U.S. Department of the Interior
U.S. Geological Survey

Prepared in Cooperation with the
U.S. ENVIRONMENTAL PROTECTION AGENCY

Geologic cross sections and Denver Formation bedrock lithology map at the Denver Radium Operable Unit VIII (Shattuck site)

U.S. GEOLOGICAL SURVEY
Open-File Report 00-041

U.S. Department of the Interior
U.S. Geological Survey

Geologic cross sections and Denver Formation bedrock lithology map at the Denver Radium Operable Unit VIII (Shattuck site)

By James K. Otton

Open-File Report 00-041

In cooperation with the
U.S. ENVIRONMENTAL PROTECTION AGENCY

Denver, Colorado: 2000

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

For additional information write to:

Team Chief Scientist
Energy Resources Team
U.S. Geological Survey
MS 939 Box 25046
Denver Federal Center
Denver, Colorado 80225

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Service
Box 25286
Denver, CO 80225-0286

CONTENTS

Abstract.....1
Introduction.....1
Sources of data.....1
Data limitations.....2
Cross sections.....3
Effects of vertical exaggeration.....3
Water levels.....13
Description of stratigraphic units.....13
Bedrock interpretive map.....14
Factors influencing bedrock interpretive map.....16
Summary.....18
References cited.....18

FIGURES

1. Locations of cross sections (figs. 3-9).....4
2. Explanation of symbols and abbreviations used to describe alluvial sediments and the Denver Formation in figures 3-9.....5
3. Cross section through A-A'. Vertical exaggeration is 40:1.....6
4. Cross section through B-B'. Vertical exaggeration is 40:1.....7
5. Cross section through C-C'. Vertical exaggeration is 40:1.....8
6. Cross section through D-D'. Vertical exaggeration is 40:1.....9
7. Cross section through E-E'. Vertical exaggeration is 40:1.....10
8. Cross section through F-F'. Vertical exaggeration is 40:1.....11
9. Cross section through G-G'. Vertical exaggeration is 40:1.....12
10. Interpretive bedrock geologic map of the Denver Formation in the vicinity of Denver Operable Unit VIII.....15

EXPLANATION

Symbols- alluvium

oooooooooooooo oooooooooooooo	Gravel- includes material granule to pebble in size
:::::::::::::: :::::::::::::::	Sand
-.-.-.-.-.-.-.-.-.-.-.-.-.- -.-.-.-.-.-.-.-.-.-.-.-.-.-	Silt
--------------- ---------------	Clay
~~ ~~~~~~~~~~~~~~~	Organic matter, usually in surface layers
ΔΔΔΔΔΔΔΔΔ	Coarse, angular debris in fill

Abbreviations- Denver Formation

Abbreviation	Meaning	Abbreviation	Meaning
bl	blue	lt	light
blk	black	mod	moderate
bn	brown	mott	mottled
char	charcoal	ol	olive
choc	chocolate	rd	red
clyst	claystone	sd	sand
cly	clay	sdy	sandy
clyy	clayey	sh	shale
cong	conglomerate	ss	sandstone
dk	dark	stf	stiff
grav	gravel	stst	siltstone
gry	gray	slty	silty
lig	lignite	yell	yellow or yellowish

Figure 2. Explanation of symbols and abbreviations used to describe alluvial sediments and the Denver Formation in figures 3-9. The relative proportion of the gravel, sand, clay, and organic matter symbols in the cross sections reflects the proportion of those materials in the described interval.

