UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

HAZARDOUS SITE CONTROL DIVISION

Remedial Planning/ Field Investigation Team (REM/FIT)

ZONE II

CONTRACT NO. 68-01-6692

CH2M HILL

Ecology & Environment

Phase I Task Report

Indian Bend Wash
Remedial Investigation
Scottsdale, Arizona

Volume I of III - TEXT

ecology and environment, inc.
120 HOWARD STREET, SUITE #640, SAN FRANCISCO, CALIFORNIA 94105, TEL. 415-777-2811
International Specialists in the Environment

Purpose:	Phase I Task Report
Site:	Indian Bend Wash Remedial Investigation Scottsdale, Arizona
	Volume I of III - TEXT

Date Remedial Investigation Began:	July 2, 1984
TDD Number:	R-09-8401-02E
EPA ID Number:	AZD 980695969
FIT Investigators:	Robert Enkeboll Kelly Hranac
Report Prepared By:	Kelly Hranac Robert Enkeboll
Report Date:	August 11, 1986
Submitted To:	Harry E. Demarest, Chief Field Inspections Section Toxics and Waste Management Division U.S. Environmental Protection Agency San Francisco, CA 94105

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

Plate

EXECUTIVE SUMMARY

Contamination of groundwater by chlorinated organic chemicals, primarily trichloroethylene (TCE), was initially discovered in the Indian Bend Wash area of Scottsdale/Tempe, Arizona in October 1981 in several City of Phoenix municipal supply wells. Following this discovery, additional groundwater sampling, which confirmed previous results, was conducted. EPA initiated the IBW Remedial Investigation/ Feasibility Study (IBW RI/FS) in 1984.

The Indian Bend Wash RI/FS Study area encompasses approximately 13 square miles in Scottsdale and Tempe in southwestern Paradise Valley, Arizona (Figure 1.1). The study area is bounded on the north by Chaparral Road, on the east by Pima Road, on the south by the Apache Boulevard, and on the west by Scottsdale Road.

The Remedial Investigation portion of the IBW RI/FS was designed to define the groundwater flow patterns in the study area, determine the vertical and lateral extent of groundwater contamination, estimate the volume of groundwater impacted, determine potential sources of contamination and obtain data for use in the Feasibility Study. This report presents the results of Phase I of the Remedial Investigation. Portions of the IBW RI/FS Phase I activities were performed by the EPA, Motorola Government Electronics Group (Motorola GEG) and Beckman Instruments. This report integrates hydrogeologic data collected by all three parties.

To delineate the extent of contamination and to characterize the hydrogeology underlying the Indian Bend Wash area, thirty-four monitor wells, three soil-test boreholes (currently used as monitor wells), and one piezometer have been installed. Twenty monitor wells and the piezometer were installed during the RI/FS Phase I well installation program; the other monitor wells and the soil-test boreholes were installed by the PRPSs separately from the RI/FS.

The alluvial sediments underlying the Indian Bend Wash area can be divided into three stratigraphic units, based on contrasting lithologic characteristics; the Upper Alluvium unit, the Middle Alluvium unit and the Lower Alluvium unit. Monitor wells were designed and installed to yield groundwater quality information from a specific stratigraphic unit. Twenty-two upper alluvium unit monitor wells (including the soil-test boreholes), thirteen Middle Alluvium unit monitor wells and one piezometer, and two Lower Alluvium unit monitor wells have been installed.

The Upper Alluvium unit (UAU) consists predominantly of well rounded, coarse gravel, cobbles, and boulders in the Indian Bend Wash area. Groundwater occurs at depths ranging from approximately 70 feet to approximately 135 feet and appears to move to the west-northwest. The average horizontal gradient is 28 feet per mile. The saturated thickness of the unit generally decreases to the north. The average transmissivity (calculated from pumping test results) of the UAU in the vicinity of the monitor wells appears to be about 30,000 gpd/ft; the transmissivity ranges from 2,700 gpd/ft to 76,000 gpd/ft. The hydraulic conductivity ranges from 700 gpd/ft^2 to 4,000 gpd/ft^2 and averages about 1700 gpd/ft^2.

The Middle Alluvium unit (MAU) consists predominantly of silt, clay, and fine sand. Layers of coarser deposits are scattered throughout the unit. Groundwater flow appears to be toward the west-northwest in the southwestern portion of the Indian Bend Wash study area and to the north-northwest elsewhere. The horizontal gradient ranges from approximately 15 feet per mile to 30 feet per mile. The transmissivity portion of the MAU tapped by the monitor wells appears to range from 360 gpd/ft at monitor well (A-2-4)35dba1[M-11MA] to 36,000 gpd/ft at (A-2-4)36dba1[M-9MA]; the average transmissivity is approximately 11,000 gpd/ft. The transmissivities at monitor wells (A-2-4)35dba1[M-11MA] and (A-2-4)26dba1[M-12MA] were approximately one order to two orders of magnitude lower than the transmissivities of the MAU at the other monitor wells. The hydraulic conductivity appears to range from 7.2 gpd/ft^2 to 700 gpd/ft^2 and appears to average about 220 gpd/ft^2.

Two monitor wells were installed into the Lower Alluvium unit (LAU). At both monitor wells the unit consisted of moderately to well-cemented gravel. The groundwater flow direction could not be accurately determined from only two data points. The pumping test of monitor well (A-2-4)35ddc3[M-10LA] indicated a transmissivity of 16,000 gpd/ft and a hydraulic conductivity of 320 gpd/ft^2.

The principal contaminants found in the monitor wells in the vicinity of Indian Bend Wash are trichloroethylene (TCE), 1,1,1-trichloroethane (TCA), tetrachloroethylene (PCE), 1,1-dichloroethylene (DCE), chloroform (CFM), and small quantities of toluene (TOL). Contaminants have been found in all three alluvium units underlying the area. In general contaminants are most abundant and appear to be most widespread in the Upper Alluvium unit and Middle Alluvium unit. TCE is the most abundant and widespread contaminant.

The highest concentrations of contaminants in the Upper Alluvium unit at the present time are found at the Motorola facility, to the northwest of the facility, and along Indian Bend Wash. Contamination in the Middle Alluvium unit has been detected in the monitor wells in the northwest half of the Motorola facilty, to the northeast of the site at (A-2-4)36dba1[M-9MA] and to the east of the site at (A-1-4)1abb2[E-1MA]. TCE contamination have been found in the Lower Alluvium unit at monitor well (A-2-4)35ddc3[M-10LA] and TCA and chloroform contamination has been detected at monitor well (A-1-4)1abbe[E-1LA] (See Plates 11 and 12).

1.0 INTRODUCTION

This report presents results obtained during Phase I of the Remedial Investigation portion of the Indian Bend Wash Remedial Investigation/Feasibility Study (IBW RI/FS). Portions of the IBW RI/FS Phase I activities were performed by the EPA, Motorola GEG and Beckman Instruments. This report integrates hydrogeologic data obtained by all three participating parties. Data obtained by Motorola GEG and Beckman Instruments was previously presented by the PRPs in individual data summary reports. These data are presented again in the appendices of this report for completeness.

The Indian Bend Wash (IBW) study area encompasses approximately thirteen square miles in Scottsdale and Tempe in southwestern Paradise Valley, Arizona (Figure 1.1). The study area is bounded on the north by Chaparral Road, on the east by Pima Road, on the south by Apache Boulevard, and on the west by Scottsdale Road.

The RI/FS was initiated by the EPA in 1984 in response to the discovery of chlorinated organic chemicals, primarily trichloroethylene (TCE), in municipal drinking water supply wells throughout the IBW area. Contamination of groundwater by TCE in the Indian Bend Wash area was initially discovered in October, 1981 in several City of Phoenix municipal supply wells. Following this discovery, additional groundwater sampling was conducted by the Arizona Department of Health Services (ADHS), the Salt River Project (SRP), the Cities of Phoenix, Scottsdale, and Tempe, and the EPA. These sampling efforts confirmed previous results and identified additional wells contaminated with TCE and a variety of other organic chemicals.

The Remedial Investigation portion of the IBW RI/FS was designed to define the groundwater flow patterns in the study area, determine the vertical and lateral extent of groundwater contamination, estimate the volume of groundwater impacted, determine potential sources of contamination, and obtain data with which to design the Feasibility Study. The purpose of the Feasibility Study is to develop and evaluate remedial action alternatives and to recommend a remedial action.

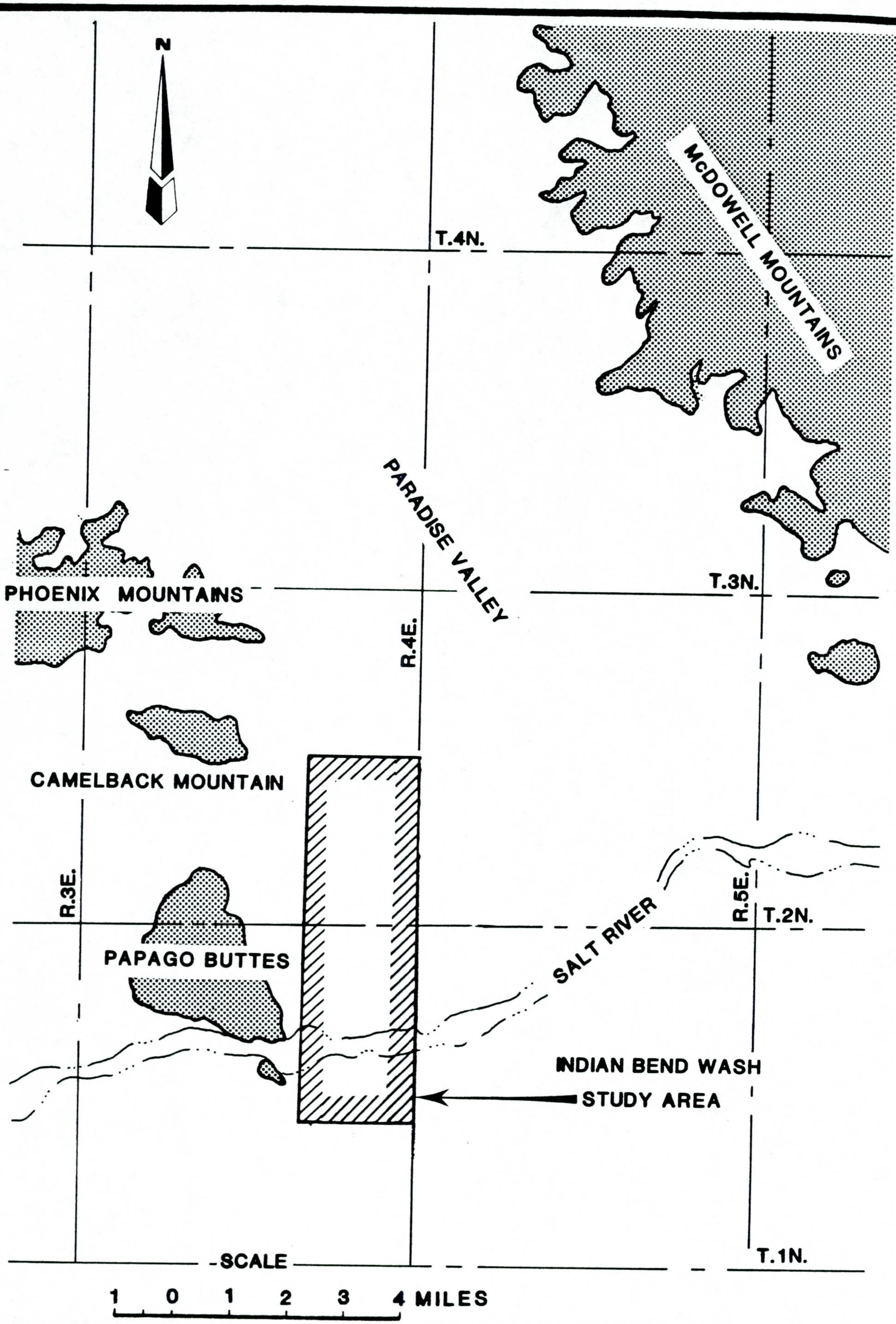


FIGURE 1.1 INDIAN BEND WASH REGIONAL LOCATION MAP

1.1 Purpose

The Remedial Investigation portion of the IBW RI/FS consists of a phased hydrogeological investigation. Phase I was designed to obtain information pertaining to the hydrogeology and extent of contamination in the IBW area. Phase I involved the installation of twenty monitor wells and included associated hydrogeological activities such as pumping tests, a monthly water level survey, and a quarterly water quality sampling program. Phase I results will be used to develop the technical approach and scope of work of Phase II of the Remedial Investigation. Phase II will be designed to determine the extent of the contaminant plume or plumes, estimate the quantity of groundwater impacted, identify source areas of contamination, and aid in developing remedial actions and mitigative alternatives. Locations of monitor wells in the IBW area are shown in Figure 1.2.

1.2 Report Organization

Results obtained during Phase I activities of the IBW RI/FS are presented in this report in the following format:

Section 2 summarizes the scope of work performed during Phase I, including monitor well installation activities, pumping tests, water quality sampling, and water level surveys.

Section 3 reviews the geologic setting and subsurface stratigraphy of the IBW area. This section incorporates stratigraphic information obtained during the Phase I monitor well installation program as well as stratigraphic information available from previously published sources.

Section 4 details the hydrogeology of the IBW area and is based primarily on hydrologic data obtained during Phase I. Hydrologic characteristics presented include groundwater flow directions, vertical and horizontal gradients, transmissivities, and hydraulic conductivities.

Section 5 reviews water quality data obtained during Phase I. The natural water quality of each alluvial unit is summarized and is followed by a discussion of the observed areal and vertical distribution of contamination.

