XVIII. TEST HOLES IN THE VALLE TOLEDO AND VALLE GRANDE (1948)

Seven test holes ranging in depth from 31 to 361 ft were drilled in the Valle Toledo and Valle Grande during the spring and summer of 1948 (Fig. XVIII-A, Table XVIII-A). The holes were drilled to determine if a water supply for Los Alamos could be obtained from the Valle Toledo or Valle Grande in Valles Caldera west of Los Alamos (Stearns 1948).

The seven test holes drilled in the caldera encountered water in the alluvium along the stream channels of San Antonio Creek, the East Fork of the Jemez and the older lake clay and sediments (Table XVIII-B). Bailing tests indicated that water was available; however, the amount could not be determined without additional investigation.

An inventory was made of the springs in the two areas (Fig. XVIII-A and Table XVIII-C). The discharge from the three springs in the Valle Toledo and the four springs in the Valle Grande ranged from 15 to 875 gpm.

REFERENCE

H. T. Stearns, “Ground-Water Supplies for Los Alamos,” Consulting Report to the U.S. Atomic Energy Commission (1948).

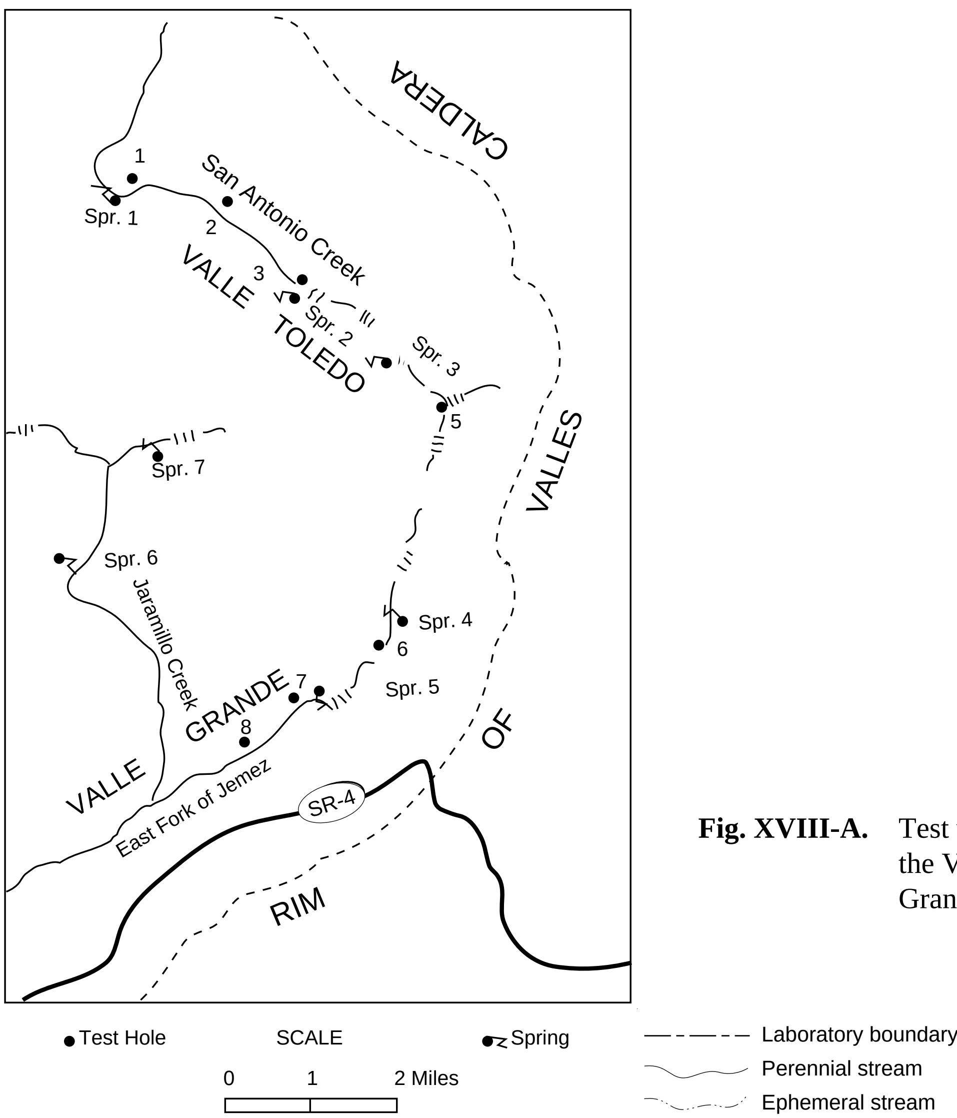

Fig. XVIII-A. Test wells and springs in the Valle Toledo and Valle Grande (Stearns 1948).

TABLE XVIII-A. Records of the Test Holes in the Valle Toledo and Valle Grande

	Date Drilled (1948)	Elevation LSD (ft)	Depth (ft)	Depth to Water (ft)	Water Level Above Nearby Stream (ft)	Remarks
<u>Valle Toledo</u>						
TH-1	6/19	8599	100	10	5	
TH-2	6/21	8650	100	+2	17	artesian
TH-3	6/23	8740	31	4.5	5	
TH-4	—	—	—	—	—	test hole not drilled
TH-5	6/25	8930	361	128.8	—	
<u>Valle Grande</u>						
TH-6	6/28	8590	140	7.7	-21	
TH-7	6/29	8532	40	6.0	2	
TH-8	6/30	8507	299	2.6	—	

Source: Stearns 1948.

TABLE XVIII-B. Geologic Logs of Test Holes in the Valle Toledo and Valle Grande (7 Test Holes)

1. Test Hole 1

Location: Valle Toledo
Depth: 100 ft
Depth to water: 10 ft after 15 min bailing and 10 min recovery; hole filled up to 73 ft with sand while bailing; abundant water.

Log	Thickness (ft)	Depth (ft)
Silt, sand, and gravel	11	11
Sand and gravel alternating with sticky brown clay	89	100

2. Test Hole 2

Location: Valle Toledo
Depth: 100 ft
Depth to water: artesian flow at 73 gpm.

Log	Thickness (ft)	Depth (ft)
Silt, sand, and gravel, cobbles	11	11
Sand and gravel alternating with sticky clay	89	100

3. Test Hole 3

Location: Valle Toledo
Depth: 31 ft
Depth to water: 4.5 ft; hole abandoned due to running sand.

Log	Thickness (ft)	Depth (ft)
Loose rock, sand, gravel, and clay	31	31

4. Test Hole 4

No hole drilled.

5. Test Hole 5

Location: Valle Toledo
Depth: 361 ft
Depth to water: 128.8 ft; there was some flow of water into the hole from the 15 ft level.

Log	Thickness (ft)	Depth (ft)
Sand and gravel, some angular, volcanic rock	11	11
Sand, gravel, with some clay lenses, all volcanic rock, containing much pumice	350	361

Note: The whole section or deposit compacted to stand as an open hole, but was not firm enough to core; from 26 to 361 ft lapilli of rhyolitic tuff, weakly consolidated.

TABLE XVIII-B. Geologic Logs of Test Holes in the Valle Toledo and Valle Grande (7 Test Holes) (Continued)

6. Test Hole 6
   Location: Valle Grande
   Depth: 140 ft
   Depth to water: 10 ft; bailed at 30 gpm without lowering water level; hole filled up with sand to 70 ft after bailing.

Log	Thickness (ft)	Depth (ft)
Gravel with some clay	10	10
Gravel, clay, volcanic debris and pumice	130	140

7. Test Hole 7

   Location: Valle Grande
   Depth: 40 ft
   Depth to water: 5.5 ft (6-29-48); 6.0 (7-1-48)

Log	Thickness (ft)	Depth (ft)
Rhyolite and obsidian gravel	40	40

   Note: Hole abandoned due to broken core barrel.

8. Test Hole 8

   Location: Valle Grande
   Depth: 299 ft
   Depth to water: 3.5 ft (6-30-48); 2.6 (7-1-48)

Log	Thickness (ft)	Depth (ft)
Sticky brown lake-bed clay	288	288
White pumice sand with quartz grains	11	299

Source: Stearns 1948.

TABLE XVIII-C. Records of Springs in the Valle Toledo and Valle Grande

	Elevation LSD (ft)	Topographic Situation and Geologic Conditions	Estimated Discharge (gpm)
Valle Toledo			
Spring 1	8570	Contact alluvium and rhyolite	875
Spring 2	8732	Contact alluvium and rhyolite	350
Spring 3	8768	Alluvium	15
Valle Grande			
Spring 4	8600	Alluvium	15
Spring 5	8524	Fractured rhyolite	1000
Spring 6	8640	Rhyolite	15
Spring 7	8700	Contact alluvium and rhyolite	30

Note: Elevations estimated with aneroid barometer; data collected June 1948.

Source: Stearns 1948.

TABLE XVIII-D. Locations and Elevations (NAD 1927)

A. Valle Toledo			
TH-1	N 1,804,000	E 431,000	8599 ft
TH-2	N 1,802,000	E 437,000	8650 ft
TH-3	N 1,799,000	E 441,000	8740 ft
TH-4	(hole not drilled)		
TH-5	N 1,791,000	E 451,000	8930 ft
B. Valle Grande			
TH-6	N 1,776,000	E 447,000	8590 ft
TH-7	N 1,773,000	E 441,000	8532 ft
TH-8	N 1,770,000	E 439,000	8507 ft
C. Valle Toledo			
Spring 1	N 1,804,000	E 430,000	8570 ft
Spring 2	N 1,799,000	E 441,000	8732 ft
Spring 3	N 1,794,000	E 444,000	8768 ft
D. Valle Grande			
Spring 4	N 1,778,000	E 447,000	8600 ft
Spring 5	N 1,773,000	E 444,000	8524 ft
Spring 6	N 1,780,800	E 427,500	8640 ft
Spring 7	N 1,788,000	E 431,000	8700 ft

Note: Location to the nearest 1000 ft; no topographic map existed when work was done (see Fig. XVIII-A).

Source: Stearns 1948.

XIX. TEST HOLES IN THE VALLE TOLEDO, VALLE GRANDE, AND VALLE DE LOS POSOS (1949)

As a result of the 1948 investigation (see Section XVIII), 17 test holes were drilled in the Valle Toledo, Valle Grande, Valle de los Posos, and adjacent areas (Figs. XIX-A, XIX-B, and XIX-C). Six holes in the Valle Toledo (H-1 through H-6) and six holes in the Valle Grande (H-7 through H-12) were laid out for aquifer tests (Fig. XIX-D and Fig. XIX-E). The remaining holes were drilled for additional geologic and hydrologic information in the Valle de los Posos (H-13, H-17), one (H-14) on the divide between Valle Toledo and Valle Grande, one (H-15) at the upper end of the Valle Grande, and one (H-16) on the east rim of the caldera (Table XIX-A).

The test holes penetrated alluvium, Quaternary fill (gravels washed out from the flanks of the caldera), and caldera fill (lake sediments and gravels). A lake occupied the depression after the formation of the Valles Caldera. Sediments that accumulated in the lake consisted of clayey silt, sand, and gravel derived from the volcanic debris that formed the inner walls and rim of the caldera. Gravel lenses are numerous, interbedded with sand and silt lenses. The lake sediments and caldera fill are porous and permeable.

The wells used in the aquifer tests were completed into the lake sediments or caldera fill as shown by the geologic logs and construction details (Table XIX-B). The results of the aquifer tests indicated that there was water available for a water supply for Los Alamos; however, the testing indicated that the amount of water that would need to be pumped would deplete the stream flow. As water in the stream was already owned by downstream users, additional testing was discontinued. The planned development of a water supply from the Valle Toledo and Valle Grande was terminated (Griggs 1955, Conover et al. 1963).

REFERENCES

R. L. Griggs, “Geology and Water Resources of the Los Alamos Area, New Mexico,” U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

C. S. Conover, C. V. Theis, and R. L. Griggs, “Geology and Hydrology of the Valle Grande and Valle Toledo, Sandoval County, New Mexico,” U.S. Geol. Survey Water-Supply Paper 1619-Y (1963).

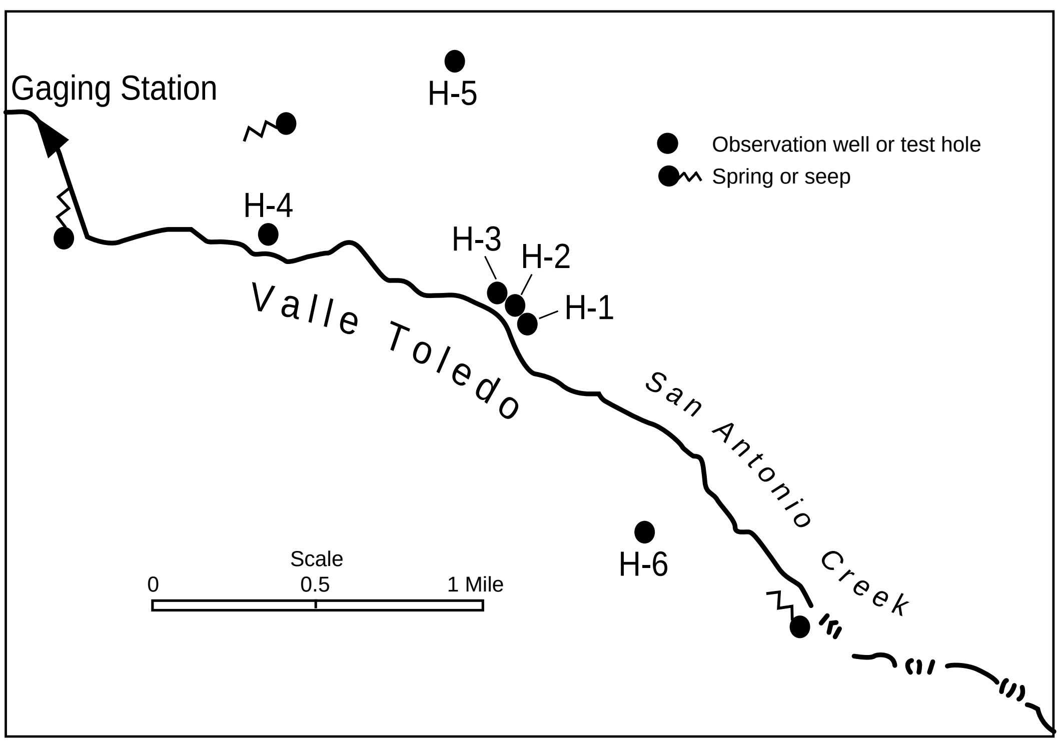

Fig. XIX-A. Locations of test holes in the Valle Toledo (1949).

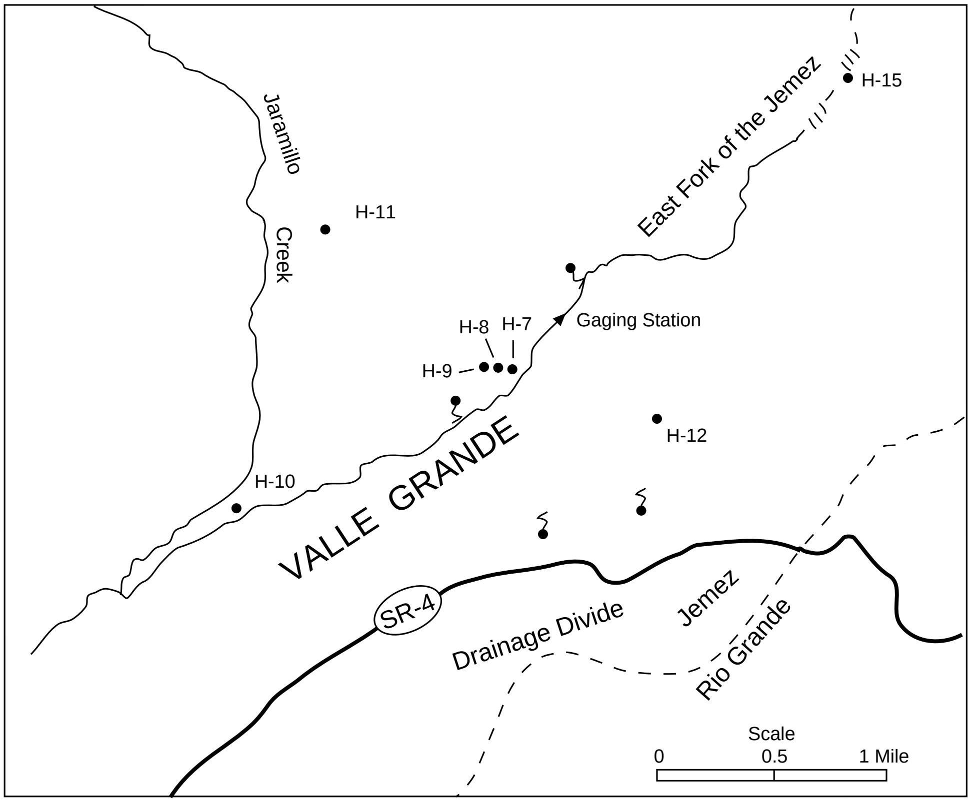

Fig. XIX-B. Generalized location of test holes in the Valle Grande (1949).

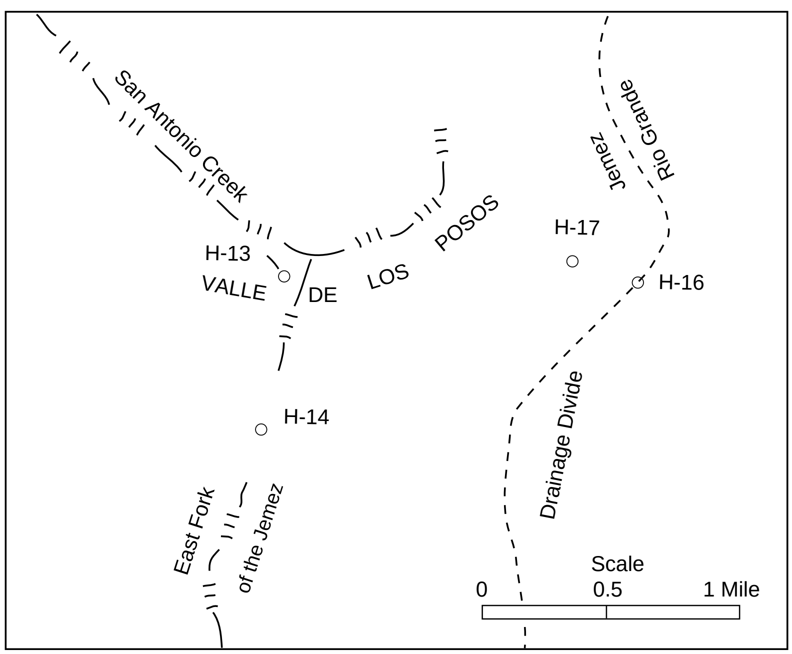

Fig. XIX-C. Locations of test holes in the Valle de los Posos and on the drainage divide.

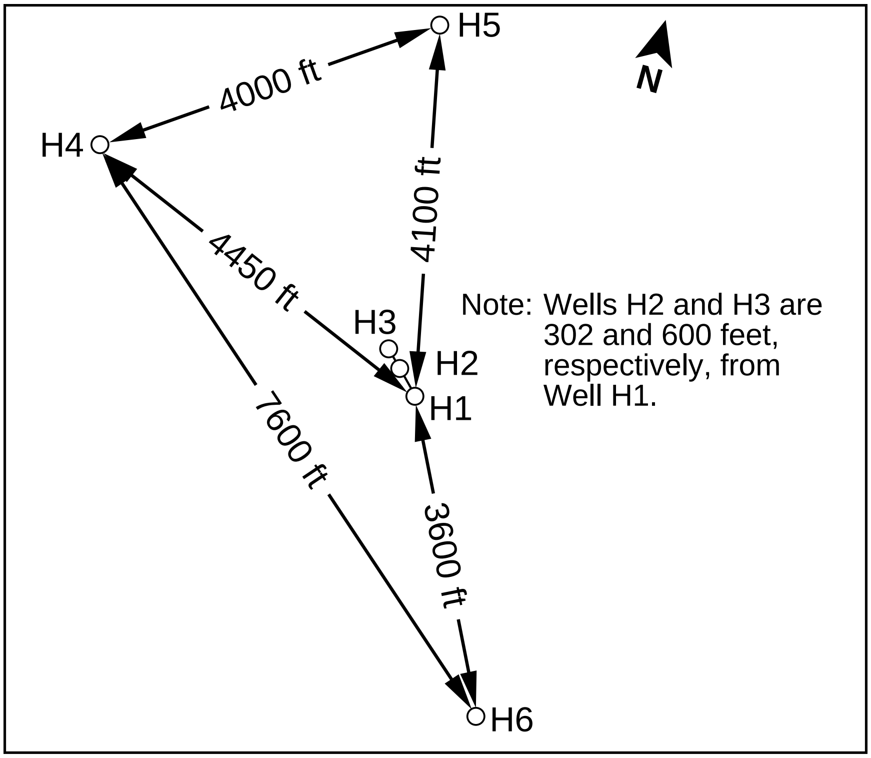

Fig. XIX-D. Locations of test holes used in the aquifer test in the Valle Toledo (Griggs 1955). See also Fig. XIX-A.

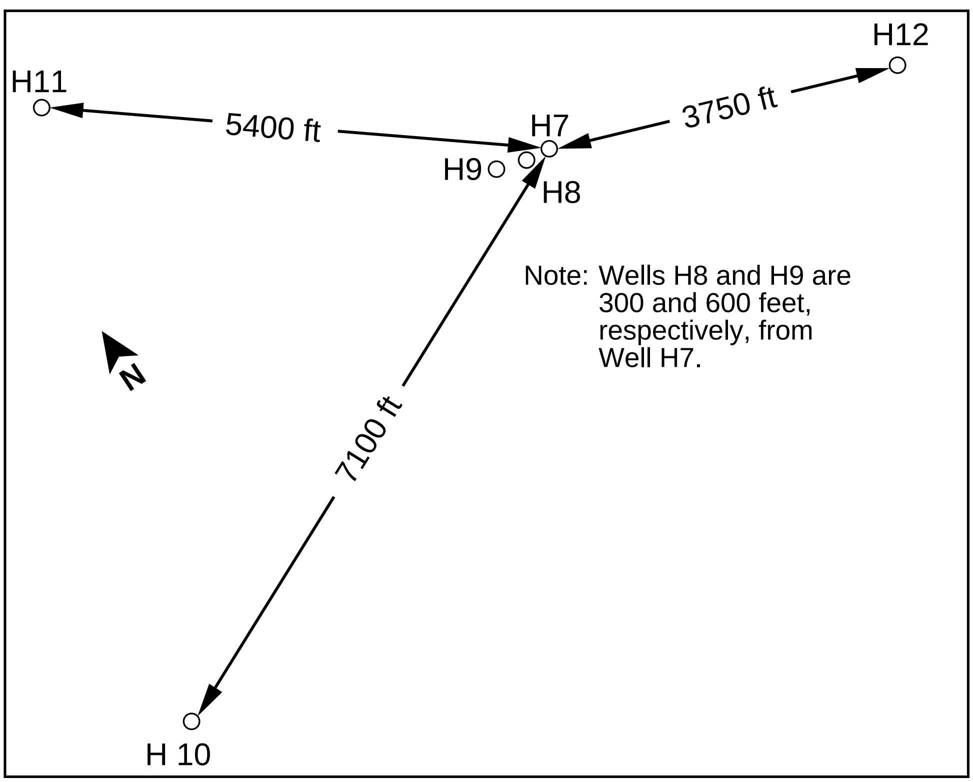

Fig. XIX-E. Locations of test holes used in the aquifer test in the Valle Grande (Griggs 1955). See also Fig. XIX-B.

TABLE XIX-A. Records of Test Holes in the Valle Toledo, Valle Grande, and Adjacent Areas

	Month Completed	Elevation LSD (ft)	Depth (ft)	Head of Pressure When Completed (+ft) Water Level below LSD (ft)	Remarks
Valle Toledo					
H-1	10/49	8650	652	+36	Specific capacity: 50 gpm/ft of drawdown
H-2	10/49	8648	410	+35	
H-3	10/49	8647	405	+38	
H-4	10/49	8603	285	-7.5	
H-5	10/49	8769	530	-71	
H-6	10/49	8684	444	+19	
Valle Grande					
H-7	11/49	8507	1185	+9.6	Specific capacity: 10 gpm/ft of drawdown
H-8	11/49	8506	595	+11	
H-9	11/49	8506	595	+11	
H-10	11/49	8491	589	+23	
H-11	11/49	8534	630	-16	
H-12	11/49	8545	634	-15	
Valle de los Posos					
H-13[a]	10/49	8930	800		Log—no mention of water
Divide					
H-14[a]	10/49	8990	420		Log—no mention of water
Valle Grande					
H-15[a]	10/49	9505	1269		Log—several water-bearing zones
East Rim of Caldera					
H-16[a]	1949	9505	1269		Log—no mention of water
Valle de los Posos					
H-17[a]	1949	9237	493		Log—no mention of water

Note: Test holes completed in caldera fill, except for H-16 and H-17 (completed in the Bandelier Tuff and Tschicoma Formation).

[a]No casing.
Source: Griggs 1955.

TABLE XIX-B. Geologic Logs and Casing Schedules of Test Holes in the Valle Toledo, Valle Grande, and Adjacent Areas (17 Test Holes)

1. Hole H-1

Location: Valle Toledo
Depth: 652 ft

Log	Thickness (ft)	Depth (ft)
Alluvium	12	12
Caldera fill	640	652
Water: 95 to 140 ft		
Water: 175 to 345 ft		
Water: 370 to 410 ft		

Casing Record
70 ft of 16-in.-diam surface casing cemented in 0 to 70 ft; 450 ft of 12-in.-diam casing with 40 ft of screen from 383 to 427 ft; 12-in.-diam casing perforated from: 80 to 120 ft; 125 to 150 ft; 170 to 240 ft; 265 to 300 ft; and 329 to 340 ft.

2. Hole H-2

Location: Valle Toledo
Depth: 410 ft

Log
Same as Hole H-1, 300 ft east

Casing Record
79 ft of 6-in.-diam surface casing cemented in 0 to 79 ft; 407 ft of 2-in.-diam tubing with 30-in. sandpoint at lower end, set 0 to 407 ft.

3. Hole H-3

Location: Valle Toledo
Depth: 405 ft

Log
Same as Hole H-1, 600 ft east

Casing Record
64 ft of 6-in.-diam casing cemented in 0 to 64 ft; 405 ft of 2-in.-diam tubing with 30-in. sandpoint at lower end, set 0 to 405 ft.

4. Hole H-4

Location: Valle Toledo
Depth: 285 ft

Log	Thickness (ft)	Depth (ft)
Alluvium	10	10
Caldera fill	275	285
Water: 115 to 210 ft		

Casing Record
49 ft of 6-in.-diam casing cemented in 0 to 49 ft; 240 ft of 4-in.-diam tubing with 30-in. sandpoint at lower end, set 0 to 240 ft.

TABLE XIX-B. Geologic Logs and Casing Schedules of Test Holes in the Valle Toledo, Valle Grande, and Adjacent Areas (17 Test Holes) (Continued)

5. Hole H-5

Location: Valle Toledo
Depth: 530 ft

Log	Thickness (ft)	Depth (ft)
Terrace material		
Gravel, sandy to silty, light gray	32	32
Caldera fill	498	530
Water: 320 to 530 ft		

Casing Record
99 ft of 6-in.-diam casing cemented in 0 to 99 ft; 527 ft of 2-in.-diam tubing with a 30-in. sandpoint on lower end set 0 to 530 ft.

6. Hole H-6

Location: Valle Toledo
Depth: 444 ft

Log	Thickness (ft)	Depth (ft)
Alluvium	5	5
Caldera fill	439	444
Water: 110 to 400 ft		

Casing Record
99 ft of 6-in.-diam casing cemented in 0 to 99 ft; 441 ft of 2-in.-diam tubing with 30-in. sandpoint on lower end, set 0 to 444 ft.

7. Hole H-7

Location: Valle Grande
Depth: 1185 ft

Log	Thickness (ft)	Depth (ft)
Alluvium	10	10
Caldera fill	1175	1185
Water: 300 to 860 ft		

Casing Record
66 ft of 16-in.-diam surface casing cemented in 0 to 66 ft; 595 ft 12-in.-diam casing with five 10-ft screen sections set up at intervals, 300 to 595 ft; the 12-in.-diam casing between the screen sections torch slotted.

8. Hole H-8

Location: Valle Grande
Depth: 595 ft

Log
Same as Hole H-7, 300 ft east

Casing Record
60 ft of 6-in.-diam casing cemented in 0 to 60 ft, 592 ft of 2-in.-diam tubing with 30-in. sandpoint at lower end, set 0 to 595 ft.

TABLE XIX-B. Geologic Logs and Casing Schedules of Test Holes in the Valle Toledo, Valle Grande, and Adjacent Areas (17 Test Holes) (Continued)

9. Hole H-9

Location: Valle Grande
Depth: 595 ft

Log
Same as Hole H-7, 700 ft east

Casing Record
67 ft of 6-in.-diam casing cemented in 0 to 67 ft; 592 ft of 2-in.-diam tubing with 30-in. sandpoint on lower end, set 0 to 595 ft.

10. Hole H-10

Location: Valle Grande
Depth: 589 ft

Log	Thickness (ft)	Depth (ft)
Alluvium	15	15
Caldera fill	574	589
Water: 205 to 589 ft		

Casing Record
65 ft of 6-in.-diam casing cemented in 0 to 65 ft; 581 ft of 2-in.-diam tubing with 30-in. sandpoint at lower end, set 0 to 584 ft.

11. Hole H-11

Location: Valle Grande
Depth: 630 ft

Log	Thickness (ft)	Depth (ft)
Terrace material,		
Sand and gravel, light gray to light buff	72	72
Caldera fill	558	630
Water: 275 to 305 ft		
Water: 310 to 630 ft		

Casing Record
88 ft of 6-in.-diam casing cemented in 0 to 88 ft; 622 ft of 2-in.-diam tubing with 30-in. sandpoint at lower end, set 0 to 625 ft.

12. Hole H-12

Location: Valle Grande
Depth: 634 ft

Log	Thickness (ft)	Depth (ft)
Terrace material		
Gravel, sandy, light buff	35	35
Caldera fill	599	634
Water: 212 to 634 ft		

12. Hole H-12 (Continued)

Casing Record
71 ft of 6-in.-diam casing cemented in 0 to 77 ft; 634 ft of 2-in.-diam tubing with 30-in. sandpoint at lower end, set 0 to 634 ft.

13. Hole H-13

Location: Valle de los Posos
Depth: 800 ft

Log	Thickness (ft)	Depth (ft)
Quaternary fan		
Gravel outwash, gray	30	30
Caldera fill	770	800
(no water)		

Casing Schedule
No casing.

14. Hole H-14

Location: Divide between the Valle Grande and the Valle de los Posos

Depth: 420 ft

Log	Thickness (ft)	Depth (ft)
Quaternary fan		
Gravel outwash, gray	97	97
Caldera Fill	311	408
Valle Rhyolite: rhyolite dome of pumiceous glass, sanidine, quartz, biotite, and hornblende	12	420
(no water)		

Casing Schedule
No casing.

15. Hole H-15

Location: Valle Grande
Depth: 600 ft

Log	Thickness (ft)	Depth (ft)
Quaternary fan		
Gravel outwash	7	7
Caldera fill	593	600
Water: 125 to 400 ft		

Casing Schedule
No casing.

TABLE XIX-B. Geologic Logs and Casing Schedules of Test Holes in the Valle Toledo, Valle Grande, and Adjacent Areas (17 Test Holes) (Continued)

16. Hole H-16

Location: East Rim of Caldera
Depth: 1269 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member	295	295
Bandelier Tuff		
Undifferentiated	332	627
Tschicoma Formation		
latite and quartz,	642	1269
latite flows		
(no water)		

Casing Schedule
No casing.

17. Hole H-17

Location: Valle de los Posos
Depth: 493 ft

Log	Thickness (ft)	Depth (ft)
Quaternary fan: gravel	10	10
Bandelier Tuff	413	423
Tschicoma Formation		
Latite flow	70	493
(no water)		

Casing Schedule
No casing.

Source: Griggs 1955.

TABLE XIX-C. Locations and Elevations (NAD 1927)

A. Valle Toledo			
H-1	N 1,802,400	E 437,200	8650 ft
H-2	N 1,802,700	E 436,900	8648 ft
H-3	N 1,802,900	E 436,700	8647 ft
H-4	N 1,803,900	E 432,900	8603 ft
H-5	N 1,806,600	E 436,000	8769 ft
H-6	N 1,799,600	E 438,900	8684 ft
B. Valle Grande			
H-7	N 1,769,900	E 439,200	8507 ft
H-8	N 1,769,900	E 438,900	8506 ft
H-9	N 1,770,000	E 438,600	8506 ft
H-10	N 1,766,600	E 432,700	8491 ft
H-11	N 1,773,100	E 434,800	8534 ft
H-12	N 1,768,700	E 442,700	8545 ft
C. Valle de los Posos			
H-13	N 1,790,900	E 450,500	8930 ft
D. Divide			
H-14	N 1,787,800	E 449,800	8990 ft
E. Valle Grande			
H-15	N 1,777,800	E 447,300	8595 ft
F. East Rim of Caldera			
H-16	N 1,790,900	E 457,700	9505 ft
G. Valle de los Posos			
H-17	N 1,792,100	E 457,100	9237 ft

Source: Griggs 1955.

XX. TEST HOLES ALONG THE RIO GRANDE AND LOWER LOS ALAMOS CANYON

Four test holes (the Rio Grande Tests) were drilled north of Otowi on the west side of the Rio Grande (Fig. XX-A). These holes, drilled in 1946, were completed to determine whether a ground water supply could be obtained from the alluvium along the river or from the sediments underlying the alluvium (Table XX-A). The holes ranged in depth from 53 to 497 ft. Limited saturation of the alluvium and the low permeability of the claystone, siltstone, and silty sandstone of the Tesuque Formation precluded their use as a water supply.

Five test holes (the Guaje Tests) were drilled west of Otowi in lower Los Alamos Canyon (Fig. XX-A). These holes were drilled in 1946 to determine whether a water supply could be developed from the alluvium or sediments underlying the alluvium (Table XX-A). The depth of these test holes ranged from 50 to 475 ft (Black and Veatch 1946, 1948). The alluvium in the canyon is too thin to provide an entire municipal supply on its own. Water flowed from the deeper test holes when completed. The sediments below the alluvium were considerably more permeable than those at the Rio Grande test holes, and the Los Alamos well field was developed in 1947 with the drilling and completion of wells LA-1, LA-2, and LA-3.

REFERENCES

Black and Veatch (Consulting Engineers, Kansas City, Mo.), “Report on Additional Water Supply Sources, Los Alamos, New Mexico,” report to the U.S. Atomic Energy Commission (two reports: 1946 and 1948).

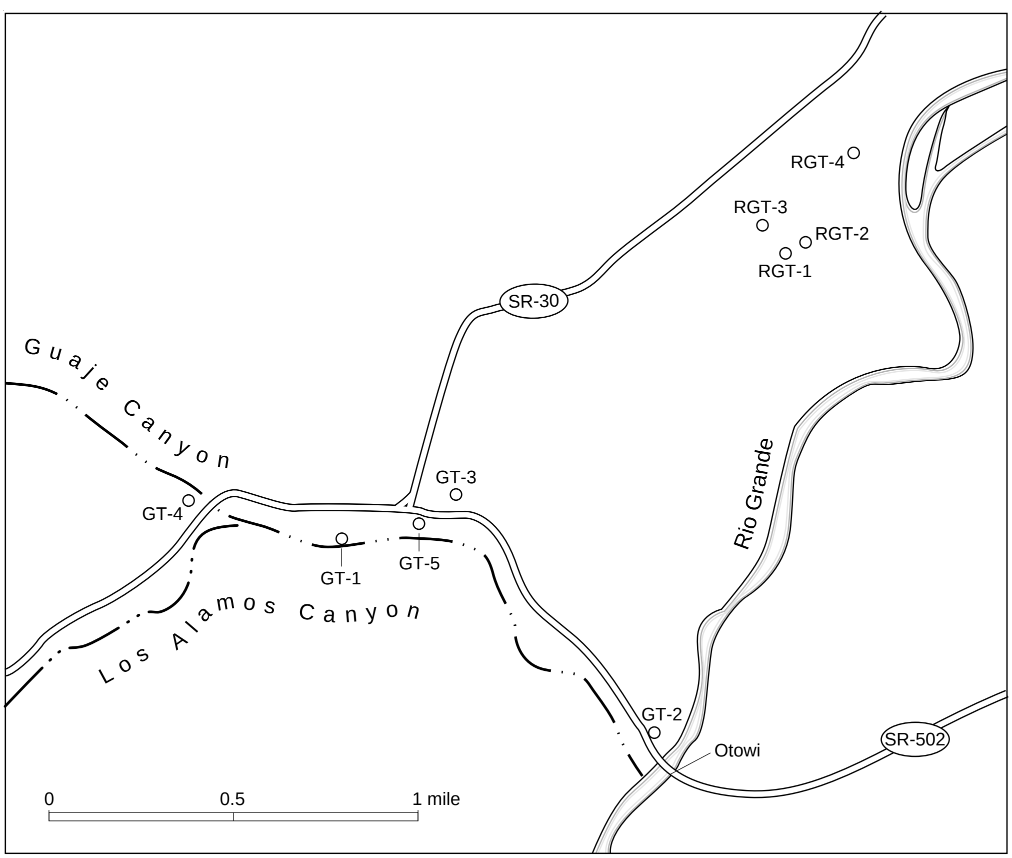

Fig. XX-A. Locations of Rio Grande and Guaje test holes.