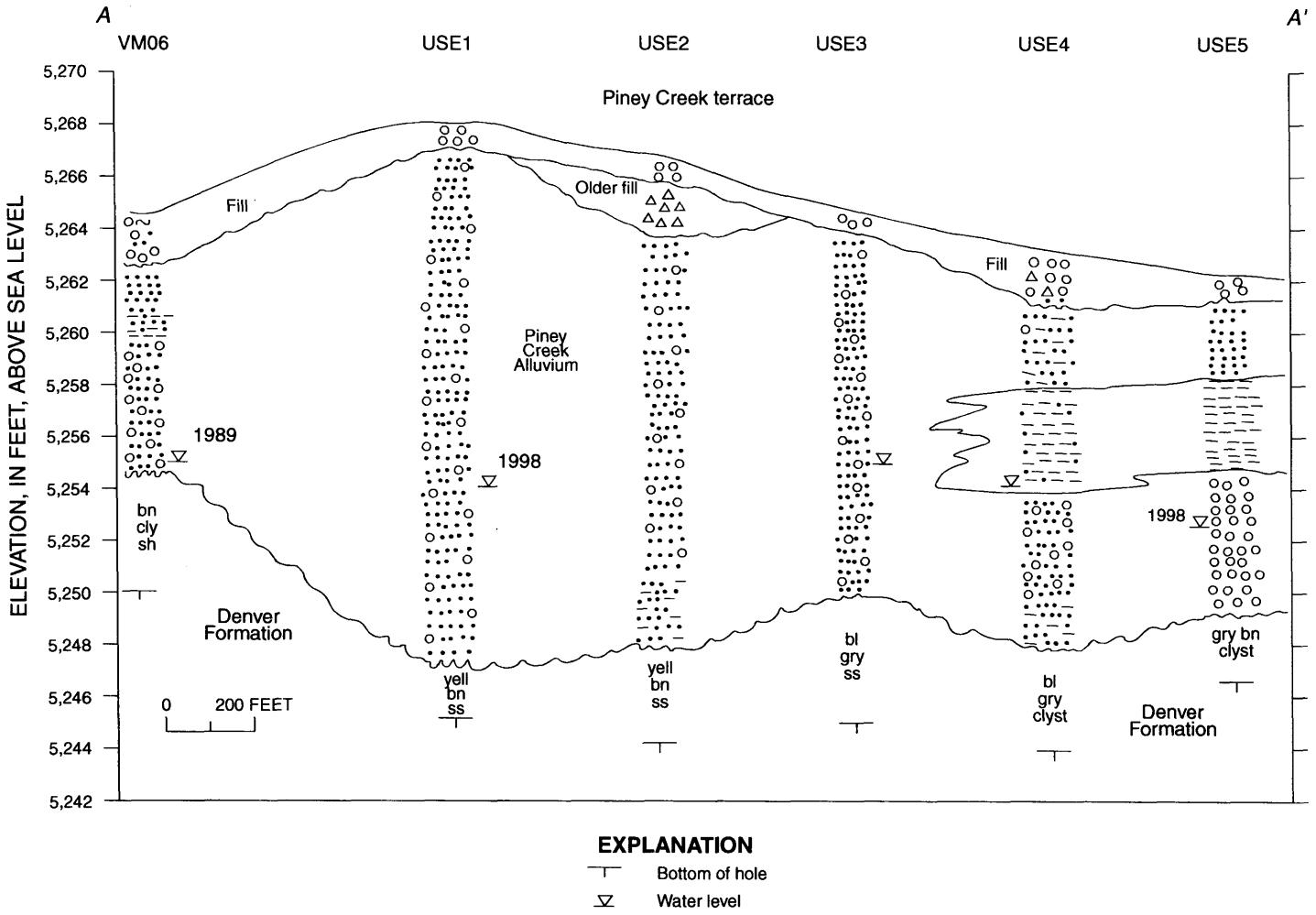

Figure 3. Cross section through A-A' along the east edge of the Shattuck site. Vertical exaggeration is 40:1.

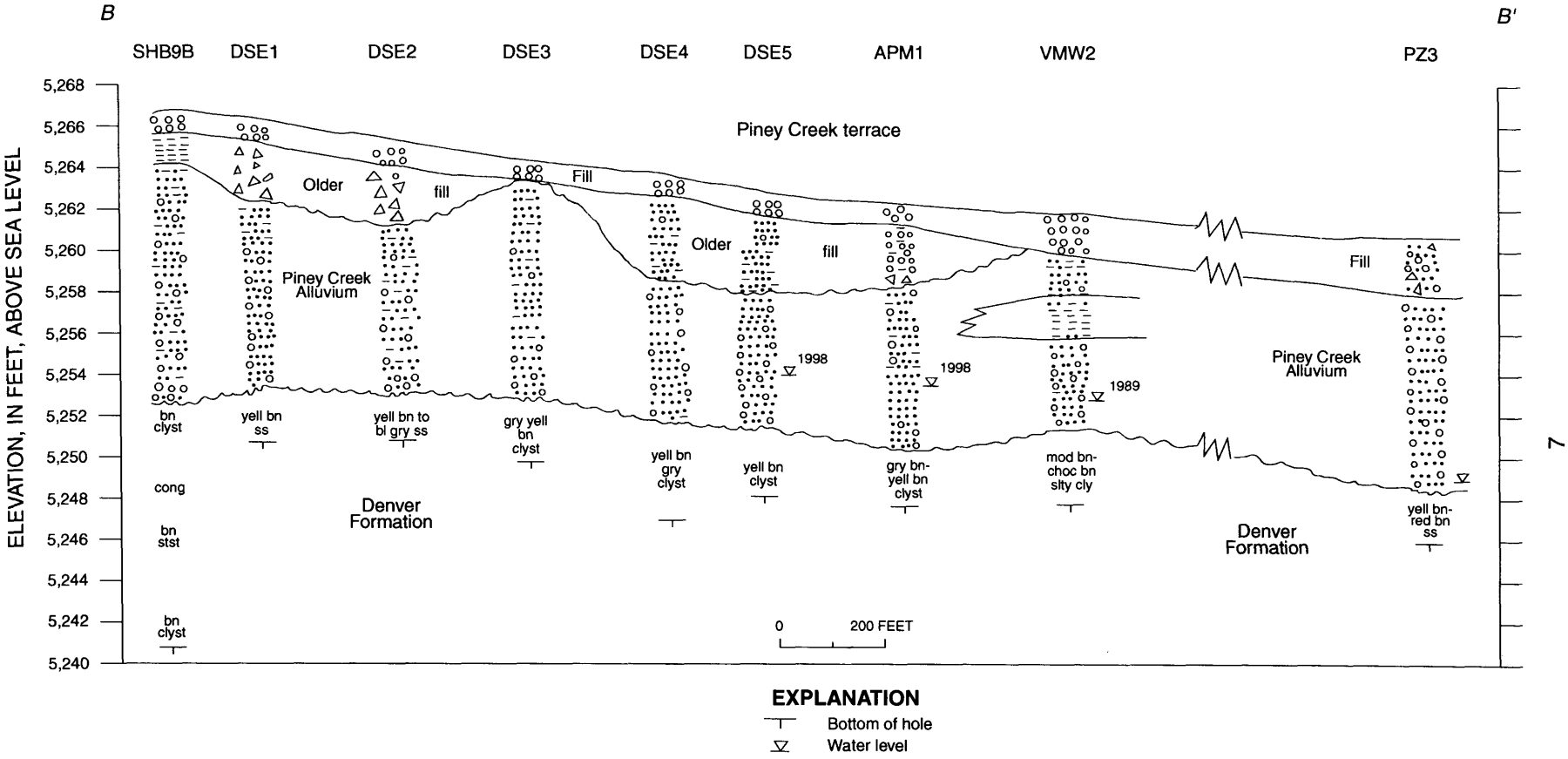

Figure 4. Cross section through B-B' along the west edge of the Shattuck site. Vertical exaggeration is 40:1.

