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Quality of Surface and Ground Water at and Adjacent to the Los Alamos National Laboratory: Reference Organic Compounds

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Quality of Surface and Ground Water at and Adjacent to the Los Alamos National Laboratory: Reference Organic Compounds

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QUALITY OF SURFACE AND GROUND WATER AT AND ADJACENT TO THE LOS ALAMOS NATIONAL LABORATORY: REFERENCE ORGANIC COMPOUNDS

by

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ABSTRACT

Surface and ground water samples were collected from 43 stations representing the major occurrences of natural and municipal water and industrial and sanitary effluents in the Los Alamos area. The samples were analyzed for volatile organics (35 compounds), semivolatile organics (65 compounds), base neutral acid fraction, pesticides (20 compounds), herbicides (3 compounds), polychlorinated biphenyls (7 compounds), and cyanides. The investigation was performed to find possible areas of organic contamination for further study; however, the impact of organic contamination in surface and ground water is minimal. A limited program of organic monitoring may be incorporated into the annual surveillance program for monitoring the quality of surface and ground water at and adjacent to the Los Alamos National Laboratory.

I. INTRODUCTION

Water samples were collected from 43 surface and ground water stations in and adjacent to the Los Alamos National Laboratory. These samples were analyzed by the Roy F. Weston, Inc. analytical laboratories for priority pollutants: volatile organics, semivolatile organics, pesticides, herbicides, polychlorinated biphenyls (PCBs), cyanides, and phenols. The samples were screened for nonvolatile organic compounds defined as the base neutral acid (BNA) fraction. The sampling stations used in this investigation represent the major occurrences of surface and ground water, natural and effluent, in the Laboratory and surrounding environs. A description of the individual stations and the general quality of water for each station is found in Appendix A, while the locations are shown in Figure 1. The investigation provides a baseline for future investigations of potential organic contamination caused by the operation of the Laboratory.

II. METHODS AND DATA ANALYSES

The water samples were collected in late September and early October of 1986. They were collected and shipped the same day to preserve the integrity of the sample. Proper sampling, preservation, packaging, and shipping procedures were adhered to in transfer of these samples from the Laboratory to Weston's Lionville, Pennsylvania, laboratory. The types of sample containers, chain-of-custody procedures, sample holding times, and analytical methodology were adhered to as described by USEPA (United States Environmental Protection Agency) guidelines (USEPA 1983 and USEPA 1985).

Care was taken in interpretation of the analytical results as most of the data were at, near, or below detection limits. Compounds that occurred in blank samples indicated some artifact of the analytical process. Concentrations of these compounds were taken into consideration in data interpretation. Concentrations were estimated by extending the

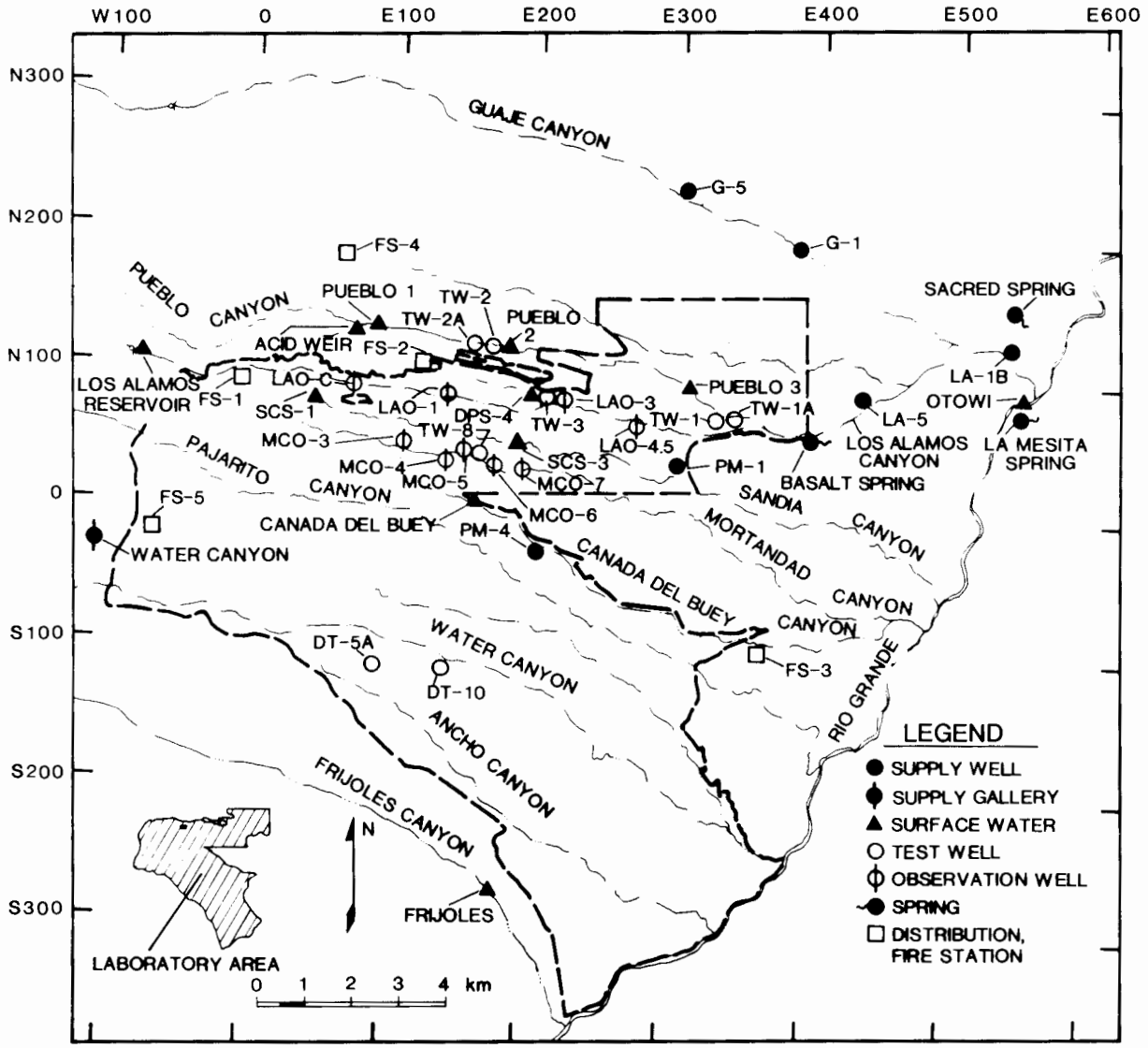

Figure 1. Map showing surface and ground water sampling stations.

calibration curve below the detection limits, although this is recognized to be an uncertain approach. Most of the estimated concentrations were deleted from the report because they reflected no particular trend or pattern as to the source of the water. Low level organic contamination can occur during the collection of the sample and in each step of analysis. Some of the most common compounds used in the laboratory and reported in the blanks are methylene chloride and acetone. They are usually reported in low concentrations, 0.5 to 20 micrograms/L. Their occurrence generally follows a pattern, present in all or almost all samples collected in or analyzed in the same batch.