TABLE XX-A. Geologic Logs and Construction Data of Rio Grande and Guaje Test Holes

	Month Drilled	Elevation (ft)	Depth (ft)	Casing	Geologic Log: Alluvium (ft)	Geologic Log: Tesuque Formation (ft)	Remarks
Rio Grande Tests							
RGT-1	2/46	5530	53	[a]	48	5	
RGT-2	2/46	5525	497	[a]	41	456	Water in alluvium
RGT-3	2/46	5545	495	[a]	68	427	Water in alluvium
RGT-4	2/46	5537	495	[a]	47	448	Water in alluvium
Guaje Tests							
GT-1	3/46	5624	400	[b]	78	322	Artesian (also known as well LA-1A)
GT-2	3/46	5560	50	[a]	40	10	
GT-3	3/46	5620	475	[a]	31	444	Artesian
GT-4	3/46	5675	315	[c]	54	261	Artesian (also known as well LA-3A)
GT-5	3/46	5609	475	[d]	38	475	Artesian (also known as Stop Sign well)

[a] Open hole.
[b] 6-in.-diam steel 0 to 76 ft; 4-in.-diam steel 0 to 400 ft.
[c] 2-in.-diam galvanized steel 0 to 315 ft; perforated 60 to 315 ft.
[d] 2-in.-diam galvanized steel 0 to undetermined depth (sounded 10/65 to 275 ft).

Source: Black and Veatch 1946, 1948.

TABLE XX-B. Locations and Elevations (NAD 1927)

A. Rio Grande Tests			
RGT-1	N 1,780,700	E 533,800	5530 ft
RGT-2	N 1,780,900	E 534,100	5525 ft
RGT-3	N 1,781,100	E 533,600	5545 ft
RGT-4	N 1,782,100	E 534,700	5537 ft
B. Guaje Tests (Lower Los Alamos Canyon)			
GT-1	N 1,776,800	E 527,700	5624 ft
GT-2	N 1,773,900	E 532,100	5560 ft
GT-3	N 1,777,300	E 529,200	5620 ft
GT-4	N 1,777,200	E 525,700	5675 ft
GT-5	N 1,776,900	E 528,800	5609 ft

Source: Black and Veatch 1946, 1948.

XXI. SUPPLY WELLS

Municipal and industrial water supply for the Laboratory and the communities of Los Alamos and White Rock is from four well fields: Los Alamos, Guaje, Pajarito, and Otowi (Fig. XXI-A). The wells in the fields range in depth from 870 ft in lower Los Alamos Canyon to 3093 ft on the Pajarito Plateau (Table XXI-A). Water levels at completion ranged from free-flowing in lower Los Alamos Canyon to over 1200 ft near the center of the plateau. The wells were completed in the main aquifer, the only aquifer in the area capable of municipal and industrial water supply.

A. Los Alamos Field

The Los Alamos Field was composed of seven wells, six completed in 1946–1948, the seventh added in 1960 (Fig. XXI-A). During the spring of 1992, production from the field was terminated. The relocation of State Road 502 crossed the transmission line. Due to the age of the wells, the production from the field had decreased to the point where it was not economically feasible to relocate the line. Pumps were removed from all wells except LA-2, which was used by the road contractor. Some of the wells were plugged and abandoned while others will be used for hydrologic data collection. Well LA-6 was taken off-line in 1977 due to excess amounts of naturally occurring arsenic.

Geologic logs for the seven supply wells are shown in Figs. XXI-B through XXI-H. Logs and construction data are presented in Table XXI-B. No record can be found of the surface casing for the six wells drilled 1946–1948. It could be assumed that surface casing was set through the alluvium into the Tesuque Formation to prevent fluid loss during drilling of the well and to allow gravel pack of the well upon completion of the drilling operation (Black and Veatch 1946, 1948, and 1951; Cushman 1965).

B. Guaje Field

The Guaje Field is composed of seven wells, six completed in the period 1950 to 1952, the seventh well added in 1964 (Fig. XXI-A and Table XXI-C). Only six wells are operational; however, the yield has declined in several of the wells so that they are not pumped except when there is heavy water demand. The well casing failed in well G-3, and when water is pumped from it, gravel pack and sand enter the well, reducing its usability.

Geologic logs for the six wells are presented in Figs. XXI-I through XXI-O. No record can be found of the surface casing of the wells drilled 1950 to 1952. Surface casing, as stated in the previous section, is probably set through the alluvium and friable fanglomerate member into the consolidated Tesuque Formation (Black and Veatch 1951; Cushman 1965; Cooper et al. 1965).

C. Pajarito Field

The Pajarito Field is composed of five wells, three completed 1964 to 1967, one added in 1981, and another in 1982 (Fig. XXI-A and Table XXI-A). All wells are operational (Cooper et al. 1965; Purtymun 1967; Purtymun et al. 1983 and 1984).

Geologic logs and construction data are presented in Table XXI-D. Geologic logs are also shown in Figs. XXI-P through XXI-T. All wells have surface casing that extends to or near the top of the main aquifer. This casing is cemented in from the bottom, to prevent surface contamination from reaching the main aquifer.

D. Otowi Field

The Otowi Field is composed of two supply wells that were completed in 1990 (Fig. XXI-A and Table XXI-A). These wells are not equipped with pumps, nor are the storage reservoirs and transmission lines complete. Geologic logs and construction data are presented in Table XXI-E. Geologic logs of the two wells are shown in Figs. XXI-U and XXI-V (Stoker et al. 1992). The wells have casing that extends from the land surface to near the top of the main aquifer. The casing is cemented in from the bottom to prevent surface contamination from reaching the main aquifer.

E. Water Supply Reports

A summary report (1947–1971) and annual reports related to well and well-field characteristics have been published to ensure a continuing historical record and to provide guidance for the management of water resources in long-range planning for the water supply system.

1947–1971 data: LA-5040-MS, November 1972
1971 data: LA-5039-MS, October 1972
1972 data: LA-5296-MS, December 1973
1973 data: LA-5636-MS, June 1974
1974 data: LA-5998-MS, June 1975
1975 data: LA-6461-PR, September 1976
1976 data: LA-6814-PR, May 1977
1977 data: LA-7436-MS, August 1978
1978 data: LA-8074-PR, October 1979
1979 data: LA-8504-PR, August 1980
1980 data: LA-9007-PR, September 1981
1981 data: LA-9734-PR, May 1983
1982 data: LA-9896-PR, January 1984
1983 data: LA-10327-PR, February 1985
1984 data: LA-10584-PR, January 1986
1985 data: LA-10835-PR, October 1986
1986 data: LA-11046-PR, August 1987
1987 data: LA-11478-PR, January 1989
1988 data: LA-11679-PR, October 1989
1989 data: LA-12276-PR, May 1992
1990 data: LA-12471-PR, February 1993
1991 data: LA-12770-PR, June 1994

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Black and Veatch, "Report on Additional Water Supply Sources, Los Alamos, New Mexico," Consulting Engineers, Kansas City, Mo., report to the U.S. Atomic Energy Commission (three reports: 1946, 1948, and 1951).

R. L. Cushman, "An Evaluation of Aquifer and Well Characteristics of Municipal Well Fields in the Los Alamos and Guaje Canyons Near Los Alamos, New Mexico," U.S. Geol. Survey Water-Supply Paper 1809-D (1965).

J. B. Cooper, W. D. Purtymun, and E. C. John, "Records of Water-Supply Wells Guaje Canyon 6, Pajarito Mesa 1, and Pajarito Mesa 2, Los Alamos, New Mexico, Basic Data Report," U.S. Geol. Survey Open-File Report (1965).

R. L. Griggs, "Geology and Water Resources of the Los Alamos Area, New Mexico," U. S. Geological Survey Admin. Report to the U. S. Atomic Energy Commission (1955).

W. D. Purtymun, "Record of Water-Supply Well PM-3, Los Alamos New Mexico," U.S. Geol. Survey Open-File Report (1967).

W. D. Purtymun, N. M. Becker, and M. Maes, "Water Supply at Los Alamos During 1981," Los Alamos National Laboratory report LA-9734-PR (1983).

W. D. Purtymun, N. M. Becker, and M. Maes, "Water Supply at Los Alamos During 1982," Los Alamos National Laboratory report LA-9896-PR (1984).

W. D. Purtymun, A. Stoker, S. McLin, M. Maes, and G. Hammock, "Water Supply at Los Alamos During 1990," Los Alamos National Laboratory report LA-12471-PR (1993).

A. Stoker, S. McLin, W. D. Purtymun, M. Maes, and G. Hammock, "Water Supply at Los Alamos During 1989," Los Alamos National Laboratory report LA-12276-PR (1992).

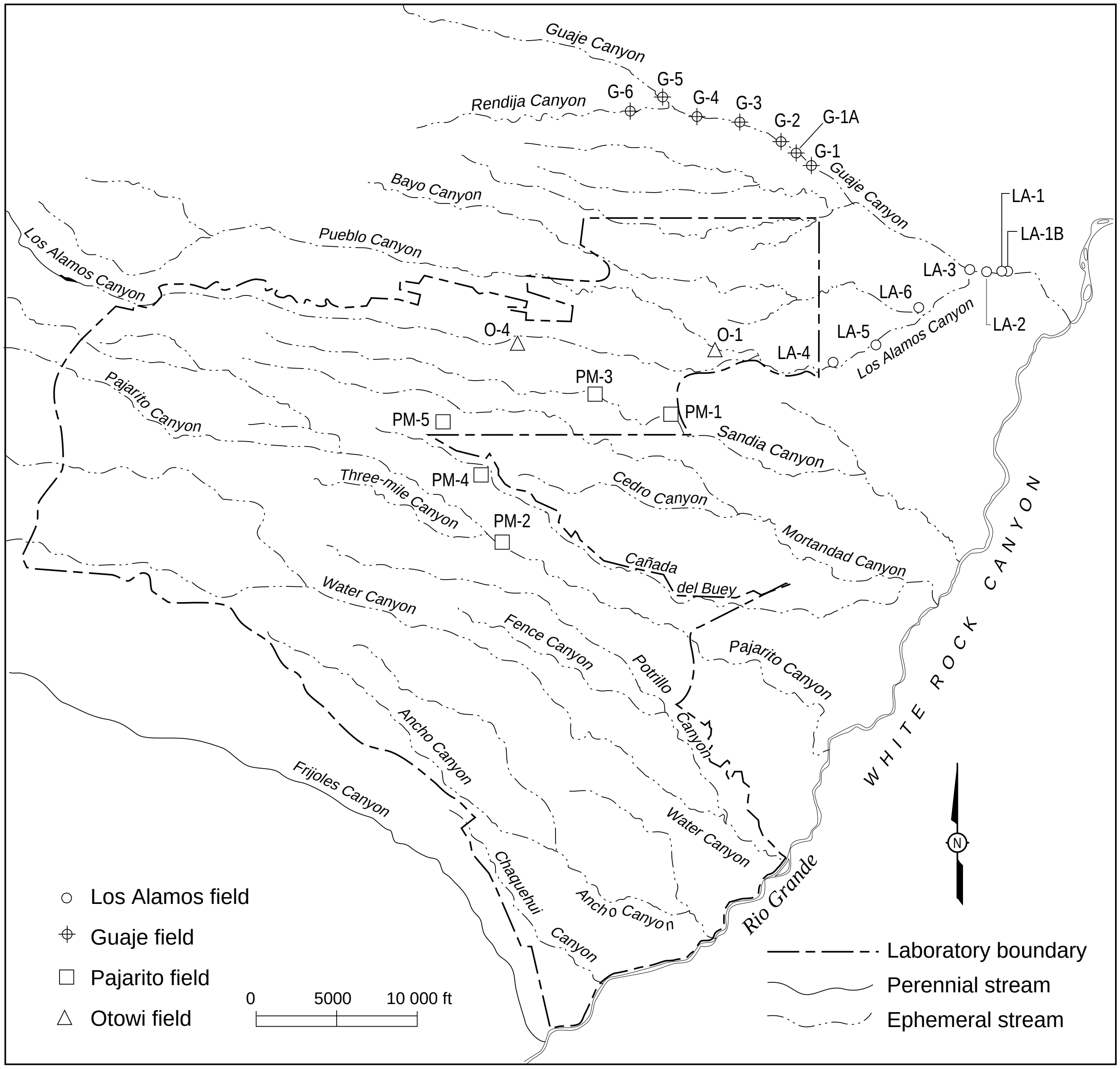


Fig. XXI-A. Locations of supply wells in the Los Alamos, Guaje, Pajarito, and Otowi well fields.

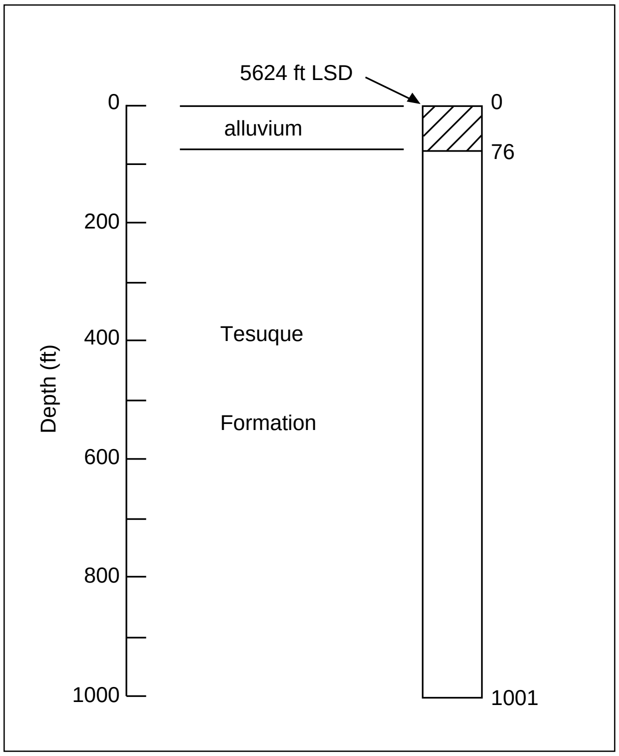


Fig. XXI-B. Geologic log of supply well LA-1, completed November 1946, flowing (Black and Veatch 1948; Cushman 1965).

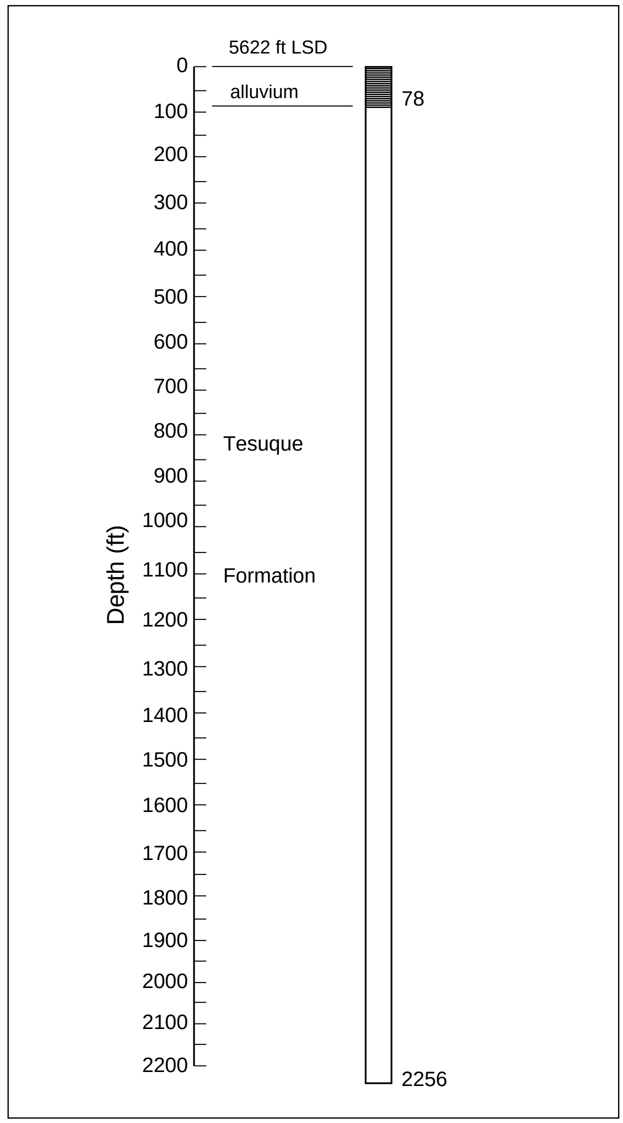


Fig. XXI-C. Geologic log of supply well LA-1B, completed May 1960, flowing (Cushman 1965).

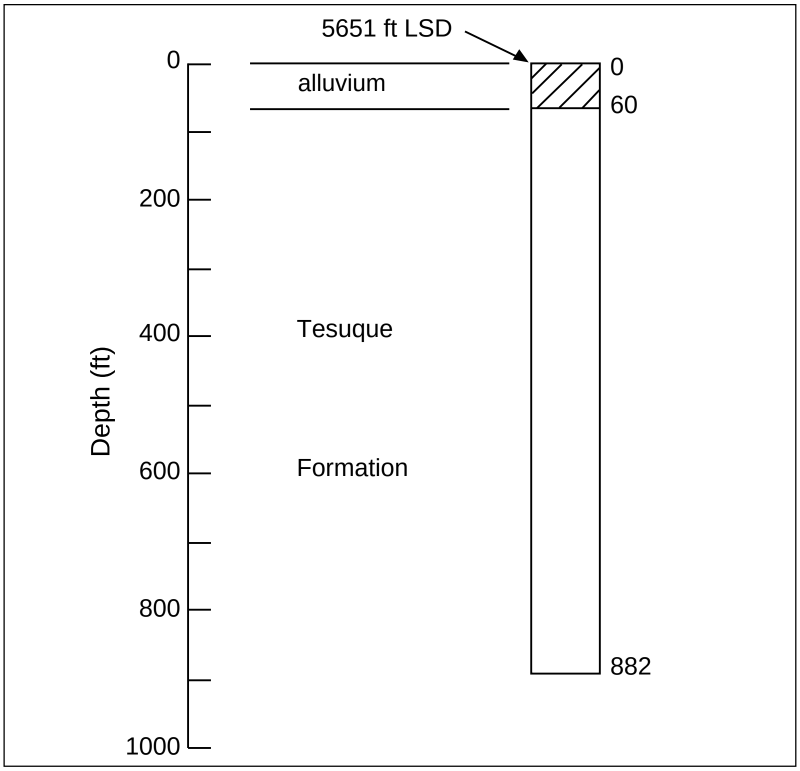


Fig. XXI-D. Geologic log of supply well LA-2, completed December 1946, flowing (Black and Veatch 1948; Cushman 1965).

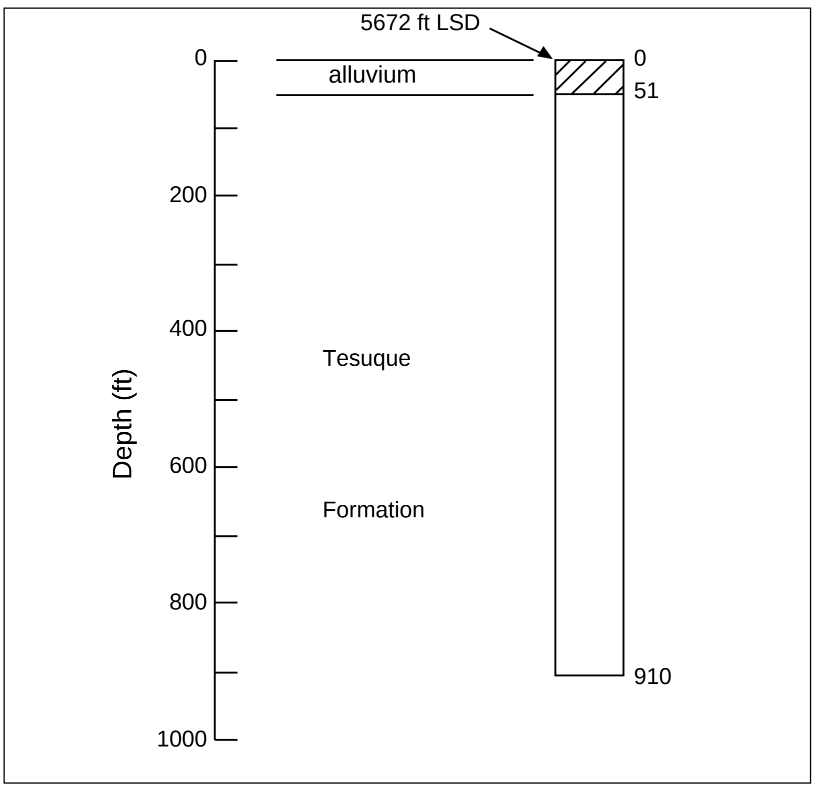


Fig. XXI-E. Geologic log of supply well LA-3, completed May 1947, flowing (Black and Veatch 1948; Cushman 1965).

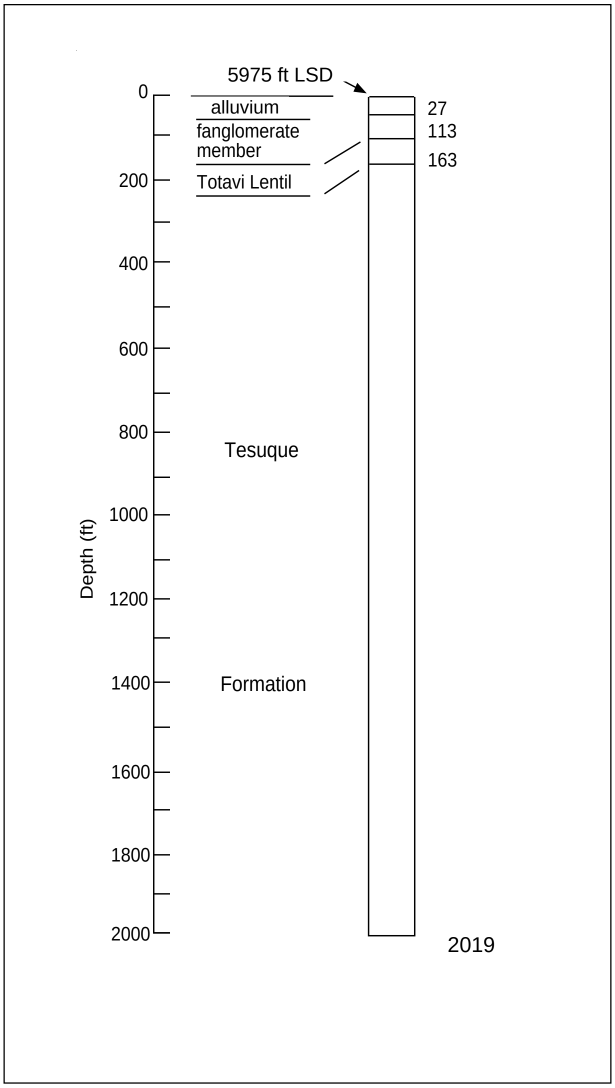


Fig. XXI-F. Geologic log of supply well LA-4, completed July 1948, water level 189 ft (Black and Veatch 1951; Cushman 1965).

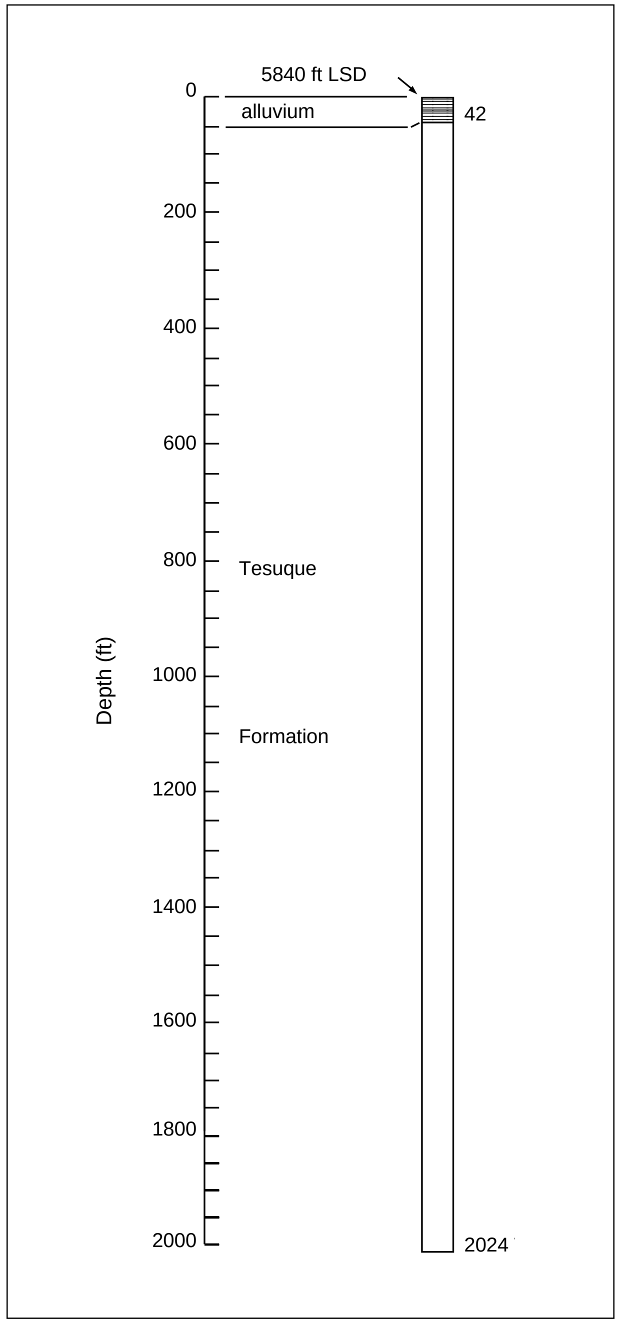


Fig. XXI-G. Geologic log of supply well LA-5, completed September 1948, water level 71 ft (Black and Veatch 1951; Cushman 1965).

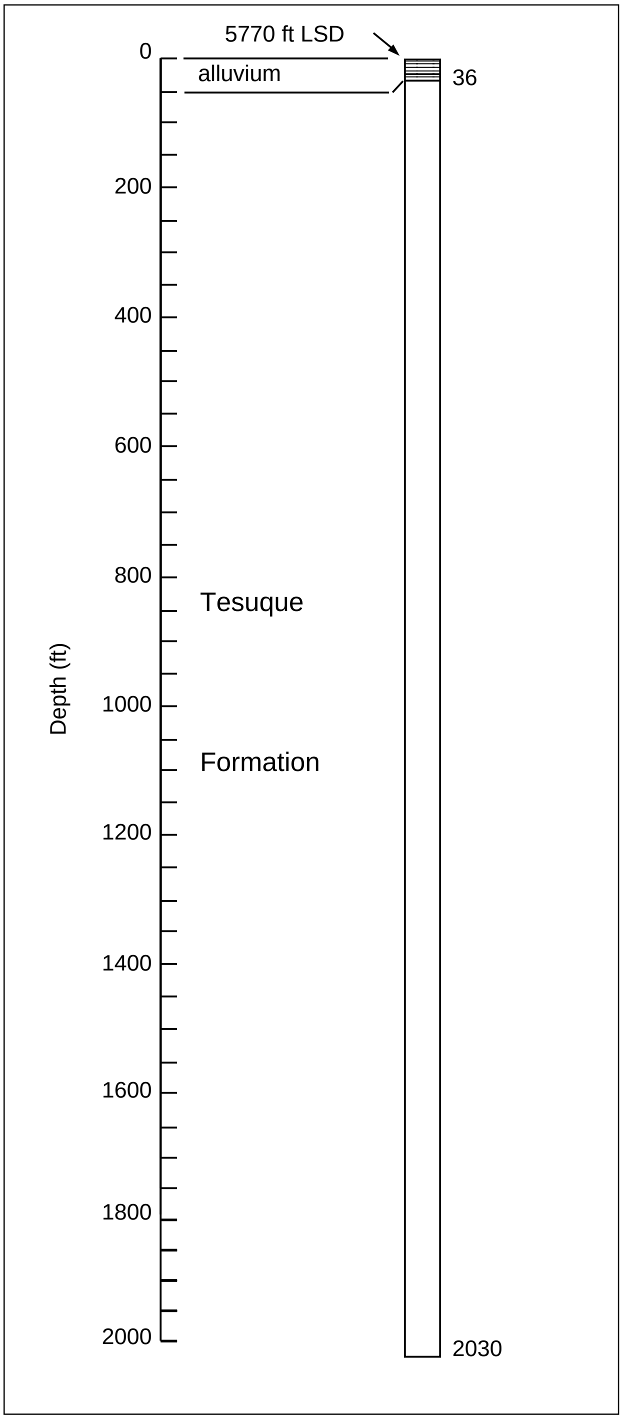


Fig. XXI-H. Geologic log of supply well LA-6, completed December 1948, water level 2 ft (Black and Veatch 1951; Cushman 1965).

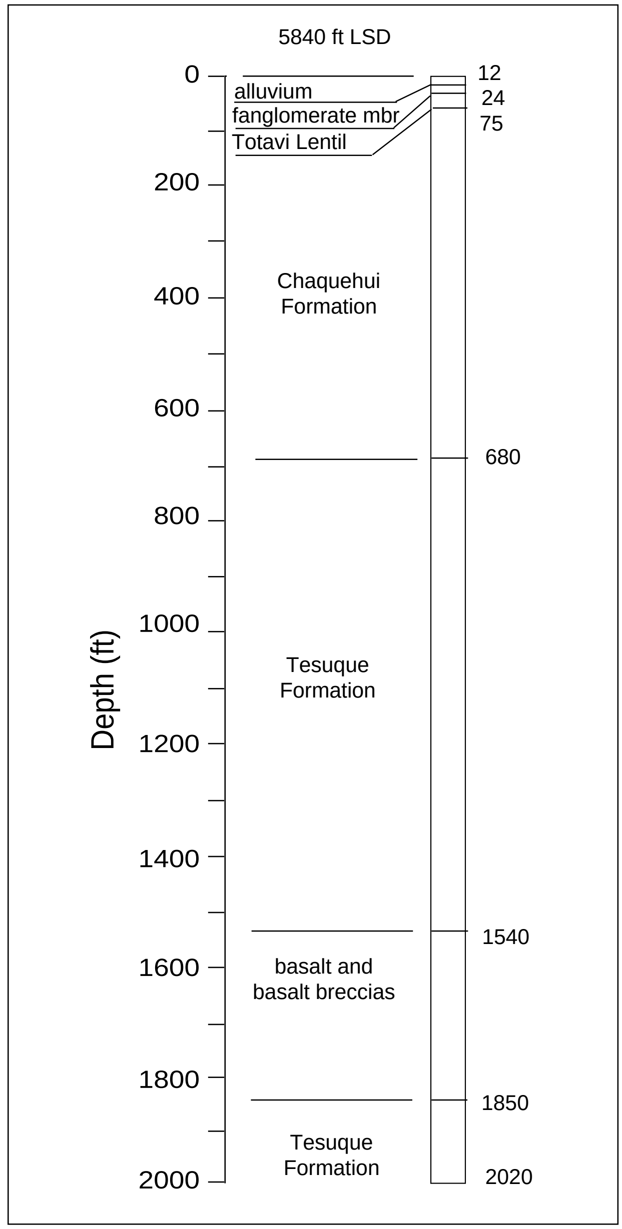


Fig. XXI-I. Geologic log of supply well G-1, completed July 1950, water level 192 ft (Black and Veatch 1951; Griggs 1955; and Cushman 1965: modified by Purtymun for this report).

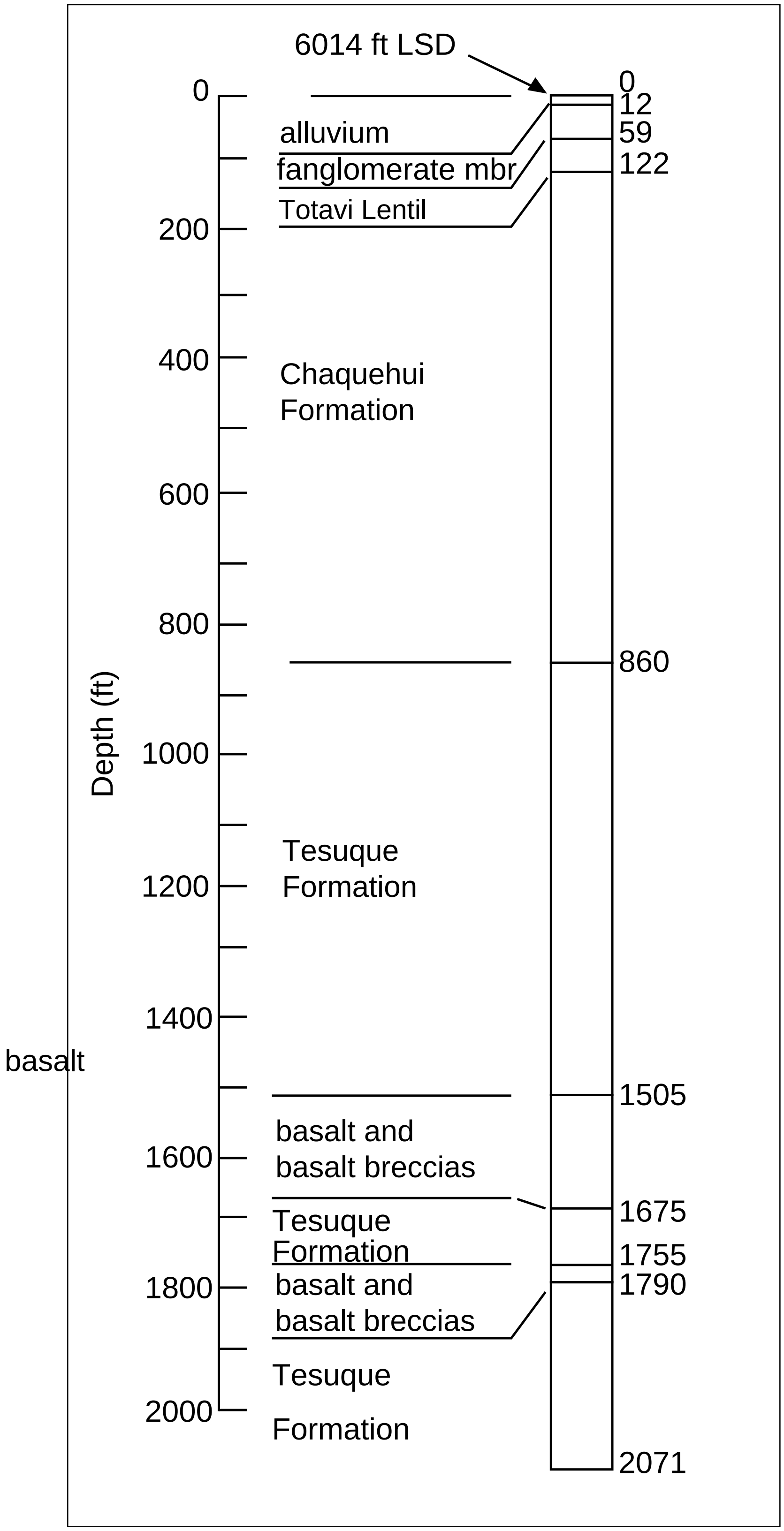


Fig. XXI-J. Geologic log of supply well G-1A, completed October 1954, water level 250 ft (Cushman 1965, modified by Purtymun for this report).

