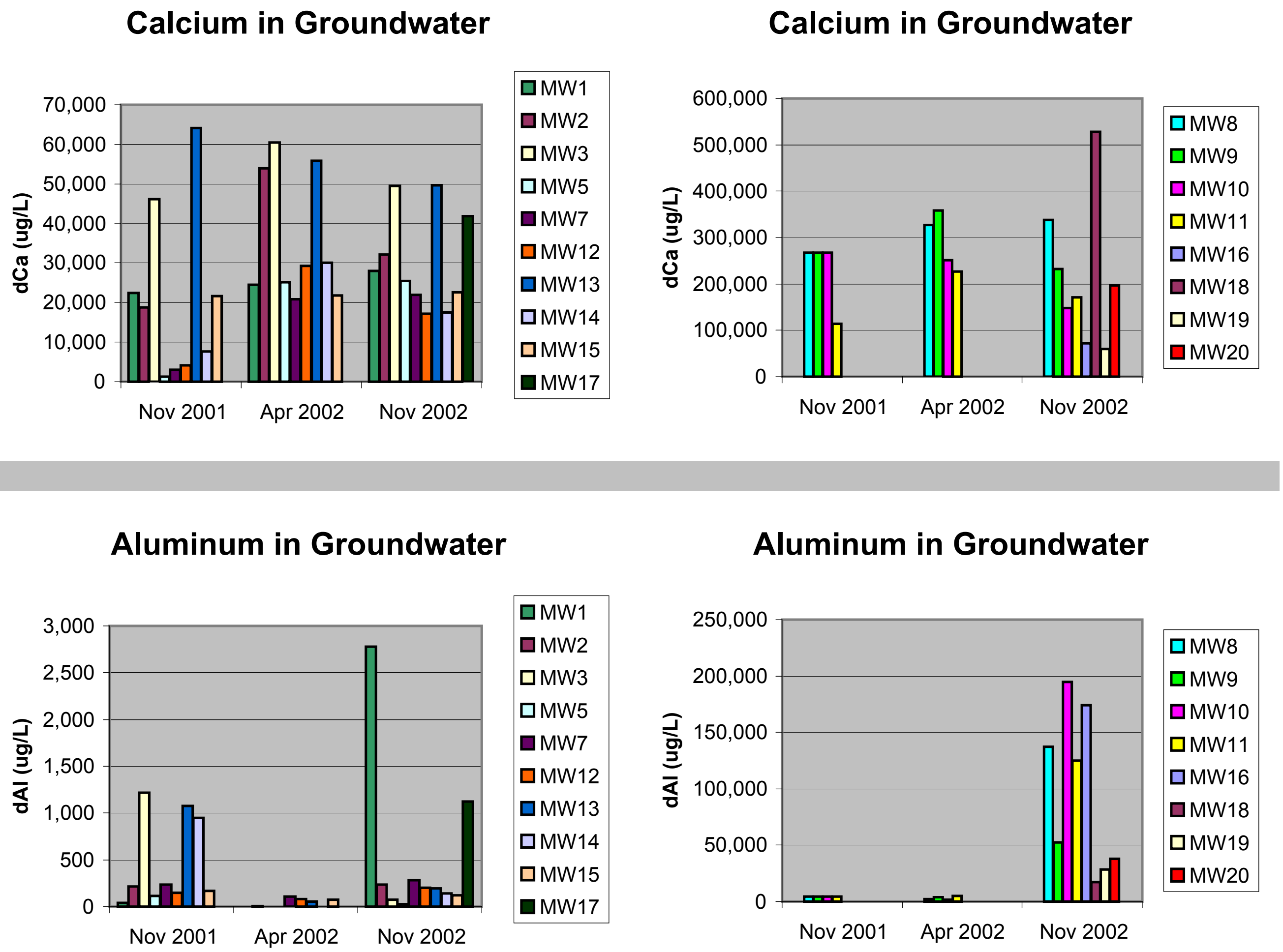


Figure 8. Calcium and aluminum concentrations in groundwater samples collected in November 2001, April 2002, and November 2002. Data are presented as two graphs for each constituent to allow for scale changes.

