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Regional Survey of Tritium in Surface and
Ground Water in the Los Alamos Area, New Mexico

August 1966 through May 1969

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of the University of California
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William D. Purtymun

LOS ALAMOS NATIONAL LABORATORY



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WATER IN THE LOS ALAMOS AREA, NEW MEXICO
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ABSTRACT

Surface and ground water samples were analyzed for tritium from 113 sampling stations during the period August 1966 through May 1969. Tritium was detected only in surface and ground water in the stream-connected aquifers in the alluvium of DP, Los Alamos, and Mortandad Canyons which are controlled areas. These canyons receive treated low-level radioactive effluents. The tritium in DP and Los Alamos Canyon is from old seepage pits that contained tritium. The tritium concentrations decrease downgradient in the canyons due to dilution with other waste water, sewage effluent, and storm runoff. Tritium in the alluvium in Lower Mortandad Canyon is residual from a release into the canyon prior to August 1966. The concentrations decreased with time due to dilution by effluents and storm runoff. The surface and ground water in the alluvium is not a source of municipal or industrial supply.

INTRODUCTION

A regional survey of tritium in surface and ground water in the Los Alamos area was made by the Environmental Group, H-8, of the Los Alamos Scientific Laboratory (LASL) in cooperation with the U. S. Geological Survey and the U. S. Atomic Energy Commission. The survey (August 1966 through May 1969) was made to determine the fate of tritium released into the environment by operations of the Laboratory.

Surface water samples were collected from streams and rivers in and adjacent to the Los Alamos area. Samples of ground water were collected from observation holes completed into stream-connected aquifers in canyons cut into

Pajarito Plateau. A stream-connected aquifer is an aquifer in alluvium or near surface volcanic sediments or flow rocks that is recharged or hydrologically connected with surface flow.

Ground water from the deep supply wells and deep test wells comes from the main aquifer. The main aquifer lies at a depth of about 1200 ft along the western edge of the plateau to a depth of 600 ft along the eastern edge. Movement of water in this aquifer is eastward toward the Rio Grande where a part is discharged into the river through seeps and springs along White Rock Canyon. Recharge to the aquifer occurs along the flanks of the mountain and deep canyon west of the plateau.¹ There is no apparent recharge from surface flow

or the stream-connected aquifer in the alluvium of the plateau itself. Descriptions of the geology, hydrology, and sampling stations in the monitoring net are found in John et al. (1966).²

Surface and ground water samples were collected from 113 sampling stations in Los Alamos and adjacent areas. The number of samples collected from individual stations ranged from one to thirty. Several samples were collected over a period of time from individual stations known to contain measurable tritium concentrations to determine dilution and migration trends.

TRITIUM SURVEY

Tritium concentrations in the water samples were determined by liquid scintillation analyses. A 0.500-ml aliquot of each water sample was mixed with 15 ml of a dioxane base liquid scintillation cocktail and assayed in a liquid scintillation counting system using 100-min count time. Instrument background was determined by counting a similarly prepared sample which contained blank reagents. The instrument background and efficiency was also cross-calibrated with vendor-supplied blank and standards which were prepared in an argon atmosphere. The limit of detection for the above method was 50 pCi/ml (picocuries of tritium per milliliter) of water sample.

The Concentration Guide as recommended in U. S. A. E. C. Manual Chapter 0524 with Appendix and Annex A³ for tritium in controlled areas is 10,000 pCi/ml and uncontrolled areas is 3000 pCi/ml.

Supply Wells

Supply wells furnish water for municipal use in the town and laboratories at Los Alamos. The wells range in depth from 870 to 2550 ft. The water from the main aquifer is pumped from the Tesuque Formation in Los Alamos and Guaje Canyons and from the lower part of the Puye Formation and Tesuque Formation on the Pajarito Plateau (Figs. 1 and 2). Pumpage for the year 1966

was 1.2 billion gallons, 1967 1.3 billion gallons, 1968 1.4 billion gallons and 1969, 1.3 billion gallons. Tritium content in water from the supply wells during the period of study was below limits of detection (Table I).