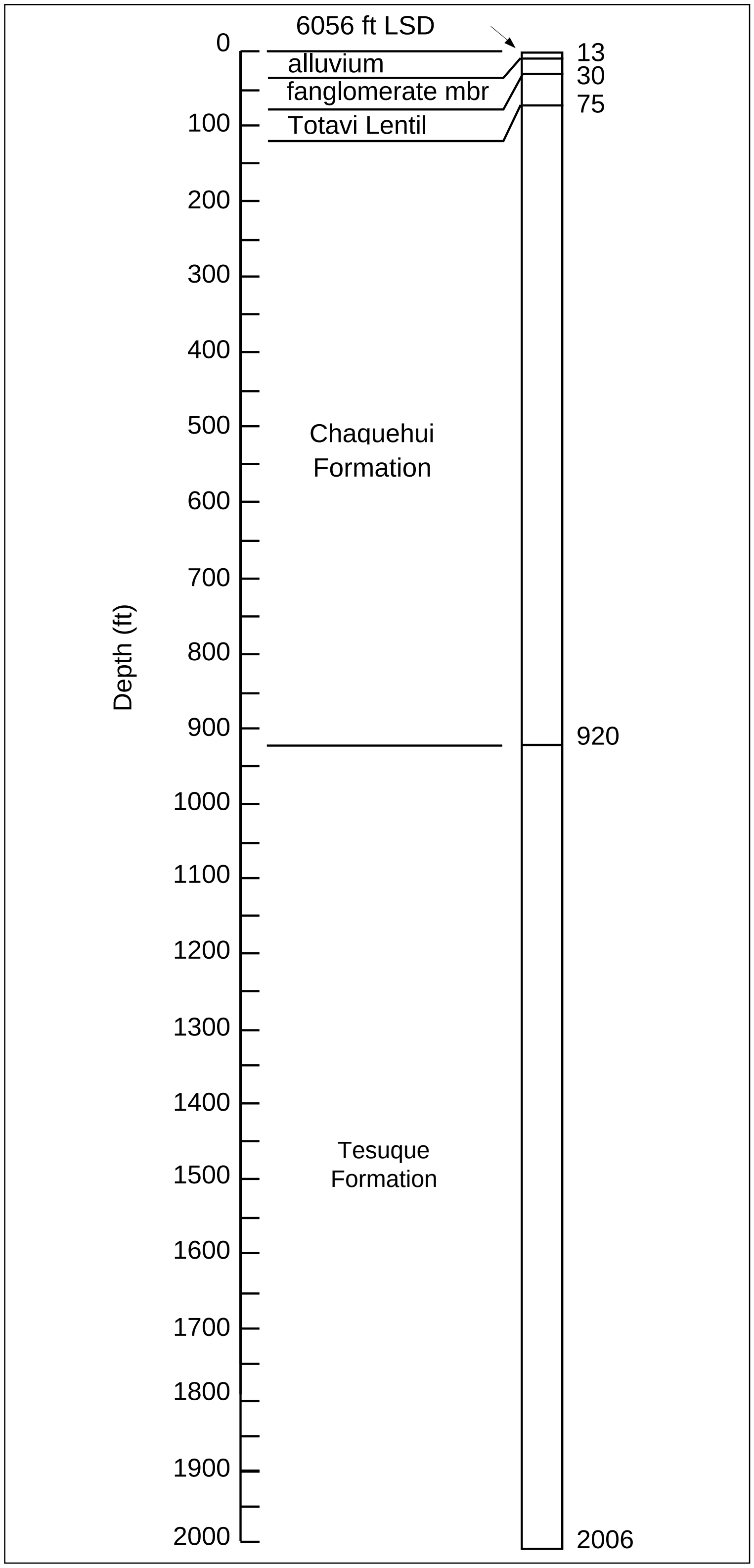


Fig. XXI-K. Geologic log of supply well G-2, completed August 1951, water level 259 ft (Black and Veatch 1951; Griggs 1955; Cushman 1965: modified by Purtymun for this report).

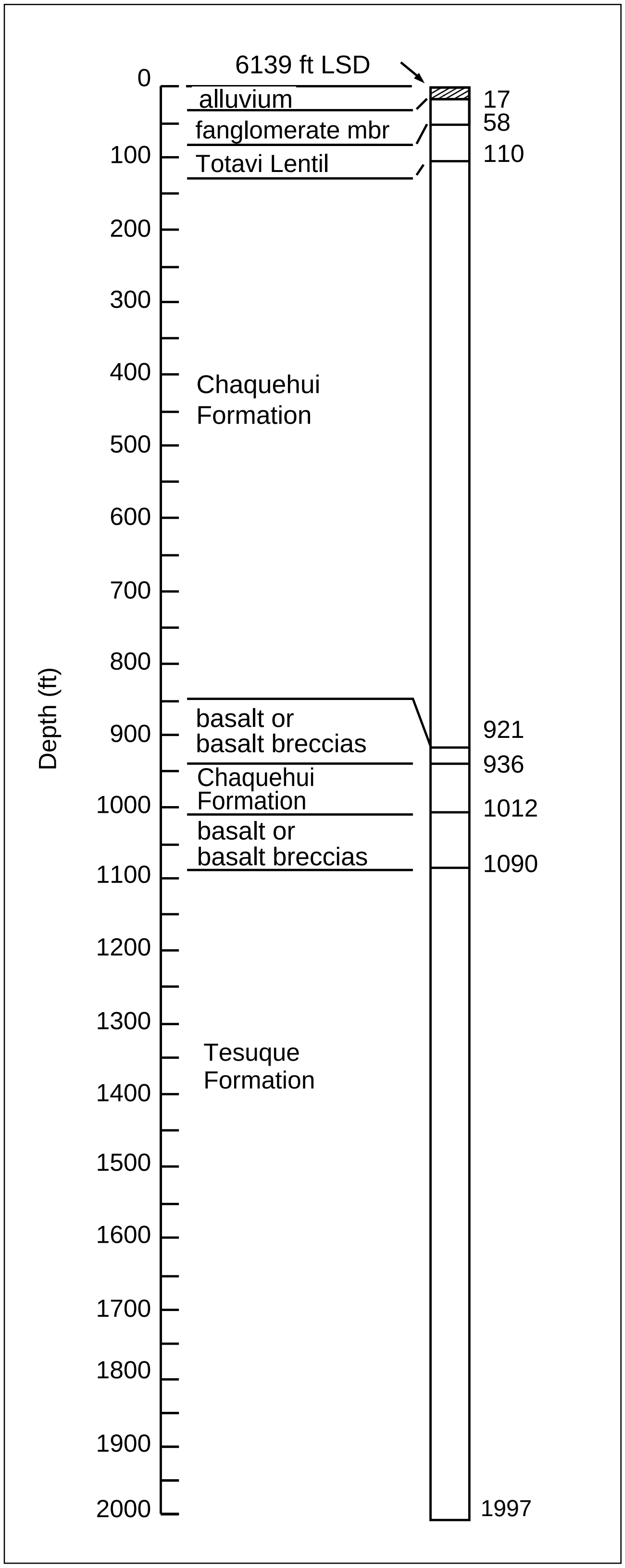


Fig. XXI-L. Geologic log of supply well G-3, completed July 1951, water level 280 ft (Black and Veatch 1951; Griggs 1955; Cushman 1965: modified by Purtymun for this report).

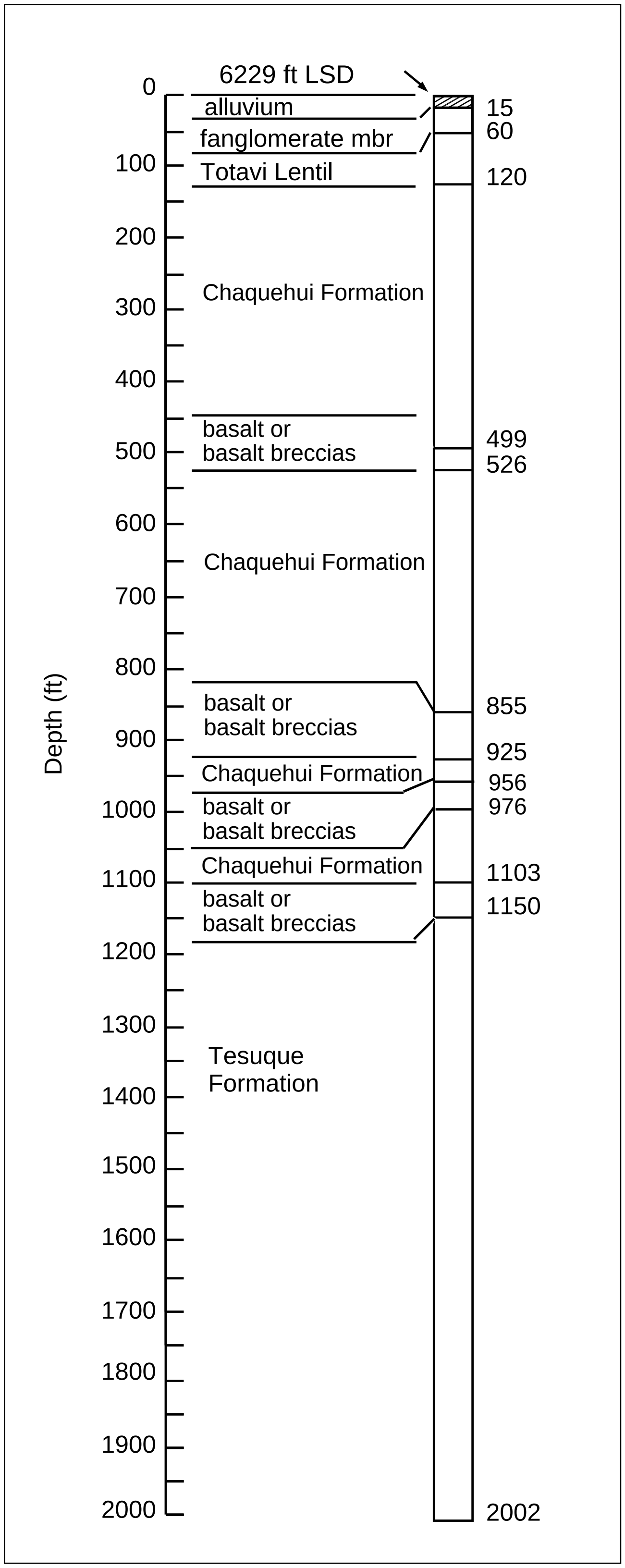


Fig. XXI-M. Geologic log of supply well G-4, completed May 1951, water level 347 ft (Black and Veatch 1951; Griggs 1955; Cushman 1965: modified by Purtymun for this report).

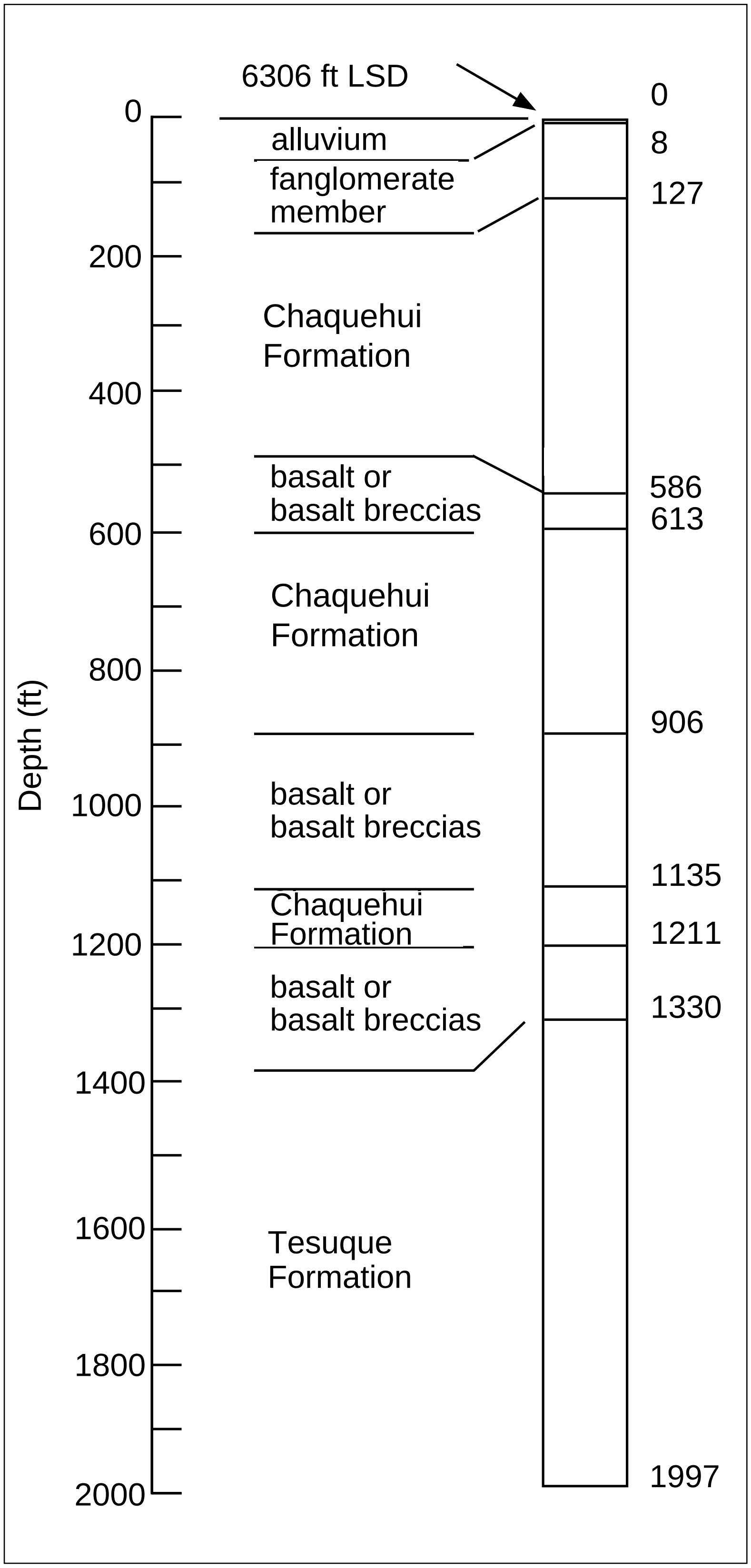


Fig. XXI-N. Geologic log of supply well G-5, completed May 1951, water level 411 ft (Black and Veatch 1951; Griggs 1955; Cushman 1965: modified by Purtymun for this report).

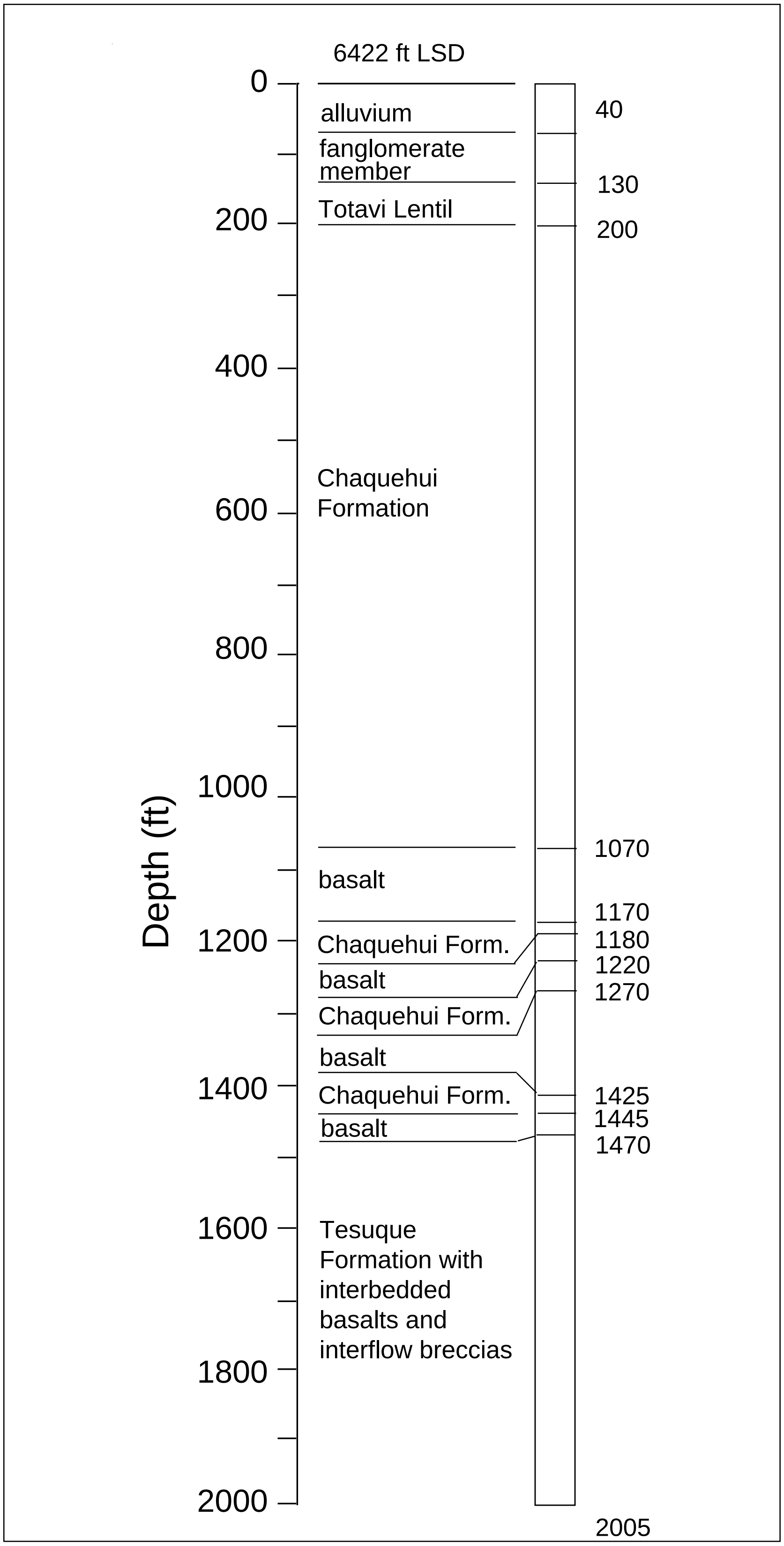


Fig. XXI-O. Geologic log of supply well G-6, completed March 1964, water level 572 ft (Cooper et al. 1965, modified by Purtymun for this report).

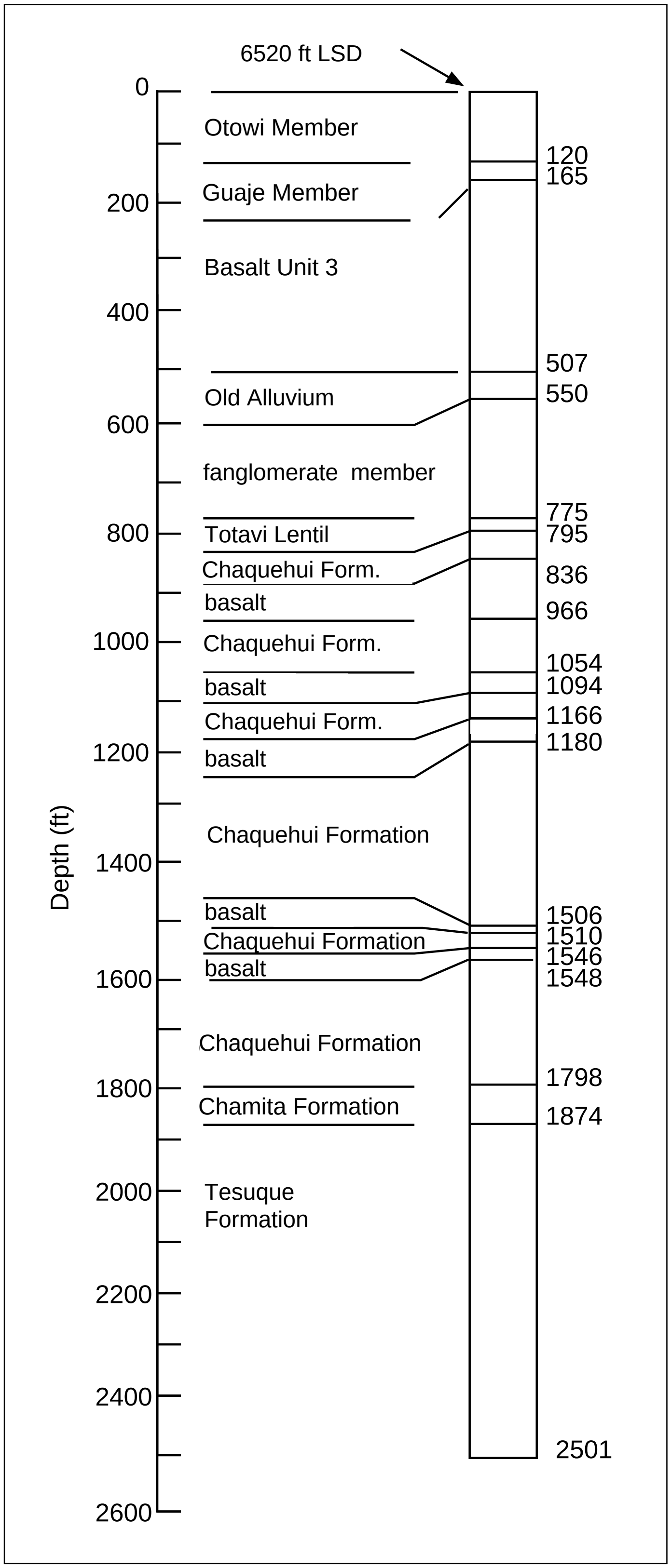


Fig. XXI-P. Geologic log of supply well PM-1, completed February 1965, water level 722 ft (Cooper et al. 1965, modified by Purtymun for this report).

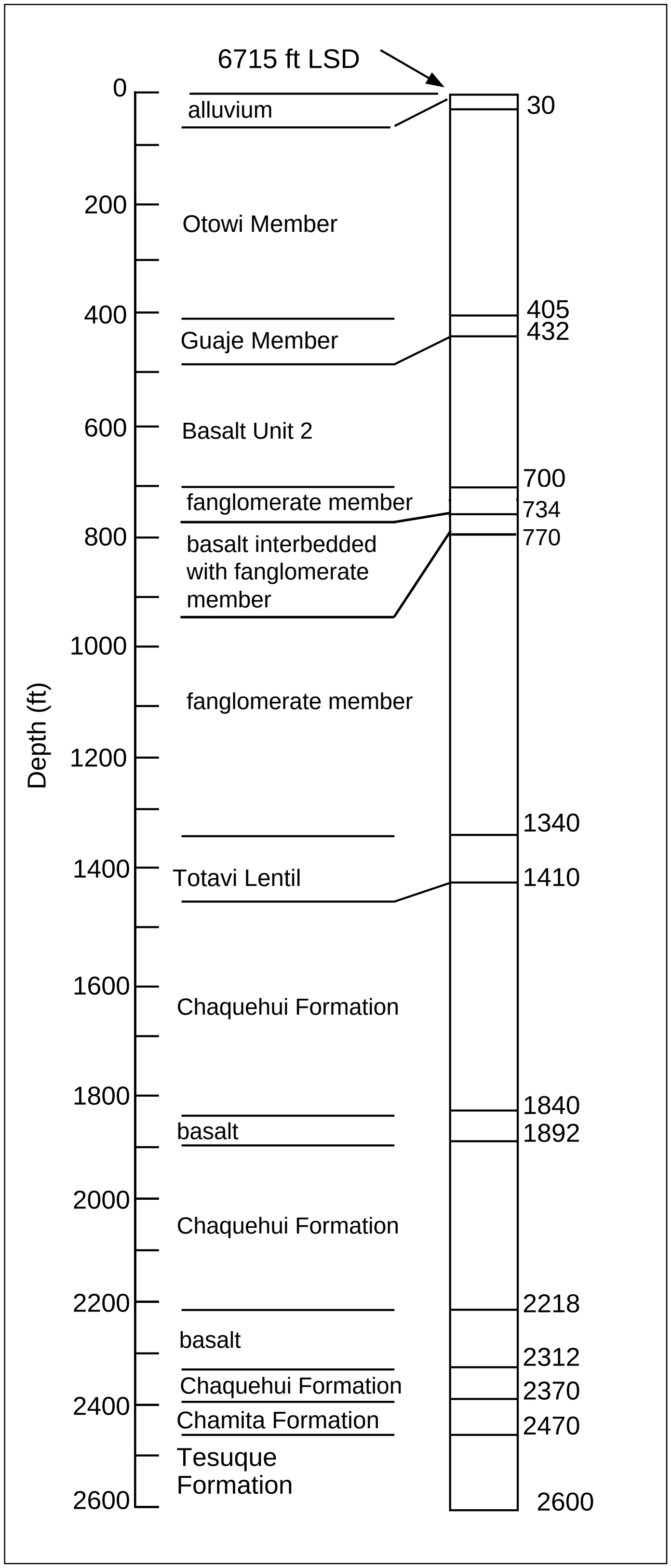


Fig. XXI-Q. Geologic log of supply well PM-2, completed July 1965, water level 823 ft (Cooper et al. 1965, modified by Purtymun for this report).

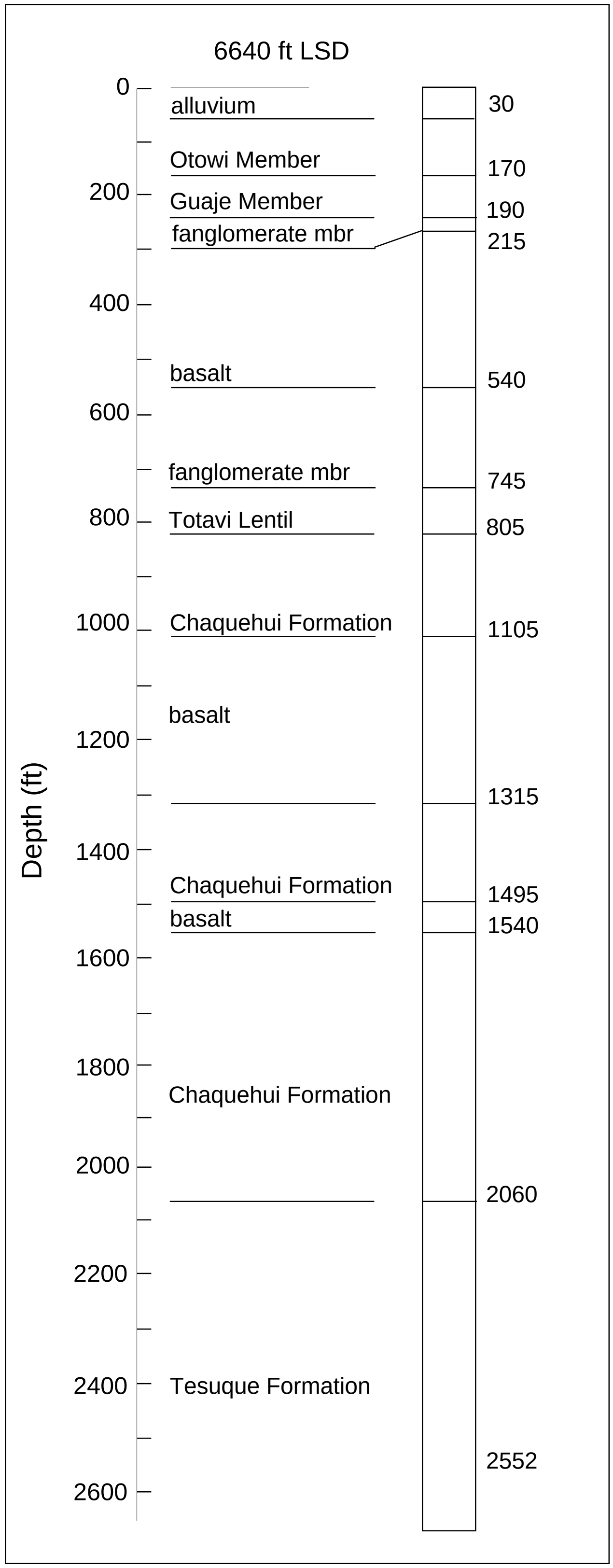


Fig. XXI-R. Geologic log of supply well PM-3, completed November 1966, water level 740 ft (Purtymun 1967, modified by Purtymun for this report).

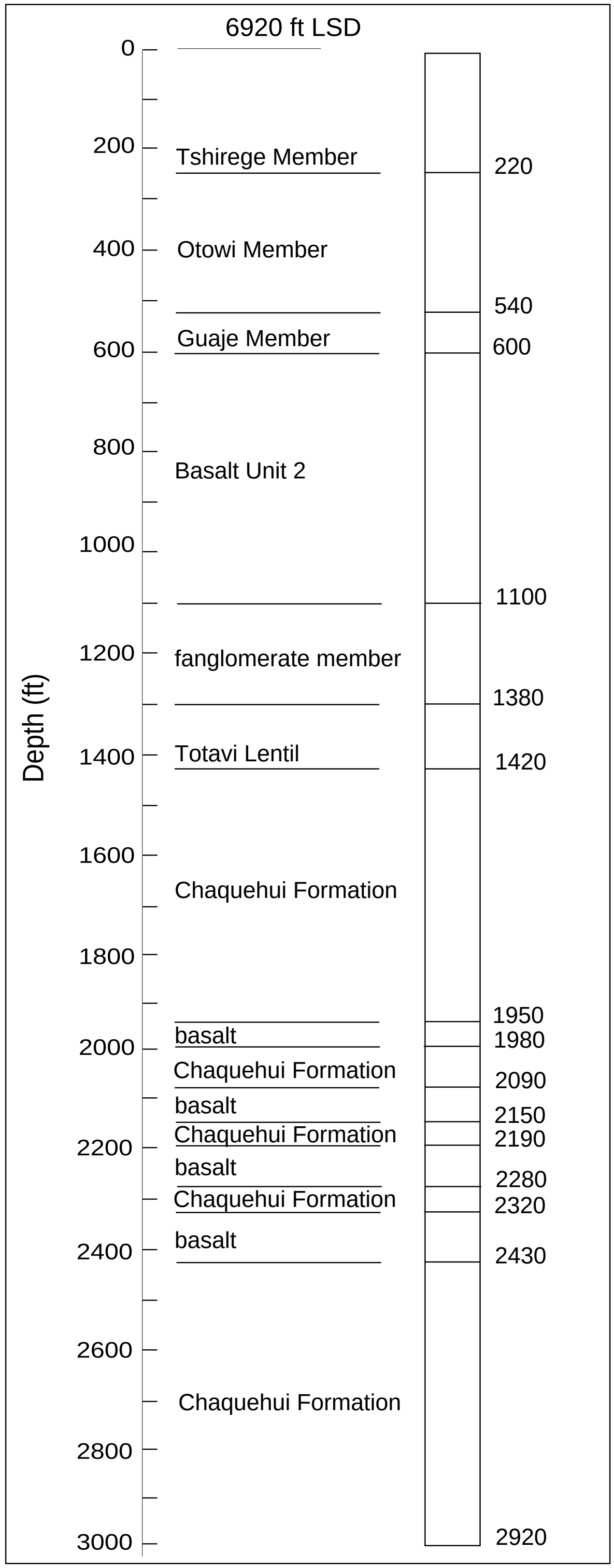


Fig. XXI-S. Geologic log of supply well PM-4, completed August 1981, water level 1060 ft (Purtymun et al. 1983, modified by Purtymun for this report).

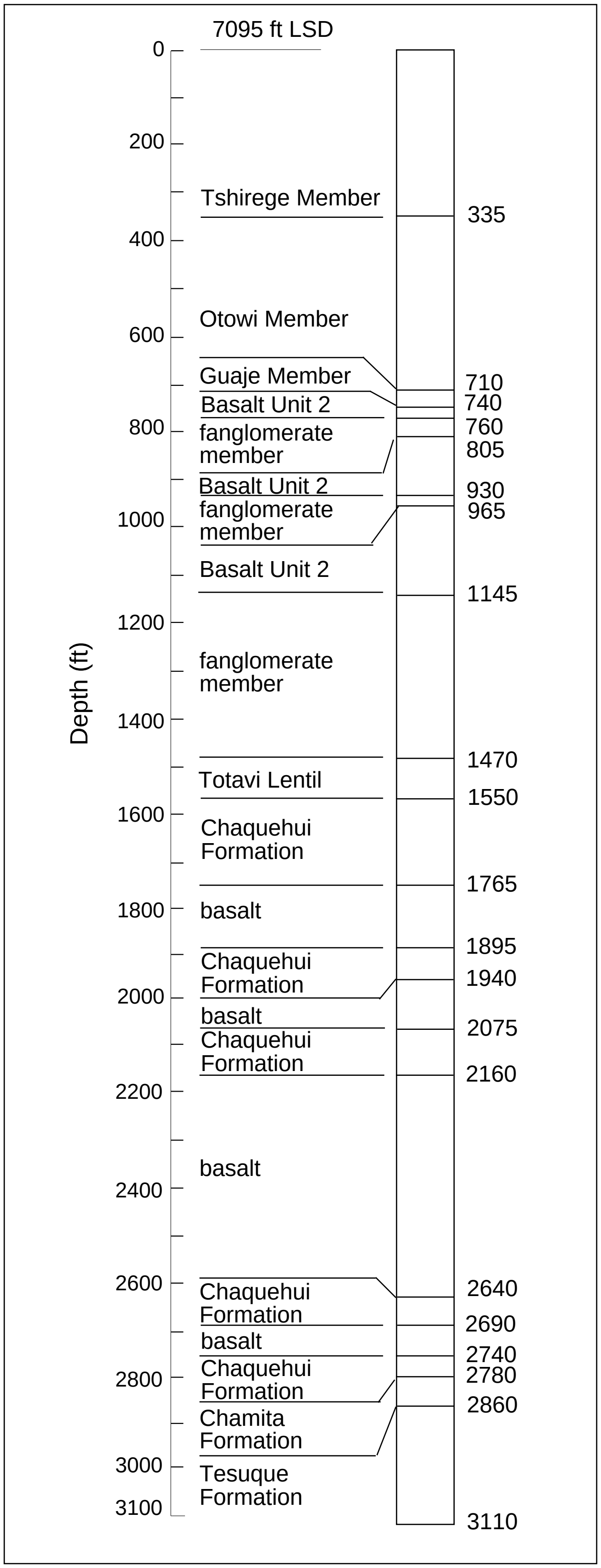


Fig. XXI-T. Geologic log of supply well PM-5, completed September 1982, water level 1208 ft (Purtymun et al. 1984, modified by Purtymun for this report).

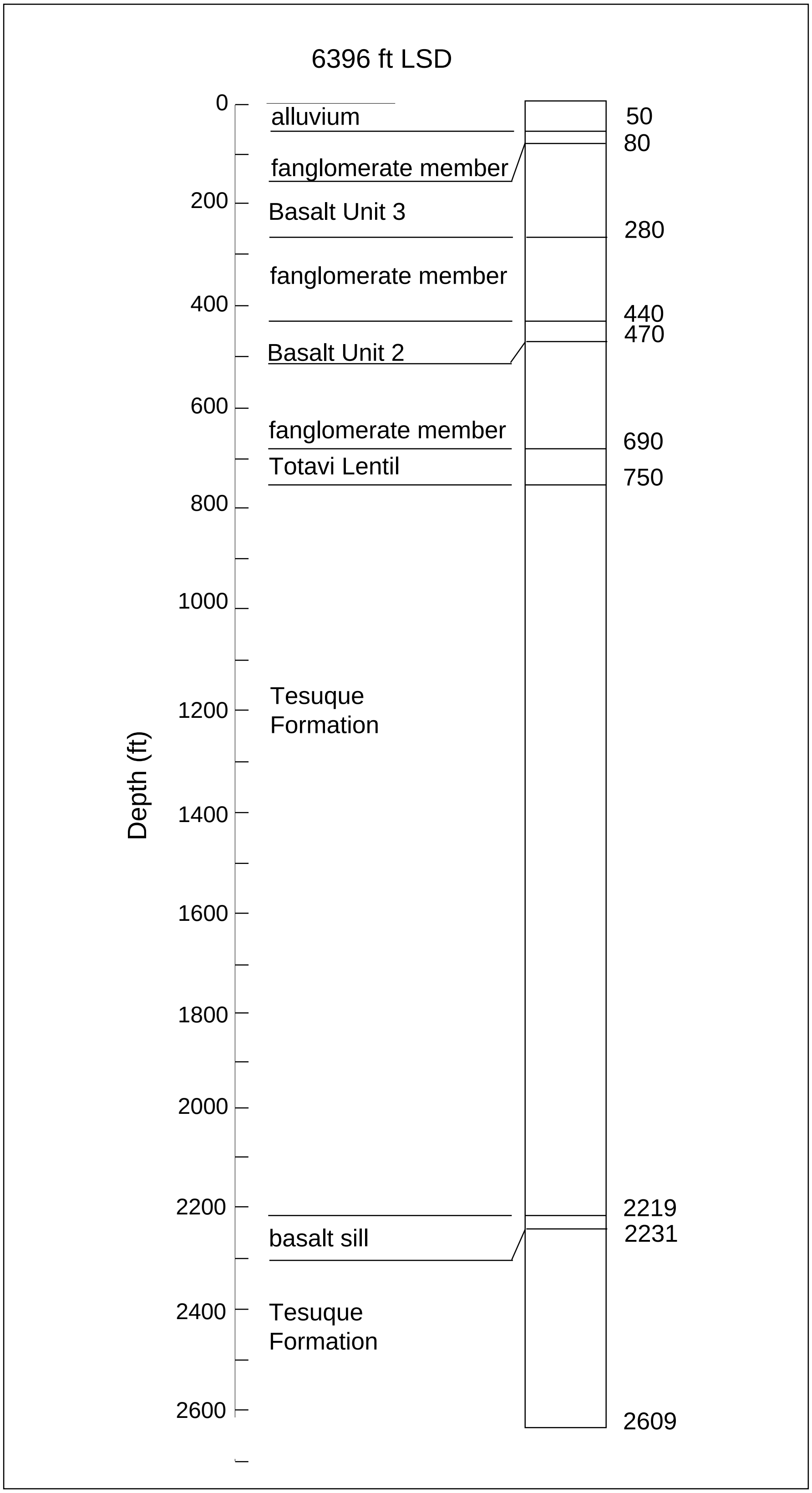


Fig. XXI-U. Geologic log of supply well O-1, completed July 1990, water level 673 ft (Purtymun et al. 1993).

