LA-13297-MS

UC-903
Issued: October 1997

Logs and Completion Data for Water and Mass Balance Wells in Mortandad and Ten Site Canyons

Stephen G. McLin[1]
William D. Purtymun[2]
Ada S. Swanton[2]
Richard J. Koch[3]

[1]*Water Quality and Hydrology Group, Los Alamos National Laboratory*
[2]*Los Alamos Technical Associates, Los Alamos, NM*
[3]*Science Applications International Corporation, Los Alamos, NM*

Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

DISCLAIMER

LOGS AND COMPLETION DATA FOR WATER AND MASS BALANCE WELLS IN MORTANDAD AND TEN-SITE CANYONS

by

Stephen G. McLin, William D. Purtymun, Ada S. Swanton, and Richard J. Koch

Abstract

Twenty-four monitoring wells were drilled and completed in December 1994 as part of a water and mass balance study for the shallow perched aquifer in the Mortandad Canyon alluvium and in the lower part of Ten-Site Canyon. The wells penetrated the alluvium containing the aquifer and were completed into the top of the weathered tuff. Twelve of these wells encountered the Tshirege Member (Cooling Unit 1g) of the Bandelier Tuff below the canyon alluvium, while ten wells made contact with the Cerro Toledo interval, which lies between the Tshirege and Otowi Members of the Bandelier Tuff. The remaining two wells were completed into the alluvium above the weathered tuff contact. These wells provide access for continuous water level measurement and water sampling. Data from these new wells will be used to determine changes in alluvial aquifer water storage, water quality sampling, and estimation of seepage into the unsaturated Bandelier Tuff below the alluvium. This report documents drilling activities and well completion logs for the water and mass balance study. These wells also provide critical new data for fourteen north-south vertical cross-sections constructed for the canyon alluvium.

I. INTRODUCTION

Mortandad Canyon receives industrial effluents containing trace amounts of chemicals and radionuclides from the wastewater treatment plant at TA-50. The effluents, wastewaters from other areas, and natural runoff commingle and recharge a shallow aquifer in the canyon. The shallow aquifer is in the alluvium and is perched on the underlying weathered Bandelier Tuff. The aquifer is of limited areal extent because the water in the aquifer is depleted by evapotranspiration and infiltration into the underlying tuff.

A number of observation wells, test holes, and moisture access tubes have been drilled in Mortandad Canyon since 1960 (Purtymun 1995). The purpose of these older wells was to determine the geology, hydrology, and extent saturation in the shallow aquifer. In addition, these older wells have provided samples to monitor variations in the chemical and radiochemical quality of the water. However, data from these observation wells are insufficient to determine subsurface infiltration below the alluvial-tuff contact. Hence, 24 additional wells were completed in the aquifer with the specific purpose of supporting a continuous water and mass balance study for the alluvium. Measured inputs for this study include stream gaging data (Shaull et al. 1996), data on water level and water quality fluctuations in observation wells, and meteorological and evapotranspiration measurements. Data from the older observation wells, test holes, and moisture access tubes were used to select final locations for wells drilled in 1994. Several of the older observation wells may be used in the water and mass balance study to supplement information from the new wells.

The wells completed in December 1994 are designated as MCWB (Mortandad Canyon Water Balance) wells, and in an adjacent tributary canyon, as TCWB (Ten-Site Canyon Water Balance) wells. Locations of these new wells are shown in Fig. 1, while summary completion and survey data are presented in Tables 1, 2, and 3. The purpose of this report is to document drilling logs, surveyed locations, and well completion data for these new wells.

II. WELL DRILLING AND CONSTRUCTION

All of the 24 wells reported herein were drilled and completed using the same basic methods of construction. For the most part, these methods strictly follow the recommendations of the U.S. Environmental Protection Agency's (EPA) Groundwater Monitoring Technical Enforcement Guidance Document (TEGD). Adherence to these construction guidelines will insure compliance with the Laboratory's Resource Conservation and Recovery Act (RCRA)/Hazardous and Solid Waste Act (HSWA) operating permit, jointly issued by the New Mexico Environment (NMED) and EPA. Sixteen wells have screened intervals that are equal to or less than ten feet (ft) in length; these 16 wells meet all RCRA/TEGD guidelines. The other eight wells have 20 ft screened intervals. Except for screen length, these eight wells also meet all RCRA/TEGD guidelines. As seen in Fig. 2, wellhead construction is designed to allow operation of a downhole pump for sampling purposes and placement of a recording pressure transducer to continuously monitor water levels. The pumps and transducers are permanent installations and will not to be removed during the course of the study except for occasional repair.

As previously stated, the water and mass balance wells were placed in locations based on data from older observation wells, test holes, and moisture access tubes in the canyon. The anticipated contact of the alluvium and weathered tuff was approximated at each location before drilling started using logs from older wells. This allowed rapid drilling of the new wells because the upper portion of the borehole above the contact was rapidly augered. Only a small interval of the lower borehole was cored in order to determine the precise contact between the alluvium and weathered tuff. This contact was defined on the basis of lithology changes in recovered core samples and rapid decreases in observed moisture content over depth. Typically the water content in core samples changed from saturated to unsaturated conditions over a short one- to two-ft interval at the base of the alluvium. In those boreholes where the core samples remained dry over the entire sampling interval, the alluvial-weathered tuff contact was based solely on changes in cored lithology.

All of the holes were drilled with a hollow stem auger having a 6.25-in. inside diameter (ID), a 9.625-in. outside diameter (OD), and 10.375-in. OD drill bit. A blank was run in the hollow stem during the augering of the upper part of the hole and was removed during the coring. The core runs were made in 2.5-ft intervals.

III. GEOLOGY AND COMPLETION LOGS

Summaries of drilling logs and completion data for each well were combined on individual figures and were obtained from field notes. These figures consist of a written and illustrated log for each well. Comments from field notes are included on each illustrated log. Figs. 3 through 26 present the geology and completion logs for each well; vertical cross-sections within the canyon are shown in Figs. 27 through 40. Stratigraphic nomenclature follows that recommended by Broxton et al. (1995). A well completion summary is shown in Table 1, while water levels and surveyed well locations are shown in Tables 2 and 3, respectively. Tables 4 through 27 summarize field notes. The figures also identify the weathered tuff below the base of the alluvium as either Tshirege Unit 1g or tuffaceous portions of the Cerro Toledo interval. According to Broxton et al. (1995, p. 44), identification of this contact can be subjective since variations in petrographic characteristics between the two units are often minor.

Geology has been generalized from the alluvium and weathered tuff. Because the canyon drainage basin heads on the Pajarito Plateau, all of the alluvium derives from the Bandelier Tuff. It is generally light brown to dark brown. When deposited as alluvium, the materials consist of lenses and beds of clays, silts, sands, and gravels with a few pebbles. The silts and clays derive from the ash. The sands and gravels mainly consist of quartz and sanadine. The gravels and pebbles are generally rock fragments of tuff, pumice, latite, and rhyolite. In general the upper 20

ft of the alluvium may contain some organic material and appear darker brown. As noted in individual drilling logs, occasional pieces of charcoal were sometimes recovered from the alluvial interval during coring operations. A 0.5-ft thick lense deposit of the El Cajete pumice (Wolff et al 1996) was also encountered during coring operations at well MCWB-6.5D at 29 ft below ground surface. This unit was clearly deposited within the alluvial interval above the weathered tuff contact. Furthermore, this ashfall deposit did not show any evidence of significant water transport or water alteration. Identification of undisturbed El Cajete pumice deposits have been used for time markers (Reneau et al. 1996).

The underlying weathered tuff ranges from gray to dark brown and contains sand-sized particles of quartz and sanadine. Its weathered ash matrix contains silts and clays with a few rock fragments of latite, rhyolite, and weathered pumice. In general, the alluvium is slightly to highly friable in core samples (usually related to moisture content or quartz sand percentage); however, the in-situ weathered tuff is more consolidated. Hence the weathered tuff is more plastic in the presence of excessive moisture and tends to hold together allowing better core recovery than that encountered in the alluvium.

The casing, screen, and end plugs used in the completion of the wells were all made of schedule-40, polyvinyl chloride (PVC), using flush-joint, internal upset-threaded connections. The casing and screen were run through the hollow stem auger because the alluvium tended to collapse into the hole when the auger was removed. The casing and screen were 3.0-in. ID (3.375-in. OD) in 5-ft lengths. A 5-ft blank section of casing with a PVC cap on the bottom was generally placed below each screen section. Some wells were completed with the cap on the end of the screen, however. All screen openings were factory slotted with 0.020-in. openings. A typical well completion diagram is shown in Fig. 2, and individual well completion data are shown in Figs. 3 to 26 and in Table 1.

The wells were cased through the hollow-stem auger. Pure quartz sand, along with bentonite and cuttings, were placed in the annulus between the hollow-stem auger and casing or screen a few feet at a time. The hollow-stem auger was removed a section at a time to allow the sand, bentonite, or cuttings to fill the space between the borehole wall and casing. The quartz sand pack ranged in size from 10 to 20 mesh (i.e., 0.0787 to 0.0331 in., respectively) and is compatible with the screen opening of 0.020 in. The sand was a pure silica, medium blasting sand marketed as Silica Sand Inc., Colorado Springs, Colorado. The bentonite was a coarse-grade Wyoming bentonite marketed as Baroid Division, Houston, Texas. Drill cuttings were used to fill portions of the annular space above a 1-ft bentonite plug. Cuttings consisted of dry alluvium augered from the hole.

Logs illustrating the geology and completion are shown on Figs. 3 to 26. These figures depict the geology, core recovery (depth of hole augered or cored, and percentage of core recovered for each 2.5-ft core run), casing schedule, and completion data (sand, bentonite, or fill). Finally, 14 north-south vertical cross-sections were constructed for the alluvium. These sections are depicted in Figs. 27 to 40 and show the variability in alluvial thickness in Mortandad Canyon. Static water levels measured on January 9, 1995, are also shown in each of these cross-sections.

IV. REFERENCES

Broxton, D.E., G. Heiken, S.J. Chipera, and F.M. Byers, Jr., 1995, "Stratigraphy, petrography, and mineralogy of the Bandelier Tuff and Cerro Toledo deposits", in *Earth Science Investigations for Environmental Restoration, Los Alamos National Laboratory Technical Area 21*, edited by D.E. Broxton and P.G. Eller, Los Alamos National Laboratory Report LA-12934-MS, Los Alamos, pp. 33-64.

Purtymun, W.D., 1995, "Geologic and hydrologic records of observation wells, test holes, test wells, supply wells, springs, and surface water stations in the Los Alamos area", Los Alamos National Laboratory Report LA-12883-MS, Los Alamos, NM, p. 339.

Reneau, S.L., et al., 1996, "Erosion and deposition on the Pajarito Plateau, New Mexico, and implications for geomorphic responses to Late Quaternary climatic changes", *New Mexico Geological Society, 47th Guidebook to the Jemez Mountains Region*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM, pp. 391-397.

Shaull, D.A., M.R. Alexander, and R.P. Reynolds, 1996, "Surface water data at Los Alamos National Laboratory: 1995 Water Year", Los Alamos National Laboratory Report LA-13177-PR, Los Alamos, NM, p. 42 .

Technical Enforcement Guidance Document, "RCRA Groundwater Monitoring: Draft Technical Guidance", Office of Solid Waste, U.S. Environmental Protection Agency Report No. EPA/530-R-93-001, Washington, D.C., (November 1992).

Wolff, J.A., J.N. Gardner, and S.L. Reneau, 1996, "Field characteristics of the El Cajete pumice deposit and associated southwestern moat rhyolites of the Valles Caldera", *New Mexico Geological Society, 47th Guidebook to the Jemez Mountains Region*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM, pp. 311-316.

Table 1. Mortandad Canyon Water and Mass Balance Well Completion Summary; all units are in feet below ground surface.[1]

Well Number	Total Depth	Tuff Contact	Screen Depth	Top of Sand	Bentonite	RCRA Code[2]
MCWB-4	15.0	8.8	10.0-15.0	9.8	8.8-9.8	A
MCWB-5	33.0	29.0	17.0-27.0	16.0	15-16	B
MCWB-5.5A	37.5	35.1	22.5-32.5	19.0	18-19	B
MCWB-5.5B	37.5	37.0	22.5-32.5	19.0	18-19	B
MCWB-6.2A	45.5	41.3	30.5-40.5	25.0	24-25	B
MCWB-6.2B	42.5	40.2	27.5-37.5	23.0	22-23	B
MCWB-6.2C	32.5	-	25.0-30.0	21.0	20-21	A
TSWB-6	40.0	31.3	25.0-35.0	17.0	16-17	B
MCWB-6.5C	47.5	46.5	32.5-42.5	29.0	28-29	B
MCWB-6.5D	42.5	-	32.5-42.5	30.0	29-30	A
MCWB-6.5E	50.0	47.5	35.0-45.0	25.0	24-25	B
MCWB-6.6	47.5	41.8	32.5-42.5	26.0	25-26	B
MCWB-7A	52.0	47.0	37.0-47.0	31.5	30.5-31.5	B
MCWB-7B	47.5	44.0	32.5-42.5	29.3	28.3-29.3	B
MCWB-7.2	67.5	65.5	42.5-62.5	39.0	38-39	C
MCWB-7.4A	70.0	69.3	45.0-65.0	39.5	38.5-39.5	C
MCWB-7.4B	70.0	66.0	45.0-65.0	40.0	39-40	C
MCWB-7.7A	67.5	67.0	52.5-62.5	50.0	49-50	B
MCWB-7.7B	70.0	69.0	55.0-65.0	45.0	44-45	B
MCWB-8.1A	75.0	69.5	50.0-70.0	48.5	47.5-48.5	C
MCWB-8.1B	72.5	69.3	47.5-67.5	45.5	44-45	C
MCWB-8.1C	80.0	62.5	55.0-75.0	50.0	49-50	C
MCWB-9A	75.0	70.0	50.0-70.0	50.0	49-50	C
MCWB-9B	80.0	68.3	55.0-75.0	45.0	44-45	C

[1]Also see Fig. 2 for well materials summary, Figs. 3 through 26 for geological logs, and Figs. 27 through 40 for north-south vertical cross-sections in the canyon alluvium.

[2]RCRA/HSWA monitoring well completion code as follows:

A - 5-ft screen with end cap at bottom.

B - 5-ft blank casing with end cap at bottom, then 10-ft screen.

C - 5-ft blank casing with end cap at bottom, then 20-ft screen.

Table 2. Mortandad Canyon Water and Mass Balance Well Characteristics and Water Levels.

Well Number	Date Drilled	Elevation (LSD)[1]	MP above LSD (ft)[2]	Water Depth on 1/9/95[3]	Water Depth on 9/18/95[3]	Water Depth on 11/13/96[3]	Water Depth on 7/7/97[3]
MCWB-4	12/06/94	6893.42	2.00	trace	dry	15.81	trace
MCWB-5	12/06/94	6876.22	1.92	18.03	20.38	20.79	20.19
MCWB-5.5A	12/22/94	6858.36	2.00	30.78	33.18	33.64	33.14
MCWB-5.5B	12/22/94	6856.89	2.17	31.07	33.56	33.97	33.55
MCWB-6.2A	12/07/94	6848.29	2.08	36.20	40.26	40.17	39.42
MCWB-6.2B	12/22/94	6848.01	2.00	dry	dry	dry	dry
MCWB-6.2C	12/07/94	6847.98	2.00	dry	dry	dry	dry
TSWB-6	12/21/94	6853.21	1.92	dry	dry	dry	dry
MCWB-6.5C	12/08/94	6841.02	2.17	38.39	42.83	44.48	41.58
MCWB-6.5D	12/08/94	6843.20	1.92	dry	dry	dry	41.68
MCWB-6.5E	12/21/94	6843.80	2.00	40.89	43.12	44.96	42.00
MCWB-6.6	12/20/94	6839.35	2.00	dry	dry	dry	49.63
MCWB-7A	12/09/94	6831.17	2.17	37.95	41.50	43.81	40.05
MCWB-7B	12/09/94	6832.45	1.92	39.07	42.42	43.93	41.24
MCWB-7.2	12/12/94	6818.86	1.92	dry	dry	67.81	64.79
MCWB-7.4A	12/13/94	6812.40	2.08	42.77	46.29	67.72	43.71
MCWB-7.4B	12/13/94	6813.07	2.17	48.30	51.02	56.71	49.09
MCWB-7.7A	12/19/94	6798.31	2.17	dry	dry	dry	dry
MCWB-7.7B	12/20/94	6798.97	2.08	58.79	60.01	68.74	58.84
MCWB-8.1A	12/14/94	6785.95	2.17	dry	dry	trace	dry
MCWB-8.1B	12/19/94	6783.80	2.17	dry	trace	dry	74.53
MCWB-8.1C	12/14/94	6785.63	2.08	dry	dry	dry	dry
MCWB-9A	12/15/94	6752.11	2.17	dry	dry	dry	dry
MCWB-9B	12/15/94	6753.60	2.08	dry	dry	dry	dry

[1]Land Surface Datum (LSD) is surveyed pin elevation in concrete pad (height [ft] above mean sea level [MSL]).
[2]Measuring Point (MP) is top of PVC casing above LSD.
[3]Depth to water (ft) below MP.

Table 3. Surveyed well locations and pin elevations.

Well Number	North Coordinate[1]	East Coordinate[1]	Pin Elevation (LSD)[2]	Well Serial Number[3]	Remarks
MCWB-4	1769745.66	1631740.56	6893.42	SN-0014	Monitor Well
MCWB-5	1769484.60	1632578.31	6876.22	SN-0015	Monitor Well
MCWB-5.5A	1769176.95	1633455.53	6858.36	SN-0016	Monitor Well
MCWB-5.5B	1769125.78	1633420.54	6856.89	SN-0017	Monitor Well
MCWB-6.2A	1768968.15	1633754.49	6848.29	SN-0018	Monitor Well
MCWB-6.2B	1768897.84	1633685.09	6848.01	SN-0019	Monitor Well
MCWB-6.2C	1768893.49	1633682.27	6847.98	SN-0020	Monitor Well
TSWB-6	1768490.75	1633383.09	6853.21	SN-0037	Monitor Well
MCWB-6.5C	1768759.41	1633993.33	6841.02	SN-0021	Monitor Well
MCWB-6.5D	1768536.19	1633878.05	6843.20	SN-0022	Monitor Well
MCWB-6.5E	1768583.81	1633833.36	6843.80	SN-0023	Monitor Well
MCWB-6.6	1768565.73	1634020.98	6839.35	SN-0024	Monitor Well
MCWB-7A	1768551.02	1634356.62	6831.17	SN-0025	Monitor Well
MCWB-7B	1768469.73	1634350.16	6832.45	SN-0026	Monitor Well
MCWB-7.2	1768491.86	1634956.96	6818.86	SN-0027	Monitor Well
MCWB-7.4A	1768569.46	1635270.33	6812.40	SN-0028	Monitor Well
MCWB-7.4B	1768407.84	1635287.73	6813.07	SN-0029	Monitor Well
MCWB-7.7A	1768700.71	1635902.25	6798.31	SN-0030	Monitor Well
MCWB-7.7B	1768517.26	1635921.84	6798.97	SN-0031	Monitor Well
MCWB-8.1A	1768704.12	1636552.36	6785.95	SN-0032	Monitor Well
MCWB-8.1B	1768618.31	1636559.97	6783.80	SN-0033	Monitor Well
MCWB-8.1C	1768531.74	1636565.71	6785.63	SN-0034	Monitor Well
MCWB-9A	1768627.67	1638123.04	6752.11	SN-0035	Monitor Well
MCWB-9B	1768490.99	1638069.00	6753.60	SN-0036	Monitor Well
ET-1[4]	1768523.84	1635042.13	6817.02	SN-0038	Concrete Pad
ET-2[4]	1769163.07	1633452.39	6857.99	SN-0039	Concrete Pad
ET-3[4]	1769496.14	1632571.81	6876.33	none	No Instrument
MCO-6	1768981.74	1633629.57	6850.29	none	Control Point

[1]New Mexico State Plane Coordinates.
[2]Land Surface Datum (LSD) is surveyed pin elevation in concrete pad (ft above MSL).
[3]See serial number identification label on well.
[4]Concrete pad for evapotranspiration instrument station.

Table 4. Drill Cuttings and Core Log Field Notes for MCWB-4.

Depth (ft)	Drill Cuttings and Core Description
0.0-2.5	22" Core recovery. Alluvium. Sandy silt, dark brown, dry.
2.5-5.0	28" Core recovery. Alluvium. 0-14" sandy silt, dark brown, dry. 14-28" medium to coarse grained quartz sand in a silt matrix, grayish-red, 5R-4/2 color, abundant sanadine crystals, dry.
5.0-7.5	28" Core recovery. Alluvium. Medium to coarse grained quartz sand (>50%) in a silt soil matrix, grayish-red, 5R-4/2 color, abundant sanadine crystals, dry.
7.5-10.0	30" Core recovery. Alluvium to 8.8 ft. 0-15" very fine grained silty clay, dry. 15-30" medium to coarse grained in-situ weathered tuff with quartz and sanadine crystals in a silty ash matrix. Distinct alluvium-tuff contact at 8.8 ft.
10.0-12.5	30" Core recovery. In-situ weathered tuff. Medium to coarse grained weathered tuff with quartz and sanadine crystals in a silty ash matrix.
12.5-15.0	0" Core recovery. Core fell out of catcher; probable water contact below 12.5 ft.

Table 5. Drill Cuttings and Core Log Field Notes for MCWB-5.

Depth (ft)	Drill Cuttings and Core Description
0.0-22.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
22.5-27.5	Alluvium. Water contact at 23 ft; soils have a wet, ropy-like texture. Augered.
27.5-30.0	30" Core recovery. Alluvium to 29.0 ft. 0-18" saturated alluvium. 18-30" in-situ weather tuff; moderate reddish-orange, 10R-6/6 color, many crystals of sanadine and quartz in an ash matrix, wet. Very distinct alluvium-tuff contact at 29.0 ft.
30.0-32.5	30" Core recovery. In-situ weathered tuff. Tuff, moderate reddish-orange, 10R-6/6 color, many crystals of sanadine and quartz in an ash matrix, wet.
32.5-33.0	Augered to TD, no cuttings at surface.

Table 6. Drill Cuttings and Core Log Field Notes for MCWB-5.5A.

Depth (ft)	Drill Cuttings and Core Description
0.0-27.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
27.5-30.0	13" Core recovery. Alluvium. Coarse grained quartz sand (>50%) with many dacite gravels (10-25 mm) in a dark brown silty ash matrix. Water contact at 30 ft. in alluvium.
30.0-32.5	30" Core recovery. Alluvium. Coarse grained quartz sand (>50%) in a dark brown silty ash matrix, saturated.
32.5-35.0	30" Core recovery. Alluvium. Silty ash matrix with some quartz sand grains (<20%); very sticky, saturated.
35.0-37.5	30" Core recovery. Alluvium to 35.1 ft. 0-1" silty matrix. 1-30" in-situ weathered tuff, pale reddish-brown, 10R-5/4 color, occasional small gray pumice fragments throughout; increased dryness with increased depth. Very distinct alluvium-tuff contact at 35.1 ft.

Table 7. Drill Cuttings and Core Log Field Notes for MCWB-5.5B.

Depth (ft)	Drill Cuttings and Core Description
0.0-30.0	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry except at bottom. Augered.
30.0-32.5	30" Core recovery. Alluvium. 0-14" very fine grained silt. 14-22" coarse grained quartz sand (>50%). 22-30" very fine grained silt. All saturated.
32.5-35.0	30" Core recovery. Alluvium. Large tuff fragments in a silty matrix. One large, 6" thick, quartz sand stringer at 34 ft.
35.0-37.5	30" Core recovery. Alluvium to 37.0 ft. 0-24" saturated alluvium. 24-30" in-situ weathered tuff, pale reddish brown, 10R-5/4 color; increased dryness with increased depth. Very distinct alluvium-tuff contact at 37.0 ft.

Table 8. Drill Cuttings and Core Log Field Notes for MCWB-6.2A.