Test Wells

Test wells were drilled on the Pajarito Plateau to obtain geologic and hydrologic information and to monitor ground water in areas of possible contamination (Figs. 1 and 2). Test wells T-1, T-2, T-3, and T-8 and test wells DT-5A, DT-9, and DT-10 are completed in the top of the main aquifer at depths to water ranging from 590 to 1173 ft below land surface. Tritium content in water from test wells was below limits of detection (Table II).

Springs

Water samples were collected from springs discharging from the main aquifer in lower Los Alamos Canyon and along the Rio Grande in White Rock Canyon (Fig. 1). Springs on the Pajarito Plateau and western flanks of the mountains discharge from perched aquifers above the main aquifer. Tritium content in water from springs was below limits of detection (Table III).

Rivers and Streams

The main stream in the north central New Mexico system is the Rio Grande (Figs. 1 and 3). Water samples were collected from stations on the Rio Grande and tributaries such as the Rio Chama and smaller streams entering the river from the Pajarito Plateau. Water samples were also collected on intermittent and perennial streams on the Pajarito Plateau and on the flanks of the mountains west of the plateau. Water from the Rio Navajo, Rio Blanco, and Little Navajo rivers, which drain into the San Juan River, was analyzed to obtain background information since part of these streams will be diverted into the Rio Grande upon completion of the San Juan Diversion Project. Waters analyzed contained tritium in concentrations below limits of detection (Table IV).

