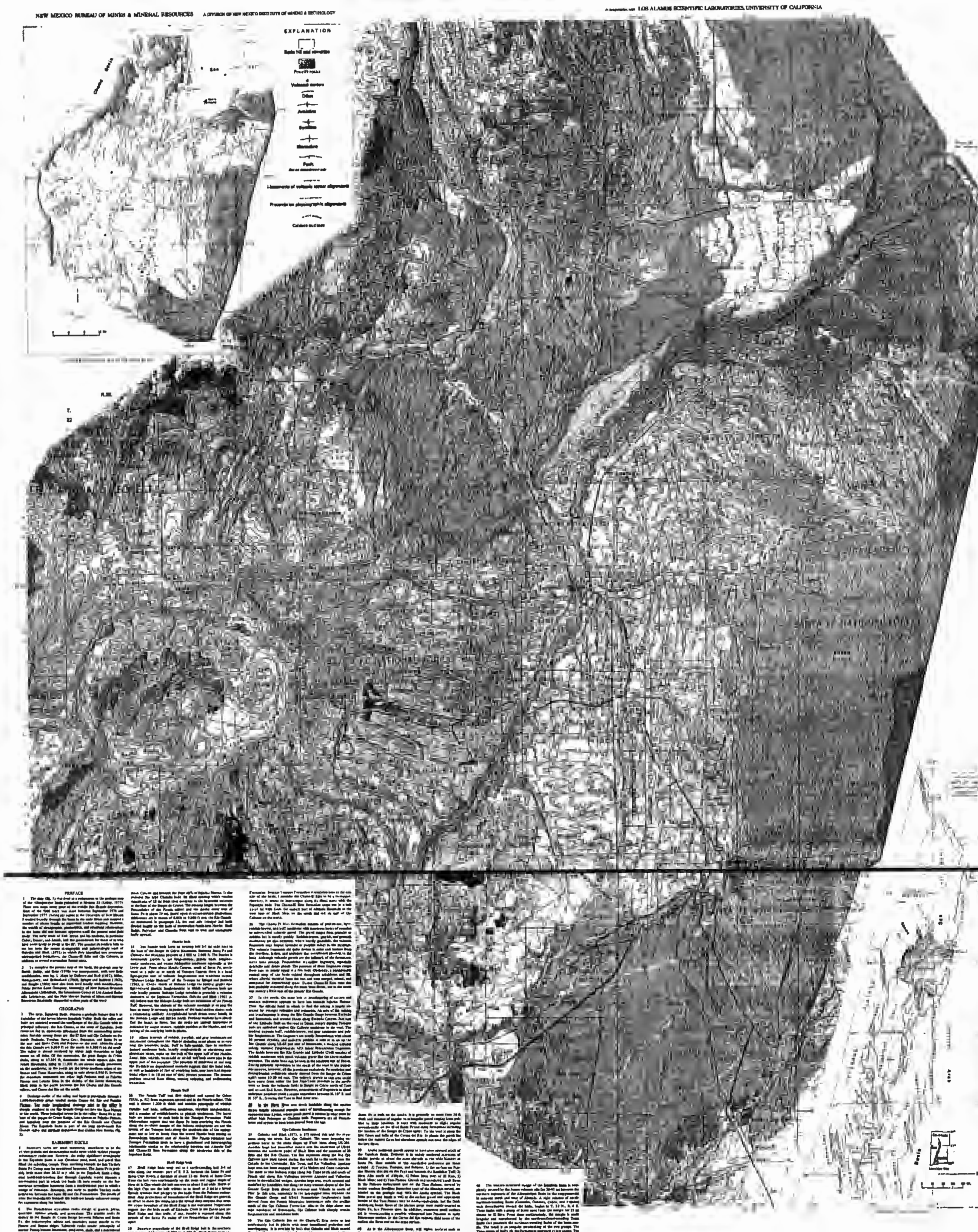
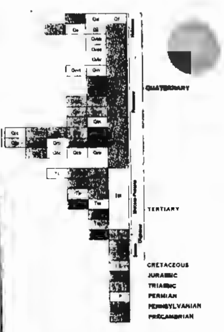
ERID 11659



CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

SYMBOLS

PREFACE

GEOGRAPHY

BASEMENT ROCKS

BASIN STRATIGRAPHY

CENOZOIC IGNEOUS ROCKS

STRUCTURE

POST-SANTA FE DEPOSITS

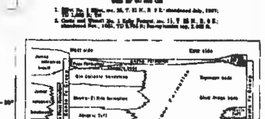


FIGURE 1—Stratigraphic diagram of Santa Fe Group and related rocks.

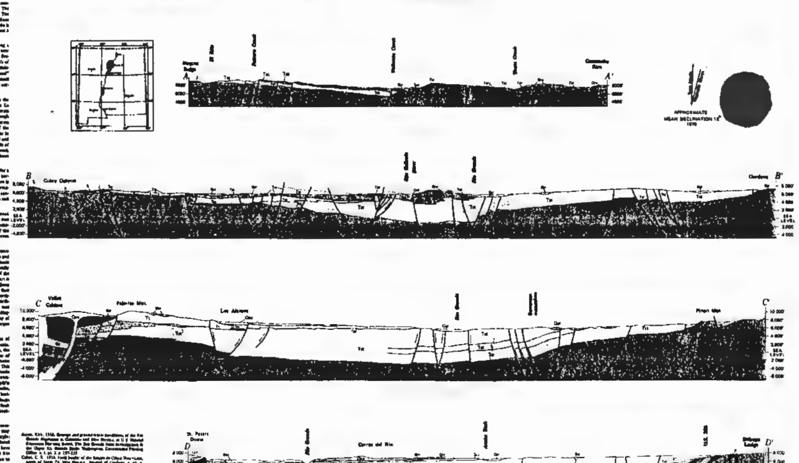


FIGURE 2—Geologic map and structure sections of Española Basin.

REFERENCES

GEOLOGY OF ESPAÑOLA BASIN, NEW MEXICO

by Vincent C. Kelley

1978

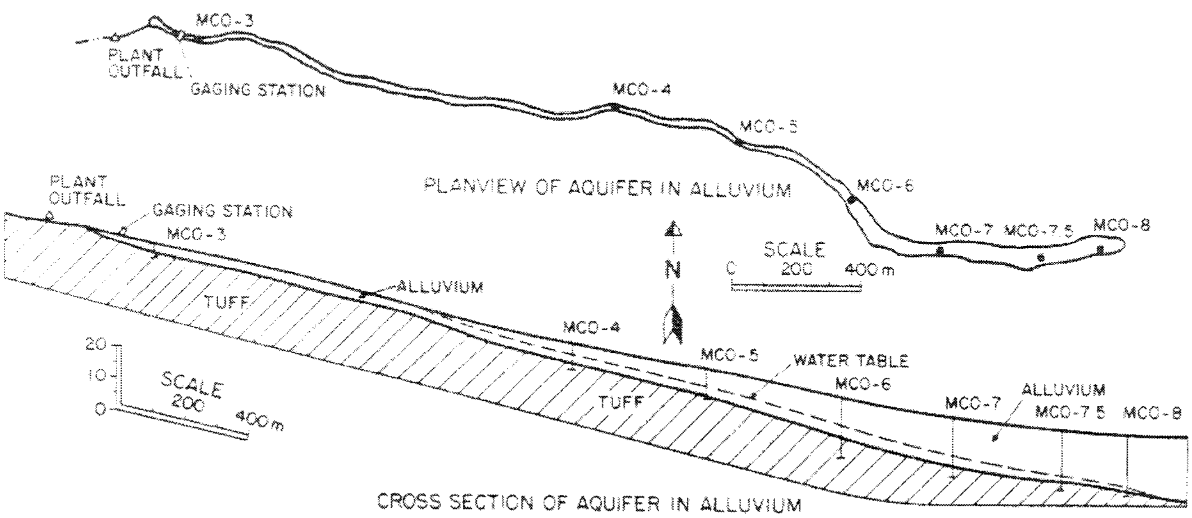


Fig. 1—Planview and cross section of aquifer in alluvium.