Depth (ft)	Drill Cuttings and Core Description
0.0-21.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
21.5-24.0	15" Core recovery. Alluvium. Very fine grained silt matrix with many thin (<10 mm) water-lain quartz sand stringers; occasional tuff fragments throughout, dry.
24.0-26.5	24" Core recovery. Alluvium. Very fine grained silty matrix with coarse quartz and sanadine crystals (>25%); occasional pumice and tuff fragments throughout; tuff is grayish-red, 10R-4/2 color; dry.
26.5-29.0	26" Core recovery. Alluvium. Very fine grained silty matrix with coarse quartz and sanadine crystals (>25%); occasional pumice and tuff fragments throughout; tuff is grayish-red, 10R-4/2 color; dry at top but moisture increases with increased depth.
29.0-31.5	30" Core recovery. Alluvium. Very fine grained silty matrix with coarse quartz sand (>50%); the silty matrix is damp.
31.5-33.0	30" Core recovery. Alluvium. Very fine grained silty matrix with coarse quartz sand (>50%); the silty matrix is saturated.
33.0-35.5	0" Core recovery. Lost core. Very wet - probably saturated.
35.5-38.0	30" Core recovery. Alluvium. Very fine grained silty matrix with coarse quartz sand (>50%) with occasional 10 mm diameter, black, hard, subangular rock fragments(probably some type of quartz); the silty matrix is saturated.
38.0-40.5	20" Core recovery. Alluvium. As above, saturated.
40.5-43.0	30" Core recovery. Alluvium to 41.3 ft. 0-9" coarse quartz sand as above; 9-21" in-situ weathered tuff (sticky clay layer with small quartz crystals in matrix); 21-30" in-situ weathered tuff, drier. Distinct alluvium-tuff contact at 41.3 ft.
43.0-45.5	Augered, no cuttings at surface. Reamed hole to TD.

Table 9. Drill Cuttings and Core Log Field Notes for MCWB-6.2C.

Depth (ft)	Drill Cuttings and Core Description
0.0-12.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
12.5-15.0	22" Core recovery. Alluvium. Very fine grained silty matrix with medium to very coarse (2-3 mm) quartz sand (>50%) with sanadine crystals and occasional pumice (5-10 mm) fragments (<1%); the silty matrix is dry.
15.0-17.5	28" Core recovery. Alluvium. 0-4" is a coarse quartz sand, dry; 4-18" is a medium quartz sand in a very fine grained silt matrix with sanadine crystals and occasional pumice fragments, dry; 18-28" is a dark brown, moist, clayey silt with occasional weathered pumice fragments and whitish-orange tuff fragments.
17.5-20.0	28" Core recovery. Alluvium. 0-5" is a moist, clayey silt with weathered pumice fragments and occasional whitish-orange tuff fragments; 5-28" downward gradational fine-to-coarse quartz sand in a silty matrix, weathered pebble-sized fragments (10 mm) of tuff; dry at bottom.
20.0-22.5	30" Core recovery. Alluvium. 0-12" is a quartz sand (1-5 mm) in a silty matrix, dry; 12-30" is a damp, clayey silt with occasional quartz and sanadine crystals throughout, dry.
22.5-25.0	28" Core recovery. Alluvium. 0-8" is a damp, clayey silt with occasional quartz and sanadine crystals, some charcoal fragments (<1%) throughout.
25.0-27.5	30" Core recovery. Alluvium. Damp, clayey silt with occasional quartz and sanadine crystals; several large (>50 mm) cobbles of tuff; bottom 0.5 ft appears saturated.
27.5-30.0	30" Core recovery. Alluvium. Medium to coarse quartz sand with sanadine crystals in a loam matrix; several large weathered tuff fragments in lower 1.0 ft, dry.
30.0-32.5	30" Core recovery. Alluvium. Coarse quartz sand with sanadine crystals in a loam matrix; several large tuff fragments, dry. Pink weathered tuff in core nose-cone (probably a large boulder).

Table 10. Drill Cuttings and Core Log Field Notes for MCWB-6.2B.

Depth (ft)	Drill Cuttings and Core Description
0.0-40.0	Surficial soils and alluvium consisting of mixed sand, silt, and clay. Augered. The alluvial cuttings between 35-40 ft appeared ropy wet, and may be saturated. Also see MCWB-6.2C field notes.
40.0-42.5	30" Core recovery. Alluvium to 40.2 ft. 0-28" medium to coarse quartz sand with sanadine crystals in a silty matrix, dry. 28-30" is a grayish-pink, 5R-8/2 tuff with many quartz and sanadine fragments in an ash matrix, dry. Distinct alluvium-tuff contact at 40.2 ft.

Table 11. Drill Cuttings and Core Log Field Notes for TSWB-6.

Depth (ft)	Drill Cuttings and Core Description
0.0-30.0	Surficial soils and alluvium consisting of mixed sand, silt, and clay; wet at 28 ft. Augered.
30.0-32.5	25" Core recovery. Alluvium to 31.3 ft. 0-15" is a silty matrix of fine quartz sand and weathered, pale-red, 5R-6/2 color, tuff; 15-25" is an in-situ weathered tuff, pale-red, 5R-6/2 color, grading downward to a grayish-red, 10R-4/2 color tuff, moist at bottom. Moderately distinct alluvium-tuff contact at 31.3 ft.
32.5-35.0	30" Core recovery. In-situ weathered tuff. Grayish-red tuff, 10R-4/2 color, with welded tuff fragment inclusions and pumice throughout, dry. Charcoal fragment sample taken at 33 ft.
35.0-37.5	30" Core recovery. In-situ weathered tuff. Grayish-red tuff, 10R-4/2 color, with welded tuff fragment inclusions and pumice throughout; some quartz and sanadine crystals apparent, dry.
37.5-40.0	30" Core recovery. In-situ weathered tuff. Pale-red tuff, 10R-6/2 color, with welded tuff fragment inclusions and pumice throughout; some quartz and sanadine crystals apparent, dry.

Table 12. Drill Cuttings and Core Log Field Notes for MCWB-6.5C.

Depth (ft)	Drill Cuttings and Core Description
0.0-22.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; moist at 12.5 ft. Augered.
22.5-25.0	26" Core recovery. Alluvium. 0-13" very fine grained silt with occasional dacite rock fragments; 13-26" coarse quartz sand (>50%) in a very fine grained silt matrix, dry.
25.0-27.5	23" Core recovery. Alluvium. Coarse quartz sand (>50%) in a very fine grained silt matrix, moist.
27.5-30.0	30" Core recovery. Alluvium. 0-12" is a very fine grained silt, saturated; 12-30" coarse quartz sand (>50%) in a very fine grained silt matrix, moist.
30.0-32.5	26" Core recovery. Alluvium. Coarse quartz sand (>50%) in a very fine grained silt matrix, moist.
32.5-35.0	30" Core recovery. Alluvium. 0-9" is a coarse quartz sand (>50%) in a very fine grained silt matrix; 9-30" is a very fine grained silt matrix with fragments of gray pumice and pink tuff throughout.
35.0-37.5	30" Core recovery. Alluvium. 0-17" is a coarse quartz sand (>50%) in a very fine grained silt matrix; 17-30" is a very fine grained silt matrix with fragments of gray pumice and pink tuff throughout. Perched water on silt layer.
37.5-40.0	30" Core recovery. Alluvium. Very fine grained silt with charcoal throughout. Charcoal sample collected.
40.0-42.5	30" Core recovery. Alluvium. Very fine grained silt with charcoal throughout. Charcoal sample collected and composited with previous sample. Large subangular dacite cobble (>75 mm) at 42 ft.
42.5-45.0	30" Core recovery. Alluvium. Water-lain, weathered tuff with large subangular dacite fragments throughout.
45.0-47.5	30" Core recovery. Alluvium to 46.5 ft.; 0-15" is water-lain weathered tuff with dacite gravels and fragments; 15-30" is in-situ weathered tuff. Distinct alluvium-tuff contact at 46.5 ft.

Table 13. Drill Cuttings and Core Log Field Notes for MCWB-6.5D.

Depth (ft)	Drill Cuttings and Core Description
0.0-22.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay. Dry above 12 ft, then ropy wet cuttings to 22.5 ft. Augered.
22.5-25.0	23" Core recovery. Alluvium. Banded layers of water-lain weathered tuff and silt, alternating between medium brown, 5YR-4/4 color, and pale yellowish brown, 10YR-6/2 color; individual layers are up to 25 mm thick; occasional thin quartz sand stringers apparent throughout, dry.
25.0-27.5	18" Core recovery. Alluvium. Banded layers of water-lain weathered tuff and silt, alternating between pale brown (5 YR-5/2) to grayish-orange (10YR-7/4) color; interbedded coarse quartz sand with sanadine crystals in a very fine grained silt matrix, dry.
27.5-30.0	30" Core recovery. Alluvium. As above but much less interbedded layering. Very distinct El Cajete Pumice layer between 29.0-29.5 ft. The pumice layer appears to be an air-fall deposit.
30.0-32.5	23" Core recovery. Alluvium. 0-13" is a gravel-sized weathered tuff, dry. 13-23" is a dense brown clay, saturated.
32.5-35.0	25" Core recovery. Alluvium. 0-13" is a dense brown clay, saturated; 13-25" is a coarse quartz sand in a very fine grained silt matrix, partially saturated.
35.0-37.5	2" Core recovery. Alluvium. 0-2" is a dense brown clay (perhaps sluff), saturated. Remainder of core fell out.
37.5-40.0	30" Core recovery. Alluvium. 0-18" is a medium quartz sand (>50%) in a silt matrix, saturated. 18-30" is a silty clay, very sticky, saturated.
40.0-42.5	30" Core recovery. Alluvium. 0-30" is a silty clay, very sticky, saturated.

Table 14. Drill Cuttings and Core Log Field Notes for MCWB-6.5E.

Depth (ft)	Drill Cuttings and Core Description
0.0-35.0	Surficial soils and alluvium consisting of mixed sand, silt, and clay; moist. Augered.
35.0-37.5	22" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix; many tuff fragments, pale red, 10R-6/2 to 5R-6/2 color, saturated at 37.5 ft.
37.5-40.0	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix; many tuff fragments, pale red, saturated.
40.0-42.5	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix; many tuff fragments, pale red, occasional pumice fragments and dacite gravels (5-10 mm); not as wet as above.
42.5-45.0	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix; many tuff fragments, pale red, occasional pumice fragments and dacite gravels (25-35 mm); very wet.
45.0-47.5	0" Core recovery. Lost core; probably saturated conditions.
47.5-50.0	30" Core recovery. In-situ weathered tuff. 0-12" dense clay (perhaps sluff); 12-30" in-situ weathered tuff. Suspect alluvium-tuff contact at or above 47.5 ft.

Table 15. Drill Cuttings and Core Log Field Notes for MCWB-6.6.

Depth (ft)	Drill Cuttings and Core Description
0.0-35.0	Surficial soils and alluvium consisting of mixed sand, silt, and clay; moist. Augered.
35.0-37.5	30" Core recovery. Alluvium. Very fine grained silt with quartz crystals, and sub-rounded tuff and pumice fragments throughout.
37.5-40.0	30" Core recovery. Alluvium. Very fine grained silt with quartz crystals, and sub-rounded tuff and pumice fragments throughout.
40.0-42.5	30" Core recovery. Alluvium to 41.8 ft. 0-22" very fine grained silt with quartz crystals, and sub-rounded tuff and pumice fragments throughout. Charcoal sample collected at 40.5 ft. 22-30" in-situ weathered tuff, moderate reddish-orange to grayish-pink, 10R-6/6 to 5R-8/2 color, dry. Distinct alluvium-tuff contact at 41.8 ft.
42.5-45.0	30" Core recovery. In-situ weathered tuff. Very fine grained ash matrix with abundant quartz and sanadine crystals, and sub-rounded tuff and pumice fragments (10-20 mm) throughout; dacite gravels (10-20 mm) near bottom.
45.0-47.5	30" Core recovery. In-situ weathered tuff. Very fine grained ash matrix with quartz crystals, and sub-rounded tuff and pumice fragments throughout.

Table 16. Drill Cuttings and Core Log Field Notes for MCWB-7A.

Depth (ft)	Drill Cuttings and Core Description
0.0-37.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
37.5-40.0	30" Core recovery. Alluvium. 0-20" coarse quartz sand (>50%) in a very fine grained silt matrix, occasional dacite gravels (10-25 mm), moderately well rounded; dry; 20-30" dense silty clay with some quartz crystals, dry.
40.0-42.5	30" Core recovery. Alluvium. 0-12" coarse quartz sand in a very fine grained silt matrix; dry; 12-30" silty clay with charcoal fragments, sample collected.
42.5-45.0	30" Core recovery. Alluvium. 0-9" silty dense clay with some quartz sand; 9-12" coarse quartz sand in very fine grained silt matrix; 12-26" silty dense clay with some charcoal; 26-30" coarse quartz sand in a very fine grained silt matrix, dry.
45.0-47.5	30" Core recovery. Alluvium to 47.0 ft. 0-16" coarse quartz sand in a very fine grained silt matrix; 16-30" dense, hard, silty clay, dry. Dense tuff in core bit. Distinct alluvium-tuff contact at 47.0 ft.
47.5-50.0	30" Core recovery. In-situ weathered tuff. Solid in-situ weathered tuff; saturated, gray to buff brown; many quartz and sanadine crystals throughout; occasional pumice fragments.
50.0-52.0	No core recovery. Hole reamed to total depth and well completed.

Table 17. Drill Cuttings and Core Log Field Notes for MCWB-7B.

Depth (ft)	Drill Cuttings and Core Description
0.0-37.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; moist. Augered.
37.5-40.0	30" Core recovery. Alluvium. Silty dense clay with many quartz sand crystals throughout; saturated. Abundant charcoal.
540.0-42.5	25" Core recovery. Alluvium. Coarse quartz sand (>50%) in a very fine grained silt matrix; saturated.
42.5-45.0	30" Core recovery. Alluvium to 44.0 ft. 0-18" coarse quartz sand (>50%) in a silty matrix; 18-30" in-situ weathered tuff. Very distinct alluvium-tuff contact at 44.0 ft.
45.0-47.5	30" Core recovery. In-situ weathered tuff with occasional fragments of pumice; abundant sanadine and quartz crystals throughout; core rind is saturated but core interior is dry.

Table 18. Drill Cuttings and Core Log Field Notes for MCWB-7.2.

Depth (ft)	Drill Cuttings and Core Description
0.0-27.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
27.5-30.0	20" Core recovery. Alluvium. 0-8" very fine grained silty matrix, dry; 8-20" medium quartz sand in a light brown silt matrix, dry. Switched back to auger.
30.0-42.5	Alluvium, as above, dry.
42.5-45.0	3" Core recovery. Adjusted barrel length.
45.0-47.5	28" Core recovery. Alluvium. Very fine grained silt, light brown, occasional sub-rounded quartz latite/dacite gravels (10-25 mm), some quartz and sanadine crystals. Saturated below 10".
47.5-50.0	30" Core recovery. Alluvium. As above, saturated.
50.0-52.5	30" Core recovery. Alluvium. As above, saturated.
52.5-55.0	30" Core recovery. Alluvium. Water-lain weathered tuff matrix with abundant quartz, sanadine, and latite crystals throughout, occasional pumice fragments, saturated. Distinct quartz sand stringer (> 3" thick) at 53 ft.
55.0-57.5	30" Core recovery. Alluvium. 0-15" as above; 15-30" medium quartz sand in a very fine grained silt matrix. Charcoal sample at 56 ft.
57.5-60.0	30" Core recovery. Alluvium. 0-16" as above; 16-30" in-situ weathered tuff, moderate reddish-orange, 10R-6/6 color, very fine grained matrix with many light gray, angular pumice (10 mm) fragments throughout.
60.0-62.5	30" Core recovery. Alluvium. 0-9" as above. 9-30" water-lain stringers of weathered tuff with many (25-30%) medium quartz sand grains in a very fine grained silt matrix.
62.5-65.0	30" Core recovery. Alluvium. 0-17" distinct layers of water-lain quartz sand; 17-30" weathered tuff.
65.0-67.5	30"CR In-situ weathered tuff. 0-6" quartz sand (suspected sluff); 6-30" in-situ weathered tuff. Non-distinct alluvium-tuff contact at 65.5 ft.

Table 19. Drill Cuttings and Core Log Field Notes for MCWB-7.4A.

Depth (ft)	Drill Cuttings and Core Description
0.0-47.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
47.5-50.0	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix, moist. Charcoal sample at 49.8 ft. Occasional tuff and pumice fragments throughout.
50.0-52.5	30" Core recovery. Alluvium. 0-13" medium quartz sand in a very fine grained silt matrix; occasional charcoal and dacite gravels; 13-30" as above but decreasing amount of quartz sand.
52.5-55.0	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix; occasional fragments of tuff and pumice. Thin dark clay stringers at 53 ft.
55.0-57.5	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix; occasional fragments of tuff and pumice. Large pumice lapilli (20 mm) with quartz inclusions at 57 ft.
57.5-60.0	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix; occasional fragments of tuff and pumice.
60.0-62.5	30" Core recovery. Alluvium. As above but some dacite gravels are also present. Saturated.
62.5-65.0	30" Core recovery. Alluvium. As above. Saturated at top but drier at bottom.
65.0-67.5	30" Core recovery. Alluvium. As above.
67.5-70.0	30" Core recovery. Alluvium to 69.3 ft. 0-21" well-sorted medium quartz sand, saturated; 21-30" in-situ weathered tuff, light brown, 5YR 5/6 color, bright white, glassy pumice fragments (5%), dark flecks of dacite (1-5 mm); entire tuff section is unsaturated. Distinct alluvium-tuff contact at 69.3 ft.

Table 20. Drill Cuttings and Core Log Field Notes for MCWB-7.4B.

Depth (ft)	Drill Cuttings and Core Description
0.0-47.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
47.5-50.0	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix, saturated; abundant sanadine crystals throughout.
50.0-52.5	30" Core recovery. Alluvium. Top 6" as above, grading downward to coarse quartz sand in very fine grained silt matrix; abundant sanadine crystals, charcoal stringers, charcoal sample at 52 ft.
52.5-55.0	30" Core recovery. Alluvium. Fine quartz sand in very fine grained silt matrix, saturated.
55.0-57.5	30" Core recovery. Alluvium. As above but sand is drier toward bottom. Occasional tuff fragments.
57.5-60.0	30" Core recovery. Alluvium. Fine sandy loam grading downward to coarse quartz sand, saturated.
60.0-62.5	24" Core recovery. Alluvium. Medium to coarse quartz sand with occasional tuff and pumice fragments throughout.
62.5-65.0	30" Core recovery. Alluvium. 0-17" coarse quartz sand (1-2 mm); 17-30" weathered tuff, pale-red, 5R-6/2 color, with pumice fragments and sanadine crystals.
65.0-67.5	30" Core recovery. Alluvium to 66 ft. 0-7" quartz sand (probably sluff); 7-30" weathered tuff, pale-red, 5R-6/2 color, with pumice fragments and sanadine crystals. The tuff contains a matrix of rusty colored clay with sanadine crystals. Non-distinct alluvium-tuff contact at 66.0 ft.
67.5-70.0	30" Core recovery. In-situ weathered tuff, rusty brown 5R-6/2 color, with white pumice fragments, sanadine crystals, and occasional dark quartz (5 mm) fragments.

Table 21. Drill Cuttings and Core Description for MCWB-7.7A.

Depth (ft)	Drill Cuttings and Core Description
0.0-60.0	Surficial soils and alluvium consisting of mixed sand, silt, and clay; moist at bottom. Augered.
60.0-62.5	30" Core recovery. Alluvium. Water-lain weathered tuff, pale red 5R-6/2 color, with molted light gray, N8 color, pumice fragments throughout, dry.
62.5-65.0	30" Core recovery. Alluvium. Water-lain weathered tuff with thin quartz sand stringers, dry.
65.0-67.5	30" Core recovery. Alluvium to 67.0 ft; 0-24" is a pale-red, 5R-6/2 to 10R-6/2 color, weathered tuff with thin sand stringers, moist; 24-30" in-situ weathered tuff, light gray, N7 color, with an ash matrix containing quartz and sanadine crystals, moist. Distinct alluvium-tuff contact at 67.0 ft.

Table 22. Drill Cuttings and Core Log Field Notes for MCWB-7.7B.

Depth (ft)	Drill Cuttings and Core Description
0.0-60.0	Surficial soils and alluvium consisting of mixed sand, silt, and clay; moist at bottom. Augered.
60.0-62.5	4" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix. Saturated at 62.5 ft. Core fell out.
62.5-65.0	0" Core recovery. Core fell out.
65.0-67.5	30" Core recovery. Alluvium. Water-lain weathered tuff, pale red 5R-6/2 color, with molted light gray, N8 color, pumice fragments throughout, moist.
67.5-70.0	30" Core recovery. Alluvium to 69.0 ft. 0-6" medium to coarse quartz sand in a very fine grained silt matrix, saturated; charcoal sample at 68 ft; 6-18" weathered tuff, pale red, 5YR-6/2 color, with thin sand stringers; 18-30" in-situ weathered tuff, pale red, 5YR-6/2 color. Distinct alluvium-tuff contact at 69.0 ft.

Table 23. Drill Cuttings and Core Log Field Notes for MCWB-8.1A.

Depth (ft)	Drill Cuttings and Core Description
0.0-52.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
52.5-55.0	2" Core recovery. Alluvium. Sandy silt. Core catcher blocked off.
55.0-57.5	2" Core recovery. Alluvium. As above. Lengthened core barrel.
57.5-60.0	18" Core recovery. Alluvium. Grayish-red silt, 5R-4/2 color, with occasional medium quartz grains, dry.
60.0-62.5	28" Core recovery. Alluvium. As above, dry.
62.5-65.0	30" Core recovery. Alluvium. 0-10" coarse quartz sand in a very fine grained silt matrix, dry; 10-30" grayish-red silt, 5R-4/2 color, with occasional gray pumice (10-25 mm) fragments, dry.
65.0-67.5	30" Core recovery. Alluvium. Grayish-red silt, 5R-4/2 color, with occasional gray pumice (10-25 mm) fragments, moist. Looks like a sticky clay when wet.
67.5-70.0	28" Core recovery. Alluvium to 69.5 ft. 0-22" as above; 22-28" in-situ weathered tuff, medium light gray, N6 color, with many pumice, quartz, and sanadine crystals. Distinct alluvium-tuff contact at 69.5 ft.
70.0-72.5	30" Core recovery. In-situ tuff. As above, dry.
72.0-75.0	30" Core recovery. In-situ tuff. 0-18" as above, dry; 18-30" as above but light brown color.

Table 24. Drill Cuttings and Core Log Field Notes for MCWB-8.1B.

Depth (ft)	Drill Cuttings and Core Description
0.0-60.0	Surficial soils and alluvium consisting of mixed sand, silt, and clay; wet below 47 ft. Augered.
60.0-62.5	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix, moist. Charcoal sample at 60.5 ft.
62.5-65.0	30" Core recovery. Alluvium. Medium quartz sand in a very fine grained silt matrix, moist.
65.0-67.5	30" Core recovery. Alluvium. Sandy gravel (>15%) in a medium quartz sand matrix (>50%) and very fine grained silt (35%), dry.
67.5-70.0	30" Core recovery. Alluvium to 69.3 ft. 0-22" as above; 22-30" in-situ weathered tuff, 5YR 4/2 color, dry. Very distinct alluvium-tuff contact at 69.3 ft.
70.0-72.5	30" Core recovery. In-situ weathered tuff, dry.

Table 25. Drill Cuttings and Core Log Field Notes for MCWB-8.1C.

Depth (ft)	Drill Cuttings and Core Description
0.0-62.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
62.5-65.0	30" Core recovery. In-situ weathered tuff. Light-brown tuff, 5YR-5/6 color, with occasional medium quartz grains, white pumice fragments, and dacite gravels throughout, dry. Non-distinct alluvium-tuff boundary at 62.5 ft.
65.0-67.5	30" Core recovery. In-situ weathered tuff. As above but less cohesive. Medium quartz sand in bottom 2".
67.5-70.0	30" Core recovery. In-situ weathered tuff. Medium quartz sand in a very fine grained silt matrix; abundant dacite fragments and pumice lapilli, all sub-rounded to well rounded and smooth, dry.
70.0-72.5	30" Core recovery. In-situ weathered tuff. As above.
72.5-75.0	30" Core recovery. In-situ weathered tuff. As above.
75.0-77.5	30" Core recovery. In-situ weathered tuff. As above.
77.5-80.0	30" Core recovery. In-situ weathered tuff. As above.

Table 26. Drill Cuttings and Core Log Field Notes for MCWB-9A.