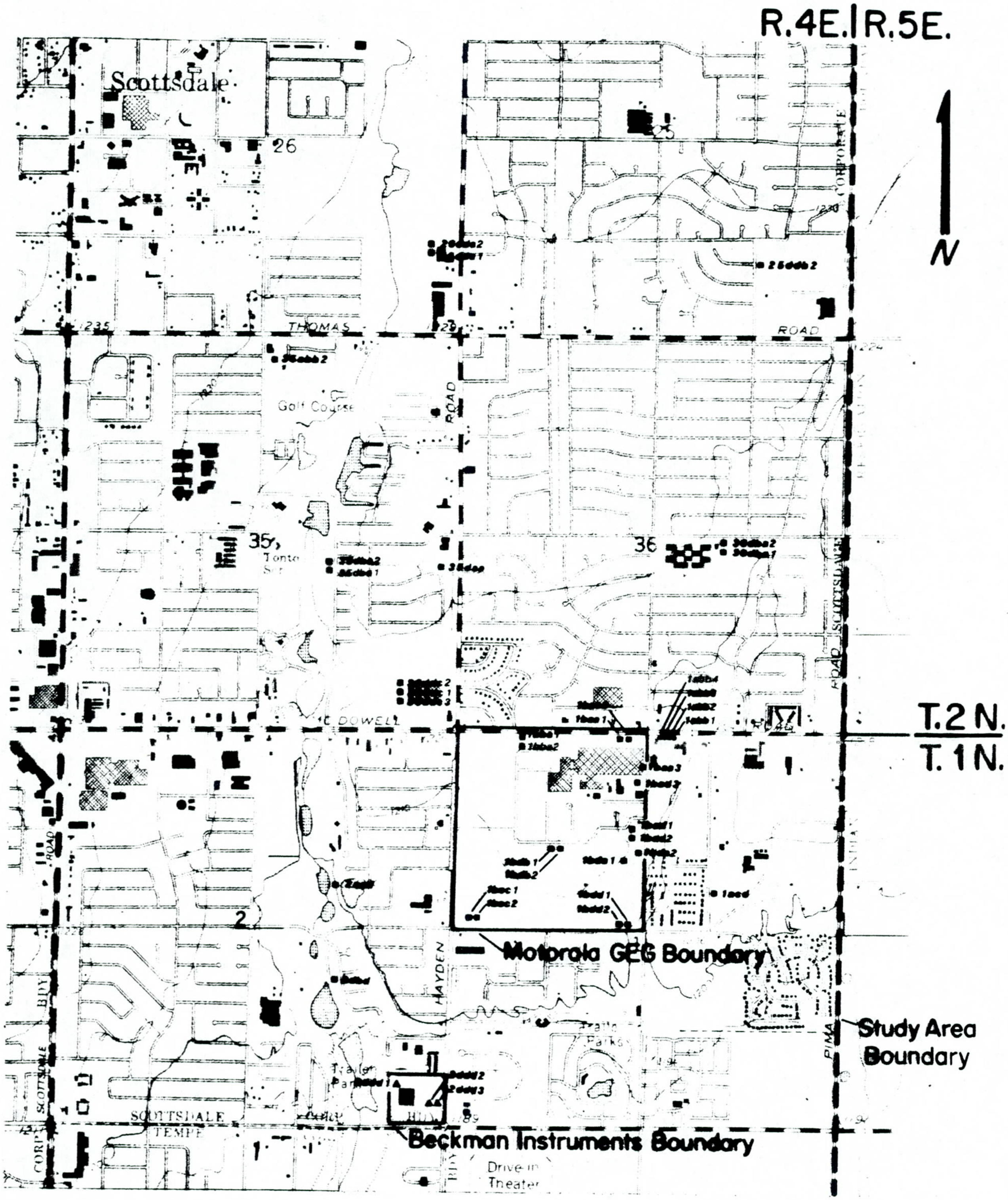


Figure 1.2 Location of Indian Bend Wash Monitor Wells

0 1000 2000 3000 4000 5000

Scale: In Feet

LEGEND

- ▪ Motorola Monitor Well
- ▴ Beckman Monitor Well
- ● EPA Monitor Well

(full well designations in Table 2.1)

2.0 PHASE I MONITOR WELL INSTALLATION PROGRAM

The Indian Bend Wash RI/FS Phase I monitor well installation program included the installation of twenty monitor wells and one piezometer. Under administrative orders on consent between EPA, Motorola GEG, and Beckman Instruments, each conducted a portion of the Phase I monitor well installation program. Motorola GEG installed ten monitor wells, Beckman Instruments installed three monitor wells, and the EPA installed seven monitor wells and the piezometer. Wells installed by Motorola GEG can be identified by either an "M" or "ST" in the bracketed ([]) well designation which follows the Arizona well identification number; for example (A-1-4)1baa3[M-7UA], where (A-1-4)1baa3 is the Arizona I.D. number. Wells installed by Beckman Instruments contain a "B", while those of EPA contain an "E". This section summarizes field-related activities carried out during the Phase I portion of the IBW RI/FS.

The Scope-of-Work for the Phase I monitor well installation program is detailed in the Indian Bend Wash RI/FS Workplan (June, 1984). Monitor well design- and installation-related activities are detailed in the Phase I Drilling, Well Installation, and Aquifer Testing Sampling Plan (July, 1984) and the Bid Specifications for the Installation of Monitoring Wells at Indian Bend Wash (December, 1984). Field procedures and protocols are detailed in the Quality Assurance Project Plan (November, 1984).

2.1 Monitor Well Installation

EPA and Motorola GEG Phase I monitor wells were installed by B-J Drilling Company Inc. under the supervision of Ecology & Environment, Inc. and Errol L. Montgomery & Associates, Inc. respectively. Beckman Instruments' monitor wells were installed by Odom Drilling under the supervision of the MARK Group.

IBW RI/FS Phase I monitor wells were installed to examine lateral and vertical variations in the hydrogeologic characteristics of the aquifer system and to determine the movement of contaminants from potential source areas. Of particular interest was determining the variability in lithologic characteristics and hydrogeologic properties such as hydraulic conductivity, flow direction, horizontal and vertical gradients, and velocities in the IBW area, as well as determining the vertical and lateral variability of groundwater quality and the extent of contamination.

Previous investigations in the Paradise Valley and Indian Bend Wash area (Halpenny and others, 1967, Arteaga and others, 1968, Hargis and Montgomery, 1983, and Errol L. Montgomery & Associates, 1985) have divided the alluvial material in the IBW study area into three stratigraphic units based on contrasting lithologic characteristics. These units, in order of decreasing age, are referred to in this report as the Lower Alluvium unit, the Middle Alluvium unit, and the Upper Alluvium unit. The geologic characteristics of these units will be described in Section 3. Phase I monitor wells were designed and installed to provide hydrogeologic properties and water quality data from a specific stratigraphic unit.

2.1.1 Upper Alluvium Unit Monitor Wells

At the conclusion of Phase I of the IBW RI/FS 22 Upper Alluvium unit (UAU) monitor wells had been installed in the IBW study area. This total includes three soil test boreholes that currently function as UAU monitor wells and seven UAU monitor wells that were installed by PRPs separately from the RI/FS, and twelve UAU monitor wells installed as part of the RI/FS.

With the exception of monitor wells (A-1-4)2dbd[B-J] and (A-1-4) 2ddd1[B-UA-3] all of the UAU monitor wells were installed similarly. A 9 7/8-inch borehole was advanced using conventional air rotary techniques to a depth of approximately 20 feet. Six-inch diameter blank steel casing was set in this borehole and cemented. Cement with an accelerator added to shorten setting time was poured into the annulus from the surface. After the surface casing had been set and cemented in place a 6-inch diameter borehole (EPA and Motorola) or 5 7/8-inch diameter borehole (Beckman Instruments) was advanced to near the contact between the Upper Alluvium unit and the Middle Alluvium unit. The boreholes for EPA and Motorola GEG monitor wells were drilled with a 6-inch diameter air hammer and conventional air rotary techniques. The main borehole for Beckman Instruments' UAU monitor well (A-1-4) 2ddd3[B-UA-1] was drilled using a 5 7/8-inch bit and conventional air rotary techniques. Four-inch diameter blank and perforated steel casing was set into the main borehole. Approximately the lower 40 to 50 feet of the steel well casing was perforated. Perforations consist of slots 1/8-inch by 3-inches with 6 slots per row and 2 rows per foot. After the four-inch steel well casing had been set, airlift development and pumping operations began.

The borehole and casing diameters of Beckman Instruments' UAU monitor wells (A-1-4)2dbd[B-J] and (A-1-4)2ddd1[B-UA-3] are different from the diameters given above. At both of these monitor wells a 14-inch diameter borehole was advanced to approximately 20 feet into which an 8-inch diameter blank steel casing was set. This was followed by drilling a 7 7/8-inch diameter borehole to near the contact between the UAU and MAU. A 4-inch diameter blank and perforated steel casing was installed into this borehole after which well development operations began. The perforated interval for these wells was approximately 50 feet. Perforations consist of 1/8-inch by 3-inch slots with 6 slots per row, and 2 rows per foot.

2.1.2 Middle Alluvium Unit Monitor Wells

At the conclusion of Phase I of the IBW RI/FS thirteen Middle Alluvium unit (MAU) monitor wells had been installed in the Indian Bend Wash study area. This total includes seven monitor wells installed by Motorola separately from the IWB RI/FS and six monitor wells installed as part of the RI/FS. This section describes the construction details of MAU monitor wells installed during Phase I of the IBW RI/FS.

The MAU monitor wells installed by EPA and Motorola GEG were constructed similarly. Beckman Instruments' MAU monitor well (A-1-4) 2ddd2[B-MA-1] was installed and constructed slightly differently and will be discussed separately. All Middle Alluvium unit monitor wells were installed to approximately 300 feet and the casing was perforated from approximately 250 to 300 feet. Construction details for specific wells are presented in Table 2.1 and Appendix A.

The surface casing borehole for MAU monitor wells installed by the EPA and Motorola GEG was drilled with a 14 3/4-inch bit using conventional air rotary techniques to a depth of approximately 20 feet. A ten-inch diameter blank steel surface casing was set and cemented into this borehole. An accelerator was added to the cement to reduce

Table 2.1
Monitor Well Construction Details

Well Number	Total Depth (feet)	Borehole Diameter (inches)	Borehole Depth (feet)	Casing Diameter (inches)	Casing Depth (feet)	Perforated Interval (feet)
Upper Alluvium Unit Monitor Wells						
(A-1-4)1abb4[E-1UA]	150	9-7/8	20	6	20	
		6	150	4	128	78-128
(A-1-4)1acd[M-8UA]	125	9-7/8	20	6	20	
		6	125	4	115	75-115
(A-1-4)1baa2[M-6UA]	125	9-7/8	19	6	19	
		6	125	4	117	75-117
(A-1-4)1baa3[M-7UA]	125	9-7/8	19	6	19	
		6	125	4	124	82-124
(A-1-4)1bad1[ST-1]	120	48	94	12	21	
		30	120	6	116	76-116
(A-1-4)1bba2[M-5UA]	125	9-7/8	19	6	19	
		6	125	4	125	83-125
(A-1-4)1bcc2[M-2UA]	125	9-7/8	21	6	21	
		6	125	4	121	79-121
(A-1-4)1bda1[ST-2]	125	48	91	12	21	
		30	125	6	125	85-125
(A-1-4)1bda2[ST-3]	105.5	48	91.5	12	21	
		30	105.5	6	104	64-104
(A-1-4)1bdb2[M-4UA]	120	9-7/8	19	6	19	
		6	120	4	115	73-115
(A-1-4)1bdd2[M-3UA]	125	9-7/8	21	6	21	
		6	125	4	124	82-124
(A-1-4)2acd[E-5UA]	132	9-7/8	20	6	20	
		6	132	4	132	78.5-132
(A-1-4)2dbd[B-J]	114	14	20	8	20	
		7-7/8	114	4	114	64-114

Table 2.1 (Cont.)
Monitor Well Construction Details

Well Number	Total Depth (feet)	Borehole Diameter (inches)	Borehole Depth (feet)	Casing Diameter (inches)	Casing Depth (feet)	Perforated Interval (feet)
Upper Alluvium Unit Monitor Wells (Cont.)						
(A-1-4)2ddd3[B-UA-1]	122	9-7/8	20	6	20	
		5-7/8	122	4	122	72-122
(A-1-4)2ddd1[B-UA-3]	120	12-1/4	20	8	20	
		7-7/8	120	4	120	70-120
(A-2-4)25ddb2[E-4UA]	160	9-7/8	20	6	20	
		6	160	4	149.5	96.5-149.5
(A-2-4)26dda2[M-12UA]	150	9-7/8	20	6	20	
		6	150	4	150	109.5-150
(A-2-4)35abb2[E-3UA]	150	9-7/8	20	6	20	
		6	150	4	150	95.5-150
(A-2-4)35daa[E-2UA]	161	9-7/8	20	6	20	
		6	161	4	150	97-150
(A-2-4)35dba2[M-11UA]	150	9-7/8	20	6	20	
		6	150	4	149	105.5-149
(A-2-4)35ddc2[M-10UA]	150	9-7/8	21	6	21	
		6	150	4	147	104-147
(A-2-4)36dba2[M-9UA]	125	9-7/8	20	6	20	
		6	125	4	124	82-124
Middle Alluvium Unit Monitor Wells						
(A-1-4)1abb2[E-1MA]	300	14-3/4	20	10	20	
		9-7/8	250	6	250	
		5-7/8	300	4	300	250-300
(A-1-4)1baa1[M-6MA]	302	14-3/4	19	10	19	
		9-7/8	251	6	251	
		5-7/8	302	4	302	249-302

Table 2.1 (Cont.)
Monitor Well Construction Details

Well Number	Total Depth (feet)	Borehole Diameter (inches)	Borehole Depth (feet)	Casing Diameter (inches)	Casing Depth (feet)	Perforated Interval (feet)
Middle Alluvium Unit Monitor Wells (Cont.)						
(A-1-4)1bad2[M-1MA]	302	14-3/4	20	10	20	
		9-7/8	251	6	251	
		5-7/8	302	4	300	252-302
(A-1-4)1bad3[M-7MA]	300	14-3/4	10	10	10	
		9-7/8	250	6	250	
		5-7/8	300	4	300	258-300
(A-1-4)1bba1[M-5MA]	302	14-3/4	19	10	19	
		9-7/8	251	6	251	
		5-7/8	302	4	302	250-302
(A-1-4)1bcc1[M-2MA]	303	14-3/4	21	10	21	
		9-7/8	251	6	251	
		5-7/8	303	4	303	250-303
(A-1-4)1bdb1[M-4MA]	302	14-3/4	19	10	19	
		9-7/8	251	6	251	
		5-7/8	302	4	302	250-302
(A-1-4)1bdd1[M-3MA]	303	14-3/4	21	10	21	
		9-7/8	250	6	250	
		5-7/8	303	4	303	250-303
(A-1-4)2ddd2[B-MA-1]	305	18	20	14	20	
		12-1/4	250	8	250	
		7-7/8	305	5	300	250-300
(A-2-4)26dda1[M-12MA]	300	14-3/4	20	10	20	
		9-7/8	250	6	250	
		5-7/8	300	4	300	246-300
(A-2-4)35dba1[M-11MA]	300	14-3/4	17.5	10	17.5	
		9-7/8	250	6	250	
		5-7/8	300	4	300	245-300

Table 2.1 (Cont.)
Monitor Well Construction Details

Well Number	Total Depth (feet)	Borehole Diameter (inches)	Borehole Depth (feet)	Casing Diameter (inches)	Casing Depth (feet)	Perforated Interval (feet)
Middle Alluvium Unit Monitor Wells (Cont.)						
(A-2-4)35ddc1[M-10MA]	302	14-3/4	17	10	17	
		9-7/8	250	6	250	
		5-7/8	302	4	302	252-302
(A-2-4)36dba1[M-9MA]	302	14-3/4	20	10	20	
		9-7/8	250	6	250	
		5-7/8	302	4	302	249-302
Lower Alluvium Unit Monitor Wells						
(A-1-4)1abb3[E-1LA]	749	14-3/4	20	10	20	
		9-7/8	695	6	695	
		5-7/8	749	4	749	695-749
(A-2-4)35ddc3[M-10LA]	700	14-3/4	20	10	20	
		9-7/8	650	6	650	
		5-7/8	700	4	700	642.5-700
Middle Alluvium Unit Piezometer						
(A-1-4)1abb1[E-1MP]	201	9-7/8	130	6	130	
		5-7/8	195	4	195	
		3-7/8	201	2	201	195-201

the setting time of the cement. The cement was poured into the annulus from the surface. After the surface casing was set, a 9 7/8-inch drill bit and conventional air rotary techniques were used to advance the borehole into the saturated portion of the Upper Alluvium unit. Mud rotary techniques were used to advance the borehole through the saturated material to a depth of approximately 250 feet. Cedar Fiber (shredded cedar bark) was added to the bentonite-based drilling mud to prevent losing mud to the formation when drilling through the Upper Alluvium unit. After the borehole had been advanced to approximately 250 feet, the borehole was geophysically logged. Section 2.3 lists the geophysical logs which were run. A 6-inch diameter blank steel conductor casing with centralizers was then pressure-grouted into the borehole from the base. The grout was allowed to set overnight. After the grout had set, a 5 7/8-inch diameter borehole was drilled using conventional mud rotary techniques to approximately 300 feet. This section of borehole was then geophysically logged. After the geophysical logging, a 4-inch diameter blank and perforated steel casing was set into the borehole. The casing was perforated from approximately 250 to 300 feet. Perforations consist of 1/8-inch by 3-inch slots with 6 slots per row, and 2 rows per foot. After the 4-inch casing had been set, the drilling mud was removed and well development operations began.