cess at this facility. Storm runoff adds to the surface flow in the canyon primarily during the spring and summer months. All of this water recharges a shallow aquifer that is perched in the alluvium on the underlying tuff (Fig. 1). Evapotranspiration and infiltration into the underlying tuff removes water from storage in the aquifer since the aquifer is not a part of the municipal or industrial water supply. The main aquifer which is the source of domestic and industrial water, lies at a depth of 295 m beneath the floor of the canyon. The two aquifers are separated by about 250 m of unsaturated strata.

The industrial liquid wastes collected at TA-50 contain varying amounts of chemical and radiochemical constituents. All of the influent wastes are subjected to a chemical-ion exchange treatment process. During treatment, various chemicals are added under controled conditions to enhance radionuclide decontamination factors. Some of the added chemicals remain in the effluent which is released when radioactivity is < 10% of the maximum permissible concentration (5). Records of volume of effluent released into the canyon are kept as part of the plant records.

The volume of surface water entering the canyon was determined from flow measurements obtained at a gaging station (Fig. 1). The station was equipped with a water-stage recorder on a 0.152-m (6-inch) modified Parshall flume (for low flow) overset with a 1.22-m (4-foot) wier (for large runoff events) and was rated using standard methods.

The volume of water in storage in the aquifer was determined from seven test holes across the canyon floor (Fig. 1). Water level measurements in the test holes were made in December to determine the volume of saturation at that time.

The chemical characteristics of TA-50 effluent were determined from composite samples of the wastes. Data from weekly composites were applied to release-volume and were averaged over the year. The chemical quality of water from the aquifer was determined 3–4 times annually and averaged for the year. Analytical methods used for various chemical constituents in the effluent and in the water from storage are outlined elsewhere (2).

RESULTS AND DISCUSSION

The volume of storm runoff and TA-48 water passing through the gaging station from 1962 through 1974 ranged from 25 × 10^3 m^3/year to 125 × 10^3 m^3/year for an average annual flow of about 58 × 10^3 m^3/year (Table 1). The volume of effluent released annually from TA-50 was less variable ranging from 40 × 10^3 m^3/year to 60 × 10^3 m^3/year. The dilution ratio (storm runoff and TA-48 water/TA-50 effluents) ranged from 0.6 to 1.7 from 1964–1974 and averaged about 1.0. The average annual volume of surface water (effluent and runoff) entering the canyon was about 105 × 10^3 m^3. There has been no surface flow out of the canyon during the period of study due to the rapid infiltration of surface water into the alluvium.

The volume of water in the aquifer in December was relatively constant from year to year (Table 1). Seasonal variations were observed with lowest volumes occurring during the winter and early spring and maximums occurring after spring snowmelt and storm runoff during the summer. The volume of water in storage at the end of each calendar year ranged from 19 × 10^3 m^3 to 30 × 10^3 m^3 during 1961–1974. Annual losses of water (i.e., added volume-storage volume) ranged from 65 × 10^3 m^3 to 146 × 10^3 m^3/year through a 13-year observation period and averaged 105 × 10^3 m^3 or about the same volume that entered the canyon each year. Water losses from the aquifer were attributed to infiltration and/or evapotranspiration. The losses attributed to evapotranspiration were estimated at about 15% based upon work described

Table 1—The estimated balance of water in the Mortandad Canyon watershed

Year	Effluent TA-50	Storm runoff and TA-48 water	Dilution ratio	Storage in aquifer†	Annual surface and ground water loss in canyon
	× 10^3 m^3			× 10^3 m^3	
1961	--	--	--	20	--
1962	--	70	--	20	70
1963	27‡	125	--	22	150
1964	51	59	1.2	24	108
1965	49	75	1.5	25	123
1966	53	35	0.7	20	93
1967	60	79	1.3	30	129
1968	60	52	0.9	24	118
1969	54	93	1.7	25	146
1970	53	50	0.9	20	108
1971	46	29	0.6	29	66
1972	57	26	0.5	23	89
1973	54	37	0.7	19	95
1974	40	25	0.6	19	65

† Storage as of December 31.
‡ Six months (July to December).