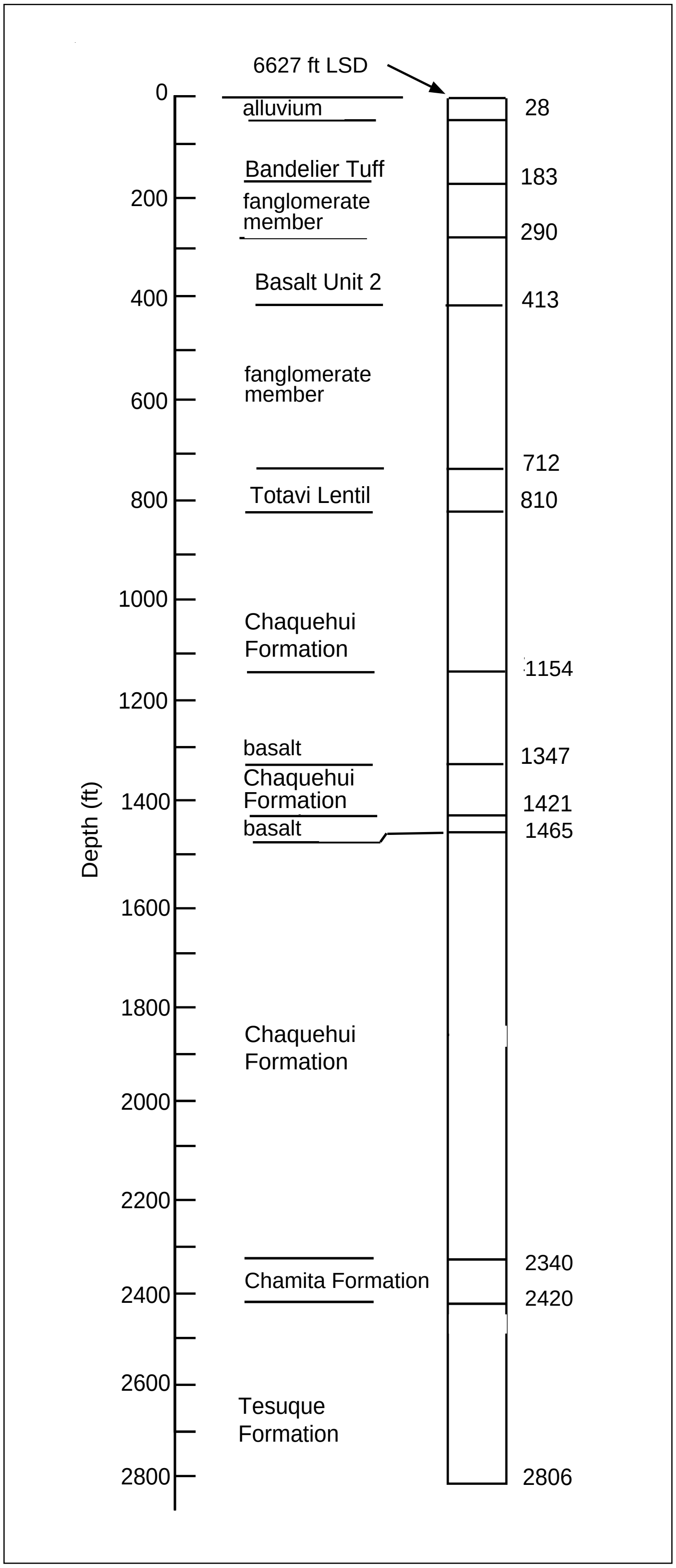


Fig. XXI-V. Geologic log of supply well O-4, completed April 1990, water level 780 ft (Stoker et al. 1992, modified by Purtymun for this report).

TABLE XXI-A. Construction Data and Hydrologic Characteristics of Supply Wells in the Los Alamos, Guaje, Pajarito, and Otowi Well Fields

	Construction				Hydrologic Characteristics				
	Year Completed	Depth Drilled (ft)	Depth Cased (ft)	Depth Open[a]	Year	Head of Pressure When Cased (+ft) or Water Level (ft) below LSD	Current Water Level (ft)	Yield (gpm)	Specific Capacity gpm/ft	Remarks
Los Alamos Well Field										
Well LA-1	1946	1001	870	598	1960	F (1946)	84 (1990)	366	0.8	unequipped (1990)
Well LA-1B	1960	2256	1750	1655	1983	+34 (1960)	70 (1990)	561	4.4	unequipped (1992)
Well LA-2	1946	882	870	878	1962	F (1946)	134 (1990)	280	1.4	
Well LA-3	1947	910	870	816	1983	F (1947)	122 (1990)	302	1.7	unequipped (1992)
Well LA-4	1948	2019	1964	1907	1988	189 (1948)	284 (1986)	552	5.9	unequipped (1990)
Well LA-5	1948	2024	1750	1954	1962	71 (1948)	168 (1986)	419	2.9	unequipped (1994)
Well LA-6	1948	2030	1710	1200	1976	2 (1948)	92 (1985)	580	10.2	unequipped (1990)
Guaje Well Field										
Well G-1	1950	2020	2000	1750	1962	192 (1951)	284 (1990)	241	1.4	
Well G-1A	1954	2071	1519	1500	1973	250 (1954)	322 (1990)	499	12.4	
Well G-2	1951	2006	1970	1707	1981	259 (1951)	321 (1990)	443	11.6	
Well G-3	1951	1997	1792	1238	1988	280 (1951)	375 (1986)	196	1.9	not on-line
Well G-4	1951	2002	1930	1177	1981	347 (1951)	381 (1990)	177	0.9	
Well G-5	1951	1997	1840	703	1986	411 (1951)	491 (1990)	390	10.0	
Well G-6	1964	2005	1530	1480	1979	572 (1964)	589 (1990)	272	3.3	
Pajarito Well Field										
Well PM-1	1965	2501	2499	2479	1973	722 (1965)	752 (1990)	561	31.6	
Well PM-2	1965	2600	2300	2286	1987	823 (1965)	860 (1990)	1319	17.6	
Well PM-3	1966	2552	2552	2552	1966	740 (1966)	767 (1990)	1382	64.7	
Well PM-4	1981	2920	2875	2875	1981	1060 (1981)	1083 (1990)	1293	34.3	
Well PM-5	1982	3120	3092	3092	1982	1208 (1982)	1234 (1990)	1250	11.7	
Otowi Well Field										
Well O-1	1990	2609	2497	2497	1990	673 (1990)	—	1000	8.1	data from aquifer test
Well O-4	1990	2806	2595	2595	1990	780 (1990)	—	1533	46.2	data from aquifer test

[a]Depth of well to where infiltrating sand has filled it in.

TABLE XXI-B. Geologic Logs and Casing Schedules for Supply Wells in the Los Alamos Well Field (7 Wells)

1. Well LA-1

Elevation (LSD): 5624 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	76	76
Santa Fe Group		
Chamita Formation	0	
Tesuque Formation	925	1001

Casing Schedule
870 ft of 12-in.-diam casing set from 0 to 870 ft; 805 ft of slots between 60 and 865 ft; gravel packed.

Geophysical Log
None.

2. Well LA-1B

Elevation (LSD): 5622 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	78	78
Santa Fe Group		
Chamita Formation	0	
Tesuque Formation	2178	2256

Casing Schedule
64 ft of 36-in.-diam corrugated metal pipe set from 0 to 64 ft; 104 ft of 26-in.-diam steel casing set from 0 to 104 ft; 650 ft of 12-in.-diam wrought iron casing set from 0 to 650 ft; 1100 ft of 10-in.-diam wrought iron casing welded to 12-in.-diam casing set from 650 ft to 1750 ft; 591 ft of perforations between 326 ft and 1694 ft; gravel packed.

Geophysical Log
Electrical log (Cushman 1965).

3. Well LA-2

Elevation (LSD): 5651 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	60	60
Santa Fe Group		
Chamita Formation	0	
Tesuque Formation	822	882

Casing Schedule
870 ft of 12-in.-diam casing set from 0 to 870 ft; 760 ft of slotted casing and screen between 105 and 865 ft; gravel packed.

Geophysical Logs
None.

4. Well LA-3

Elevation (LSD): 5672 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	51	51

TABLE XXI-B. Geologic Logs and Casing Schedules for Supply Wells in the Los Alamos Well Field (7 Wells) (Continued)

4. Well LA-3 (Continued)

Santa Fe Group		
Chamita Formation	0	
Tesuque Formation	859	910

Casing Schedule
870 ft of 12-in.-diam casing set from 0 to 870 ft; 760 ft of slotted casing and screen between 105 and 865 ft; gravel packed.

Geophysical Logs
None.

5. Well LA-4

Elevation (LSD): 5975 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	27	27
Puye Conglomerate		
Fanglomerate member	86	113
Totavi Lentil	50	163
Santa Fe Group		
Chamita Formation	0	
Tesuque Formation	1856	2019

Casing Schedule
754 ft of 12-in.-diam casing set 0 to 754 ft; with 1211 ft of 10-in.-diam casing from 754 to 1965 ft; 350 ft of slotted casing between 754 ft and 1964 ft; gravel packed.

Geophysical Log
Electrical (Cushman 1965).

6. Well LA-5

Elevation (LSD): 5840 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	42	42
Santa Fe Group		
Chamita Formation	0	
Tesuque Formation	1982	2024

Casing Schedule
630 ft of 12-in.-diam casing set from 0 to 630 ft; 1120 ft of 10-in.-diam casing from 630 to 1750 ft; 350 ft of slotted casing between 440 ft and 1740 ft; gravel packed.

Geophysical Log
Electrical (Cushman 1965).

TABLE XXI-B. Geologic Logs and Casing Schedules for Supply Wells in the Los Alamos Well Field (7 Wells) (Continued)

7. Well LA-6

Elevation (LSD): 5770 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	36	36
Santa Fe Group		
Chamita Formation	0	
Tesuque Formation	1994	2030

Casing Schedule
597 ft of 12-in.-diam casing set from 0 to 597 ft; 1193 ft of 10-in.-diam casing from 597 to 1790 ft; 400 ft of slotted casing between 420 ft and 1778 ft; gravel packed.

Geophysical Log
Electrical (Cushman 1965); conductivity, temperature, gamma-ray/neutron (Purtymun 1977).

TABLE XXI-C. Geologic Logs and Casing Schedules for Supply Wells in the Guaje Well Field (7 Wells)

1. Well G-1

Elevation (LSD): 5973 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	12	12
Puye Conglomerate		
Fanglomerate member	13	25
Totavi Lentil	50	75
Santa Fe Group		
Chaquehui Formation	605	680
Chamita Formation	0	
Tesuque Formation		
Basalts or basalt breccias logged from 1540 to 1838 ft	1340	2020

Casing Schedule
490 ft of 12-in.-diam casing set 0 to 490 ft; 1510 ft of 10-in.-diam casing from 490 to 2000 ft; 490 ft of slotted casing between 282 and 1980 ft; gravel packed.

Geophysical Log
Electrical (Cushman 1965).

2. Well G-1A

Elevation (LSD): 6014 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	12	12
Puye Conglomerate		
Fanglomerate member	47	59
Totavi Lentil	63	122
Santa Fe Group		
Chaquehui Formation	738	860
Chamita Formation	0	
Tesuque Formation		
Basalt or basalt breccias logged from 1505 to 1675 ft; 1755 to 1790 ft	1211	2071

Casing Schedule
663 ft of 12-in.-diam casing set from 0 to 663 ft; 856 ft of 10-in.-diam casing from 663 to 1519 ft; 563 ft of slotted casing between 272 and 1513 ft; gravel packed.

Geophysical Log
Electrical (Cushman 1965).

3. Well G-2

Elevation (LSD): 6056 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	13	13
Puye Conglomerate		
Fanglomerate member	17	30
Totavi Lentil	45	75

TABLE XXI-C. Geologic Logs and Casing Schedules for Supply Wells in the Guaje Well Field (7 Wells) (Continued)

3. Well G-2 (Continued)

Santa Fe Group		
Chaquehui Formation	845	920
Chamita Formation	0	
Tesuque Formation	1086	2006
(no basalts logged)		

Casing Schedule
600 ft of 12-in.-diam casing set from 0 to 600 ft; 1370 ft of 10-in.-diam casing from 600 to 1970 ft; 425 ft of slotted casing from 281 to 1960 ft; gravel packed.

Geophysical Log
Electrical (Cushman 1965).

4. Well G-3

Elevation (LSD): 6139 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	17	17
Puye Conglomerate		
Fanglomerate member	41	58
Totavi Lentil	52	110
Santa Fe Group		
Chaquehui Formation		
Basalt or basalt breccias logged from 921 to 936 ft; 1012 to 1090 ft	980	1090
Chamita Formation	0	
Tesuque Formation	906	1997

Casing Schedule
12-in.-diam casing set from 0 to 695 ft; 1097 ft of 10 in.-diam casing from 695 to 1792 ft; 400 ft of slotted casing between 441 and 1785 ft; gravel packed.

Geophysical Log
Electrical (Cushman 1965).

5. Well G-4

Elevation (LSD): 6229 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	15	15
Puye Conglomerate		
Fanglomerate member	45	60
Totavi Lentil	60	120
Santa Fe Group		
Chaquehui Formation		
Basalt or basalt breccias from 499 to 526 ft; 855 to 925 ft; 956 to 976 ft; 1103 to 1150 ft	1030	1150
Chamita Formation	0	
Tesuque Formation	852	2002

TABLE XXI-C. Geologic Logs and Casing Schedules for Supply Wells in the Guaje Well Field (7 Wells) (Continued)

5. Well G-4 (Continued)

Casing Schedule
720 ft of 12-in.-diam casing set 0 to 720 ft; 1210 ft of 10-in.-diam casing from 720 to 1930 ft; 360 ft of slotted casing between 426 and 1925 ft; well damage repaired 1977, slotted liner set in well from 1214 to 1750 ft; gravel packed.

Geophysical Log
Electrical (Cushman 1965).

6. Well G-5

Elevation (LSD): 6306 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	8	8
Puye Conglomerate		
Fanglomerate member	119	127
Totavi Lentil		
Santa Fe Group		
Chaquehui Formation		
Basalt or basalt breccias from 586 to 613 ft; 906 to 1135 ft; 1211 ft to 1330 ft	1203	1330
Chamita Formation	0	
Tesuque Formation	667	1997

Casing Schedule
739 ft of 12-in.-diam casing set from 0 to 739 ft; 1101 ft of 10-in.-diam casing from 739 to 1840 ft; 400 ft of slotted casing between 462 and 1830 ft.

Geophysical Log
Electrical (Cushman 1965).

7. Well G-6

Elevation (LSD): 6422 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	40	40
Puye Conglomerate		
Fanglomerate member	90	130
Totavi Lentil	70	200
Santa Fe Group		
Chaquehui Formation		
Basalt from 1070 to 1170 ft; 1180 to 1220 ft; 1270 to 1425 ft; 1445 ft to 1470 ft	1270	1470
Chamita Formation	0	
Tesuque Formation		
Basalt 1605 to 1665 ft; basalt or basalt breccias 1720 to 1730 ft; 1815 to 1825 ft; 1905 to 1915 ft; 1955 to 1970 ft	535	2005

TABLE XXI-C. Geologic Logs and Casing Schedules for Supply Wells in the Guaje Well Field (7 Wells) (Continued)

7. Well G-6 (Continued)

Casing Schedule
206 ft of 24-in.-diam casing cemented in 0 to 206 ft; 1530 ft of 12-in.-diam casing: blank from 0 to 700 ft with louvers from 700 to 1510 ft, blank from 1510 to 1530 ft.

Geophysical Log
Temperature, gamma-ray/neutron, induction-electric, and microlog with caliper (Cooper et al. 1965).

TABLE XXI-D. Geologic Logs and Casing Schedules for Supply Wells in the Pajarito Well Field (5 Wells)

1. Well PM-1

Elevation (LSD): 6520 ft

Geologic Log	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Otowi Member	120	120
Guaje Member	45	165
Basaltic Rocks of Chino Mesa		
Unit 3	342	507
Old Alluvium	43	550
Puye Conglomerate		
Fanglomerate member	225	775
Totavi Lentil	20	795
Santa Fe Group		
Chaquehui Formation		
Basalt from 836 to 966 ft; 1054 to 1094 ft; 1166 to 1180 ft; 1506 to 1510 ft; 1546 to 1548 ft	1003	1798
Chamita Formation	76	1874
Tesuque Formation	627	2501

Casing Schedule

474 ft of 24-in.-diam casing cemented in hole from 0 to 474 ft; 2499 ft of 12-in.-diam casing: blank from 0 to 945 ft; with louvers from 945 to 2479 ft; blank from 2479 to 2499 ft; gravel packed.

Geophysical Logs

Temperature, gamma-ray/neutron, induction-electric, microlog with caliper (Cooper et al. 1965.)

2. Well PM-2

Elevation (LSD): 6715 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	30	30
Bandelier Tuff		
Otowi Member	375	405
Guaje Member	27	432
Basaltic Rocks of Chino Mesa		
Unit 2	268	700
Puye Conglomerate		
Fanglomerate member		
Basalt Unit 2 from 734 to 738 ft; 758 to 770 ft	640	1340
Totavi Lentil	70	1410
Santa Fe Group		
Chaquehui Formation		
Basalt from 1840 to 1892 ft; 2218 to 2312 ft	960	2370
Chamita Formation	40	2410
Tesuque Formation	190	2600

2. Well PM-2 (Continued)

Casing Schedule
504 ft of 26-in.-diam casing cemented in 0 to 504 ft; 2300 ft of 14-in.-diam casing: blank from 0 to 1004 ft, louvers from 1004 to 2280 ft, blank from 2280 to 2300 ft.

Geophysical Logs
Temperature, gamma-ray/neutron, induction-electrical, and microlog with caliper (Cooper et al.1965.)

3. Well PM-3

Elevation (LSD): 6640 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	30	30
Bandelier Tuff		
Otowi Member	140	170
Guaje Member	20	190
Puye Conglomerate		
Fanglomerate member	25	215
Basaltic Rocks of Chino Mesa		
Unit 2	325	540
Puye Conglomerate		
Fanglomerate member	205	745
Totavi Lentil	60	805
Santa Fe Group		
Chaquehui Formation		
Basalt from 1105 to 1315 ft; 1495 to 1540 ft	1255	2060
Chamita Formation	0	
Tesuque Formation	492	2552

Casing Schedule
552 ft of 26-in.-diam casing cemented in 0 to 552 ft; 2552 ft of 14-in.-diam casing: blank from 0 to 956 ft, louvers from 956 ft to 2532 ft, blank from 2532 to 2552 ft; gravel packed.

Geophysical Logs
Temperature, gamma-ray/neutron, induction-electrical, and microlog with caliper (Purtymun 1967).

4. Well PM-4

Elevation (LSD): 6920 ft

Geologic Log	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member	220	220
Otowi Member	320	540
Guaje Member	60	600
Basaltic Rocks of Chino Mesa		
Unit 2	500	1100

TABLE XXI-D. Geologic Logs and Casing Schedules for Supply Wells in the Pajarito Well Field (5 Wells) (Continued)

4. Well PM-4 (Continued)

Puye Conglomerate		
Fanglomerate member	280	1380
Totavi Lentil	40	1420
Santa Fe Group		
Chaquehui Formation		
Basalt 1950 to 1980 ft; 2090 to 2150 ft; 2190 to 2280; 2320 to 2430 ft	1500	2920

Casing Schedule
41 ft of 42-in.-diam casing cemented in from 0 to 41 ft; 923 ft of 28-in.-diam casing cemented in 0 to 923 ft; 2874 ft of 16-in.-diam casing: blank from 0 to 1260 ft; louvers from 1260 to 2854 ft; blank 2854 to 2874 ft; gravel packed.

Geophysical Logs
Dual-induction, microlaterolog-microlog, compensated neutron-formation density, and temperature (files available from ESH-18 Geohydrology section).

5. Well PM-5

Elevation (LSD): 7095 ft

Geologic Log	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member	335	335
Otowi Member	375	710
Guaje Member	30	740
Basaltic Rocks of Chino Mesa		
Unit 2	20	760
Puye Conglomerate		
Fanglomerate member	45	805
Basaltic Rocks of Chino Mesa		
Unit 2	125	930
Puye Conglomerate		
Fanglomerate member	35	965
Basaltic Rocks of Chino Mesa		
Unit 2	180	1145
Puye Conglomerate		
Fanglomerate member	325	1470
Totavi Lentil	80	1550
Santa Fe Group		
Chaquehui Formation		
Basalt from 1765 to 1895 ft; 1940 to 2075 ft; 2160 to 2640 ft; 2690 to 2740 ft	1230	2780
Chamita Formation	80	2860
Tesuque Formation	250	3110

Casing Schedule
40 ft of 42-in.-diam casing cemented in 0 to 40 ft; 1178 ft of 28-in.-diam blank casing cemented in 0 to 1178 ft; 3092 ft of 16-in.-diam casing: blank 0 to 1440 ft, louvers from 1440 to 3072 ft, blank 3072 to 3092 ft.

Geophysical Log
Dual-induction, microlaterolog-microlog, compensated neutron-formation density, and temperature (files available from ESH-18 Geohydrology section).

TABLE XXI-E. Geologic Logs and Casing Schedules for Supply Wells in the Otowi Well Field (2 Wells)

1. Well O-1

Elevation (LSD): 6396 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	50	50
Puye Conglomerate		
Fanglomerate member	30	80
Basaltic Rocks of Chino Mesa		
Unit 3	200	280
Puye Conglomerate		
Fanglomerate member	160	440
Basaltic Rocks of Chino Mesa		
Unit 2	30	470
Puye Conglomerate		
Fanglomerate member	220	690
Totavi Lentil	60	750
Santa Fe Group		
Chaquehui Formation	0	
Chamita Formation	0	
Tesuque Formation		
Basalt sill from 2219 to 2231 ft	1859	2609

Casing Schedule
60 ft of 38-in.-diam blank casing cemented in 0 to 60 ft; 662 ft of 28-in.-diam blank casing cemented in 0 to 662 ft; 2498 ft of 16-in.-diam casing: blank 0 to 1017 ft; louvers 1017 to 2477 ft; 20 ft blank casing 2477 to 2497 ft.

Geophysical Logs
Temperature, microlog, compensated neutron-formation density, and dual induction–SFL (files available from ESH-18 Geohydrology section).

2. Well O-4

Elevation (LSD): 6627 ft

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	28	28
Bandelier Tuff	155	183
Puye Conglomerate		
Fanglomerate member	107	290
Basaltic Rocks of Chino Mesa		
Unit 2	123	413
Puye Conglomerate		
Fanglomerate member	299	712
Totavi Lentil	98	810
Santa Fe Group		
Chaquehui Formation		
Basalt from 1154 to 1347 ft ; 1421 to 1465 ft	1530	2340
Chamita Formation	80	2420
Tesuque Formation	386	2806

Casing Schedule
60 ft of 38-in.-diam blank casing cemented in 0 to 60 ft; 723 ft of 28-in.-diam blank casing cemented in 0 to 723 ft; 2617 ft of 16-in.-diam casing: blank 0 to 1115 ft, louvers 1115 to 2596 ft blank 2596 to 2617 ft.

Geophysical Logs
Temperature, microlog, compensated neutron-formation density, and dual induction–SFL (files available from ESH-18 Geohydrology section).

TABLE XXI-F. Locations and Elevations (NAD 1927)

A. Los Alamos Well Field

Well LA-1	N 1,776,865	E 527,838	5624 ft
Well LA-1B	N 1,776,890	E 528,004	5622 ft
Well LA-2	N 1,777,157	E 526,681	5651 ft
Well LA-3	N 1,777,123	E 525,747	5672 ft
Well LA-4	N 1,771,171	E 517,203	5975 ft
Well LA-5	N 1,772,471	E 519,582	5840 ft
Well LA-6	N 1,774,531	E 522,637	5770 ft

B. Guaje Well Field

Well G-1	N 1,783,547	E 515,946	5973 ft
Well G-1A	N 1,784,291	E 514,997	6014 ft
Well G-2	N 1,785,061	E 513,966	6056 ft
Well G-3	N 1,786,156	E 511,432	6139 ft
Well G-4	N 1,786,390	E 508,705	6229 ft
Well G-5	N 1,787,845	E 506,705	6306 ft
Well G-6	N 1,786,789	E 504,580	6422 ft

C. Pajarito Well Field

Well PM-1	N 1,768,050	E 507,490	6520 ft
Well PM-2	N 1,760,264	E 496,542	6715 ft
Well PM-3	N 1,769,364	E 505,387	6640 ft
Well PM-4	N 1,764,612	E 495,472	6920 ft
Well PM-5	N 1,767,747	E 492,839	7095 ft

D. Otowi Well Field

Well O-1	N 1,772,169	E 509,152	6396 ft
Well O-4	N 1,772,933	E 497,093	6627 ft

XXII. SPRINGS IN THE LOS ALAMOS AREA

Springs in the Los Alamos area divide into three groups: (1) springs on the flanks of the Sierra de los Valles; (2) springs in lower Los Alamos Canyon; and (3) springs in White Rock Canyon. Springs in DP and Pajarito canyons were discussed in sections IV and VII respectively.

A. Springs on the Flanks of the Mountains

There are 13 springs located on the flanks of the mountains west of the Pajarito Plateau (Fig. XXII-A). Some discharge from alluvium in the canyon bottoms from seepage from coalluvium on the canyon walls or from perched areas in the Bandelier Tuff (Table XXII-A). A number of these springs furnished the early water supply to the ranch school (prior to 1943) and the Laboratory (thereafter).

The 1948 investigation of the caldera included a study of springs on the flanks of the mountains, with the aim of determining whether they could furnish a water supply to Los Alamos. The study indicated that only a small number of springs were suitable for water supply development, and that the amount of water available fell short of the projected demand (Stearns 1948).

B. Springs in Lower Los Alamos Canyon

Basalt Spring, in Los Alamos Canyon, discharges from Unit 3 of the Basaltic Rocks of Chino Mesa from a perched aquifer located in Pueblo, Los Alamos and Sandia Canyons to the west (Fig. XXII-B). This same perched aquifer probably recharges Sandia Spring, which discharges from the Totavi Lentil. Los Alamos Spring discharges from Unit 4 of the Basaltic Rocks of Chino Mesa (Table XXII-A). The spring is a seep recharged locally.

Indian and Sacred Springs discharge from a fault zone in the siltstones and silty sandstones of the Tesuque Formation that extends north/south from Los Alamos Canyon to the unnamed canyon to the north.

C. Springs in White Rock Canyon

Twenty-seven springs discharge from the main aquifer in and along the Rio Grande in White Rock Canyon (Fig. XXII-B). Twenty-two of the springs are separated into three groups of similar aquifer-related chemical quality (Table XXII-A). The five remaining springs make up a fourth group that varies in quality according to localized conditions in the aquifer.

Group I springs discharge from the Totavi Lentil that is composed of sand, gravel, cobbles, and boulders of quartzite, massive white-to-pink quartz, granite, and other felsic rock debris. The lentil is generally less than 50 ft thick. The water is mainly a calcium-bicarbonate type with average total dissolved solids of 165 mg/L.

Group II springs discharge from the coarse-grained sediments composed of arkosic siltstones and sandstone with a mixture of volcanic sediments. These sediments represent the Chaquehui Formation and associated maar sediments. They are interbedded in some places with some of the older basalt flows. The water is a sodium-bicarbonate type with average total dissolved solids of 185 mg/L.

Group III springs discharge from fine-grained sediments of the Tesuque Formation that consist of arkosic siltstones and silty sandstones, with an occasional lens of siltstone or pebbly conglomerate. The water is mainly a calcium-bicarbonite type, with average total dissolved solids of 215 mg/L.

Group IV springs are five springs located on the east side of the river which discharge from the fine-grained sediments of the Tesuque Formation in areas that are associated with faulting or basalt plugs. Chemical constituents are higher in general, with average total dissolved solids of 510 mg/L.

Spring 4A and Ancho Spring discharge from the Totavi Lentil above the river in the lower parts of Pajarito and Ancho Canyons (Fig. XXII-B and Table XXII-A). Stream flow from these springs is of sufficient volume to reach the Rio Grande (Table XXII-B). There are 11 major canyons that enter the Rio Grande in the 12-mile reach of the river from Otowi to the mouth of Frijoles Canyon.

REFERENCES

R. L. Griggs, "Geology and Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

W. D. Purtymun, "Geology and Hydrology of White Rock Canyon from Otowi to the Confluence of Frijoles Canyon, Los Alamos and Santa Fe Counties, New Mexico," U.S. Geol. Survey Open-File Report (1966).

W. D. Purtymun, R. J. Peters, and J. W. Owens, "Geohydrology of White Rock Canyon of the Rio Grande from Otowi to Frijoles Canyon," Los Alamos Scientific Laboratory report LA-8635-MS (1980).

H. T. Stearns, "Ground-Water Supplies for Los Alamos, New Mexico," Consulting Geologist Report to the U.S. Atomic Energy Commission (1948).

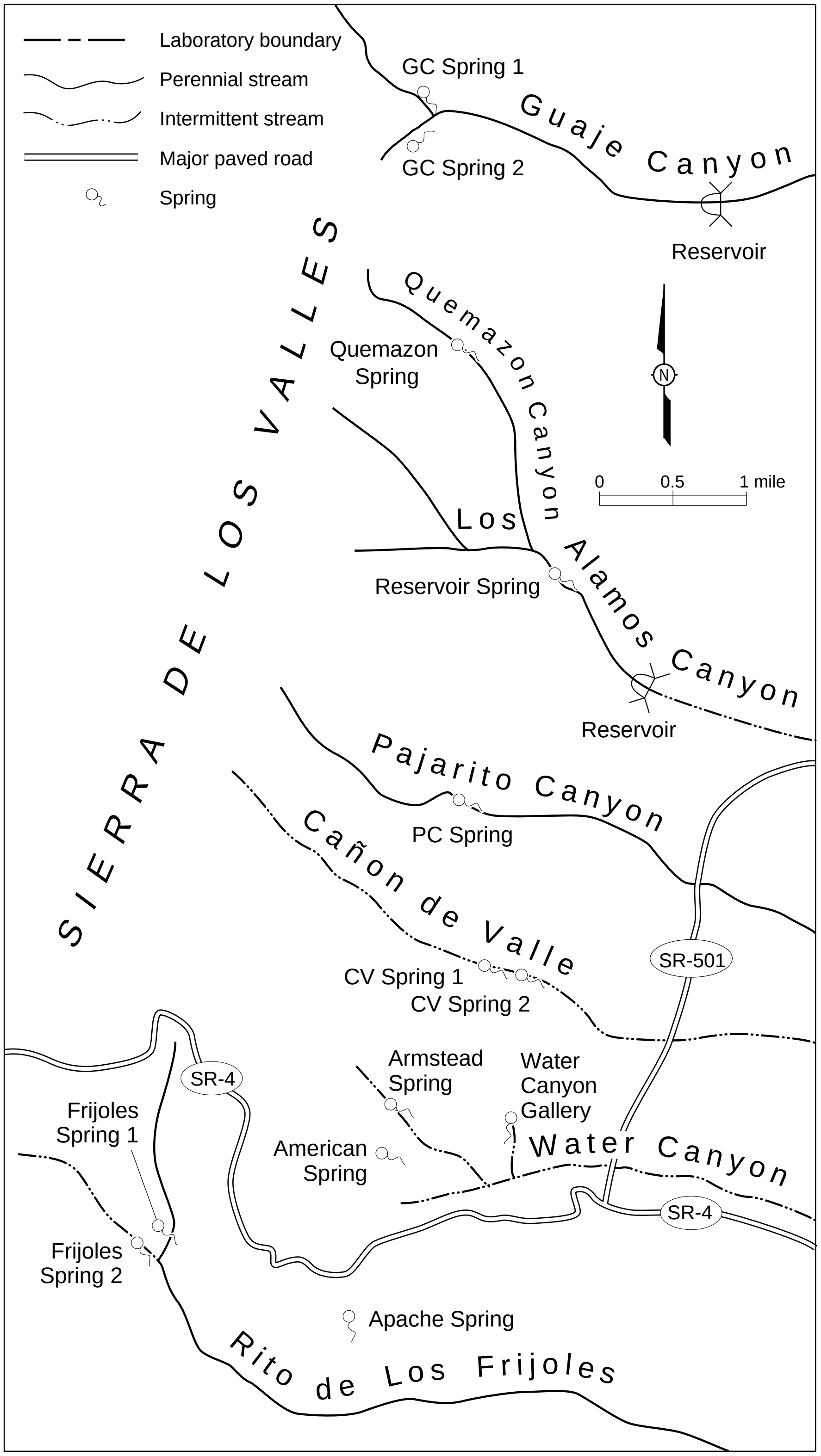


Fig. XXII-A. Locations of springs on the east flank of the Sierra de los Valles.

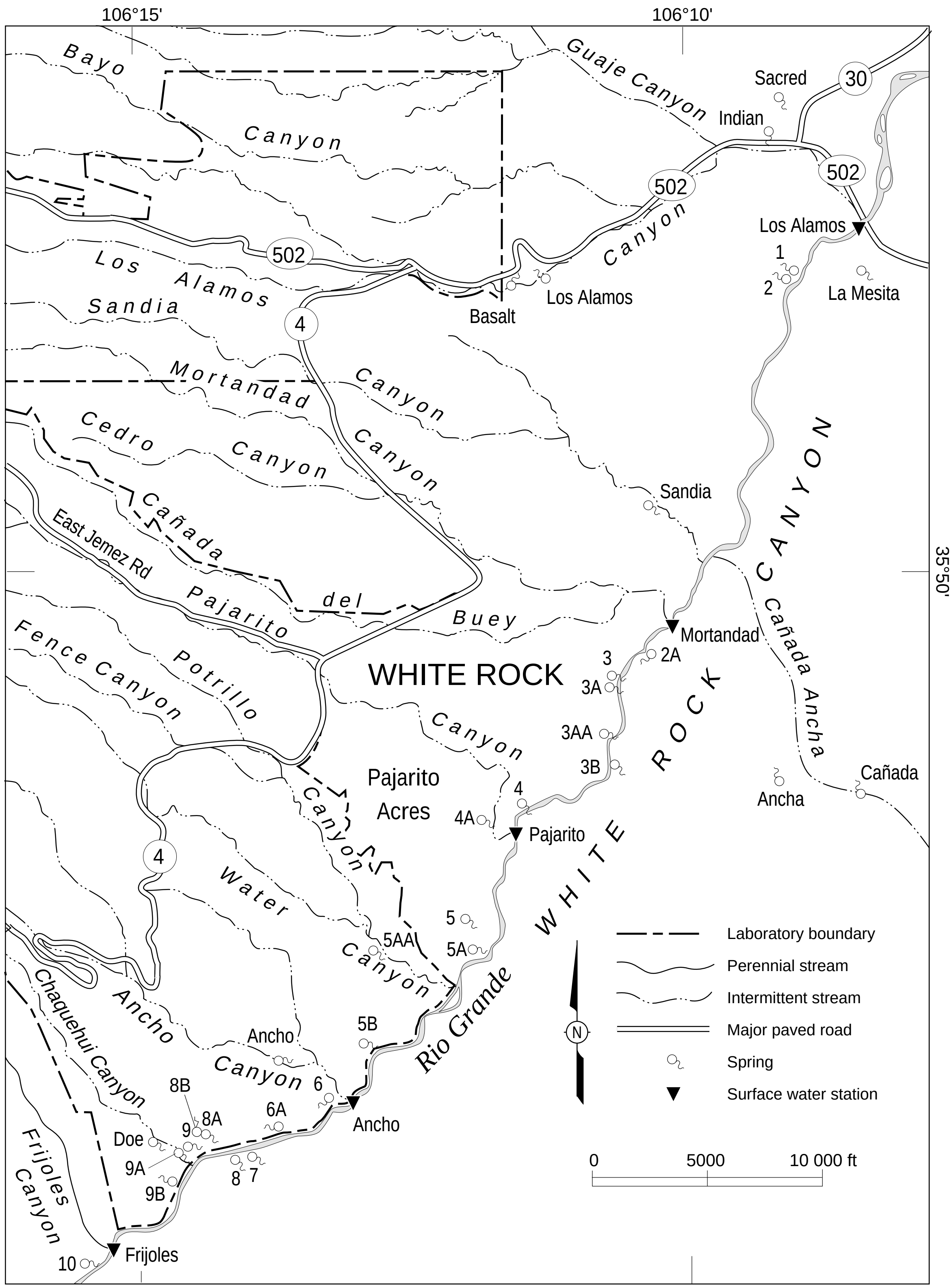


Fig. XXII-B. Locations of springs in lower Los Alamos Canyon and in White Rock Canyon along the Rio Grande.