Depth (ft)	Drill Cuttings and Core Description
0.0-57.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
57.5-60.0	20" Core recovery. Alluvium. Fine quartz sand in a very fine grained silt matrix, dry.
60.0-62.5	0" Core recovery. Core fell out.
62.5-65.0	0" Core recovery. Core fell out.
65.0-67.5	12" Core recovery. Alluvium. As above (may also be sluff).
67.5-70.0	6" Core recovery. Alluvium. As above.
70.0-72.5	30" Core recovery. In-situ weathered tuff, pinkish-gray to light gray, 5-YR-8/1 to N8 color, with weathered pumice and sanadine crystals, dry. Non-distinct alluvium-tuff contact at 70.0 ft.
72.5-75.0	24" Core recovery. In-situ weathered tuff, light gray, N8 color, with horizontal iron staining in core, some pumice lapilli apparent, dry.

Table 27. Drill Cuttings and Core Log Field Notes for MCWB-9B.

Depth (ft)	Drill Cuttings and Core Description
0.0-57.5	Surficial soils and alluvium consisting of mixed sand, silt, and clay; dry. Augered.
57.5-60.0	21" Core recovery. Alluvium. Fine quartz sand in a very fine grained silt matrix, damp.
60.0-62.5	22" Core recovery. Alluvium. Fine quartz sand in a very fine grained silt matrix, occasional tuff and pumice fragments, dry.
62.5-65.0	23" Core recovery. Alluvium. Fine quartz sand in a very fine grained silt matrix, occasional large 75 mm cobbles of tuff; fine gray weathered pumice near bottom, dry.
65.0-67.5	21" Core recovery. Alluvium. Very fine quartz sand in a very fine grained silt matrix, occasional pale orange tuff fragments, 10YR-8/7 color with white pumice fragments up to 30 mm, dry.
67.5-70.0	23" Core recovery. Alluvium to 68.3 ft. 0-2" as above; 2-23" in-situ weathered tuff, 5YR-8/1 color, with small pumice fragments, dry. Non-distinct alluvium-tuff contact at 68.3 ft, dry.
70.0-72.5	21" Core recovery. In-situ weathered tuff, pinkish-gray to light gray, 5YR-8/1 to N8 color, with weathered pumice, dry.
72.5-75.0	23" Core recovery. Same as above, dry.
75.0-77.5	30" Core recovery. Same as above, dry.
77.5-80.0	30" Core recovery. Same as above, dry. Amount of pumice decreasing with depth.

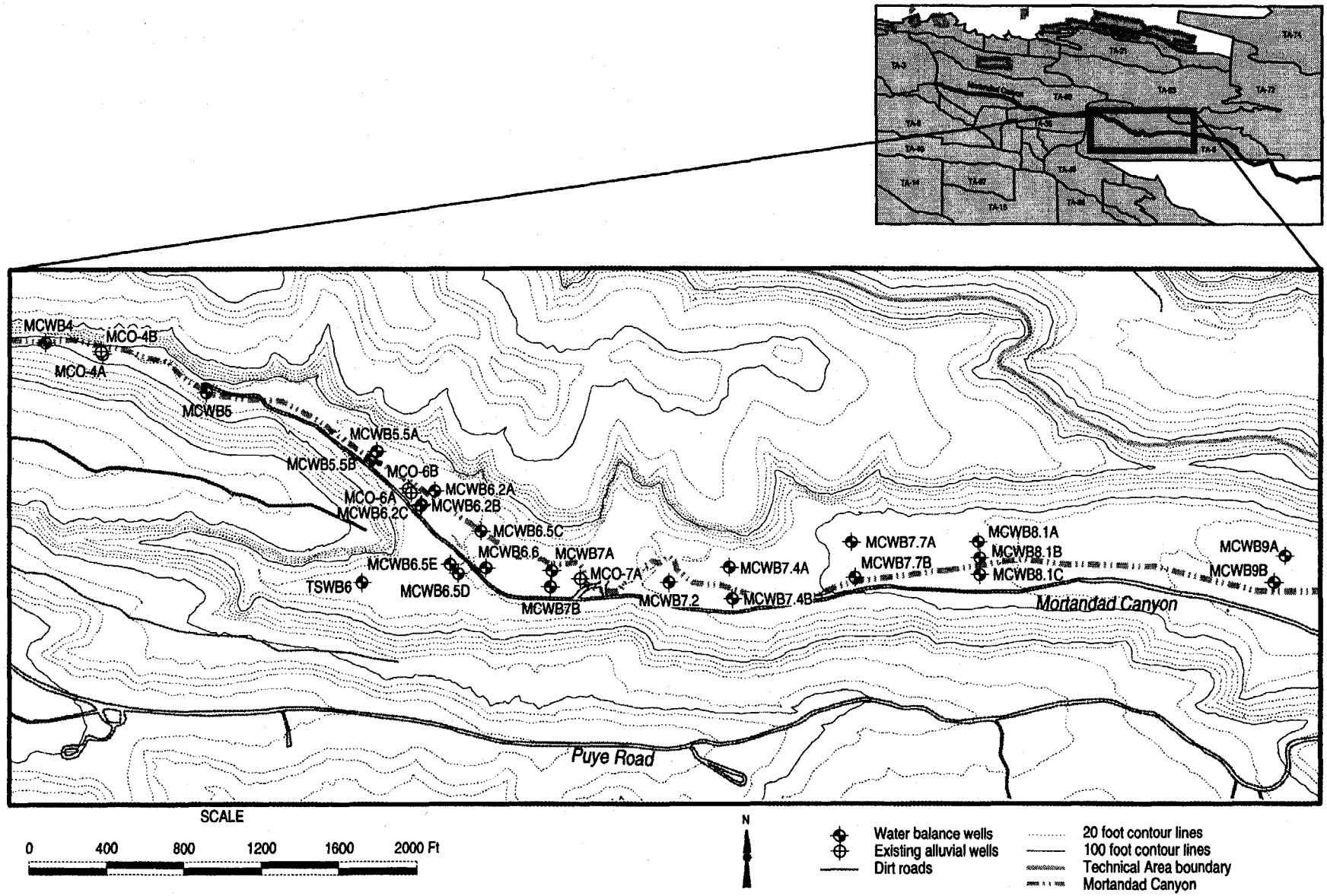

Fig. 1. Mortandad Canyon water balance wells location map.

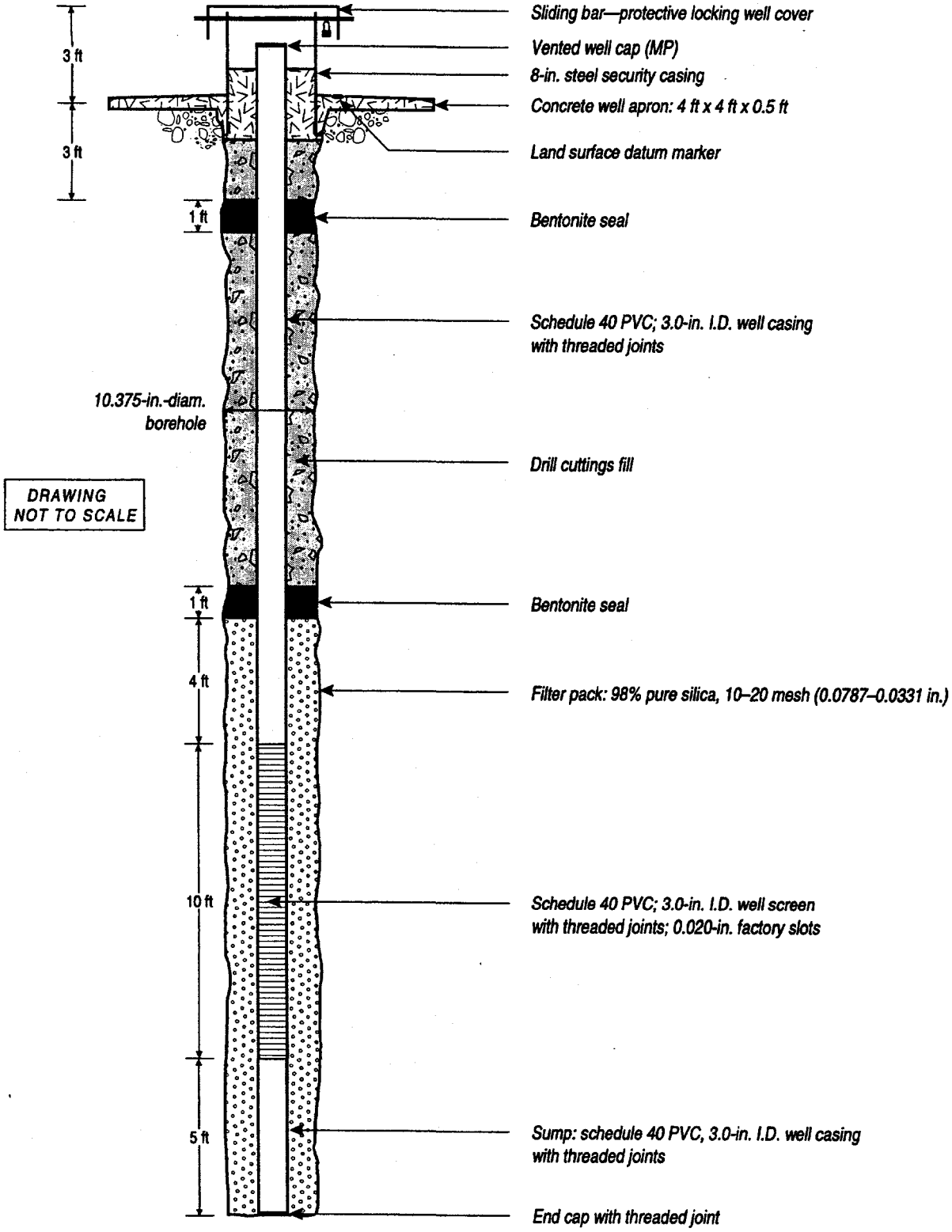

Fig. 2. Typical diagram for water and mass balance wells in Mortandad Canyon.

MCWB-4

DRILL DATE:	December 6, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1769745.66 North	HOLE DIAMETER:	10.375 inches
	1631740.56 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6893.42 LSD (ft)	TOTAL DEPTH:	15.0 ft

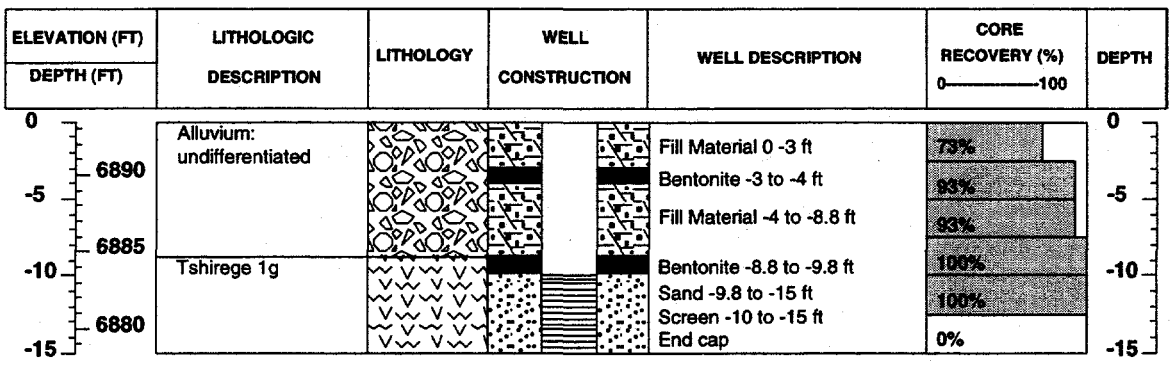

Fig. 3. Drill log and well completion diagram for MCWB-4.

MCWB-5

DRILL DATE:	December 6, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1769484.60 North	HOLE DIAMETER:	10.375 inches
	1632578.31 East	WATER LEVEL:	6860.11 ASL (ft)
ELEVATION:	6876.22 LSD (ft)	TOTAL DEPTH:	33.0 ft

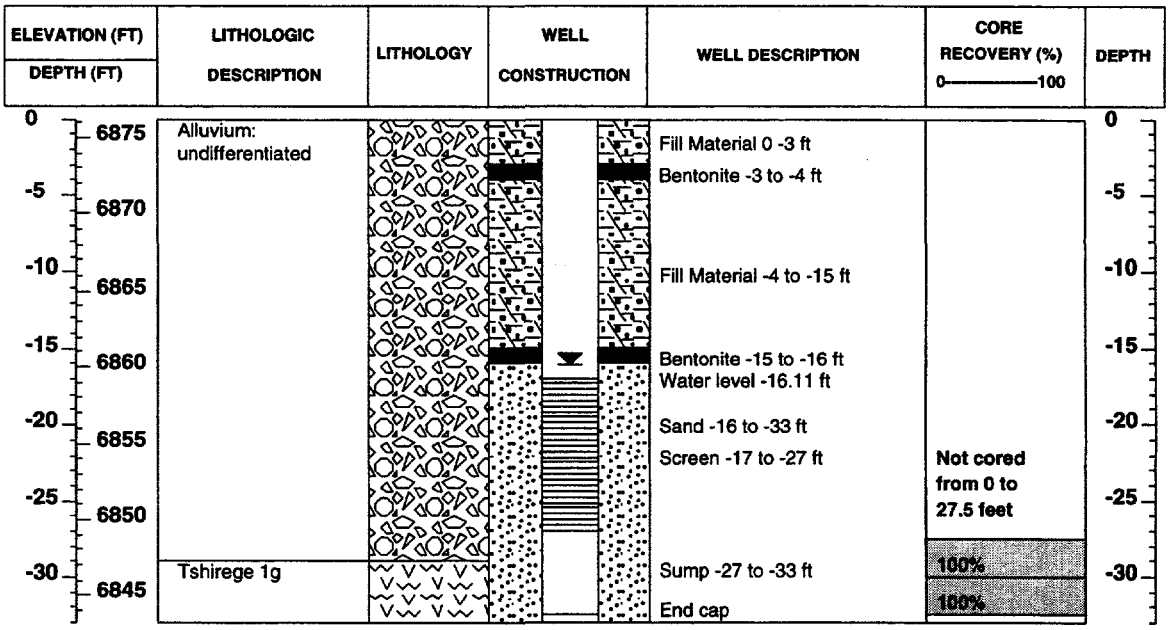

Fig. 4. Drill log and well completion diagram for MCWB-5.

MCWB-5.5A

DRILL DATE:	December 22, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1769176.95 North	HOLE DIAMETER:	10.375 inches
	1633455.53 East	WATER LEVEL:	6829.58 ASL (ft)
ELEVATION:	6858.36 LSD (ft)	TOTAL DEPTH:	37.5 ft

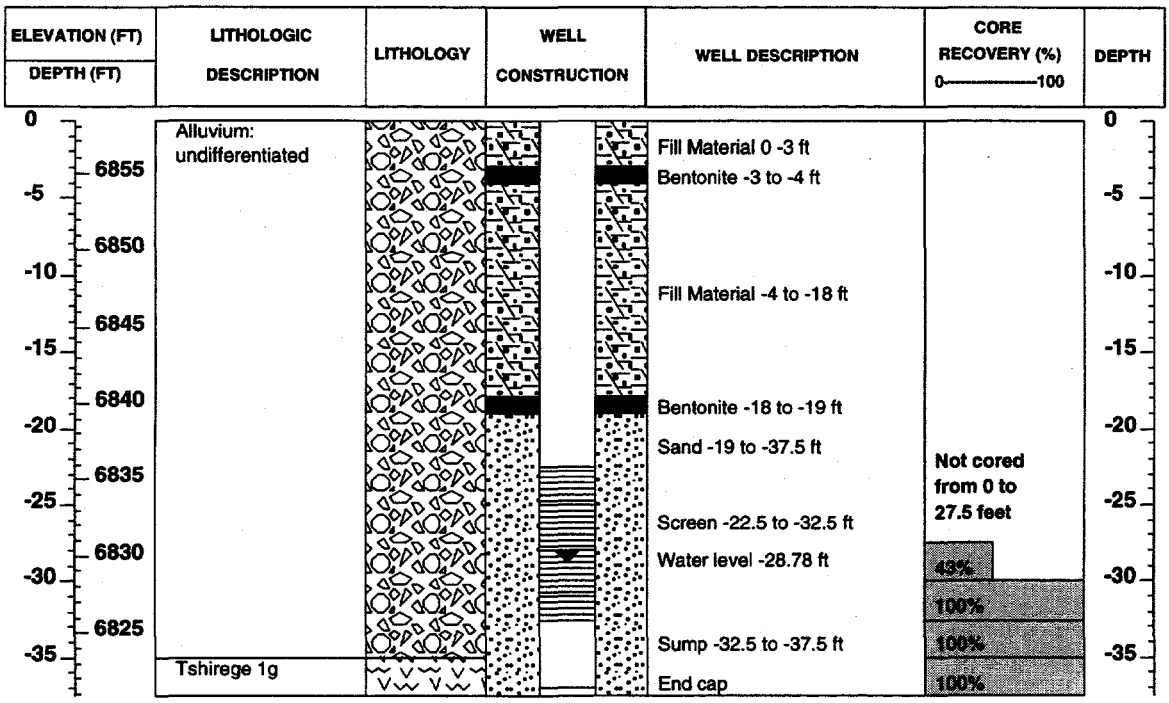

Fig. 5. Drill log and well completion diagram for MCWB-5.5A.

MCWB-5.5B

DRILL DATE:	December 22, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1769125.78 North	HOLE DIAMETER:	10.375 inches
	1633420.54 East	WATER LEVEL:	6827.99 ASL (ft)
ELEVATION:	6856.89 LSD (ft)	TOTAL DEPTH:	37.5 ft

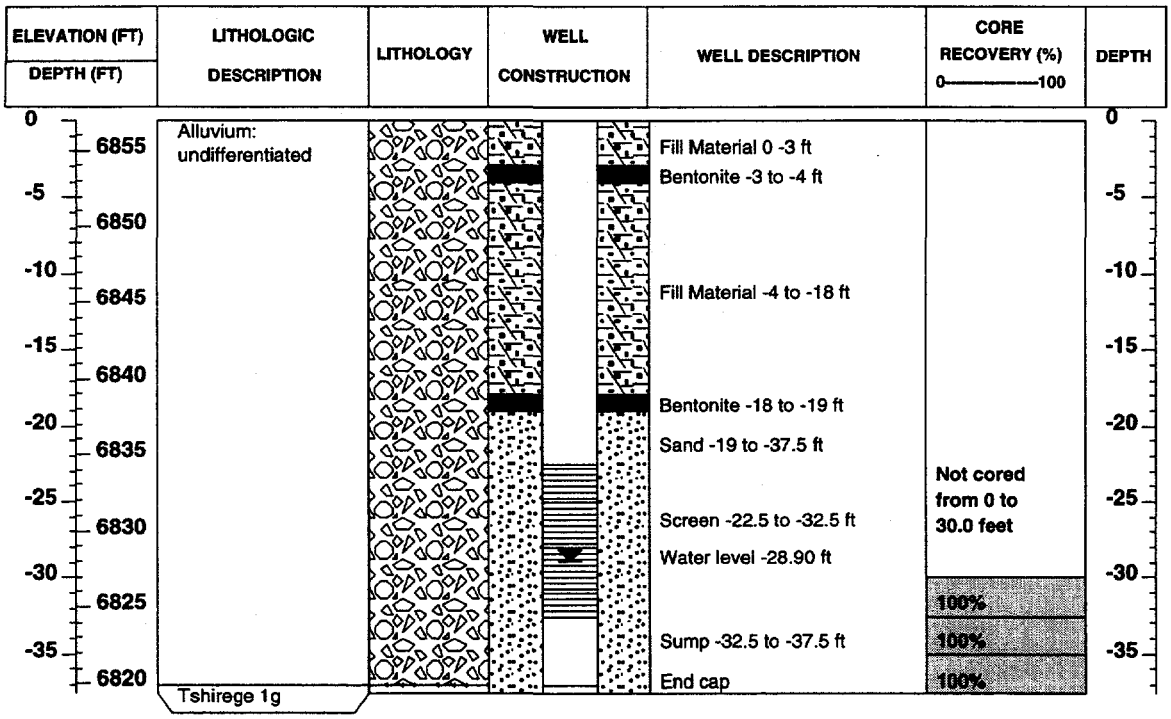

Fig. 6. Drill log and well completion diagram for MCWB-5.5B.

MCWB-6.2A

DRILL DATE:	December 7, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768968.15 North	HOLE DIAMETER:	10.375 inches
	1633754.49 East	WATER LEVEL:	6814.17 ASL (ft)
ELEVATION:	6848.29 LSD (ft)	TOTAL DEPTH:	45.5 ft

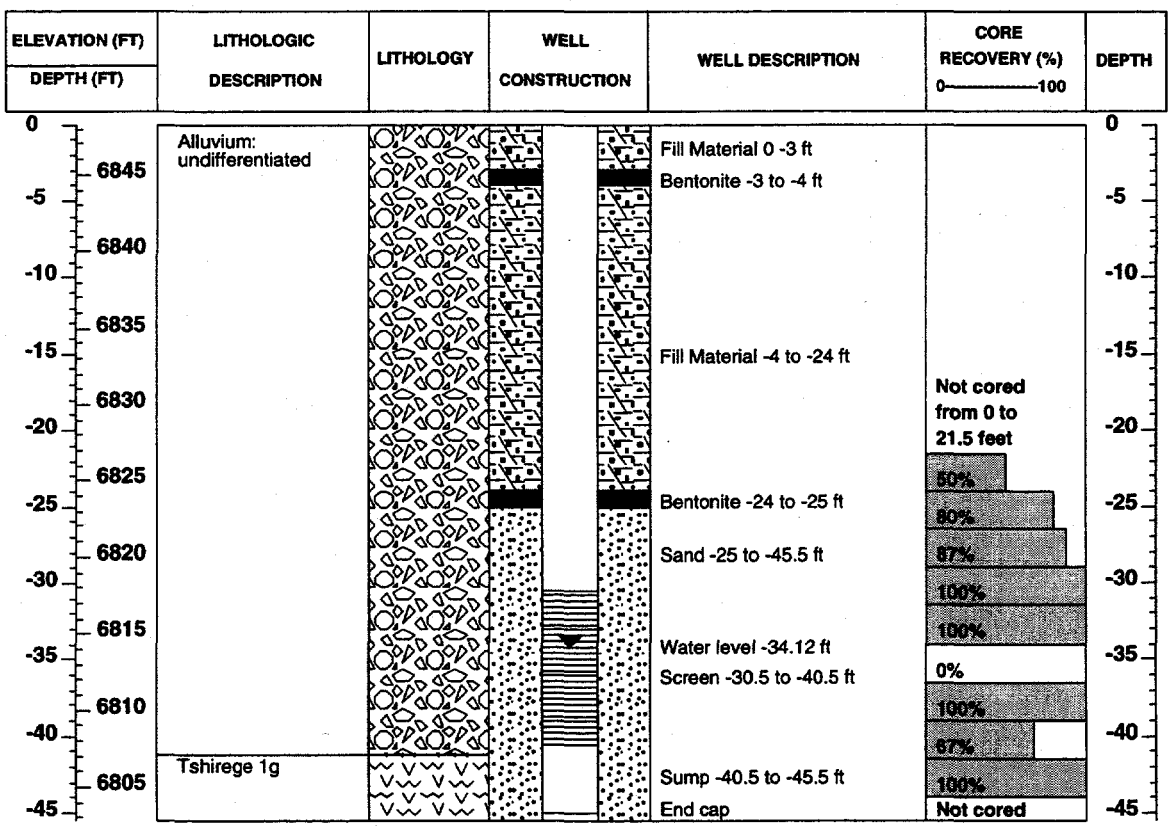

Fig. 7. Drill log and well completion diagram for MCWB-6.2A.