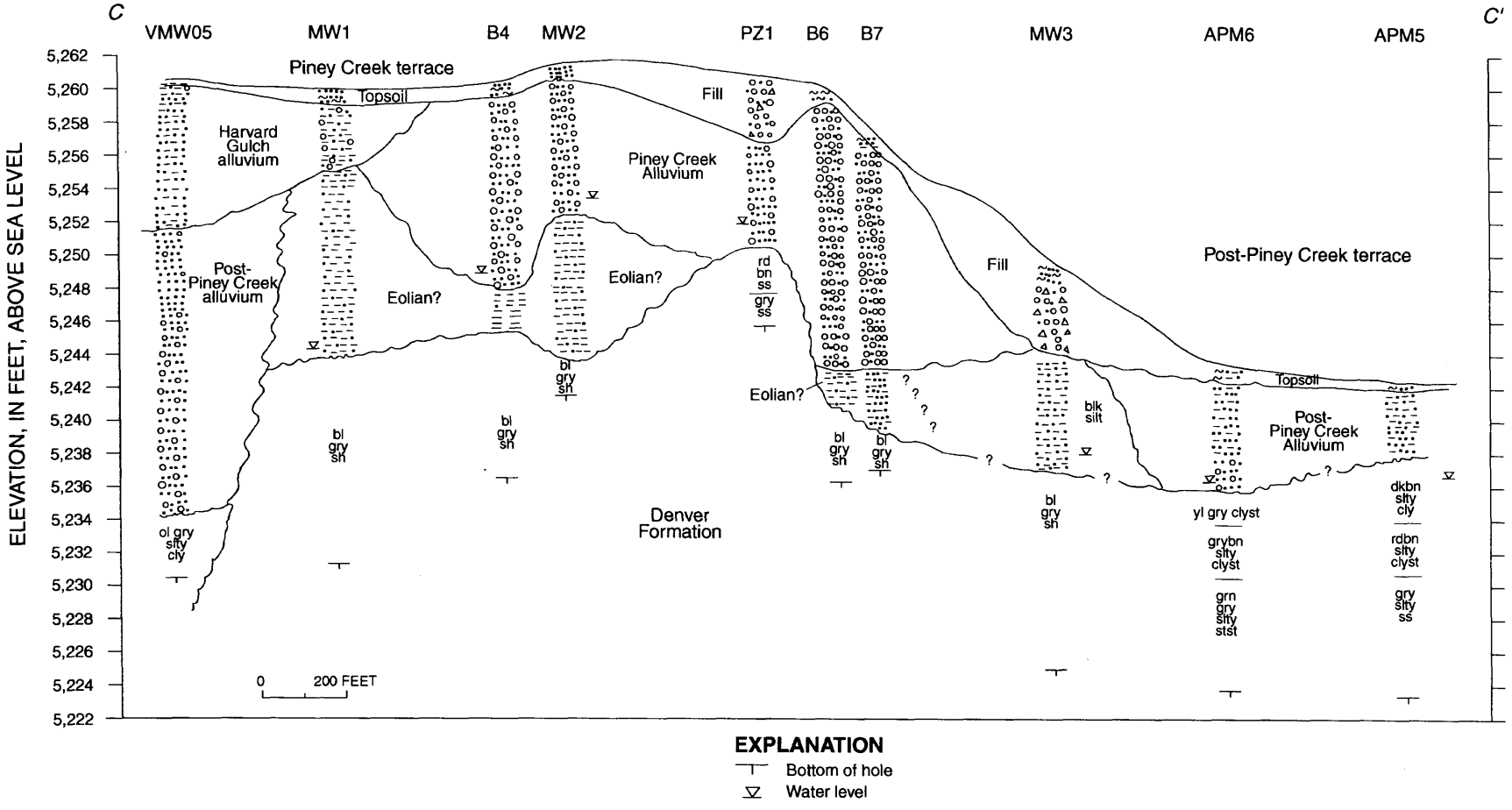

Figure 5. Cross section through C-C' along the west side of Santa Fe Drive. Vertical exaggeration is 40:1.