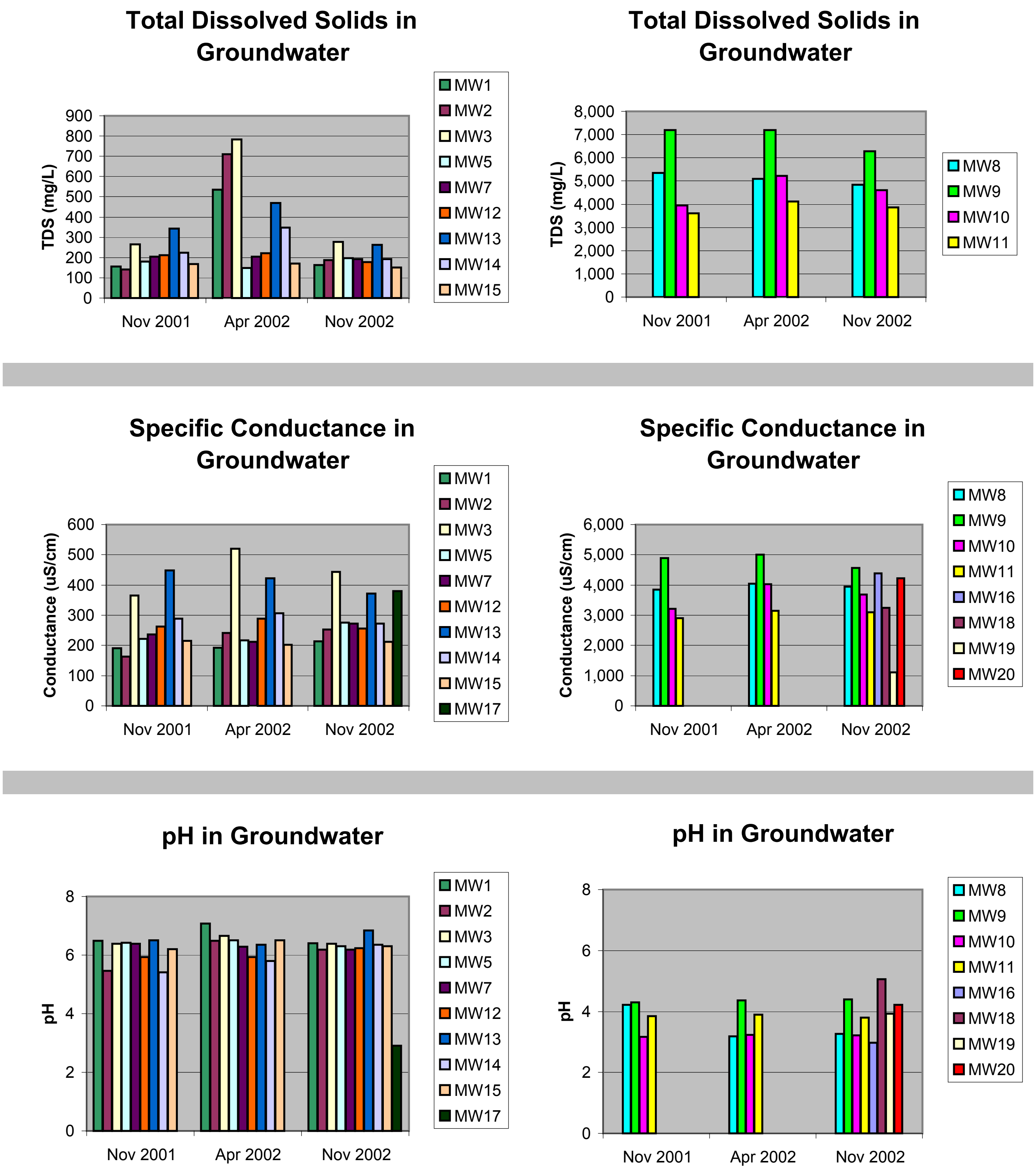


Figure 9. Total dissolved solids, specific conductance, and pH in groundwater samples collected in November 2001, April 2002, and November 2002. Data are presented as two graphs for each constituent to allow for scale changes. Total dissolved solids were not analyzed at the USACE wells in November 2002.