MCWB-6.2B

DRILL DATE:	December 22, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768897.84 North	HOLE DIAMETER:	10.375 inches
	1633685.09 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6848.01 LSD (ft)	TOTAL DEPTH:	42.5 ft

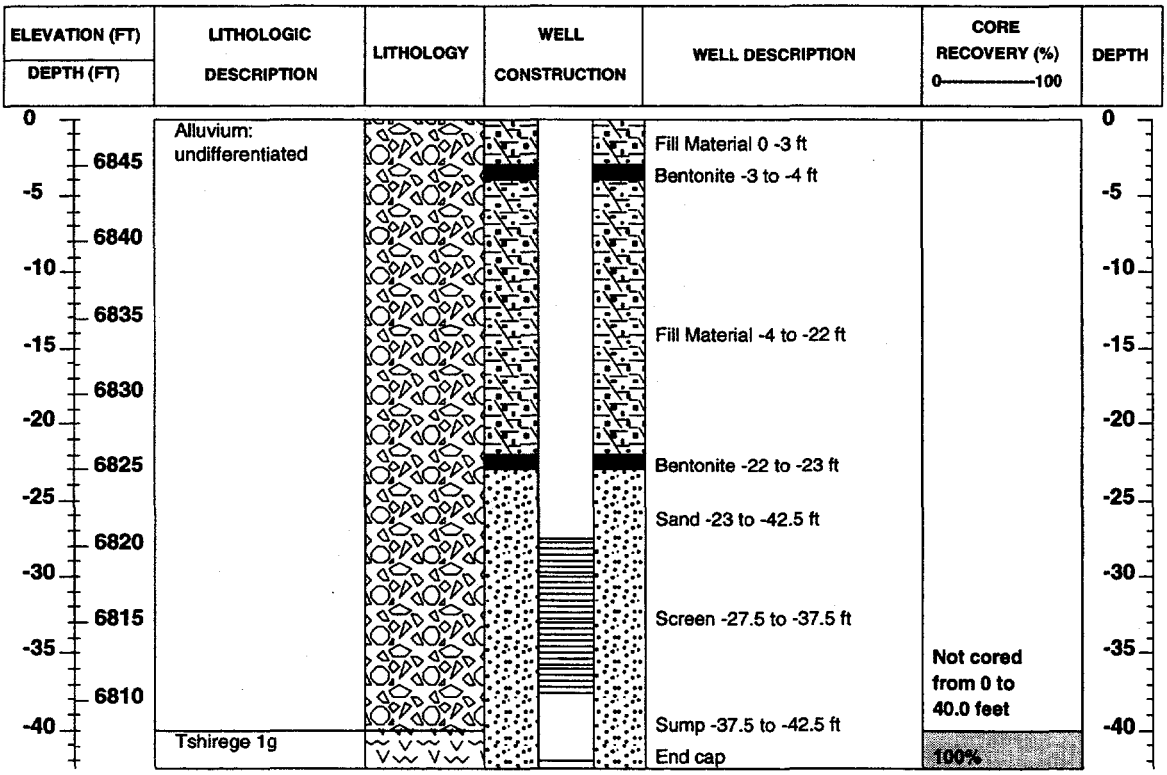

Fig. 8. Drill log and well completion diagram for MCWB-6.2B.

MCWB-6.2C

DRILL DATE:	December 7, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768893.49 North	HOLE DIAMETER:	10.375 inches
	1633682.27 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6847.98 LSD (ft)	TOTAL DEPTH:	32.5 ft

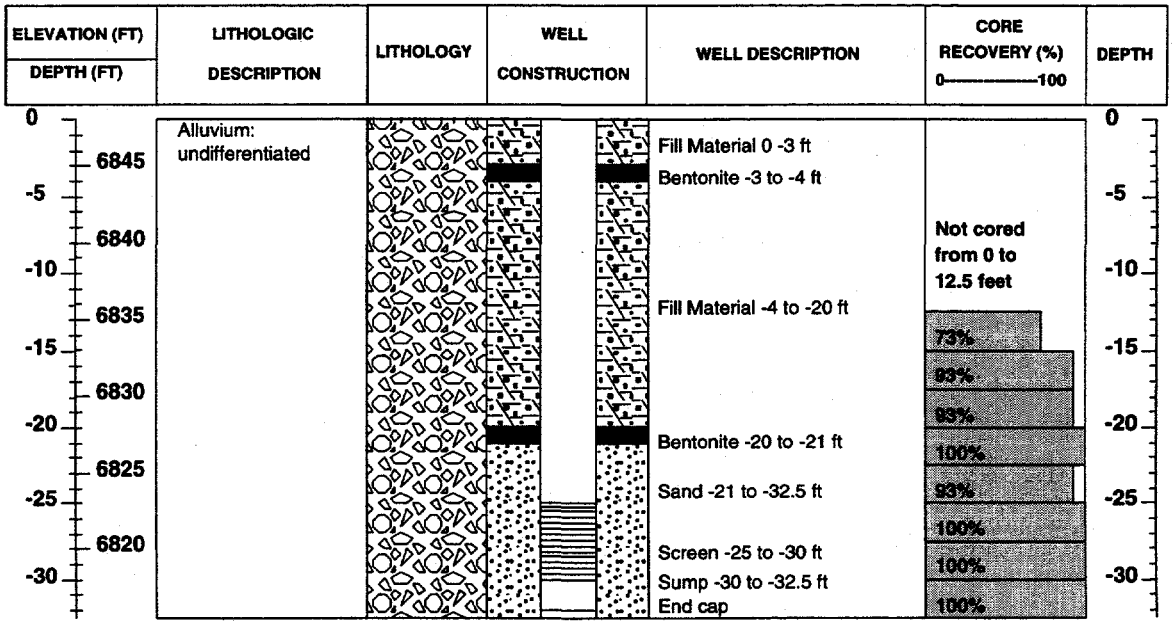

Fig. 9. Drill log and well completion diagram for MCWB-6.2C.

TCWB-6

DRILL DATE:	December 21, 1994	DRILLING METHOD:	Hollow Stem Auge
COORDINATE:	1768490.75 North	HOLE DIAMETER:	10.375 inches
	1633383.09 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6853.21 LSD (ft)	TOTAL DEPTH:	40.0 ft

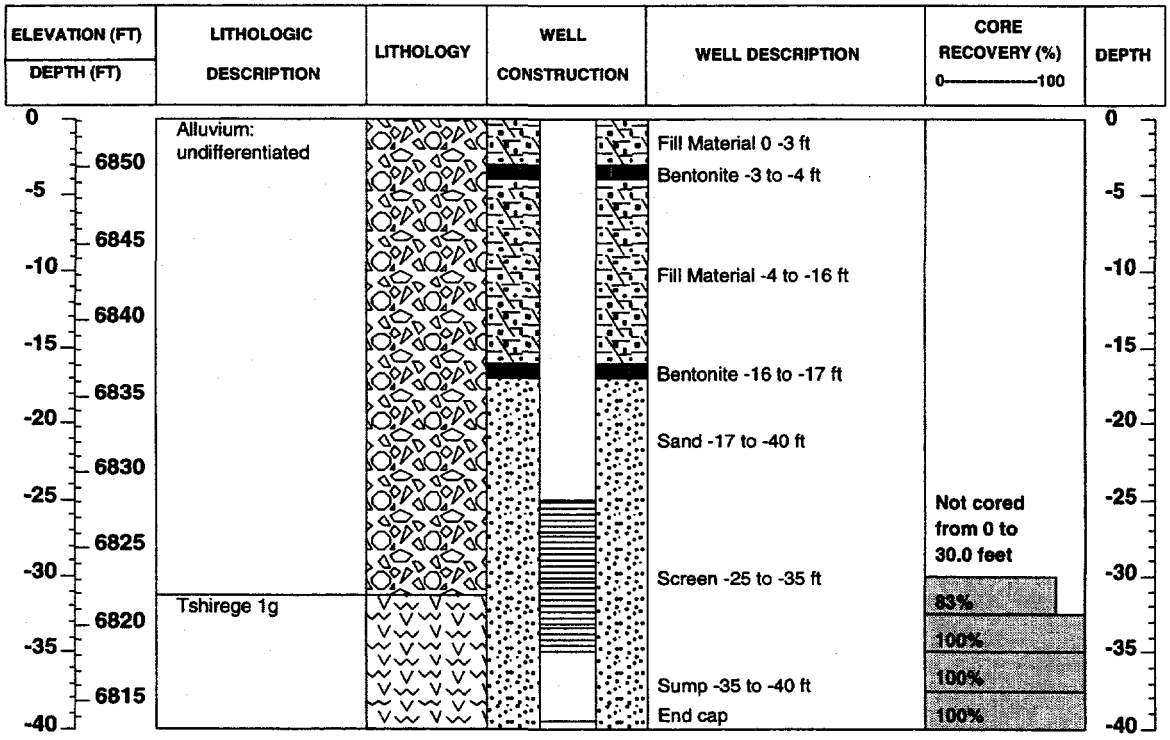

Fig. 10. Drill log and well completion diagram for TCWB-6.

MCWB-6.5C

DRILL DATE:	December 8, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768759.41 North	HOLE DIAMETER:	10.375 inches
	1633993.33 East	WATER LEVEL:	6804.81 ASL (ft)
ELEVATION:	6841.02 LSD (ft)	TOTAL DEPTH:	47.5 ft

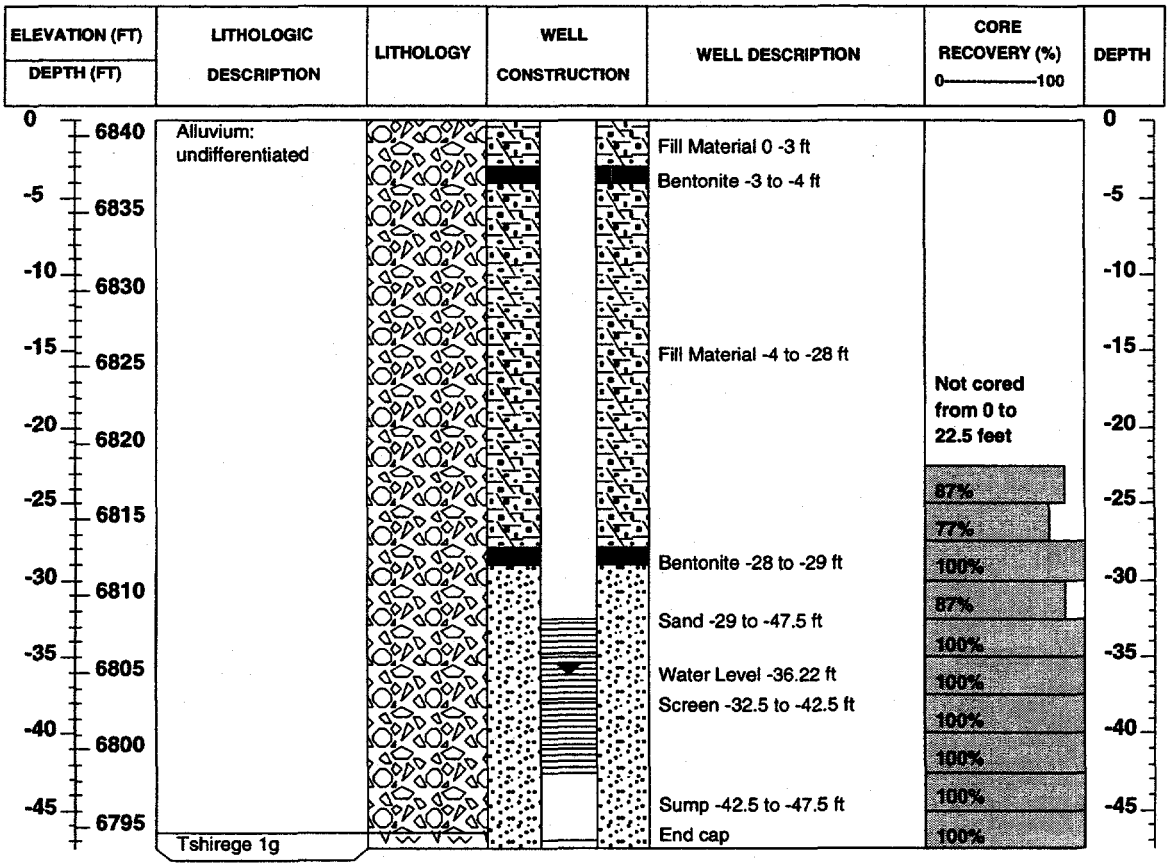

Fig. 11. Drill log and well completion diagram for MCWB-6.5C.

MCWB-6.5D

DRILL DATE:	December 8, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768536.19 North	HOLE DIAMETER:	10.375 inches
	1633878.05 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6843.20 LSD (ft)	TOTAL DEPTH:	42.5 ft

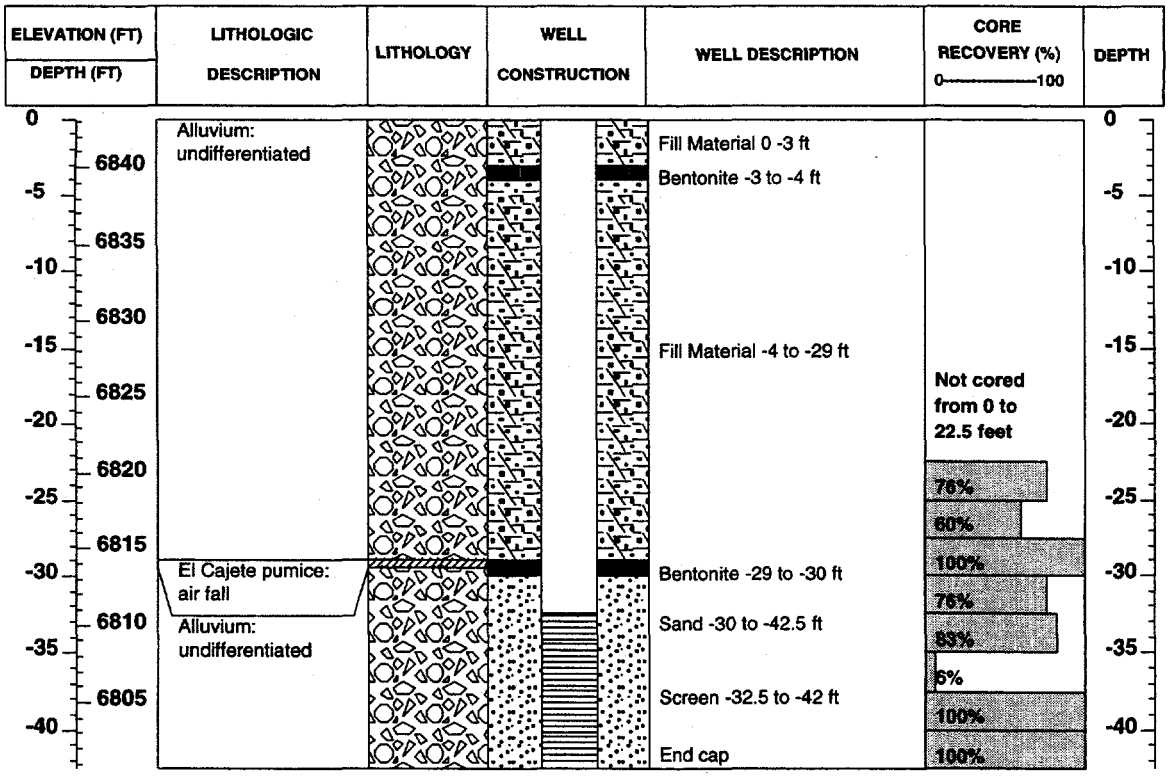

Fig. 12. Drill log and well completion diagram for MCWB-6.5D.

MCWB-6.5E

DRILL DATE:	December 21, 1994	DRILLING METHOD:	Hollow Stem Auge:
COORDINATE:	1768583.81 North	HOLE DIAMETER:	10.375 inches
	1633833.36 East	WATER LEVEL:	6804.91 ASL (ft)
ELEVATION:	6843.80 LSD (ft)	TOTAL DEPTH:	50.0 ft

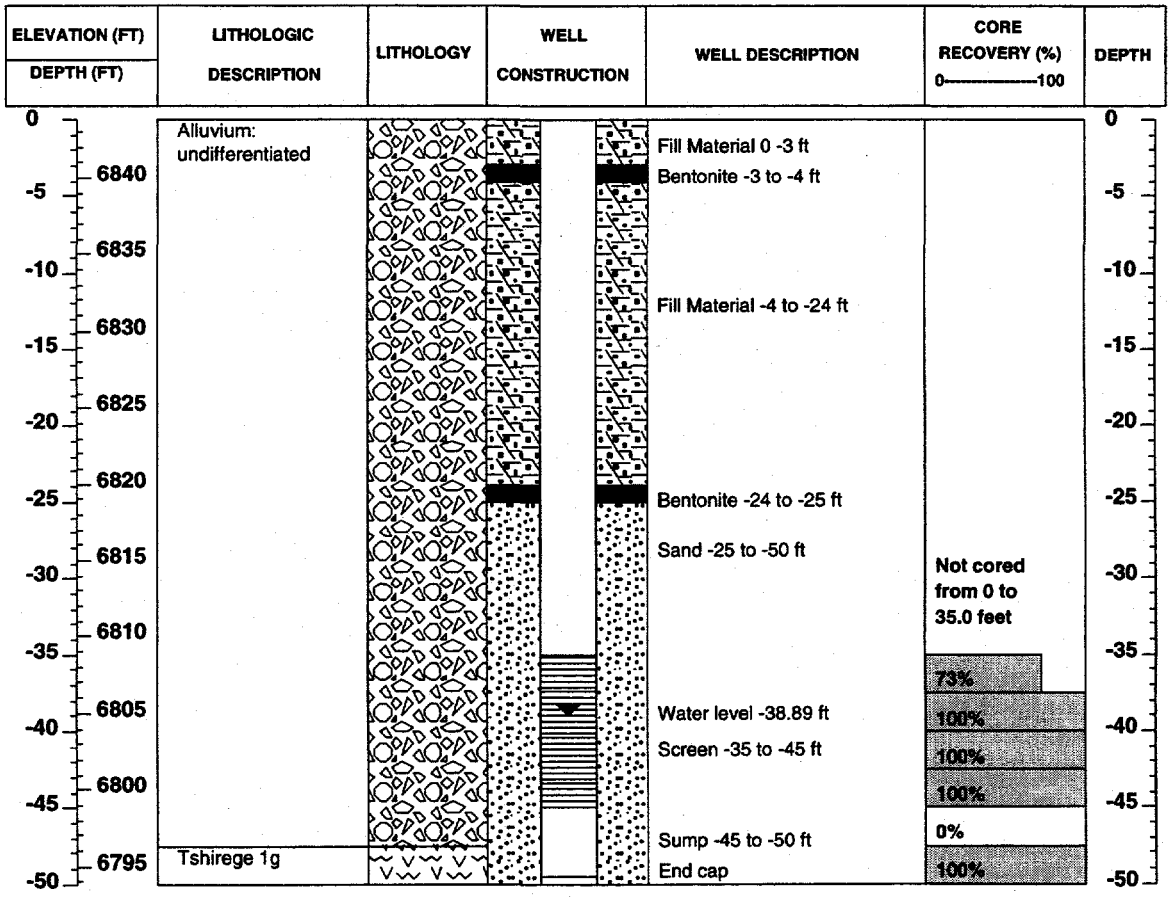

Fig. 13. Drill log and well completion diagram for MCWB-6.5E.

MCWB-6.6

DRILL DATE:	December 20, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768565.73 North	HOLE DIAMETER:	10.375 inches
	1634020.98 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6839.35 LSD (ft)	TOTAL DEPTH:	47.5 ft

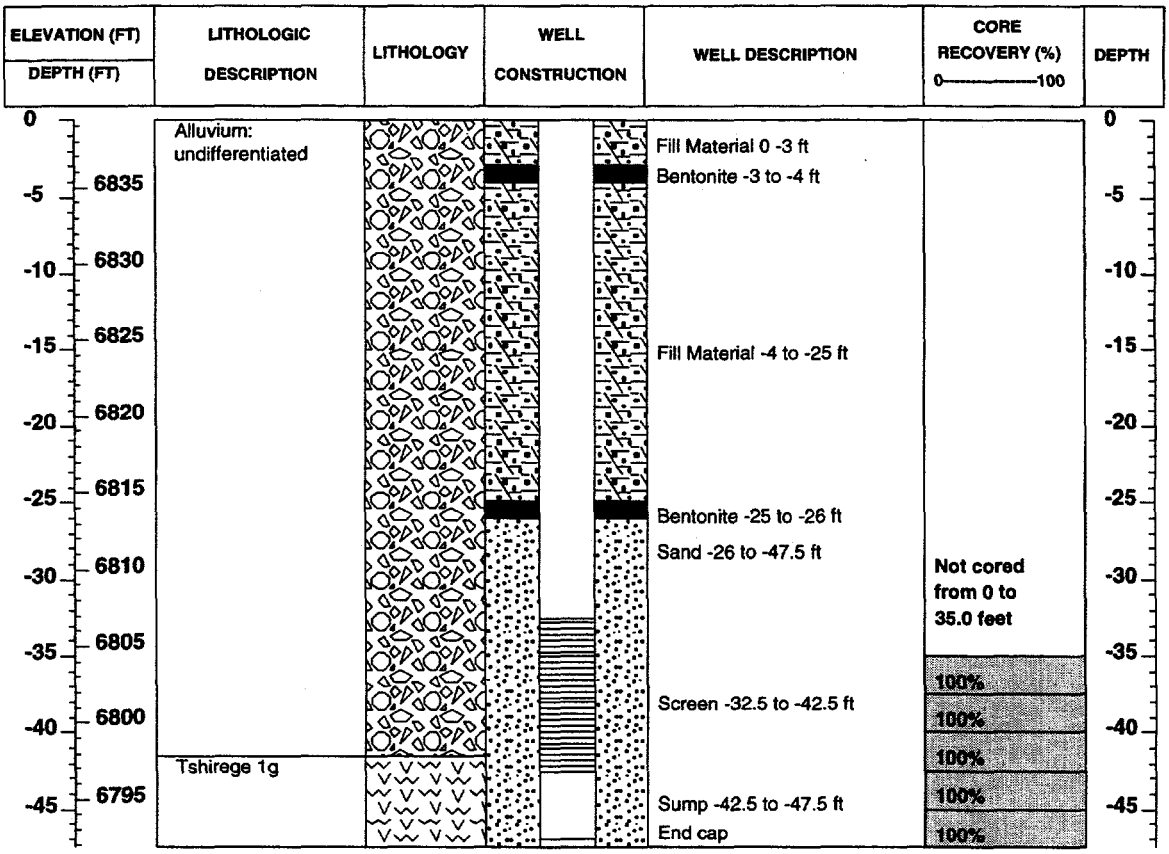

Fig. 14. Drill log and well completion diagram for MCWB-6.6.

MCWB-7A

DRILL DATE:	December 9, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768551.02 North	HOLE DIAMETER:	10.375 inches
	1634356.62 East	WATER LEVEL:	6795.39 ASL (ft)
ELEVATION:	6831.17 LSD (ft)	TOTAL DEPTH:	52.0 ft

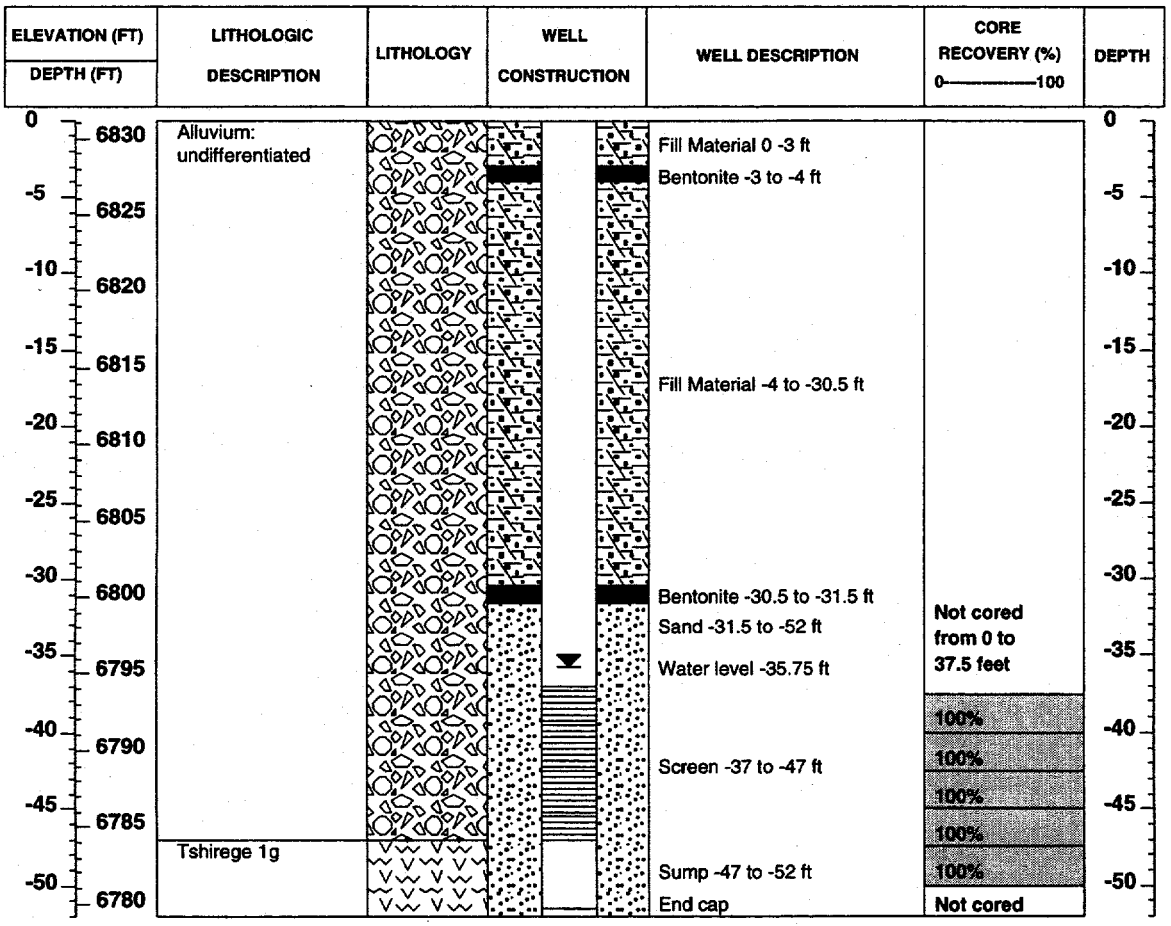

Fig. 15. Drill log and well completion diagram for MCWB-7A.

