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Perched Zone Monitoring Well 1995 Analytical Results

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Abstract

This report discusses 1995 analytical data collected to evaluate possible differences in results between older alluvial observation wells and newer wells constructed in 1990. Too few samples were available to compare individual pairs of wells, so the data for the entire group of old vs. new wells were pooled. Earlier sample results from 1990 suggested that lower levels of plutonium were measured in the new wells in Mortandad Canyon. Sampling in 1995 shows that there was no significant difference in radiological constituent concentrations between the new and old wells.

Results from the 1990 sampling also suggested that metals concentrations, especially barium and lead, might be higher in the new wells than the old wells. The 1995 sampling showed a statistically significant difference in the metals concentrations between the new and old wells for all pooled filtered and unfiltered results, with the higher concentrations in the new wells. These differences might be due to differences in turbidity or total suspended sediment content between old and new wells, although insufficient data are available to evaluate this possibility. As would be expected, metals concentrations are greater in the unfiltered samples.

Based on statistics, there is no significant difference in overall lead concentrations between the pooled new and old wells. This generalization is not universal, however, as examination of the data shows that lead levels in 1990 well MCO-7A are double those in the older MCO-7. Barium concentrations are apparently higher in the new wells. The higher barium values and the larger differences between barium concentrations in well pairs occur in Mortandad Canyon, in wells MCO-6/ MCO-6B, and in wells MCO-7/ MCO-7A.

Introduction

Los Alamos National Laboratory's Hazardous Waste Permit (issued under the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act) contains several special conditions in Module VIII, Section C (EPA 1990). The first condition required the installation of several groundwater monitoring wells, and chemical analyses of the waters. The Laboratory installed these wells (or, in some cases, boreholes) according to EPA's RCRA guidelines in 1990 (Purtymun 1990, Stoker 1990, EPG 1992). Construction details are found in Purtymun (1990).

The wells or boreholes included:
- a new well in Pueblo Canyon (APCO-1);
- three wells in Los Alamos Canyon near existing wells LAO-3, LAO-4.5, and LAO-5 (LAO-3A, LAO-4.5C, and LAO-6A);
- two wells in Sandia Canyon near water supply wells PM-1 and PM-3 (SCO-1 and SCO-2);
- three wells in Mortandad Canyon near wells MCO-4, MCO-6, and MCO-7.5 (MCO-4B, MCO-6B, and MCO-7A);
- wells in Potrillo Canyon and Fence Canyon above State Road 4 (test hole PCTH-1 and well FCO-1);
- and three wells in Water Canyon (WCO-1, WCO-2, and WCO-3).

The wells or borings in Sandia, Potrillo, Fence, and Water Canyons have remained dry.

All of the new wells containing water were sampled in 1990 and results of the chemical analyses were compared between the new wells and the adjacent older wells used in routine surveillance. For the most part, analytical results for the paired wells were similar. An exception was that lower levels of plutonium were found in the new wells in Mortandad Canyon. LANL attributed this difference to possible higher plutonium adsorption near the newer wells because of new sediment surfaces made available for adsorption during well installation (EPG 1992).

The EPA completed a Comprehensive Groundwater Monitoring Evaluation Report for the Laboratory in March 1993. The EPA concluded from the 1990 sampling that concentrations of barium and lead were higher in the new HSWA wells than the older wells in Los Alamos Canyon (Honker 1994, Stoker 1990). Because of this finding, the EPA requested that additional sampling of the new wells be conducted, and results be compared to analyses for the neighboring wells. In response to this request, the Laboratory sampled these wells on a quarterly basis during 1995. The 1995 results for three canyons (Acid-Pueblo, Los Alamos, and Mortandad) are presented in Appendix A of this report. Where two neighboring wells were sampled at the same time, the table is arranged so that these samples are adjacent in the table.

Field Sampling Procedures

The figure entitled **"Location of HSWA perched zone monitoring wells"** shows the locations of the wells discussed here, and locations of additional wells and borings drilled as part of this project but not discussed here. The new HSWA wells and the pre-existing alluvial wells were checked quarterly in 1995 for the presence of water. Sampling and analyses were conducted according to guidelines in the sampling and analysis plan (ER 1995), including purging before sampling. Wells that contained water were sampled using dedicated bladder pumps, at a typical rate of 1 gallon per minute. A minimum of three casing volumes was purged.

Groundwater samples drawn from the canyon bottom alluvium can be quite turbid because of suspended sediment that has entered the well casings. Both filtered and unfiltered samples were collected at each of the stations, in order to evaluate the quantity of metals and radionuclides associated with the suspended sediment portion of the water samples. Filtered samples were collected first, using a 0.45-micron in-line filter, and then unfiltered samples were collected. Samples were preserved and stored in a cooler in the field immediately after collection.