Table 2—Chemical quality of industrial effluent from TA-50, storm runoff and waste water from TA-48.

Effluent TA-50	Chemical constituents										Specific conductance at 25C	pH
	Calcium	Magnesium	Sodium	Carbonate	Bicarbonate	Chloride	Fluoride	Nitrate	Dissolved solids	Total hardness		
year	mg/liter										µmhos/cm	
1963†	52	1.4	188	302	376	28	1.7	63	830	135	1,730	11.6
1964	36	0.9	219	280	386	41	2.5	97	960	94	1,950	11.6
1965	40	0.8	196	278	367	30	2.2	131	860	109	2,070	10.9
1966	52	3.2	151	213	292	17	1.4	50	660	145	1,280	11.4
1967	110	3.1	120	226	306	21	2.3	55	570	289	1,520	11.2
1968	100	2.7	153	265	353	28	3.2	63	620	259	1,630	11.2
1969	91	2.3	286	300	428	34	2.7	131	940	235	1,990	11.2
1970	56	4.8	406	354	472	38	2.1	551	1,500	155	2,340	11.2
1971	42	3.9	433	218	641	169	2.7	372	1,590	120	2,460	9.2
1972	30	3.6	571	91	506	108	1.2	766	1,670	91	2,570	8.8
1973	33	5	310	52	331	60	1.5	310	1,150	105	1,530	9.0
1974	43	4	443	256	561	53	2.6	290	1,540	123	2,640	7.9
Storm runoff	29 (26)‡	3 (46)	22 (26)	0	102 (31)	9 (46)	0.3 (75)	0.5 (41)	174 (21)	103 (17)	192 (35)	8.7
Waste water TA-48	11 (28)	4.3 (77)	58 (49)	0	140 (34)	7.6 (45)	0.9 (33)	1.0 (53)	280 (47)	47 (43)	202 (44)	7.5

† Six months (July to December).
‡ Parenthetic values equal the coefficient of variation [(standard deviation/mean) × 100]; storm runoff means based on a sample size of 12, waste water (TA-48) on a sample size of 9.

elsewhere with infiltration accounting for the remainder (4).

The alluvium in Mortandad Canyon is derived from erosion and weathering of a rhyolite tuff. This alluvium is quite permeable; studies using tritium and chloride as tracers indicate water velocity in the aquifer ranges from 2 to 20 m/day with the higher velocity occurring in the upper reaches of the canyon. Total travel time from the effluent outfall to the eastern extent of the aquifer (about 3 km) is about 1 year (4).

The water from the cooling process at TA-48 originates from a supply which contains ambient levels of the various chemicals. Chemicals are not added during use of this water, thus, chemical quality has not changed significantly through the years (Table 2). Analysis of storm runoff indicates little chemical changes over a 12-year observation period as evidenced by the generally small coefficients of variation (Table 2).

Liquid effluents from TA-50 are the major source of chemicals entering Mortandad Canyon (Table 2). Most of the measured chemical concentrations generally averaged 2 to 20 times higher in TA-50 effluent than in the other two sources (TA-48 and runoff). One exception was magnesium, which averaged higher in storm runoff water. Many of the chemicals in the effluent from TA-50 have increased since 1963 although not in a consistent pattern. Parameters exhibiting increases include magnesium, sodium, bicarbonate, chloride, nitrate, dissolved solids, and conductivity. Relatively stable or decreasing values were observed for calcium, carbonate, fluoride, total hardness, and pH.