APPENDIX A

MFG BORING LOGS

LOG OF BORING MW-~~3~~ 1

(Page 1 of 2)

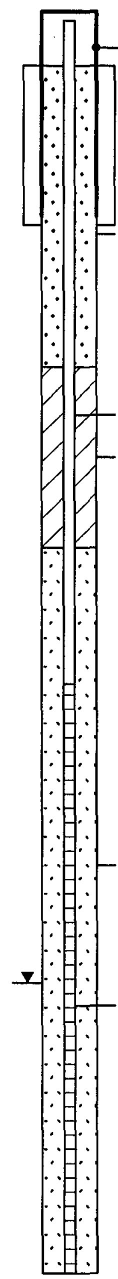
McCulley Frick & Gilman, Inc.

~~Willow~~ Creek Reclamation Committee
Creede, Colorado
MFG Project 010002-2.5

Driller	: Layne Western Drilling	Location	: Floodplain South of Creede, CO
Drill Rig	: CME 75	Northing/Easting	:
Drilling Method	: Air percussion hammer/ODEX	Surface Elevation	: ~8600 ft.
Hole Diameter	: ~6"	Date Completed	: 9/21/99
Logged By	: C. Foulk		

Depth in ft	Surf. Elev. 8600	DESCRIPTION	GRAPHIC	USCS	REMARKS
0	8600	Cuttings (0 - 3 ft bgs): Sandy, gravelly cobbles, medium brown, dry. (Volcanic cobbles.)			
		Cuttings (3 - 8 ft bgs): Sandy, gravelly cobbles, medium red-brown, dry.			
5	8595				
		Cuttings (8 - 13 ft bgs): Brown, coarse to very coarse grained sand with cobbles and gravel. Wet.		COBBLES W/ SAND AND GRAVEL	
10	8590				
		Some water in the borehole at 13 ft bgs.			
		Cuttings (13 - 18 ft bgs): Same as above. Saturated. More cobbles.			
15	8585	Water at 15.5 ft bgs in casing.			Water level @ approximately 15.2 ft bgs in monitoring well on 9/23/99.
		Cuttings (18 - 23 ft bgs): Cobbley-gravelly sand. Saturated.			
20					

Well: MW-~~3~~ 1
Elev.: 8600



10-14-1999 J:\10002\FIELD~1\MW3.BOR

LOG OF BORING MW-~~3~~1

McCulley Frick & Gilman, Inc.

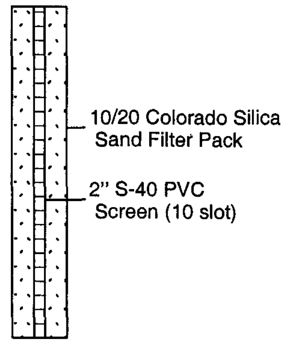
Willow Creek Reclamation Committee
Creede, Colorado

MFG Project 010002-2.5

Driller	: Layne Western Drilling	Location	: Floodplain South of Creede, CO
Drill Rig	: CME 75	Northing/Easting	:
Drilling Method	: Air percussion hammer/ODEX	Surface Elevation	: ~8600 ft.
Hole Diameter	: ~6"	Date Completed	: 9/21/99
Logged By	: C. Foulk		

Depth in ft	Surf. Elev. 8600	DESCRIPTION	GRAPHIC	USCS	REMARKS
20	8580				
		Cuttings (23 - 25 ft bgs): Cobbles, very hard, slow drilling.		COBBLES W/ SAND AND GRAVEL	
25	8575				
		Total depth = 25.5 ft bgs			
		ft: feet bgs: below ground surface			
30	8570				
35	8565				
40					