The total individual analyses from each of the 43 stations constitute 5,676 individual analytical results. The individual analyses are not reported in total because so many of the results are zeros. Table I summarizes the analytical results from the individual stations with reference to the types of compounds

Table I. Summary of Stations and Analysis

Stations	Date of Collection 1986 Month/Day	Volatile Organics (35 Compounds)	Semivolatile Organics (65 Compounds)	BNA Fraction	Pesticides (20 Compounds)	Herbicides (3 Compounds)	Polychlorinated Biphenyls (PCB) (7 Compounds)	Cyanide
Regional								
Rio Grande at Otowi	9-25	U[a]	U	U	U	U	U	U
Perimeter								
Los Alamos Reservoir	9-25	U	U	U	U	U	U	U
La Mesita Spring	9-25	U	U	U	U	U	U	U
Frijoles Canyon	9-29	U	X (1)[b]	U	U	U	U	U
Sacred Spring	9-25	U	X (1)	X (5)	U	U	U	U
Onsite (Noneffluent Area)								
Test Well TW-1	9-25	U	U	U	U	U	U	U
Test Well TW-2	9-30	U	U	U	U	U	U	U
Test Well TW-3	9-30	U	X (1)	U	U	U	U	U
Test Well TD-5A	9-29	U	U	U	U	U	U	U
Test Well TW-8	9-30	X (1)	U	U	U	U	U	U
Test Well DT-10	9-29	U	U	U	U	U	U	U
Canada del Buey	9-29	X (1)	X (1)	U	U	U	U	U
Onsite (Effluent Areas)								
Acid Pueblo Canyon								
Acid Weir	9-29	X (1)	U	U	U	U	U	X (1)
Pueblo 1	9-29	X (2)	U	X (1)	U	U	U	U
Pueblo 2	9-29	U	U	U	U	U	U	U
Pueblo 3	9-29	U	U	U	U	U	U	U
Test Well TW-1A	9-29	U	X (1)	U	U	U	U	U
Test Well TW-2A	9-30	U	U	U	U	U	U	U

Table I (cont)

Stations	Date of Collection 1986 Month/Day	Volatile Organics (35 Compounds)	Semivolatile Organics (65 Compounds)	BNA Fraction	Pesticides (20 Compounds)	Herbicides (3 Compounds)	Polychlorinated Biphenyls (PCB) (7 Compounds)	Cyanide
DP - Los Alamos Canyon								
DDS-4	9-30	U	X (1)	U	U	U	U	U
LAO-C	10-1	U	U	X (1)	U	U	U	U
LAO-1	10-1	X (1)	U	U	U	U	U	U
LAO-3	10-1	U	U	U	U	U	U	U
LAO-4.5	10-1	U	U	U	U	U	U	U
Basalt Spring	9-29	U	U	U	U	U	U	U
Sandia Canyon								
SCS-1	9-25	U	U	U	U	U	U	X (1)
SCS-3	9-25	U	U	U	U	U	U	U
Mortandad Canyon								
MCO-3	10-1	U	U	--	U	U	U	X (1)
MCO-4	10-1	U	U	--	U	U	U	X (1)
MCO-5	10-1	U	U	--	U	U	U	X (1)
MCO-6	10-1	U	U	U	U	U	U	X (1)
MCO-7	10-2	U	U	--	U	U	U	X (1)
Water Supply Wells								
LA-1B	9-25	U	X (1)	U	U	U	U	U
LA-5	9-25	U	X (1)	U	U	U	U	U
G-1	9-25	U	U	U	U	U	U	U
G-5	9-25	U	U	U	U	U	U	U
PM-1	9-25	U	U	U	U	U	U	U
PM-4	9-25	U	U	U	U	U	U	U

Table I (cont)

Stations	Date of Collection 1986 Month/Day	Volatile Organics (35 Compounds)	Semivolatile Organics (65 Compounds)	BNA Fraction	Pesticides (20 Compounds)	Herbicides (3 Compounds)	Polychlorinated Biphenyls (PCB) (7 Compounds)	Cyanide
Gallery								
Water Canyon	9-25	U	X (1)	U	U	U	U	U
Distribution								
Fire Station 1	9-25	U	U	X (1)	U	U	U	U
Fire station 2	9-25	U	U	X (1)	U	U	U	U
Fire Station 3	9-25	U	X (2)	X (1)	U	U	U	U
Fire Station 4	9-25	X (1)	U	X (1)	U	U	U	U
Fire Station 5	9-25	X (2)	X (3)	X (1)	U	U	U	U

[a]U - analysis peformed; results below detection limits.
[b]X - compound detected; parentheses enclose number of compounds detected.

Note: Number of compounds under heading analyses performed; i.e., volatile organic samples from each station analyzed for 35 compounds.

detected. The table indicates that, during this study, water from all stations was analyzed for volatile organics, semivolatile organics, BNA fraction, pesticides, herbicides, PCBs, cyanides, and phenols. In each section of the report, only compounds or chemicals that are at or above the detection limits are discussed and shown in the table for that section of the report. Results were not reported for a station if a compound or chemical was not present at or above the detection limit. Appendices B through D list all of the compounds for which analyses were performed, their detection limits, and references for specific analytical methods (Appendix B, volatile organics; Appendix C, semivolatile organics; Appendix D, pesticides, herbicides, and polychlorinated biphenyls.

The USEPA and New Mexico Environmental Improvement Division (NMEID) have established maximum contaminant levels (MCL) for eight organic compounds in respect to drinking water standards (NMEID 1987). These MCL will go into effect in January 1988. If any of the eight compounds are present in the analytical results, the MCL is used for comparison. The MCL for certain pesticides and herbicides have been established for drinking water and are used for comparison with limits of detection in Appendix D (USEPA 1976).

A. Quality Control and Quality Assurance

The Roy F. Weston, Inc. analytical laboratories maintain an internal quality control (QC) program for their analytical results. In addition to this, several spiked samples were sent along with the samples that were submitted from Los Alamos as quality assurance (QA) samples. The results of both the Weston QC samples and the Los Alamos QA samples are discussed below. (QC samples are internal checks used by Roy F. Weston, Inc. to evaluate their own work and QA samples are external checks provided by the Los Alamos National Laboratory.)

- Volatile Organics: Five Los Alamos QA samples were submitted. The average percent recovery for these samples ranged from 64% to 92%, with a mean average recovery of 82%. There was one instance in which a compound that was present in a sample was not detected. The samples submitted to Weston were analyzed by Gulf Coast Laboratories, Inc. No data are available for the Weston QC samples.

- Semivolatile Organics: Two Los Alamos QA samples were submitted. The average recovery values on these samples were 52% and 65%. There were seven instances in which compounds that were present in a sample were not detected. Weston's QC samples consisted both of spiked blanks and spiked Los Alamos samples. A total of 408 QC samples were run. The percent recoveries ranged from 0% to 392%, with a mean recovery of 65% and a standard deviation of $\pm$40%.

- Pesticides: Three Los Alamos QA samples were submitted. All of these were below the Weston detection limits. A total of 68 Weston QC samples were run. The percent recoveries ranged from 45% to 208%, with a mean recovery of 105% and a standard deviation of $\pm$30%.

- Herbicides: Five Los Alamos QA samples were submitted. The average percent recovery for these samples ranged from 49% to 80%, with a mean average recovery of 59%. Weston submitted a total of 12 QC samples. The percent recoveries ranged from 53% to 141%, with a mean recovery of 82% and a standard deviation of $\pm$27%.

- Cyanide: Five Los Alamos QA samples were submitted. The average percent recovery for these samples ranged from 68% to 107%, with a mean average recovery of 91%. A total of four Weston QC samples were run. The recoveries on these samples ranged from 89% to 91%.

- Phenols: Five Los Alamos QA samples were submitted. The average percent recovery for these samples ranged from 16% to 42%, with a mean average recovery of 35%. A total of six Weston QC samples were run. The recoveries on these samples ranged from 93% to 108%. The reason for the discrepancy between the QA samples and the QC samples is unknown.

- PCB and BNA Fraction: No QA or QC data are available for these samples.

III. VOLATILE ORGANICS

Water samples from 43 stations were analyzed for 35 different volatile organic compounds (Appendix B). Of the 43 stations, volatile organic compounds were reported in water from seven stations at concentrations at or above the detection limits (Table II).

The compound 1,1,1-trichloroethane with detection limit of 5 micrograms/L, was reported from Test Well TW-8 (5 micrograms/L), Cañada del Buey (6 micrograms/L), Acid Weir (6 micrograms/L), and Pueblo 1 (7 micrograms/L). The concentration of the compound 1,1,1-trichloroethane from these four stations is below the MCL (USEPA 1987). Trichloroethane is a common laboratory contaminant.