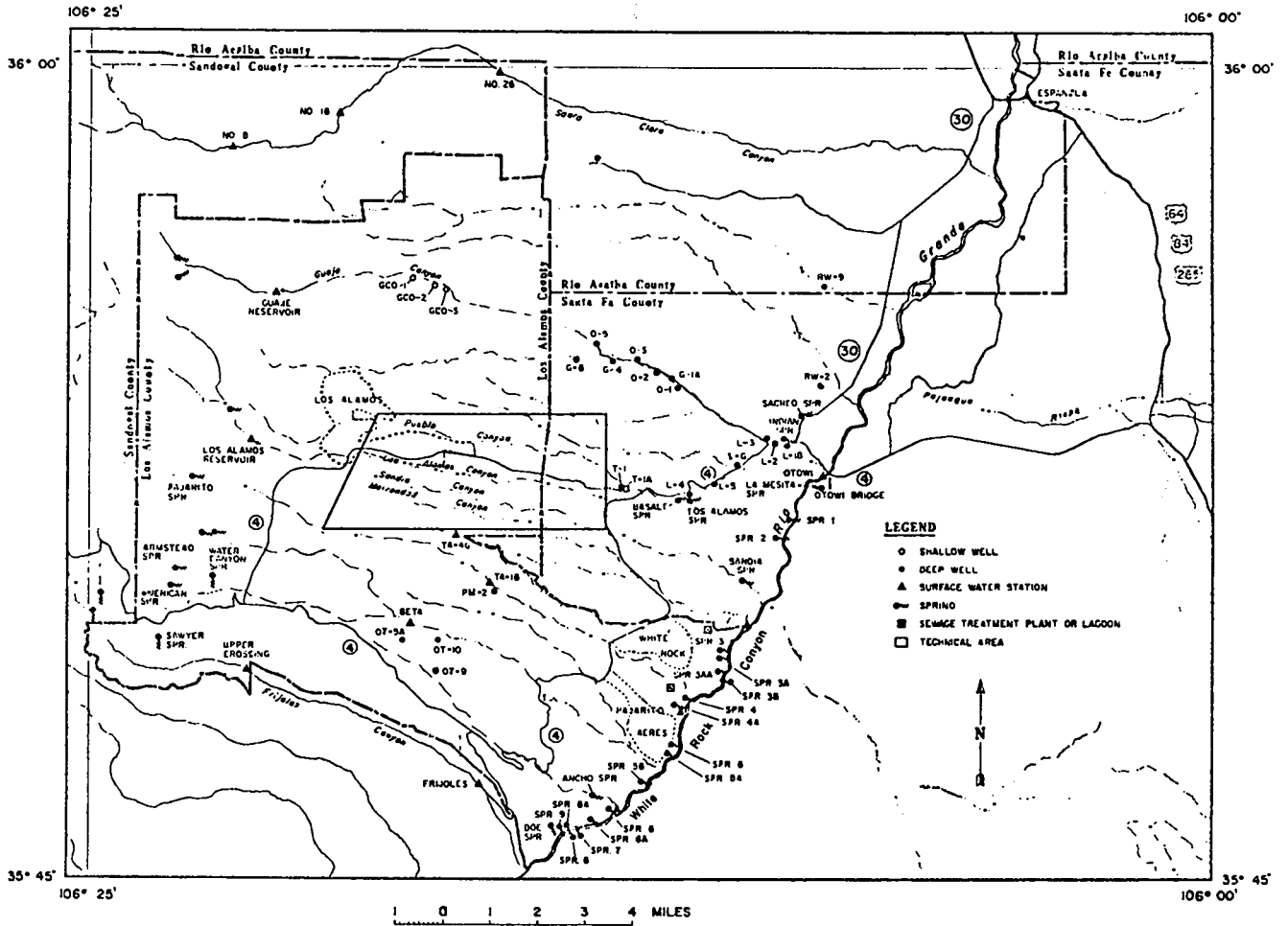


Fig. 1. Sampling stations on the Pajarito Plateau.

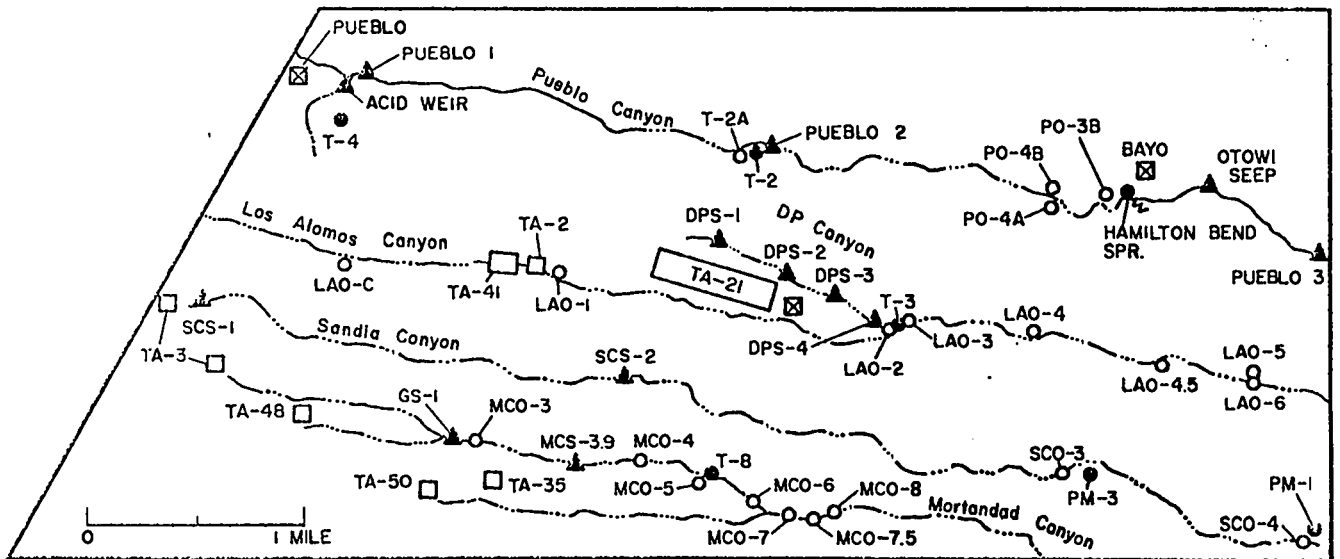


Fig. 2. Sampling stations in Pueblo, DP, Los Alamos, Sandia, and Mortandad Canyons.

TABLE I
SUPPLY WELLS

Field and Well	Number of Samples	Tritium (pCi/ml)
Los Alamos Field		
LA-1B	3	ND
LA-2	1	ND
LA-3	3	ND
LA-4	2	ND
LA-5	2	ND
LA-6	3	ND
Guaje Field		
G-1	3	ND
G-1A	2	ND
G-2	2	ND
G-3	2	ND
G-4	2	ND
G-5	2	ND
G-6	3	ND
Pajarito Field		
PM-1	7	ND
PM-2	7	ND
PM-3	5	ND

ND - Below limits of detection, <50 pCi/ml.