Data Interpretation Methods

The statistical tests reported here use a data pool that includes all of the data in a particular category for paired wells. For example, all unfiltered samples might be compared between the old and new (that is, HSWA) wells. While it would have been preferable to compare results for paired wells directly (for example, results of LAO-3 to LAO-3A), such a comparison would be based on too few results to have statistical significance. For this reason larger data pools were used, for example, lumping all of the newer 1990 wells together for a specific analyte for comparison with the corresponding preexisting wells. While based on a larger pool, conclusions from these tests may be weak because they combine a larger number of cases (such as wells in different canyons) and cannot distinguish among several possible

Insert map here.

contributing factors. Conclusions from these tests are further weakened by the fact that only the analytical results are included in the evaluation, and not the analytical uncertainties.

Wilcoxon Signed Rank Test

The 2-sided Wilcoxon signed rank test (Statistical Sciences, 1995) was used to determine whether there were differences between the new and old wells, and between filtered and unfiltered samples from the same well. This test is the non-parametric alternative to the commonly used paired *t* test. The non-parametric test was selected over the *t* test because the *t* test requires the assumption that sample data come from a normally-distributed population, while the assumptions associated with the Wilcoxon signed rank test are less restrictive. The signed rank test requires that the data distribution be symmetric, although no separate test of symmetry was performed on the data.

Several Wilcoxon statistical tests vary in their assumptions and type of information used. The Wilcoxon tests are intended to evaluate the significance of differences between two sets of data drawn from two pools (for example two experimental treatments) and are based on the sign and size of numerical differences between pairs of data. The Wilcoxon sign test uses only the signs of the differences, addressing whether the values from one group were larger. The Wilcoxon signed rank test is similar to the Wilcoxon sign test but uses the magnitudes of differences in addition to the sign. This test generally has more power than the sign test to find differences in two populations (Gilbert 1987). The 2-sided test was used because there was no *a priori* expectation of which group would have the greater median value.

A statistical test uses observed sample values to calculate a statistic. The value is then compared to a calculated distribution for that statistic under the null hypothesis. For the 2-sided Wilcoxon signed rank test, the null hypothesis is that there is no difference in median values between the two groups, or that “the median difference of the paired observations equals zero.” The p-value is the probability of obtaining a value for the particular statistic that is at least as great as the observed value, given that the null hypothesis is true. Therefore, a small p-value means that the observed statistic is very unlikely if there is no difference between the two members of each pair.

While not strictly correct, it may be useful to think of the p-value as the uncertainty of a conclusion. For example, assume the null hypothesis is that the concentration of barium in filtered samples is from the same population distribution as the concentration of barium in unfiltered samples. If the Wilcoxon signed rank test produces a p-value of 0.05, that means that the two populations are different with a 95% certainty. A common threshold of statistical significance is a 95% certainty level, or a p-value of 0.05. In the following discussions, p-values up to 0.10 are listed in order to provide additional information.

Data Pairs

The statistical analyses were all performed on paired sample data. Several types of pairs were considered, in order to evaluate possible differences between old and new wells, and differences related to filtering. For an old vs. new well data pair, one observation came from the old well, one from the new well. For a filtered/unfiltered data pair, both members came from the same well and one member of the pair was filtered, one was unfiltered. The data pairs were developed as follows:

- Both members of the pair measured the same analyte;
- Both members of the pair were collected during the same quarter (usually within the same week);
- Both members of the pair were either field duplicates, laboratory duplicates, both field and laboratory duplicates, or were not duplicates.

Some of the data are reported as below the detection limit. If both members of the pair were below the detection limit, the pair was not used in the analysis. If one of the values in the pair was reported as less than the detection limit, the pair was used, and the detection limit was used for the value below the detection limit in the statistical analysis.

The paired observations used here are not completely independent. Some correlation between samples from a single well over time may be expected. In addition, filtered and unfiltered samples were collected at the same time. In some of the results discussed below, unfiltered and filtered observations were considered together when evaluating differences between old and new wells. For the old vs. new well pairs test, there may be a correlation between the filtered and unfiltered observations. Likewise, there may be correlation between the observations from the new and old well pairs in the filtered versus unfiltered test. No adjustment to the significance levels was made to account for the effects of conducting numerous simultaneous tests.

Discussion of Analytical and Statistical Results

General Chemistry

General chemistry and water quality parameters from paired wells were compared to determine if both wells were sampling the same water. The table **Water Quality**, in Appendix A, lists the general chemistry and water quality results for samples collected during the 1995 quarterly sampling.

Piper diagrams comparing each set of wells are displayed in Appendix B. Piper diagrams show the relative proportions of major ions of positive and negative charge in the lower two triangles, and combine these results in the upper diamond-shaped panel. Overall, the results for each set of wells show that there is little difference in water composition based on filtered or unfiltered samples, or between adjacent pairs of wells. There are some differences based on date of sampling, as discussed for individual cases.

The results for well APCO-1 indicate little change in major ion chemistry during the year, and no significant differences between filtered and unfiltered samples.