TABLE XXII-A. Records of Springs in the Los Alamos Area (46 Springs)

	Elevation LSD (ft)	Topographic Situation and Geologic Formation	Temp. (˚F)	Estimated Discharge into Rio Grande (gpm)	Remarks
Springs on the Eastern Flank of the Sierra de los Valles					
GC Spring 1	8850	Canyon floor Qb_t		25	base flow Guaje Stream
GC Spring 2	8840	Canyon floor Qb_t		40	base flow Guaje Stream
Quemazon Spring	8660	Canyon floor Qal–Qb_t		15	
Reservoir Spring	8000	Canyon floor Qal–Qb_t		20	
PC Springs	8660	Canyon floor Qal–Qb_t		25	
CV Spring 1	8260	Canyon floor Qal–Qb_t		4	
CV Spring 2	8240	Canyon floor Qal–Qb_t		4	
Water Canyon Gallery	8000	Cliff end of canyon Qb_t		≈150	industrial water supply S-Site
Armstead Spring	8216	Canyon floor Qal–Qb_t		2	probably seepage from talus
American Spring	8280	Ridge above canyon Qb_t		5	
Apache Spring	8320	Steep slope Qb_t		<1	CCC - stock tank
Frijoles Spring 1	8430	West wall– North Fork Frijoles Canyon Qb_t		100	base flow Frijoles Stream
Frijoles Spring 2	8430	North wall– West Fork Frijoles Canyon Qb_t		110	base flow Frijoles Stream
Springs in the Vicinity of Lower Los Alamos Canyon					
Basalt Spring	6000	Talus slope - QTb_3	≈51	3	
Los Alamos Spring	6000	Seepage from basalt - QTb_4	≈51	<1	
Indian Spring	5640	Canyon slope - road cut - T_t	≈62	<1	discharge from fault zone
Sacred Spring	5640	Seep area above stream - T_t	≈58	<1	discharge from fault zone
Springs in White Rock Canyon					
Group I					
Totavi Lentil					
Sandia Spring	5700	Seep area in and adjacent to channel	72	0	Sandia Canyon
Spring 3	5560	Gravel terrace above river	72	20	
Spring 3A	5560	Gravel terrace above river	72	50	
Spring 3AA	5460	Gravel terrace above river	66	<1	
Spring 4	5570	Gravel slope above river	66	80	
Spring 4A	5570	Gravel terrace above channel	70	120	Pajarito Canyon
Spring 5	5770	Gravel on steep slope above river	70	10	
Spring 5AA	5760	Seep in channel forms pools	64	0	Water Canyon
Ancho Spring	5700	Gravels underlying basalt in channel	72	65	Ancho Canyon

TABLE XXII-A. Records of Springs in the Los Alamos Area (46 Springs) (Continued)

	Elevation LSD (ft)	Topographic Situation and Geologic Formation	Temp. (˚F)	Estimated Discharge into Rio Grande (gpm)	Remarks
Springs in White Rock Canyon					
Group II					
Chaquehui Formation and Associated Basalts and Maar Sediments					
Spring 5A	5395	Fractures in basalt at edge of river	70	25	
Spring 5B	5390	Steep slope at edge of river	61	10	
Spring 6	5380	Fractures in basalt at edge of river	73	60	
Spring 6A	5375	Fractures in basalt at river level	72	150	
Spring 7	5370	Slope at edge of river	70	175	
Spring 8	5370	Slope at edge of river	72	70	
Spring 8A	5370	Slope at edge of river	72	25	
Spring 8B	5380	Seep in channel above river	68	10	
Spring 9	5385	Large seep above river	68	10	
Spring 9A	5525	Seep area on canyon wall	66	0	Chaquehui Canyon
Spring 9B	5525	Seep in cave/canyon wall	65	0	west side Rio Grande
Spring 10	5390	Edge of alluvium above river	66	<1	Frijoles Canyon
Doe Spring	5600	Seep area in channel and canyon wall	70	<1	Chaquehui Canyon
Group III					
Tesuque Formation					
Spring 1	5615	Seep area on slope above river	65	<1	
Spring 2	5600	Seep area on slope above river	65	<1	
Group IV					
Tesuque Formation (fine-grained basalt intrusion or faults)					
La Mesita Spring	5580	Seep area above channel	65	<1	remains of gallery above channel
Ancha Spring	5775	Seep area in channel, basalt sediments		70	0
Spring 2A	5490	Gravels along edge of river	72	<1	
Spring 3B	5450	Terrace on slope above river	68	30	
Cañada Spring	5780	Seep area in channel	66	0	

Note:
Qal–recent alluvium
QTb_4–Basaltic Rocks of Chino Mesa Unit 4
QTb_3–Basaltic Rocks of Chino Mesa Unit 3
Qbt–Bandelier Tuff
T_t–Tesuque Formation

TABLE XXII-B. Major Canyons and Streams Entering the Rio Grande in White Rock Canyon

Canyon	Drainage Area (mi^2)	Elevation at River (ft)	Type of Flow[a]	Discharge at River (gpm)	Source
Los Alamos	58.7	5495	I	—	—
La Mesita	—	5490	P	≈2	La Mesita Spring
Sandia	5.6	5465	I	—	—
Cañada Ancha	—	5445	I	—	—
Mortandad	10.4	5435	P	10 to 100	sanitary effluent
Spring 3B	—	5420	P	≈10	Spring 3B
Pajarito	13.6	5410	P	≈450	Spring 4A
Water	19.5	5395	I	—	—
Ancho	7.0	5390	P	≈30	Ancho Spring
Chaquehui	1.5	5370	I	—	—
Frijoles	18.0	5365	P	≈20	Frijoles Springs 1 and 2

Note: La Mesita, Cañada Ancha, and Spring 3B enter the Rio Grande from the east; the others enter the Rio Grande from the west or from the Pajarito Plateau.\

[a]I = intermittent; P = perennial

TABLE XXII-C. Locations and Elevations (NAD 1927)

A. Springs on the Flank of the Mountains

Guaje Spring 1	N 1,797,700	E 460,200	8850 ft
Guaje Spring 2	N 1,796,000	E 460,200	8840 ft
Quemazon Spring	N 1,788,400	E 462,800	8660 ft
Reservoir Spring	N 1,778,800	E 465,700	8000 ft
PC Spring	N 1,773,200	E 461,600	8660 ft
Valle Spring 1	N 1,766,400	E 463,900	8260 ft
Valle Spring 2	N 1,766,500	E 464,100	8240 ft
Water Canyon Gallery	N 1,762,500	E 463,900	8000 ft
Armstead Spring	N 1,762,700	E 459,500	8216 ft
American Spring	N 1,760,000	E 460,800	8280 ft
Apache Spring	N 1,753,600	E 458,900	8320 ft
Frijoles Spring 1	N 1,759,500	E 452,100	8430 ft
Frijoles Spring 2	N 1,759,300	E 449,100	8430 ft

B. Springs in Lower Los Alamos Canyon

Basalt Spring	N 1,770,700	E 516,300	6000 ft
Los Alamos Spring	N 1,770,900	E 517,200	6000 ft
Indian Spring	N 1,777,200	E 525,700	5640 ft
Sacred Spring	N 1,780,300	E 529,800	5640 ft

C. Springs in White Rock Canyon

Group I (Totavi Lentil)

Sandia Spring	N 1,761,500	E 523,000	5700 ft
Spring 3	N 1,753,611	E 521,071	5560 ft
Spring 3A	N 1,753,345	E 521,100	5560 ft
Spring 3AA	N 1,751,492	E 520,883	5460 ft
Spring 4	N 1,748,348	E 517,189	5570 ft
Spring 4A	N 1,747,815	E 515,904	5570 ft
Spring 5	N 1,742,987	E 515,240	5770 ft
Spring 5AA	N 1,742,500	E 510,900	5760 ft
Ancho Spring	N 1,737,900	E 505,400	5700 ft

Group II (Chaquehui Formation and Associated Basalts and Maar Sediments)

Spring 5A	N 1,741,921	E 515,500	5395 ft
Spring 5B	N 1,738,109	E 510,836	5390 ft
Spring 6	N 1,735,617	E 508,947	5380 ft
Spring 6A	N 1,734,503	E 507,146	5375 ft
Spring 7	N 1,733,541	E 504,763	5370 ft
Spring 8	N 1,733,417	E 504,168	5370 ft
Spring 8A	N 1,733,958	E 503,173	5370 ft
Spring 8B	N 1,733,491	E 503,040	5380 ft
Spring 9	N 1,733,676	E 502,687	5385 ft
Spring 9A	N 1,733,407	E 502,408	5525 ft
Spring 9B	N 1,732,876	E 502,193	5525 ft
Spring 10	N 1,728,932	E 498,467	5390 ft
Doe Spring	N 1,733,800	E 501,800	5600 ft

XXII-C. Locations and Elevations (NAD 1927) (Continued)

Group III (Tesuque Formation)

Spring 1	N 1,771,547	E 529,268	5615 ft
Spring 2	N 1,771,084	E 529,052	5600 ft

Group IV (Tesuque Formation - Basalt Intrusion or Fault)

La Mesita Spring	N 1,771,600	E 532,100	5580 ft
Ancha Spring	N 1,749,600	E 528,900	5775 ft
Spring 2A	N 1,754,818	E 522,427	5490 ft
Spring 3B	N 1,749,934	E 521,345	5450 ft
Cañada Spring	N 1,748,600	E 532,500	5780 ft

D. Streams Entering the Rio Grande in White Rock Canyon

Los Alamos	N 1,773,000	E 532,300	5495 ft
La Mesita	N 1,772,700	E 531,600	5490 ft
Sandia	N 1,759,300	E 525,400	5465 ft
Cañada Ancha	N 1,754,100	E 535,500	5445 ft
Mortandad	N 1,756,400	E 523,500	5435 ft
Spring 3B	N 1,749,600	E 520,900	5420 ft
Pajarito	N 1,747,400	E 516,800	5410 ft
Water	N 1,741,000	E 513,300	5395 ft
Ancho	N 1,735,700	E 509,400	5390 ft
Chaquehui	N 1,733,100	E 502,600	5370 ft
Frijoles	N 1,729,500	E 499,300	5365 ft

XXIII. DOCUMENTED STUDIES RELATED TO GEOLOGY, HYDROLOGY, OR SURVEILLANCE

Specific studies related to geology, hydrology, or surveillance have been reported in formal and semi-formal reports. The purpose of this section is to identify reports that were the results of these studies. The reports resulting from the studies are referenced, and the locations of their subjects are shown on a generalized map of the area (Fig. XXIII-A).

A. Decontamination of TA-1

Over 140 test holes ranging in depth from 3 ft to over 30 ft were drilled to collect samples for radio-chemical analyses in the decontamination of former TA-1. Map location TA-1-A (Fig. XXIII-A).

REFERENCES

A. J. Ahiquist, A. K. Stoker, and L. K. Trocki, “Radio-logical Survey and Decontamination of the Former Main Technical Area (TA-1) at Los Alamos, New Mexico,” Los Alamos Scientific Laboratory report LA-6887 (1977).

W. D. Purtymun, “Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990,” Los Alamos National Laboratory report LA-12733-MS (1994), chapters 49, 50, 51, 52, 53, and 57.

B. Test Holes in Seepage Beds at TA-21 (1953)

To determine the retention of plutonium in the soil and tuff under and adjacent to seepage pits used to dispose of radioactive effluents, five test holes were drilled to collect samples from the berm adjacent to the pits (two holes), through the seepage bed (two holes), and under the seepage bed (one angle hole). Holes ranged in depth from 10 ft to 20 ft. Map location TA-21-A (Fig. XXIII-A).

REFERENCE

W. D. Purtymun, “Geohydrology of the Pajarito Plateau with Reference to Quality of Water 1949–1972,” Los Alamos Scientific Laboratory, Group H-8 internal document, 1975, pp. 69–71.

C. Test Holes in Seepage Beds at TA-21 (1985)

Four holes were cored through the seepage pits that received radioactive effluents from 1943 to 1952 to determine the depth to which contamination was carried beneath the pits. The holes were cored to a depth of 100 ft. Map location TA-21-B (Fig. XXIII-A).

REFERENCE

J. Nyhan, B. Drennon, W. Abeele, M. Wheeler, W. D. Purtymun, G. Trujillo, W. Herrera, and J. Booth, “Distribution of Plutonium and Americium beneath a 33-Year-Old Liquid Waste Disposal Site,” *Journal of Environmental Quality* **14**, no. 4 (Oct–Dec 1985).

D. Movement of Plutonium through Tuff at TA-21

A shaft about 6 ft wide, 12 ft long, and 30 ft deep was dug in the berm between two of the seepage pits that received radioactive wastes from 1944 through 1952. Horizontal holes were drilled from the shaft under the pit. The holes were paired at various depths, one hole was used as a moisture-access hole, the other equipped with a vacuum cup system. Water or effluent was added to the seepage pit, moisture measured, and samples of fluids collected by the vacuum system, if possible. Six vertical holes were drilled in the berm around the shaft to depths of about 100 ft. These holes were used as moisture-access holes to determine the moisture content of the tuff at depths below the shaft and seepage pit. Map location TA-21-C (Fig. XXIII-A).

REFERENCE

C. W. Christenson and R. G. Thomas, “Movement of Plutonium through Los Alamos Tuff,” in Second Ground Disposal of Radioactive Waste Conference, U.S. Department of Commerce TID-7628 (1962).

E. Movement of Fluids and Plutonium from Shafts at TA-21

A study was done in two parts: (1) to determine the movement of fluids (water containing treated chemicals) and radioactive contaminates from a shaft filled with waste-cement paste under normal operation conditions, and (2) to determine the movement of fluids and plutonium under test conditions without the radioactive sludge fixed with cement.

In the first part of the study, a 59-ft-deep, 6-ft-diam shaft was drilled about 2 ft from a previously constructed 100-ft moisture-access hole. The shaft was filled with contaminated-sludge-cement paste. Moisture moving from the paste into the tuff was measured. A second test hole was drilled and samples collected for analysis.

In the second part of the study, a 20-ft-deep, 2-ft-diam shaft was constructed, with four moisture-access holes (40 ft deep) at various distances from the shaft. The shaft was partly filled with contaminated sludge. Moisture moving from the sludge into the tuff was monitored. When moisture in the tuff did not change, three holes were cored to a depth of about 35 ft. Samples were collected for analysis in holes at various distances from the shaft and at different depths. Map location TA-21-D (Fig. XXIII-A).

REFERENCE

W. D. Purtymun, R. Garde, and R. Peters, "Movement of Fluids and Plutonium from Shafts at Los Alamos, New Mexico," Los Alamos Scientific Laboratory report LA-7379-MS (1978).

F. Exploratory and Foundation Test Holes at TA-3 (1948)

The report cited describes the core drilling of exploratory and foundation test holes for the new main technical area (TA-3) on South Mesa (south of Los Alamos Canyon), for the bridge crossing Los Alamos Canyon south and west of the present hospital, and for foundation tests at the hospital itself.

There were 63 holes cored during the study. Forty-nine of the holes were drilled in the South Mesa area (TA-3), 12 at the bridge crossing, and 2 at the new hospital site. Seven of the holes were 350 ft deep and the remaining holes ranged in depth from 50 ft to 100 ft. Load-bearing tests were conducted at the proposed locations for the three heaviest structures: the power plant, the Van de Graaff Building, and the main warehouse. Map location TA-3-A (Fig. XXIII-A).

REFERENCE

W. C. Kruger & Associates, "Subsurface Investigation of South Mesa and Vicinity," Kruger and Associates, Architect-Engineers report to the U.S. Atomic Energy Commission and Engineering Division of Los Alamos Scientific Laboratory (1948).

G. Exploratory and Foundation Test Holes at TA-53 (1966)

During the preliminary site investigation for the Meson Physics Facility, 28 test holes were cored on the Mesita de los Alamos. In addition to performing detailed geologic mapping, bearing capacities of the tuff and ground vibration characteristics of the mesa were determined. Map location TA-53-A (Fig. XXIII-A).

REFERENCES

W. D. Purtymun, "Geology and Physical Properties of the Near-Surface Rocks of Mesita de los Alamos, Los Alamos County, New Mexico," U.S. Geol. Survey Open-File Report (1966).

M. D. Keller, "Geologic Studies and Material Property Investigations of Mesita de los Alamos," Los Alamos Scientific Laboratory report LA-3728 (1968).

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapters 4, 5, 6, 9, 17, 18, 72, 95, 96, 101, 180, and 193.

H. Preliminary Site Investigation of the Plutonium Processing Facility at TA-55

A detailed investigation was made of the geology, hydrology, and seismic characteristics of the site. A number of test holes were drilled to determine the physical characteristics of the tuff. The study also included trenching to determine if there was any possibility of extension of the Los Alamos fault into the area from the north. Map location TA-55-A (Fig. XXIII-A).

REFERENCE

Dames and Moore, "Report of Geologic, Foundation, Hydrologic, and Seismic Investigations for the Plutonium Processing Facility at the Los Alamos Scientific Laboratory," Consulting Engineers report to the U.S. Atomic Energy Commission and the Los Alamos Scientific Laboratory (1972).

I. Movement of Tritium through Tuff at TA-54 Area G

The movement of tritium from wastes disposed of in shafts at TA-54 Area G was investigated by drilling 14 test holes to a depth of 50 ft adjacent to a shaft disposal area that contained tritium wastes. The tuff was not saturated, having a moisture content of less than 8% by volume. Tritium migrated in the vapor phase a distance of 105 ft in 4 years. Map location TA-54-A (Fig. XXIII-A).

REFERENCES

W. D. Purtymun, "Underground Movement of Tritium from Solid-Waste Storage Shafts," Los Alamos Scientific Laboratory report LA-5286-MS (1973).

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapter 20.

J. Containment of Tritium in Buried Wastes at TA-54, Area G

Asphalt had been used since 1970 to contain the migration of tritium from disposal shafts. Methods used have not been effective and new techniques are being implemented. During this investigation 18 test holes were drilled, and samples were collected and analyzed for moisture and tritium. The test holes were drilled to a depth of 40 ft. Map location TA-54-B (Fig. XXIII-A).

REFERENCE

M. L. Wheeler and J. L. Warren, "Tritium Containment after Burial of Contaminated Solid Waste," *Proceedings of 23rd Conference on Remote Systems Technology*, San Francisco, Calif. (1975).

K. Horizontal Core Holes at TA-54 Area G and Other Studies at TA-54 Areas G and L

Five horizontal holes were cored from a canyon under a waste disposal pit at Area G. The length of the holes ranged from 240 ft to 287 ft. They were drilled using air as a cuttings carrier. The holes penetrated both Units 2A and 2B of the Tshirege Member of the Bandelier Tuff. Total core recovery ranged from 51% to 75%. A vertical hole was cored from the same drill pad to a depth of 157 ft. The hole penetrated the lower units of the Tshirege Member, the Otowi Member, and the Guaje Member, and was completed into the top of Unit 2 of the Basaltic Rocks of Chino Mesa. No core was recovered. The purpose of the holes was to determine if contamination had leached from the pits into the underlying tuff. No apparent contamination was encountered. Map Location TA-54-C (Fig. XXIII-A). Other studies related to storage and disposal of wastes and to the geology of Areas G and L may be found in Purtymun (1994).

REFERENCES

Reynolds Electric and Engineering Co., "Horizontal Monitoring Holes, Los Alamos, New Mexico," Completion Report to U.S. Energy Research and Development Agency, Contract E(26-1)-410 (1976).

W. D. Purtymun, M. L. Wheeler, and M. A. Rogers, "Geologic Description of Cores from Holes P-2 MH-1 through P-2 MH-5, Area G, Technical Area 54," Los Alamos Scientific Laboratory report LA-7308-MS (1978).

W. D. Purtymun, M. L. Wheeler, and M. A. Rogers, "Radiochemical Analyses of Samples from Beneath a Solid Radioactive Waste Disposal Pit at Los Alamos, New Mexico," Los Alamos Scientific Laboratory report LA-8422-MS (1980).

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapters 7, 8, 20, 25, 32–34, 58, 98, 104, 109, 110, 116, 118, 119, 121–123, 125, 136, 137, 139, 140, 143, 147, 150, 155, 156, 163, 168, 171, 174, 185, 186, 196, and 202.

L. Test Holes at TA-33

During an investigation to determine the extent of any possible contamination resulting from underground experiments, six holes were cored with depths ranging from 29 ft to 59 ft at Area D; six holes were cored with depths ranging from 29 ft to 59 ft at Area E; and two holes with depths of 149 ft and 174 ft were cored at the tritium facility at Area T. Map location T-33-A (Fig. XXIII-A).

REFERENCES

Weston, Consulting Engineers, "Weston Data Material from Areas T and E," Volumes 1 and 2, and "Weston Data Material from Area D, TA-33," Basic Data Report in the files of Group CL-1 (1989).

M. Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)

A source document concerning the history and environmental setting of eight LASL near-surface land disposal facilities was prepared in two volumes. The report contains a number of references to test holes drilled in the solid disposal area. Map location TA-0-A (Fig. XXIII-A).

A second similar type of report was prepared by the U.S. Geological Survey covering the same sites.

REFERENCES

M. A. Rodgers, "History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (A, B, C. D, E, F, G, and T), A Source Document," Los Alamos Scientific Laboratory report LA-6848-MS, Vol. I and II (1977).

T. E. Kelley, "Evaluation of Monitoring of Radioactive Solid-Waste Burial Sites at Los Alamos, New Mexico," U.S. Geol. Survey Open-File Report 75-406 (1975).

N. Pumice Investigation

One of the first geologic reports prepared for the U.S. Atomic Energy Commission related to the development and mining of pumice from the lower beds of the Bandelier Tuff or Guaje Member. Data related to the thickness and distribution of the pumice. Map location TA-0-B (Fig. XXIII-A).

REFERENCE

V. C. Kelley, "Geology and Pumice Deposits of the Pajarito Plateau, Sandoval, Santa Fe, and Rio Arriba Counties, New Mexico," Los Alamos Project—Pumice Investigations for the Operations Division, Los Alamos Scientific Laboratory, Contract No. AT-(29-1)-553 (1948).

O. Subsurface Geology of the Pajarito Plateau

Geologic report integrating data from wells, geophysical surveys, and surface exposures to develop structure contour and paleogeologic maps of the pre-Bandelier Tuff surface beneath the Pajarito Plateau. Map location TA-0-C (Fig. XXIII-A).

REFERENCE

B. J. Dransfield and J. N. Gardner, "Subsurface Geology of the Pajarito Plateau, Española Basin, New Mexico," Los Alamos National Laboratory report LA-10455-MS (1985).

P. Proposed Borrow Pit in Mortandad Canyon

Test holes drilled in the eastern part of Mortandad Canyon indicated that in the study area about 170 000 cubic yards of uncontaminated fill material is available in the upper 9 yards of the canyon bottom. Map location TA-O-D (Fig. XXIII-A).

REFERENCE

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapter 132.

Q. Construction of Sediment Retention Ponds in Mortandad Canyon

Prior to the construction of retention ponds, five injection shafts were constructed in the stream bed to retain and store runoff and suspended sediments in lower Mortandad Canyon. Map location TA-O-E (Fig. XXIII-A).

REFERENCE

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapters 40, 41, and 181.

R. Long-Range Plan for Water Supply (1986)

A long-range plan concerning the water supply at Los Alamos was prepared for the Department of Energy. This included a short-term management plan for the San Juan–Chama water.

REFERENCE

U.S. Corps of Engineers, "Los Alamos Water Supply, Los Alamos, New Mexico," Contract No. D.E.-A132-83Al22421, U.S. Corps of Engineers, Albuquerque, New Mexico (1986).

S. Buckman Well Field

The Buckman Well Field, which furnishes a part of the water supply to Santa Fe, lies east of the Rio Grande about a mile south of Otowi. A preliminary report was prepared to define the geologic and hydrologic properties of the aquifer underlying the Buckman Well Field and the effects of pumpage on the aquifer.

REFERENCE

Black and Veatch (Consulting Engineers), "Preliminary Report to the Public Service Company of New Mexico, Buckman Well Field," Black and Veatch, Project 6607, Denver, Colo. (1976).

T. Ground Water Model of the Buckman Well Field

A ground water flow model was prepared to evaluate the ground water withdrawal from the Buckman Well Field. A simulated effect of the historic withdrawal 1972 to 1986 was prepared as was the future effect on the aquifer for the period 1987 to 2045.

REFERENCE

D. P. McAda, "Simulation Effect of Ground-Water Withdrawal from a Well Field Adjacent to the Rio Grande, Santa Fe County, New Mexico," U.S. Geol. Survey Water Resources Investigation Report 89-4184 (1990).

U. Test Holes Drilled on the Cerros del Rio

Across the Rio Grande from the Pajarito Plateau 106 test holes were drilled into the Cerros del Rio. The holes were drilled and logged as part of a uranium investigation. Geologic logs and some hydrologic data related to the test holes are available from the State Engineer.

REFERENCE

R. L. Borton, "A Listing of Geohydrologic Data for 106 Exploratory Holes Drilled by Nuclear Dynamics, Inc., in Rio Arriba, Sandoval, and Santa Fe Counties, New Mexico 1970-1972," State Engineer Open-File Report (1974).

V. Environmental Study of the Pueblo of San Ildefonso

A cooperative agreement was made between the Pueblo of San Ildefonso, the Bureau of Indian Affairs, and the Department of Energy in order to evaluate the environmental impact of the Laboratory operation on off-site areas. The agreement in 1987 was the beginning of annual investigations made to evaluate the quality of surface and ground water, soil, and sediments in the pueblo.

REFERENCES

W. D. Purtymun and M. N. Maes, "Environmental Study of the Pueblo of San Ildefonso: Reference to Water, Soil, and Sediments," Los Alamos National Laboratory document LA-UR-88-3646 (1988). Reporting data annually in LA-11628-ENV (1988), LA-12000-ENV (1989), and LA-12271-MS (1990).

W. Seismic Hazards Program Core Holes

Four holes were cored as part of the Laboratory's Seismic Hazards Program for the purpose of determining near-surface seismic velocity at key Laboratory facilities (Fig. XXIII-B). The report does not cover the velocity structure surveys but reports on characteristics of the drilling, geology, and some of the hydrologic aspects of the holes.

REFERENCE

J. N. Gardner, T. Kolbe, and S. Chang, “Geology, Drilling, and Some Hydrologic Aspects of Seismic Hazards Program Core Holes, Los Alamos National Laboratory, New Mexico,” Los Alamos National Laboratory report LA-12460-MS (1993).

X. Earthquake and Rockfall Potential at Omega Site

In August 1970 the U.S. Geological Survey conducted a brief geologic reconnaissance in the vicinity of the Omega West Reactor in order to determine the possibility of damage to the reactor by rockfalls triggered by earthquakes or other factors. Other rockfall investigations were conducted and are reported in Purtymun (1994).

REFERENCES

T. E. Kelley, “Earthquake and Rockfall Potential near Omega Site, Los Alamos, New Mexico,” U.S. Geological Survey informal report, Albuquerque, New Mexico, September 1970.

W. D. Purtymun, “Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990,” Los Alamos National Laboratory report LA-12733-MS (1994), chapters 68, 85, 100, 117, 131, 145, 176, 191, 199, 200, 204, and 205.

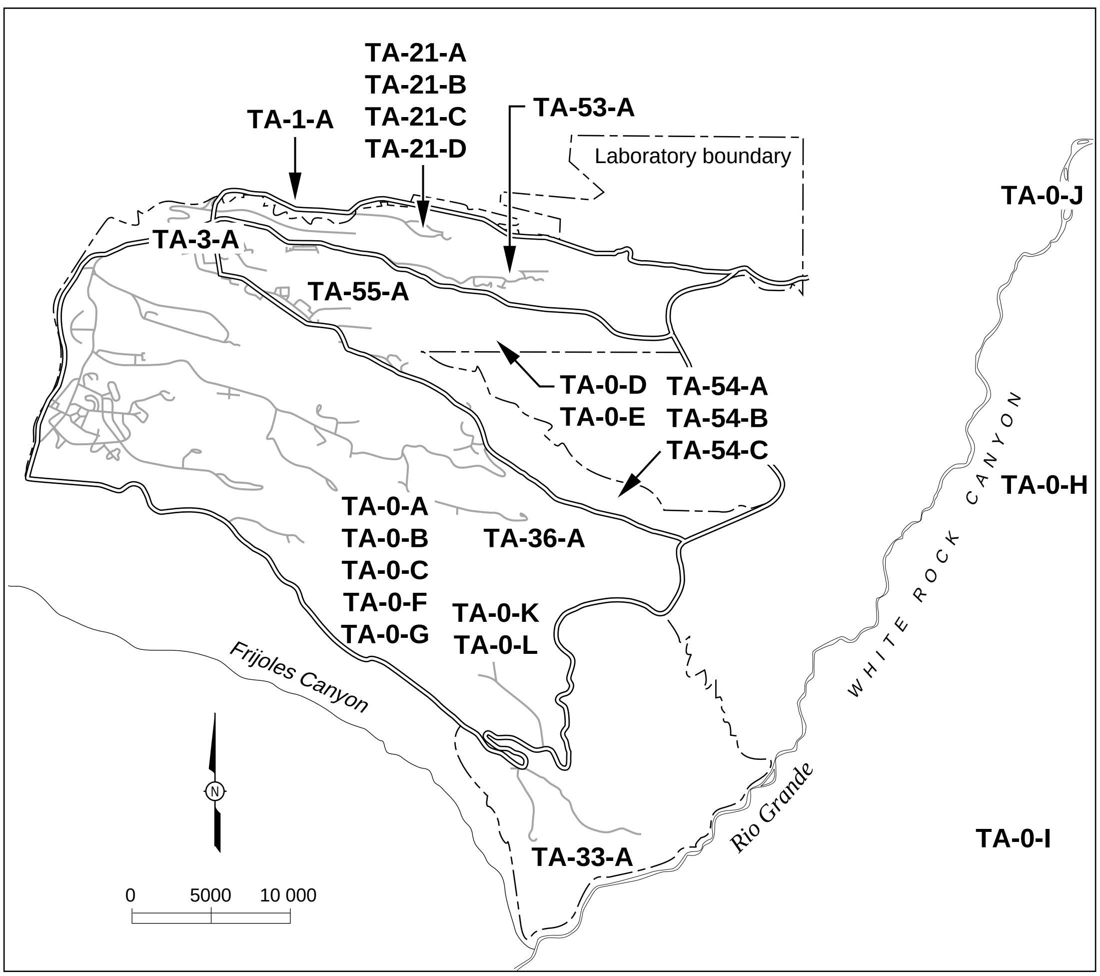


Fig. XXIII-A. Locations of geologic, hydrologic, engineering, and environmental investigations.

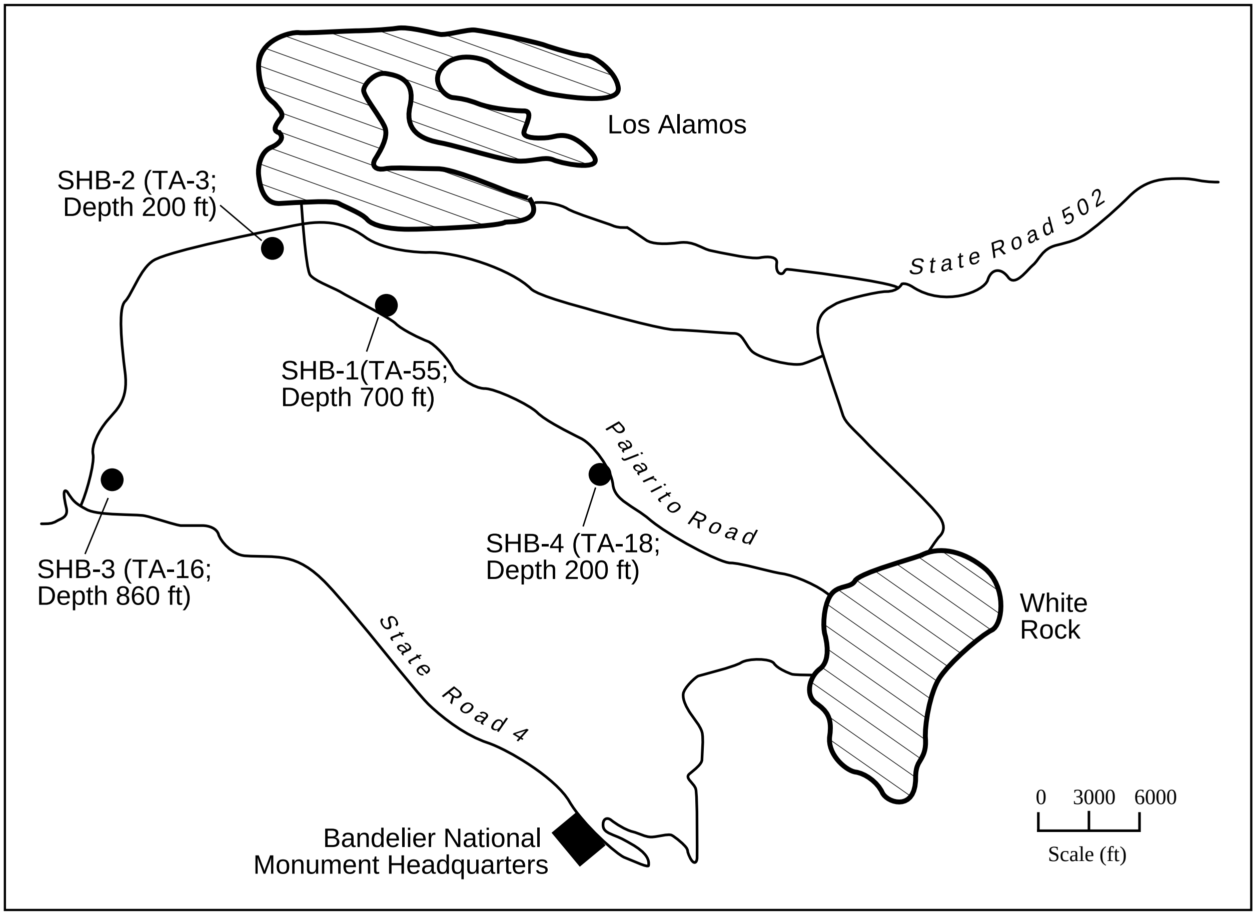


Fig. XXIII-B. Locations of test holes for seismic investigation.

XXIV. RACK ASSEMBLY ALIGNMENT FACILITIES

In order to check the tolerance and alignment of instruments and instrument packages to be run down holes at the Nevada Test Site, towers or bays were constructed over holes. The older RAAC (Rack Assembly Alignment Complex) facilities are at TA-3 near SM-38 (Fig. XXIV-A). These facilities are no longer in use, and the testing is now done at TA-60.