MCWB-7B

DRILL DATE:	December 9, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768469.73 North	HOLE DIAMETER:	10.375 inches
	1634350.16 East	WATER LEVEL:	6795.30 ASL (ft)
ELEVATION:	6832.45 LSD (ft)	TOTAL DEPTH:	47.5 ft

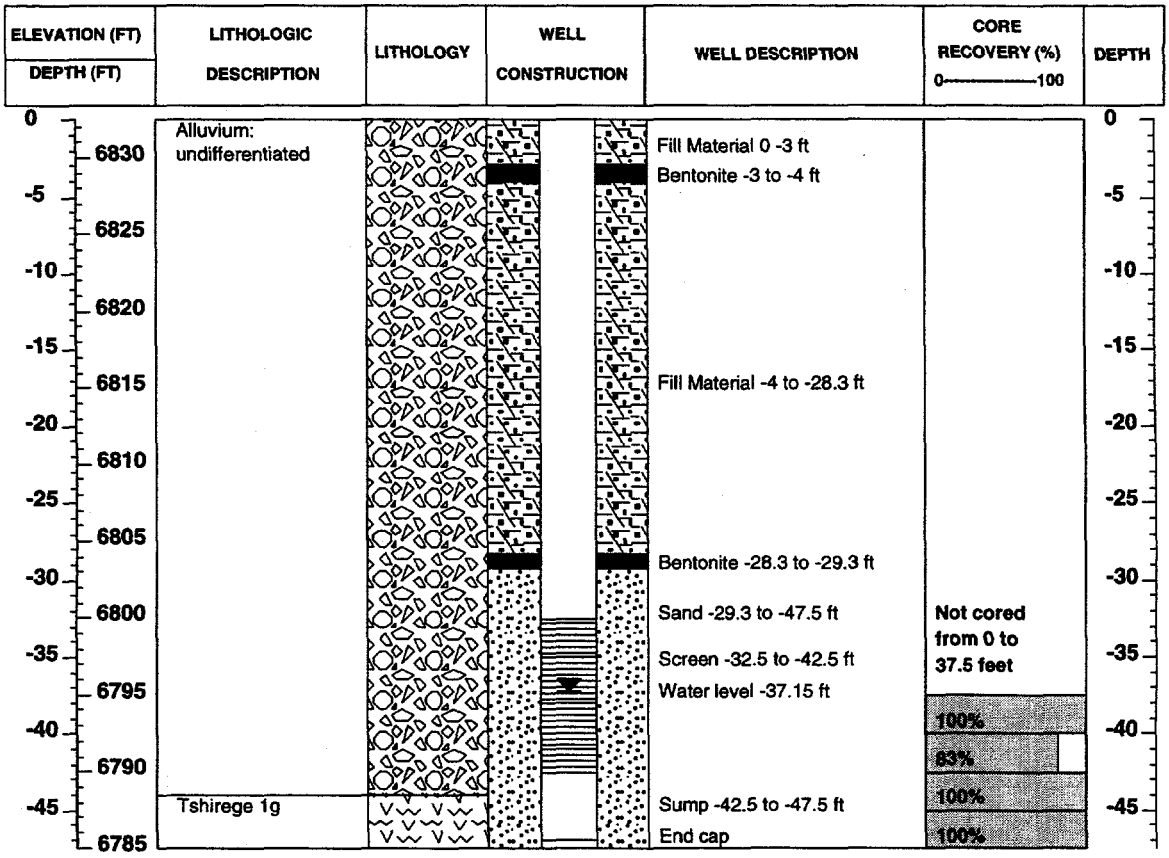

Fig. 16. Drill log and well completion diagram for MCWB-7B.

MCWB-7.2

DRILL DATE:	December 12, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768491.86 North	HOLE DIAMETER:	10.375 inches
	1634956.96 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6818.86 LSD (ft)	TOTAL DEPTH:	67.5 ft

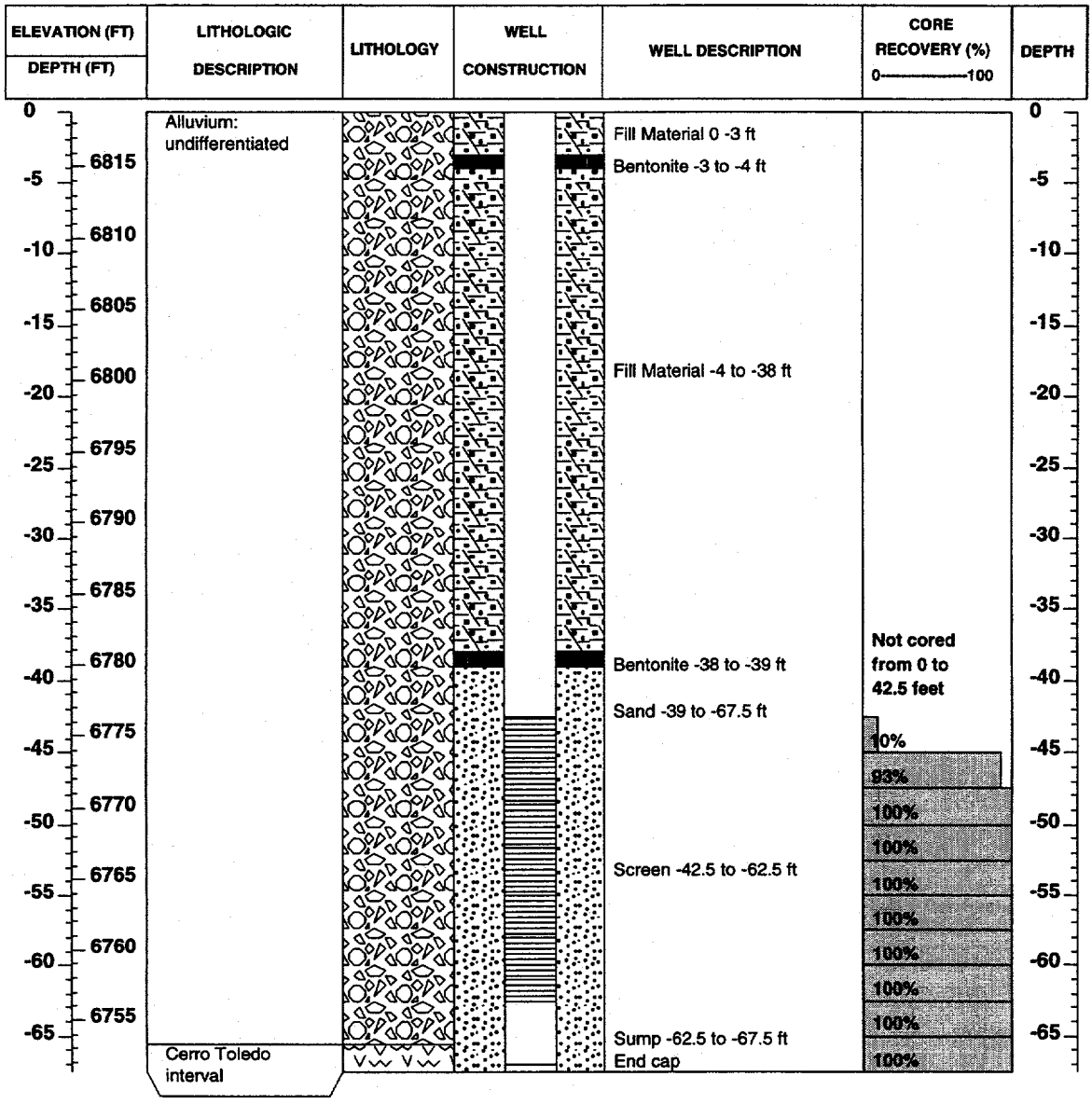

Fig. 17. Drill log and well completion diagram for MCWB-7.2.

MCWB-7.4A

DRILL DATE:	December 13, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768569.46 North	HOLE DIAMETER:	10.375 inches
	1635270.33 East	WATER LEVEL:	6771.71 ASL (ft)
ELEVATION:	6812.40 LSD (ft)	TOTAL DEPTH:	70.0 ft

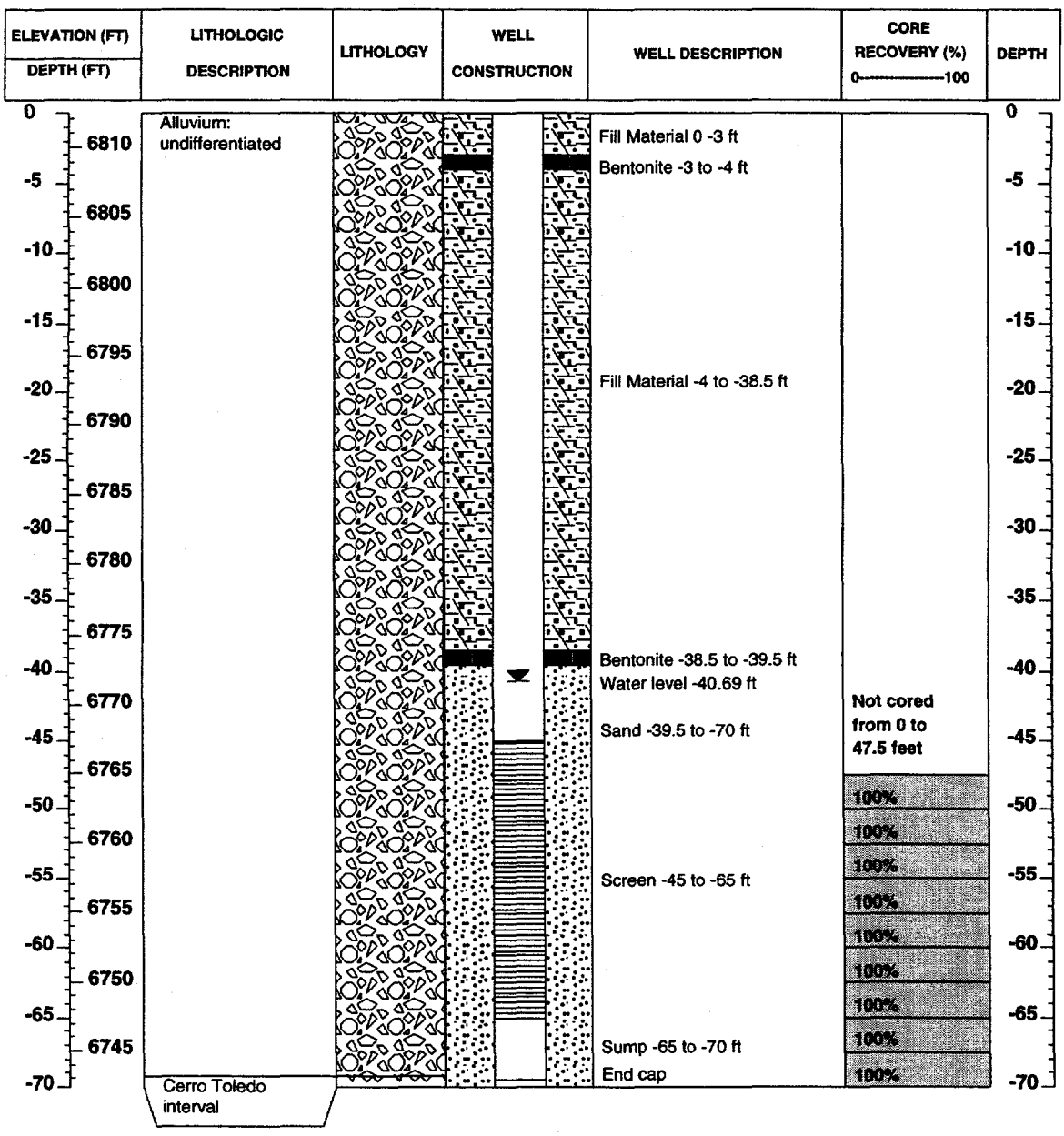

Fig. 18. Drill log and well completion diagram for MCWB-7.4A.

MCWB-7.4B

DRILL DATE:	December 13, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768407.84 North	HOLE DIAMETER:	10.375 inches
	1635287.73 East	WATER LEVEL:	6766.94 ASL (ft)
ELEVATION:	6813.07 LSD (ft)	TOTAL DEPTH:	70.0 ft

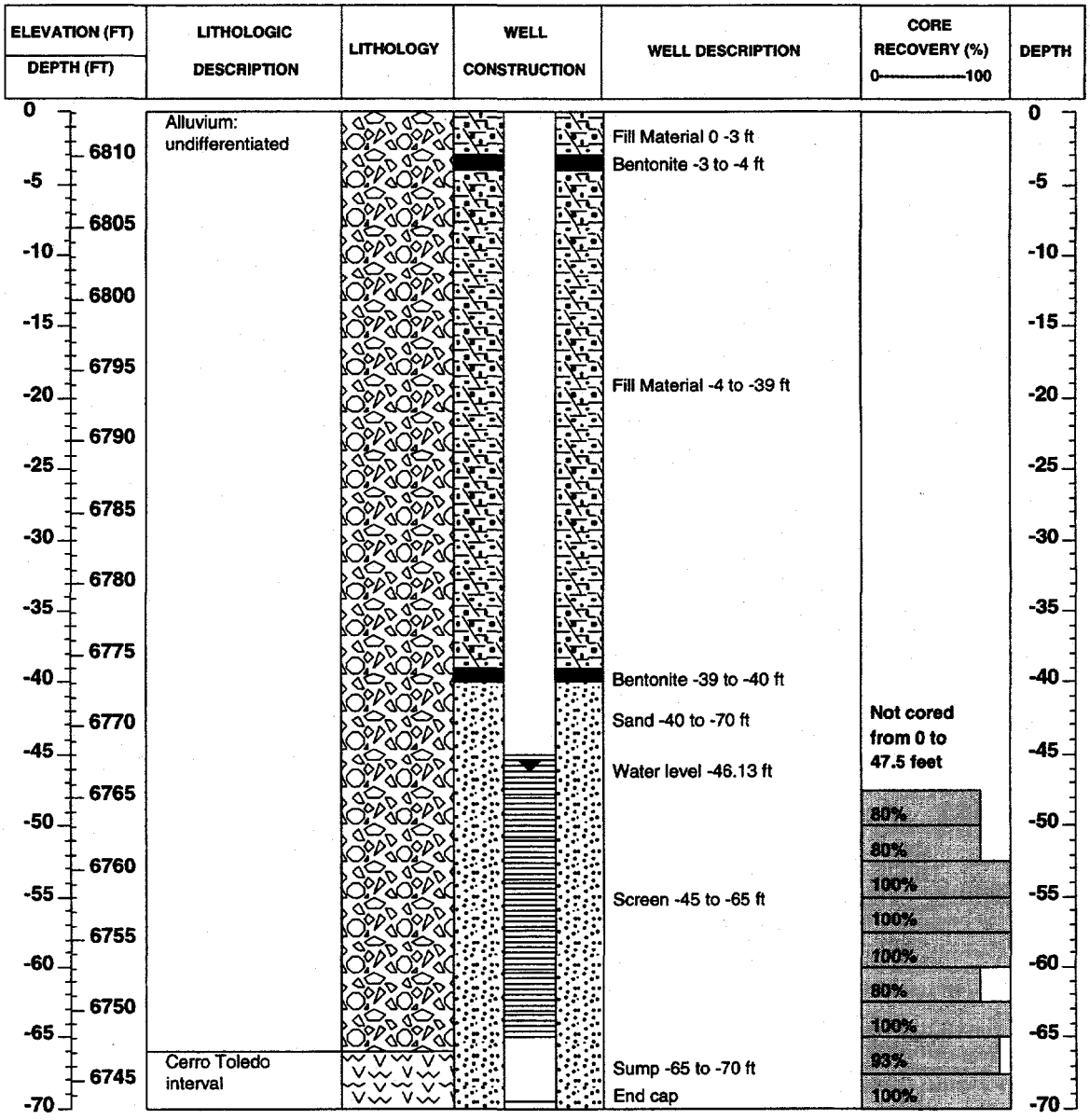

Fig. 19. Drill log and well completion diagram for MCWB-7.4B.

MCWB-7.7A

DRILL DATE:	December 19, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768700.71 North	HOLE DIAMETER:	10.375 inches
	1635902.25 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6798.31 LSD (ft)	TOTAL DEPTH:	67.5 ft

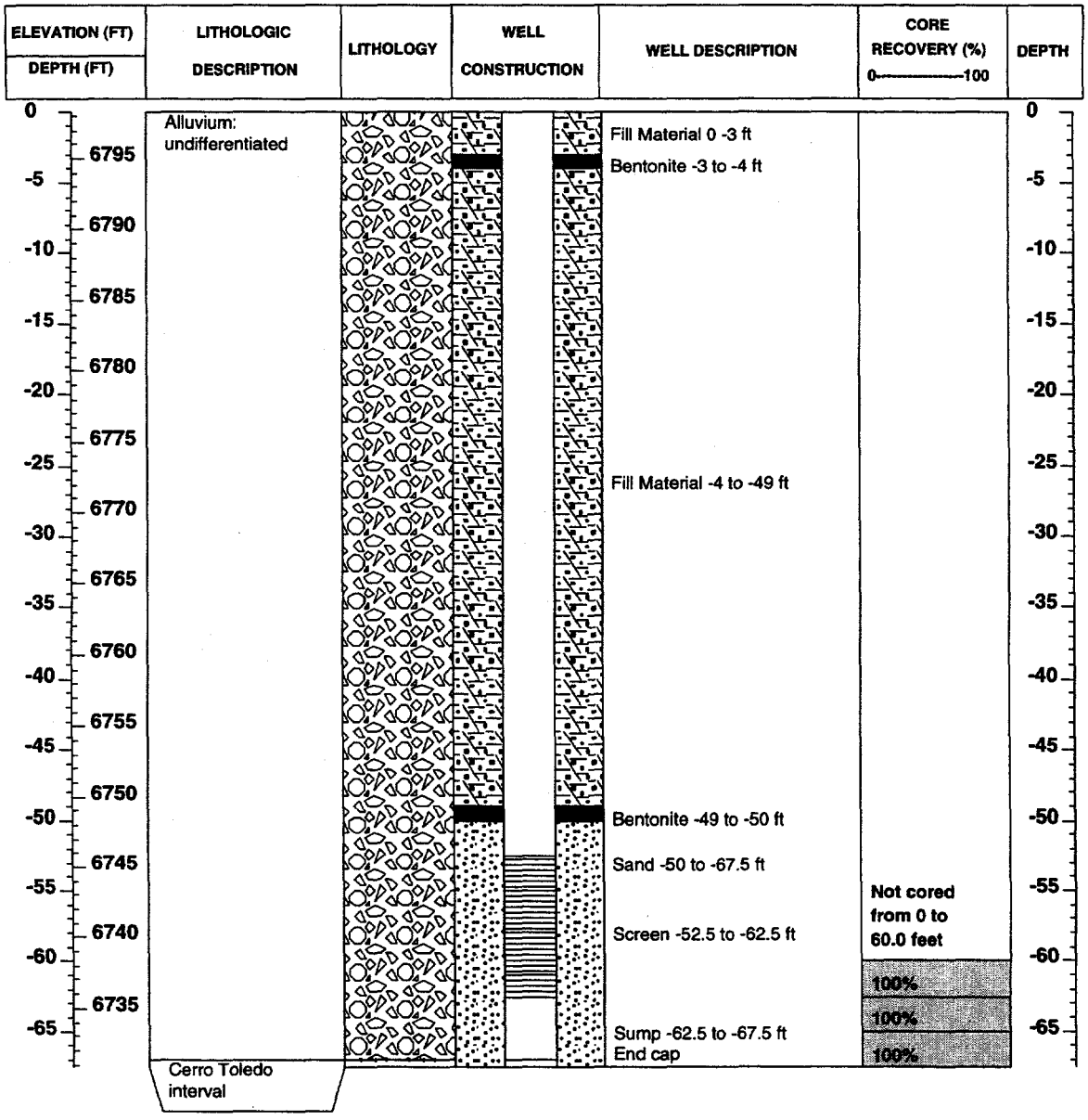

Fig. 20. Drill log and well completion diagram for MCWB-7.7A.

MCWB-7.7B

DRILL DATE:	December 20, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768517.26 North	HOLE DIAMETER:	10.375 inches
	1635921.84 East	WATER LEVEL:	6742.26 ASL (ft)
ELEVATION:	6798.97 LSD (ft)	TOTAL DEPTH:	70.0 ft

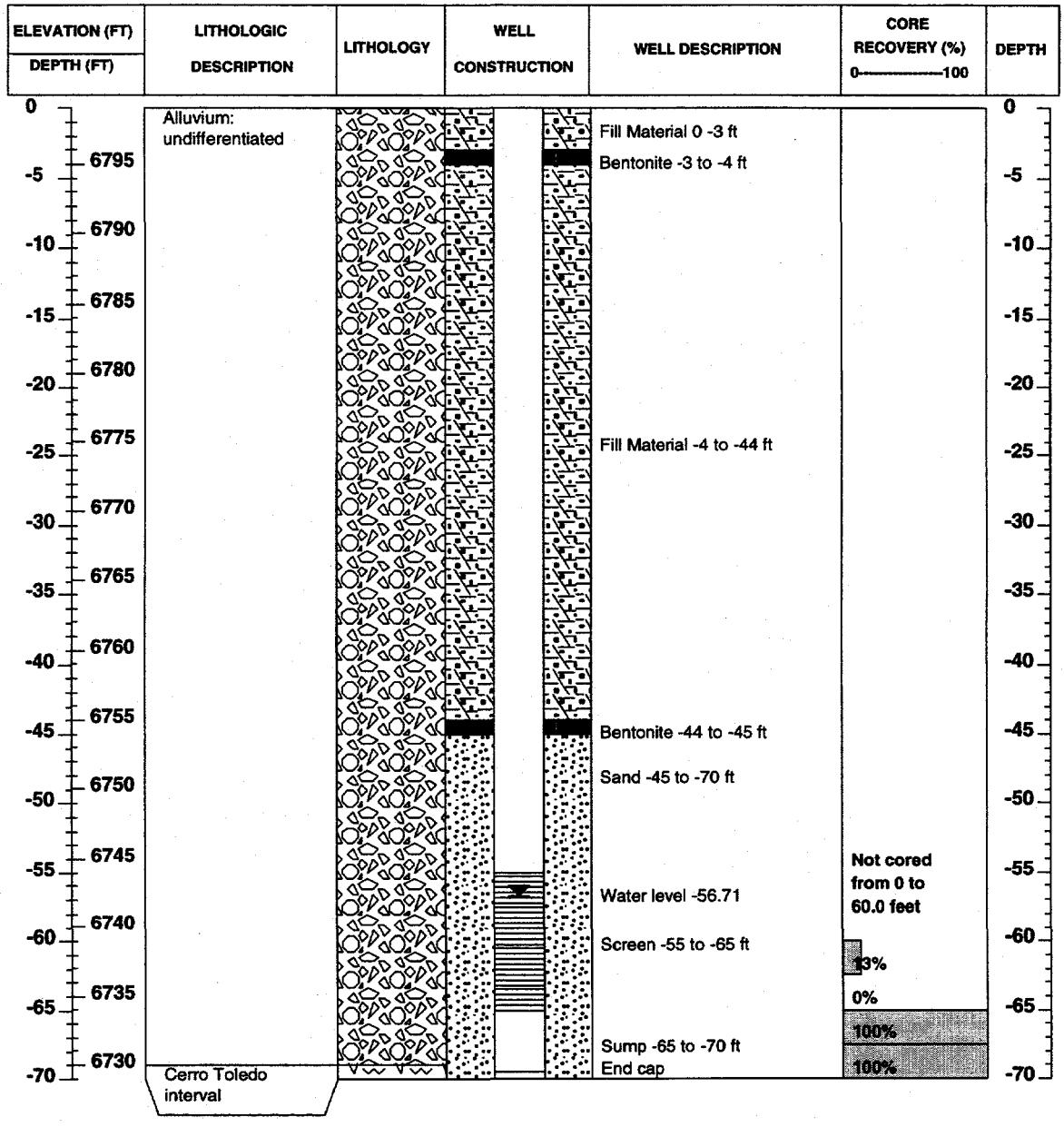

Fig. 21. Drill log and well completion diagram for MCWB-7.7B.