TABLE II
TEST WELLS

Test Wells	Number of Samples	Tritium (pCi/ml)
T-1	2	ND
T-2	4	ND
T-3	7	ND
DT-5A	3	ND
T-8	4	ND
DT-9	1	ND
DT-10	2	ND
RWP-2 *	1	ND
RWP-5 *	1	ND

ND - Below limits of detection, <50 pCi/ml.
*Stock wells, Bureau of Indian Affairs, east of Guaje Well Field.

TABLE III

SPRINGS

Source	Number of Samples	Tritium (pCi/ml)
Spring 1	1	ND
Spring 2	1	ND
Spring 3	1	ND
Spring 3A	1	ND
Spring 3AA	1	ND
Spring 3B	1	ND
Spring 4	1	ND
Spring 4A	4	ND
Spring 5	1	ND
Spring 5A	1	ND
Spring 6	1	ND
Spring 6A	1	ND
Spring 7	1	ND
Spring 8	1	ND
Spring 8A	1	ND
Spring 9	1	ND
Sawyer Spring	1	ND
Armstead Spring	1	ND
Water Canyon (S-Site Water)	1	ND
American Spring	2	ND
Doe Spring	2	ND
Sacred Spring	3	ND
Indian Spring	3	ND
La Mesita Spring	1	ND
Basalt Spring	6	ND
Los Alamos Spring	5	ND

ND - Below limits of detection, <50 pCi/ml.

TABLE IV

RIVERS AND STREAMS

Source	Number of Samples	Tritium (pCi/ml)
Rio Chama at Chamita	10	ND
Rio Grande at Embudo	9	ND
Rio Grande at Otowi	11	ND
Rio Grande at Cochiti	10	ND
Stream entering Rio Grande		
Los Alamos Canyon	2	ND
Mortandad Canyon	1	ND
Pajarito Canyon	1	ND
Ancho Canyon	1	ND
Frijoles Canyon	1	ND
Rio Navajo at		
Oso Tunnel	2	ND
Rio Blanco above		
Div. Dam	2	ND
Little Navajo above		
Div. Dam	2	ND
Santa Clara Canyon No. 16	1	ND
Guaje Canyon Reservoir	1	ND
Los Alamos		
Canyon Reservoir	1	ND
Pajarito Canyon at TA-18	1	ND
Pajarito Canyon at Highway 4	7	ND
Valle Canyon	2	ND
Ten-Site Canyon	1	ND
Upper Frijoles Canyon	1	ND

ND - Below limits of detection, <50 pCi/ml.

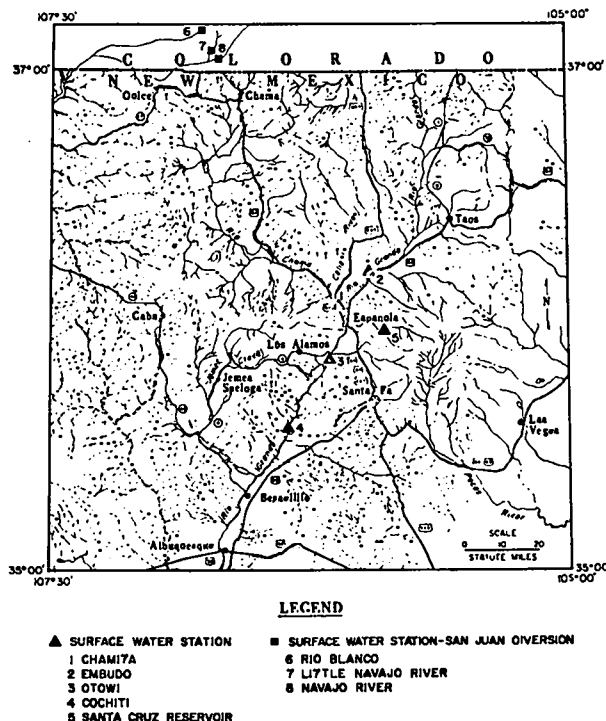


Fig. 3. Sampling stations in adjacent areas.