The borehole and casing diameters of Beckman Instruments' MAU monitor well (A-1-4)2ddd2[B-MA-1] were slightly different from those of the other MAU monitor wells installed during Phase I of the IBW RI/FS. In addition, Beckman Instruments' MAU monitor well included a gravel pack. The borehole for the surface casing was 18 inches in diameter and 20 feet deep. The surface casing installed in this borehole was 14-inch diameter blank steel. A 12 1/4-inch borehole was advanced through the surface casing to 250 feet and 8-inch blank steel conductor casing with centralizers was grouted in place after the hole was geophysically logged. A 7 7/8-inch diameter borehole was then advanced to a depth of 305 feet. The borehole was again geophysically logged, after which 300 feet of 5-inch diameter steel well casing, blank and perforated, was installed. The well casing was perforated between 250 and 300 feet with 1/8-inch by 3-inch slots, 6 slots per row, and 2 rows per foot. A gravel pack which extended approximately three feet above the bottom of the conductor casing was added. The gravel pack was Tacna #20 gravel, which consisted of sub-rounded to rounded gravel ranging from 1/4 inch to 3/16 inches in diameter.

2.1.3 Lower Alluvium Unit Monitor Wells

EPA and Motorola GEG each installed one Lower Alluvium unit (LAU) monitor well during Phase I of the IBW RI/FS. No LAU monitor wells were installed by Beckman Instruments. No LAU monitor wells were installed in the IBW study area prior to the initiation of the RI/FS.

The LAU monitor wells installed by EPA and Motorola GEG were constructed similarly. The EPA Lower Alluvium unit monitor well (A-1-4)1abb3[E-1LA] was installed to 749 feet and the Motorola GEG Lower Alluvium unit monitor well, (A-2-4)35ddc3[M-10LA] was installed to 700 feet. The casing was perforated for approximately the last 50 feet in both wells. Construction details for specific wells are presented in Table 2.1 and Appendix A.

The surface casing borehole for LAU monitor wells installed by the EPA and Motorola GEG was drilled with a 14 3/4-inch bit using conventional air rotary techniques to a depth of approximately 20 feet. A ten-inch diameter blank steel surface casing was set and cemented into this borehole. An accelerator was added to the cement to reduce the setting time of the cement. The cement was poured into the annulus from the surface. After the surface casing was set, a 9 7/8-inch drill bit and conventional air rotary techniques were used to advance the borehole into the saturated portion of the Upper Alluvium unit. Mud rotary techniques were used to advance the borehole through the saturated material to a depth of 695 feet in the EPA well and 650 feet in the Motorola GEG well. Cedar Fiber (shredded cedar bark) was added to the bentonite-based drilling mud to prevent losing mud to the formation. Before proceeding, the borehole was geophysically logged. Section 2.3 lists the geophysical logs which were run. A 6-inch diameter blank steel conductor casing with centralizers was then pressure-grouted into the borehole from the base. The grout was allowed to set overnight. After the grout had set, a 5 7/8-inch diameter borehole was drilled using conventional mud rotary techniques to 749 feet in the EPA well and 700 feet in the Motorola GEG well.

This section of borehole was then geophysically logged. After the geophysical logging, a 4-inch diameter blank and perforated steel casing was set into the borehole. Monitor well (A-1-4)1abb3[E-1LA] was screened from 695 to 749 feet while monitor well (A-2-4)35ddc3 [M-10LA] was screened from 642.5 to 700 feet, although only the 650 to 700 foot interval was open to the formation. Perforations consist of 1/8-inch by 3-inch slots with 6 slots per row, and 2 rows per foot. After the 4-inch casing had been set, the drilling mud was removed and well development operations began.

2.1.4 Middle Alluvium Unit Piezometer

The EPA installed a Middle Alluvium unit (MAU) piezometer (A-1-4) abb1[E-1MP] at the cluster site on McDowell Road approximately 250 feet west of well (A-1-4)1aba1[SRP 23.6E,6N]. This piezometer was installed to monitor water levels in the fine-grained portion of the Middle Alluvium unit during a proposed long term aquifer test of SRP Well 23.6E,6N (informally referred to as the Granite Reef Well).

The piezometer was originally installed to a depth of 140 feet in the uppermost portion of the Middle Alluvium unit. Monitoring water levels in this piezometer while performing the pumping test on (A-1-4) 1abb4[E-1UA] indicated that the piezometer may have been in hydraulic connection with monitor well (A-1-4)1abb4[E-1UA]. It was subsequently determined that this was not acceptable for the purpose of the proposed long-term aquifer test of the Granite Reef Well and it was decided by the IBW Technical Committee that the piezometer be deepened.

The piezometer was deepened to a depth of 201 feet and is screened from 195 to 201 feet. The piezometer consists of a 195 foot, 4-inch blank steel conductor casing, that was pressure-grouted in place from the base to the surface. After the grout had been allowed to set for at least twelve hours, a 3 7/8-inch borehole was drilled using conventional air rotary techniques to a depth of 201 feet. Casing was then set to 201 feet. The casing consists of 2-inch diameter blank galvanized steel casing to 195 feet and 2-inch diameter stainless steel, 20-slot Johnson well screen from 195 feet to 201 feet.

2.2 Lithologic Logging

All boreholes were lithologically logged by an on-site geologist. Drill cuttings were collected at 5 foot intervals and described in terms of color, grain size, texture, mineral composition, and degree of cementation. Lithologic logs are presented in Appendix B. The on-site geologist also recorded drilling rates, drilling mud viscosity, and drilling density.

2.3 Geophysical Logging

Middle Alluvium unit and Lower Alluvium unit monitor wells installed during Phase I of the Indian Bend Wash RI/FS were geophysically logged. Logging was performed by Century Geophysical Corporation of Tulsa, Oklahoma. Geophysical logs run included spontaneous potential, resistivity, gamma, neutron-neutron porosity, gamma-gamma porosity, and caliper. Geophysical logs of monitor wells installed during IBW RI/FS are presented in Appendix C. Geophysical logs of monitor wells installed prior to the RI/FS are also included in Appendix C.

2.4 Well Development

Following construction of the monitor wells, each well, with the exception of (A-2-4)26dda2[M-12UA], was developed by air-lift and surging techniques until the discharge water was adequately clear and free of sand as determined by the on-site geologist. Well development ranged from about two hours to eight hours; most wells were sufficiently developed after about four hours. During development the sand content of the discharge water was measured with a "sand cone" five minutes after a surge. The "sand cone" is a one-liter clear plastic cone graduated in milliliters. Well development was carried out until the sand content had decreased to 0.5 ml of sand per liter of water or until the sand content had reach a low (generally less than 5 ml/l) and constant level as determined by the on-site geologist.

2.5 Pumping Tests

Following well development, short-term, single-borehole, constant yield pumping tests were successfully performed on all monitor wells installed during Phase I of the IBW RI/FS with the exceptions of (A-2-4)26dda2[M-12UA], and (A-1-4)1abb3[E-1LA]. A constant discharge could not be maintained at monitor well (A-2-4)26dda2[M-12UA] due to insufficient saturated thickness in the well and insufficient permeability of the aquifer material. Drawdown and recovery during the pumping test of (A-1-4)1abb3[E-1LA] were measured with a pressure-sensitive transducer and results obtained were erratic and could not be analyzed. Pumping test results yield information about aquifer characteristics and are useful in determining the size and placement of the dedicated submersible pumps.

Test pumping was carried out until drawdown had stabilized, generally between 3.5 and 12 hours. Recovery was measured for the same duration as pumping at a particular well. Water levels observed during pumping tests performed by Motorola GEG and Beckman Instruments were measured with a calibrated electrical sounder. Water levels observed during pumping tests performed by EPA were measured with either pressure-sensitive transducers or a calibrated electric sounder. Pumping test results for individual monitor wells will be discussed in Section 4.

2.6 Dedicated Submersible Pumps

Following pumping test operations, dedicated submersible pumps were installed in the monitor wells. A pump was not installed in monitor well (A-2-4)26dda2[M-12UA] for reasons discussed in Section 2.5. Table 2.1 presents a summary of pump settings.

2.7 Water Quality Sampling

Groundwater samples for water quality sampling were initially collected during pumping test operations. A quarterly water quality sampling program was initiated in mid-August, 1985.

Groundwater samples were collected from EPA monitor wells at three intervals during pumping test operations; after five borehole volumes of groundwater had been evacuated, halfway through the pumping test, and at the end of the pumping test. Groundwater sampled after five borehole volumes had been evacuated and at the halfway point of the pumping test were analyzed for volatile organic constituents only. At the end of the pumping test groundwater samples were analyzed for volatile organics, extractable organics, inorganics, cyanide, and cations and anions.

A quarterly water quality sampling program was initiated in mid-August, 1985. This sampling program is coordinated between the EPA and PRPs and is designed to detect areal and vertical changes in contamination with time. Groundwater samples collected in mid-August and mid-November, 1985 were analyzed for volatile organics, extractable organics, inorganics (metals), cyanide, cations, and anions. Water quality results from monitor wells in the Indian Bend Wash study area presented in Appendicies L and M, will be discussed in Section 5.

2.8 Monthly Water Level Survey

A monthly water level survey of monitor wells and selected public supply wells in the Indian Bend Wash area was initiated in mid-August, 1985. Water levels in EPA and Beckman Instruments' monitor wells, as well as selected public supply wells are measured by EPA's consultant Ecology and Environment, Inc. Water levels in Motorola GEG monitor wells are measured by Motorola's consultant, Errol L. Montgomery and Associates. In addition to the mid-month monthly water levels, water levels in Motorola's monitor wells are also measured at the beginning of each month. Water levels are measured with calibrated electric sounders.

3.0 GEOLOGY AND SUBSURFACE STRATIGRAPHY

This section is based primarily on subsurface stratigraphic information obtained from the installation of monitor wells in the Indian Bend Wash area. All boreholes were lithologically logged by on-site geologists and many were also geophysically logged. Geophysical logs of boreholes provide the most objective and accurate information regarding variations in the properties of a sediment with depth. Geophysical logs are invaluable for accurate determinations of unit contacts and for correlating stratigraphic units between boreholes.

In addition to subsurface information obtained from the installation of the monitor wells, this section also incorporates stratigraphic information obtained from the numerous municipal, domestic, industrial, and irrigation wells that are present in the vicinity of the Indian Bend Wash. The quality of lithologic and stratigraphic data available from these wells is highly variable; typically a borehole was logged by the driller who usually was not a trained geologist and rarely was a borehole geophysically logged. Nevertheless, information from municipal supply wells represents a large body of subsurface data and can, when evaluated critically, provide valuable stratigraphic information. Lithologic logs of public supply wells used in the interpretation of the subsurface stratigraphy in the Indian Bend Wash area are presented in Appendix N.

Papers published by Halpenny, Harshbarger, and Greene (1967) and Arteaga, White, Cooley, and Sutheimer (1968) provided valuable characterizations of subsurface conditions in Paradise Valley; findings presented in these papers have been incorporated into this section. Subsurface information obtained from monitor wells installed prior to the RI/FS has also been assimilated into this discussion of the subsurface stratigraphy. This information has been previously presented in reports by Hargis & Montgomery (1983), and Errol L. Montgomery & Associates (1985).

3.1 Regional Structural Geologic Setting

The Indian Bend Wash study area is located near the southwestern edge of Paradise Valley, approximately two miles southeast of

Camelback Mountain and one mile east of Papago and Tempe Buttes (see Figure 1.1). Paradise Valley is a north-northwest-trending structural geologic basin within the Basin and Range Province of central Arizona. This province is characterized by fault-bounded basins separated by mountainous ranges. Mountain range blocks have been uplifted, relative to the basins, along high-angle normal faults. Basins are floored by bedrock and are commonly filled with thousands of feet of sedimentary material derived from the erosion of the adjacent mountain range blocks.

The Paradise Valley is bounded on the east by the McDowell Mountains and on the west by the Phoenix Mountains, Camelback Mountain, Papago Buttes, and Tempe Butte. The McDowell Mountains are comprised primarily of granitic and metamorphic rocks. The Phoenix Mountains, Camelback Mountains, Papago Buttes, and Tempe Butte are comprised of granitic, metamorphic, volcanic igneous, and sedimentary rocks.

3.2 Pre-Basin Geology

Faulting that resulted in the basin and range physiography of central Arizona is generally thought to have begun approximately 12 to 13 million years ago (Eberly and Stanley, Jr., 1978). The bedrock complex that existed prior to the basin and range faulting was comprised of crystalline, volcanic, and sedimentary rock types.

Pre-basin and range crystalline rocks consist of granitic igneous rock types and a variety of metamorphic rock types including schist, gneiss, and quartzite. Pre-basin and range volcanic rocks include basaltic, andesitic, and rhyolitic flows and pyroclastic rocks. These crystalline and volcanic rocks are generally not significant water-bearing materials in the Paradise Valley basin.

Pre-basin and range sedimentary rocks consist of rust-red colored, generally well-cemented conglomerate, breccia, sandstone, and siltstone. These rocks are referred to as the Red Unit. The breccia and conglomerate are typically poorly sorted with gravel, cobbles, and boulders embedded in a fine sandy, silty, and clayey matrix. The Red Unit locally consists of thinly-bedded siltstone and sandstone. The unit is generally well cemented with calcium carbonate. Near the Indian Bend Wash study area the Red Unit is exposed on Papago and Tempe Buttes. Layers exposed on Papago Buttes dip approximately 20 to

45 degrees to the west. A number of production wells in the vicinity of the Indian Bend Wash study area appear to penetrate the Red Unit. These wells generally tap more than one geologic unit, but suggest that the Red Unit may be a significant water-bearing unit in the area.

3.3 Basin Alluvial Stratigraphy

With the initiation of basin and range faulting, the Paradise Valley basin began to form and fill with alluvial material derived from erosion of adjacent uplifted regions. The alluvial deposits within the Paradise Valley basin can generally be divided, based on lithologic characteristics, into three stratigraphic units. In this report these units are referred to as, from youngest to oldest, the Upper Alluvium unit (UAU), the Middle Alluvium unit (MAU), and the Lower Alluvium unit (LAU).

Cross sections A-A' through E-E' (Plates 2 through 6) were constructed from available subsurface information in the IBW area and depict the general stratigraphic relationship between these units. Cross section locations are shown on Plate 1. Lithologic data from which these cross sections were constructed are presented in Appendices B, N, and O. Stratigraphic data used to construct Plates 2 through 10 are presented in Table 3.1. These data were derived from information presented in Appendices B, N, and O.

Cross section C-C' (Plate 4) extends west to within approximately one mile of Camelback Mountain. Differentiating three distinct stratigraphic units in the western portion of this cross section is extremely tenuous. Drillers' logs of wells in (A-2-4) section 22 (presented in Appendix N) generally show numerous alternating layers of coarse and fine material. This suggests that near the edges of the basin the division of alluvial material into three stratigraphic units may not be applicable. Subsurface stratigraphic information obtained during the IBW RI/FS Phase I monitor well installation program, however, indicates that the alluvial material penetrated at all of the Phase I drill sites can be divided into three stratigraphic units. The units will be discussed in order of increasing age.