MCWB-8.1A

DRILL DATE:	December 14, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768704.12 North	HOLE DIAMETER:	10.375 inches
	1636552.36 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6785.95 LSD (ft)	TOTAL DEPTH:	75.0 ft

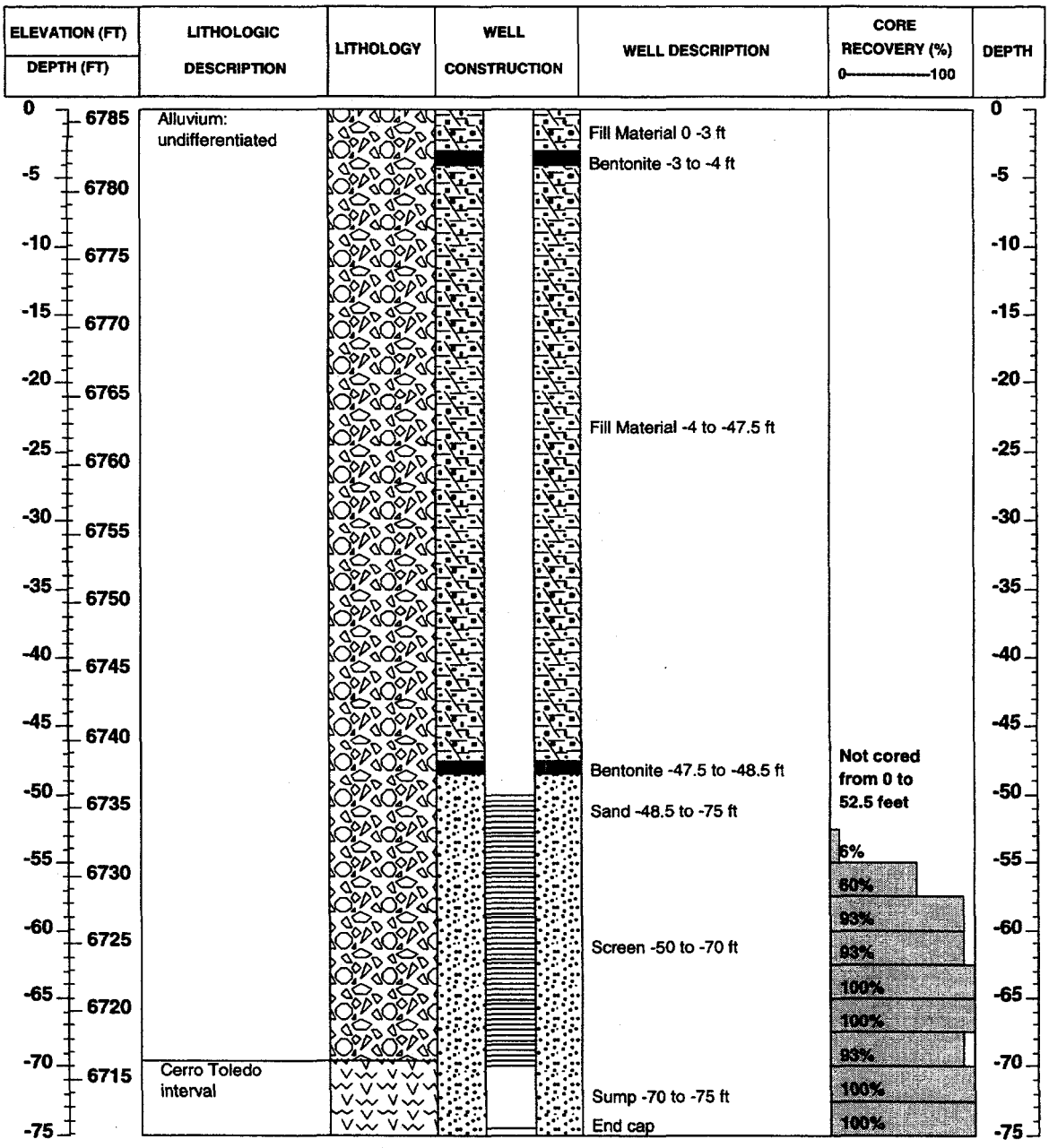

Fig. 22. Drill log and well completion diagram for MCWB-8.1A.

MCWB-8.1B

DRILL DATE:	December 19, 1994	DRILLING METHOD:	Hollow Stem Auge:
COORDINATE:	1768618.31 North	HOLE DIAMETER:	10.375 inches
	1636559.97 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6783.80 LSD (ft)	TOTAL DEPTH:	72.5 ft

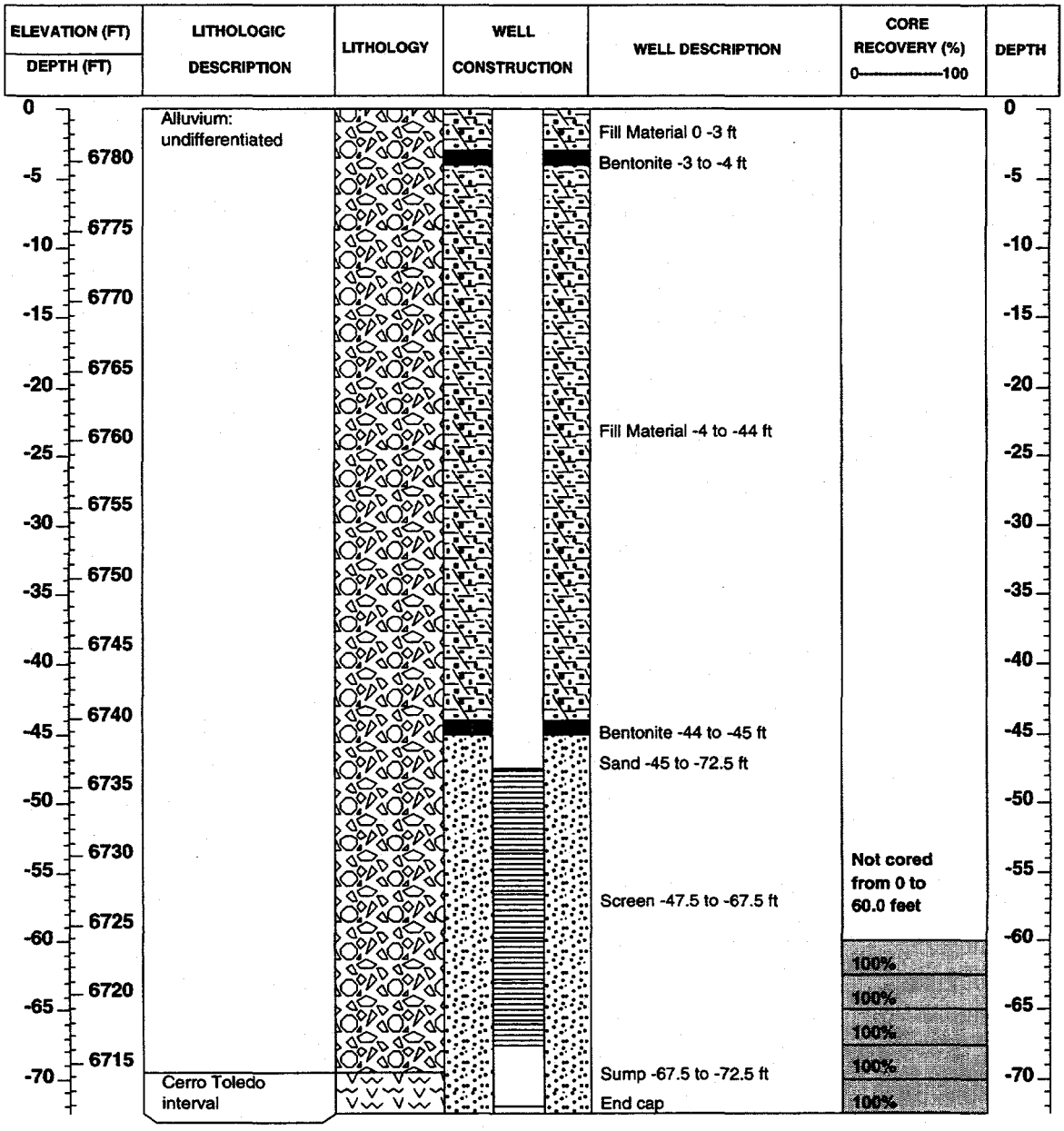

Fig. 23. Drill log and well completion diagram for MCWB-8.1B.

MCWB-8.1C

DRILL DATE:	December 14, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768531.74 North	HOLE DIAMETER:	10.375 inches
	1636565.71 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6785.63 LSD (ft)	TOTAL DEPTH:	80.0 ft

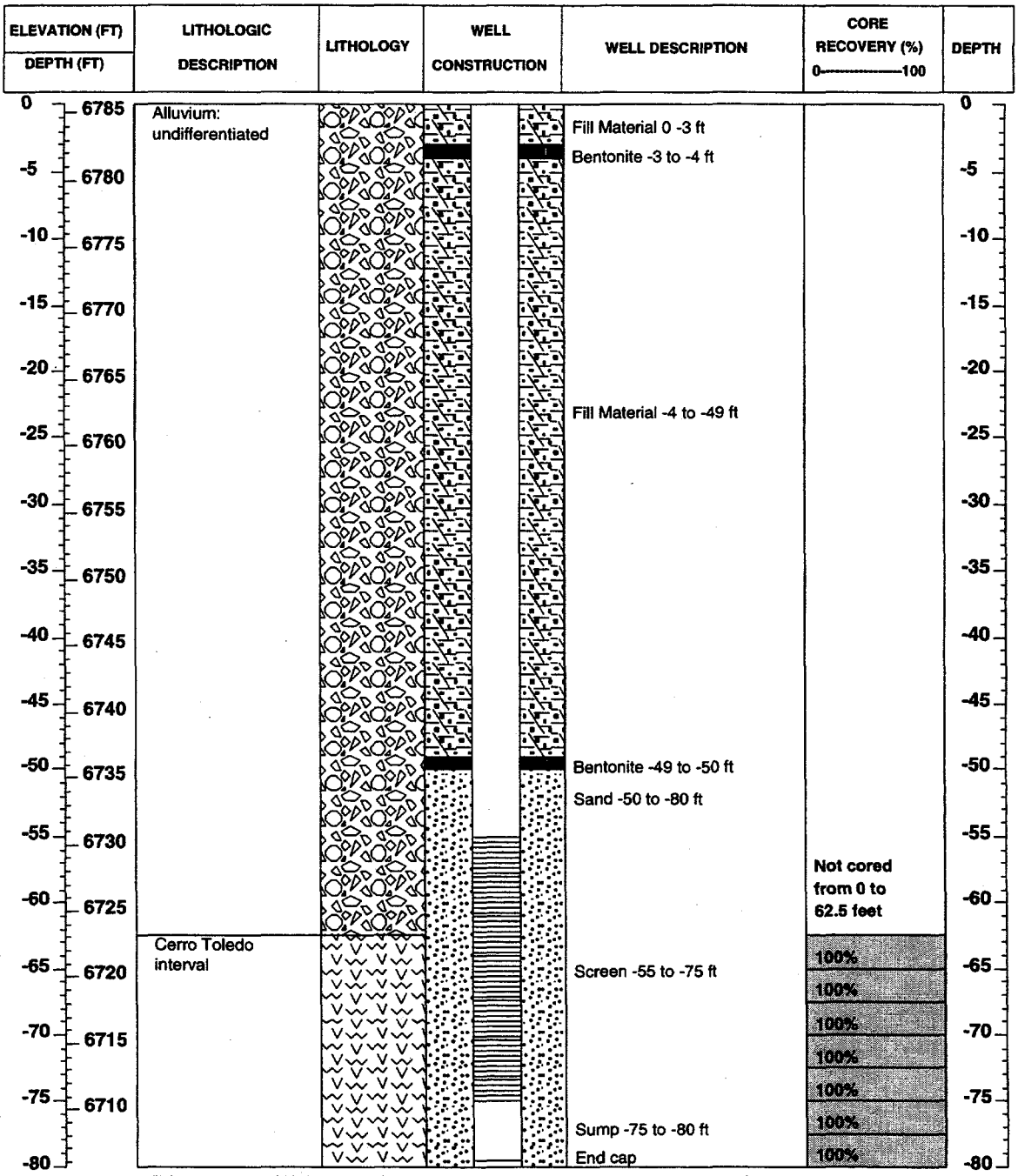

Fig. 24. Drill log and well completion diagram for MCWB-8.1C.

MCWB-9A

DRILL DATE:	December 15, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768627.67 North	HOLE DIAMETER:	10.375 inches
	1638123.04 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6752.11 LSD (ft)	TOTAL DEPTH:	75.0 ft

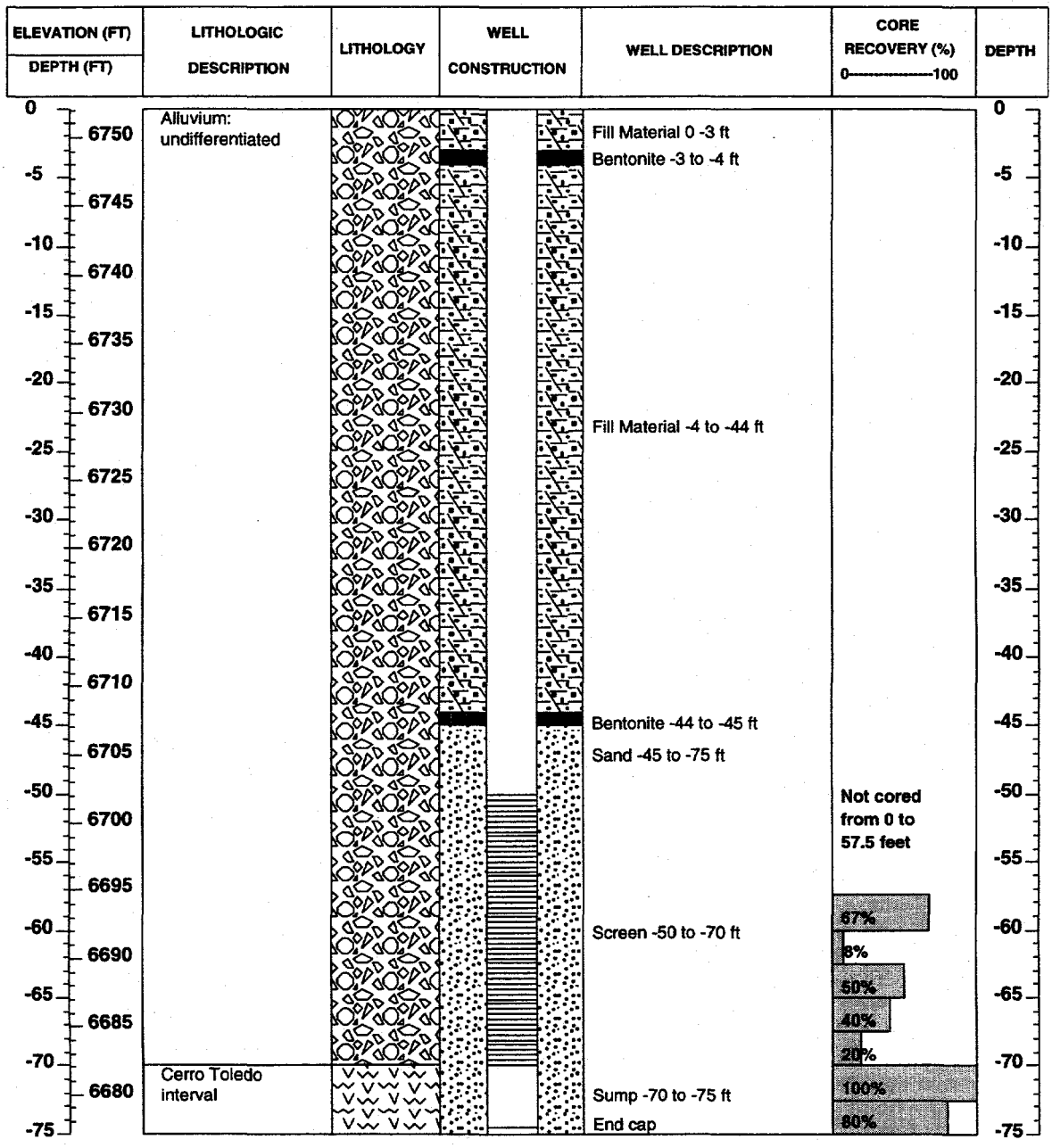

Fig. 25. Drill log and well completion diagram for MCWB-9A.

MCWB-9B

DRILL DATE:	December 15, 1994	DRILLING METHOD:	Hollow Stem Auger
COORDINATE:	1768490.99 North	HOLE DIAMETER:	10.375 inches
	1638069.00 East	WATER LEVEL:	dry ASL (ft)
ELEVATION:	6753.60 LSD (ft)	TOTAL DEPTH:	80.0 ft

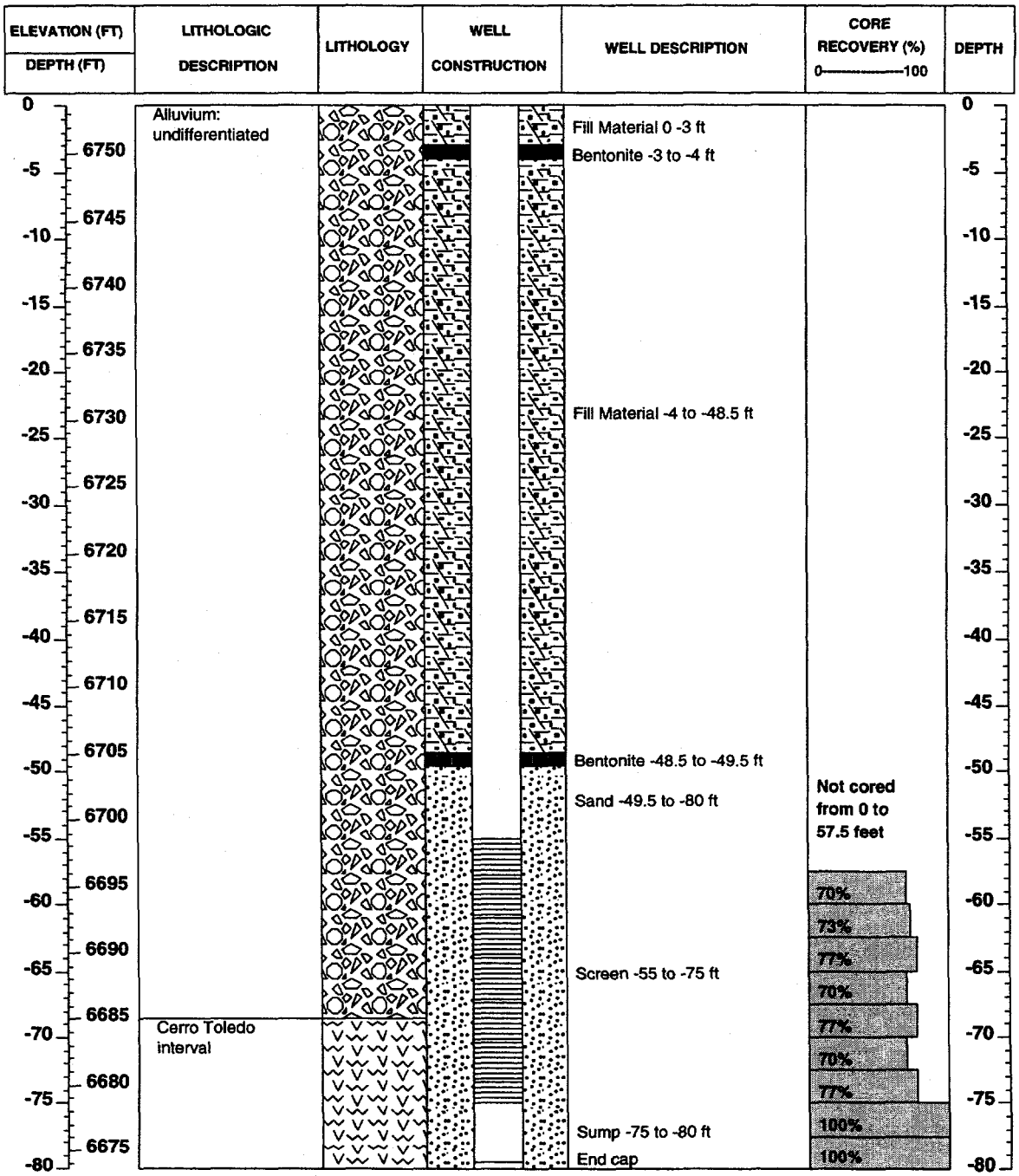

Fig. 26. Drill log and well completion diagram for MCWB-9B.

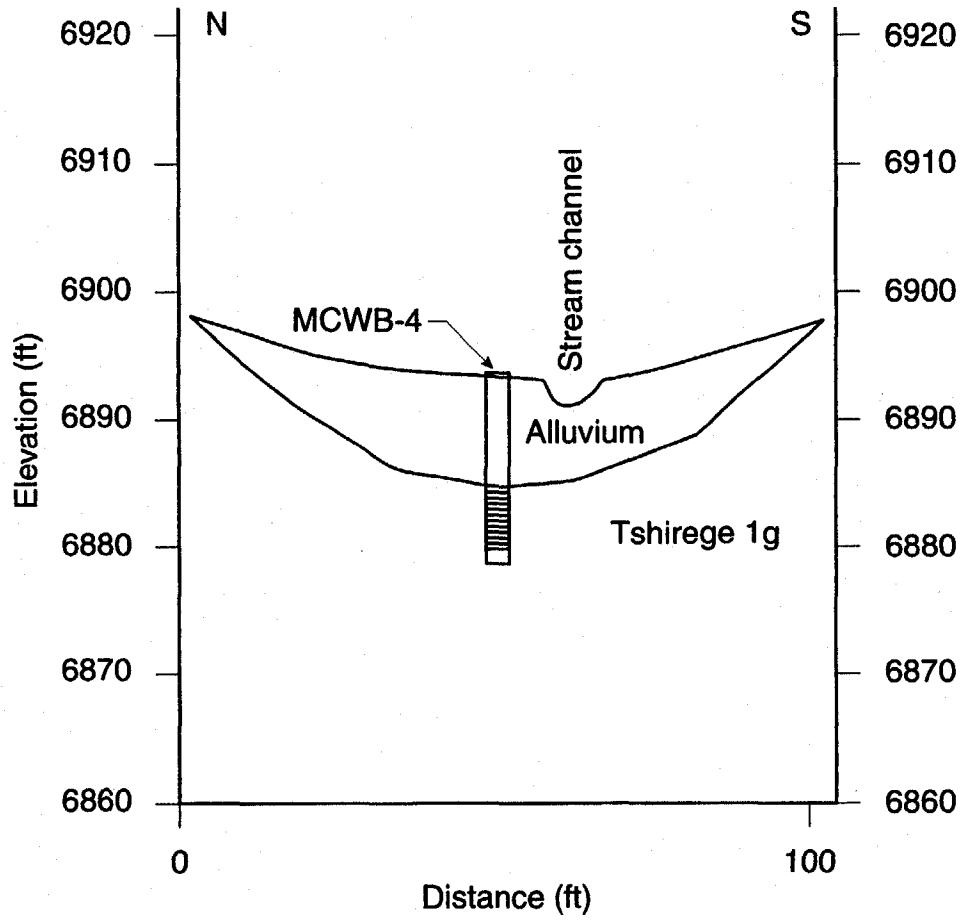

Figure 27. Vertical cross section at well MCWB-4.