The older RAAC facilities at TA-3 consisted of three test holes. The oldest test hole at SM-245 was about 3 ft in diameter and about 100 ft deep. This hole was plugged and abandoned. The next oldest test hole at TA-3, at SM-447, has a hole drilled to a depth of 96 ft. The upper part of the hole is cased to a depth of 20 ft with a 5-ft-4-in.-diam CMP (corrugated metal pipe). The holes were completed in the Tshirege Member of the Bandelier Tuff.

The last RAAC structure is at SM-1483. The hole was drilled to a depth of 120 ft. The upper part of the hole is cased with 20 ft of 7.5-ft-diam CMP.

The new rack facilities are located at TA-60 at SM-19 (Fig. XXIV-A). There are two holes augered to a depth of 100 ft. The diameter of the holes is 11 ft. The upper part of both holes is cased to a depth of 20 ft with 10-ft-2-in.-diam CMP.

REFERENCE

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapter 134.

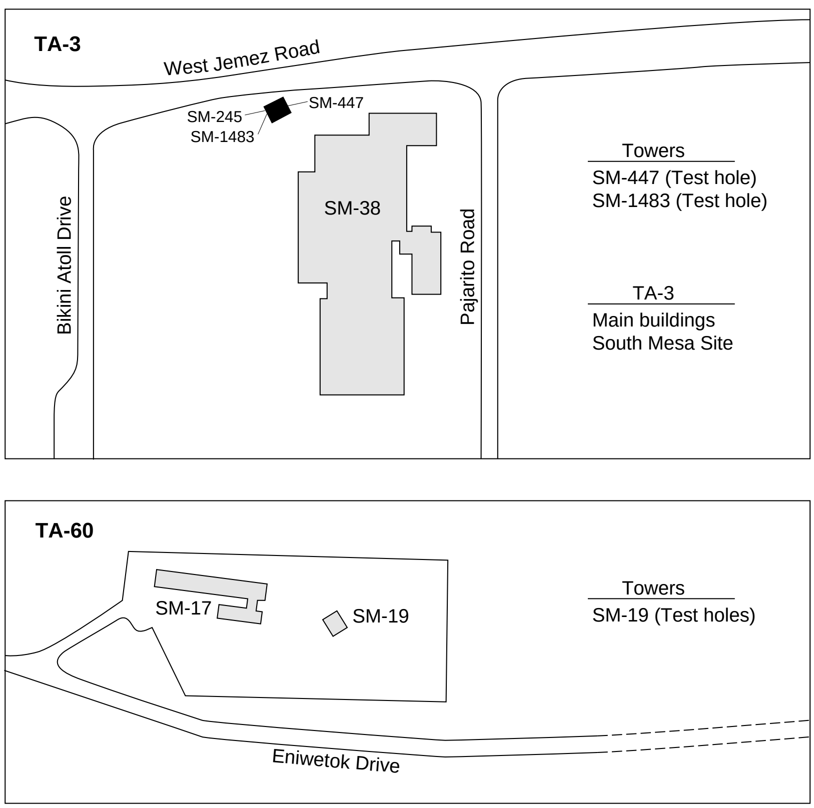


Fig. XXIV-A. Locations of rack alignment holes at TA-3 and TA-60.

TABLE XXIV-A. Locations and Elevations (NAD 1927)

A. TA-3	N 1,774,200	E 477,200	7440 ft
B. TA-60	N 7,771,800	E 483,000	7330 ft

XXV. TEST HOLES IN UPPER GUAJE CANYON

Two shallow test holes were drilled in upper Guaje Canyon between the Los Alamos and Guaje Faults in the fall of 1966 (Fig. XXV-A). The holes were drilled to determine the rock type and the depth of saturation between the two faults, and to explore the possibility of developing short-term high-yield wells.

Test hole 1 (elevation 7180 ft) was drilled to a depth of about 23 ft and was completed in the alluvium. The alluvium was saturated to near the stream level. Test hole 2 (elevation 7060 ft) was drilled to a depth of 103 ft, penetrating 17 ft of alluvium and 86 ft of the gravel of the Puye Conglomerate. The alluvium and gravel were saturated to near the stream level.

Both holes were cased with 2-in.-diam perforated plastic pipe; the depth and the length of the perforations are unknown. The test holes indicated a saturated thickness of the gravels penetrated; however, the saturated thickness is not sufficient to develop a high-yield well. Additional testing would be necessary to determine the total thickness of saturated gravels between the two faults.

REFERENCE

W. D. Purtymun, “Geohydrology of the Pajarito Plateau with Reference to Quality of Water 1949–1972,” Los Alamos Scientific Laboratory internal document, 1975.

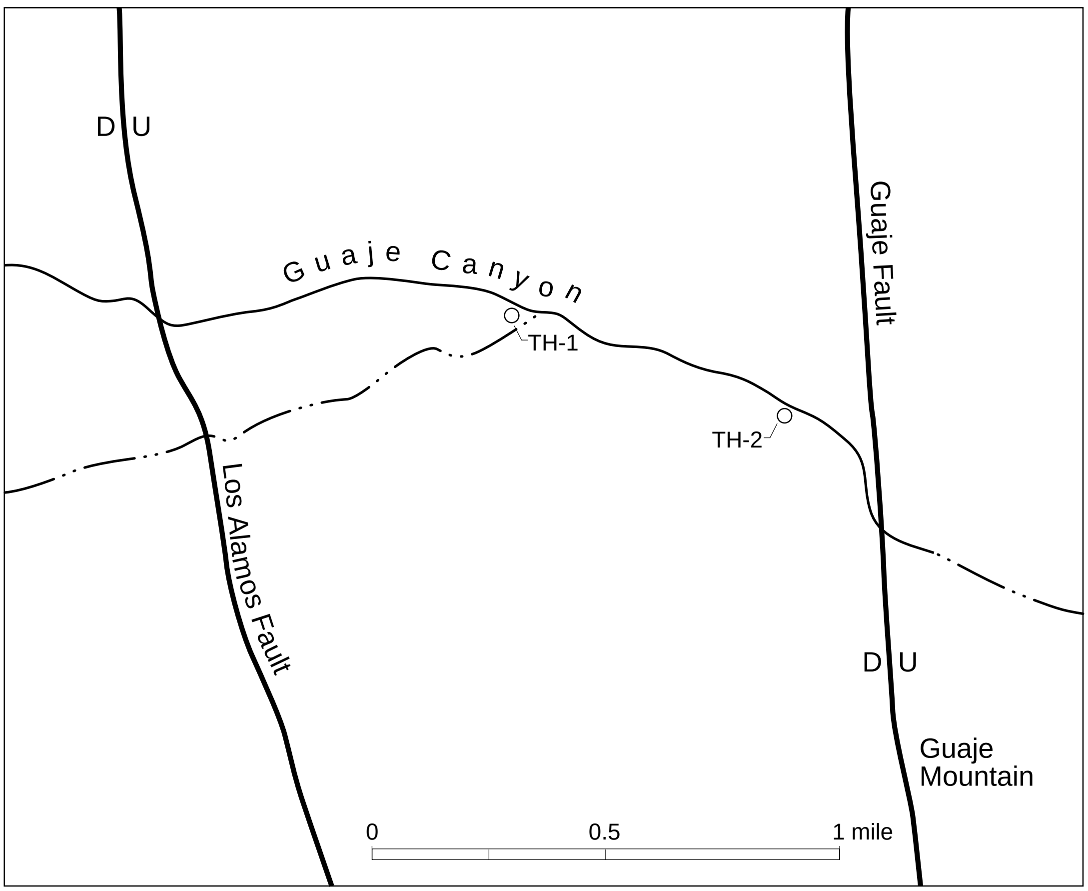


Fig. XXV-A. Location of test holes in upper Guaje Canyon.

TABLE XXV-A. Locations and Elevations (NAD 1927)

A. Test Hole 1	N 1,795,700	E 484,600	7180 ft
B. Test Hole 2	N 1,794,600	E 486,600	7060 ft

XXVI. FENTON HILL

Fenton Hill is located about 35 miles west of Los Alamos on the western flanks of the Valles Caldera. The studies at this site have been based on extracting heat from dry geothermal reservoirs by developing artificial hydrothermal systems. Two systems were developed at the site. The first system was composed of two deep holes drilled into the dry Precambrian rock to a depth of about 10 000 ft. The holes are connected by a fracture induced by hydrologic pressure. Water is circulated under pressure through this system to recover heat from the fractured area.

The second similar system has been developed at the site to a depth of about 14 000 ft. Both systems have been tested.

Site selection for the test area began in the winter of 1971–1972. In December 1971, seven shallow heat-flow holes (Sites 1, 2, 3, 4, 5, 6, and 7) were drilled to about 100 ft around the Valles Caldera (Fig. XXVI-A). Three additional holes (Sites 8, 9, and 10) were drilled on the west side of the caldera in February 1972 (Fig. XXVI-A). These holes were less than 80 ft deep and were cased with 2-in.-diam plastic pipe. The heat-flow measurements in the holes indicated that the heat flow was greatest west of the caldera, and other data from the U.S. Geological Survey indicated that the geologic structure there was the least complex and that the depth to the Precambrian rocks was moderate. This was the type of geologic environment necessary for the development of dry geothermal energy.

In the spring of 1972, test holes TH-A, TH-B, TH-C, and TH-D were drilled around the west rim of the Valles Caldera (Fig. XXVI-B). Cores were taken in 10-ft samples for every 100 ft of depth. The holes ranged from 500 to 750 ft in depth (geologic logs and construction data appear in Table XXVI-A). Surface casing was cemented in the top of the holes and blank casing was set into the lower part to facilitate heat-flow logging. The heat-flow measurements indicated that the heat flow was greatest near the rim of the caldera and decreased westward. Upon completion of the core holes and heat-flow logging, a deep test hole GT-1 (depth 2575 ft) was drilled 470 ft into the top of the Precambrian granite (Fig. XXVI-B, Table XXVI-A). Based on heat-flow measurements and geology, the test site, Fenton Hill TA-57, was located north of La Cueva at the top of Fenton Hill, just off State Road 126 (Fig. XXVI-B).

Two test holes were drilled near Fenton Hill for the placement of geophones for the site seismic operations and to obtain geologic and hydrologic information (Fig. XXVI-B). The holes, PC-1 and PC-2, were drilled through the volcanics and into the sediments. The holes were completed in the sediments just above the Precambrian level (Table XXVI-B).

Within the site, two sets of energy extraction holes were drilled, GT-2 and EE-1 (about 10 000 ft deep) and EE-2 and EE-4 (about 14 000 ft deep), both completed in the Precambrian rocks (Fig. XXVI-C). A well was drilled and completed in a shallow aquifer to provide a water supply (water level about 360 ft, base of aquifer at about 460 ft). Two additional wells were added (Fig. XXVI-C, Table XXVI-C). Five observation wells, 6 in. in diameter, were drilled to depths of 500 ft. They were used to test the aquifer and as a support for applications for water rights. The observation wells were completed through the aquifer, the Abiquiu Tuff, and into the perching formation of silts and clays of the Abo Formation. They were cased with 2-in.-diam galvanized pipe with the lower 50 ft slotted.

A preliminary study of the quality of surface and ground water in the drainage area of the Jemez River and the Rio Guadalupe was made to establish background data, prior to any experiments by the Laboratory. The data include chemical analyses from 17 surface water stations, 15 mineral and thermal springs (Fig. XXVI-D), and 53 ground water stations (Fig. XXVI-E).

Based on the preliminary study of the quality of water in the vicinity of Fenton Hill, a number of surface and ground water stations were established to monitor any effect of the operations of the Fenton Hill site on the environment. The collection of quality-of-water data began in 1974 and has continued to the present (Fig. XXVI-F). The number of stations has remained about the same, with little change: 13 surface water stations (Table XXVI-D) and 20 ground water stations (Table XXVI-E). The chemical quality of the surface and ground water is grouped around common chemical properties and total dissolved solids. The water-quality data and related hydrologic data collected at Fenton Hill have been published in a series of Los Alamos reports:

1974 data: LA-6093-MS, December 1975
1975 data: LA-6511-MS, September 1976
1976 data: LA-7307-MS, May 1978
1977 data: LA-7468-PR, September 1978
1978 data: LA-8217-PR, January 1980
1979 data: LA-8424-PR, June 1980
1980 data: LA-9007-PR, September 1981
1981–1982 data: LA-9854-PR, September 1983
1983–1984 data: LA-10892-PR, January 1987
1985–1986 data: LA-11210-PR, March 1988
1987–1988 data: LA-12030-PR, March 1991
1989 data: LA-12000-ENV, December 1990
1990 data: LA-12271-MS, March 1992

REFERENCES

American Ground Water Consultants, Inc., "Hydrology of the Hot Dry Rock Site at Fenton Hill, Sandoval County, New Mexico," report submitted to the Los Alamos Scientific Laboratory (June 1980).

American Ground Water Consultants, Inc., "Results of Ground Water Model Studies at Fenton Hill, Sandoval County, New Mexico," report submitted to the Los Alamos Scientific Laboratory (July 1980).

N.M. Becker, W. D. Purtymun, and W. C. Ballance, "Aquifer Evaluation at Fenton Hill, October and November 1980," Los Alamos National Laboratory report LA-8964-MS (1981).

W. D. Purtymun, "Geology of the Jemez Plateau West of the Valles Caldera," Los Alamos Scientific Laboratory report LA-5124-MS (1973).

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994) chapters 26, 28, 36, 44, 54, 59, 60, 73, 79, 80, 86, 87, 89, 116, 154, 166, and 198.

W. D. Purtymun, R. W. Ferenbaugh, A. K. Stoker, W. H. Adams, "Quality of Water in the Vicinity of Fenton Hill, 1979," Los Alamos Scientific Laboratory report LA-8424-PR (1980).

W. D. Purtymun, R. W. Ferenbaugh, N. M. Becker, M. C. Williams, and M. N. Maes, "Water Quality in the Vicinity of Fenton Hill, 1983 and 1984," Los Alamos National Laboratory report LA-10892-PR (1987)

W. D. Purtymun, F. G. West, and W. H. Adams, "Preliminary Study of the Quality of Water in the Drainage Area of the Jemez River and Rio Guadalupe," Los Alamos Scientific Laboratory report LA-5595-MS (1974)

W. D. Purtymun, F. G. West, and R. A. Pettitt, "Geology of Geothermal Test Hole GT-2, Fenton Hill Site, July 1974," Los Alamos Scientific Laboratory report LA- 5780-MS (1974).

J. W. Tester, "Proceedings of the NATO-CCMS Information Meeting on Dry Hot Rock Geothermal Energy," Los Alamos Scientific Laboratory report LA-5518-C, NATO CCMS report No. 38 (1974).

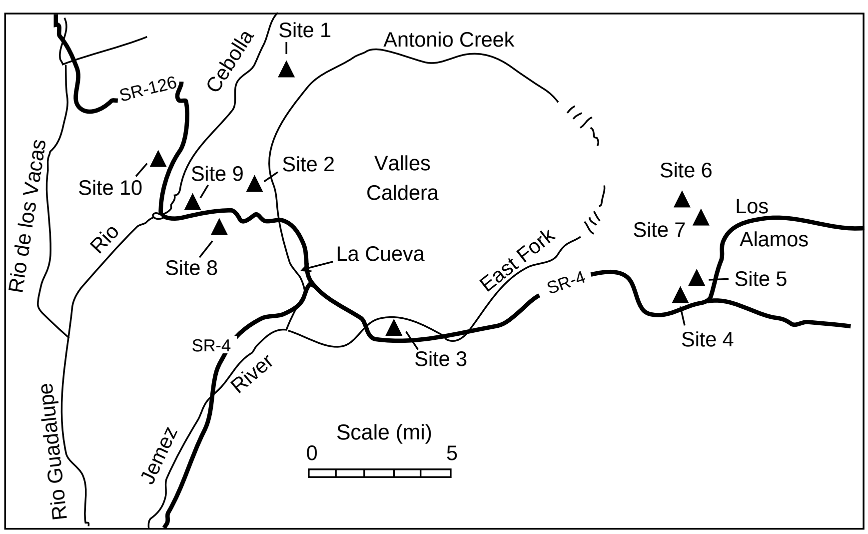


Fig. XXVI-A. Heat-flow sites, December 1971 and February 1972 (Purtymun 1994).

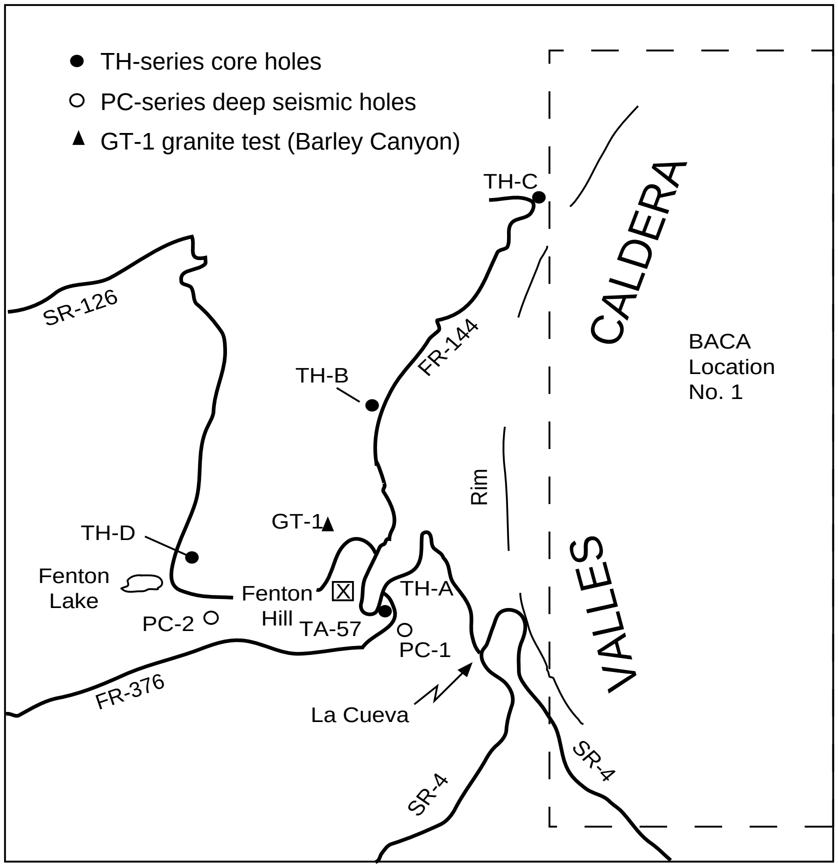


Fig. XXVI-B. Location of test holes (TH-series, PC-series, and GT-1) west of the Valles Caldera (Purtymun et al. 1987).

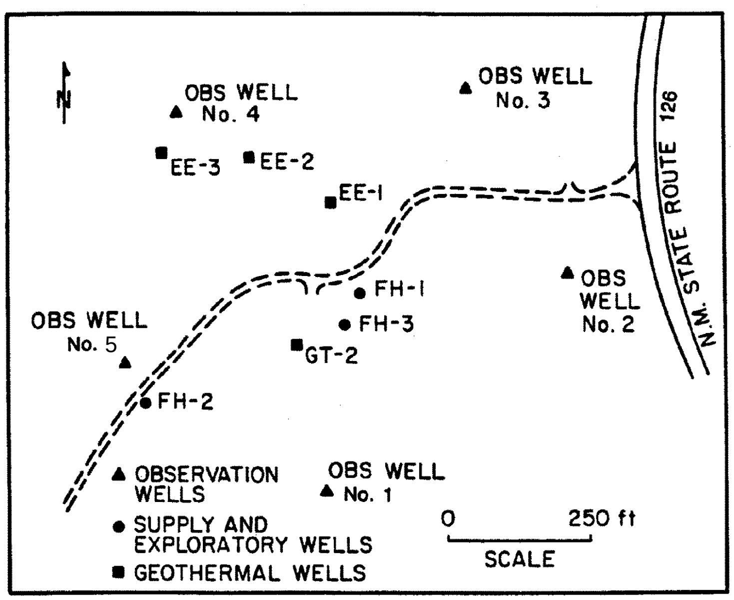


Fig. XXVI-C. Site map of Fenton Hill showing locations of observation, supply, exploratory, and geothermal wells (Becker et al, 1981).

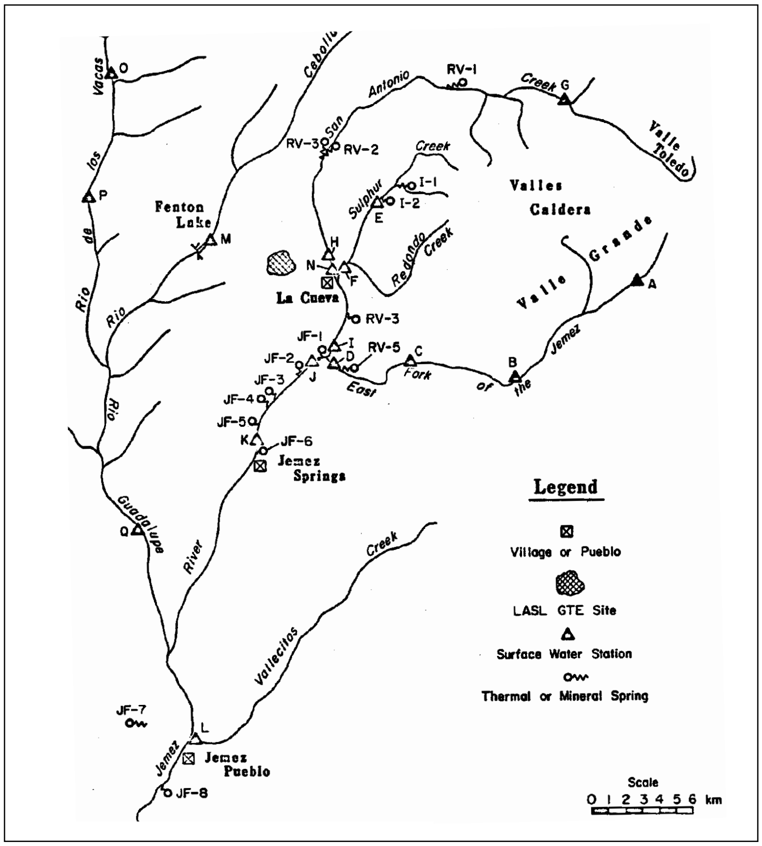


Fig. XXVI-D. Surface water stations, thermal and mineral springs (Purtymun et al. 1974).

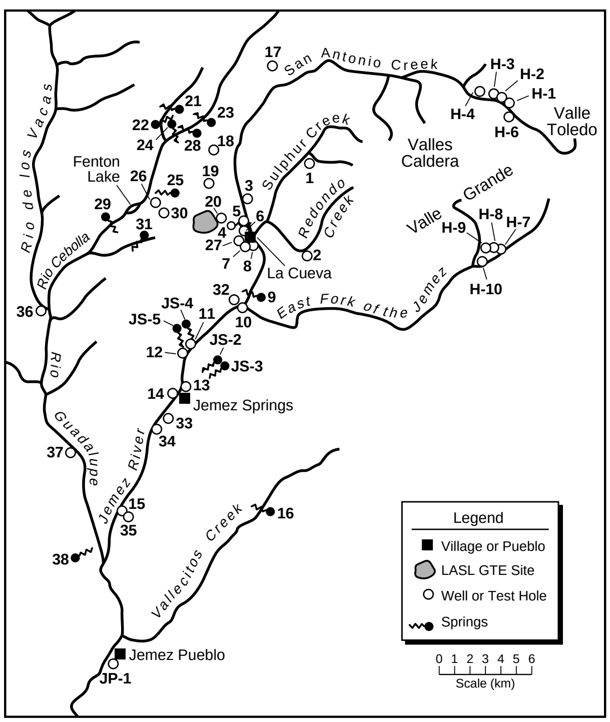
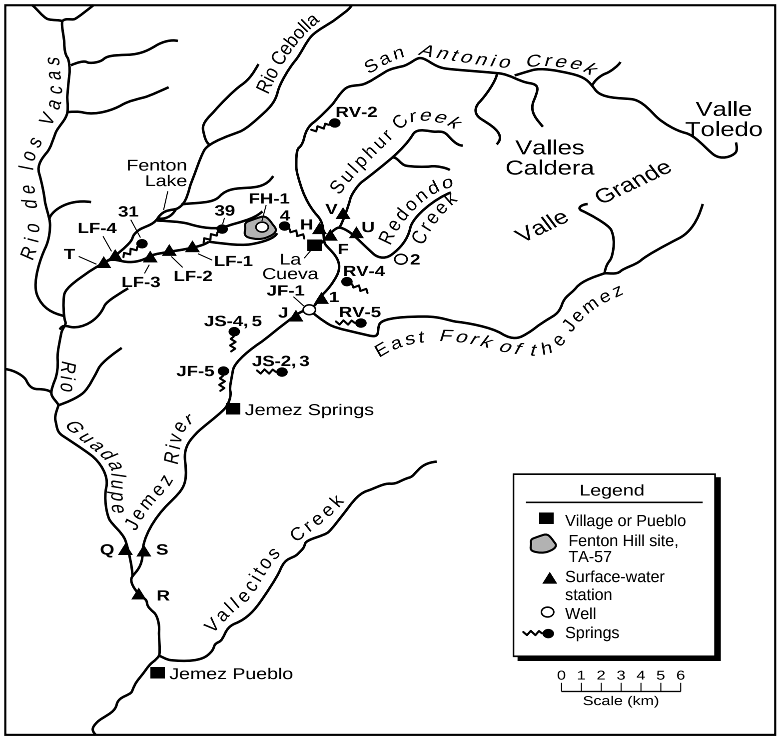
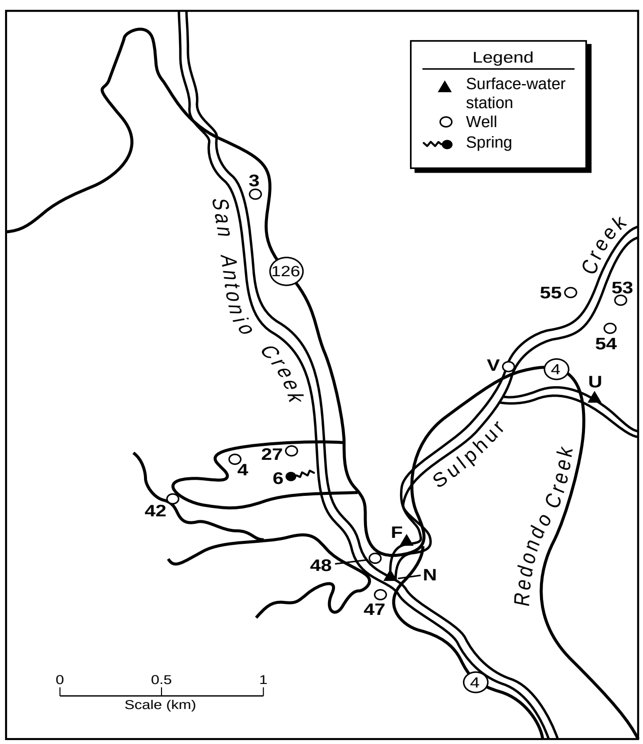


Fig. XXVI-E. Wells, test holes, and springs (Purtymun et al. 1974).



Locations of sampling stations



Locations of sampling stations at La Cueva

Fig. XXVI-F. Locations of surface-water stations and wells used in monitoring quality of water after 1974 (Purtymun et al. 1980).

TABLE XXVI-A. Geologic Logs and Construction Data for Granite Test Hole (GT-1) and Test Holes TH-A, TH-B, TH-C, and TH-D

GT-1 — June 1972 — Elevation 8475 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	60	60
Abiquiu Tuff	100	160
Abo Formation	910	1070
Magdalena Group		
Upper limestone member	590	1660
Lower limestone member	155	1815
Sandia Formation		
Upper clastic member	235	2050
Lower limestone	55	2105
Precambrian rock	470	2575

TH-A — April 1972 — Elevation 8450 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	30	30
Abiquiu Tuff	120	155
Abo Formation	435	590

TH-B — April 1972 — Elevation 8625 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	380	380
Abiquiu Tuff	60	440
Abo Formation	210	650

TH-C — April 1972 — Elevation 8700 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	240	240
Abiquiu Tuff	340	580
Abo Formation	170	750

TH-D — April 1972 — Elevation 7900 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	120	120
Abo Formation	380	500

TABLE XXVI-A. Geologic Logs and Construction Data for Granite Test Hole (GT-1) and Test Holes TH-A, TH-B, TH-C, and TH-D (Continued)

Construction

GT-1	Depth 2575 ft	
Hole diam		3 3/4 in. to 280 ft
		9 7/8 in. to 1600 ft
		6 3/4 in. to 2410 ft
		4 1/4 in. to 2575 ft
Casing schedule (outside diam)		10 3/4 in. to 258 ft
		7 5/8 in. to 1357 ft
		5 in. to 2400 ft
		open hole 2400 to 2575 ft

Drilled air-mist-rotary to 2410 ft, core-water-rotary to 2410 to 2575 ft, all strings cemented in.

TH-A	Depth 590 ft	
Hole diam		9 5/8 in. to 100 ft
		6 1/4 in. to 590 ft
Casing schedule (outside diam)		7 in. to 97 ft
		4 1/2 in. to 578 ft
TH-B	Depth 650 ft	
Hole diam		9 5/8 in. to 100 ft
		6 1/4 in. to 650 ft
Casing schedule (outside diam)		7 in. to 97 ft
		4 1/4 in. to 566 ft
TH-C	Depth 750 ft	
Hole diam		9 5/8 in. to 100 ft
		6 1/4 in. to 500 ft
Casing schedule (outside diam)		7 in. to 97 ft
		4 1/4 in. to 750 ft
TH-D	Depth 500 ft	
Hole diam		9 5/8 in. to 100 ft
		6 1/4 in. to 750 ft
Casing schedule (outside diam)		7 in. to 97 ft
		4 1/4 in. to 500 ft

Note: TH-A,-B,-C,-D were mud-rotary drilled and cored at intervals; 4-1/4 in.-outside-diam (o.d.) final string for heat-flow measurements: no slots, open end. Only the surface string had a 7-in.-o.d. pipe cemented in.

Source: Purtymun 1973.

TABLE XXVI-B. Precambrian Test Holes PC-1 and PC-2

PC-1 | December 1983 | Elevation 8400 ft

Log	Thickness (ft)	Depth (ft)
Overburden	12	12
Bandelier Tuff	181	193
Abo Formation	814	1007
Madera Limestone	1171	2178

Note: Completed in granite wash above the Precambrian. Hole cased to depth of 2175 ft. Drilled by cable tool. No geophysical logs. Geology by Dan Miles in Purtymun et al. 1987.

PC-2 | December 1983 | Elevation 8623 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	394	394
Abo Formation	737	1131
Madera Limestone	694	1825

Note: Hole blew out at a depth of 1825 ft when a pocket of gas was encountered; hole cased to a depth of 1819 ft. Drilled by cable tool. No geophysical logs. Geology by Dan Miles in Purtymun et al. 1987.

Source: Purtymun et al. 1987.

TABLE XXVI-C. Geologic Logs and Construction Data for Supply Wells at Fenton Hill

Supply Wells

FH-1 August 1976 Elevation 8690 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	50	50
Paliza Canyon Formation	310	360
Abiquiu Tuff	90	450

FH-2 December 1980 Elevation 8691 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	50	50
Paliza Canyon Formation	310	360
Abiquiu Tuff	73	433
Abo Formation	17	450

FH-3 March 1980 Elevation 8692 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	50	50
Paliza Canyon Formation	310	360
Abiquiu Tuff	95	455
Abo Formation	5	460

Well Construction FH-1, FH-2, and FH-3

	FH-1	FH-2	FH-3
Diameter of Casing (in.)	7[a]	16	16
Depth Cased (ft)	450	450	460
Depth to Water (ft)	372	371	373
Elevation to Water Surface (ft)	8318	8320	8319
Thickness to Aquifer (ft)	78+	63	85
Length of Screen or Slots (ft)	60[b]	59[c]	69[c]
Specific Capacity (gpm/ft)	100+	≈1	<1

[a]Set with screen on liner 5-1/2 in.
[b]Slotted screen 0.025-in. slots
[c]Torch-slotted casing.

Note: Water levels from 1980 measurements.

Source: Becker et al. 1981.

TABLE XXVI-D. Surface Water Quality at Water Stations in the Jemez Mountains

Sodium Chloride	Remarks
Redondo Creek (U)	above confluence with Sulphur Creek
Jemez River (R)	below confluence with Rio Guadalupe
Calcium Bicarbonate	
San Antonio Creek (N)	above confluence with Sulphur Creek
Rio Cebolla (T)	below confluence with Lake Fork Canyon
Rio Guadalupe	above confluence with Jemez River
Lake Fork 1 (LF-1)	at crossing to stock corral
Lake Fork 2 (LF-2)	change in channel gradient
Lake Fork 3 (LF-3)	bend in road, old beaver dam in channel
Lake Fork 4 (LF-4)	below corral on north side of valley
Calcium Sulfate	
Sulphur Creek (V)	at SR-4 above confluence with Redondo Creek
Sulphur Creek (F)	above confluence with San Antonio Creek
Sodium Bicarbonate	
Jemez River (J)	at U.S. Geol. Survey gaging station

Note: Letters or combinations of letters and numbers refer to the sampling locations shown in Fig. XXVI-F.

Sources: Purtymun et al. 1974 and 1991.

TABLE XXVI-E. Ground Water Quality at Water Stations in the Jemez Mountains

Sodium Chloride	Remarks
Location JF-1	Limestone Spring (mineral) CMP under SR-4
Location JF-5	Soda Dam (Hot Spring) west side SR-4
Calcium Bicarbonate	
FH-1	supply well Fenton Hill site
FH-2	observation well Fenton Hill site
Location 6	spring overflow (pump house) in valley
Location 27	artesian well overflow from tank
Location 39	USFS cattle tank—Lake Fork Canyon
Location 42	well (Goldstone)
Location 48	well (La Cueva Lumber Yard)
Location 53	well (Crane, Sulphur Creek)
Location 54	well (Hansen, Sulphur Creek)
Location 55	well (Olsen, Sulphur Creek)
Sodium Bicarbonate	
JS-2,3	USFS Compound—Water Supply Jemez
JS-4,5	USFS Office—Water Supply Jemez
Location 4	Hofheins, Community Water Source
Location 31	Cold Spring—discharge Bandelier Tuff
RV-2	San Antonio Hot Spring
RV-4	Spence Hot Spring
RV-5	McCannley Hot Spring
Location 47	well (Lewis)

Note: Numbers or combinations of numbers and letters refer to the sampling locations shown in Fig. XXVI-F.

Sources: Purtymun et al. 1974 and 1991.

TABLE XXVI-F. Locations and Elevations (NAD 1927)

A. Heat-Flow Sites

No locations (generalized in Fig. XXVI-A)

B. Test Holes

GT-1	N 1,784,600	E 375,600	8475 ft
TH-A	N 1,775,700	E 376,700	8450 ft
TH-B	N 1,799,600	E 380,600	8625 ft
TH-C	N 1,808,600	E 389,300	8700 ft
TH-D	N 1,779,600	E 363,400	7900 ft
PC-1	N 1,774,600	E 378,000	8400 ft
PC-2	N 1,774,400	E 371,500	8623 ft

C. Supply Well and Observation Holes

No coordinates or elevations (within TA-57, see Fig. XXVI-C)

TA-57	N 1,775,800	E 375,000	8700 ft

D. Surface Water Stations

Redondo Creek (U)	N 1,774,500	E 388,100	7750 ft
Jemez River (R)	N 1,699,300	E 356,200	5645 ft
Jemez River (S)	N 1,699,900	E 356,100	5650 ft
San Antonio Creek (N)	N 1,770,800	E 384,700	7620 ft
Rio Cebolla (T)	N 1,766,200	E 348,000	7460 ft
Rio Guadalupe (Q)	N 1,699,900	E 355,900	5650 ft
Lake Fork 1 (LF-1)	N 1,769,800	E 360,500	7845 ft
Lake Fork 2 (LF-2)	N 1,768,300	E 357,000	7800 ft
Lake Fork 3 (LF-3)	N 1,766,800	E 352,500	7610 ft
Lake Fork 4 (LF-4)	N 1,766,900	E 350,800	7510 ft
Sulphur Creek (V)	N 1,774,700	E 386,800	7720 ft
Sulphur Creek (F)	N 1,770,900	E 385,000	7620 ft
Jemez River (J)	N 1,756,500	E 381,300	6750 ft

E. Ground Water Stations

Location JF-1 (Hot Spring)	N 1,757,500	E 382,300	6780 ft
Location JF-5 (Hot Spring)	N 1,743,600	E 370,600	6400 ft
FH-1 Supply Well	N 1,775,800	E 375,000	8675 ft
FH-2 Observation Well	N 1,775,800	E 375,000	8692 ft
Location 6 (Spring)	N 1,772,800	E 383,600	7670 ft
Location 27 (Well)	N 1.773,600	E 383,900	7650 ft
Location 39 (Spring)	N 1,770,300	E 361,900	7880 ft
Location 42 (Well)	N 1,772,300	E 381,400	7840 ft
Location 48 (Well)	N 1,771,200	E 384,600	7630 ft
Location 53 (Well)	N 1,776,700	E 388,800	7835 ft
Location 54 (Well)	N 1,776,200	E 388,200	7795 ft
Location 55 (Well)	N 1,776,600	E 388,500	7805 ft
JS-2, 3 (Spring)	N 1,735,700	E 369,300	6220 ft
JS-4, 5 (Spring)	N 1,741,100	E 370,800	6265 ft
Location 4 (Well)	N 1,773,000	E 382,200	7760 ft
Location 31 (Spring)	N 1,767,200	E 350,900	7600 ft
RV-2 (Hot Spring)	N 1,796,800	E 383,000	8360 ft
RV-4 (Hot Spring)	N 1,764,700	E 387,800	7360 ft
RV-5 (Hot Spring)	N 1,753,900	E 388,300	7340 ft
Location 47 (Well)	N 1,770,700	E 384,600	7640 ft

XXVII. GUAJE AND LOS ALAMOS RESERVOIRS

Water from Guaje and Los Alamos Reservoirs was used for municipal and industrial use at Los Alamos during the early days of the Manhattan Project (Fig. XXVII-A). Use of the water from the reservoirs was discontinued in 1959 because of intermittent periods of turbidity caused by storm runoff and because of difficulties in maintaining bacteriological levels below the limits allowed for municipal supply.