Chloroform with detection limit of 5 micrograms/L was reported from Pueblo 1 (10 micrograms/L), LAO-1 (7 micrograms/L), and at Fire Station 5 (23 micrograms/L). Bromoform with a detection limit of 5 micrograms/L was reported from Fire Station 4 (8 micrograms/L), while bromodichloromethane with, a detection limit of 5 micrograms/L, was reported from Fire Station 5 (7 micrograms/L). Maximum contaminant levels have not been set for these compounds. All of these compounds are trihalomethanes, which are often associated with chlorinated water systems. Finding low levels of these compounds is not unusual; however, the routine surveillance of the water system has never indicated the presence of these compounds (ESG 1988).

Test Well TW-8 is completed in the main aquifer and should contain no organic contamination. Cañada del Buey, Acid Weir, Pueblo 1, and LA0-1 are stations in sanitary or industrial release areas that could contain some organic contamination. Fire Stations 4 and 5 are sampled as part of the municipal water supply at Los Alamos and should contain no organic contamination.

The compounds reported from the seven stations are at concentrations at or near detection limits and may reflect some artifact that occurred during sample collection or analytical process. Additional water samples were collected from Fire Stations 4 and 5 and were analyzed for chloroform, bromoform, and bromodichloromethane. The analyses failed to detect these compounds at or below the detection limits.

IV. SEMIVOLATILE ORGANICS

Water samples from 43 stations were analyzed for 65 semivolatile compounds (Appendix D). Of the 43 stations, semivolatiles above the detection limits were reported from 11 stations (Table III). Maximum concentration levels have not been set for the compounds identified in this section.

There were two phthalate type compounds found at eight stations. The compound bis(2-ethylhexyl) phthalate with a detection limit of 10 micrograms/L was found in water from Frijoles Canyon (560 micrograms/L), Canada del Buey (460 micrograms/L), and in water from station DPS-4 (400 micrograms/L). The compound di-n-butyl phthalate, with a detection limit of 10 micrograms/L, was found in water from Test Well TW-3 (16 micrograms/L), Test Well TW-1A (14 micrograms/L), Supply Well LA-1B (23 micrograms/L), Supply Well G-5 (41 micrograms/L), Water Canyon (20 micrograms/L), and Fire Station 3 (170 micrograms/L). Phthalates are used in plastic or plasticizers.

Phthalates that are widely distributed in the environment are reported in water samples. In some cases the phthalates may be contamination associated with sample collection or laboratory procedures in analyses. Phthalates are quite common in surface waters such as at Frijoles Canyon, Cañada del Buey, and DPS-4 due to release of sanitary effluents, cooling water, or the impact of intense use (visitors Frijoles Canyon). The perched aquifer at TW-1A is recharged from the stream in Pueblo Canyon, which could contain phthalates. The phthalate concentrations observed in waters from wells in the main aquifer and part of the water supply (TW-3, Supply Wells LA-1B and G-5, and Water Canyon Gallery) are low, 41 micrograms/L or less, and are probably the result of sample contamination during collection or in the laboratory. Water from the distribution system at Fire Station 3 was recollected and subsequent analyses failed to detect any di-n-butyl phthalate.

The compound benzyl alcohol, with a detection limit of 10 micrograms/L, was reported from Sacred Spring (22 micrograms/L). The spring is natural, away from the highway, and other than an open pool has no source for contamination.

Table II. Volatile Organic Compounds Detected

Station	Volatile Compounds	Concentration (µg/L)	Detection Limit (µg/L)	Maximum Contaminant Level (µg/L)
Onsite (Noneffluent Area)				
Test Well TW-8	1,1,1-trichloroethane	5	5	200
Cañada del Buey	1,1,1-trichloroethane	6	5	200
Onsite (Effluent)				
Acid-Pueblo Canyon				
Acid-Weir	1,1,1-trichloroethane	6	5	200
Pueblo 1	chloroform	10	5	--
	1,1,1-trichloroethane	7	5	200
DP-Los Alamos Canyon				
LAO-1	chloroform	7	5	--
Water Supply				
Distribution				
Fire Station 4	bromoform	8	5	--
Fire Station 5	chloroform	23	5	--
	bromodichloromethane	7	5	--

Table III. Semivolatile Compounds Detected

Station	Semivolatile Compounds	Concentration (µg/L)	Detection Limit (µg/L)	Maximum Contaminant Level (µg/L)
Perimeter				
Frijoles	bis(2-ethylhexyl) phthalate	560	10	--
Sacred Spring	benzyl alcohol	22	10	--
Onsite (Noneffluent Area)				
Test Well TW-3	di-n-butyl phthalate	16	10	--
Canada del Buey	bis(2-ethylhexyl) phthalate	460	10	
Onsite (Effluent)				
Acid-Pueblo Canyon				
Test Well TW-1A	di-n-butyl phthalate	14	10	--
DP-Los Alamos Canyon				
DPS-4	bis(2-ethylhexyl) phthalate	400	10	--
Water Supply				
Wells				
LA-1B	di-n-butyl phthalate	23	10	--
G-5	di-n-butyl phthalate	41	10	--
Gallery				
Water Canyon	di-n-butyl phthalate	20	10	--
Distribution				
Fire Station 3	phenol	17	10	--
	di-n-butyl phthalate	170	10	--
Fire Station 5	1,3-dichlorobenzene	26	10	--
	1,4-dichlorobenzene	23	10	--
	1,2-dichlorobenzene	20	10	--

The compound phenol, with a detection limit of 10 micrograms/L, was reported in the water supply distribution system at Fire Station 5 (17 micrograms/L). Another sample collected at the same time was analyzed using a slightly different method with a detection limit of 3 micrograms/L. This analysis failed to detect any phenol. A later sample collected and analyzed for phenol from the distribution system at the fire station did not show any phenol.

The water in the distribution system at Fire Station 5 contained 3 different compounds of benzene. The compounds were 1,3-dichlorobenzene (26 micrograms/L), 1,4-dichlorobenzene (23 micrograms/L), and 1,2-dichlorobenzene (20 micrograms/L). The detection limits of the three compounds is 10 micrograms/L. These benzene compounds are related to detergents and solvents. The fact that the concentrations of the compounds are low, 26 micrograms/L or less, and are of similar concentrations seems to indicate that the samples were contaminated when collected or in the laboratory, although these are not common contaminants. Later resample and analyses failed to detect the presence of these three compounds in the distribution system at any of the five stations or at Fire Station 5.

An extra set of samples was taken from the 43 stations. This additional set of samples was also analyzed for phenol (method of analysis, USEPA 1984). With a detection limit of 5 micrograms/L, only two samples contained phenol in concentrations above the detection limit. The water from the Regional Station at Otowi on the Rio Grande contained 20 micrograms/L of phenol, while the Perimeter Station at Sacred Spring had 71 micrograms/L of phenol. No phenols were reported in the first set of samples collected at Otowi or Sacred Spring, which also were analyzed for semivolatile analyses.

V. BNA FRACTION

Analysis of BNA fraction is a procedure used for screening for the nonvolatile organic compounds. The process identifies additional compounds that are not identified as part of the 35 volatile organic compounds in Section III and 65 semivolatile compounds in Section IV of this report. This method is used as a scan to detect the presence of compounds found in Appendices B and C for qualitative analyses. If the identification of additional compounds is not readily available it will be recorded as a scan number (unknown compound). The detection limits are about 25 micrograms/L for the BNA fraction. The concentrations of the known and unknown compounds are estimated from the nearest known compound that has a calibration curve. Thus the concentrations are relative and must be assumed to be estimated. The samples from all 43 stations were screened for the BNA fraction except as noted (Table IV). Of the compounds identified or known, the MCL for these compounds have not been set.

There were three unknown compounds and two known compounds in water from Sacred Spring (Table IV). The known compounds are ethyl phenol and benzenepropanioc acid. The estimated concentrations ranged from 25 to 120 micrograms/L.