Table 3.1
Indian Bend Wash Subsurface Stratigraphic Data

Well Number	Ground Surface Elevation (feet above MSL)	Depth to MAU (feet)	Elevation of UAU/MAU Contact (feet above MSL)	Depth to LAU (feet)	Elevation of MAU/LAU Contact (feet above MSL)	Thickness of MAU (feet)	Type of Information
(A-1-4)1abb3[E-1LA]	1215.22	124	1091	695	520	571	Geophysical Log
(A-1-4)1baa1[M-6MA]	1216.99	126	1091	-	-	-	Geophysical Log
(A-1-4)1bad2[M-1MA]	1210.43	130	1080	-	-	-	Geophysical Log
(A-1-4)1bad3[M-7MA]	1213.62	128	1086	-	-	-	Geophysical Log
(A-1-4)1bba1[M-5MA]	1217.16	116	1101	-	-	-	Geophysical Log
(A-1-4)1bcc1[M-2MA]	1209.58	122	1088	-	-	-	Geophysical Log
(A-1-4)1bdb1[M-4MA]	1214.34	131	1083	-	-	-	Geophysical Log
(A-1-4)1bdd1[M-3MA]	1205.15	125	1080	-	-	-	Geophysical Log
(A-1-4)1cda2	1197.0	116	1081	750	447	634	Driller's Log
(A-1-4)2acd[E-5UA]	1199.85	126	1074	-	-	-	Geologist's Log
(A-1-4)2dbb	1200.0	154	1046	468	732	314	Driller's Log
(A-1-4)2dbd[B-J]	1192.14	109	1083	-	-	-	Geologist's Log
(A-1-4)2ddb	1189.0	117	1072	560	629	443	Driller's Log
(A-1-4)2ddd[B-UA-3]	1192.00	114	1078	-	-	-	Geologist's Log
(A-1-4)2ddd2[B-MA-1]	1192.15	117	1075	-	-	-	Geologist's Log
(A-1-4)2ddd3[B-UA-1]	1191.84	117	1075	-	-	-	Geologist's Log
(A-1-4)11aaa2	1189.0	120	1069	-	-	-	Driller's Log

Table 3.1 (Cont.)
Indian Bend Wash Subsurface Stratigrahic Data

Well Number	Ground Surface Elevation (feet above MSL)	Depth to MAU (feet)	Elevation of UAU/MAU Contact (feet above MSL)	Depth to LAU (feet)	Elevation of MAU/LAU Contact (feet above MSL)	Thickness of MAU (feet)	Type of Information
(A-1-4)11aba	1185.0	160	1025	595	590	435	Driller's Log
(A-1-4)11acd	1170.0	134	1036	472	698	338	Driller's Log
(A-1-4)11bac2	1188.0	148	1040	412	776	264	Driller's Log
(A-1-4)11cda	1170.0	134	1036	554	616	420	Driller's Log
(A-1-4)13add	1182.0	120	1062	200	982	80	Driller's Log
(A-1-4)13bac	1180.0	160	1020	350	830	190	Driller's Log
(A-1-4)14daa	1171.0	ND[1]	-	535	636	-	Driller's Log
(A-1-4)15dcc	1167.0	NP[2]	1167	118	1049	0	Driller's Log
(A-1-4)22dbc	1166.0	150	1016	385	781	235	Driller's Log
(A-1-4)24abc	1185.0	155	1030	385	800	230	Driller's Log
(A-1-4)24bbc2	1178.0	150	1028	475	703	325	Driller's Log
(A-2-4)23bcc2	1270.0	166	1104	600	670	434	Driller's Log
(A-2-4)23ddd2	1236.0	175	1061	750	486	575	Driller's Log
(A-2-4)24bad	1252.0	145	1107	635	617	490	Driller's Log
(A-2-4)25aaa	1243.0	147	1096	820	423	673	Driller's Log
(A-2-4)25aab	1243.0	140	1103	785	458	645	Driller's Log
(A-2-4)25bcd	1235.0	160	1075	760	475	600	Driller's Log

Table 3.1 (Cont.)
Indian Bend Wash Subsurface Stratigrahic Data

Well Number	Ground Surface Elevation (feet above MSL)	Depth to MAU (feet)	Elevation of UAU/MAU Contact (feet above MSL)	Depth to LAU (feet)	Elevation of MAU/LAU Contact (feet above MSL)	Thickness of MAU (feet)	Type of Information
(A-2-4)25cdb2	1228.0	152	1076	710	518	558	Driller's Log
(A-2-4)25dca	1228.0	140	1088	-	-	-	Driller's Log
(A-2-4)25dcc	1225.0	146	1079	-	-	-	Driller's Log
(A-2-4)26dda1[M-12MA]	1227.54	145	1083	-	-	-	Geophysical Log
(A-2-4)25ddb1	1228.0	125	1103	550	678	425	Driller's Log
(A-2-4)25ddb2[E-4UA]	1229.52	140	1090	-	-	-	Geologist's Log
(A-2-4)35aab2	1220.0	150	1070	658	562	508	Driller's Log
(A-2-4)35abb1	1229.0	157	1072	585	644	428	Driller's Log
(A-2-4)35abb2[E-3UA]	1224.22	145	1079	-	-	-	Geologist's Log
(A-2-4)35daa[E-2UA]	1224.93	154	1071	-	-	-	Geologist's Log
(A-2-4)35dba1[M-11MA]	1211.48	138	1073	-	-	-	Geophysical Log
(A-2-4)35dcc2	1208.0	149	1059	512	696	363	Driller's Log
(A-2-4)35ddc3[M-10LA]	1218.21	140	1078	610	608	470	Geophysical Log
(A-2-4)36dba1[M-9MA]	1220.32	116	1104	-	-	-	Geophysical Log

1. ND = No data.

2. NP = Not present.

3.3.1 Upper Alluvium Unit

The Upper Alluvium unit, in the vicinity of IBW consists of a fine-grained, near-surface zone underlain by a very coarse-grained zone. The near-surface, fine-grained zone appears to range from approximately 10 to 30 feet thick, and consists of unconsolidated tan silty clay and clayey silt with minor amounts of sand and gravel and occasional hard, usually thin, layers of caliche. Calcium carbonate is disseminated throughout the zone. The contact with the underlying coarse deposits appears to be abrupt.

The coarse-grained zone of the Upper Alluvium unit consists primarily of well-rouned coarse gravel, cobbles, and boulders at all Phase I drill sites except (A-2-4)25ddb2[E-4UA]. Layers of finer material (coarse sand, fine gravel, and rarely silt and clay) occur throughout the unit but in general coarse gravel, cobbles, and boulders are dominant.

The sedimentary sequence penetrated at monitor well (A-2-4) 25ddb2[E-4UA] is distinct from that encountered at the other Phase I monitor well drill sites. As mentioned above, the UAU, in general consists of a relatively uniform sequence of very coarse material with only occasional thin layers of finer material. The sequence at (A-2-4)25ddb2[E-4UA], however, consists of alternating layers of sandy gravel and cobbles and gravelly sand. Individual layers range from about 5 feet to 20 feet thick. The sand generally range from 1/4 inch to 2 inches. the bottom 35 to 40 feet of the hole appeared to consist of significantly more clayey material although poor drill cutting return from this zone made lithologic logging difficult and less certain. At the monitor well site other than (A-2-4)25ddb2[E-4UA], the coarse-grained zone of the UAU typically consists of between 60 and 90 percent cobbles and boulders, 10 to 30 percetn coarse sand and fine gravel, and less than 15 percent silt and clay.

The thickness of the Upper Alluvium unit encountered in the monitor wells in the IBW study area to ranges from 109 feet at monitor well (A-1-4)2dbd[B-J well] to 153 feet at (A-2-4)35daa[E-2UA]. Only Upper Alluvium unit monitor wells are present at both of these sites, however, and the boreholes were no geophysically logged. These thicknesses are probably not as accurate as thicknesses determined at sites where the boreholes were geophysically logged. At monitor well sites where borehole geophysical logs were run, the thickness of the

USU appears to range from 116 feet at monitor wells (A-1-4)1bba [M-5MA] and (A-2-4)36dba1[M-9MA] to 145 feet at monitor well (A-2-4) 26dda[M-12MA].

Combining stratigraphic data obtained during the Phase I monitor well installation program with stratigraphic data from municipal supply wells in the area suggests that north of the Salt River, the UAU appears to increase in thickness to the north or northeast.

3.3.2 Middle Alluvium Unit

Drilling associated with the installation of monitor wells in the IBW area has penetrated the entire thickness of the Middle Alluvium unit (MAU) at two locations and penetrated the upper portion of the unit to a depth of approximately 300 feet below ground surface at thirteen locations. Subsurface information obtained during the installation of the monitor wells indicates that the MAU in the IBW area is comprised primarily of weakly to moderately consolidated fine-grained sediment. Silty clay, clayey silt, clay, and fine sandy silt predominate, however, interbeds of coarser material (medium sand to fine gravel) occur throughout the unit. Calcium carbonate is disseminated throughout the fine-grained portion of the unit and thin layers of fine sand typically are moderately cemented with calcium carbonate.

Monitor well (A-1-4)1abb3[E-1LA] penetrated the entire thickness of the Middle Alluvium unit. At this location the unit is 571 feet thick and occurs at a depth of 124 feet below the ground surface. Drill cuttings consisted primarily of silt and clay. Borehole geophysical logs and occasional sandy and fine gravelly material in the drill cuttings indicate that coarser layers occur throughout the stratigraphic sequence of the MAU. Thin (less than 1/2-inch thick) drill cuttings chips of moderately-cemented siltstone and very-fine sandstone are common throughout the MAU at (A-1-4)1abb3[E-1LA]. Thicker coarser layers consisting of medium-grained sand to fine gravel also occur. The borehole geophysical log indicates that these layers generally are five feet thick or less. A layer approximately 15 feet thick occurs between about 290 and 305 feet below ground surface and a gravelly sand layer approximately 20 feet thick occurs between about 545 and 565 feet below ground surface.

Monitor well (A-2-4)35ddc3[M-10LA] also penetrated the entire thickness of the Middle Alluvium unit. At this location the unit is 470 feet thick and occurs at a depth of 140 feet below the ground surface. The borehole geophysical log as well as the lithologic descriptions of drill cuttings indicates that the sedimentary sequence at this site is not substantially different than at (A-1-4)1 abb3[E-1LA]. Silt and clay are dominant and thin coarser layers appear to occur throughout the unit.

Thirteen monitor wells penetrated into the Middle Alluvial unit to a depth of approximately 300 feet below ground surface. Borehole geophysical logs indicate that the depth from the ground surface to the top of the MAU ranges from 116 feet at monitor wells (A-1-4)1bba1[M-5MA] and (A-2-4)36dba1[M-9MA] to 145 feet at monitor well (A-2-4)26dda1[M-12MA]. The lithologic log for monitor well (A-1-4)2dbd[B-J] suggests that at this location the MAU may occur at a depth of 109 feet below ground surface, however, no geophysical logs were run at this site.

Borehole geophysical logs and lithologic descriptions of drill cuttings indicate that, with the exception of the sites (A-2-4) 35dba1[M-11MA] and (A-2-4)26dda1[M-12MA], the sedimentary sequences encountered do not appear substantially different from one another. Generally up to about ten coarser or more permeable zones can be identified on the borehole geophysical logs. Fewer coarse layers appear at monitor well site (A-2-4)35dba1 [M-11MA]. No definite permeable zones can be observed on the geophysical logs of the borehole at site (A-2-4) 26dda1[M-12MA].

The variation in the thickness of the Middle Alluvium unit in the vicinity of the Indian Bend Wash study area is presented in Plate 8. The thicknesses presented are based on analysis of drillers' logs of municipal supply wells and new data obtained during Phase I of the IBW RI/FS.

3.3.3 Lower Alluvium Unit

During Phase I drilling only monitor wells (A-1-4)1abb3[E-1LA] and (A-2-4)35ddc3[M-10LA] penetrated into the Lower Alluvium unit. This section, therefore, will also incorporate lithologic descriptions of drill cuttings of the Lower Alluvium unit presented in drillers' logs of municipal supply wells in the vicinity of the Indian Bend Wash study area (see Appendix N).

Monitor well (A-1-4)1abb3[E-1LA] penetrated 54 feet and monitor well (A-2-4)35ddc3[M-10LA] penetrated 90 feet of the Lower Alluvium unit. Moderately- to well-cemented coarse gravel and cobbles were encountered in both boreholes. The coarse-grained, and cemented nature of the Lower Alluvium unit is reflected in lithologic descriptions in drillers' logs of municipal wells in the area. Descriptions in drillers' logs such as conglomerate, cemented granite boulders, tight mountain rock, cemented boulders, cemented mountain wash, hard conglomerate, tight conglomerate, cemented sand and gravel, and cemented conglomerate are characteristic of driller descriptions of the Lower Alluvium unit.

Cross sections C-C', D-D', E-E', (Plates 4,5,6) and Plate 7 (Elevation of the top of the Lower Alluvium unit) show that, in general, the top of the LAU occurs at a deeper depth in the eastern portin of the IBW area than in the western portion. In addition, Plate 7 shows that the top of the LAU occurs at a shallower depth approximately south of the Salt River than to the north. This difference in elevation of the top of the LAU suggests that the LAU may have been affected by basin and range faulting. Arteaga and others (1968) report that surface exposures of the LAU along the edges of Paradise Valley show that the unit has been tilted slightly; this also suggests that the unit may have been affected by faulting.

4.0 HYDROGEOLOGY OF THE IBW STUDY AREA

The principal water-bearing units in the Indian Bend Wash area are the basin fill deposits of Quaternary and Tertiary age and the sandstone/conglomerate Red unit of Tertiary age. The basin fill deposits are informally classified as the Upper, Middle and Lower Alluvium units (also referred to as UAU, MAU and LAU). As mentioned earlier, the Lower Alluvium and Red units have not been differentiated for the purposes of this study and will be referred to collectively as the Lower Alluvium unit or LAU. Geologic descriptions and occurrence of these units was discussed in Section 3.

4.1 Methods of Data Collection and Analysis

Data contained in this section were obtained through use of water level measurements, drillers logs, geophysical logs and pumping test results of monitor wells installed by EPA, Motorola GEG and Beckman Instruments during 1983, 1984 and 1985. In general, only data obtained from depth-specific monitor wells were used for the various hydrogeologic maps and calculations. The production well (A-2-4) 25ddb1[Phoenix #223] appears to be open to only the LAU and was therefore included in the discussions of water quality.

4.1.1 Water Level Measurments

Static water levels were measured in the monitor wells as they were completed, prior to and following short-term single borehole pumping tests (if a test was conducted) and at monthly (EPA and Beckman Instruments wells) or bi-monthly (Motorola GEG wells) intervals. A formal water level survey was initiated in August 1985 to provide for monthly water level measurements of all the monitor wells and selected community wells. Appendix D lists the wells in the water level survey and summarizes the water levels collected through December, 1985. All water levels collected during one water level survey are usually measured within a one to three day period and can thus be used to observe areal variations in water levels across the study area at a specific point in time. All water levels are measured with an electric well sounder according to the methods outlined in the QAPP (November 1984).

In addition to the water levels mentioned above, monitor wells installed on the Motorola GEG site during 1983 and 1984 have water level records dating from the time of completion. Soil boring (A-1-4) 1bdal[ST-2], on the Motorola GEG plant site, was completed as a monitor well and equipped with a continuous water level recorder in 1984.