For well pair LAO-3/ LAO-3A, there is little difference between filtered and unfiltered samples and between the two wells at a given date. For all samples throughout the year, cation chemistry is similar and the compositional variations that occur are in anion proportions and concentrations. The samples from March (3/28 and 3/29) show a higher proportion of chloride than samples from August. The two samples taken in December have higher sulfate than the other samples. The higher chloride in the spring may reflect road salt in winter runoff, which is diluted later in the season.

Results for pairs LAO-4.5/ LAO-4.5C and LAO-6/ LAO-6A show a chloride pattern similar to wells LAO-3/ LAO-3A, and also show little difference between filtered and unfiltered samples or between the two wells at a given date. As with wells LAO-3/ LAO-3A, well pairs LAO-4.5/ LAO-4.5C and LAO-6/ LAO-6A show no little or no change in proportion of cations over the year.

Portion of Radiochemical Samples Analyzed by CST Division

No. of Samples	Sr-90	Cs-137	U	Pu-238	Pu-239,240	Am-241	Gross Alpha	Gross Beta	Gross Gamma
All Samples (Filtered and Unfiltered)									
Total	99	104	104	105	108	150	95	100	93
Analyzed by CST	64	65	68	78	78	109	60	65	66
% Analyzed by CST	65	63	65	75	72	73	63	65	71
Unfiltered Samples									
Total	56	60	61	61	61	80	55	57	53
Analyzed by CST	36	36	38	43	43	56	35	37	37
% Analyzed by CST	64	60	62	70	70	70	64	65	70

Due to a miscommunication with the CST Division analytical laboratory, all samples submitted for radiochemical analyses were filtered in that laboratory, including those intended to be analyzed unfiltered. These samples had been previously acidified in the field. In general, the fraction of a metal (including most radionuclides) in the adsorbed phase decreases as pH decreases. Therefore, a sample that was first acidified in the field and then filtered in the laboratory could have a higher dissolved radionuclide concentration than a corresponding sample that was filtered and then acidified in the field. However, an unknown fraction of the radionuclides might remain adsorbed on the sediments removed in samples that were filtered in the lab. The portion of the samples that were analyzed by CST Division is given in the table **Portion of Radiochemical Samples Analyzed by CST Division**. About 64% of the samples intended to be unfiltered were analyzed by CST Division, and therefore were inadvertently filtered.

Radiological data are typically reported uncensored (that is, all measured values are given even if below detection limit). The instrument output is reported along with an uncertainty. Some radiological measurements were reported as negative numbers. Negative numbers occur because analysis of radiochemical samples requires that analytical or instrumental backgrounds be subtracted to obtain net values. Consequently, individual measurements can result in values of positive or negative numbers. These negative numbers were included in the statistical analysis.

Results of the gamma spectroscopy, reported in table **Gamma Spectroscopy Screening for Radiochemical Constituents**, suggest only a few detections of radionuclides. In many cases, apparent detections (evaluated as measured values exceeding uncertainties by a factor of 4.66 times the uncertainty) are contrasted with very different values (mainly non-detections) for corresponding laboratory or field duplicates. This apparent inconsistency emphasizes the screening nature of these gamma spectroscopy measurements. Of particular note, however, is an apparent detection of ^{226}Ra on 12/18/95 in both an unfiltered sample and a laboratory duplicate from MCO-4B. These samples gave analytical values of about 183 (36.3) and 136 (26.4) pCi/L, where the number in parentheses is the uncertainty. The state groundwater standard for ^{226}Ra is 30 pCi/L. Other possible detections in the same sample include ^{211}Bi, ^{40}K, ^{22}Na, ^{210}Pb, ^{214}Pb, and ^{234}Th. Some of these isotopes were also found in other wells in Mortandad Canyon during 1995. These measurements should probably be viewed as cause for further sampling and confirmation rather than as definite detections.

All of the ^{137}Cs analyses were performed by gamma spectroscopy although preparation methods varied (shown on the **Radiochemical Data** table). This led to wide differences in the precision of the measurements as suggested by the accompanying analytical uncertainties. The LANL analytical laboratory analyzed ^{137}Cs by different methods for the data reported here. Typically, the residue from a 900-ml sample was deposited on a planchet and measured by gamma spectroscopy. In 1993, the method was modified to extend the count times from 10k seconds to 30k seconds. In 1995 several ^{137}Cs analysis were performed on a 500-ml aqueous sample. These results are indicated by a “*” on the table. This method is less sensitive as indicated by the uncertainties.

Radiochemical Statistical Results

When the radiochemical results for all analytes are pooled there is no significant difference (p=0.27) between the old and new wells.

The new wells, constructed to RCRA standards and including a sand pack, would ideally be more effective at preventing suspended solids from entering the well. In very fine-grained alluvium, however, a sand pack of a given size cannot prevent clay or silt-sized particles from passing through to the well bore. The total suspended solids (TSS) data shown on the table **Water Quality** in Appendix A are sparse, but do not show a systematic trend related to the type of well construction.