Both of the reservoirs and adjacent areas are open for recreational use. Water from the reservoirs is available for irrigation of lawns and shrubs in the community and Laboratory. Parts of the water lines are above ground and are subject to freezing; thus, water use from the reservoirs is limited to the period from late spring to early fall.

Guaje Reservoir in upper Guaje Canyon has a capacity of 250 000 gallons and has a drainage area of 5.6 sq mi. The reservoir is for diversion rather than storage, as perennial flow is maintained by a spring in the canyon above the reservoir. Water flows by gravity through 6.8 miles of distribution lines to Los Alamos.

Los Alamos Reservoir in upper Los Alamos Canyon has a capacity of about 13 000 000 gallons and has a drainage area of 6.4 sq mi. Water flows by gravity through 2.6 miles of distribution lines to the townsite.

Since 1958, the water lines from both reservoirs have not been part of, or been connected to, the distribution system for the municipal water supply.

REFERENCES

Black and Veatch, "Report on Water Supply, Los Alamos Project, New Mexico," Consulting Engineers, Kansas City, Mo. Administrative Report to the U.S. Atomic Energy Commission (1951).

W. D. Purtymun, M. N. Maes, and S. G. McLin, "Water Supply at Los Alamos During 1988," Los Alamos National Laboratory report LA-11679-PR (1989).

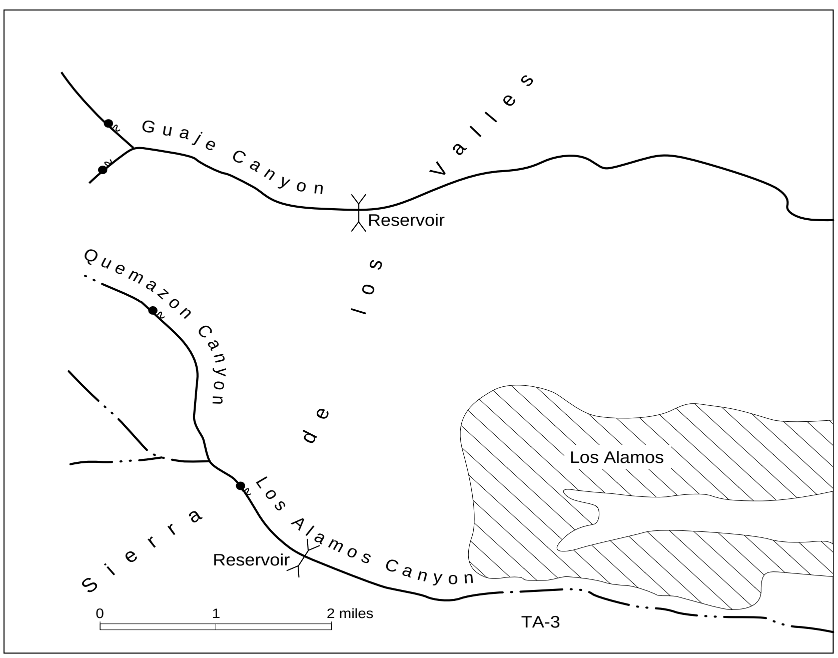


Fig. XXVII-A. Locations of Guaje and Los Alamos reservoirs.

TABLE XXVII-A. Locations and Elevations (NAD 1927)

Guaje Reservoir	N 1,794,000	E 471,600	8017 ft
Los Alamos Reservoir	N 1,777,200	E 468,600	7659 ft

XXVIII. LOW-FLOW INVESTIGATIONS IN SANTA CLARA, GUAJE, LOS ALAMOS, AND FRIJOLES CANYONS

Low-flow investigations were made in Santa Clara, Guaje, Los Alamos, and Frijoles Canyons in 1958, 1959, and 1960 (Fig. XXVIII-A). An additional set of measurements were made in Santa Clara Canyon in 1967. The low-flow investigations were made to relate geology or geologic structure to loss or gain in stream flow in evaluating recharge or discharge to stream-connected aquifers or the main aquifer.

Geologic sections were prepared along the stream channels of Santa Clara (Fig. XXVIII-B), Guaje (Fig. XXVIII-C), and Los Alamos Canyons (Fig. XXVIII-D), and the Rito de los Frijoles (Fig. XXVIII-E) using existing geologic maps modified by field investigations. The subsurface correlations were interpreted from outcrops and logs of existing test holes or wells.

The results of the low-flow measurements (cu ft/s) for Santa Clara, Guaje, Los Alamos, and Frijoles Canyons are shown in Tables XXVIII-A through XXVIII-D respectively. The annual runoff (volume of runoff as determined from gaging station records as compared to drainage area) for Santa Clara and Frijoles Canyons is also shown on the tables for those canyons.

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U.S. Geological Survey, "Surface Water Supply of the United States, Part 8, 1959, Western Gulf of Mexico Basins," U. S. Geol. Survey Water-Supply Paper 1632 (1962).

U.S. Geological Survey, "Surface Water Supply of the United States, Part 8, 1959," U.S. Geol. Survey Water-Supply Paper 1712 (1963).

U.S. Geological Survey, "Quality of Surface Water of the United States, Parts 7 and 8, 1959, Lower Mississippi River Basin and Western Gulf of Mexico Basins," U.S. Geol. Survey Water-Supply Paper 1744 (1961).

U.S. Geological Survey, "Quality of Surface Water of the United States, Parts 7 and 8, 1960, Lower Mississippi River Basins and Western Gulf of Mexico Basins," U.S. Geol. Survey Water-Supply Paper 1814 (1962).

W.D. Purtymun, "Geohydrology of the Pajarito Plateau with Reference to Quality of Water, 1949–1972," Los Alamos Scientific Laboratory, internal document, 1975.

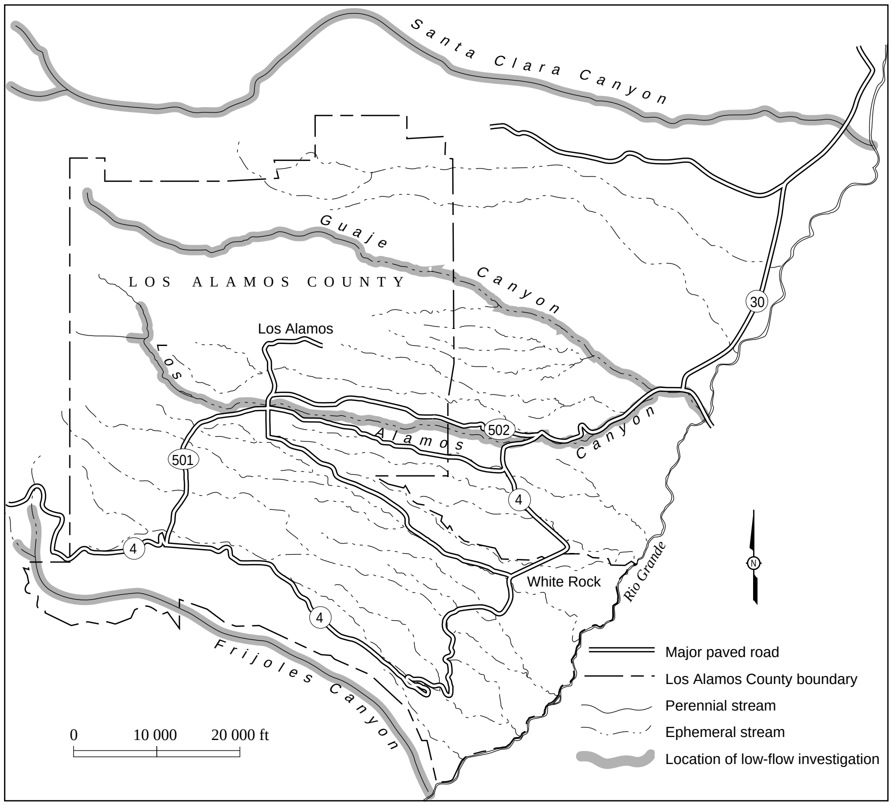

Fig. XXVIII-A. Locations of low-flow investigations in Santa Clara, Guaje, Los Alamos, and Frijoles Canyons.

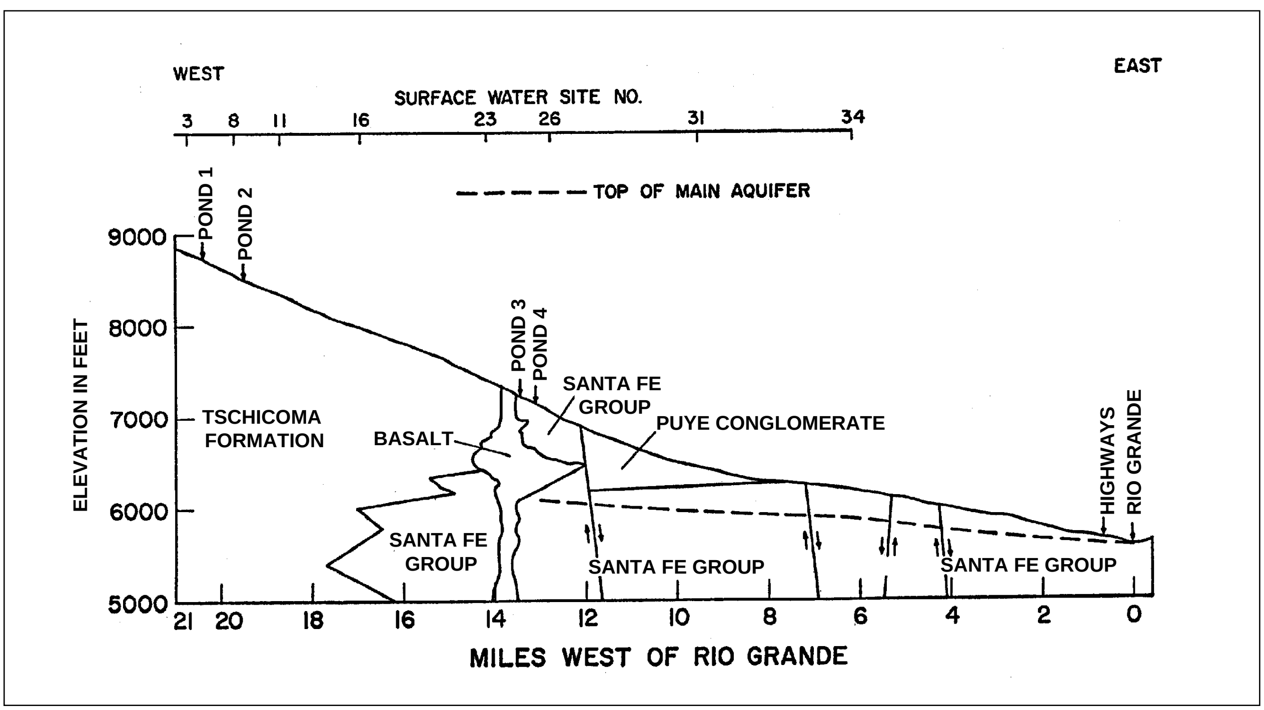

Fig. XXVIII-B. Geologic section of Santa Clara Canyon showing locations of low-flow measurements.

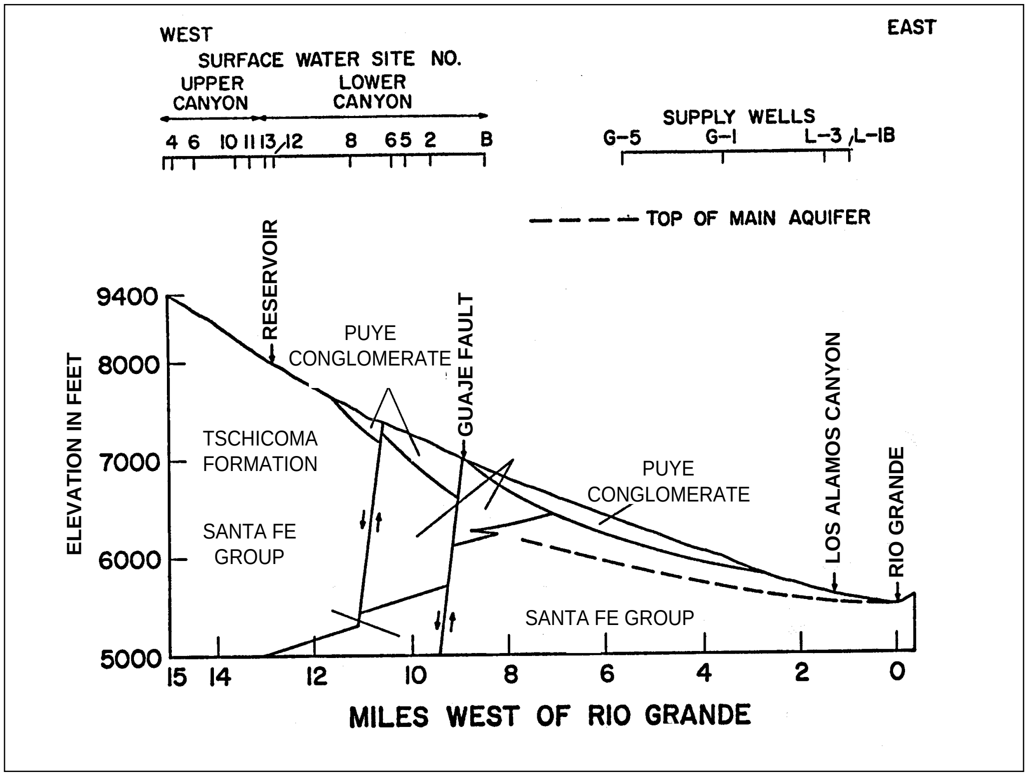

Fig. XXVIII-C. Geologic section of Guaje Canyon showing locations of low-flow measurements.

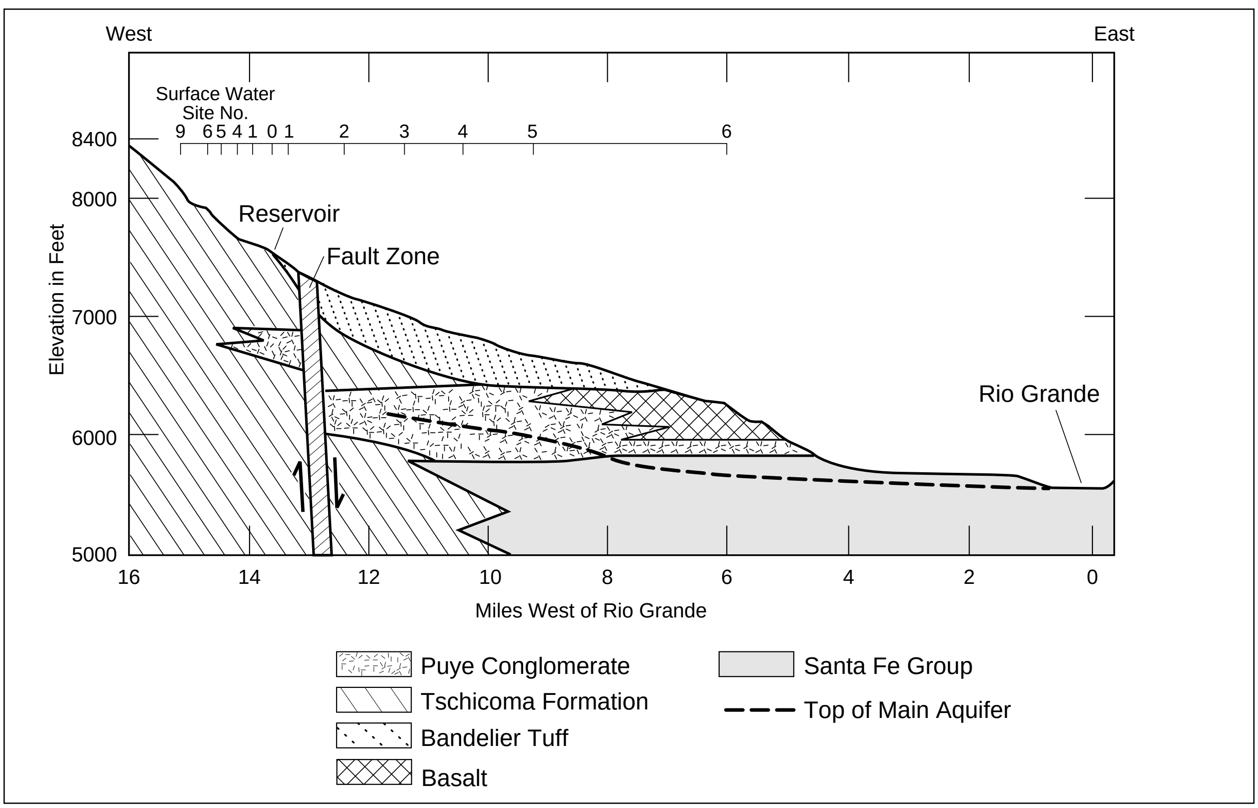

Fig. XXVIII-D. Geologic section of Los Alamos Canyon showing locations of low-flow measurements.

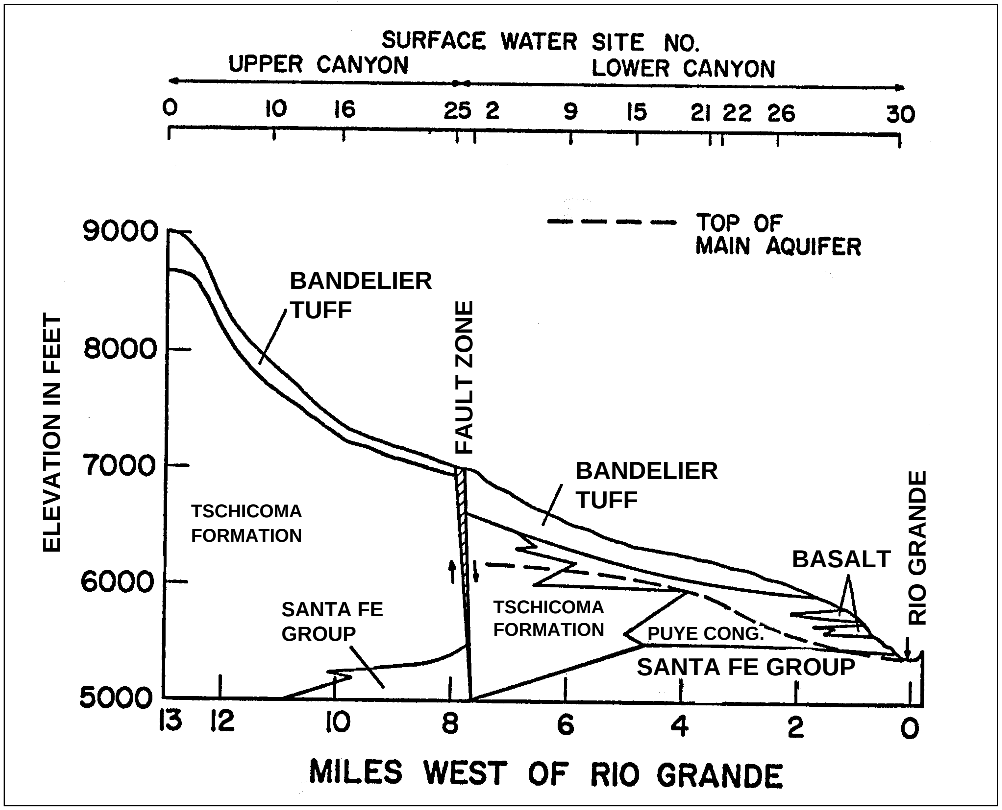

Fig. XXVIII-E. Geologic section of Frijoles Canyon showing locations of low-flow measurements.

TABLE XXVIII-A. Low-Flow Measurements and Annual Runoff in Santa Clara Canyon

Santa Clara Low-Flow Measurements (cubic feet per second)

	1958	1959				1960		1967
Site No.	Oct. 14–15	Apr. 14	June 2	Aug. 31	Oct. 12–14	May 16–17	June 20–22	June 30
3	2.0	2.2	2.7	2.6	2.2	5.4	1.9	—
8	4.0	4.0	4.9	4.1	3.4	7.1	2.0	3.6
11	4.0	4.1	5.2	4.8	3.8	8.6	2.8	3.5
16	4.6	5.4	4.9	5.6	4.5	8.6	2.8	3.4
23	4.5	5.4	5.2	6.1	4.3	7.9	3.7	3.4
26	3.9	6.0	5.3	4.9	4.2	8.8	4.3	3.2
31	5.5	5.0	4.6	5.3	3.4	8.3	3.6	2.7
34	3.1	3.6	3.9	4.3	3.2	7.4	2.1	—

Annual Runoff at Gaging Station in Santa Clara Canyon

Water Year	Annual Runoff	
	Acre Feet	Inches
1937	3368	1.8
1938	3039	1.7
1939	2630	1.4
1940	2825	1.5
1941	5602	3.0
1950	2460	1.3

Drainage area 34.5 sq mi.

TABLE XXVIII-B. Low-Flow Measurements in Guaje Canyon

Guaje Canyon Low-Flow Measurements (cubic feet per second)

1958		1959				1960		1967	
Site No.	Oct. 17	Apr. 15	June 3	Sept. 1 & 4	Oct. 12–14	May 16–17	June 20–22	May 3[a]	June 9[a]
4	0.2	0.2	0.3	0.5	0.2	0.4	0.3		
6	0.4	0.4	0.4	1.0	0.4	1.0	0.5		
10	0.4	0.4	0.5	2.0	0.4	1.1	0.5		
11	0.5	0.5	0.5	2.0	0.4	1.0	0.6		
13	0.4	0.6	0.4	2.7	0.5	1.5	0.5	0.34	0.31
Dam[b]									
12	0.3	0.7	0		0	0.9	0	0.36	0.34
8	0.3	0.8	0.04		0.01	0.8	0.04	0.29	0.26
6	0.2	0.5	0.02		0	1.0	0.05	0.24	0.21
5	0.03	0.3	0		0	1.0	0	0.17	0.15
2	0.05	0.4	0.04		0.08	1.2	0.1	0.21	0.18
B	0	—	0		0	0.9	0	0	0

[a] Measurements with Parshall flume.

[b] Water diverted to Los Alamos on all runs except April 15, 1959.

TABLE XXVIII-C. Low-Flow Measurements in Los Alamos Canyon

Los Alamos Canyon Low-Flow Measurements (cubic feet per second)

	1958	1959			1961
Site No.	May 23	Oct. 30	Apr. 15	May 15	Apr 27
9	—	0.0	0.0	0.0	—
6	—	0.4	0.3	0.4	—
5	—	0.1	0.4	0.4	—
4	—	0.1	0.4	0.4	—
1	—	0.1	0.5	0.5	—
Dam					
1	—	—	—	—	3.2[a]
2	—	—	—	—	3.2
3	9.0[a]	—	—	—	2.9
4	—	—	—	—	3.1
5	6.3	—	—	—	1.2
6	5.5	—	—	—	0.3

[a] Runoff over dam.

TABLE XXVIII-D. Low-Flow Measurements and Annual Runoff in Frijoles Canyon

Frijoles Canyon Low-Flow Measurements (cubic feet per second)

Site No.	1958 Oct. 20	1959 Apr. 16	1959 Apr. 29	1959 June 2–3	1959 Sept. 2–3	1959 Oct. 12–14	1960 May 16–17	1960 June 20–22
10	—	—	0.9	0.5	0.3	0.1	0.9	0.5
16	—	—	1.4	0.9	0.6	0.6	1.4	0.9
25	—	—	2.1	1.5	1.2	1.2	1.6	1.2
2	1.9	2.7	—	1.6	—	1.4	2.1	1.2
9	1.2	2.6	—	1.5	1.2	1.0	1.5	0.8
15	1.5	2.4	—	1.1	1.2	1.1	—	0.9
21	1.2	2.2	—	1.3	1.2	1.0	1.7	1.0
22	1.3	2.6	—	1.1	1.1	1.0	1.5	0.8
26	1.2	1.6	—	1.1	1.2	0.8	1.4	0.8
30	—	—	—	—	0.7	0.5	1.2	0.3

Annual Runoff at Gaging Station in Frijoles Canyon

Water Year	Annual Runoff	
	Acre Feet	Inches
1960	1332	2.8
1961	1180	2.5
1962	1240	2.6
1963	—	—
1964	580	0.6
1965	830	0.8
1966	735	0.8
1967	673	0.7
1968	1260	1.3
1969	1040	1.1

Gaging station moved in 1963; drainage area 1960–1962, 8.9 sq mi; 1964–1967, 17.5 sq mi.

TABLE XXVIII-E. Locations and Elevations

Locations of low-flow stations in each of the four canyons are shown in Figs. XXVII-B through E.

XXIX. SURFACE WATER GAGING STATIONS ON THE RIO CHAMA, RIO GRANDE, JEMEZ RIVER, RIO GUADALUPE, SANTA CLARA CREEK, AND RITO DE LOS FRIJOLES

Surface water stations that have gaging records on the Rio Chama, Rio Grande, Jemez River, Rio Guadalupe, Santa Clara Creek, and Rito de los Frijoles have been used in monitoring the quality of surface and ground water at or adjacent to Los Alamos or in low-flow investigations in the area (Fig. XXIX-A). The stations have been operated by the U.S. Geological Survey Water Resources Division in Albuquerque, New Mexico. The Laboratory has used these stations upgradient from Los Alamos for the collection of surface water for chemical and radiochemical background, and to evaluate the effect (if any) of the Laboratory's operation on the downgradient stations.

A. Rio Chama

The Rio Chama at Chamita has a drainage area of about 3144 sq mi in north-central New Mexico and a small part of southern Colorado. The Rio Chama is tributary to the Rio Grande about 2.5 mi west of the gaging station. The river also receives some transmountain diversion water from the San Juan River. The period of record is from October 1912 to 1990. The range in discharge during the period of record has been from no flow at times to as much as 15 000 cfs (cubic ft/sec) on May 22, 1920.

B. Rio Grande

The three stations on the Rio Grande used for monitoring that have gaging stations are at Embudo, Otowi, and Cochiti. A fourth station that has no gaging station at present but is used for monitoring is on the Rio Grande at Bernalillo (Fig. XXIX-A).

The Rio Grande at Embudo has a drainage area of about 10 400 sq mi in north-central New Mexico and southern Colorado. The period of record is from January 1889 to 1990. The discharge during the period of record has ranged from 130 cfs on June 30, 1902, to 16 200 cfs on June 19, 1903.

The Rio Grande at Otowi has a drainage area of about 14 300 sq mi in north-central New Mexico and southern Colorado. The period of record is from February 1895 to 1905 and from June 1909 to 1990. The discharge during the period of record has ranged from 60 cfs July 4–5, 1902, to 24 400 cfs May 23, 1920.

The Rio Grande below Cochiti Dam has a drainage area of about 14 900 sq mi in north-central New Mexico and southern Colorado. The period of record is from October 1970 to 1990. The discharge is controlled by Cochiti Reservoir and has ranged from 0.5 cfs August 3–5, 1977, to 10 300 cfs on July 26, 1971.

The Rio Grande at Bernalillo (at SR-44) has been used as a monitoring station from the early 1970s. The drainage area above the station is 25 400 sq mi in north-central New Mexico and southern Colorado. A gaging station was operated at the site from May 1941 to September 1969, when it was discontinued. The discharge during the period of record ranged from no flow at times to 25 400 cfs.

C. Jemez River

There are two gaging stations on the Jemez River and one on the Rio Guadalupe, a tributary of the Jemez, that are near or at monitoring stations.

The upper gaging station is on the Jemez River below the East Fork, Jemez Springs, NM. The drainage area above the station is 173 sq mi, mainly from the Valles Caldera. The periods of record are from July 1949 to October 1950, May 1951 to September 1957, March 1958 to September 1976, and July 1981 to September 1990, when the station was discontinued.

The discharge during these periods ranged from 0.9 cfs on January 24, 1969, to 2500 cfs on April 21, 1958.

The second station lies on the Jemez River below the confluence with the Rio Guadalupe, near Jemez, NM. Its drainage area is about 470 sq mi, from the Valles Caldera and the western side of the caldera. The periods of record are from June 1936 to May 1941, August 1949 to October 1950, May 1951 to September 1952, and March 1953 to 1990. The discharge during these periods ranged from 1.2 cfs on July 25, 1981, to 5900 cfs April 21, 1958.

D. Rio Guadalupe

The drainage area above the gaging station on the Rio Guadalupe at Box Canyon, NM is about 235 sq mi, along the western side of the Valles Caldera. The periods of record are from November 1938 to September 1942, August 1949 to September 1950, May 1951 to September 1957, May 1958 to September 1976, and July 1981 to 1990. The discharge during these periods ranged from 2.8 cfs on December 9, 1967, to 3190 cfs on May 13 and 14, 1941.

E. Santa Clara Creek

Low-flow investigations utilized some of the data from the gaging station on Santa Clara Creek. Santa Clara Creek is on the Santa Clara Pueblo Indian Reservation. The drainage area above the gaging station is 34.5 sq mi, along the eastern flank of the Sierra de los Valles and part of the Pajarito Plateau. The creek discharges into the Rio Grande. The periods of record for the station are from February 1936 to September 1941, August 1949 to September 1961, and April 1984 to 1990. There is some diversion for irrigation above the gage. The discharge during the periods of record ranged from no flow August 8–13, 1984 and March 9, 1990 (during periods of extreme diversion), to 970 cfs on September 22, 1941.

F. Rito de los Frijoles

The Rito de los Frijoles heads on the flanks of the Sierra de los Valles and has cut a deep canyon across the Pajarito Plateau to discharge into the Rio Grande. The stream and canyon are in Bandelier National Monument. Gaging stations have been operated on the Rito de los Frijoles at two different locations. In 1959 a station was located about 5.8 mi west of the park headquarters at the upper crossing. The station was operated at the western edge of the Pajarito Plateau (at the Pajarito Fault Zone) to aid in the low-flow investigations. In 1963 the station was moved to the park headquarters, to monitor flow across the plateau.

The drainage area above the gaging station at the upper crossing (on the flanks of the mountains) is 8.9 sq mi. The period of record for the station was from August 1959 to October 1963. The discharge during that period ranged from 0.7 cfs on April 7, 1960, to 13 cfs on June 29, 1960.

When the station was moved to near the park headquarters, the drainage area above the station increased to 18.1 sq mi. The periods of record for the new station were July 1963 to September 1969 and July 1977 to September 1982. The discharge ranged from no flow (due to a freeze-up) on February 6, 1968, to 3030 cfs on July 21, 1978. Prior to the 1977 forest fire that destroyed 44% of the vegetation and trees in the drainage area, the largest discharge was 19 cfs on June 18, 1965. The forest fire changed the runoff characteristics of the canyon.

REFERENCES

W. D. Purtymun, “Geohydrology of Bandelier National Monument, New Mexico,” Los Alamos Scientific Laboratory report LA-5716-MS (1980).

Surface Water Records for the above U.S. Geol. Survey Gaging Stations from 1936 to 1961 are found in the annual reports “Surface Water Supply of the United States, Part 8, Western Gulf of Mexico Basins,” U.S. Geol. Survey Water-Supply Papers.

Surface Water Records for the above U.S. Geol. Survey Gaging Stations from 1961 through 1990 are found in the annual reports “Water Resources Data For New Mexico,” U.S. Geol. Survey, Water Resources Division, Albuquerque, New Mexico.

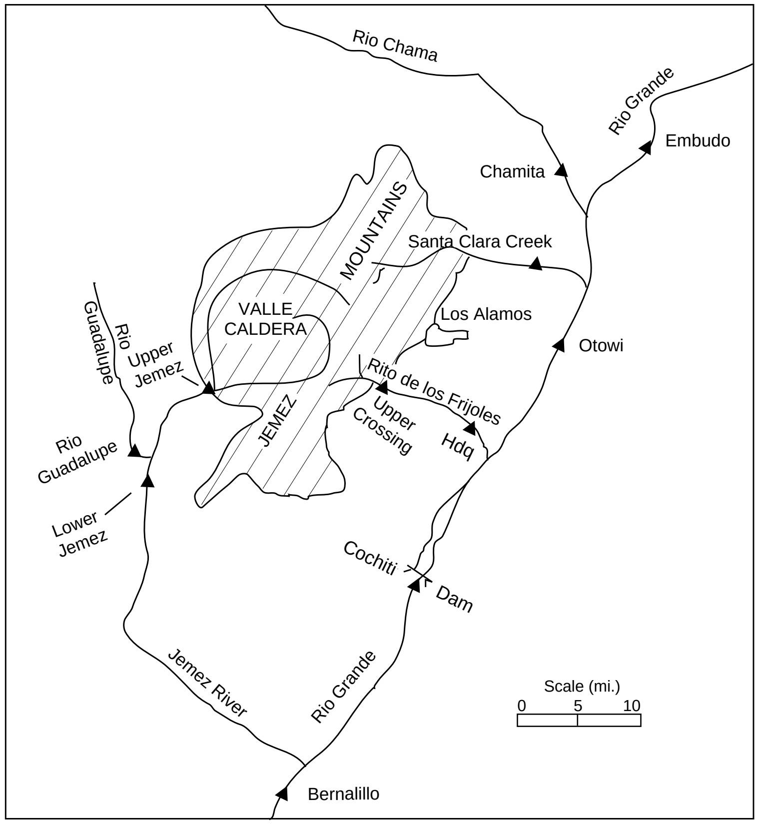

Fig. XXIX-A. Locations of gaging stations on the Rio Chama, Rio Grande, Jemez River, Rio Guadalupe, Santa Clara Creek, and Rito de los Frijoles.

TABLE XXIX-A. Locations and Elevations of Gaging Stations (NAD 1927)

A. Rio Chama			
Chamita	N 1,846,000	E 541,200	5660 ft
B. Rio Grande			
Embudo	N 1,874,100	E 584,400	5812 ft
Otowi	N 1,773,600	E 533,000	5495 ft
Cochiti (below dam)	N 1,685,400	E 479,500	5240 ft
Bernalillo	N 1,552,700	E 379,900	5054 ft
C. Jemez River			
Near Jemez Springs	N 1,756,200	E 381,400	6700 ft
Near Jemez Pueblo	N 1,699,600	E 353,500	5650 ft
D. Rio Guadalupe			
Box Canyon	N 1,722,000	E 347,900	6040 ft
E. Santa Clara Creek			
Gaging Station	N 1,810,300	E 525,300	6080 ft
F. Rito de los Frijoles			
Upper Crossing	N 1,751,900	E 467,100	7015 ft
Park Headquarters	N 1,738,100	E 494,500	6040 ft

XXX. STUDY OF SURFACE IMPOUNDMENT AT TA-53

The study of the surface impoundment at TA-53 was made to meet certain requirements of the Resource Conservation and Recovery Act and to support the Part B permit application for surface impoundment. The basic information collected describes the potential for human exposure to contaminants via several pathways. The main pathways referred to in this report are ground water, surface water, and release from the soil. In the course of this investigation, eight test holes were drilled; five were completed as moisture-access holes for future monitoring of the dispersion and movement of moisture from the surface impoundments; one was completed as a pore gas monitoring hole with five sampling ports at various depths; and two open holes were drilled for geologic and hydrologic information.