Acid and Pueblo Canyons

The monitoring net in Acid and Pueblo Canyons consists of five observation holes in the stream-connected alluvium aquifer, four surface water-sampling stations, and a spring (Fig. 2). Prior to 1951, untreated radioactive liquid wastes were released into Acid and Pueblo Canyons. A waste treatment plant released only treated effluents from 1951 through 1963. Treated sewage effluents are released into Pueblo Canyon from the Pueblo and Bayo plant (Fig. 2). Test holes T-1A and T-2A are completed in aquifers that are perched in basalt (T-1A) and in the Puye Formation (T-2A) above the main aquifer. The perched zones of saturation are recharged from stream flow or from the stream-connected aquifer in the alluvium in Pueblo and Los Alamos Canyons. The tritium content in water from surface flow, observation and test holes, and the spring was below limits of detection (Table V). Water from the main aquifer in T-1 and T-2 (Table III) also was below limits of detection.

TABLE V
PUEBLO CANYON

Source	Number of Samples	Tritium Picocuries Per Milliliter
Observation Holes		
PO-3B	4	ND
PO-4A	4	ND
PO-4B	4	ND
PC-10	2	ND
PC-11	2	ND
T-1A	7	ND
T-2A	1	ND
Surface Water		
Acid Weir	1	ND
Pueblo 1	1	ND
Pueblo 2	1	ND
Pueblo 3	1	ND
Hamilton Bend Spring	4	ND

ND - Below limits of detection, <50 picocuries per milliliter.

TABLE VI

DP and LOS ALAMOS CANYON
November 1966 through May 1969

Source	Number of Samples	Tritium Picocuries Per Milliliter Range (Min) (Max)	
DP Canyon			
Surface Water			
DPS-1	15	170	4860
DPS-2	8	290	1880
DPS-3	10	170	1760
DPS-4	19	180	1260
Sewage effluent (DP West)	3	ND	ND
Flood flow DPS-4	30	ND	ND
Los Alamos Canyon			
Observation Holes			
LAO-1	22	ND	80
LAO-1.2	1	---	---
LAO-1.8	1	---	---
LAO-2	18	ND	860
LAO-3	21	ND	510
LAO-4	14	ND	330
LAO-4.5	1	---	---
LAO-5	8	60	130
LAO-6	6	50	140
Los Alamos Canyon Surface Water			
Near LAO-1	4	ND	100
Near LAO-4.5	4	70	170

ND - Below limits of detection, <50 picocuries per milliliter.

DP and Los Alamos Canyon

Low-level liquid wastes are processed at the waste treatment plant at TA-21 to reduce radioactive contaminants prior to their release into DP Canyon. DP Canyon is a tributary to Los Alamos Canyon near the center of the plateau (Fig. 2). Both canyons are in controlled areas west of Highway 4.

Cooling water and sewage effluent are released into Los Alamos Canyon from TA-2 and TA-41. Water in the alluvium of Los Alamos Canyon (holes LAO-1, LAO-1.2, and LAO-1.8) and surface water from near LAO-1 contained tritium in concentrations either below the limits of detection or in small concentrations (Table VI). Surface water from four stations in DP Canyon and from observation holes in the alluvium in Los Alamos Canyon east of their junction, contained tritium in concentrations above the limits of detection. Surface water samples from DPS-1 through DPS-4 showed a rather wide range of concentrations. The tritium is due to seepage from old disposal pits containing tritium contaminated materials near the head of the canyon.

In general, the tritium concentration in surface water from DP Canyon decreased with increased distance from the plant by dilution with sewage effluent, waste water and storm runoff (Fig. 4). The effect of the surface water recharge to water in the alluvium of Los Alamos Canyon is seen by increased concentration of tritium at observation hole LAO-2.

Water from Basalt Spring which is recharged from stream flow and water in the alluvium from Pueblo and Los Alamos Canyons contained no detectable amounts of tritium (Table III). Water from test well 3 in the main aquifer near the junction of DP and Los Alamos Canyons (depth to water 750 ft) contained no detectable concentrations of tritium (Table II).