One question addressed was whether well construction differences between old and new wells affects analytical values. To evaluate this, results of the Wilcoxon signed rank test are presented for data subsets that include both filtered and unfiltered samples and for a data subset including only the unfiltered samples. The results of the Wilcoxon signed rank test for individual analytes with a p-value less than 0.1 (corresponding to a 90% confidence level) are listed in the table **Radionuclides: Old Wells vs. New Wells.** These are the analytes where there may be a significant difference in results between the old and new wells. The table also indicates whether the results for the new or old wells tended to be greater. The results of the Wilcoxon signed rank test for all the radiochemical analytes are presented in Appendix C. The table in Appendix C does not include a column for “Old or New Greater” because there was no significant difference between new and old for the analytes listed in Appendix C and not listed here.

The results in **Radionuclides: Old Wells vs. New Wells** indicate that values from the new wells were greater for gross alpha, gross beta, strontium-90, and uranium. In general, this conclusion stems from a few large values found in particular wells. In the case of gross alpha, values for most wells are very low. The larger gross alpha values occur in MCO-6/ MCO-6B. In one case (12/20/95) the value for MCO-7/ MCO-7A is 6.5 pCi/L vs. 43.2 pCi/L, with the new well higher. For strontium-90, results for most well pairs were below detection limit. The exceptions were one pair for MCO-6/ MCO-6B, and several pairs for LAO-3/ LAO-3A, where there are large differences between results for the old and new wells. In the case of uranium, most values for the wells are quite small: less than about 0.5 µg/L in Los Alamos Canyon, and fall in the range of about 1 to 3 µg/L in Mortandad Canyon.

The results in **Radionuclides: Old Wells vs. New Wells** show big differences between the p-values for the pooled filtered and unfiltered data compared to the unfiltered data. It is difficult to evaluate the significance of this observation, as the number of pairs is different for the two data pools, and the two groups may represent different numbers of samples from particular wells.

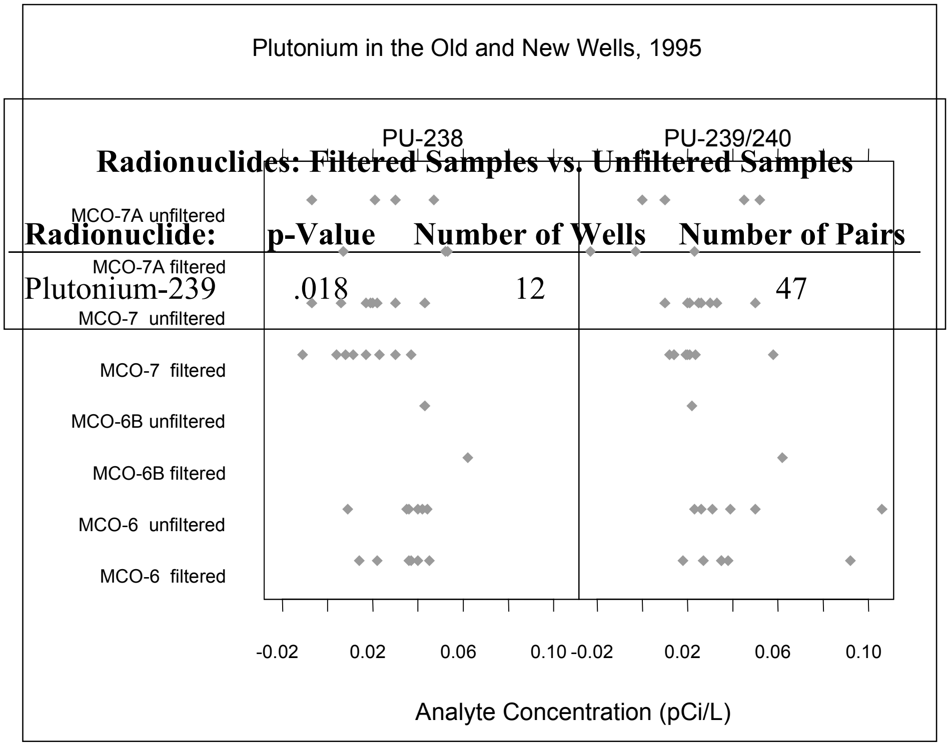
Radionuclides: Old Wells vs. New Wells

	Filtered & Unfiltered				**Unfiltered Only**			
Analyte	**p-Value**	**Number of Well Pairs**	**Number of Pairs**	**Old or New Greater**	**p-Value**	**Number of Well Pairs**	**Number of Pairs**	**Old or New Greater**
Gross Alpha	0.069	5	25	new	0.345	5	14	new
Gross Beta	0.075	5	25	new	0.109	5	14	new
Strontium-90	0.035	5	25	new	0.019	5	14	new
Uranium	0.078	5	25	new	0.594	5	14	new

The table **Radionuclides: Filtered Samples vs. Unfiltered Samples** shows that the only significant difference between filtered and unfiltered results was for $^{239/240}$Pu. Plutonium-239/240 was found in higher concentrations in the unfiltered samples. However, most of the analytical results either are non-detections or are quite close to the detection limit. This conclusion is based on a detection criterion of 4.66σ, meaning that a value less than 4.66 times the analytical uncertainty is a nondetection. Thus, this statistical conclusion regarding $^{239/240}$Pu differences is of dubious value. The principal exceptions are two unfiltered samples: one from MCO-4B on 12/18, and one from MCO-6 on 3/31. In the latter case, the analytical result is contradicted by a much smaller value in a field duplicate.