4.1.2 Pumping Tests of Monitor Wells

The single borehole pumping tests conducted by Ecology and Environment on EPA monitor wells consisted of approximately four hours of pumping drawdown measurements and four hours of recovery measurements after the pump was shut off. Drawdown and recovery water levels were measured at the same time increments. Water levels during the test were measured with electric pressure transducers for wells (A-1-4)1abb4[E-1UA], (A-1-4)1abb2[E-1MA], (A-1-4)1abb3[E-1LA] (6/11-12/85 tests), (A-2-4)34daa[E-2UA],(A-2-4)35abb2[E-3UA], and (A-1-4)2acd[E-5UA]. Water levels during pumping tests of wells (A-1-4)1abb3[E-1LA] (11/15/85) and (A-2-4)24ddb2[E-4UA] were measured with electric sounders. Static water level of the well to be tested was monitored for two to four hours prior to the start of the test. Water quality samples were collected for volatile organic analysis after five borehole volumes of water had been removed and after two hours of pumping; samples collected just prior to the end of the test were analyzed for contaminants on the Hazardous Substance List (Appendix E). Pumping discharge rates, field water quality parameters (pH, temperature and electrical conductivity) and times of water quality sample collection are summarized in Appendix F. Water quality results of samples taken during the pumping test are presented in Appendices L and M. Procedures used in conducting the pumping tests are described in the Quality Assurance Project Plan (QAPP, November, 1984).

Single borehole pumping tests of Motorola on-site wells (A-1-4) 1bdd2[M-3UA], (A-1-4)1bad2[M-1MA], (A-1-4)1bba1[M-5MA], and (A-1-4) 1bba2[M-5UA] conducted by Errol L. Montgomery and Associates, consisted of approximately 12 hours of pumping drawdown measurements and 12 hours of water level recovery measurements, taken at like time intervals. Pumping rates of (A-1-4)1bdd2[M-3UA], (A-1-4)1bad2[M-1MA], and (A-1-4)1bba1[M-5MA] were measured with a two-inch McCrometer flow meter installed in the discharge line. Pumping discharge rates were checked with a stop-watch and five gallon container. Pumping rate of M-5UA was measured by stop-watch and five-gallon container (Montgomery and Associates, February, 1985).

The pumping tests of the Motorola off-site monitor wells consisted of 12 hours of pumping and recovery measurements as described above, with the exception of the pumping test of (A-2-4)35ddc2 [M-10UA], which lasted only nine hours, due to generator failure. A pumping test was not conducted on (A-2-4)26dda2[M-12UA], because a pumping rate could not be sustained. Pumping rates for (A-1-4)1acd [M-8UA], (A-2-4)35ddc2[M-10UA], (A-2-4)35ddc1M-10MA], (A-2-4)35dba1 [M-11MA], (A-2-4)26dda1[M-12MA] and (A-2-4)35ddc3[M-10LA], were measured with a totalizing flow meter and checked with a stop-watch and calibrated 15-gallon container; pumping rates for (A-2-4)36dba2 [M-9UA], (A-2-4)36dba1[M-9MA] and (A-2-4)35dba2[M-11UA] were measured with a stop watch and calibrated 15-gallon container. Pumping rate, temperature, specific electrical conductance and pH for the Motorola off-site pumping tests are given in Appendix F.

Single borehole pumping tests of the Beckman monitor wells (A-1-4)2ddd1[B-UA-3], (A-1-4)2ddd2[B-MA-1], (A-1-4)2ddd3[B-UA-1] and (A-1-4)2dbd[B-J] consisted of approximately six hours of pumping and 1-1/2 to 3-1/2 hours of recovery water level measurements. Pumping rates were measured with a barrel and stop-watch. Pumping discharge rates and barometric data from the time of the pumping tests are presented in Appendix F.

4.1.3 Pumping Test Results

Ecology and Environment, Inc. analyzed the pumping test results from EPA monitor wells, while Errol L. Montgomery and Associates, Motorola GEG's consultant, analyzed the pumping test results for the Motorola monitor wells. Drawdown/recovery plots and transmissivity calculations for Motorola monitor wells (A-1-4)1bdd2 [M-3UA], (A-1-4) 1bad2[M-1MA], (A-1-4)1bba1[M-5MA] and (A-1-4)1bba2[M-5UA] were taken from the Motorola Phase II on-site report (February 1985). Analyses for Motorola monitor wells (A-1-4)1acd[M-8UA), (A-2-4)36dba1[M-9MA], (A-2-4)36dba2[M-9UA], (A-2-4)35ddc1[M-10MA], (A-2-4)35ddc2[M-10UA], (A-2-4)35dba1[M-11MA], (A-2-4)35dba2[M-11UA], (A-2-4)26dda1[M-12MA] and (A-2-4)35ddc3[M-10LA] were taken from Motorola's Phase I off-site report, (November 1985). Pumping test analyses for the Beckman Instruments monitor wells are not presented, as Beckman's consultant, the MARK Group, has not provided any analyses to date. Data collected during the pumping tests of the Beckman wells were provided to the IBW Committee and are presented as Appendix I. Drawdown/recovery plots are presented in Appendices G (EPA monitor wells) and H (Motorola GEG monitor wells).

4.1.4 Pumping Test Analysis Methods

Drawdown data from pumping tests of EPA monitor wells were analyzed using the Theis Methods (a log-log method also known as "curve matching") and the Jacob (semi-log) method, an approximation to the Theis method. Water level recovery data were analyzed using the Theis Recovery (semi-log) method. Errol L. Montgomery and Associates also used the above three methods to analyze the pumping test results from the Motorola GEG monitor wells. A discussion of these methods and the assumptions underlying the use of them are presented in Freeze and Cherry (1979) and other basic hydrogeology texts. While both the Theis and Jacob methods are based on the simplifying assumption that the aquifer is confined, these methods were also used to analyze the pumping test results from the unconfined Upper Alluvium aquifer. The argument of the well function (u) was defined in terms of specific yield, Sy, rather than storativity, S, and the transmissivity was defined as T=Kb, where b was the initial saturated thickness of the UAU. The Theis and Jacob methods provide a good approximation of the transmissivity which would be obtained from more complicated unconfined analyses. Application of methods designed for unconfined aquifers may give slightly different results. The equations used to calculate transmissivity from the drawdown and recovery plots are presented below.

Theis Equation: $$T = \frac{Q}{4 s'} W(u)$$

Where T = transmissivity

Q = discharge rate of pumping well

$W(u)$ = Theis well function

s' = drawdown

Jacob Approximation

$$T = \frac{2.303Q}{4\pi s'}$$

when variables are as defined previously

Theis Recovery Equation: $$T = \frac{2.3Q}{4\pi s'} \text{ Log } \frac{t}{t'}$$

where t = time since pumping began

t' = time since pumping stopped

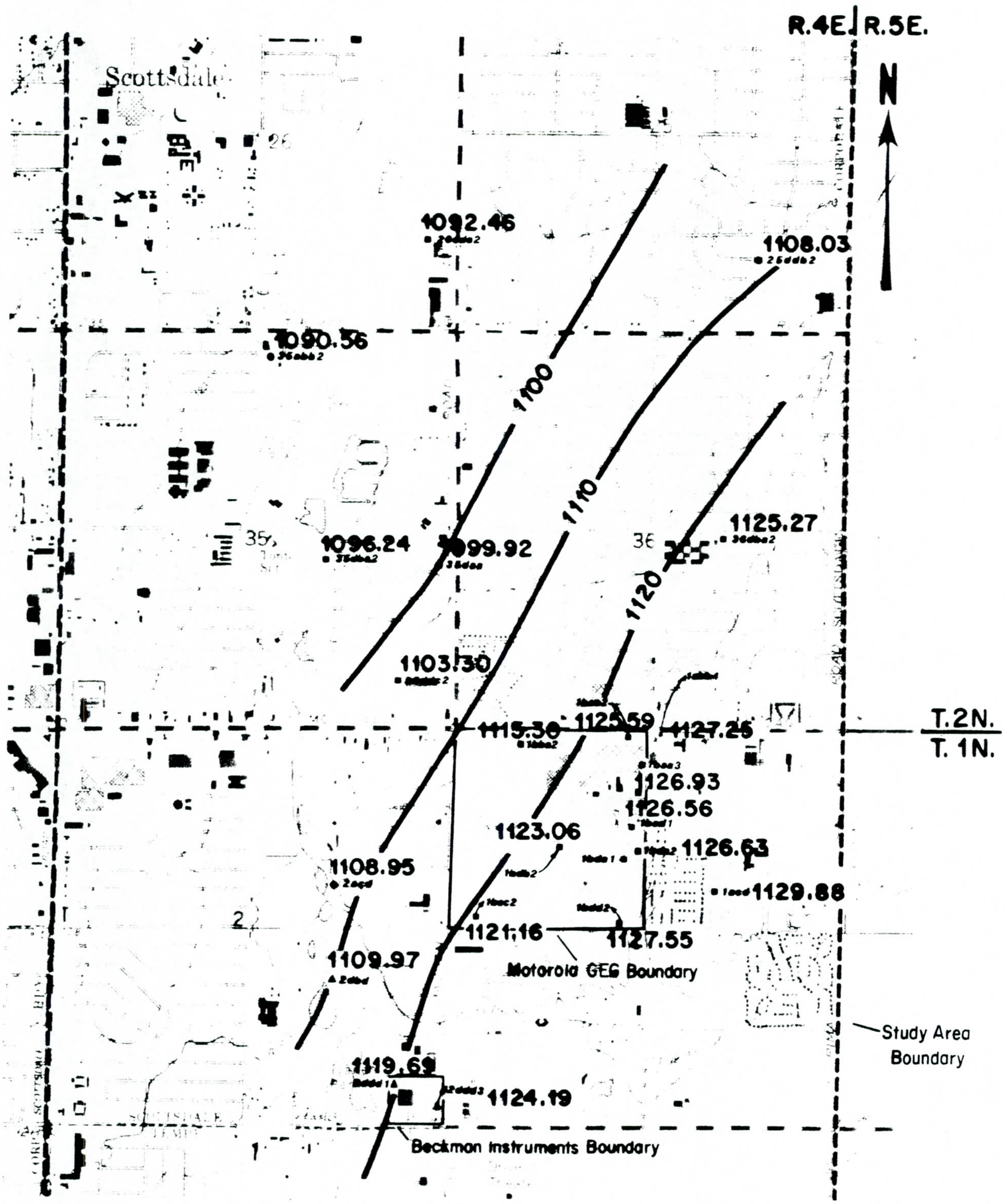
and other variables are as defined previously

4.2 Upper Alluvium Unit

The Upper Alluvium unit in the Indian Bend Wash area is a coarse-grained deposit averaging approximately 60-70% cobbles and boulders, 10-30% coarse sand and fine gravel and less than 15% sand and clay (as described in drill cutting logs of monitor wells installed by EPA, Motorola GEG and Beckman Instruments). Locations of the UAU monitor wells are shown in Figure 4.1 and the well completion diagrams are presented in Appendix A. In the vicinity of the monitor wells, the Upper Alluvium unit was found to be from 116 to 145 feet thick, with the greatest thickness exhibited in T.2N.,R.4E., Section 25, 26, 35 (Plate 9).

4.2.1 Potentiometric Surface and Groundwater Flow

A water level contour map of the Upper Alluvium unit, using water levels from the mid-October 1985 water level survey, is presented in Figure 4.1. Analysis of the water level contours indicates that groundwater movement in the UAU in the vicinity of the IBW study area moves to the west-northwest. The horizontal gradient is steepest between the 1,100 and 1,200 foot contours and flattens both to the west-northwest of the 1,100 foot contour and the east-southeast of the 1,200 foot contour. The average horizontal gradient for the portion of the study area shown in Figure 4.1 is 28 feet/mile. Based on mid-October 1985 water levels, saturated thickness generally decreases in a northward direction. The exception to this is monitor well (A-1-4)



0 1000 2000 3000 4000 5000

Scale: In Feet

Figure 4.1 Water Level Contour Map of Upper Alluvium Unit

LEGEND

- ■ Motorola Monitor Well
- ▲ Beckman Monitor Well
- ● EPA Monitor Well

(full well designations in Table 2.1)

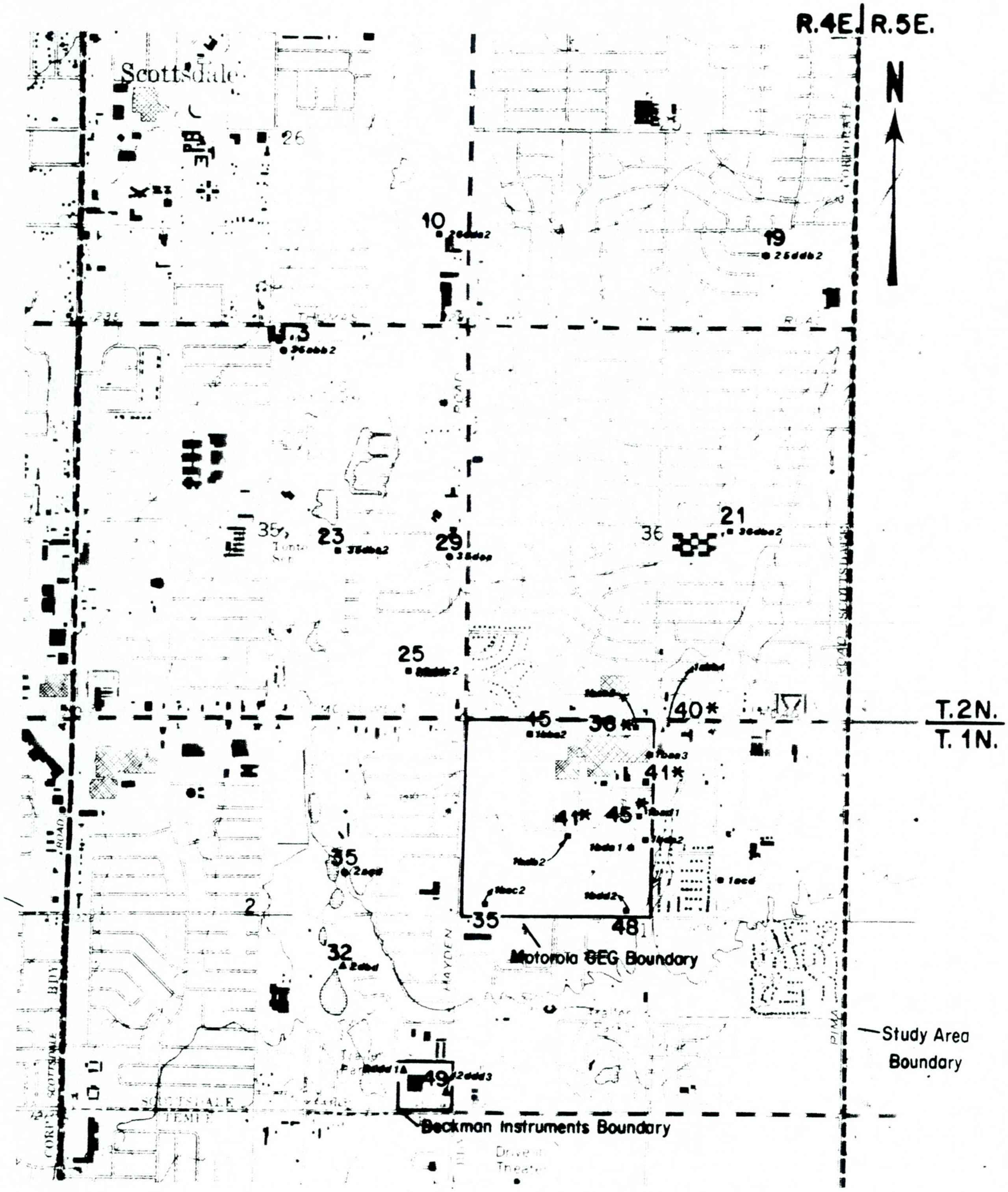
■ 1108.95 Water level in feet above mean sea level, collected 10/15-16/85

1bba2[M-5UA], which has both a smaller total UAU thickness and saturated thickness than other nearby UAU monitor wells (Figure 4.2).