Three stations in effluent release areas for either sanitary or industrial effluents contained some known and unknown organic compounds. The water from Acid-Pueblo Canyon at Pueblo 1 contained an unknown compound with an estimated concentration of 30 micrograms/L, while water from DP-Los Alamos Canyon at station LAO-C contained three unknown compounds ranging from 30 to 40 micrograms/L. No BNA screening was performed on water from shallow observation wells MCO-3, -4, -5, and -7 as the analyses or samples were lost in the laboratory.

Chlorocyclohexanol was reported from all five fire stations in estimated concentrations ranging from 60 to 170 micrograms/L.

Resample and analysis of water from the five fire stations failed to detect any volatile or semivolatile organic compounds. The screening by BNA methods resulted in unknown and known compounds. The BNA procedure is just a screening method and should not be used for quantitative evaluation.

VI. PESTICIDES

Water from the 43 stations was analyzed for 20 different pesticide compounds. The results of the analyses indicate that all compounds were below both the detection limits and the MCL of those compounds that have been assigned a maximum concentration level (Appendix D).

VII. HERBICIDES

Water samples from 43 stations were analyzed for 3 different herbicide compounds. The results of the analyses indicate that all compounds were below

Table IV. BNA Fraction Detected

Station	BNA Fraction Compound Name	Scan Number	Estimated Concentration (µg/L)	Detection Limits (µg/L)
Perimeter				
Sacred Spring	unknown	460	70	25
	unknown	588	120	25
	ethyl phenol	600	45	25
	benzenepropanioc acid	755	40	25
	unknown	1870	25	25
Onsite (Noneffluent Area)				
Acid-Pueblo Canyon				
Pueblo 1	unknown	1713	30	25
DP-Los Alamos Canyon				
LAO-C	unknown	1535	40	25
	unknown	1700	30	25
	unknown	1774	40	25
Mortandad Canyon[a]				
MCO-3	--	--	--	--
MCO-4	--	--	--	--
MCO-5	--	--	--	--
Water Supply				
Fire Station 1	chlorocyclohexanol	464	170	25
Fire Station 2	chlorocyclohexanol	466	140	25
Fire Station 3	chloroxyclohexanol	467	140	25
Fire Station 4	chlorocyclohexanol	466	60	25
Fire Station 5	chlorocyclohexanol	466	130	25

[a]No data reported.

detection limits and also the MCL of those compounds that have been assigned maximum levels (Appendix D).

VIII. POLYCHLORINATED BIPHENYLS (PCB)

Water samples were analyzed for seven different PCB compounds. The results of the analyses indicated that the compounds were below the limits of detection (Appendix D). There are no MCL or standards for drinking water or municipal water supply.

IX. CYANIDE

Water samples were collected from 43 stations and were analyzed for cyanide (methods of analysis, USEPA 1983). The detection limit for cyanides is 10 micrograms/L. Water from seven stations in effluent release areas contained cyanide in excess of the detection limit.

Water from Acid-Pueblo Canyon station Pueblo 1 (40 micrograms/L), Sandia Canyon SCS-1 (19 micrograms/L), and Mortandad Canyon observation wells MCO-3 (15 micrograms), MCO-4 (50 micrograms/L), MCO-5 (30 micrograms/L), MCO-6 (20 micrograms/L), and MCO-6 (30 micrograms/L) contained traces of cyanide.

Cyanides break down readily in the environment. The stations reporting the cyanides are widely separated; other stations in the same release area did not contain any traces of cyanides.

The maximum concentration level of cyanide for drinking water set by the State of New Mexico is 200 micrograms/L (NMEID 1987). The concentrations of cyanide from the seven stations are below MCL. The water from these seven stations is not a source of municipal or industrial supply.

X. CONCLUSIONS

The results of the analysis reporting the presence of volatile, semivolatile, BNA fraction, PCB, and cyanide indicated no particular trend with relation to type or location of station. The analytical results of volatile, semivolatile, and BNA fraction organic compounds were low, and in the resampling and analyses from the same station failed to detect any of the compounds.

Volatile organic compounds were reported from seven station in concentrations ranging from 5 to 23 micrograms/L. The compounds were below the MCL where it has been determined by the USEPA. Three volatile compounds (bromoform, 8 micrograms/L; chloroform, 23 micrograms/L; and bromodichloromethane, 7 micrograms/L) were reported from two water distribution systems at two of the fire stations. The five fire stations on the distribution system were resampled, and the three volatile compounds previously reported were not present.

Semivolatile organic compounds were determined in waters from 11 different stations in concentrations ranging from 14 to 560 micrograms/L. None of the compounds have a MCL. Most were phthalate compounds that are the result of plastics in the environment or laboratory. Phthalates in Frijoles Canyon (560 micrograms/L) and in the effluent release area stations DPS-4 (400 micrograms/L) and Canada del Buey (460 micrograms/L) may be contamination in the water.

Five different semivolatile compounds were reported from the the water supply distribution system at two fire stations. They were phenol (7 micrograms/L), di-n-butyl phthalate (170 micrograms/L), and three types of dichlorobenze (20 to 23 micrograms/L). The distribution system at the fire stations were resampled and the five different compounds previously reported were not detected.

The BNA fraction screening detected seven unknown and three known compounds from eight stations. There was no correlation of BNA results of known compounds with the results obtained for the volatile and semivolatile compounds that were analyzed from the 43 stations. The BNA analyses is a screening method and should not be used for quantitative evaluation.

Pesticide, herbicide, and PCB analyses of water from the 43 stations were below detection limits and were below the existing or proposed MCL.

Traces of cyanide above the detection limit (10 micrograms/L) were reported in waters from two effluent release areas. The concentrations were low, ranging from 20 to 40 micrograms/L. The source of the cyanides in the two effluent areas is unknown as other stations in the same effluent release area did not contain cyanide. The concentrations were well below the MCL of 200 micrograms/L.

The water samples collected represented the major occurrence of natural water and industrial and sanitary effluents in the environment adjacent to and within the Los Alamos National Laboratory. The study

did not discover any major areas of concern; however, a limited program of monitoring for organic compounds should be incorporated in the annual surveillance program to document the possible effect, if any, of the Laboratory operation on the environment.

APPENDIX A

DESCRIPTION OF SURFACE AND GROUND WATER STATIONS

The 43 surface and ground water stations that were sampled are part of the monitoring network of stations that is reported in the Environmental Surveillance Report that the Laboratory publishes annually. These 43 stations were sampled as part of this study for organic compounds, pesticides, herbicides, PCBs, and cyanide in late September 1986. The stations represent the major occurrence of surface and ground water at the Laboratory and community. The stations sampled were regional, perimeter, noneffluent areas, and effluent areas. A brief description of the stations and general water quality is presented as follows. For a detailed water quality description see the report for 1986 (ESG 1987) or as noted for 1985 (ESG 1986). Station locations are shown in Figure 1.

I. REGIONAL STATION

A. Rio Grande at Otowi

The drainage area above Otowi on the Rio Grande and Rio Chama is about 14,300 mi^2 in northern New Mexico and southern Colorado. In 1986, the water was a calcium-bicarbonate type with total dissolved solids (TDS) of 195 milligrams/L. The chemical constituents are low: SO_4, 58 milligrams/L; Cl, 4 milligrams/L; F, 0.3 milligram/L; and N, 0.3 milligram/L.

II. PERIMETER STATIONS

A. Los Alamos Reservoir

Los Alamos Reservoir is located west of the Laboratory on the eastern flanks of the Jemez mountains. The reservoir has a drainage area of about 6.4 mi^2 and a capacity of about 13.4 million gallons. The reservoir is fed by several springs and by storm runoff. Drainage area on the mountain flanks includes a ski and recreation area. The reservoir also is used for recreation, and in the summer some of the water is used for lawn irrigation in the townsite. The water in 1985 was a calcium-bicarbonate type with a TDS of 95 milligrams/L. The chemical constituents are low: SO_4, 10 milligrams/L; Cl, 3 milligrams/L; F, 0.1 milligram/L; and N, 0.3 milligram/L (ESG 1986).