Radionuclides: Filtered Samples vs. Unfiltered Samples

Radionuclide:	**p-Value**	**Number of Wells**	**Number of Pairs**
Plutonium-239	.018	12	47


Plutonium in the Old and New Wells, 1995

The 1990 sampling suggested that plutonium levels were lower in the new wells in Mortandad Canyon. This was attributed to higher plutonium adsorption near the newer wells because of new sediment surfaces made available for adsorption through disturbance during well installation (EPG 1992). The plot **Plutonium in Old and New Wells, 1995** presents the concentrations for ^{238}Pu and $^{239/240}$Pu in the Mortandad Canyon wells. Inspection of the plot confirms that the 1995 sampling shows there is no significant difference in plutonium concentrations between the old and new wells.

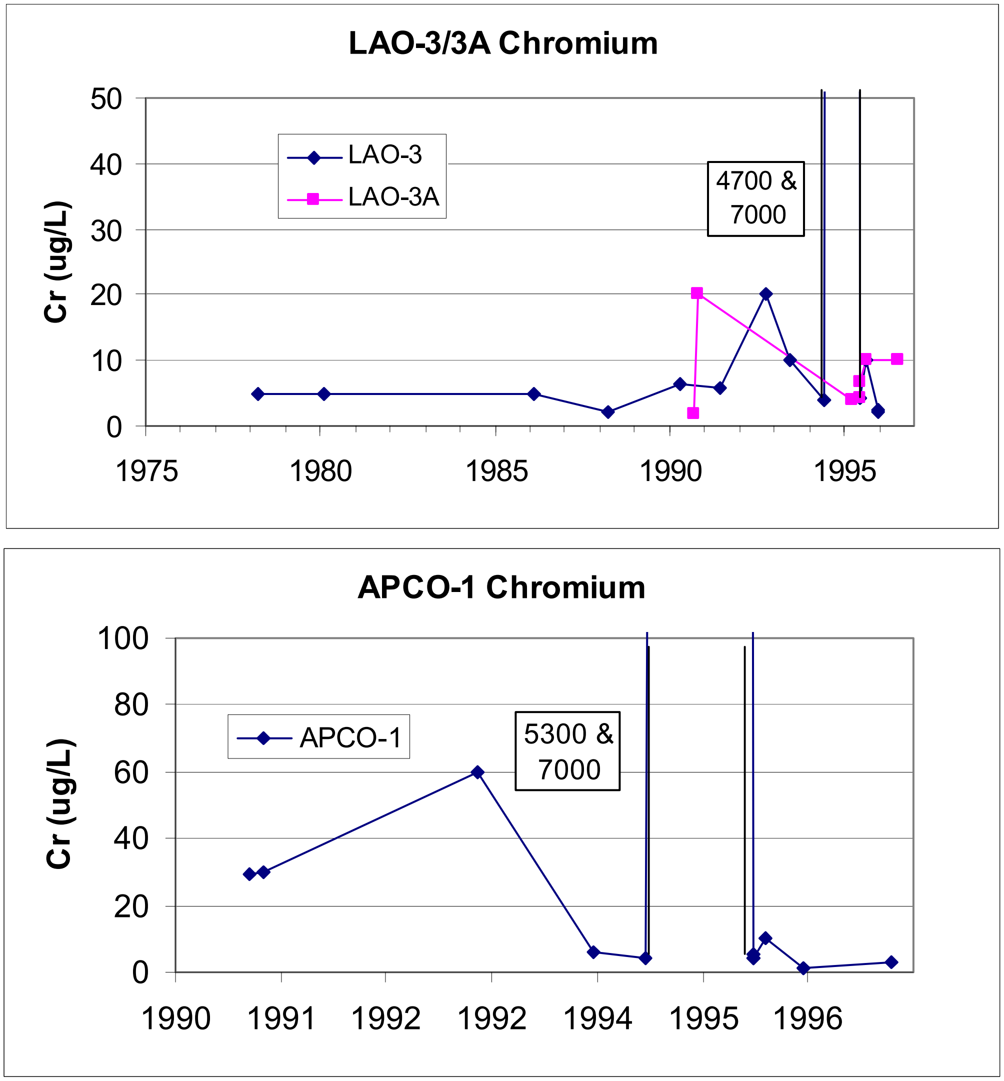
Metals Data

Analytical results for metals are reported in the table Metals Data in Appendix A. Analyses from March 29, 1995 in wells APCO-1 and LAO-3 showed unusually high levels of chromium (Cr) compared to other samples collected from these wells. We suspect that potassium dichromate, typically added to preserve the mercury sample, was added to the metals sample bottle. Samples collected for mercury analysis were preserved