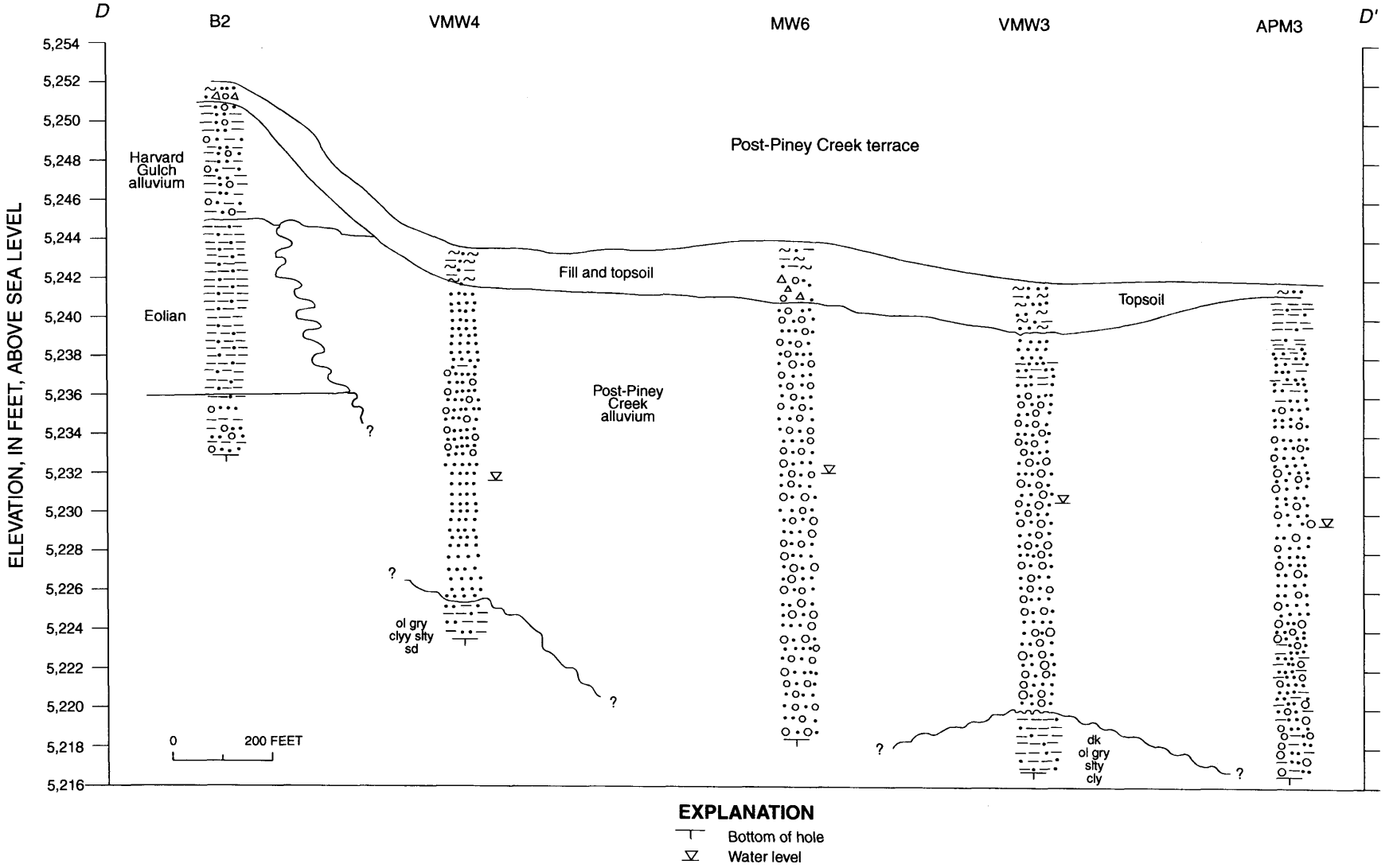

Figure 6. Cross section through D-D' extending from W. Jewell Ave across the Overland Park Golf Course to W. Florida Ave. Vertical exaggeration is 40:1.

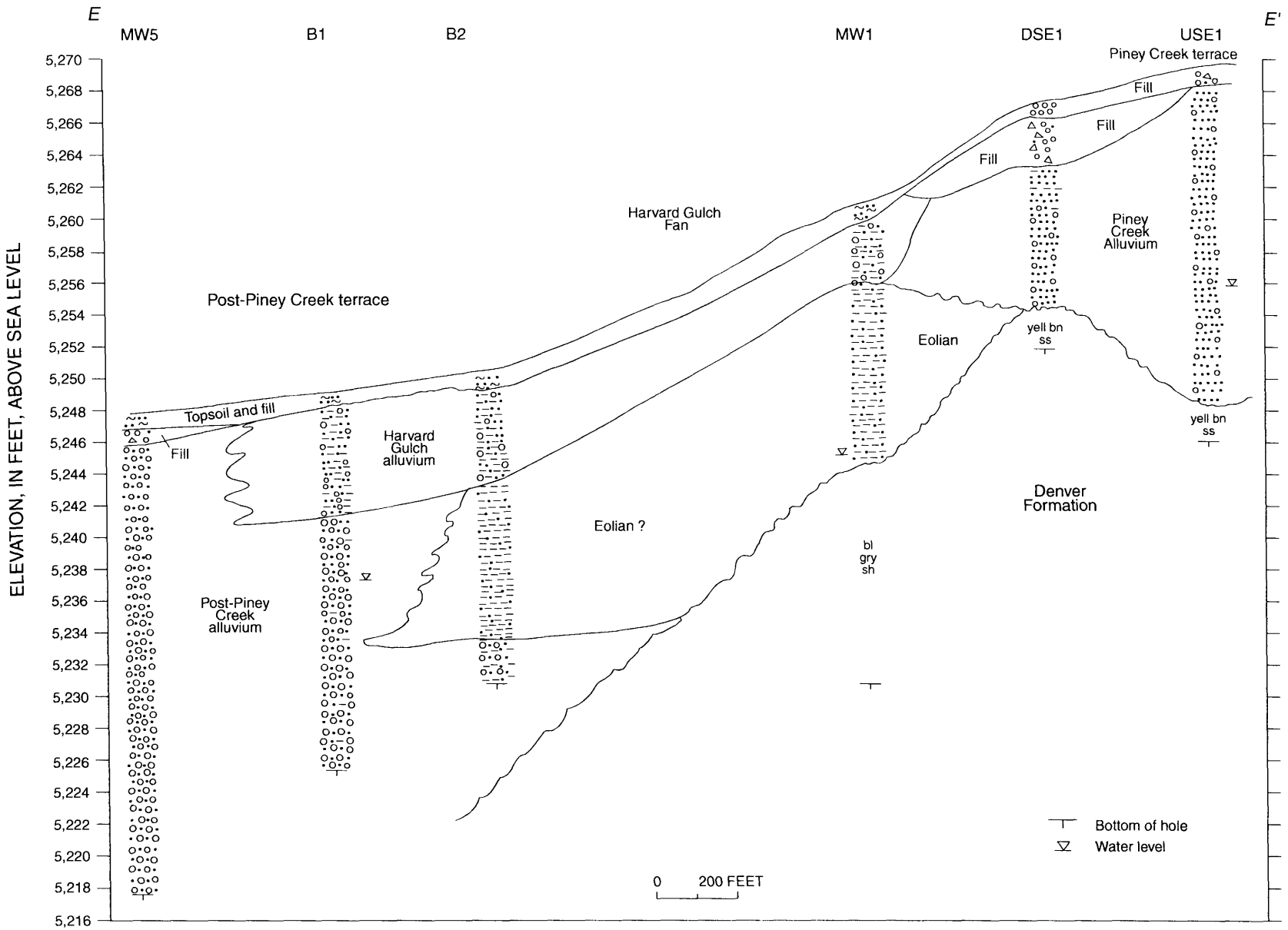

Figure 7. Cross section through E-E' along W. Jewell Ave. Vertical exaggeration is 40:1.