B. La Mesita Spring

The spring is east of the Rio Grande just below Otowi in an arroyo that is tributary to the river. The spring on the south wall of the arroyo issues from a concealed fault in the siltstones and sandstones of the Tesuque Formation. In 1986, the water was a calcium-bicarbonate type with a TDS of 197 milligrams/L. The chemical constituents were low: SO_4, 12 milligrams/L; Cl, 6 milligrams/L; F, 0.4 milligram/L; and N, 1.9 milligrams/L.

C. Frijoles Canyon

The sampling station in Frijoles Canyon is at the Visitor Center of Bandelier National Monument. Frijoles stream has cut a deep canyon into the Pajarito Plateau. The stream in the canyon originates from a series of springs near the head of the canyon. The drainage area above the Visitor Center is about 17 mi^2. In 1986, the water was a sodium-bicarbonate type with a TDS of 114 milligrams/L. The chemical constituents are low: SO_4, 3 milligrams/L; Cl, 2 milligrams/L; F, 0.2 milligram/L; and N, 0.1 milligram/L.

D. Sacred Spring

The spring is located on the San Ildefonso Indian Pueblo and discharges from a fault zone in the siltstones and sandstones of the Tesuque Formation. The seep forms a shallow pool. The water appears stagnant, containing plant material in various stages of decay. In 1986, the water was a calcium-bicarbonate type with a TDS of 172 milligrams/L. The chemical constituents are low: SO_4, 5 milligrams/L; Cl, 9 milligrams/L; F, 0.5 milligram/L; and N, 0.5 milligram/L.

III. NONEFFLUENT AREAS

The test wells in the noneffluent areas are completed into the main aquifer of the Los Alamos area. The wells were drilled to obtain geologic and hydrologic information and were completed to monitor the quality of water in the main aquifer. The main aquifer

is the only aquifer capable of municipal and industrial water supply in the Los Alamos area. The aquifer slopes gently eastward from the western edge of the Pajarito Plateau to the Rio Grande, where a part of the water in the aquifer is discharged into the river through seeps and springs. The depth of the aquifer is about 1,300 ft along the western edge of the plateau, decreasing to about 600 ft along the eastern edge of the plateau above the river (Purtymun 1984).

A. Test Well 1

Test Well 1 is located in lower Pueblo Canyon. The well is completed at a depth of 642 ft with the water level at about 590 ft. The well is completed into the gravels of the Puye Formation, which lies above the Tesuque Formation. The well is equipped with a jack pump to facilitate sample collection. In 1986, the water was calcium-bicarbonate type with a TDS of 268 milligrams/L. The chemical constituents were low: SO_4, 22 gm/L; Cl, 38 milligrams/L; F, 0.7 milligram/L; and N, 6.4 milligrams/L.

B. Test Well 2

Test Well 2 is located in the midreach of Pueblo Canyon. The well is completed at a depth of 789 ft with the water level at 760 ft. The well is completed into the Puye Formation and is equipped with a submersible stainless steel pump. In 1986, the water was calcium-bicarbonate type with a TDS of 76 milligrams/L. The chemical constituents were low: SO_4, <1 milligram/L; Cl, 2 milligrams/L; F, 0.4 milligram/L; and N, 0.1 milligram/L.

C. Test Well 3

Test Well 3 is located in the midreach of Los Alamos Canyon. The well was completed at a depth of 815 ft with the water level at about 750 ft. The well is completed into the Puye Formation and is equipped with a submersible stainless steel pump. In 1986, the water was a calcium-bicarbonate type with a TDS of 96 milligrams/L. The chemical constituents were low: SO_4, 2 milligrams/L; Cl, 4 milligrams/L; F, 0.3 milligram/L; and N, <0.1 milligram/L.

D. Test Well DT-5A

Test Well DT-5A is located on the top of the plateau along the southern boundary of the Laboratory. The well is completed at a depth of 1,821 ft with the water level at 1,178 ft. The well is completed into the gravels of the Puye Formation and into the underlying siltstones and sandstones of the Tesuque Formation. The well is equipped with a jack pump. In 1986, the water was of a sodium-bicarbonate type with a TDS of 130 milligrams/L. The chemical constituents were low: SO_4, 1 milligram/L; Cl, 2 milligrams/L; F, 0.6 milligram/L; and N, 3.9 milligrams/L.

E. Test Well 8

Test Well 8 is located in the midreach of Mortandad Canyon. The well is completed at a depth of 1,065 ft with the water level at 965 ft. The well is completed into the Puye Formation. In 1986, the water was a calcium-bicarbonate type with a TDS of 113 milligrams/L. The chemical constituents were low: SO_4, 2 milligrams/L; Cl, 2 milligrams/L; F, 0.2 milligram/L; and N, 0.2 milligram/L.

F. Test Well TD-10

Test Well TD-10 is located on the plateau along the southern boundary of the Laboratory. The well is completed at a depth of 1,409 ft with a water level of 1,090 ft. The well is completed into the Puye Formation. In 1986, the water was a calcium-bicarbonate type with a TDS of 108 milligrams/L. The chemical constituents were low: SO_4, 1 gm/L; Cl, 2 milligrams/L; F, 0.3 milligram/L; and N, 0.2 milligram/L.

G. Cañada del Buey

Cañada del Buey has a small drainage area that heads on the plateau. The sampling station is in the midreach of the canyon below Technical Area 46 (TA-46). There is a small amount of storm run-off in the canyon; however, most of the water at the sampling station is cooling water released from the site. In 1986, the water was a sodium-bicarbonate type with a TDS of 113 milligrams/L. The chemical constituents were low: SO_4, 5 gm/L; Cl, 20 milligrams/L; F, 1 milligram/L; and N, 0.8 milligram/L.

IV. EFFLUENT AREAS

The effluent areas consist of three canyons that receive or have received treated waste effluents. A fourth canyon included with effluent areas receives

sanitary effluents and cooling water from the power plant.

A. Acid-Pueblo Canyon

Untreated radioactive wastes were released into the canyon from 1943 to about 1950 when a treatment plant was constructed at the head of Acid Canyon. The liquid wastes were processed in a manner that removed most of the radionuclides before the remaining effluents were released into the canyon. The plant was closed in 1964 when a new plant at TA-50 became operational. Radionuclides in the untreated wastes and the remaining radionuclides in the treated wastes were bound through ion-exchange or adsorption to silts and clays in the alluvium of the channels in Acid and Pueblo Canyons, thus reducing the amounts in the effluent and storm run-off. There are still small concentrations of radionuclides in the alluvium. The radionuclides in the silts and clays are subject to transport in storm run-off in suspended and bed sediments. Monitoring in the canyons indicates that there is also some resuspension of radionuclides in solution in storm run-off. Sanitary effluents from the Los Alamos County sewage treatment plants are released into the upper reach of Pueblo Canyon above the confluence with Acid Canyon at the Pueblo plant and also are released into the lower reach of Pueblo from the Bayo plant (Fig. 1).

1. Acid Weir. Acid Weir sampling station is located in Acid Canyon just above the confluence with Pueblo Canyon. The water at the station is run-off, some from lawn irrigation in the town, and possibly some drainage from the pool at the High School. Surface flow at Acid Weir is perennial. In 1986, the water was a sodium-bicarbonate type with a TDS of 326 milligrams/L. The chemical constituents were slightly higher than encountered in the regional, perimeter, and onsite noneffluent areas: SO_4, 8 milligrams/L; Cl, 138 milligrams/L; F, 0.4 milligram/L; and N, 1.3 milligrams/L.

2. Pueblo 1. Pueblo 1 is located in Pueblo Canyon below the confluence with Acid Canyon. The water is a mixture of run-off from Acid Canyon and sanitary effluents from the Pueblo plant. In 1986, the water was a sodium-bicarbonate type with TDS of 357 milligrams/L. The chemical constituents reflect the quality of the sanitary effluents with SO_4, 30 milligrams/L; Cl, 68 milligrams/L; F, 0.9 milligram/L; and N, 10 milligrams/L.