with nitric acid and 5 drops of a 50-mg/ml solution of potassium dichromate. This quantity of preservative if added to the one-liter metals sample bottle would result in a Cr concentration of about 4,400 µg/L. The Cr values reported for the March 29 APCO-1 samples were 5,300 and 7,700 µg/L, and in LAO-3 the values were 4,700 and 7,000 µg/L. These values are within the range that would be expected if the potassium dichromate preservative was added. Further confirmation is found in elevated potassium levels that were measured in the March 29 samples when compared to the samples collected from the same wells on June 23. The figure **Chromium Histories for APCO-1 and LAO-3 Series Wells** shows that such high chromium values have not been encountered in these wells before or since this sampling event.

Metals Statistical Results

The results of the Wilcoxon signed rank test for each metal are listed in Appendix C**.**

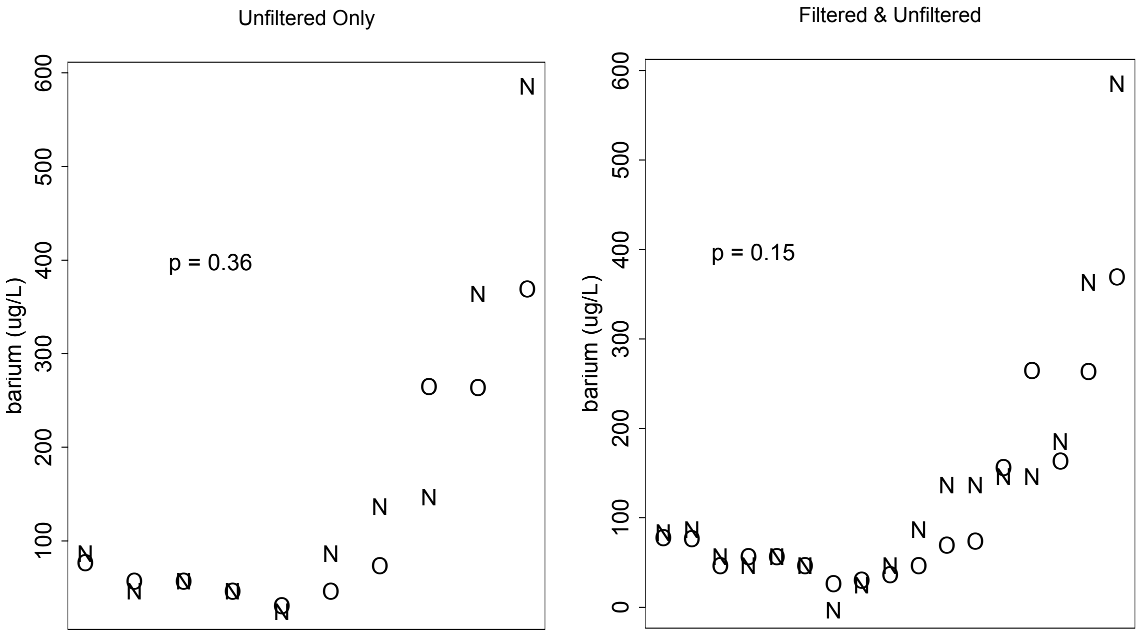
Chromium Histories for APCO-1 and LAO-3 Series Wells



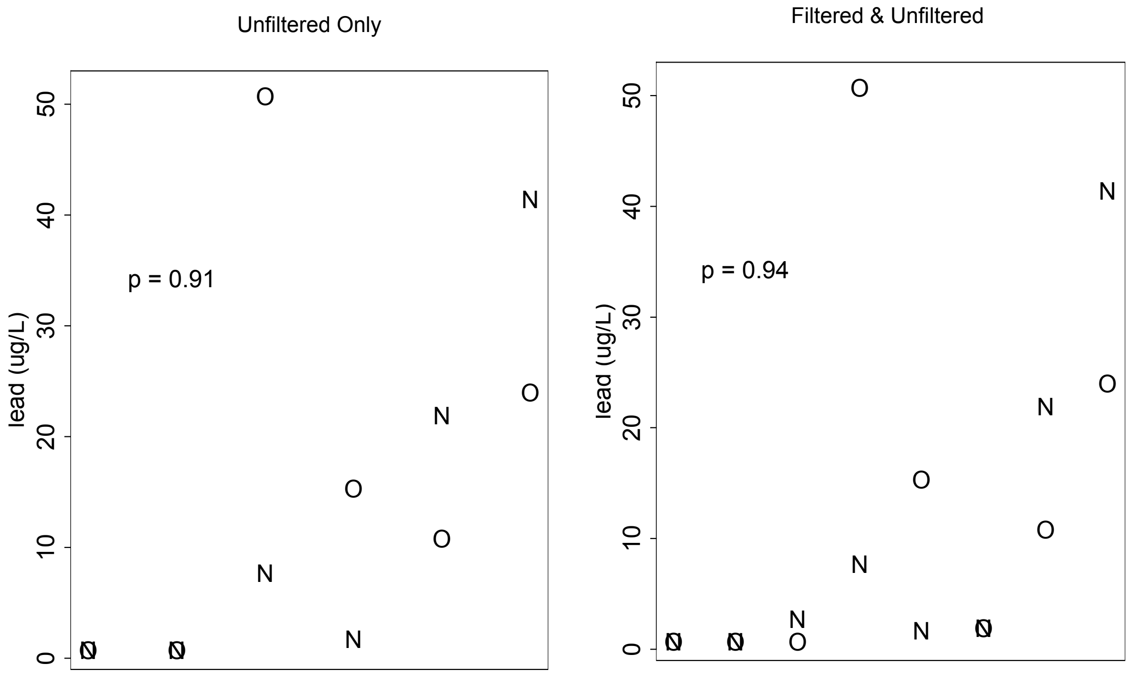
When all the metals results for all analytes are pooled there is a significant difference (p=0.005) between the old and new wells, with the concentrations highest in the new wells.