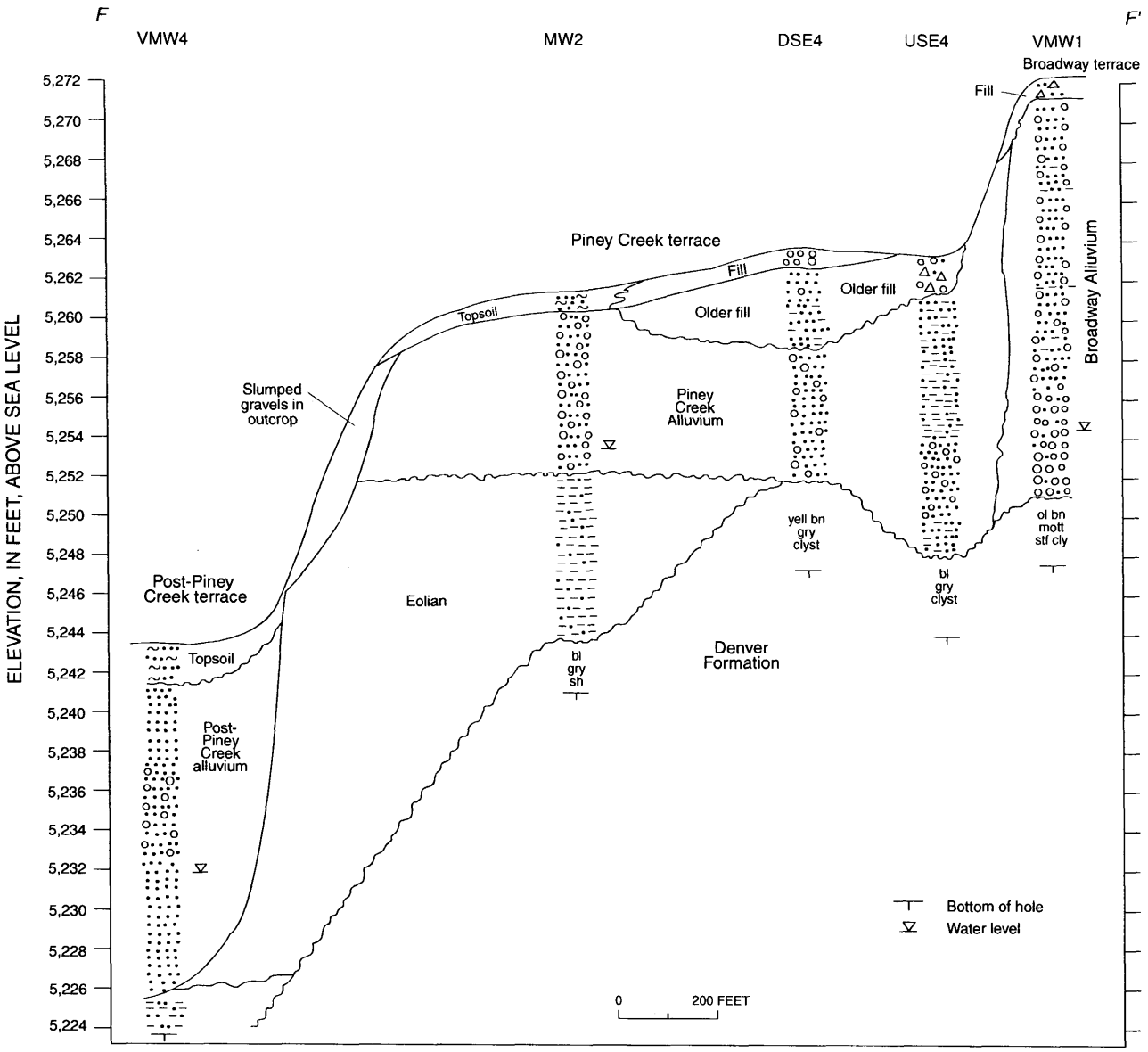

Figure 8. Cross section through F-F' extending from just east of the Shattuck site onto the Overland Park Golf Course. The monolith is not portrayed in the cross section. Vertical exaggeration is 40:1.