Well: MW-3
Elev.: 8600



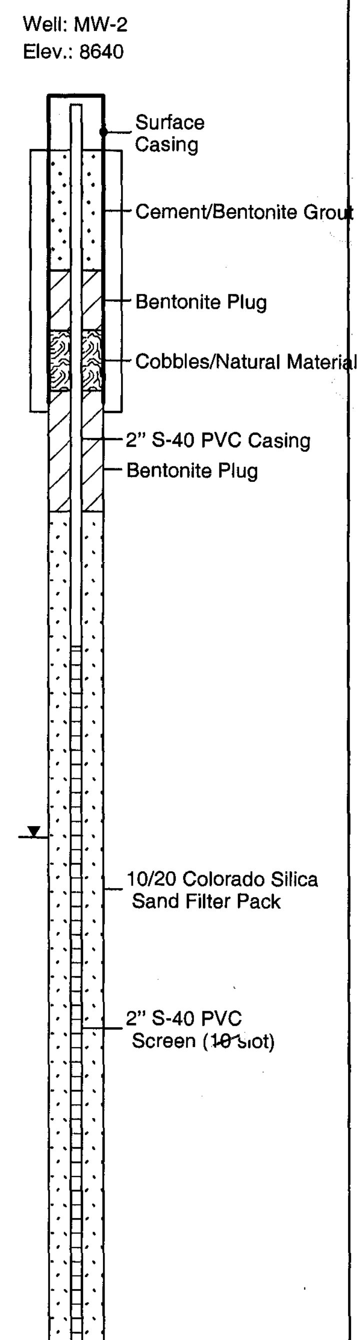
LOG OF BORING MW-2

Willow Creek Reclamation Committee
Creede, Colorado
MFG Project 010002-2.5

McCulley Frick & Gilman, Inc.

Driller	: Layne Western Drilling	Location	: Floodplain South of Creede, CO
Drill Rig	: CME 75	Northing/Easting	:
Drilling Method	: Air percussion hammer/ODEX	Surface Elevation	: ~8640 ft.
Hole Diameter	: ~6"	Date Completed	: 9/22/99
Logged By	: C. Foulk		

Depth in ft	Surf. Elev. 8640	DESCRIPTION	GRAPHIC	USCS	REMARKS
0	8640	Cuttings (0 - 3.5 ft bgs): Cobbles and gravel with some brown sandy top soil and roots, dry.			
		Cuttings (3.5 - 8.5 ft bgs): Sand and gravel with some cobbles. The sand content in upper part of interval. Coarse to very coarse sand, poorly sorted, brown, dry to damp. Wide variety of volcanic fragments.			
5	8635				
		Cuttings (8.5 - 13.5 ft bgs): Same as above. Saturated at 12 to 13 feet bgs.			
10	8630			COBBLES W/ SAND AND GRAVEL	
					Water level @ approximately 11.7 ft bgs in monitoring well on 9/23/99.
		Cuttings (13.5 - 18.5 ft bgs): Same as above. Saturated. Some clay in lower 2 ft of interval (i.e., sand matrix is cohesive).			
15	8625				
		Cuttings (18.5 - 23.5 ft bgs): Same as above. Very soft sand layer at 22 ft bgs.			
20					



10-14-1999 J:\10002\FIELD~1\MW2.BOR

LOG OF BORING MW-2

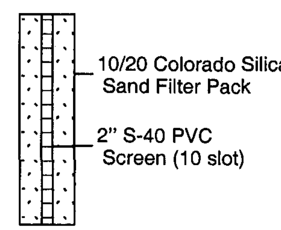
McCulley Frick & Gilman, Inc.

Willow Creek Reclamation Committee
Creede, Colorado
MFG Project 010002-2.5

Driller	: Layne Western Drilling	Location	: Floodplain South of Creede, CO
Drill Rig	: CME 75	Northing/Easting	:
Drilling Method	: Air percussion hammer/ODEX	Surface Elevation	: ~8640 ft.
Hole Diameter	: ~6"	Date Completed	: 9/22/99
Logged By	: C. Foulk		

Depth in ft	Surf. Elev. 8640	DESCRIPTION	GRAPHIC	USCS	REMARKS
20	8620			COBBLES W/ SAND AND GRAVEL	
		Total depth = 23.5 ft bgs.			
25	8615				
		ft: feet bgs: below ground surface			
30	8610				
35	8605				
40					