Water level hydrographs for the UAU monitor wells, except (A-1-4)1bda1[ST-2] are shown in Appendix D. Inspection of these hydrographs shows that the Motorola on-site UAU monitor wells and monitor wells (A-2-4)36dba2[M-9UA] and (A-1-4)1abb4[E-1UA] have generally similar hydrographs; water levels in 1985 rose until September and then declined through December (D-1, D-9 through D-18). The 1985 water level hydrographs for monitor wells (A-2-4)35daa[E-2UA], (A-2-4)35abb2[E-3UA], (A-2-4)25ddb2[E-4UA], (A-2-4)35dcc2[M-10UA], (A-2-4)35dba2[M-11UA] and (A-2-4)26dda2[M-12UA] show gradually rising water levels during the period presented (D-2 to D-4, D-19 through D-21). Monitor wells (A-1-4)2ddd1[B-UA-3], (A-1-4)2ddd3[B-UA-1] and (A-1-4)2acd[E-5UA] exhibit declining water levels from October through December, 1985 (D-5, D-6, D-7).

4.2.2 Transmissivity and Hydraulic Conductivity of EPA Monitor Wells

Transmissivity and associated hydraulic conductivities calculated from the results of the short-term pumping tests are given in Table 4.1. The best or average value of transmissivity, the saturated thickness, and the hydraulic conductivity were estimated using the criteria discussed below (all G designations refer to pages in Appendix G). The hydraulic conductivity at a site is determined by dividing the transmissivity value, obtained from analysis of pumping test data, by the saturated thickness of the formation open to the well (for an unconfined aquifer) or the screened interval of the well (for a confined aquifer). As can be seen in Table 4.1, two different values for saturated thickness, and thus the hydraulic conductivity, are presented for several monitor wells (denoted Methods 1 and 2). The discrepancy is the result of a difference in interpretation of the "saturated thickness" of the UAU monitor wells and occurs only in monitor wells where the screened interval extends below the UAU/MAU contact and into the MAU. In UAU monitor wells that penetrate into the MAU, Errol L. Montgomery and Associates has assumed that the water contributed to the well from the MAU is negligible and the effective saturated thickness is the distance from the water table to the UAU/MAU contact (Method 1 on Table 4.1). The hydraulic properties of this



0 1000 2000 3000 4000 5000

Scale: In Feet

Figure 4.2 Saturated Thickness of the Upper Alluvium Unit

LEGEND

Saturated Thickness
- 35 ▪ Motorola Monitor Well
- 32 ▲ Beckman Monitor Well
- 24 • EPA Monitor Well

(full well designations in Table 2.1)

* UAU/MAU contact from MAU well at site

10/15-16/85 water levels used for calculations

Table 4.1

TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY
FOR SOME UPPER ALLUVIUM UNIT MONITOR WELLS

		Transmissivity (gpd/ft)				Hydraulic Conductivity (gpd/ft^2)			
Well Owner	Well I.D.	Jacob (Semi-Log) Method	Theis Recovery (Semi-Log) Method	Theis Curve Matching (Log-Log) Method	Average or Best Value	Method 1*	Saturated Thickness	Method 2†	Saturated Thickness
EPA	(A-1-4)1abb4 [E-1UA]	130,000	65,000	87,000	76,000	2,120	35.9	2,120	35.9
	(A-2-4)35daa [E-2UA]	Drawdown not analyzed	29,000	Drawdown not analyzed	29,000	1,430	20.3	1,430	20.3
	(A-2-4)35abb2 [E-3UA]	43,000	33,000	Not analyzed	38,000	3,960	9.6	2,600	14.6
	(A-2-4)25ddb2 [E-4UA]	5,700	19,000	6,800	6,300	450	14	270	23.5
	(A-1-4)2acd [E-5UA]	16,000	35,000	16,000	22,000	650	33.9	550	39.9
Motorola GEG	(A-1-4)1bdd2 [M-3UA]	35,000	140,000	33,000	35,000	830	42	760	46
	(A-1-4)1bba2 [M-5UA]	Not analyzed	7,500	2,700	7,500	940	8	690	10.8
	(A-1-4)1acd [M-8UA]	37,000	31,000	32,000	33,000	1,170	28.1	1,170	28.1
	(A-2-4)36dba2 [M-9UA]	2,600	13,000	27,000	13,000	3,420	3.8	1,100	11.8
	(A-2-4)35dcc2 [M-10UA]	50,000	36,000	39,000	42,000	2,320	18.1	1,670	25.1
	(A-2-4)dba2 [M-11UA]	9,500	28,000	6,400	28,000	1,490	18.8	940	29.8
Beckman Instruments	(A-1-4)2ddd1 [B-UA-3]; (A-1-4)2ddd3 [B-UA-1]; (A-1-4)2dbd [B-J]	Analyses not provided	Analyses not provided	Analyses not provided	Analyses not provided	Analyses not provided		Analyses not provided	

* Hydraulic Conductivity = average or best transmissivity / saturated screened interval above UAU/MAU contact on day of test

† Hydraulic Conductivity = average or best transmissivity / screened interval from water table to bottom of screen on day of test

portion of the MAU have not yet been determined, therefore Ecology and Environment chose to assume the MAU contributed water to the well. The hydraulic conductivity and saturated thickness noted as Method 2 on Table 4.1 assumes a saturated thickness equal to the distance from the water table to the bottom of the well. The hydraulic conductivity presented is an average taken over the entire screened interval. As the saturated thickness calculated by Method 1 is smaller than that calculated by Method 2, the average hydraulic conductivity over the screened internal at a given well is larger. Values calculated by both methods are presented, where applicable. Methods 1 and 2 provided identical results for wells screened entirely in the UAU. To avoid confusion and maintain consistency with the Motorola reports, Method 1 will be used in Figures and discussions.

Monitor Well (A-1-4)1abb4[E-1UA]

The transmissivities calculated from the drawdown trends (G-1 and G-2) are of the same order of magnitude and indicate the transmissivity at monitor well E-1UA may be 76,000 gpd/ft. Saturated thickness at E-1UA on the day of the pumping test was 35.9 feet, giving a hydraulic conductivity value of 2,120 gpd/ft^2.

Monitor Well (A-2-4)35daa[E-2UA]

After an initial drawdown of 0.9 feet, the water level continued to rise during the pumping test of E-2UA. The drawdown plot (G-3) was not analyzed and a Theis plot was not prepared. The trend of the recovery data indicates the transmissivity may be 29,000 gpd/ft. Saturated thickness of the UAU on the day of the test was 20.3 feet, indicating that the hydraulic conductivity is about 1,430 gpd/ft^2.

Monitor Well (A-2-4)35abb2[E-3UA]

Transmissivities calculated from the semi-log drawdown and recovery plots (G-4) are of the same order of magnitude and indicate that the transmissivity at E-3UA maybe 38,000 gpd/ft. Saturated thickness of the UAU on the day of the test was 9.6 feet, giving an estimated hydraulic conductivity of 3,960 gpd/ft^2 (Method 1). Saturated screened interval of E-3UA on the day of the pumping test was 14.6 feet, giving an estimated hydraulic conductivity of 2,600 gpd/ft^2 (Method 2).

Monitor Well (A-2-4)25ddb2[E-4UA]

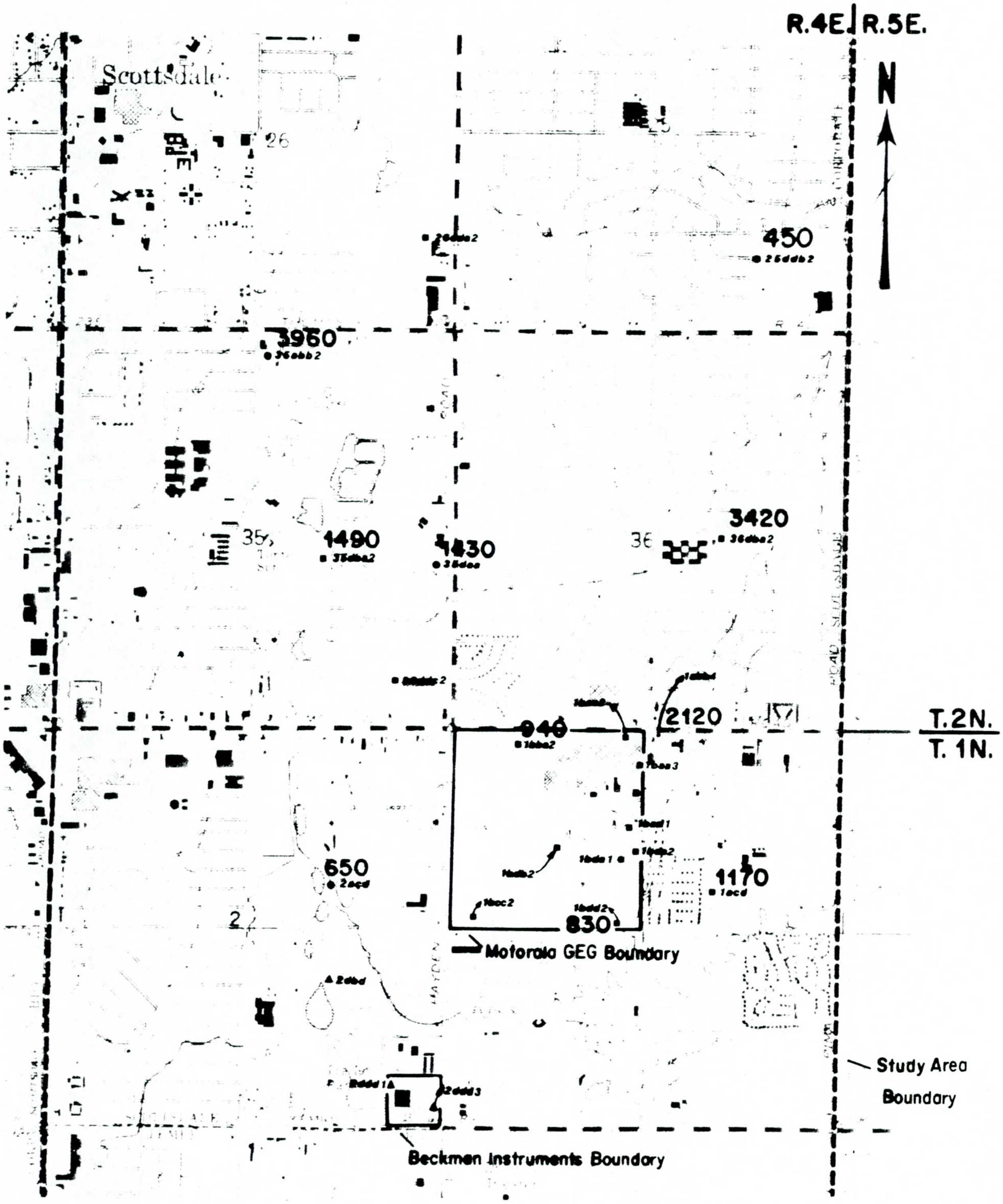
Transmissivity values calculated from drawdown plots (G-6, G-7) were approximately 5,700 and 6,800 gpd/ft. The transmissivity calculated from the recovery data (G-6), was 19,000 gpd/ft. The transmissitvities calculated from the drawdown data were both of the same order of magnitude and appear to the consistent with the observed lithology at the well. Therefore, the best estimate of transmissivity at this site is approximately 6,300 gpd/ft. Saturated thickness of the UAU at E-4UA on the day of the pumping test was 14 feet, yielding a hydraulic conductivity value of 450 gpd/ft^2 (Method 1). Saturated screened interval at this well on the day of the test was 23.5 feet, yielding a hydraulic conductivity of 250 gpd/ft^2 (Method 2).

Monitor Well (A-1-4)2acd[E-5UA]

Transmissivity values calculated from drawdown plots (G-8, G-9) for monitor well E-5UA indicate a value of 16,000 gpd/ft, while the recovery plot (G-8) indicates transmissivity may be 35,000 gpd/ft. As all transmissivity values were of the same magnitude, the transmissivity at E-5UA is estimated to be 22,000 gpd/ft. Saturated thickness of the UAU at monitor well E-5UA on the day of the pumping test was 33.9 feet, yielding a hydraulic conductivity of 650 gpd/ft^2 (Method 1). Saturated screened interval on the same day was 39.9 feet, yielding a hydraulic conductivity of 550 gpd/ft^2 (Method 2).

4.2.3 Summary of Hydraulic Properties

The hydraulic conductivity of the UAU, as estimated from analyses of pumping test results, appears to range from 500 gpd/ft^2 at (A-2-4)25ddb2[E-4UA] to 4,000 gpd/ft^2 at (A-2-4)35abb2[E-3UA] and average about 1,700 gpd/ft^2 in the vicinity of the monitor wells (Figure 4.3). Values shown on Figure 4.3 were calculated assuming only the UAU contributed water to the well (Method 1). These hydraulic conductivities indicate that the most permeable portion of the UAU in this part of IBW study area are T.2N.,R.4E., Section 36 and the northeast portion of Section 35.



0 1000 2000 3000 4000 5000

Scale: In Feet

Figure 4.3 Hydraulic Conductivity of the Upper Alluvium Unit

LEGEND

- ▪ Motorola Monitor Well
- ▴ Beckman Monitor Well
- • EPA Monitor Well

(full well designations in Table 2.1)

▪ 760 Hydraulic Conductivity in gallons/day/foot^2, assuming 1:1 hydraulic gradient

Saturated thickness calculated using only the portion of the screened interval actually in the UAU and 10/15-16/85 water levels. (See section 4.2.2 for discussion)

Assuming that the MAU also contributes water to monitor wells (A-2-4)35abb2[E-3UA], (A-2-4)25ddb2[E-4UA], (A-1-4)2acd[E-5UA], (A-1-4)1bdd2[M-3UA], (A-1-4)1bba2[M-5UA], (A-2-4)36dba2[M-9UA], (A-2-4)35ddc2[M-10UA], and (A-2-4)35dba2[M-11UA] (Method 2) indicates that the hydraulic conductivity opposite the screened interval of the monitor wells range from about 300 gpd/ft^2 to 2,600 gpd/ft^2 (Table 4.1).

4.3 Middle Alluvium Unit

The Middle Alluvium unit is finer-grained than either the Upper or Lower Alluvium units in the IBW area and is generally comprised of approximately 90% clay and silt and 10% fine sand with occasional coarser layers (as described in drill cutting logs of monitor wells installed by EPA, Motorola GEG and Beckman Instruments). Locations of MAU monitor wells are shown in Figure 4.4 and the well construction diagrams are presented in Appendix A.

4.3.1 Piezometric Surface and Groundwater Flow

A water level contour map of the Middle Alluvium unit using water levels from the mid-October 1985 water level survey, is presented in Figure 4.4. Analysis of the water level contours indicates that the direction of groundwater movement in the MAU may be to the west-north-west and north-northwest in the vicinity of the IBW study area. Due to the small number of monitor wells installed into the MAU, the 1,040 foot contour shown in Figure 4.4 is the only contour which can be drawn with a degree of confidence. Horizontal gradients, calculated normal to this contour, range from approximately 15 feet/mile ((A-1-4)1abb2[M-1MA] and (A-1-4)1bad2[M-1MA]) to 30 feet/mile ((A-1-4)1bcc1[M-2MA], (A-1-4)1baa1[M-5MA] and (A-1-4)1bdd1[M-3MA]).