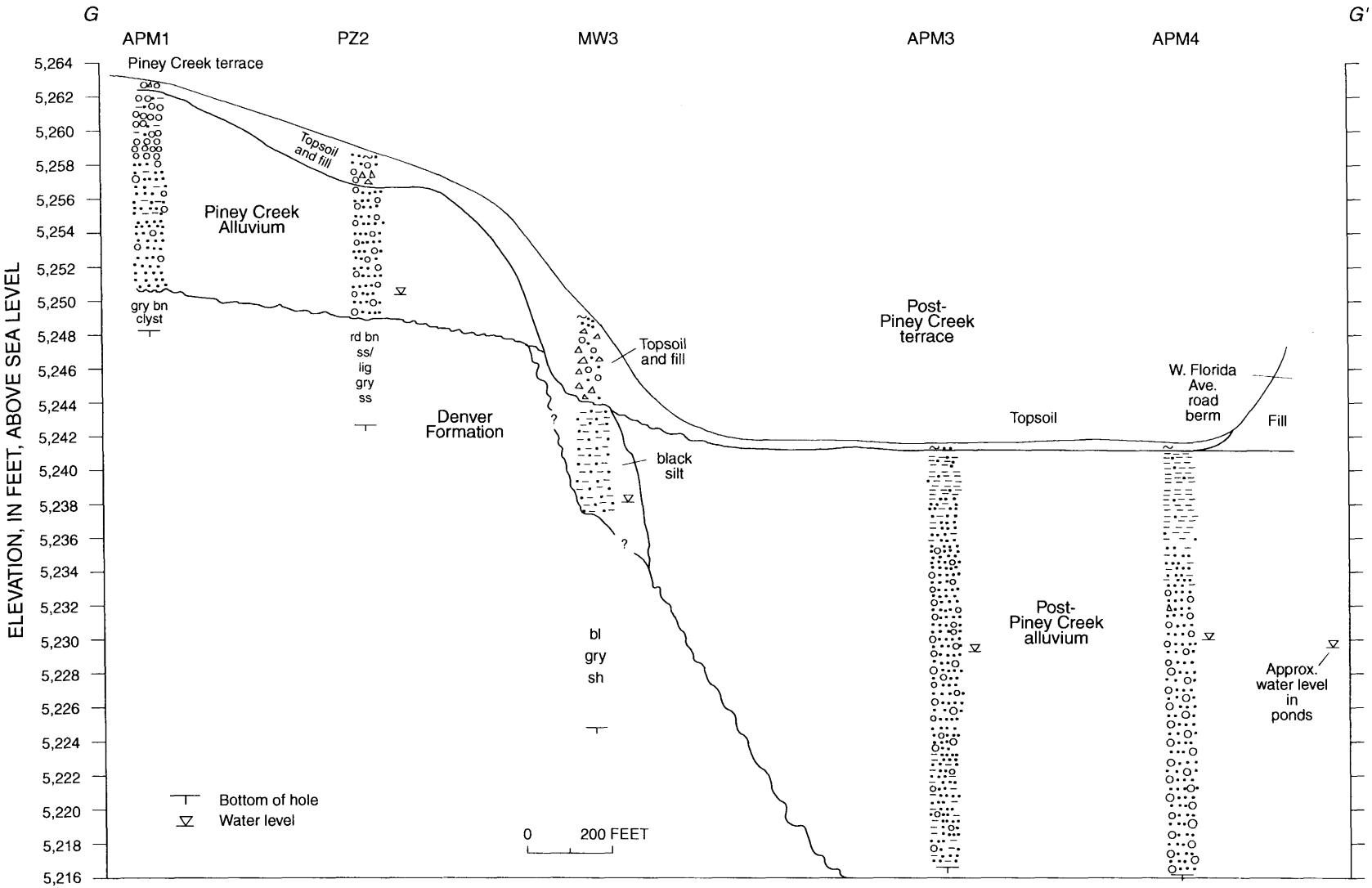

Figure 9. Cross section through G-G' extending from the northwest corner of the Shattuck site northwest across part of the Overland Park Golf Course to W. Florida Ave. Vertical exaggeration is 40:1.

Water levels in cross sections

Water levels are shown in several of the lithologic columns to give the user of these cross sections a general idea of where water levels have been reported. These water levels were measured at various times over a period of 10 years and should not be used to characterize current water levels.

DESCRIPTIONS OF STRATIGRAPHIC UNITS

Alluvial material underlying the terrace on which the Shattuck site sits (the Piney Creek terrace, Shroba, 1980) consists primarily of granule to pebble sand that is somewhat coarser along the western edge of the terrace. Lenses of finer grained material are present in some horizons (Wells USE4 and USE5, fig. 3). To the east is a higher terrace, the Broadway terrace, underlain by coarse sand and gravel. These sediments underlie Well VMW01 (fig. 8). To the west is the lower, Post-Piney Creek terrace, which is underlain mostly by medium- to coarse-grained sand and gravel (fig. 6). To the south is the Harvard Gulch drainage, which contains generally finer grained alluvium than that underlying the Broadway, Piney Creek, and post-Piney Creek terraces (MW1, B2, B1, fig. 7). The subsurface data suggest that the alluvium in Harvard Gulch is, in part, contemporaneous with the post-Piney Creek alluvium. The alluvium from Harvard Gulch forms an alluvial fan, expressed as an irregular, elevated topographic surface extending out onto the surface of the post-Piney Creek terrace. This feature occurs from the intersection of Santa Fe Drive and Jewell Avenue westward along Jewell and northwestward onto the Overland Park golf course. This suggests that the Harvard Gulch alluvium, in part, post-dates the post-Piney Creek alluvium.

Fine-grained sediments of uncertain affinity occur in the subsurface at the west margin of the Piney Creek terrace. They are described variously as sandy clay, clayey sand, and black silt. In lithologic logs they are described as "soft." They are as much as 12 feet thick and extend north to south from Well MW1 to Well B6 (fig. 5). The water table sometimes occurs within these sediments just above underlying Denver Formation contact but, more often, it occurs above the sediments in overlying alluvium. Materials like these generally have not been described in mapping of Quaternary terrace sediments along the major rivers in the Front Range area (Richard Madole, U.S.

Geological Survey, oral commun., 1999). In some wells this material underlies Piney Creek Alluvium and Harvard Gulch alluvium. The sediments described as sandy clay to clayey sand are herein interpreted as eolian deposits, on the basis of their position in the landscape (adjacent to the downwind side of the valley wall), uniform grain size over substantial thicknesses, and abrupt thickness changes laterally to the east and west. The author has mapped and augered similarly textured materials in the Eastlake 7.5-minute quadrangle north of the Denver metropolitan area (Otton and Zielinski, unpublished mapping, 1998-99; Schwochow, 1972).

The black silt described in Well MW3 (figs. 5 and 9) may represent an organic-rich facies of the alluvium or weathered Denver Formation lignite accumulating on a hillslope below an outcrop. If this material is organic-rich, as suggested by either of these two interpretations, it may have adsorbed substantial quantities of metals and other contaminants from the site plume.