3. Pueblo 2. Pueblo 2 is located in the midreach of Pueblo Canyon. The water is a mixture of run-off from Acid Canyon and sanitary effluent from the Pueblo plant. In 1986, the water was a sodium-bicarbonate type with a TDS of 346 milligrams/L. The chemical constituents were similar to those at Pueblo 1 with SO_4, 31 milligrams/L; Cl, 53 milligrams/L; F, 1 milligram/L; and N, 3.3 milligrams/L.

4. Pueblo 3. Pueblo 3 is located in the lower reach of Pueblo Canyon. The water is a mixture of that from Pueblo 2 and additional sanitary effluents from the Bayo plant. In 1986, the water was a sodium-bicarbonate with a TDS of 349 milligrams/L. Chemical constituents were about the same as the other two Pueblo stations with SO_4, 27 milligrams/L; Cl, 63 milligrams/L; F, 0.7 milligram/L; and N, 1.4 milligrams/L.

5. Test Well 1A. Test Well 1A is located in the lower reach of Pueblo Canyon. The well is completed in a perched aquifer above the main aquifer at a depth of 225 ft. The water level in the well stands at about 180 ft. The well is completed in a basalt flow within the gravels of the Puye Formation. Recharge to the perched aquifer is from stream flow in lower Pueblo Canyon, a mixture of storm run-off and sanitary effluent. In 1986, the water was a sodium-bicarbonate type with a TDS of 351 milligrams/L. Chemical constituents were similar to stream flow in Pueblo Canyon with SO_4, 31 milligrams/L; Cl, 60 milligrams/L; F, 1 milligram/L; and N, 12 milligrams/L.

6. Test Well 2A. Test Well 2A is located in the midreach of Pueblo Canyon. The depth of the well is 133 ft with a water level of about 115 ft. The well is completed into a perched aquifer within the gravels of the Puye Formation. The inferred recharge to the perched aquifer is from stream flow in the canyon; however, the chemical quality of the aquifer is not similar. In 1986, the water was a calcium-bicarbonate type with a TDS of 125 milligrams/L. The chemical concentrations are SO_4, 1 milligram/L; Cl, 40 milligrams/L; F, 0.4 milligram/L; and N, 0.6 milligram/L.

B. DP-Los Alamos Canyon

DP Canyon heads within the townsite along the western edge of the plateau and is tributary to Los Alamos Canyon near the center of the plateau. The drainage area thus covers much of the townsite and part of the technical area (TA-21) that lies between DP-Canyon and Los Alamos Canyon. Liquid radioactive wastes were treated at the TA-21 plant from about 1950 to 1983. The treated effluent was released into DP-Canyon. As in Acid-Pueblo Canyon, trace amounts of radionuclides in the effluent were bound to clays and silts in the alluvium and were subject to resuspension and transport in solution, suspended sediment, and bed sediments. There is also release of sanitary effluents from the plant at TA-21 into DP Canyon.

Los Alamos Canyon heads on the flanks of the Jemez Mountains west of the plateau. Los Alamos Reservoir lies on the flanks of the mountains within Los Alamos Canyon. Run-off in the canyon consists of normal overflow and run-off from the reservoir, storm run-off that in part drains some of the townsite and Laboratory technical areas, and some sanitary effluent and cooling water discharge from two technical areas in the canyon above the confluence with DP Canyon. Pueblo Canyon is a tributary to Los Alamos Canyon near the eastern edge of the plateau well below the confluence with DP Canyon. Los Alamos is confluent to the Rio Grande at Otowi.

1. DPS-4. DPS-4 is a surface water station in DP Canyon just above the junction with Los Alamos Canyon. Surface flow at the station consists of storm run-off and sanitary effluent. In 1986, the water was a sodium-bicarbonate type with a TDS of 391 milligrams/L. The chemical constituents reflect sanitary effluent with SO_4, 34 milligrams/L; Cl, 118 milligrams/L; F, 5.5 milligrams/L; and N, 2.2 milligrams/L.

2. LAO-C. LAO-C is a shallow well in Los Alamos Canyon located upgradient from two technical areas (Fig. 1). The well is about 9 ft deep and is completed into the alluvium of the canyon. It is recharged from the stream; the water level is at stream level, less than 2 ft below land surface. In 1986, the water was a sodium-bicarbonate type with a TDS of 231 milligrams/L. The chemical constituent concentrations were SO_4, 11 milligrams/L; Cl, 90 milligrams/L; F, 0.9 milligram/L; and N, 0.3 milligram/L.

3. LAO-1. LAO-1 is a shallow well located in Los Alamos Canyon downgradient from the two technical areas. The well is about 32 ft deep with about 20 ft of casing hanging in the hole. It is completed in the gravels of the alluvium. The water level is at stream level, 1 to 2 ft below the top of the casing. The well is recharged from stream flow and water moving downgradient in the alluvium. The water is from run-off and any discharge of cooling water effluent that takes place at the two technical areas immediately upgradient from the well. In 1986, the water was a sodium-bicarbonate type with a TDS of 283 milligrams/L. Chemical concentrations in the water were SO_4, 26 milligrams/L; Cl, 50 milligrams/L; F, 2.4 milligrams/L; and N, 2.5 milligrams/L.

4. LAO-3. LAO-3 is a shallow well located in Los Alamos Canyon just below the junction with DP-Canyon. The well is 32 ft deep with about 30 ft of casing hanging in the hole. The alluvium consists of gravels hanging about 19 ft thick overlying the tuff, which perches the water in the gravels of the alluvium. Water in the well is from run-off and water moving through the alluvium from upper Los Alamos Canyon and from DP Canyon. In 1986, the water was a sodium-bicarbonate type with a TDS of 295 milligrams/L. The chemical concentrations in the water were SO_4, 28 milligrams/L; Cl, 49 milligrams/L; F, 2.4 milligrams/L; and N, 2.8 milligrams/L.

5. LAO-4.5. LAO-4.5 is a shallow well located in Los Alamos Canyon west of State Road 4 (SR4). The well was drilled to a depth of about 48 ft and was completed by hanging 20 ft of casing in the hole. The water level is at stream level when the stream is running or about 10 ft below land surface 3 weeks after the stream is dry. The well, completed in the alluvium, is recharged from the stream and water moving downgradient in the alluvium. The water quality reflects the quality found in the alluvium upgradient from the well. In 1986, the water was a sodium-bicarbonate type with a TDS of 196 milligrams/L. The chemical concentrations were SO_4, 12 milligrams/L; Cl, 32 milligrams/L; F, 0.9 milligram/L; and N, 0.1 milligram/L.

6. Basalt Spring. Basalt Spring is located in Los Alamos Canyon east (downgradient) of the junction with Pueblo Canyon. The spring discharges 10 to 15 gpm from the fractures of a basalt flow above the

stream channel. The recharge to the spring is from water in the alluvium in both Los Alamos (near LAO-4.5) and Pueblo Canyons (near Pueblo 3) west of the confluence with the two streams. In 1986, the water was calcium-bicarbonate type with a TDS of 178 milligrams/L. The chemical concentrations were SO_4, 18 milligrams/L; Cl, 13 milligrams/L; F, 0.6 milligram/L; and N, 2.3 /L.

C. Sandia Canyon

Sandia Canyon has a small drainage area and heads along the western edge of the plateau. The drainage area includes the major Laboratory technical areas containing administration, shops, warehouses, and large numbers of parking areas. Perennial flow in the upper reach of the canyon is from sanitary effluents and cooling water discharge. Included in the drainage area are batch plants for asphalt and cement. Along the north wall of the upper part of the canyon is a sanitary landfill used by both the Laboratory and County.