Well: MW-2
Elev.: 8640



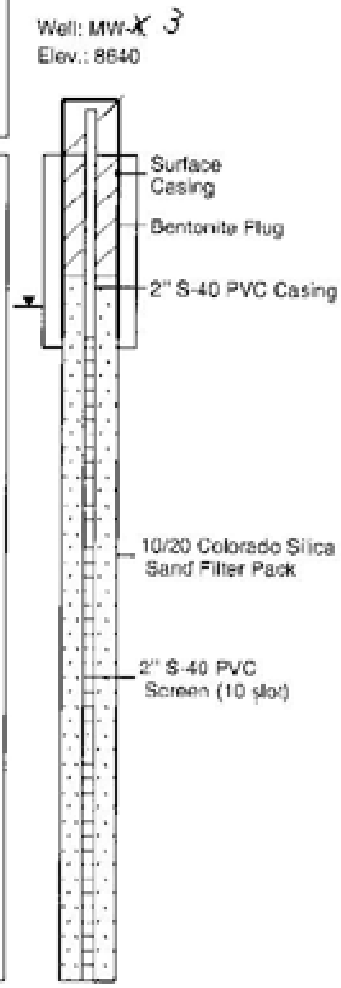
LOG OF BORING MW-X 3

(Page 1 of 1)

Willow Creek Reclamation Committee
Creede, Colorado
MFG Project 010002-2.5

Driller	: Layne Western Drilling	Location	: Floodplain South of Creede, CO
Drill Rig	: CME 75	Northing/Easting	:
Drilling Method	: Air percussion hammer/ODEX	Surface Elevation	: ~8640 ft.
Hole Diameter	: ~6"	Date Completed	: 9/23/99
Logged By	: P. Anderson		

Depth in ft	Surf Elev. 8640	DESCRIPTION	GRAPHIC	USCS	REMARKS
0	8640	Cuttings (0 - 3 ft bgs): Dark brown, slightly moist (rain last night), gravelly sand mixed with top soil and cobbles.		GP W/ COBBLES	
		Cuttings (3 - 8 ft bgs): Cobbles with gravel and sand, dark brown, wet.		COBBLES W/ SAND AND GRAVEL	Water level @ approximately 2.5 ft bgs in monitoring well on 9/23/99
5	8635				
		Cuttings (8 - 13 ft bgs): Cobbles with gravel and sand, dark brown, wet.			
10	8630				
15	8625				
20					



Total Depth = 13.5 ft bgs

ft: feet
bgs: below ground surface

10-14-1999 J:\10002\ 9.5\40...MW1.BOR

APPENDIX B

APRIL 2003 DATA

Appendix B. Groundwater data from samples collected April 29, 2003.