Underlying all of these alluvial materials is bedrock of the Denver Formation. It consists of variably colored claystone, siltstone, sandstone, shale, and minor conglomerate. Coalified wood fragments and thin lignite layers occur in some sandstone units (PZ2, fig. 9). Several wells penetrate a distinctive blue-gray shale known locally as the "Denver blue," especially along the Santa Fe Drive north-south cross section (fig. 5). The sandstones of the Denver Formation at the Shattuck site are thought to be laterally discontinuous, sinuous, channel-fill sand bodies, based on exposures of the Denver Formation elsewhere and the change in lithologies observed in site wells over distances of a few feet.

BEDROCK INTERPRETIVE MAP

Figure 10 is an interpretive map depicting the subsurface geology of the Denver Formation as if all the overlying alluvial sediments were stripped away, exposing the Denver Formation. This map is derived from descriptions of the first Denver Formation sediments penetrated while drilling monitoring wells. The map portrays those areas where sandstone aquifers in the Denver Formation may be in contact with the overlying alluvial aquifer and the contaminant plume that the overlying aquifer contains in parts of the site. These contact zones could be entry zones for contaminants to move into the

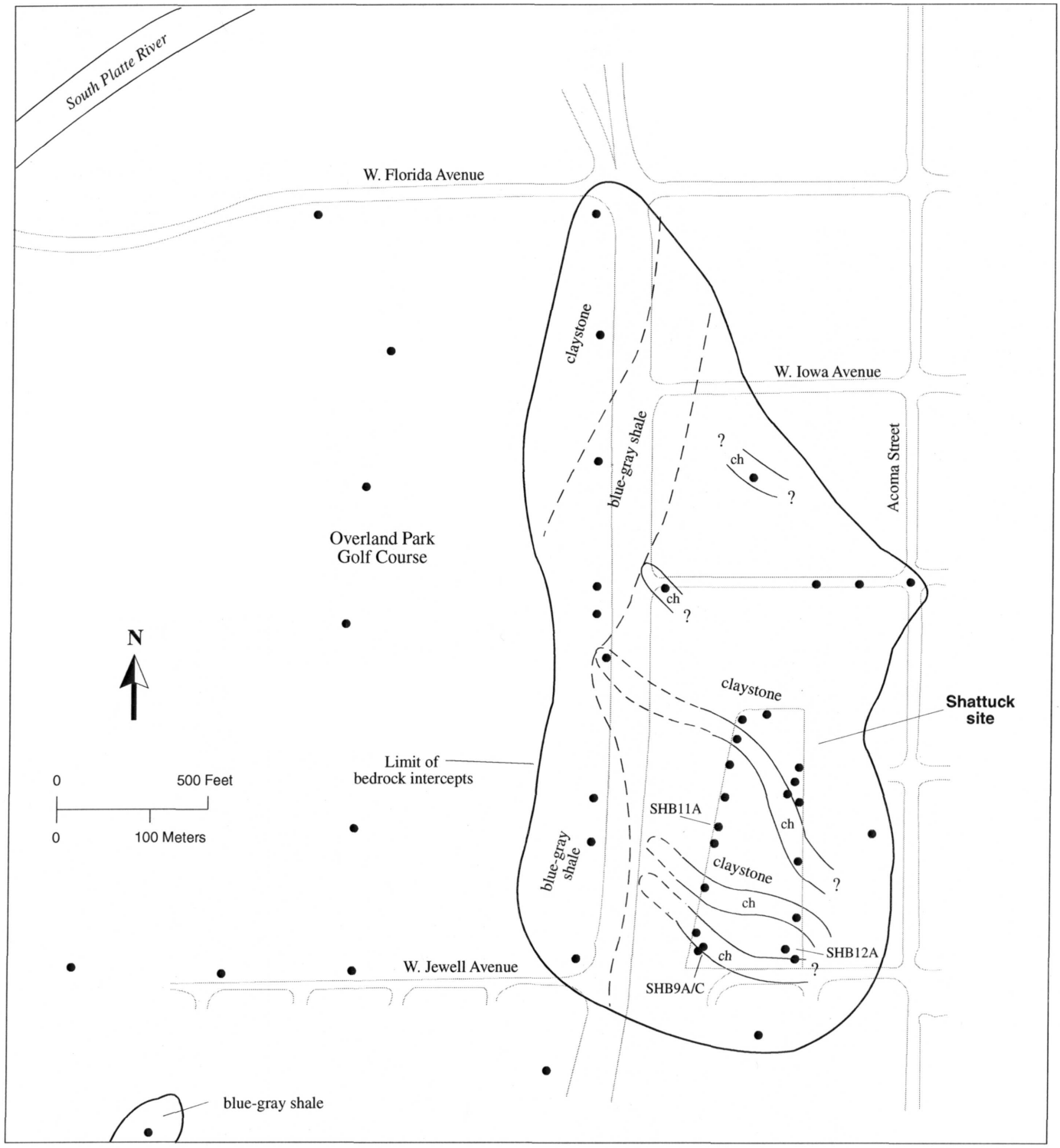

Figure 10. Interpretive bedrock geologic map of the Denver Formation in the vicinity of Denver Operable Unit VIII, the Shattuck site.

underlying Denver Formation if the hydraulic gradient and the permeability of the sandstones favor such movement.

Factors Influencing the Bedrock Interpretive Map

Models for the geometry of water-bearing sandstones in the Denver Formation in this area suggest that they occur in sinuous, channel-shaped bodies largely enclosed by shale and claystone (Robert Raynolds, Denver Museum of Natural History, oral presentation at the Geological Society of America 1999 annual meeting, Denver Colorado). The percentage of sandstone in the Denver Formation at the Shattuck site is about 30 percent, based on the proportion of sandstone to claystone and shale in lithologic logs examined in this study. The sinuous channel geometry is used to portray sandstones in the Denver Formation underneath the Shattuck site in figure 10.