The moisture-access and pore gas sampling holes and one of the open holes were completed on the surface of the mesa (Fig. XXX-A). The eighth hole was completed in Sandia Canyon just south of the surface impoundment that is on the mesa top. Geologic logs and completion data for the test holes are shown on Table XXX-A. Geologic descriptions used are after Baltz (1963), Keller (1968), and Purtymun (1966); see also sections I-D4 and XXIII-G of this report. The locations and elevations of these holes were not surveyed.

REFERENCE

S. G. McLin, "Identification of Potential Pathways of Human Exposure to Hazardous Wastes Constituent Releases from the TA-53 Surface Impoundments," Los Alamos National Laboratory, Group EM-8 internal document, Sept. 6, 1991.

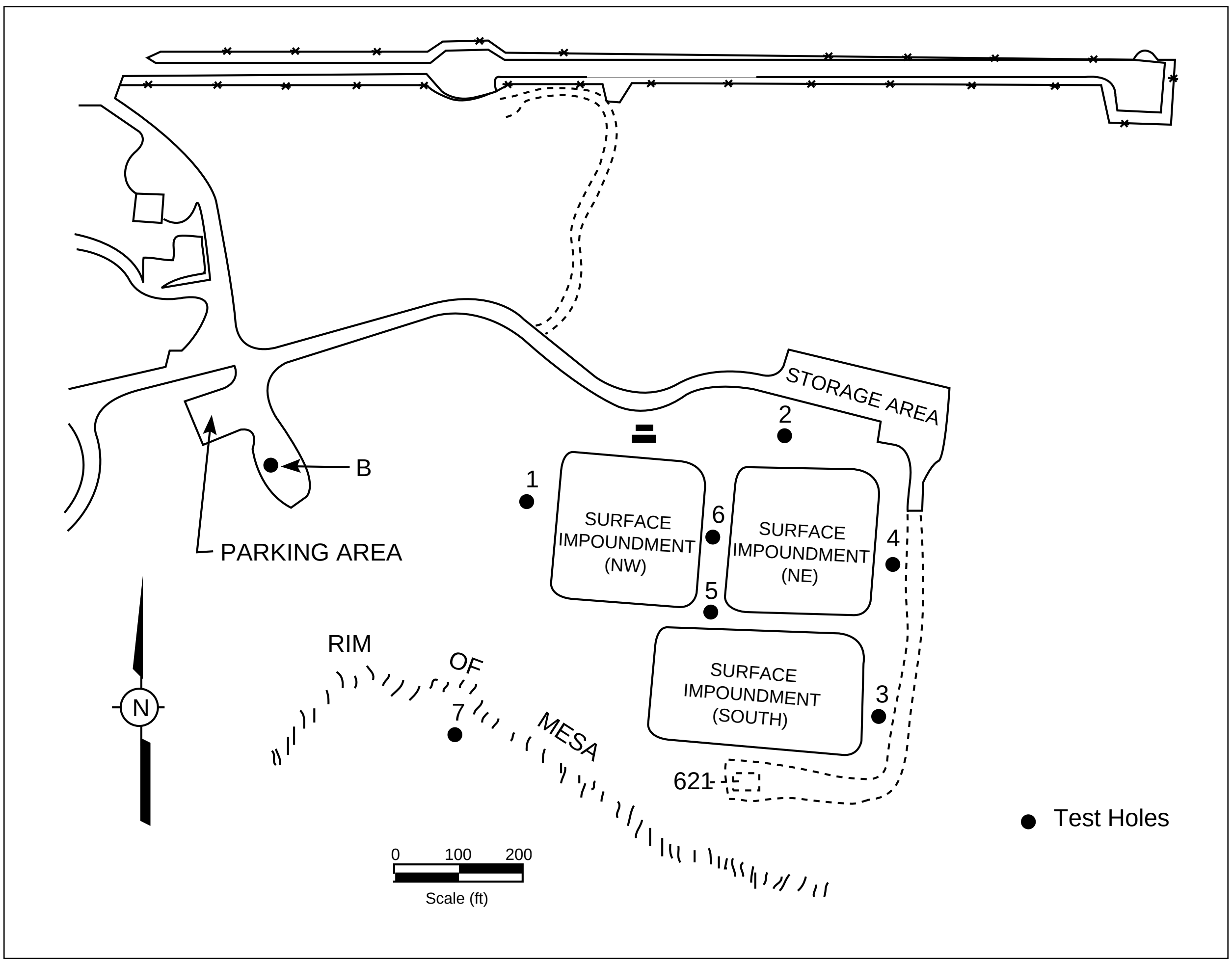

Fig. XXX-A. Locations of test holes near the TA-53 surface impoundment.

TABLE XXX-A. Geologic Logs and Construction Data for Test Holes at TA-53

1. Test Hole B-53 — Hole: Dry
Moisture-Access Hole

Log	Thickness (ft)	Depth (ft)
Surface fill material	1	1
Tuff, Tshirege Member, Unit 2B low moisture content	48	49

Construction: Hole augered to 4-in. diam; 45 ft of 2-in.-diam aluminum pipe set 0 to 45 ft; steel locking cap.

2. Test Hole 1-53 — Hole: Dry
Moisture-Access Hole

Log	Thickness (ft)	Depth (ft)
Surface fill material	1	1
Tuff, Tshirege Member, Unit 2B low moisture content	48	49

Construction: Hole augered to 4-in. diam; 46 ft of 2-in.-diam aluminum pipe set 0 to 46 ft; steel locking cap.

3. Test Hole 2-53 — Hole: Dry
Moisture-Access Hole

Log	Thickness (ft)	Depth (ft)
Surface fill material	1	1
Tuff, Tshirege Member, Unit 2B low moisture content	48	49

Construction: Hole augered to 4-in. diam; 46 ft of 2-in.-diam aluminum pipe set 0 to 46 ft; steel locking cap.

4. Test Hole 3-53 — Hole: Dry
Moisture-Access Hole

Log	Thickness (ft)	Depth (ft)
Surface fill material	1	1
Tuff, Tshirege Member, Unit 2B low moisture content	48	49

Construction: Hole augered to 4-in.-diam; 48 ft of 2-in.-diam aluminum pipe set 0 to 48 ft; steel locking cap.

5. Test Hole 4-53 — Hole: Dry
Moisture-Access Hole

Log	Thickness (ft)	Depth (ft)
Surface fill material	1	1
Tuff, Tshirege Member, Unit 2B low moisture content	48	49

Construction: Hole augered to 4-in. diam; 47 ft of 2-in.-diam aluminum pipe set 0 to 47 ft; steel locking cap.

6. Test Hole 5-53
Pore Gas Well

Hole: Dry

Log	Thickness (ft)	Depth (ft)
Surface fill material	3	3
Tuff, Tshirege Member, Unit 2B low moisture content	65	68
Tuff, Tshirege Member, Unit 2A low moisture content	32	100

Construction: Hole augered to 4-in. diam; 4 ft of aluminum casing 0 to 4 ft; cement 0 to 1 ft; bentonite 1 to 4 ft; sampling ports at 20 ft, 40 ft, 60 ft, 80 ft, and 93.5 ft; hole adjacent to sampling tube filled with sand; steel locking cap.

7. Test Hole 6-53
Open Hole

Hole: Dry

Log	Thickness (ft)	Depth (ft)
Surface fill material	3	3
Tuff, Tshirege Member, Unit 2B low moisture content	65	68
Tuff, Tshirege Member, Unit 2A low moisture content	45	113
Tuff, Tshirege Member, Unit 1B	20	133
Tuff, Tshirege Member, Unit 1A	17	150

Construction: Open hole.

8. Test Hole 7-53
Open Hole

Hole: Dry

Log	Thickness (ft)	Depth (ft)
Alluvium	1	1
Tuff, Tshirege Member, Unit 2B low moisture content	23	24
Tsankawi Member, low moisture content	19	43
Otowi Member, low moisture content	37	80

Construction: 77 ft of 2-in.-diam aluminum pipe set in hole 0 to 77 ft; bentonite pellets 0 to 0.5 ft; silica sand 0.5 to 35 ft; bentonite 35 to 37 ft; lysimeter port at 37 ft with fine silica from 37 to 39 ft; 39 ft to 40 ft silica sand; 40 to 77 ft fine sand; steel locking cap; hole cored to 6.875-in. diam; hole diam 7.25 in.

XXXI. TRANSPORT STUDIES OF URANIUM IN POTRILLO CANYON TA-36

Three shallow moisture-access holes were drilled in Potrillo Canyon in 1989 to investigate the infiltration of surface water into the alluvium. Two deeper holes were cored in 1991. These test holes were completed as wells. One had three zones at various depths separated from each other by bentonite and cement; the second well was constructed with two zones. The zones were packed with sand. The moisture-access holes and wells were completed as part of a study to determine whether there was recharge to the alluvium and underlying tuff and transport of depleted uranium from the intermittent stream in Potrillo Canyon in TA-36. The wells were installed to study the chemistry and radiochemistry of infiltrating water at different depths.

The locations of the three moisture-access holes and two wells are shown in Fig. XXXI-A. The construction and geologic logs for the moisture-access holes appear in Table XXXI-A, while the logs for the test wells appear in Figs. XXXI-B and XXXI-C.

REFERENCE

N. M. Becker, “Influence of Hydraulic and Geomorphologic Components of a Semi-Arid Watershed on Depleted Uranium Transport,” Los Alamos National Laboratory document LA-UR-93-2165.

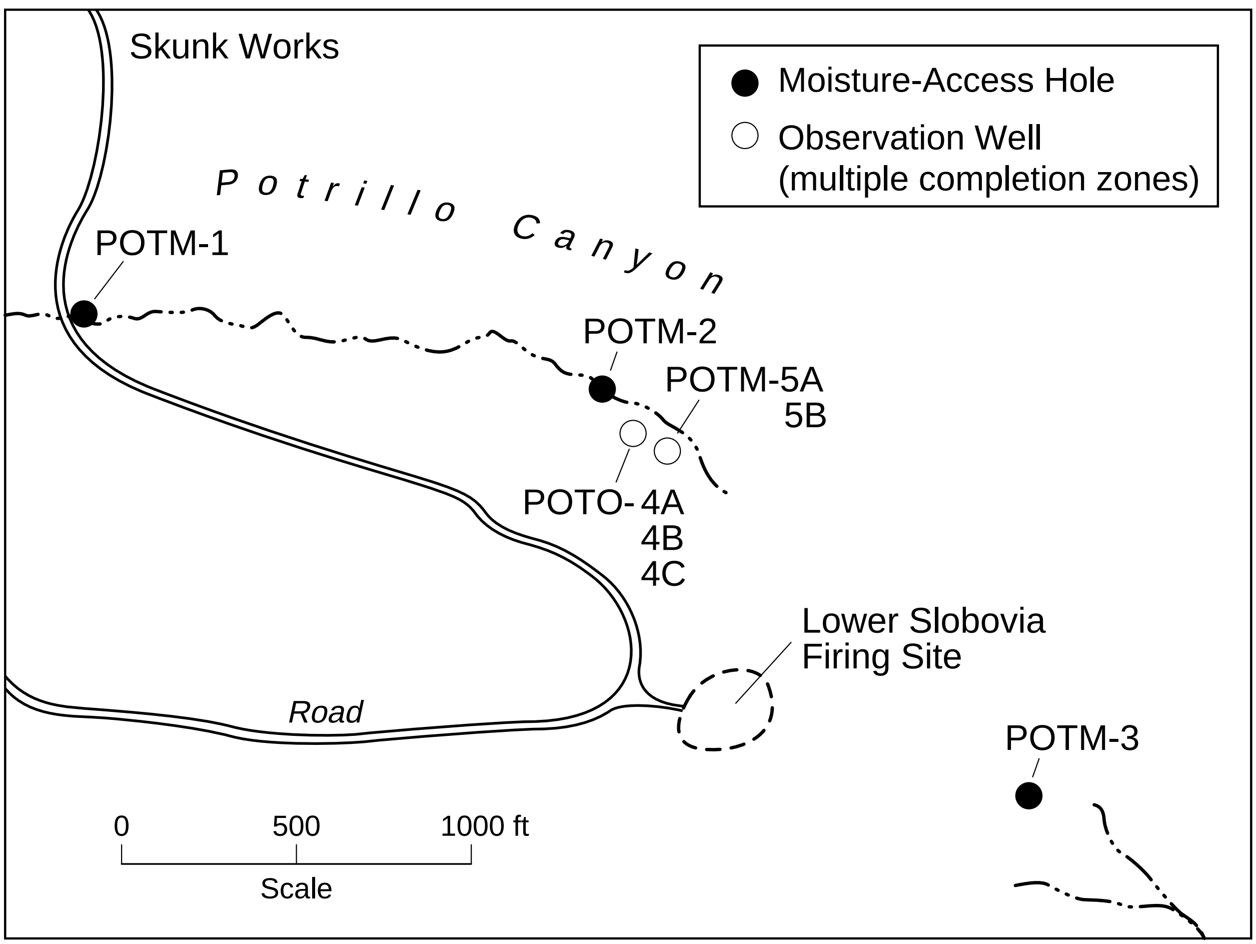

Fig. XXXI-A. Locations of moisture-access holes and observation wells in Potrillo Canyon.

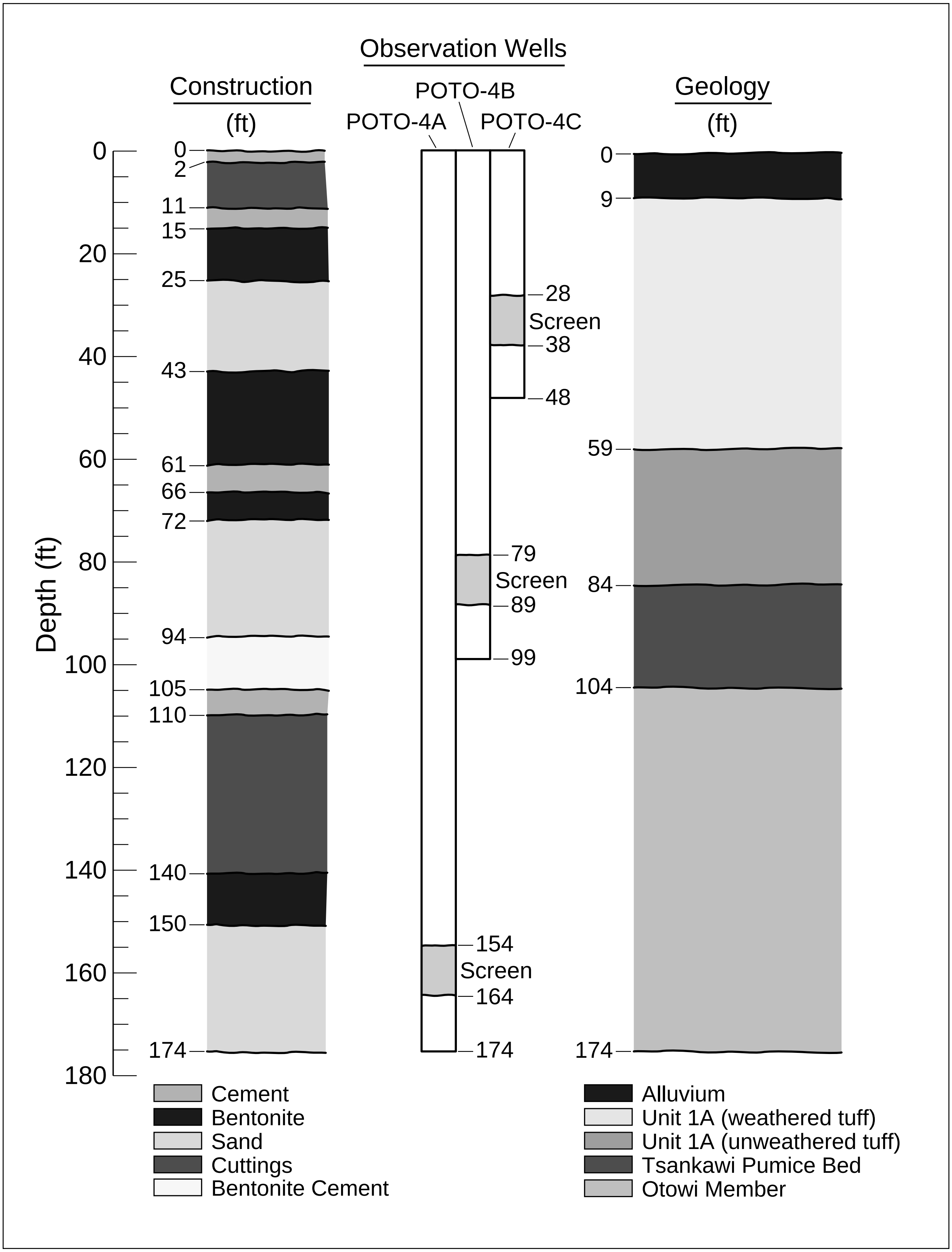

Fig. XXXI-B. Construction and geologic logs of observation wells POTO-4A, POTO-4B, and POTO-4C.

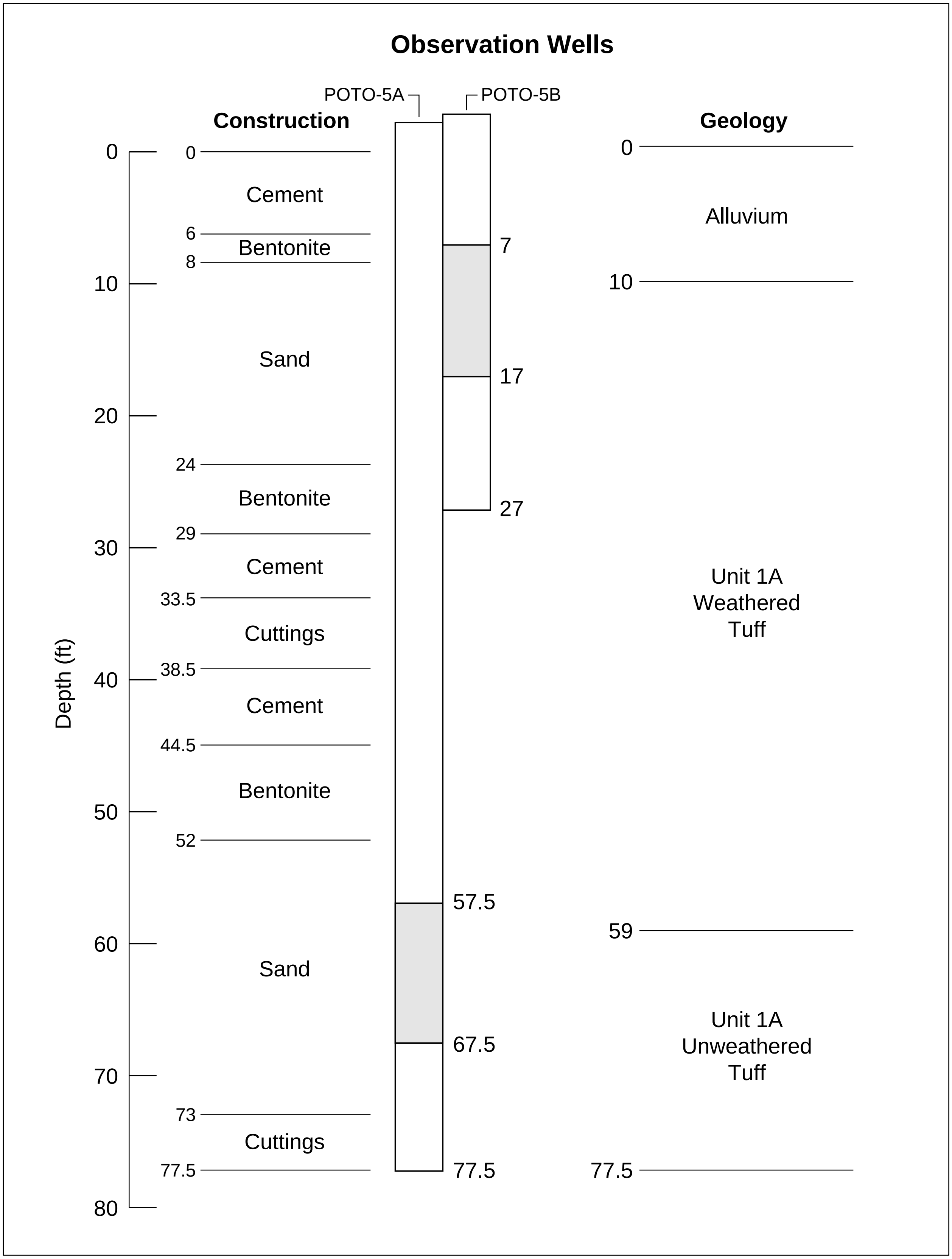

Fig. XXXI-C. Construction and geologic logs of observation wells POTO-5A and POTO-5B.

TABLE XXXI-A. Geologic Logs and Construction Data for Moisture-Access Holes in Potrillo Canyon

	POTM-1	POTM-2	POTM-3
Alluvium	0–28	0–11	0–15
Weathered Tuff (ft)	28–50	11–56	15–52
Casing Tuff (ft)	47	54	48

Construction: 2-in.-diam aluminum casing with cap welded on bottom, casing cemented in 5 to 9 ft; holes offset with shallow moisture-access holes 5 to 9 ft to study moisture content of alluvium adjacent to the cemented sections of deeper moisture-access holes.

TABLE XXXI-B. Locations and Elevations (NAD 1927)

POTM-1	N 1,757,200	E 497,600	6655 ft
POTM-2	N 1,757,100	E 498,300	6620 ft
POTM-3	N 1,755,600	E 500,000	6575 ft
POTM-4 ABC	N 1,757,000	E 498,400	6620 ft
POTM-5 AB	N 1,757,000	E 498,400	6620 ft

XXXII. SPECIAL TEST HOLES AT TA-49 TO MEASURE BAROMETRIC EFFECTS AND DEFORMATION OF THE TUFF

Two test holes were cored (7 1/4-in. diam) near the eastern edge of TA-49 near well DT-10 (Fig. XXXII-A). The holes were completed in the upper units of the Tshirege Member of the Bandelier Tuff (Fig. XXXII-B). Geologic units are those described by Weir and Purtymun (1962).

Test hole TBM-1 was constructed to measure the barometric effect in the tuff caused by atmospheric pressure changes (Fig. XXXII-C). Test hole TBM-2 was equipped with a Geodetic Biaxial Tiltmeter to determine the deformation of the tuff caused by seismic events. The wellheads for both holes have an 8-ft-sq concrete slab about 6 in. thick. Location is N 1,754,534 E 488,302 (NAD 1927) at an elevation of 7038 ft.

REFERENCES

W. D. Purtymun, Los Alamos National Laboratory, unpublished data (EM-8 field notes), 1993.

J. E. Weir and W. D. Purtymun, “Geology and Hydrology of Technical Area 49, Frijoles Mesa, Los Alamos County, New Mexico,” U.S. Geol. Survey Admin. Report (1962).

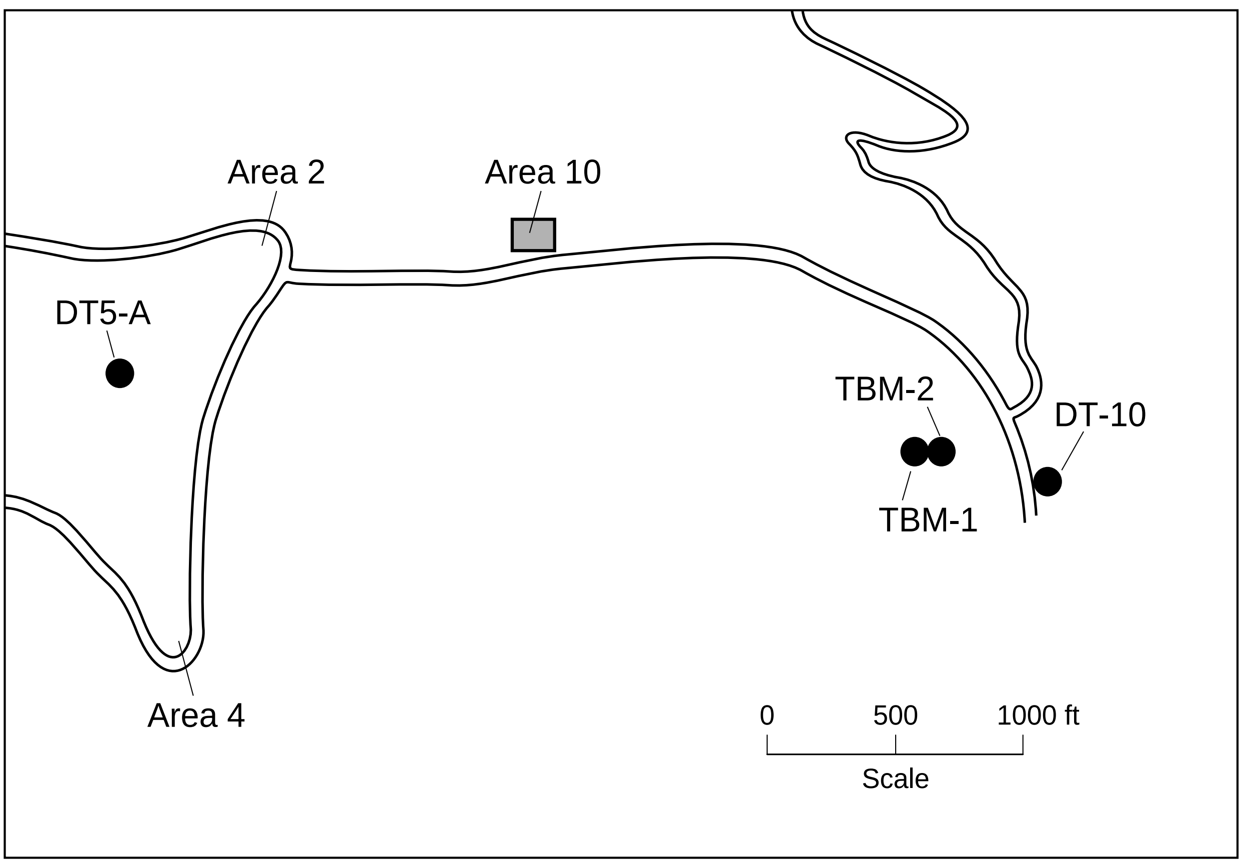

Fig. XXXII-A. Locations of test holes TBM-1 and TBM-2 at TA-49 (Purtymun 1993).

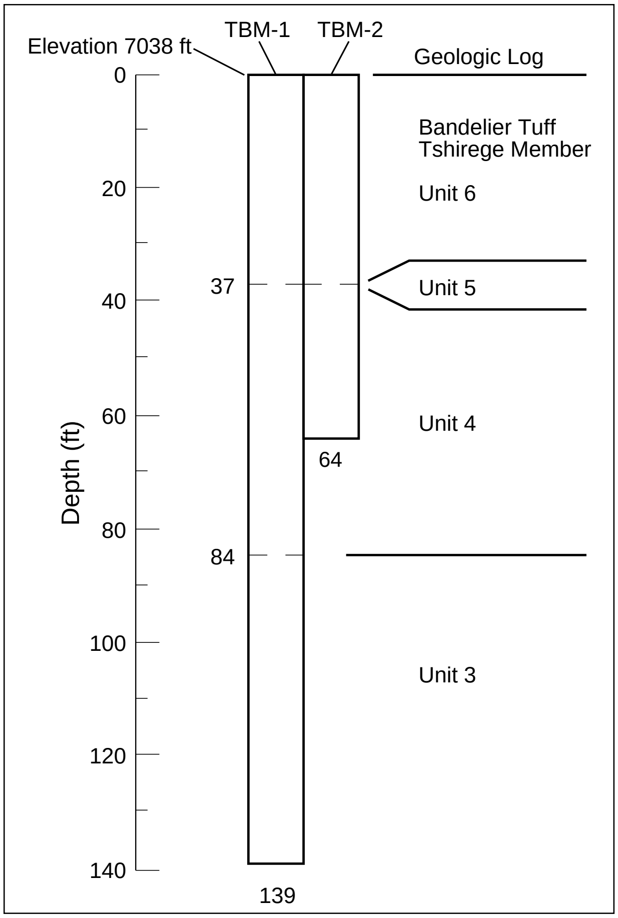

Fig. XXXII-B. Geologic logs of test holes TBM-1 and TBM-2 at TA-49 (Purtymun 1993).

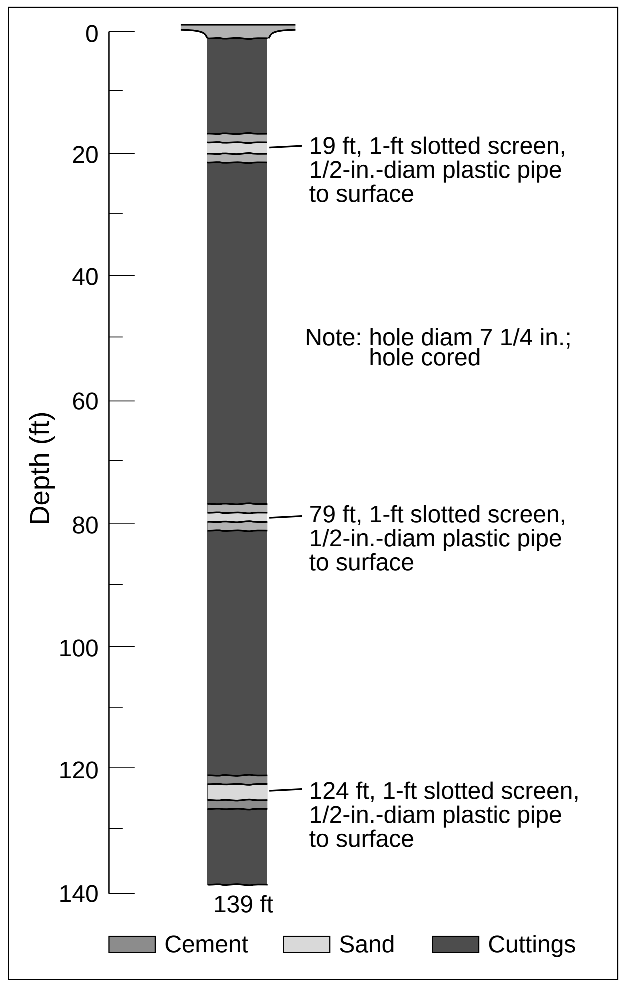

Fig. XXXII-C. Test hole TBM-1 constructed with three zones to measure barometric pressures in the tuff at depths of 19, 79, and 124 ft.

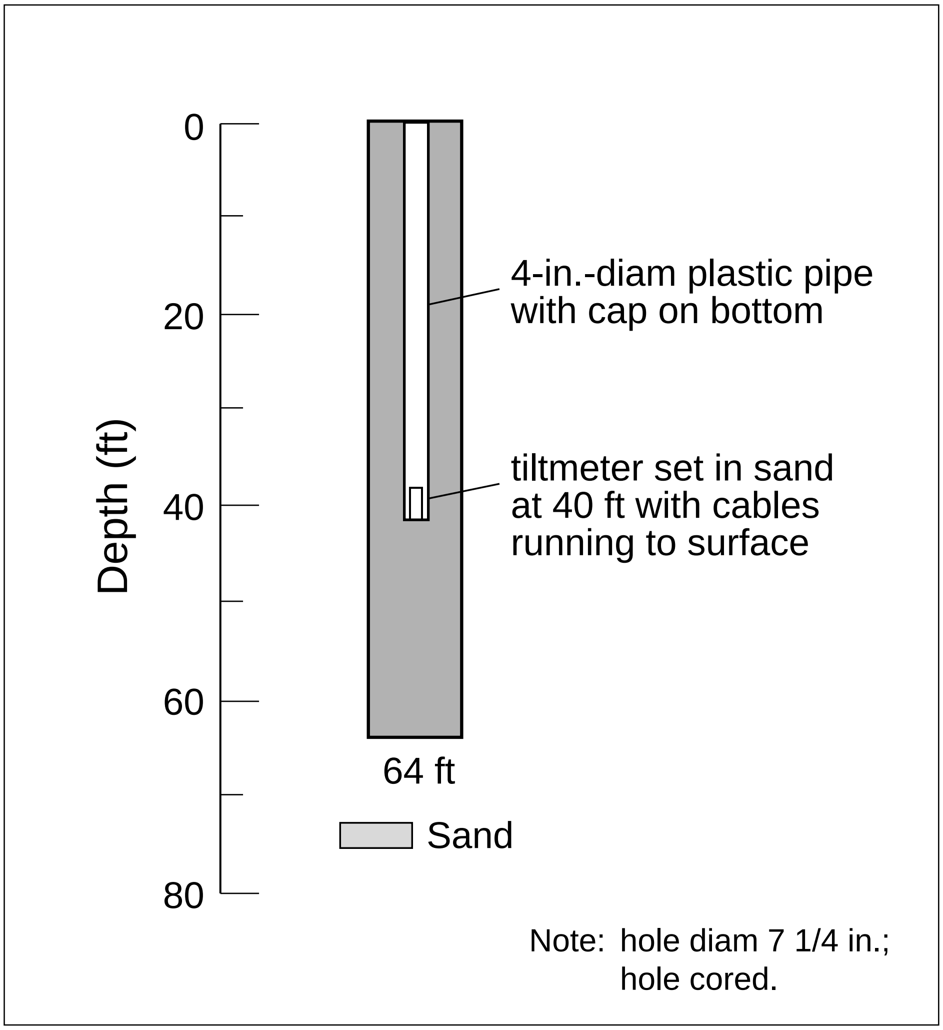

Fig. XXXII-D. Test hole TBM-2 equipped with a biaxial tiltmeter to measure deformation of the tuff at 40 ft.

Traditional drilling equipment on the CM-55 drill rig.

ACKNOWLEDGMENTS

The data contained in this report cover an almost 50-year span and were collected by many individuals. From the U.S. Geological Survey Water Resources Division, Roy Griggs, Bert Weir, Elmer Baltz, Bob Cushman, Jim Cooper, J. L. Kunkler, and John Abrahams must be acknowledged. Frank Koopman was the greatest; he taught me that the studies that were in progress were not work, but an adventure. Also acknowledged is the work of Roy Bailey and Bob Smith of the Geologic Division of the U.S. Geological Survey.

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Close ties existed with the AEC and DOE in the development of the water supply for Los Alamos. Those that provided support were Edwin Wingfield, Tom Roehl, Cecil Bingham, and Eloy Nuñez. Glenn Hammock, consulting engineer, provided technical support on drilling and well construction over a period of 26 years with the construction of 8 supply wells.

Environmental issues became a front runner in popularity in the early 1980s, but the AEC and the Laboratory began monitoring water, soil, and sediments in the mid-1940s. The Environmental Studies Group, H-8 (formed in 1971), and the Water Quality and Hydrology Group (ESH-18) have been major players in monitoring the environment. Those in the group that contributed support and collection of data used in this report are Eric Koenig, Steve McLin, Don Van Etten, and Naomi Becker. Naomi's support through countless field studies is especially appreciated. Dick Peters provided radiochemistry support and took part in many of the studies. Max Maes has been my good arm during the period from 1972 to the present. Max has collected tons of water, as well as soil and sediment samples, for analysis as part of the monitoring program. He has been a big help in reducing the hydrologic data from the supply wells into a usable form. The two of us have drilled hundreds of wells and test holes together.

The list of acknowledgments would not be complete without Alan Stoker, my mentor. He provided support, contributed to the data collection, and made suggestions for studies. I also wish to acknowledge Steven Reneau (EES-1), Jake Turin (EES-1), John Schrandt (ESH-18), Bruce Gallaher of ESH-18 (who performed the technical review of this report), and Jered Sneesby and Greg Cole of EES-1, who checked and corrected many of the NAD 1927 locations.

Special thanks are due to the staff of CIC-1 Central. Vai Stewart edited this report, harmonizing and correcting the text, figures, and tables, and coordinating the project. Many compositors (in our group as well as in CIC-1) put together the many papers and reports that make up this report. Deidre´ Plumlee composed this report's final version, revising and redrawing many of the figures. Kim Valencia and Joyce Martinez created many of the figures in the report. Patrick McFarlin contributed to the composition and the drawing of figures, as did Chad Kieffer, Karina Berta, and Zena Kolshorn. Eileen Patterson proofread the report when it was near its final form.

Although the data presented here will undoubtedly be expanded and clarified in the future, this represents the amalgamation and distillation of the efforts of three generations of investigators, who have sought to understand our local environment and who have worked hard to protect it. My hope is that this report will contribute to the continuation of that work.

Back cover photo: the venerable CM-55 coring drill rig.

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