Station	Station Description	Condition	Depth to water from PVC	Depth of well from PVC	field pH	lab pH	Temp (C)	tALK (mg/L)	Cond (uS/cm)	dAl (ug/L)	dCa (ug/L)	dCd (ug/L)	dCu (ug/L)	dFe (ug/L)	dMg (ug/L)	dMn (ug/L)	dPb (ug/L)	dZn (ug/L)	SO4 (mg/L)	Cl (mg/L)	TDS (mg/L)	dSi (mg/L)	dK (mg/L)	DOC (mg/L)	Na (mg/L)
MW1	Fence		19.56	28.52	7.1	6.0	5.5	7	230	<3	15300	<0.1	<1	13	3100	154	<2	23	58.6	1.9	147	17.7	0.8	17	1.8
MW2	Headgate		8.57	25.50	6.9	5.5	4.5	10	206	46	20900	<0.1	<1	116	2500	174	<2	388	49.4	2.3	133	13.2	1.2	25	3.9
MW3	Lagoon		5.25	15.40	6.2	6.5	4.1	91	341	18	37300	5.5	4	<10	3500	1372	<2	1477	34.0	11.7	205	18.9	1.6	<1	16.9
MWFP5			5.38	14.17	6.2	5.9	5.7	12	201	6	15300	7.1	<1	50	1600	230	4.3	7072	50.1	1.9	133	15.7	1.2	19	5.8
MWFP6		dry																							
MWFP7			7.80	16.00	6.2	5.8	5.9	12	171	43	12200	4.9	<1	38	1300	264	9.1	6502	39.9	1.9	108	16.3	1.1	22	5.3
MW720	field dup		7.80	16.00	6.2	5.8	5.9	12	171	40	11600	5.2	<1	39	1300	280	<2	6477	38.2	1.9	121	14.5	1.3	39	5.1
MWFP8			4.10	14.10	3.2	2.9	6.9	<1	3810	33693	141000	423.0	696	48450	110000	176900	<2	572200	2104.7	17.4	4559	42.3	6.3	23	12.7
MWFP9			7.70	17.20	4.0	3.6	7.2	<1	4420	12021	88000	397.9	24	444000	94000	186650	8.7	528400	2723.9	16.2	4559	22.6	17.7	5	27.5
MWFP10			3.48	12.35	3.1	2.9	7.3	<1	3830	32727	58000	846.7	1238	240000	80000	164300	4.3	475250	2327.3	17.8	4713	77.4	8.7	<1	18.3
MWFP11			6.70	15.00	3.6	3.3	9.1	<1	3030	35933	40000	717.7	541	225000	70000	128205	6.9	365550	1803.3	17.3	3524	50.1	12.5	19	15.8
MWFP12			3.52	11.48	5.7	5.7	8.3	12	291	34	14700	16.6	20	382	1900	92	4.2	13320	82.0	5.7	189	18.3	2.5	59	8.8
MWFP13			3.30	13.80	6.2	6.5	6.5	45	254	26	28900	8.6	<1	65	2100	17	10.1	3424	55.3	2.8	170	15.8	2.0	44	6.8
MWFP14			3.50	13.25	6.1	6.0	6.8	25	315	50	14000	25.4	<1	167	1900	22	<2	17430	88.2	4.7	214	18.0	2.5	9	8.9
MWFP15			7.10	15.10	6.2	6.2	7.5	37	206	26	21900	5.6	<1	179	2000	32	149.1	1695	48.3	2.9	136	21.4	3.4	11	5.6
MW16			8.70	19.00	3.1	2.9	8.2	<1	4240	81687	86000	987.0	5541	152000	108000	135950	8.8	583800	2339.8	16.3	6151	64.9	3.3	15	9.4
MW1620	field dup		8.70	19.00	3.1	2.9	8.2	<1	4240	62423	125000	1053.0	6269	96300	92000	123800	13.3	549600	4445.5	17.1	6321	79.1	4.4	14	9.8
MW17			12.30	19.80	5.4	4.4	7.1	<1	334	386	17800	9.3	<1	15	2300	191	<2	15095	155.0	1.9	280	22.1	2.4	47	5.9
MW18			7.95	11.88	4.9	4.8	6.1	5	3200	38567	182000	267.4	678	107	70000	113800	<2	361850	19.4	19.8	6313	30.6	12.7	18	26.7
MW19			7.20	10.70	4.2	3.8	4.9	<1	857	5476	45700	162.1	163	50	11900	13595	6	86080	360.4	16.1	765	35.7	3.3	<1	10.1
MW1910	field blank					3.8		<1		<3	<1000	0.3	<1	46	<500	<10	<2	130	<1	<1	<1	0.9	<0.5	6	<1
MW20			8.10	20.20	4.0	3.4	7.5	<1	4280	13644	200000	288.5	202	453000	105000	164500	21	545800	2529.2	16.2	5750	34.9	17.5	<1	24.6
MWEW1			6.21	13.68	5.9	5.9	2.7	18	65	47	5800	4.1	<1	299	1100	54	89.8	1455	7.9	1.8	61	14.8	0.9	16	1.9
MWNCC1			1.35	9.00	6.3	5.6	4.2	10	42	298	3800	0.6	<1	1130	700	201	<2	574	16.9	1.6	99	10.1	1.9	<1	<1
MWNCC2		dry																							
seep near MWNCC1	seep									196		0.2	3	1130		70	10.2	92							