The results of the Wilcoxon signed rank test for individual metals with a p-value less than 0.1 for the pooled filtered and unfiltered data, and for unfiltered data only, are listed in the table

Old and New Well Pairs – Barium



Old and New Well Pairs - Lead



Metals: Old Wells vs. New Wells. The table also indicates whether the results for the new or old wells tended to be greater. The table in Appendix C does not include a column for "Old or New Greater" because there was no significant difference between new and old for the analytes listed in Appendix C and not listed in table **Metals: Old Wells vs. New Wells**.

Metals: Old Wells vs. New Wells

	Filtered & Unfiltered				Unfiltered Only			
Analyte	**p-Value**	**Number of Well Pairs**	**Number of Pairs**	**Old or New Greater**	**p-Value**	**Number of Well Pairs**	**Number of Pairs**	**Old or New Greater**
Aluminum	0.053	5	24	new	0.220	5	13	new
Copper	0.063	2	5	old	0.250	1	3	old
Iron	0.053	5	24	new	0.216	5	13	new
Magnesium	0.044	5	17	new	0.154	5	11	new

Stoker (1990) suggested that barium and lead were higher in the new wells. To examine this possibility, the figures **Old and New Well Pairs- Barium** and **Old and New Well Pairs-Lead** show plots of the concentrations of lead and barium for each well pair. For each analyte, the observed concentrations for the new and the old member were plotted using the symbols "N" for the new member, "O" for the old member. The Wilcoxon signed rank test was conducted for each analyte on the pairs. First, a two-sided Wilcoxon signed rank test was carried out on the pooled filtered and unfiltered data, to test whether the analyte concentrations might be greater in either the new or the old wells. The p-value for barium was 0.15 and the p-value for lead was 0.94, suggesting no significant differences in concentrations between the old and new wells. Inspection of the plots suggests that barium is higher in the new wells. Therefore a one sided test was carried out, to test whether the analyte concentration is greater in the new wells. The p-value from the one sided test for the pooled filtered and unfiltered data is 0.075 for barium and suggests barium concentrations are significantly higher in the new wells. The higher barium values and the larger differences between wells occur in Mortandad Canyon, in wells MCO-6 and MCO-6B, and wells MCO-7 and MCO-7A. Based on statistics, there is no significant difference overall in lead concentrations between the new and old wells. However, examination of the data shows that lead levels in MCO-7A are double those in MCO-7.

The table **Metals: Filtered Samples vs. Unfiltered Samples** presents the metals that were found in significantly higher concentrations in the unfiltered samples. For all the metals, the unfiltered samples tended to have higher concentrations than the filtered samples. Since some metals either are themselves constituents of suspended sediment or tend to adsorb to suspended sediment particles these results are not surprising.

Metals: Filtered Samples vs. Unfiltered Samples

Analyte	p-Value	Number of Wells	Number of Pairs
Aluminum	< 0.001	12	39
Arsenic	0.063	7	13
Barium	0.004	11	31
Copper	0.098	7	9
Iron	<0.001	12	39
Manganese	<0.001	12	32
Lead	0.013	8	10
Strontium	0.002	12	41
Zinc	0.008	10	18

Organic Data

The table **Number of Organic Compounds Detected above LOQs** (Appendix A) shows the locations and dates where organic samples were collected and the number of detections associated with each sample. The table **Organics Detected above LOQs** (Appendix A) presents the compounds measured above the limit of quantitation (LOQ). All detections, except at LAO-3A, are discounted. This is either because the same compound was present in the method blank at greater than 1/10 the sample values, or because the compound is a common laboratory contaminant, and was not detected in follow-up sampling. The exception was 2,4-dimethyl-3-pentanone, which was found in the tentatively identified compounds (TIC) screen for the sample collected at LAO-3A on June 23, 1995. This compound is not a target compound. TIC results should be treated with caution because the compound is not specifically identified, and because the analytical process is not specifically calibrated to quantify this compound. A peak in the chromatogram was observed and compared to a library to suggest the presence of 2,4-dimethyl-3-pentanone. The estimated concentration was 6 µg/L, just above the typical limit of quantitation. There was no evidence of this compound in follow-up sampling in the two following quarters.