Water level hydrographs for Middle Alluvium Unit monitor wells are presented in Appendix D. All MAU monitor wells exhibited a water level rise between October and December 1985, except well

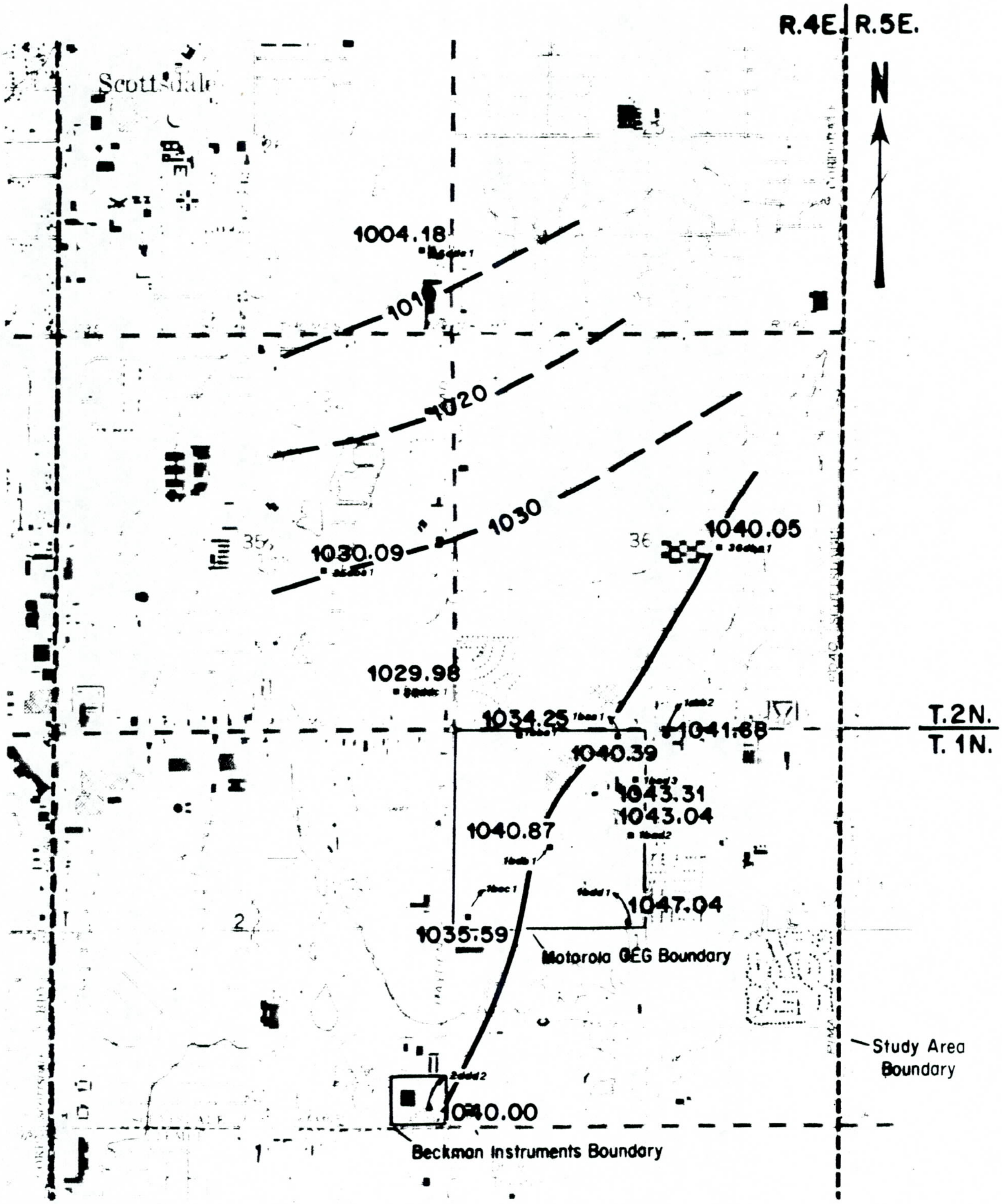


Figure 4.4 Water Level Contour Map of the Middle Alluvium Unit

LEGEND

- ▪ Motorola Monitor Well
- ▲ Beckman Monitor Well
- • EPA Monitor Well

(full well designations in Table 2.1)

• 1041.68 Water level in feet above mean sea level, collected 10/15-16/85

(A-1-4)1abb2 [E-1MA] which did not exhibit a water level rise until December. Water level hydrographs of the Motorola on-site monitor wells and (A-2-4)35dcc1[M-10MA] are similar (D-24 through D-30, D-32). Likewise, hydrographs of Motorola, off-site monitor wells (A-2-4)36dba1[M-9MA], (A-2-4)35dba1[M-11MA] and (A-2-4)26dda1[M-12MA] bear resemblance (D-31, D-33, D-34).

4.3.2 Transmissivity and Hydraulic Conductivity at Monitor Wells

Transmissivities and associated hydraulic conductivities calculated from the results of the short-term pumping tests are given in Table 4.2. The drawdown/recovery plots are presented in Appendix G (EPA wells) or Appendix H (Motorola wells) and the pumping discharge and field parameters measured during the tests are presented in Appendix F. Analysis of pumping tests of Motorola GEG monitor wells were obtained from either the Motorola Phase II on-site report or the Phase I off-site report. Analysis of Beckman Instruments pumping tests were not provided.

EPA Monitor Well (A-1-4)1abb2[E-1MA]

Analysis of the semi-log plots (G-10) of drawdown and recovery data for E-1MA indicate the transmissivity may be approximately 11,000 gpd/ft. Analysis of the drawdown data of the log-log plot (G-11) for this well indicates a transmissivity of about 9,300 gpd/ft. A value of 11,000 gpd/ft was considered the best estimate of the transmissivity for this monitor well. The screened interval of monitor well E-1MA is 48 feet, yielding a hydraulic conductivity of 230 gpd/ft^2.

4.3.3 Summary of Hydraulic Properties

The hydraulic conductivity of the MAU, as estimated from pumping test results, appears to range from about 7 gpd/ft^2 at (A-2-4)35dba1[M-11MA] to 680 gpd/ft^2 at (A-2-4)36dba1[M-9MA] and average about 220 gpd/ft^2, in the vicinity of the monitor wells (Figure 4.5). Hydraulic conductivity values presented on Figure 4.5 indicate that the most permeable portion of the MAU in this part of the IBW study are alies near the center of T.2N,R.4E., Section 36 and decreases to the west, northwest and south of this area.

Table 4.2

TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY FOR SOME MIDDLE ALLUVIUM UNIT MONITOR WELLS

		Transmissivity (gpd/ft)				
Well Owner	Well I.D.	Jacob (Semi-Log) Method	Theis Recovery (Semi-Log) Method	Theis Curve Matching (Log-Log) Method	Average or Best Value	Hydraulic Conductivity (gpd/ft^2)*
EPA	(A-1-4) 1abb2 [E-1MA]	11,000	11,000	9,300	11,000	230
Motorola GEG	(A-1-4)1bad2 [E-1MA]	2,400	1,800	3,600	2,400	48
	(A-1-4)1bba1 [M-5MA]	14,000	17,000	15,000	15,000	290
	(A-2-4)36dba1 [M-9MA]	Not analyzed	36,000	Not analyzed	36,000	700
	(A-2-4)35ddc1 [M-10MA]	17,000	13,000	10,000	13,000	260
	(A-2-4)35dba1 [M-11MA]	520	350	210	360	7.2
	(A-2-4)26daa1 [M-12MA]	1,500	170	480	700	14
Beckman Instruments	(A-1-4)2ddd2 [B-MA-1]	Analysis not provided	Analysis not provided	Analysis not provided	-	-

* Hydraulic Conductivity = $\frac{\text{average or best transmissivity}}{\text{screened interval open to formation}}$

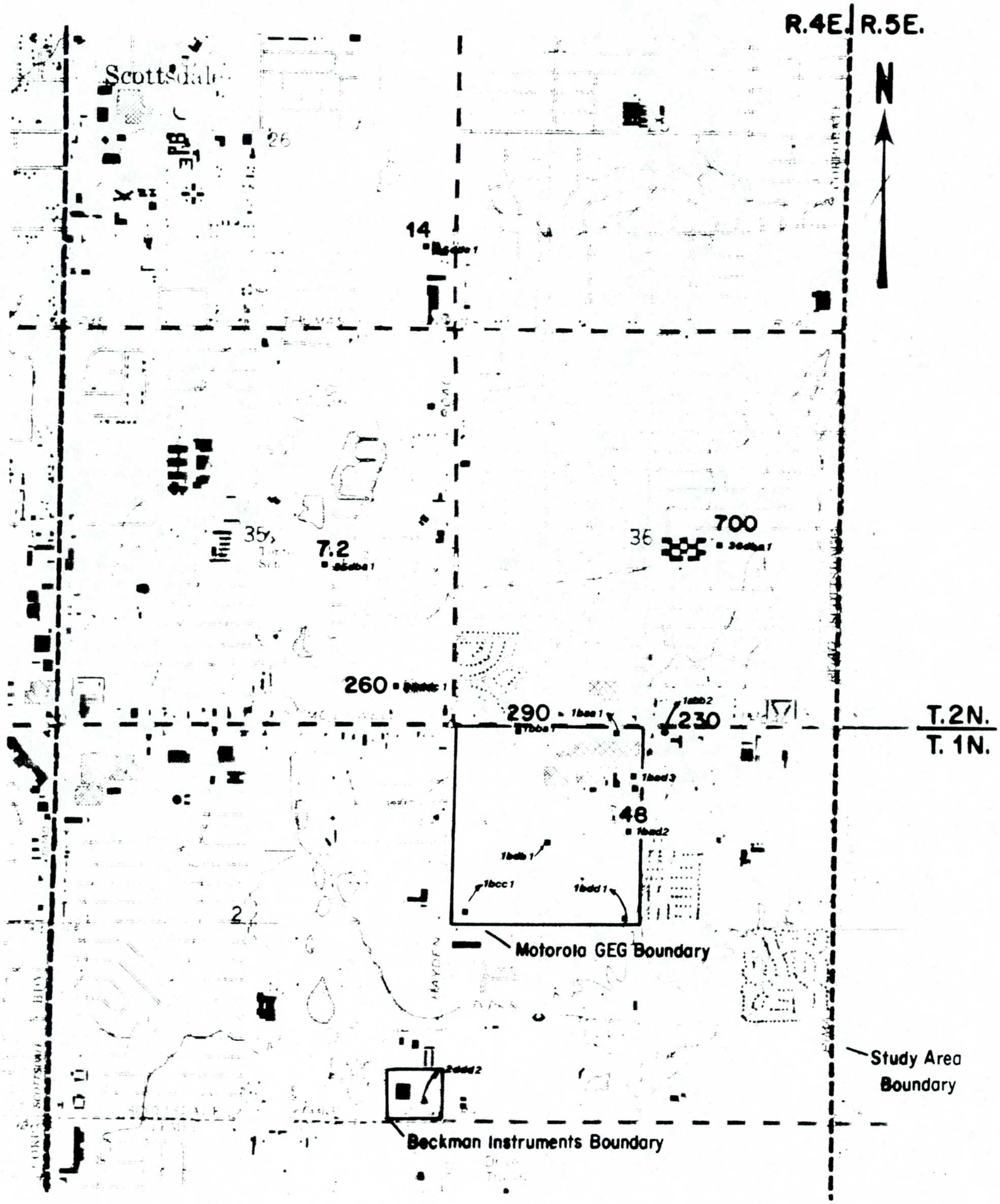


Figure 4.5 Hydraulic Conductivity of the Middle Alluvium Unit

0 1000 2000 3000 4000 5000

Scale: In Feet

LEGEND

- ■ Motorola Monitor Well
- ▲ Beckman Monitor Well
- • EPA Monitor Well

(full well designations in Table 2.1)

- ■ 48 Hydraulic Conductivity in gallons/ day/foot2, assuming a 1:1 hydraulic gradient

4.3.4 Laboratory Test Results of Core Samples

During drilling of the Lower Alluvium monitor well (A-1-4)1abb3 [E-1LA], core samples were collected from three zones in the MAU (235, 320 and 422 feet). Laboratory consolidation and falling head permeameter tests were conducted on these cores by Harding Lawson Associates. Results of these tests show that both the compression index and the permeability of the MAU increase with depth (Table 4.3). The increase in permeability with depth observed in the these samples may be primarily a function of the limited number of cores collected rather than a general trend within the MAU.

4.4 Lower Alluvium Unit

The Lower Alluvium unit consists of a heterogeneous mixture of weakly-to-strongly-cemented boulders, gravel, sand, sandy clay, silty sand and clay. Two monitor wells were installed in the LAU during the Phase I drilling program. Monitor well (A-1-4)1abb3[E-1LA] was screened from 695 to 749 feet and monitor well (A-2-4)35dcc3[M-10LA] was screened from 642.5 to 700 feet, although only the 650 to 700 foot interval is open to the formation. The only other well in the IBW study area (north of the Salt River) found to be screened solely in the LAU was (A-2-4)25ddb1[Phoenix#223], which is screened from 800 to 1,200 feet.

4.4.1 Water Levels and Groundwater Flow

Water levels for monitor wells (A-1-4)1abb3[E-1LA] and (A-2-4) 35dcc3[M-10LA] collected on October 15, 1985 are shown on Figure 4.6. No water level was collected for Phoenix #223, as the well was pumping continuously during the water level survey. Inspection of Figure 4.6 shows virtually the same water level at both monitor wells E-1LA and M-10LA. Water levels for the LAU wells through December 1985 are presented in Appendix D. As the August water levels show, the direction of groundwater flow in the vicinity of the monitor wells may have a northward component. No estimates of groundwater gradient or flow pattern of the LAU can be made using only these three LAU wells which are widely spaced and screened in different intervals. Water level hydrographs for Lower Alluvium unit wells are presented in Appendix D (D-35, D-36, D-37).

Table 4.3

RESULTS OF FALLING HEAD PERMEAMETER AND CONSOLIDATION TESTS

Core	Permeability (cm/sec)	Compression Index	Original Void Ratio
235 feet	1.9×10^{-6}	.040	.643
320 feet	8.8×10^{-6}	.125	.822
422 feet	4.8×10^{-5}	.515	1.183

Laboratory worksheets provided by Harding Lawson Associates are presented in Appendix J.