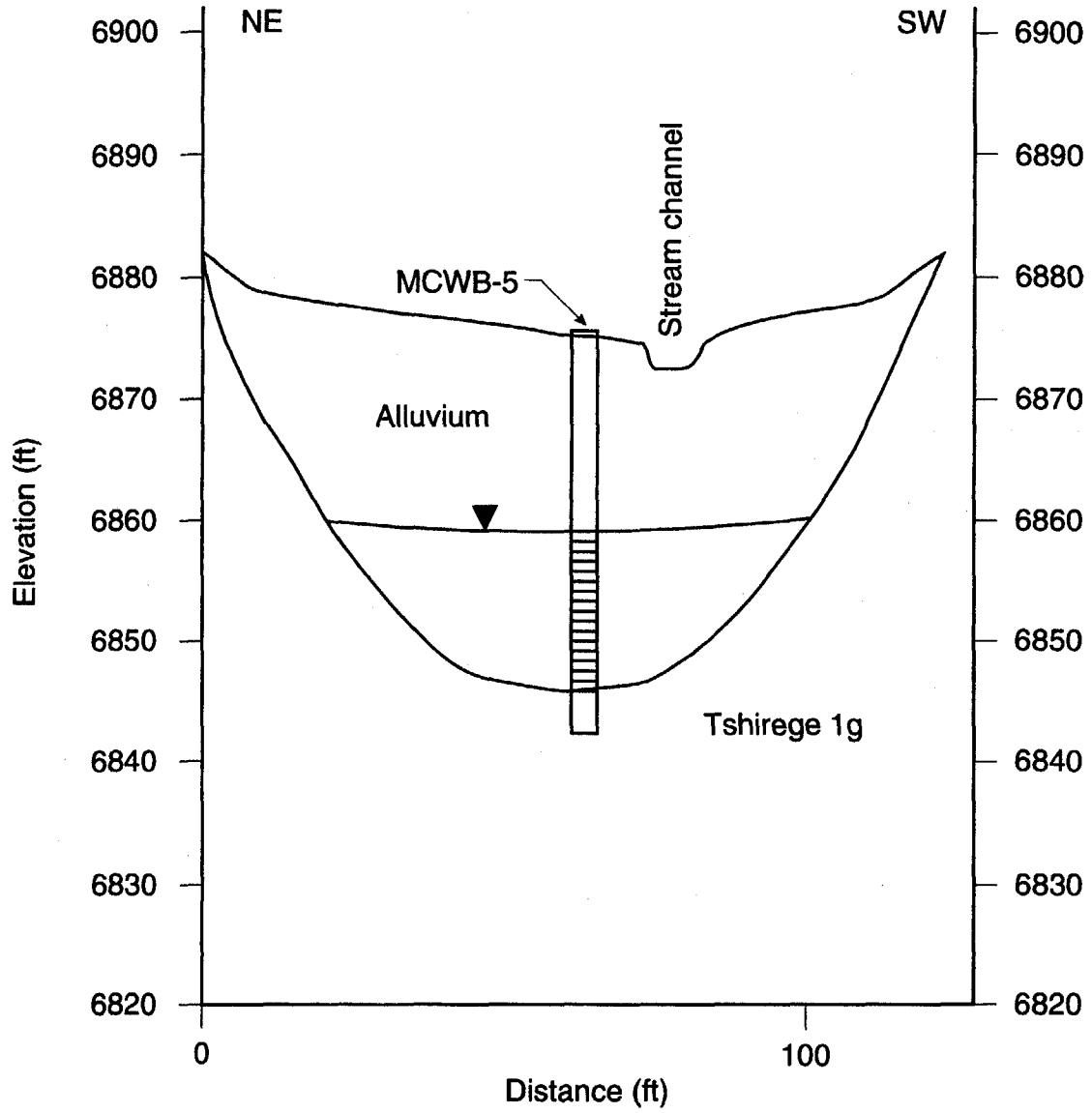

Figure 28. Vertical cross section at well MCWB-5.

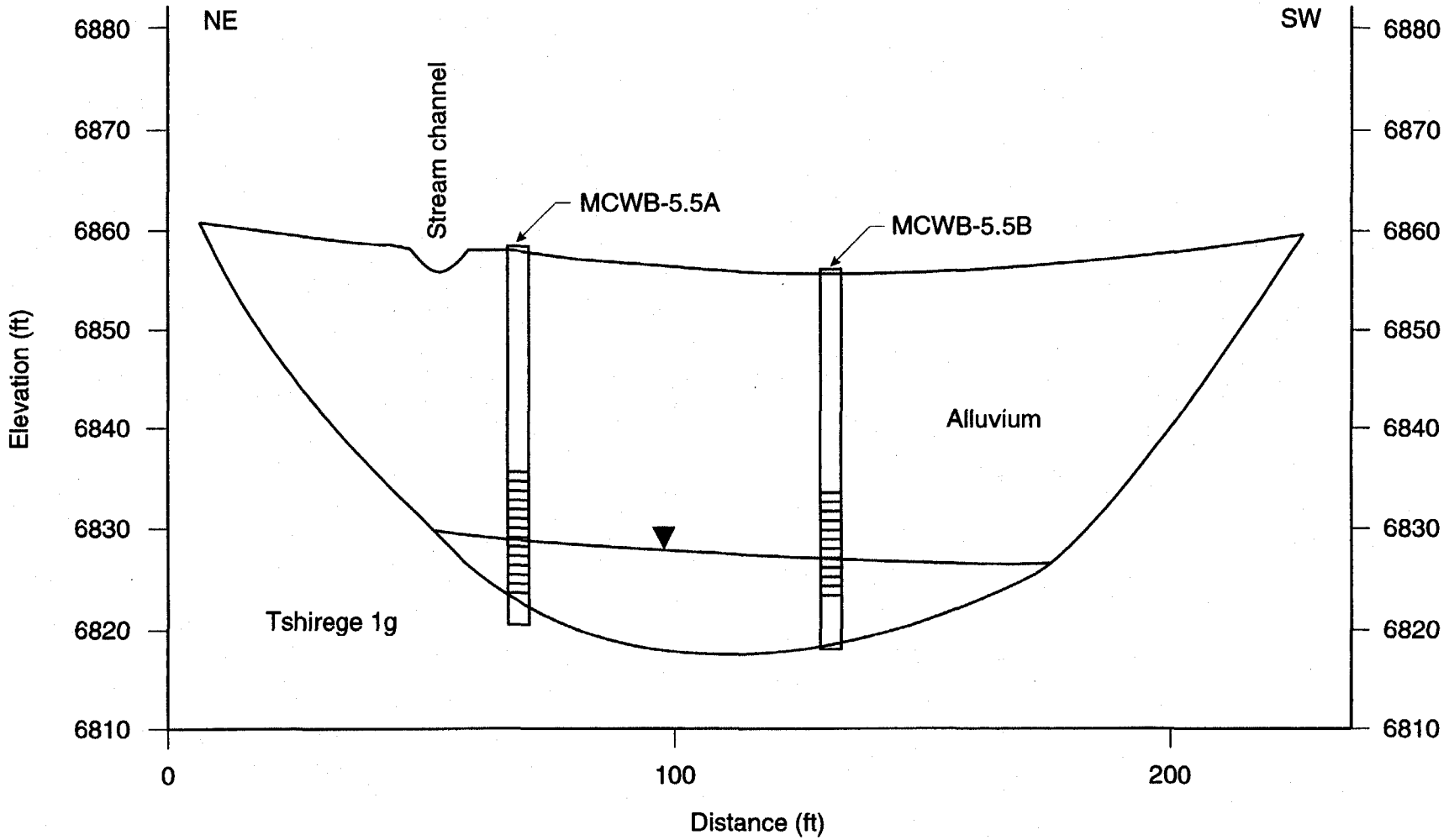

Figure 29. Vertical cross section at wells MCWB-5.5A and MCWB-5.5B

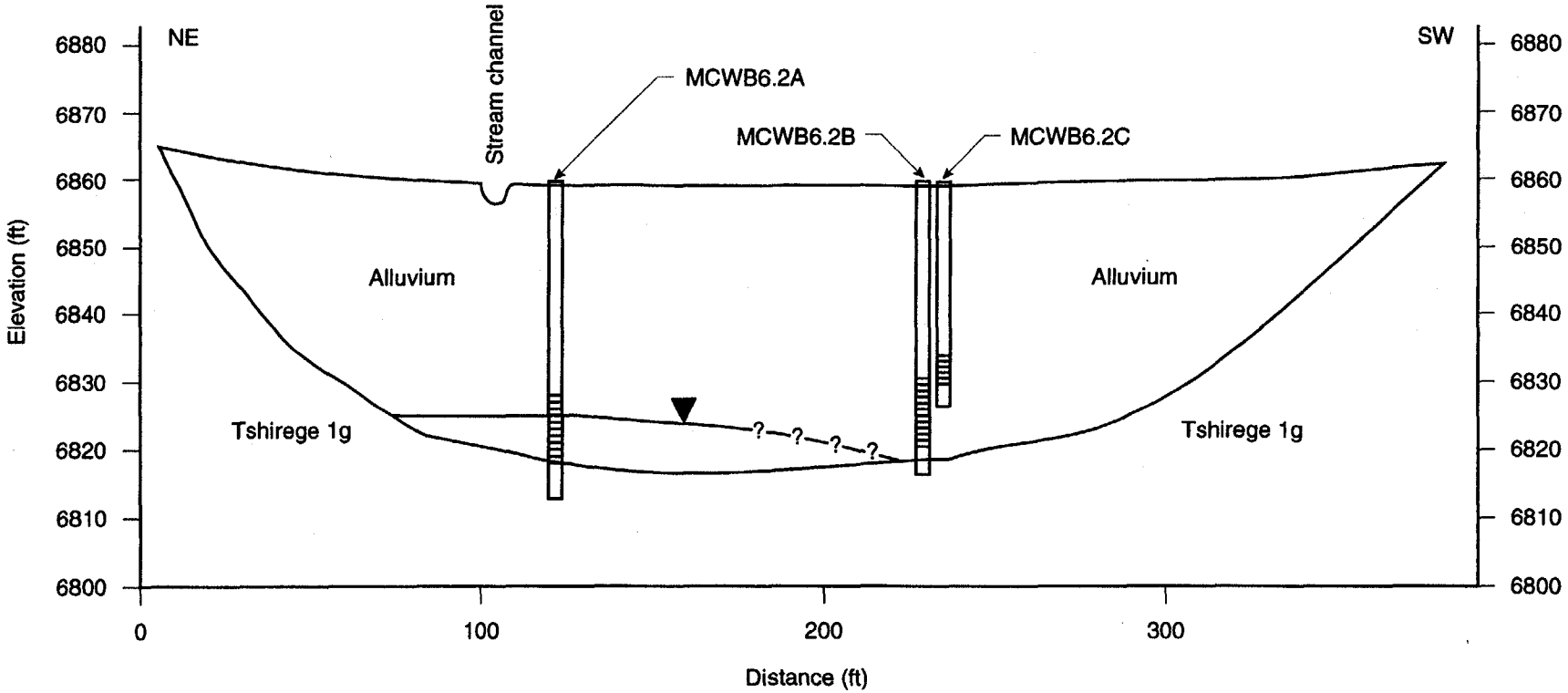

Figure 30. Vertical cross section at wells MCWB-6.2A, MCWB-6.2B, and MCWB-6.2C.

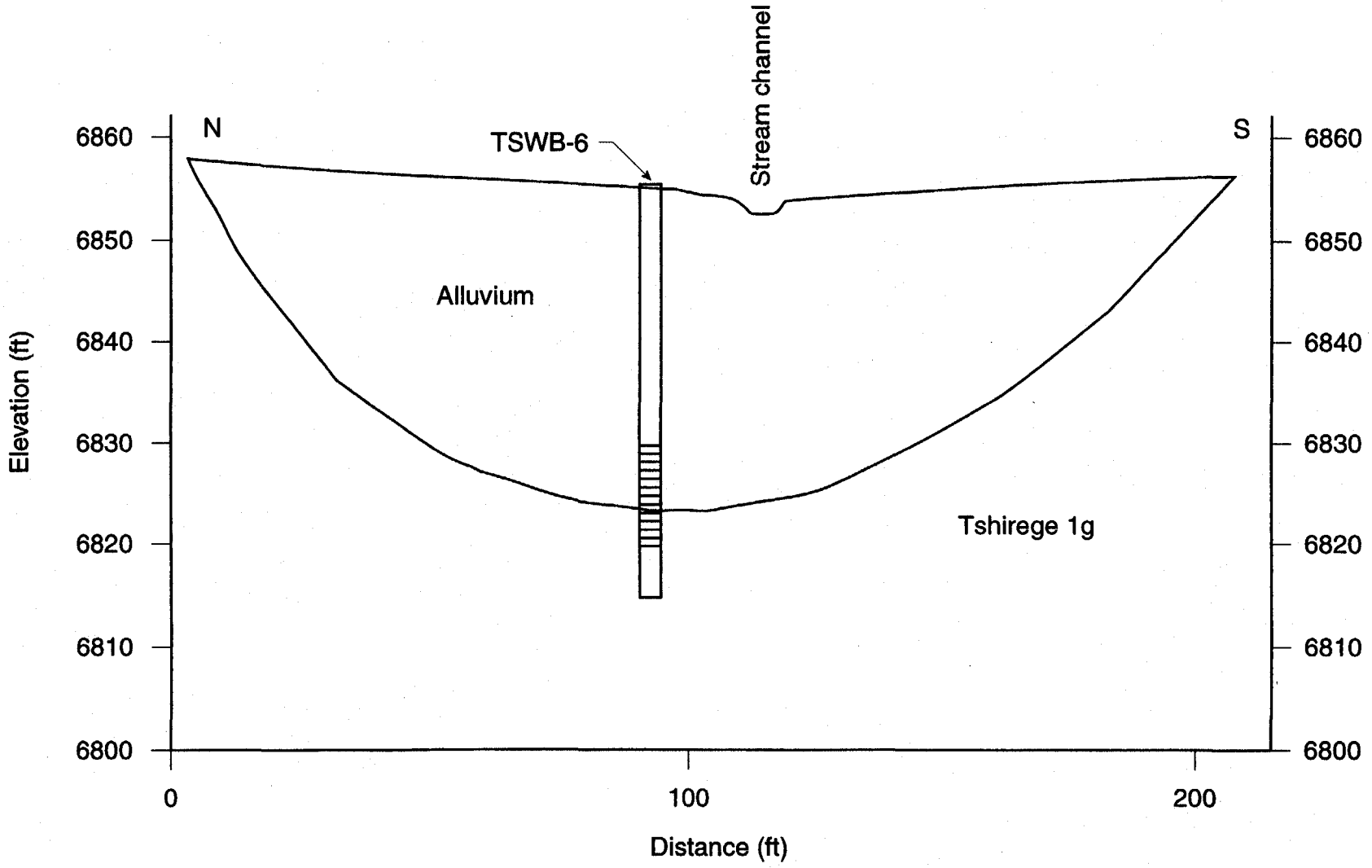

Figure 31. Vertical cross section at well TSWB-6.

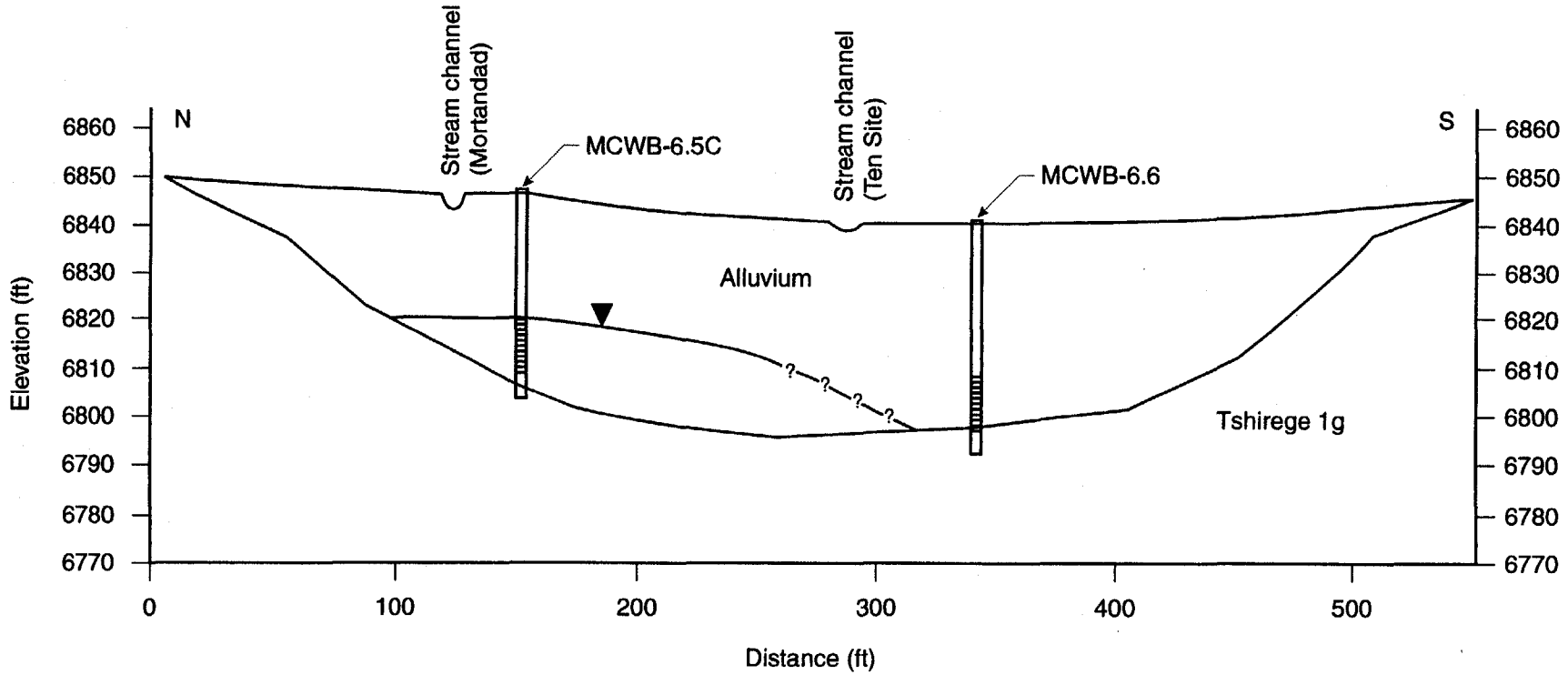

Figure 32. Vertical cross section at wells MCWB-6.5C and MCWB-6.6.

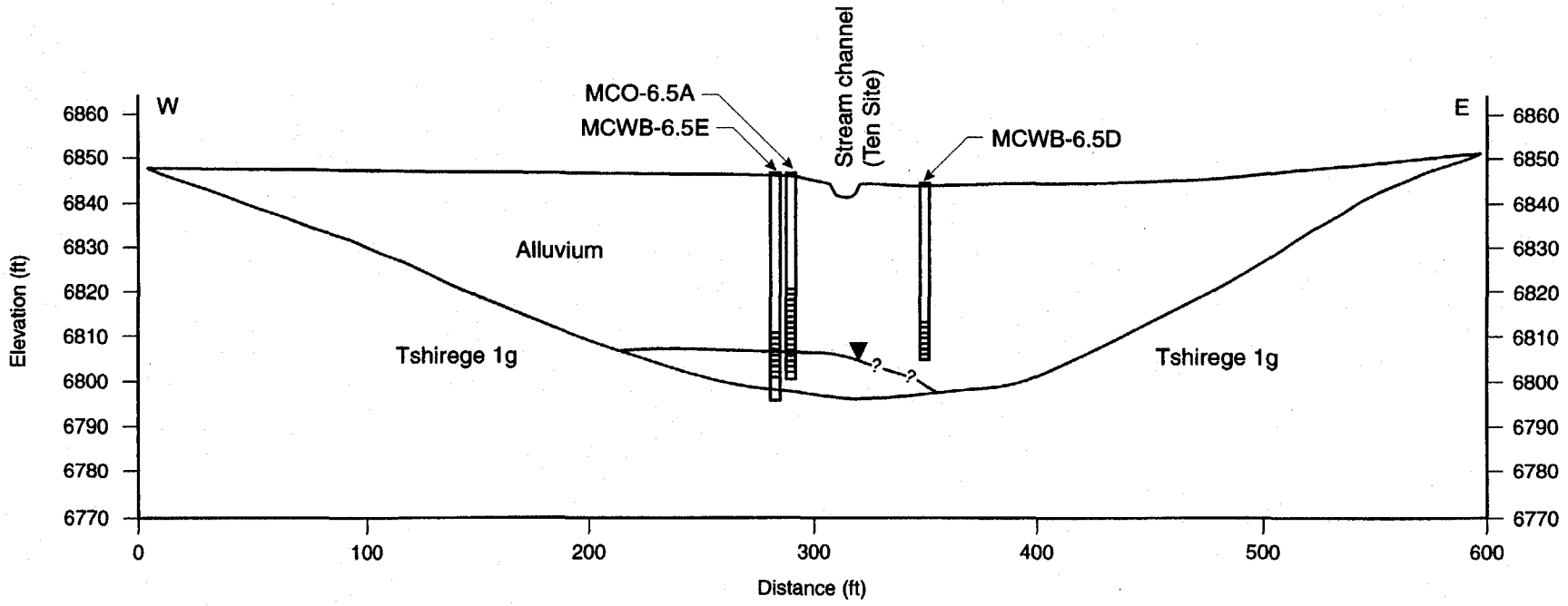

Figure 33. Vertical cross section at wells MCWB-6.5D and MCWB-6.5E.

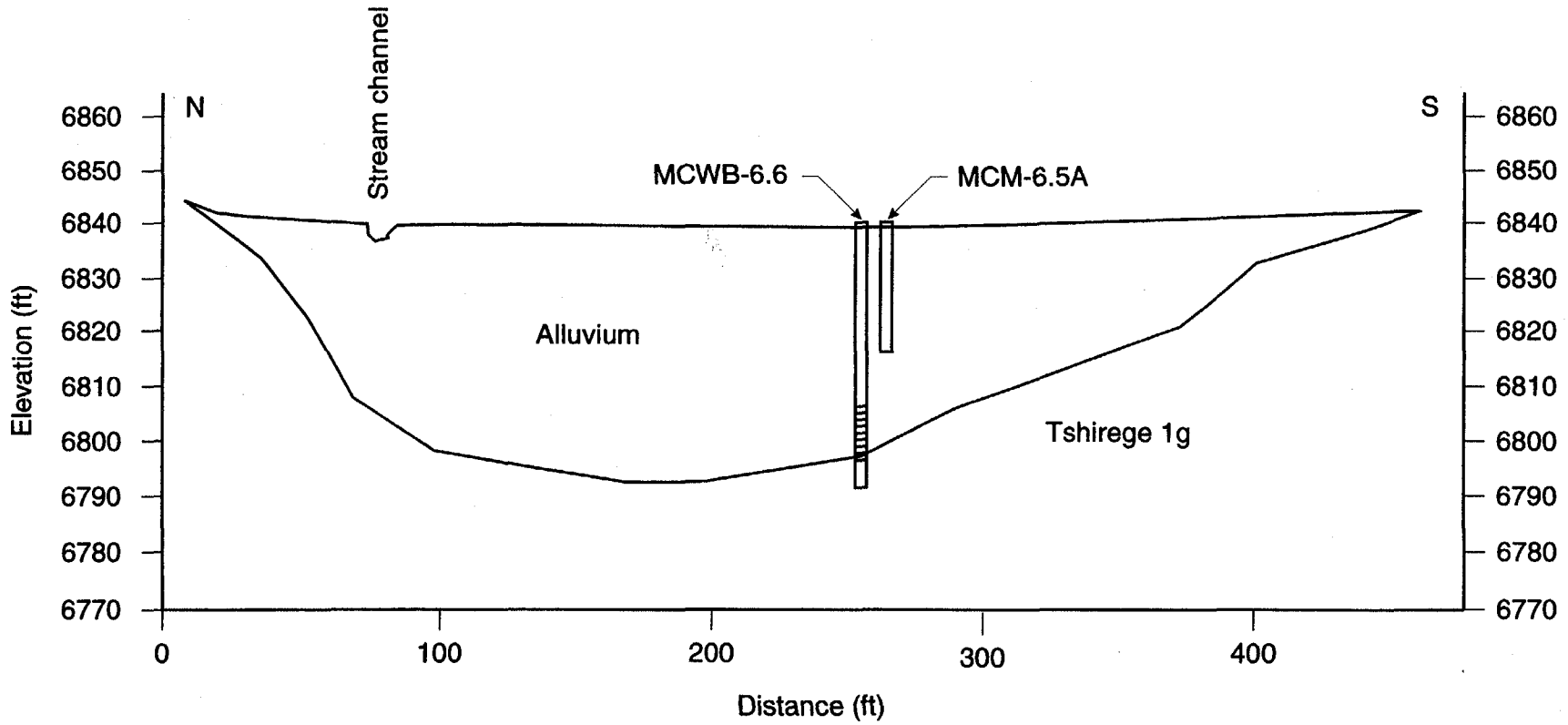

Figure 34. Vertical cross section at well MCWB-6.6.