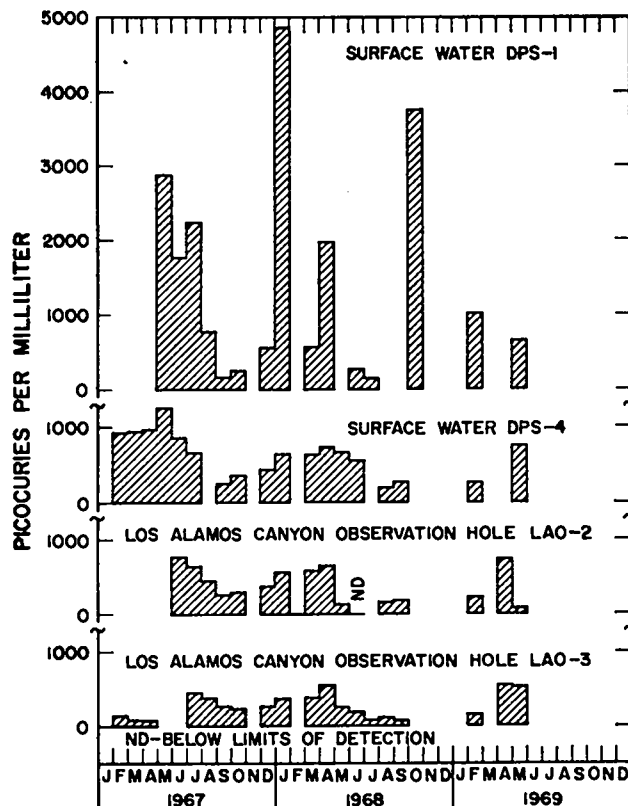


Fig. 4. Tritium concentrations in water from DP and Los Alamos Canyons.

Mortandad Canyon

Mortandad Canyon is in a controlled area for the disposal of liquid wastes treated at TA-50. The Canyon heads on the Pajarito Plateau and thus has a small drainage area (Fig. 2). Because of the large volume of alluvium in the canyon, all storm runoff since hydrologic observations began in 1960 has been absorbed by the alluvium. The liquid wastes from TA-50, TA-48, TA-3 (New Sigma), and storm runoff recharge the stream-connected aquifer in the alluvium which is temporarily perched on the underlying tuff. As the water in the aquifer moves eastward, steady loss to evapotranspiration and infiltration and infiltration into the tuff occur. Due to these losses the aquifer underlies the area of the canyon only to a limited extent from Gaging Station 1 where the

alluvium is thin to a few hundred feet east of observation hole MCO-8 where the alluvium thickens to over 80 ft (depth to water about 62 ft).

Water samples for tritium analyses were collected from four surface water stations and 10 observation holes in alluvium (Table VII). The results of the analyses indicate only small amounts of tritium entered the canyon with liquid wastes from TA-50. These amounts ranged from non-detectable amounts to trace amounts in individual releases (Gaging Station 1, Fig. 5).

Tritium was detected in the stream-connected aquifer in the alluvium of the canyon (MCO-3 to MCO-8, Table VII). Concentrations were greater in the lower part of the canyon (Fig. 5). The tritium was probably residual from liquid waste released in early operations of the treatment plant at TA-50 (1963 through 1966) or from TA-35 in the late 1950's or early 1960's. The tritium concentrations decrease with time due to the dilution of the water with the inflow of waste effluents and storm runoff into the alluvium and tritium losses to evapotranspiration.

Storage of water in the alluvium was computed from the known volume of saturation obtained from water-level measurements in observation holes. It was estimated in February 1967 that storage in the lower canyon was about 19.0 million liters. The average tritium concentration (MCO-6, MCO-7, MCO-7.5, and MCO-8) for February was 490 pCi/ml; thus, it was estimated that the water in storage contained about 9.3 Ci of tritium. In May 1969 the storage was estimated at 14.4 million liters with an average tritium concentration of 80 pCi/ml or about 1.2 Ci of tritium in the total water in storage.

Test Well 8 is located in the main aquifer (depth to water 960 ft) near the center of the canyon (Fig. 2). Water analyses for this well during the survey indicated that tritium was below limits of detection.