1. SCS-1. SCS-1 is a surface water station in Sandia Canyon that is located downgradient from the outfall from the sanitary and power plants, as well as the landfill and the asphalt batch plant. The canyon contains storm run-off from the parking lot areas and effluents from the two plants. In 1986, the water was a sodium-bicarbonate type with a TDS of 419 milligrams/L. The chemical concentrations were SO_4, 26 milligrams/L; Cl, 94 milligrams/L; F, 12 milligrams/L; and N, 2.2 milligrams/L.

2. SCS-3. SCS-3 is a surface water station located in Sandia Canyon about the center of the plateau, usually the end of the surface flow from sanitary effluents and cooling water discharge. In 1986, the water was sodium-bicarbonate type with a TDS of 583 milligrams/L. The chemical concentrations at SCS-3 were slightly higher than those concentrations at SCS-1, with SO_4, 78 milligrams/L; Cl, 165 milligrams/L; F, 1.6 milligrams/L; and N, 2 milligrams/L.

D. Mortandad Canyon

Mortandad Canyon has a small drainage area that heads along the western edge of the plateau. The canyon drains from several Laboratory technical areas and their parking lots. It receives several releases of cooling water from various processes and is the major release area for low-level radioactive effluents released from the main treatment plant at TA-50. The treatment plant became operational in 1962 and is in operation at the present (1988). Radionuclides remaining in the effluents when released are adsorbed into the silts and clays of the alluvium of the canyon. These silts and clays are subject to transport with storm run-off. Hydrologic studies began in the canyon in 1960. Since that time there has been no run-off from the Laboratory onto the adjacent San Ildefonso Indian Reservation. The small drainage area reduces the volume of run-off, and the large volume of unsaturated alluvium within the Laboratory is able to retain by infiltration and storage any run-off that has occurred. Thus, there has been no transport of contaminants off of Laboratory property.

The alluvium in the upper and middle sections of the canyon contains water perched in the alluvium with the underlying tuff forming the perching bed. The water in the alluvium is recharged from surface water, effluents, and storm run-off.

1. MCO-3. MCO-3 is a shallow well located downgradient from the effluent outfall from TA-50 (Fig. 1). The well is about 12 ft deep with a water level at stream level or at about 4 ft below land surface. In 1986, the water was a sodium-bicarbonate type with a TDS of 175 milligrams/L. The chemical concentrations were SO_4, 3 milligrams/L; Cl, 6 milligrams/L; F, 3.4 milligrams/L; and N, 3.9 milligrams/L.

2. MCO-4. MCO-4 is a shallow well downgradient from MCO-3. The well is completed in the alluvium at a depth of about 18 ft with a water level of 4 to 6 ft. The perennial flow in the canyon ends about a quarter of a mile to the east. Thus, most of the recharge to the well and the other wells to the east is from water moving downgradient in the alluvium. The water strongly reflects the chemical quality of the effluent released from the treatment plant at TA-50. In 1986, the water was a sodium-bicarbonate type with a TDS of 944 milligrams/L. The chemical concentrations were SO_4, 44 milligrams/L; Cl, 29 milligrams/L; F, 4 milligrams/L; and N, 90 milligrams/L.

3. MCO-5. MCO-5 is a shallow well completed in the alluvium at a depth of about 38 ft with a water level, depending on time of year, ranging from 8 to 15 ft. Major recharge to the well is water moving eastward downgradient in the alluvium. In 1986, the water

was sodium-bicarbonate type with a TDS of 1,071 milligrams/L. The chemical concentrations were SO_4, 53 milligrams/L; Cl, 29 milligrams/L; F, 4 milligrams/L; and N, 106 milligrams/L.

4. MCO-6. MCO-6 is a shallow well completed at a depth of about 36 ft with the water level standing 10 to 15 ft below land surface. Recharge of the well is water moving through the alluvium. In 1986, the water was a sodium-bicarbonate type with a TDS of 1,037 milligrams/L. The chemical concentrations were SO_4, 52 milligrams/L; Cl, 29 milligrams/L; F, 2.9 milligrams/L; and N, 102 milligrams/L.

5. MCO-7. MCO-7 is a shallow well completed at a depth of about 55 ft in the alluvium with water levels ranging from 12 to 20 ft. Recharge to the well is water moving eastward through the alluvium. In 1986, the water was a sodium-bicarbonate type with a TDS of 854 milligrams/L. The chemical concentrations were SO_4, 41 milligrams/L; Cl, 32 milligrams/L; F, 2 milligrams/L; and N, 74 milligrams/L.

IV. SUPPLY WELLS

There are 19 wells in 3 well fields that furnish industrial and municipal water supply to the Laboratory and to the County. These wells are completed into the main aquifer of the Los Alamos area. Two wells in each field were sampled as part of this study. Small additional production to the water supply system is collected from the Water Canyon Gallery. The gallery is spring discharge from fractures in a densely welded tuff collected by a tunnel dug into the aquifer. The water from the gallery also was sampled.

A. Well LA-1B

Well LA-1B is located in Los Alamos Canyon well field. The well was completed at a depth of 1,750 ft. Water is under semiartesian pressure with the water level in 1986, about 40 ft below land surface. In 1986, the water was a sodium-bicarbonate type with a TDS of 456 milligrams/L. The chemical concentrations were SO_4, 40 milligrams/L; Cl, 17 milligrams/L; F, 3.3 milligrams/L; and N, 0.6 milligram/L.

B. Well LA-5

Well LA-5 is located in the Los Alamos well field. The well was completed at a depth of 1,750 ft. Water level is about 160 ft below land surface. In 1986, the water was a sodium-bicarbonate type with a TDS of 251 milligrams/L. The chemical concentrations were low at SO_4, 4 milligrams/L; Cl, 2 milligrams/L; F, 0.4 milligram/L; and N, 0.6 milligram/L.

C. Well G-1

Well G-1 is located in the Guaje Canyon well field. The well is completed at a depth of 2,000 ft. Water level is at a depth of about 275 ft below land surface. In 1986, the water was sodium-bicarbonate type with a TDS of 166 milligrams/L. The chemical concentrations were SO_4, 4 milligrams/L; Cl, 3 milligrams/L; F, 0.4 milligram/L; and N, 0.6 milligram/L.

D. Well G-5

Well G-5 is located in the Guaje Canyon well field. The well was completed at a depth of 1,840 ft; however, the casing collapsed and the well is only open to a depth of 690 ft. The water level stands at about 455 ft below land surface. Although the collapsed casing has shortened the effective depth of the well, the well produced 17% of the production from the seven wells in the field in 1986. In 1985 the water was a calcium-bicarbonate type with a TDS of 139 milligrams/L. The chemical concentrations were low with SO_4, 5 milligrams/L; Cl, 4 milligrams/L; F, 0.3 milligram/L; and N, 0.5 milligram/L.

E. Well PM-1

Well PM-1 is located in the Pajarito well field. The well is completed at a depth of 2,500 ft. The water level stands at a depth of about 750 ft below land surface. In 1986, the water was a sodium-bicarbonate type with a TDS of 213 milligrams/L. The chemical concentrations were SO_4, 3 milligrams/L; Cl, 3 milligrams/L; F, 0.3 milligram/L; and N, 1.5 milligrams/L.

F. Well PM-4

Well PM-4 is located in the Pajarito well field. The well is completed at a depth of 2,875 ft. The water level stands at a depth of about 1,050 ft below land surface. In 1985 the water was a sodium-bicarbonate type with a TDS of 152 milligrams/L. The chemical concentrations were SO_4, 2 milligrams/L; Cl, 3

milligrams/L; F, 0.3 milligram/L; and N, 0.2 milligram/L.

G. Water Canyon Gallery

Water Canyon Gallery is located west of the plateau on the flanks of the mountain. The water is fed through transmission lines by gravity into a station where it is fed through a microfilter, chlorinated, and then pumped into storage for distribution. In 1986, the water was a sodium-bicarbonate type with a TDS of 91 milligrams/L. The chemical concentrations in the water were SO_4, 2 milligrams/L; Cl, 1 milligram/L; F, 0.1 milligram/L; and N, 0.4 milligram/L.