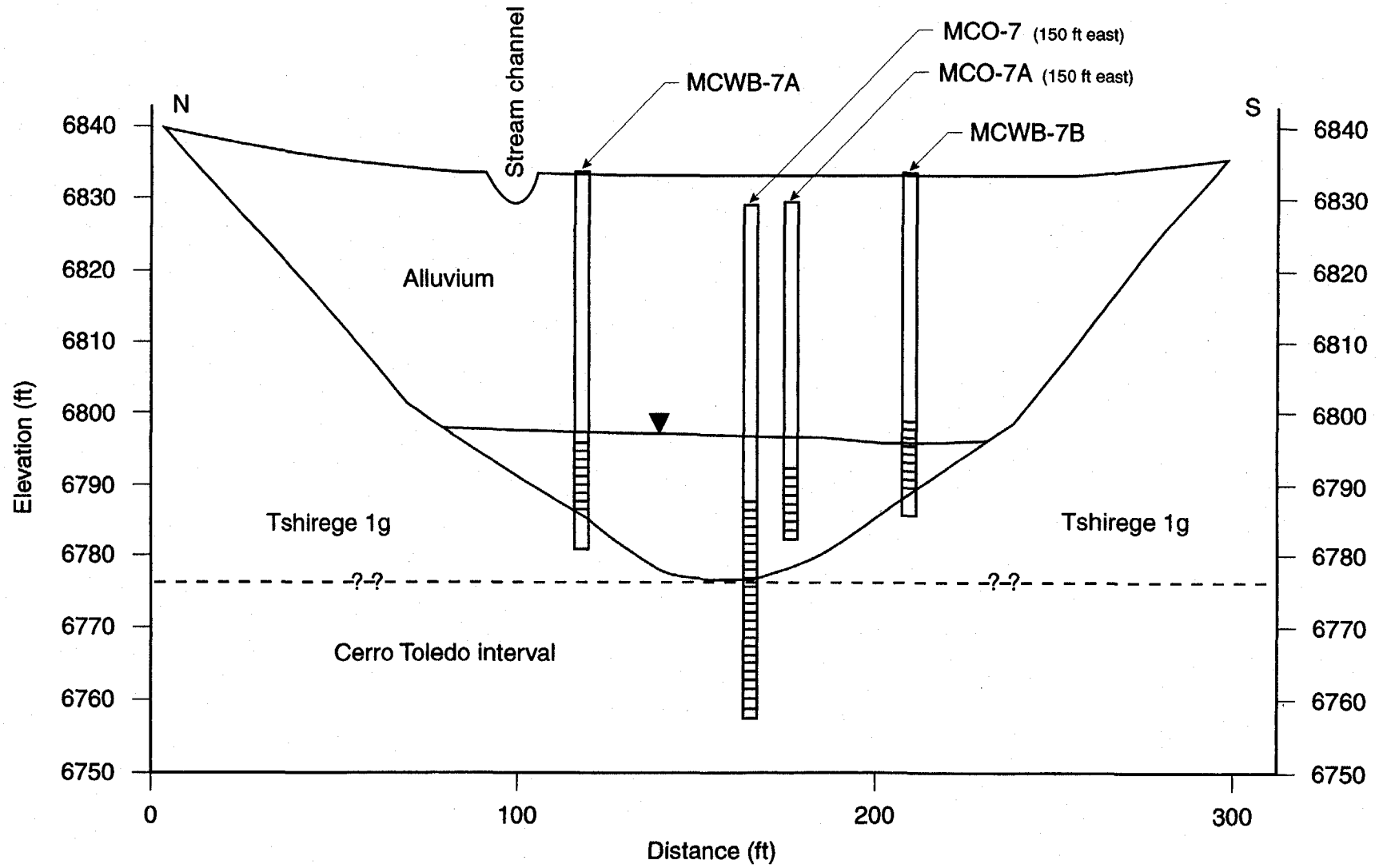

Figure 35. Vertical cross section at wells MCWB-7A and MCWB-7B.

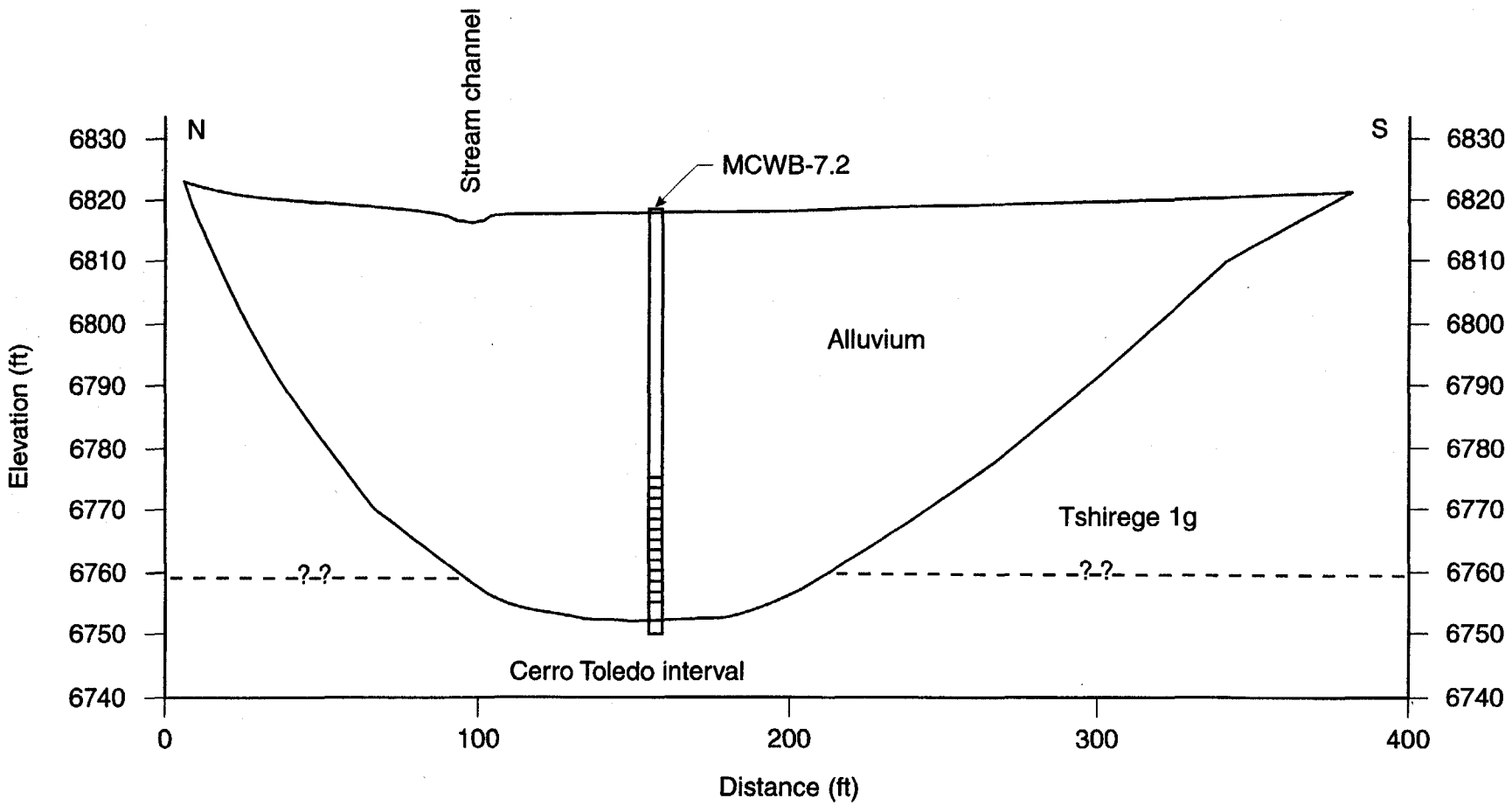

Figure 36. Vertical cross section at well MCWB-7.2.

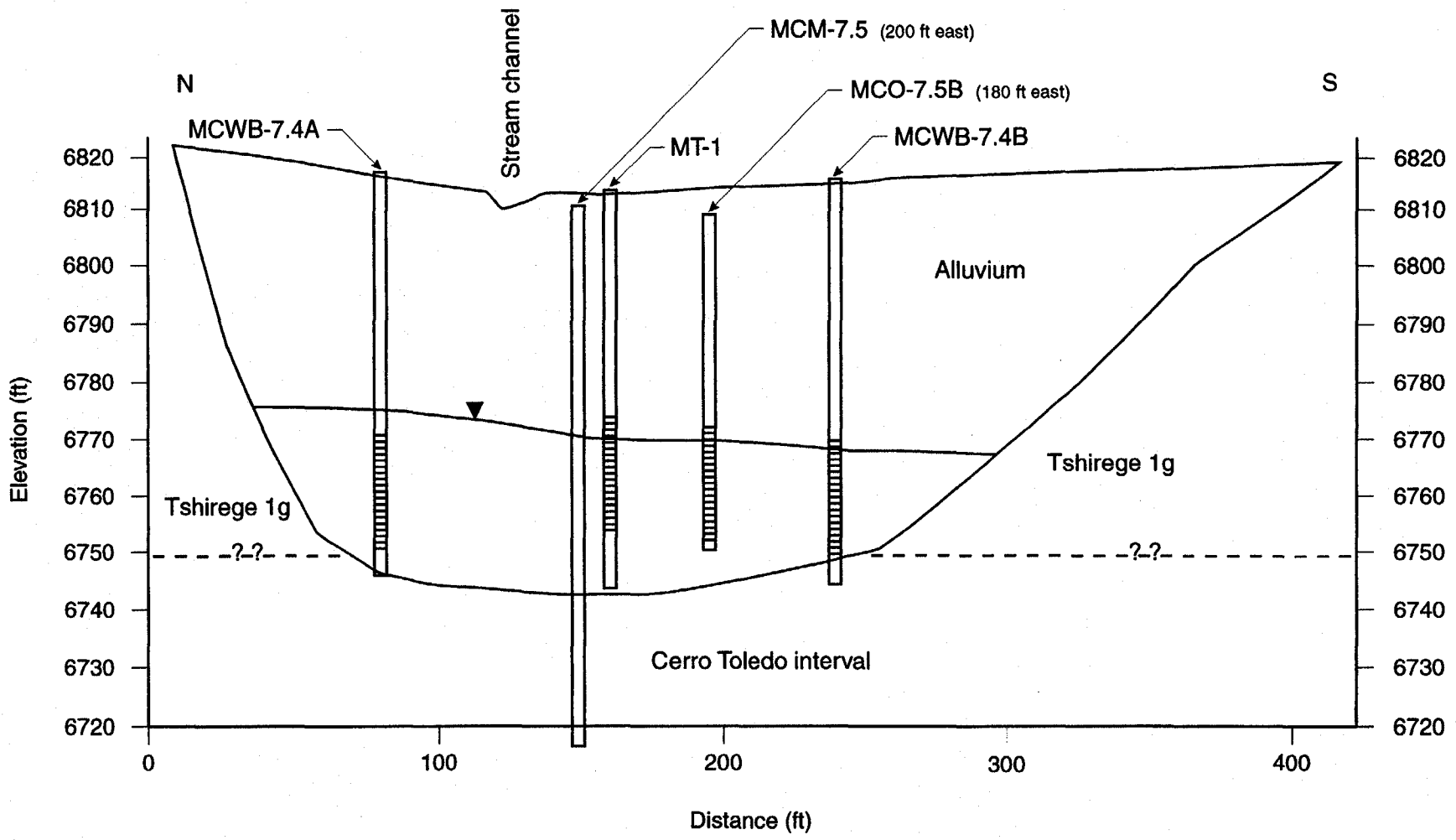

Figure 37. Vertical cross section at wells MCWB-7.4A and MCWB-7.4B.

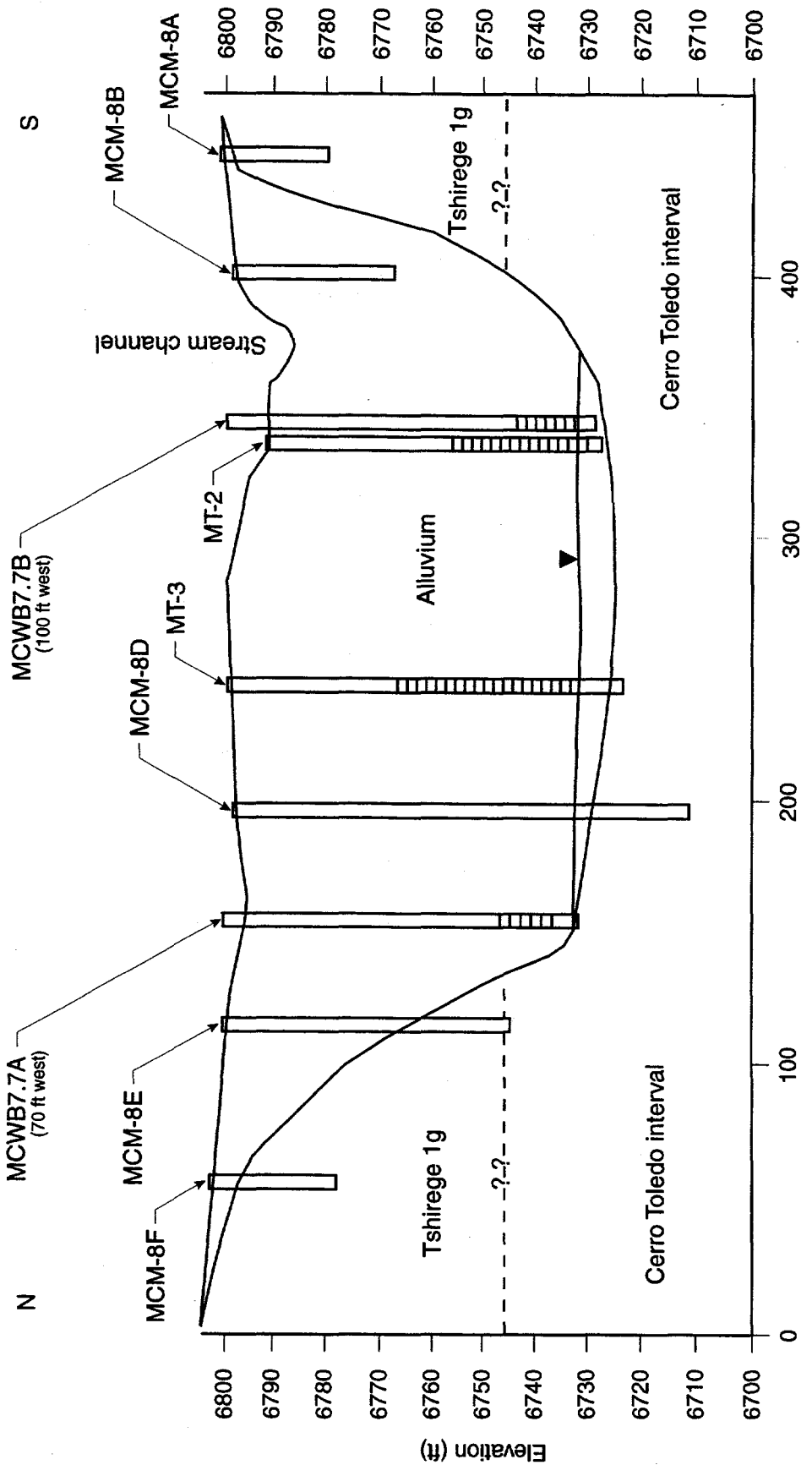

Figure 38. Vertical cross section at wells MCWB-7.7A and MCWB-7.7B.

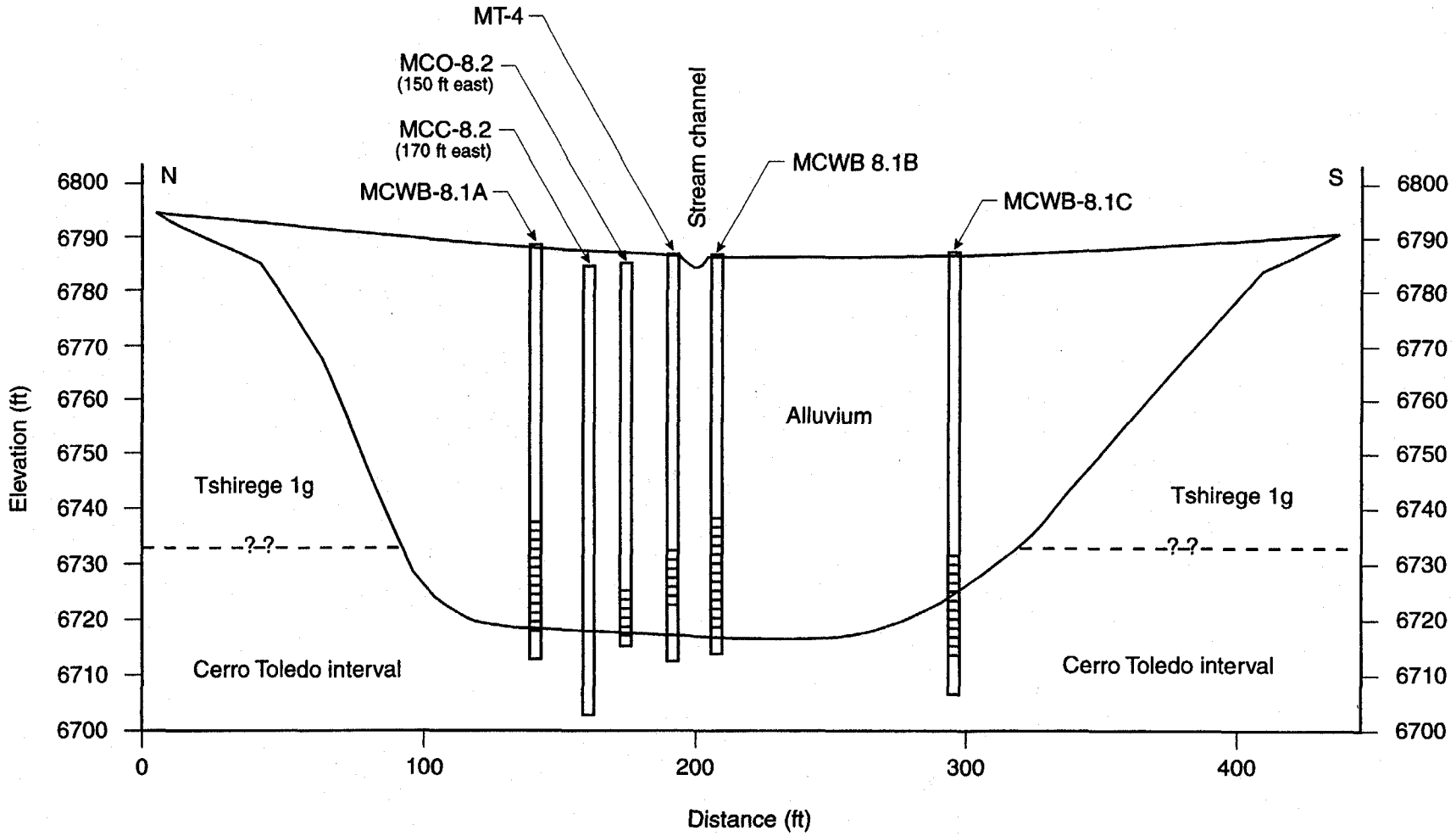

Figure 39. Vertical cross section at wells MCWB-8.1A , MCWB-8.1B, and MCWB-8.1C.

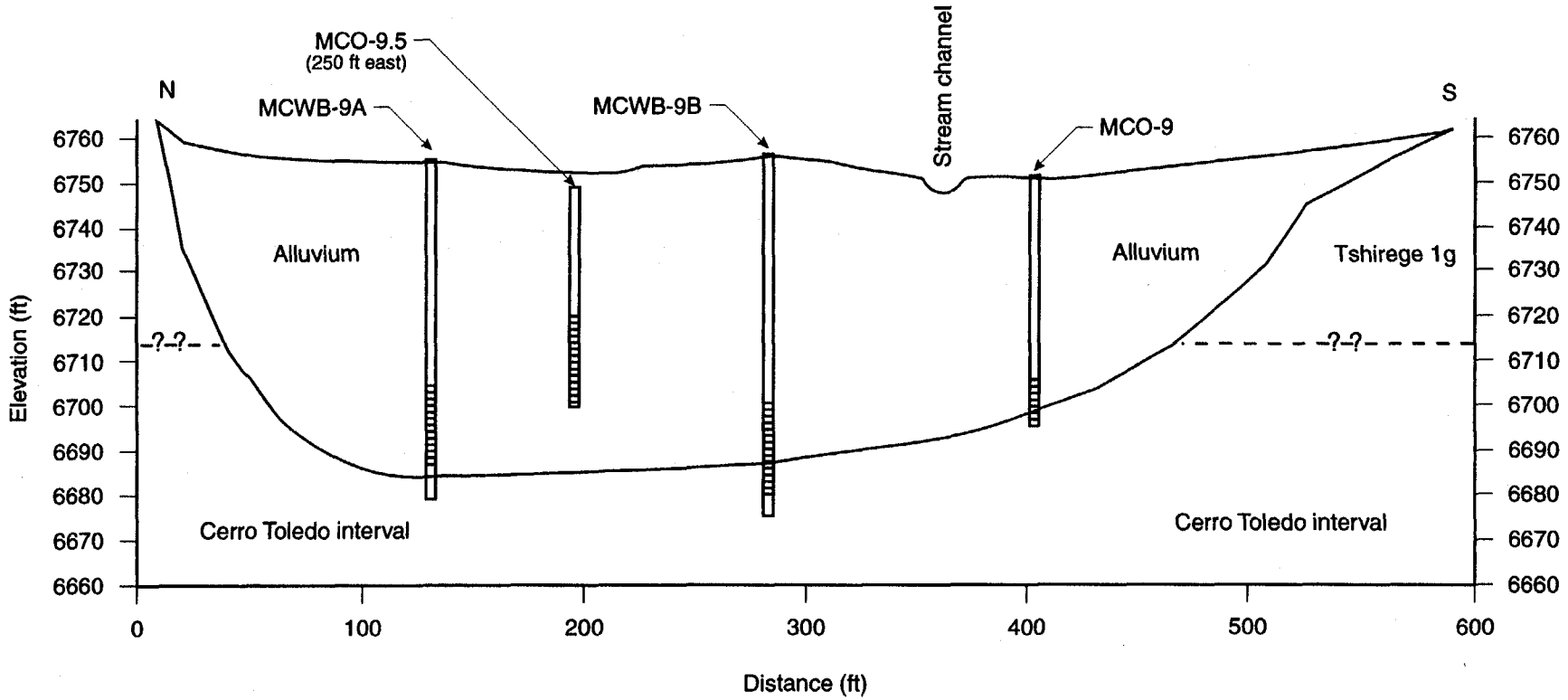

Figure 40. Vertical cross section at wells MCWB-9A, MCWB-9B, and MCO-9.