Conclusions

The 1990 sample results suggested lower levels of plutonium were measured in the new wells in Mortandad Canyon. Sampling in 1995 shows that overall there was no significant difference between the concentrations of radiological constituents between the new and old wells.

Results from the 1990 sampling suggested that metals concentrations, especially barium and lead, might be higher in the new wells than the old wells. The 1995 sampling showed a statistically significant difference in the concentration between the new and old wells for the pooled filtered and unfiltered metals results, with the higher concentrations in the new wells. These differences might be due to differences in total suspended sediment content between old and new wells, although insufficient data are available to evaluate this possibility. As would be expected, metals concentrations are greater in the unfiltered samples.

Based on statistics, there is no significant difference in lead concentrations between the new and old wells. However, examination of the data shows that lead levels in MCO-7A are double those in MCO-7. Barium concentrations are apparently higher in the new wells. The higher barium values and the larger differences between barium concentrations in paired wells occur in Mortandad Canyon, in wells MCO-6 and MCO-6B, and wells MCO-7 and MCO-7A.

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Appendix A- Analytical Results

Appendix B- Piper Diagrams

Appendix C- Statistical Results

Radionuclides: Old Wells vs. New Wells

	Filtered & Unfiltered			Unfiltered Only		
Analyte	**p-Value**	**# of Well Pairs**	**# of Pairs**	**p-Value**	**# of Well Pairs**	**# of Pairs**
Gross Alpha	0.069	5	25	0.345	5	14
Americium-241	0.768	5	21	0.638	5	12
Gross Beta	0.075	5	25	0.109	5	14
Cesium-137	0.839	5	13	0.742	4	8
Gross Gamma	0.146	5	25	0.706	5	14
Tritium	0.117	5	25	0.376	5	14
Plutonium-238	0.788	5	25	0.431	5	14
Plutonium-239	0.203	5	27	0.495	5	15
Strontium-90	0.035	5	25	0.019	5	14
Uranium	0.078	5	25	0.594	5	14

Radionuclides: Filtered Samples vs. Unfiltered Samples

Analyte	p-Value	# of Wells	# of Pairs
Gross Alpha	0.348	12	42
Americium-241	0.227	12	45
Gross Beta	0.114	12	42
Cesium-137	0.656	11	22
Gross Gamma	0.696	12	39
Tritium	0.234	12	42
Plutonium-238	0.285	12	47
Plutonium-239	0.018	12	47
Strontium-90	0.698	12	42
Uranium	0.182	12	41

Metals: Old Wells vs. New Wells

Analyte	Filtered & Unfiltered			Unfiltered Only		
	p-Value	# of Well Pairs	# of Pairs	p-Value	# of Well Pairs	# of Pairs
Silver	0.230	2	4	0.617	2	2
Aluminum	0.053	5	24	0.220	5	13
Arsenic	1.000	3	8	0.892	3	5
Boron	0.792	5	18	0.511	5	9
Barium	0.154	5	17	0.356	5	10
Beryllium	0.500	2	2	1.000	1	1
Cadmium	0.250	2	3	0.500	2	2
Cobalt	0.710	2	4	0.750	2	3
Chromium	0.730	4	7	0.589	4	6
Copper	0.063	2	5	0.250	1	3
Iron	0.053	5	24	0.216	5	13
Mercury		1	1		1	1
Manganese	0.044	5	17	0.154	5	11
Molybdenum	0.153	3	15	0.160	3	8
Nickel	0.454	2	4	1.000	2	3
Lead	0.942	4	8	0.914	4	6
Antimony		1	2		1	1
Selenium	1.000	3	3	1.000	3	3
Tin	0.617	2	2		1	1
Strontium	0.462	5	24	0.751	5	13
Thallium		1	2		1	1
Vanadium	0.137	2	4	0.267	2	3
Zinc	0.442	4	10	0.734	4	7

Metals: Filtered Samples vs. Unfiltered Samples

Analyte	p-Value	# of Wells	# of Pairs
Silver	1.000	5	5
Aluminum	<.001	12	39
Arsenic	0.063	7	13
Boron	0.196	12	28
Barium	0.004	11	31
Beryllium		1	1
Cadmium	0.267	3	3
Cobalt	0.438	4	5
Chromium	0.115	7	12
Copper	0.098	7	9
Iron	<.001	12	39
Mercury		1	1
Manganese	<.001	12	32
Molybdenum	0.599	9	28
Nickel	0.111	6	6
Lead	0.013	8	10
Antimony		2	2
Selenium	0.118	4	5
Tin		1	1
Strontium	0.002	12	41
Thallium	0.505	3	3
Vanadium	0.612	6	8
Zinc	0.008	10	18