The bedrock surface underlying much of the Piney Creek terrace is irregular and has as much as 4 feet of relief north to south across the limits of the drillhole data, but apparent local relief is mostly 1-2 feet. This apparent local relief is probably close to the probable margin of logger error in picking the contact between the overlying alluvium and the Denver Formation. Overall, the bedrock surface on the Piney Creek terrace is nearly horizontal north to south and east to west (about 10 minutes- about 1/6 of a degree- of slope to the north between VMW06 and PZ3 and slopes of similar magnitude east to west). Data for the altitude of the base of the Denver Formation derived from well data in Romero (1976) indicate that in this area the Denver Formation has dips of 15-20 minutes southeasterly (about 1/4 to 1/3 of a degree). If so, the section drops 3-6 feet across the approximately 800- to 1000-foot width of this terrace. Thus, the base of a sandstone channel at depth on the east edge of the Shattuck site will rise vertically a few feet to the west, where it could readily be intercepted by a well on the west edge of the Shattuck site.

In drawing the features in figure 10, an approximately east-southeast trend to such channels has been assumed, based on recent work suggesting that sandstone channels in the Denver Formation were derived from alluvial fans with sources along the uplifted Golden Fault to the west-northwest (Robert Raynolds, Denver Museum of Natural History, oral presentation at the Geological Society of America 1999 annual meeting, Denver, Colorado). Sandstone

channel positions different from those shown could be drawn and still fit the available data.

With the essentially horizontal character of these sandstone channels, vertical movement of contaminants will occur readily only where superposed sandstone channels at different elevations are by chance in contact with one another or if significant vertical fracturing connects channels. Water movement through the shale and claystone is expected to be very slow.

Near the west edge of the Piney Creek terrace, the bedrock surface drops. In an area of beds having low dips, planar contacts in bedrock follow contours on surface topography very closely. A blue-gray shale was penetrated in six wells along Santa Fe Drive from MW1 to MW3 (fig. 5). PZ1 is in the middle of this sequence. PZ1 intercepted only sandstone but at an elevation above that where blue-gray shale was logged in adjacent holes (B6, MW2, fig. 5). If PZ1 were drilled deeper, the blue-gray shale would likely be penetrated. The persistence of the blue-gray shale suggests that it may be a laterally continuous unit between an underlying and an overlying sequence of claystone with sand channels. Assuming these two contacts are planar, the contacts would follow topography on the bedrock surface, perhaps in the manner portrayed in figure 10. Claystone bedrock intercepts in Wells APM5 and APM6 (fig. 5) represent claystone underlying the blue-gray shale.

Only a few monitoring wells were drilled more than a few feet below the bedrock contact. These wells, however, provide some potentially useful information about contaminant movement into the Denver Formation at the Shattuck site beyond the information portrayed in figure 10. Well SHB12A (southeast corner of Shattuck site, fig. 10) penetrated 7 feet of claystone overlying 15.5 feet of sandstone, suggesting that it intercepted a thick sand channel or possibly stacked channels in the section below the level of erosion of the bedrock on the Piney Creek terrace. Assuming lateral continuity and low dips as before, this thick sandstone channel probably intercepts the bedrock surface to the west-northwest at the same altitude as the blue-gray shale. Existing wells in that direction did not penetrate thick sand intercepts; thus, there is no means of predicting where the sand body may intercept the bedrock surface, if at all, so a sand channel is not portrayed in figure 10. If the alluvial contaminant plume were in contact with this sandstone channel at its probable bedrock-surface intercept, this channel could be a

conduit for contaminant movement into the Denver Formation, assuming that the hydraulic gradient were favorable for such movement.

Two other deep wells on the Piney Creek terrace beneath the Shattuck site penetrated thick sections of fine-grained sediments below the alluvium-bedrock contact. Well SHB9A/C (southwest corner of Shattuck site, fig. 10) intercepted 5.5 feet of sandstone, then 20 feet of claystone and shale. Well SHB11A (west edge of Shattuck site, fig. 10) intercepted 23.5 feet of claystone and shale. The presence of thick sections of fine-grained rock in these two holes supports the model that the Denver Formation at this site is characterized by isolated sandstone channels enclosed by fine-grained sediments.

SUMMARY

Cross sections through monitoring wells at the Shattuck site show that alluvial sediments underlying the Broadway, Piney Creek, and post-Piney Creek terraces consist mostly of coarse sand, granule to pebble sand, and sandy gravel. These materials are likely to be very permeable. Thin lenses of finer grained material occur locally within the coarser alluvium. At the western edge of the present-day Piney Creek terrace, uniformly fine-grained sediments, herein interpreted as eolian deposits, underlie the Piney Creek Alluvium. Shallow ground water generally occurs at the base of the coarse-grained alluvium on the Broadway and Piney Creek terraces. A thick column of saturated alluvium occurs under the post-Piney Creek terrace surface.

The underlying Denver Formation bedrock is composed of nearly flat-lying claystone and shale with isolated, sinuous channel-sandstone bodies. These channel sandstones form approximately 30 percent of the bedrock. Vertical movement of ground water through the Denver Formation is likely to be limited by the isolated nature of these more permeable units and the limited permeability of the enclosing claystone and shale.

REFERENCES CITED

Romero, J.C., 1976, Ground water resources of the bedrock aquifers of the Denver Basin, Colorado: Colorado Department of Natural Resources, Division of Water Resources, 109 p.

Schwochow, S.D., 1972, Surficial geology of the Eastlake Quadrangle, Adams County, Colorado: Golden, Colorado School of Mines, Master's thesis, 152 p., plates.

Shroba, R.R., 1980, Geologic map and physical properties of the surficial and bedrock units of the Englewood quadrangle, Denver, Arapahoe, and Adams Counties, Colorado: U.S. Geological Survey Map GQ-1524, 1 plate with text and tables.