V. DISTRIBUTION SYSTEM

The water distribution system was sampled at the five fire stations that represents uniformity in the community and Laboratory distributions. In 1986, the water met Federal and State Drinking Water standards (ESG-1987). Water samples collected from the five fire stations in late September contained concentrations (<200 g/L) of organic compounds. The stations were resampled in July 1987 at two locations. One sample was collected from the tap in the water closet (normal station) and the other from the tap in the kitchen. The organics previously reported were not found in the later samples.

A. Fire Station 1

Fire Station 1 is located at TA-3. The water at the station is a mixture from wells in the Pajarito well field. In 1986, the water was a sodium-bicarbonate type with a TDS of 170 milligrams/L. The chemical concentrations were low with SO_4, 3 milligrams/L; Cl, 3 milligrams/L; F, 0.3 milligram/L; and N, 0.4 milligram/L.

B. Fire Station 2

Fire Station 2 is located near TA-21. The water is a mixture of water from wells in the Los Alamos field. In 1986, the water was a sodium-bicarbonate type with a TDS of 172 milligrams/L. The chemical constituents were low with SO_4, 5 milligrams/L; Cl, 4 milligrams/L; F, 0.6 milligram/L; and N, 0.6 milligram/L.

C. Fire Station 3

Fire Station 3 is located in the community of White Rock. The water is a mixture of water from wells in the Pajarito field. In 1986, the water was a calcium-bicarbonate type with a TDS of 234 milligrams/L. The chemical concentrations were low with SO_4, 6 milligrams/L; Cl, 8 milligrams/L; F, 0.8 milligram/L; and N, 0.6 milligram/L.

D. Fire Station 4

Fire Station 4 is located in the community near the golf course. The water is a mixture of water from wells in the Guaje field. In 1986, the water was a sodium-bicarbonate type with a TDS of 177 milligrams/L. The chemical concentrations were SO_4, 5 milligrams/L; Cl, 4 milligrams/L; F, 0.6 milligram/L; and N, 0.6 milligram/L.

E. Fire Station 5

Fire Station 5 is located at TA-16 (S-Site). The water is a mixture of water from the Pajarito field and from the gallery in Water Canyon. In 1986, the water was a sodium-bicarbonate type with a TDS of 151 milligrams/L. The chemical concentrations were SO_4, 2 milligrams/L; Cl, 2 milligrams/L; F, 0.3 milligram/L; and N, 0.5 milligram/L.

APPENDIX B

VOLATILE COMPOUNDS AND DETECTION LIMITS

Volatile Compounds	Detection Limits (μg/L)
Chloromethane	10
Bromomethane	10
Vinyl Chloride	10
Chloroethane	10
Methylene Chloride	5
Acetone	10
Carbon Disulfide	5
1,1-Dichloroethene	5
1,1-Dichloroethane	5
Trans-1,2-Dichloroethene	5
Chloroform	5
1,2-Dichloroethane	5
2-Butanone	10
1,1,1-Trichloroethane	5
Carbon Tetrachloride	5
Vinyl Acetate	10
Bromodichloromethane	5
1,2-Dichloropropane	5
Trans-1,3-Dichloropropene	5
Trichloroethene	5
Dibromochloromethane	5
1,1,2-Trichloroethane	5
Benzene	5
cis-1,3-Dichloropropene	5
2-Chloroethylvinylether	10
Bromoform	5
4-Methyl-2-Pentanone	10
2-Hexanone	10
Tetrachloroethene	5
1,1,2,2-Tetrachloroethane	5
Toluene	5
Chlorobenzene	5
Ethylbenzene	5
Styrene	5
Total Xylenes	15

Methods of Analysis:
USEPA 1985: (Methods 624 and 625)

APPENDIX C

SEMIVOLATILE COMPOUNDS AND DETECTION LIMITS

Semivolatile Compounds	Detection Limits (µg/L)
Phenol	10
bis(2-Chloroethyl) Ether	10
2-Chlorophenol	10
1,3-Dichlorobenzene	10
1,4-Dichlorobenzene	10
Benzyl Alcohol	10
1,2-Dichlorobenzene	10
2-Methylphenol	10
bis(2-Chloroisopropyl) Ether	10
4-Methylphenol	10
N-Nitroso-di-n-propylamine	10
Hexachloroethane	10
Nitrobenzene	10
Isophorone	10
2-Nitrophenol	10
2,4-Dimethylphenol	10
Benzoic Acid (2)	50
bis(2-Chloroethoxy) Methane	10
2,4-Dichlorophenol	10
1,2,4-Trichlorobenzene	10
Naphthalene	10
4-Chloroaniline	10
Hexachlorobutadiene	10
4-Chloro-3-methylphenol	10
2-Methylnaphthalene	10
Hexachlorocyclopentadiene	10
2,4,6-Trichlorophenol	10
2,4,5-Trichlorophenol (2)	50
2-Chloronaphthalene	10
2-Nitroaniline (2)	50
Dimethyl Phthalate	10
Acenapthylene	10
3-Nitroaniline (2)	50
Acenaphthene	10
2,4-Dinitrophenol (2)	50
4-Nitrophenol (2)	50
Dibenzofuran	10
2,4-Dinitrotoluene	10
2,6-Dinitrotoluene	10

APPENDIX C (cont)

Semivolatile Compounds	Detection Limits (µg/L)
Diethyl Phthalate	10
4-Chlorophenyl-phenylether	10
Fluorine	10
4-Nitroaniline (2)	50
4,6-Dinitro-2-methylphenol (2)	50
N-Nitrosodiphenylamine (1)	10
4-Bromophenyl-phenylether	10
Hexachlorobenzene	10
Pentachlorophenol (2)	50
Phenanthrene	10
Anthracene	10
di-n-Butyl Phthalate	10
Fluoranthene	10
Pyrene	10
Butyl Benzyl Phthalate	10
3,3'-Dichlorobenzidine (3)	20
Benzo (a) Anthracene	10
bis(2-Ethylhexyl) Phthalate	10
Chrysene	10
di-n-Octyl Phthalate	10
Benzo (b) Fluoranthene	10
Benzo (k) Fluoranthene	10
Benzo (a) Pyrene	10
Indeno (1,2,3-cd) Pyrene	10
Dibenz (a,h) Anthracene	10
Benzo (g,h,i) Perylene	10

Method of Analysis: USEPA 1985 (Methods 625 and 625).

APPENDIX D

PESTICIDES, HERBICIDES, AND POLYCHLORINATED BIPHENYLS COMPOUND MAXIMUM CONTAMINANT LEVELS AND DETECTION LIMITS

Pesticides[a]	Maximum Contaminant Levels (µg/L)	Detection Limits (µg/L)
Alpha-BHC	--	0.3
Beta-BHC	--	0.3
Delta-BHC	--	0.3
Gamma-BHC (Lindane)	4.0	0.3
Heptachlor	--	0.3
Aldrin	--	0.3
Heptachlor Epoxide	--	0.3
Endosulfan I	--	0.3
Dieldrin	--	0.5
4,4'-DDE	--	0.5
Endrin	0.2	0.5
Endosulfan II	--	0.5
4,4'-DDD	--	0.5
Endrin Aldehyde	--	0.5
Endosulfan Sulfate	--	0.5
4,4'-DDT	--	0.5
Methoxychlor	100	3.0
Endrin Ketone	--	0.5
Chlordane	--	0.3
Toxaphene	5.0	5.0
Herbicides[b]		
2,4-D	100	0.5
2,4,5-T	--	3.0
2,4,5-TP (Silvex)	10	3.0
Polychlorinated Biphenyls (PCB)[a]		
Aroclor-1016	--	3.0
Aroclor-1221	--	3.0
Aroclor-1232	--	3.0
Aroclor-1242	--	3.0
Aroclor-1248	--	3.0
Aroclor-1254	--	5.0
Aroclor-1260	--	5.0

Method of Analysis:

[a]USEPA 1985.
[b]USEPA 1983 and APHS 1985.

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