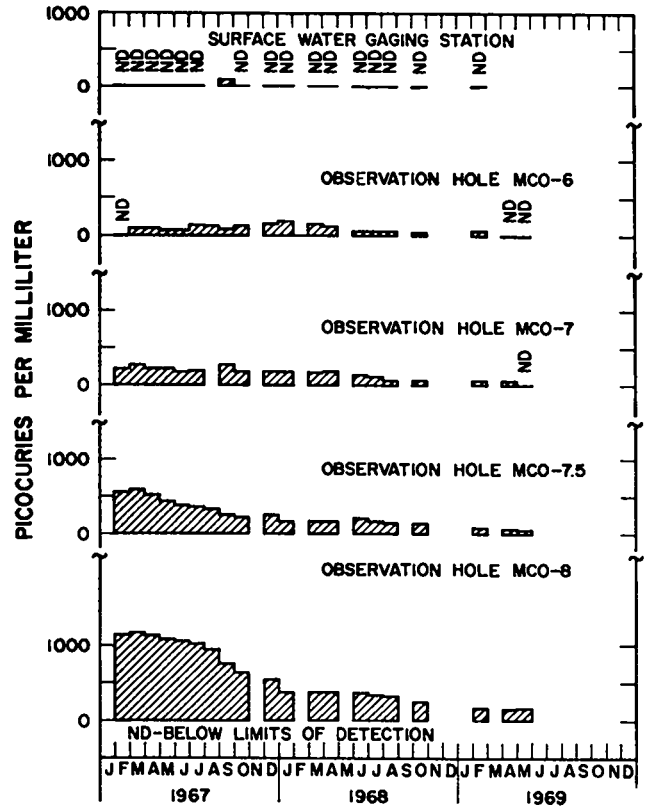


Fig. 5. Tritium concentrations in water from Mortandad Canyon.

TABLE VII
MORTANDAD CANYON
November 1966 through May 1969

Source	Number of Samples	Tritium Picocuries Per Milliliter	
		Range (Min)	(Max)
Observation Hole			
MCO-3	22	ND	270
MCO-4	23	ND	610
MCO-5	23	ND	370
MCO-6	24	ND	530
MCO-6.5A	5	ND	180
MCO-6.5B	7	70	220
MCO-7	23	ND	980
MCO-7.5	23	700	850
MCO-8	24	140	2200
MCO-8.2	9	230	600
Surface Water			
Gaging Station 1	19	ND	100
MCS-3.8	6	ND	60
MCS-3.9	7	ND	80
Gaging Station 2	4	ND	50

ND - Below limits of detection, < 50 picocuries per milliliter.

SUMMARY

The regional survey of tritium in surface and ground water indicated tritium was detected in controlled areas in DP, Los Alamos, and Mortandad Canyons. These canyons received treated low-level radioactive wastes either from the waste treatment plants at TA-21 or TA-50. Tritium in these canyons was found in surface water or in stream-connected aquifers in the alluvium. The surface water and water in alluvium is not a part of municipal or industrial supply in the Los Alamos area.

Tritium concentrations in surface water in DP Canyon varied during the study due to seepage from old disposal pits near the head of the canyon. The tritium concentrations were highest near the effluent outfall from the treatment plant but with increased distance from the plant, the concentrations decreased due to dilution with other waste water, sewage effluent, and storm runoff. Tritium concentrations in the alluvium of Los Alamos Canyon indicated recharge by surface water from DP Canyon.

Surface water entering Mortandad Canyon at Gaging Station 1 indicated that the low-level radioactive effluents released from the treatment plant at TA-50 contained little if any tritium during the study. Analyses of water in the alluvium in the lower canyon (MCO-6 through MCO-8) indicated that prior to 1967 tritium was released into the canyon from the treatment plant at TA-50 or from laboratories at TA-35. Tritium concentrations steadily declined during the study due to dilution by the inflow of waste effluents and storm runoff.

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2. C. E. John, E. Enyart, W. D. Purtymun, "Records of Wells, Test Holes, Springs and Surface Water Stations in the Los Alamos Area, New Mexico," U. S. Geological Survey open-file report, 1966.
3. U. S. Atomic Energy Commission Manual, Chapter 0524, Standards for Radiation Protection, with Appendix and Annex A.