The release of industrial effluents into the canyon has changed the quality of the water in the aquifer (Table 3). The pH of the water has changed from 6 to 8 due to the alkaline nature of the liquid effluents. Most of the remaining chemical parameters have increased since 1962, although not consistently with time. The levels of fluoride and bicarbonate have approximately doubled, while for values for calcium, magnesium, sodium, chloride, nitrate, dissolved solids, and specific conductance have increased by factors of 3 to 7. Carbonates remained nondetectable in aquifer water through the entire observation period due to their conversion to HCO_3^- and CO_2 under the conditions in the aquifer.

Annual average concentrations of sodium, chloride, nitrate, and total dissolved solids in the effluent were compared with corresponding concentrations in solution in the aquifer to determine the relationship between

Table 3—Chemical quality of water in aquifer

Year	Chemical constituents										Specific conductance at 25C	pH
	Calcium	Magnesium	Sodium	Carbonate	Bicarbonate	Chloride	Fluoride	Nitrate	Dissolved solids	Total hardness		
	mg/liter										µmhos/cm	
1962	11	4	32	0	91	7	0.6	3.0	320	45	360	6.8
1963	14	5	53	0	90	9	0.5	16	310	67	360	7.2
1964	19	7	100	0	123	21	0.7	68	500	76	510	7.5
1965	16	5	99	0	143	13	0.7	40	400	59	440	7.6
1966	18	4	97	0	172	25	0.4	28	400	62	470	7.7
1967	21	7	140	0	147	16	0.7	15	340	82	400	7.7
1968	17	6	110	0	138	12	0.7	8	300	68	360	7.9
1969	23	5	140	0	129	11	0.5	25	370	81	410	8.2
1970	26	7	132	0	143	15	0.5	137	530	84	560	7.6
1971	44	11	228	0	176	54	0.9	366	990	153	1,130	7.7
1972	40	11	215	0	223	54	0.7	248	910	144	1,000	7.5
1973	33	7	164	0	221	34	1.0	204	786	112	910	7.7
1974	27	6	188	0	254	32	1.0	207	785	93	970	7.7

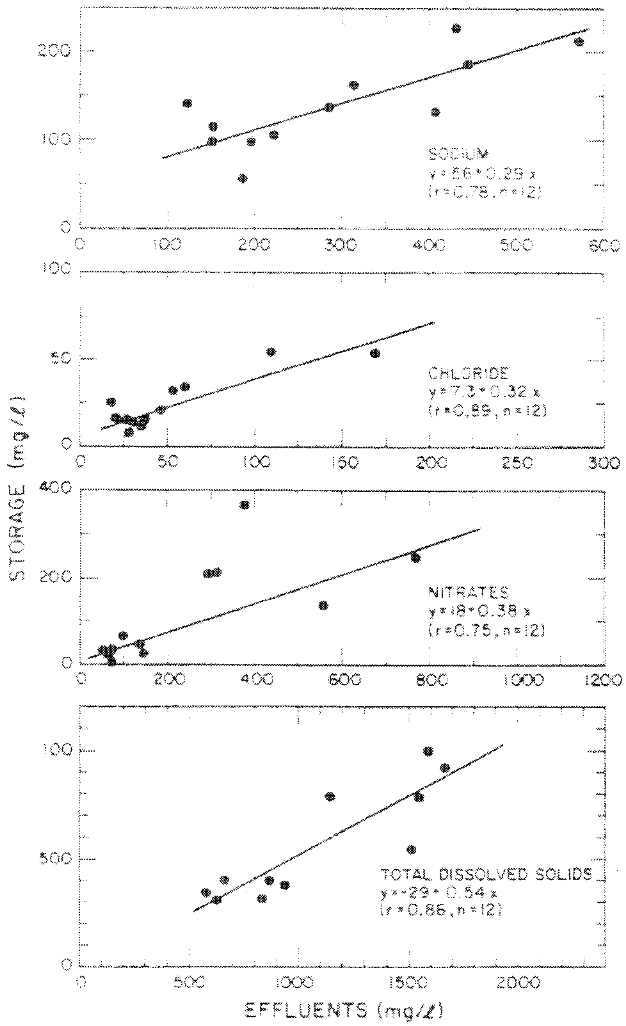


Fig. 2—The relationship of concentrations of sodium, chloride, nitrate, and total dissolved solids in treated effluent to corresponding concentrations in solution in the aquifer.

chemical release and levels appearing in the aquifer (Fig. 2). The linear least squares regressions were all highly significant ($P < 0.01$) with multiple correlation coefficients (r^2) ranging from 0.61 to 0.80.

The slopes of the four regression lines indicate that concentrations of the chemicals in solution in the aquifer averaged from 30–50% of those measured in the effluent when prerelease concentrations (i.e., intercept values) were taken into consideration. Recall that the chemical effluents from TA-50 are diluted with about equal volumes of storm runoff and TA-48 water. Thus, the reduction in chemical concentrations in the aquifer could be the result of dilution alone. The intercepts of the regression lines for sodium, chloride, and nitrate were not significantly different from pre-effluent release levels of chemicals in the aquifer indicating a rapid "turn-over" of

Table 4—Mass inventory of chemicals released and in storage

Constituents	Effluents, TA-50	In storage	
	1963–1974	1962	1974
	kg × 10³		
Calcium	[illegible]	0.2	0.6
Magnesium	1.8	0.08	0.1
Sodium	170	0.6	3.6
Carbonate	84	0	0
Bicarbonate	160	1.8	4.8
Chloride	31	0.1	0.6
Fluoride	1.3	0.01	0.02
Nitrate	150	0.06	3.9
Total dissolved solids	640	6.4	15

the water in storage. This is supported by results of the tracer studies indicating water transit times of about 1 year (4).

The mass of chemicals added to Mortandad Canyon was estimated from the concentration and volume data in Tables 1 and 2. Corresponding estimates for aquifer water were made from data in Tables 1 and 3. About 625,000 kg of the eight chemicals listed in Table 4 were released into Mortandad Canyon from 1963–1974. Nearly 90% of this mass consisted of nitrates, bicarbonates, carbonates, and sodium with calcium, magnesium, chloride, and fluoride comprising the remainder.

Mass inventories of most of the chemicals in solution in the aquifer during 1974 were higher by factors of 2 to 65 over pre-effluent release inventories (Table 4) and averaged 1–6% of the total chemical releases. The largest increases over prerelease inventories were noted for sodium and nitrate, reflecting relatively larger concentrations of these chemicals in TA-50 effluent.

Chemical concentrations in solution in the aquifer have increased over prerelease levels, however, there has not been a steady accumulation of these materials in the water with time. The rapid loss of water and its associated chemicals from the aquifer prevents chemical accumulation and indicates that cessation of effluent release to the canyon would rapidly improve the quality of water in the aquifer.

LITERATURE CITED

1. Abrahams, J. H., E. H. Baltz, and W. D. Purtymun. 1962. Movement of perched ground water in alluvium near Los Alamos, New Mexico. U. S. Geol. Surv. Prof. Pap. 450-B. U. S. Government Printing Office, Washington, D. C. 405 p.
2. American Public Health Association. 1971. Standard methods for examination of water and wastewater. 13 ed. New York, N. Y. 874 p.
3. Baltz, E. H., J. H. Abrahams, and W. D. Purtymun. 1963. Preliminary report on the geology and hydrology of Mortandad Canyon near Los Alamos, New Mexico. U. S. Geol. Surv., Albuquerque, N. Mex.
4. Purtymun, W. D. 1974. Dispersion and movement of tritium in a shallow aquifer in Mortandad Canyon at the Los Alamos Scientific Laboratory. Report LA-5716-MS. Los Alamos Sci. Lab., Los Alamos, N. Mex. 10 p.
5. U. S. Energy Resource and Development Administration. 1975. Standards for radiation protection. Manual Chapter 0524. 8 Apr 1975. U. S. Government Printing Office, Washington, D. C. 25 p.