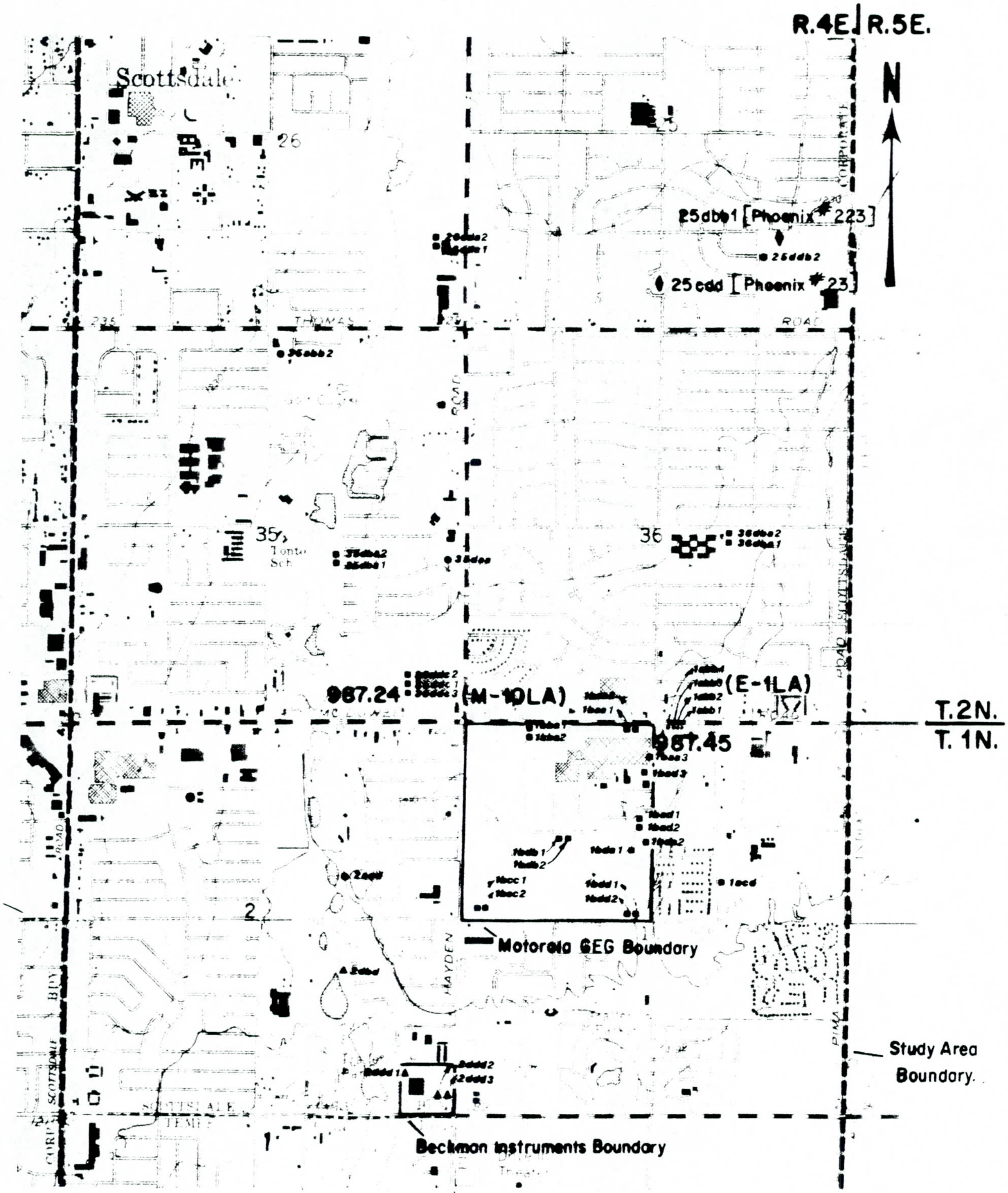


Figure 4.6 Water Levels in the Lower Alluvium Unit

0 1000 2000 3000 4000 5000

Scale: In Feet

LEGEND

- ▪ Motorola Monitor Well
- ▴ Beckman Monitor Well
- • EPA Monitor Well

(full well designations in Table 2.1)

- ▪ 987.24 water level in feet above mean sea level, collected 10/15/85

4.4.2 Transmissivity and Hydraulic Conductivity

Motorola Monitor Well (A-2-4)35ddc3[M-10LA]

Transmissivity of the LAU at (A-2-4)35ddc3[M-10LA], calculated from the drawdown period of the short-term single borehole pumping test, was 15,000 gpd/ft for the semi-log plot and 17,000 gpd/ft for the log-log plot (Appendix H). Using an average transmissivity of 16,000 gpd/ft, the hydraulic conductivity opposite the 50 foot screened interval at M-10LA may be about 320 gpd/ft^2. Field water quality parameters collected during this test are presented in Appendix F (all information regarding M-10LA was obtained from Motorola's Phase I off-site report).

EPA Monitor Well (A-1-4)1abb3[E-1LA]

Transmissivity could not be calculated from the drawdown/recovery plots of data collected during the June 11, 1985 pumping test at (A-1-4)1abb3[E-1LA](G-13, G-14). The transducer used to record water level measurments during the test malfunctioned, giving erratic drawdown and recovery readings. A second pumping test of E-1LA was conducted on November 15, 1985 using the smaller capacity permanent pump. Water levels during this test were measured with an electric sounder. The results of the second pumping test, shown on page G-14, could not be analyzed. After a slight initial drawdown, the water levels rose during the pumping period and continued to rise during the recovery period. Static water level at the end of the recovery period was about 1 foot above that at the beginning of the pumping test. The water level rise observed at E-1LA during the pumping test may be water level recovery from drawdown imposed by pumping at (A-2-4)25cdd [Phoenix #23]. Phoenix #23 (screened from 100 to 480 feet and 500 to 1,185 feet), was found to have pumped continuously for the four days prior to the pumping test at (A-1-4)1abb3[E-1LA].

4.5 Vertical Gradients Between the Upper/Middle and Middle/Lower Alluvium Units

Vertical hydraulic gradients between the Upper and Middle Alluvium units were calculated using October 15-16, 1985 water levels and the mid-point of the screened saturated interval for each well (Table 4.4). The vertical gradient in the vicinity of the monitor wells appears to be downward and fairly uniform across this area, ranging from 0.46-0.51. The exception to this is the northern-most monitor well site (M-12), where a downward vertical gradient of 0.67 was observed.

Vertical gradients between the Middle and Lower Alluvium units were also calculated using October 15-16, 1985 water levels and the mid-points of the effective screened intervals (Table 4.5). The vertical gradients at both sites were downward and nearly the same.

Table 4.4

VERTICAL GRADIENTS BETWEEN THE
UPPER AND MIDDLE ALLUVIUM UNITS

UAU Monitor Well	MAU Monitor Well	Vertical Gradient*
(A-1-4)1bad1[ST-1]	(A-1-4)1bad2[M-1MA]	0.47
(A-1-4)1bcc2[M-2UA]	(A-1-4)1bcc1[M-2MA]	0.50
(A-1-4)1bdd2[M-3UA]	(A-1-4)1bdd1[M-3MA]	0.46
(A-1-4)1bdb2[M-4UA]	(A-1-4)1bdb1[M-4MA]	0.48
(A-1-4)1bba2[M-5UA]	(A-1-4)1bba1[M-5MA]	0.50
(A-1-4)1baa2[M-6UA]	(A-1-4)1baa1[M-6MA]	0.50
(A-1-4)1baa3[M-7UA]	(A-1-4)1bad3[M-7MA]	0.48
(A-2-4)36dba2[M-9UA]	(A-1-4)36dba1[M-9MA]	0.51
(A-2-4)35ddc2[M-10UA]	(A-2-4)35ddc1[M-10MA]	0.50
(A-2-4)35dba2[M-11UA]	(A-2-4)35dba1[M-11MA]	0.46
(A-2-4)26daa2[M-12UA]	(A-2-4)26dda1[M-12MA]	0.67
(A-1-4)1abb4[E-1UA]	(A-2-4)1aab2[E-1MA]	0.51
(A-1-4)2ddd3[B-UA-1]	(A-1-4)2ddd2[B-MA-1]	0.46

* Gradient direction is downward.

Table 4.5

VERTICAL GRADIENTS BETWEEN THE
MIDDLE AND LOWER ALLUVIUM UNITS

MAU MONITOR WELL	LAU MONITOR WELL	VERTICAL GRADIENT
(A-1-4)1abb2[E-1MA]	(A-1-4)1abb3[E-1LA]	.12
(A-2-4)35dcc1[M-10MA]	(A-2-4)35dcc3[M-10LA]	.11

5.0 WATER QUALITY

Water quality samples were collected by Ecology and Environment during the pumping tests of the EPA monitor wells. These samples were analyzed for volatile and semi-volatile organics, cations, anions, metals and pesticides. Results of these analyses are presented in Appendices L and M. Water quality samples collected by Errol L. Montgomery and Associates from the Motorola monitor wells prior to August 1985 also given in Appendices L and M.

In August 1985, a quarterly water quality sampling program was initiated so that all monitor wells could be sampled during the same time period using similar sampling procedures. Samples collected under the above program provide consistent data to be used in determining water quality trends. The EPA and Beckman Instruments monitor wells are sampled by Ecology and Environment, while the Motorola GEG monitor wells are sampled by Errol L. Montgomery and Associates. All samples are analyzed for volatile and semi-volatile organics, cations, anions, metals and pesticides. Appendix L presents the results of analyses for routine constituents and any metals which were found. Appendix M presents the results of analyses for volatile and semi-volatile organics and pesticides. Only those compounds found in the sample are presented.

5.1 Background Water Quality (Routine Constituents)

Stiff diagrams were constructed from the results of analyses for routine constituents of the IBW monitor wells. These diagrams show the concentration of the six principal ions found in the water in equivalents per million (epm). The shape of the Stiff diagrams provides a means of comparing, correlating and characterizing water types. The width of the diagrams is proportional to the total ionic content of the water (Hem, 1970). Only water analyses from unit-specific wells were used to construct Stiff diagrams.

Water samples were classified using the system presented in Hem (1970), whereby the water is named for the principal cation and anion which represent over 50% of the total cation or anion epm. If no cation or anion represents 50% of the total, the water is considered a "mixed" type and is named for all the principal constituents in order of importance. For the analysis of the routine constituents, it has been assumed that the organic contaminants found in some of the groundwater samples do not interact with the naturally occurring cation and anion species. This appears to be a reasonable assumption because most of the charge balance errors calculated for the routine constituent analyses are acceptable, and probably due to laboratory error.

5.1.1 Upper Alluvium Unit

The over-all water type of the Upper Alluvium unit in the IBW study area in 1985 appears to be soduim chloride, although sodium chloride-bicarbonate water and sodium bicarbonate-chloride water were observed at several monitor wells (Water types are presented with routine constituent analyses in Appendix L). Inspection of the Stiff diagrams (Figure 5.1) indicates monitor wells (A-2-4)36dda2[M-12UA], (A-1-4)2dbd[B-J], (A-1-4)2ddd1[B-UA-3] and (A-1-4)2ddd3[B-UA-1] have more saline water than the other monitor wells. Monitor wells (A-2-4) 25ddb2[E-4UA] and (A-1-4)1acd[M-8UA] have a more bicarbonate water and smaller total ionic content than other monitor wells.

5.1.2 Middle Alluvium Unit

Water of the Middle Alluvium unit in the vicinity of the monitor wells appears to be fairly uniform and of sodium chloride type, except for the water at (A-1-4)1bad3[M-7MA] which is a mixed type, sodium-calcium-magnesium chloride type. (Water types are shown in Appendix L.) Inspection of the Stiff diagrams (Figure 5.2) indicates that water samples collected at monitor wells (A-1-4)1bad3[M-7MA] and (A-1-4)1abb2[E-1MA] have a somewhat higher total ionic content and a slightly different relationship among the principal constituents.

5.1.3 Lower Alluvium Unit

The water type of the Lower Alluvium unit in the vicinity of the monitor wells cannot be determined as there are only three wells, screened in different zones of the LAU, present in this area. Each of

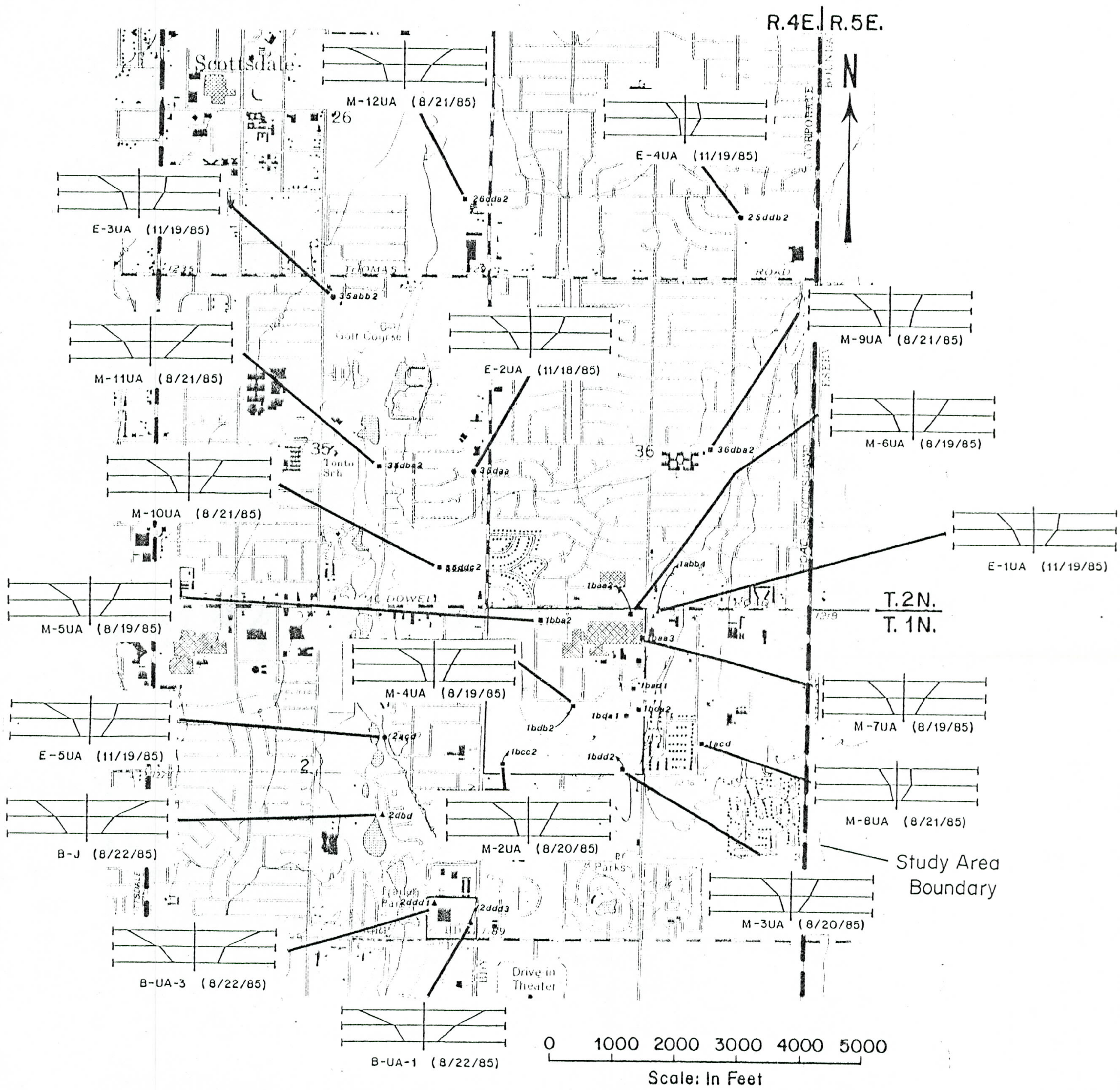
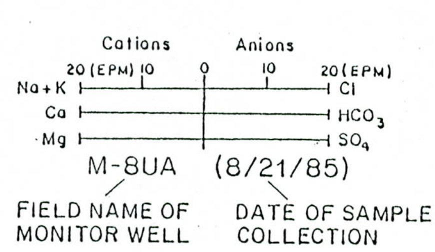


Figure 5.1 Stiff Diagrams for Upper Alluvium Unit Monitor Wells

LEGEND

- ▪ Motorola Monitor Well
- ▲ Beckman Monitor Well
- • EPA Monitor Well



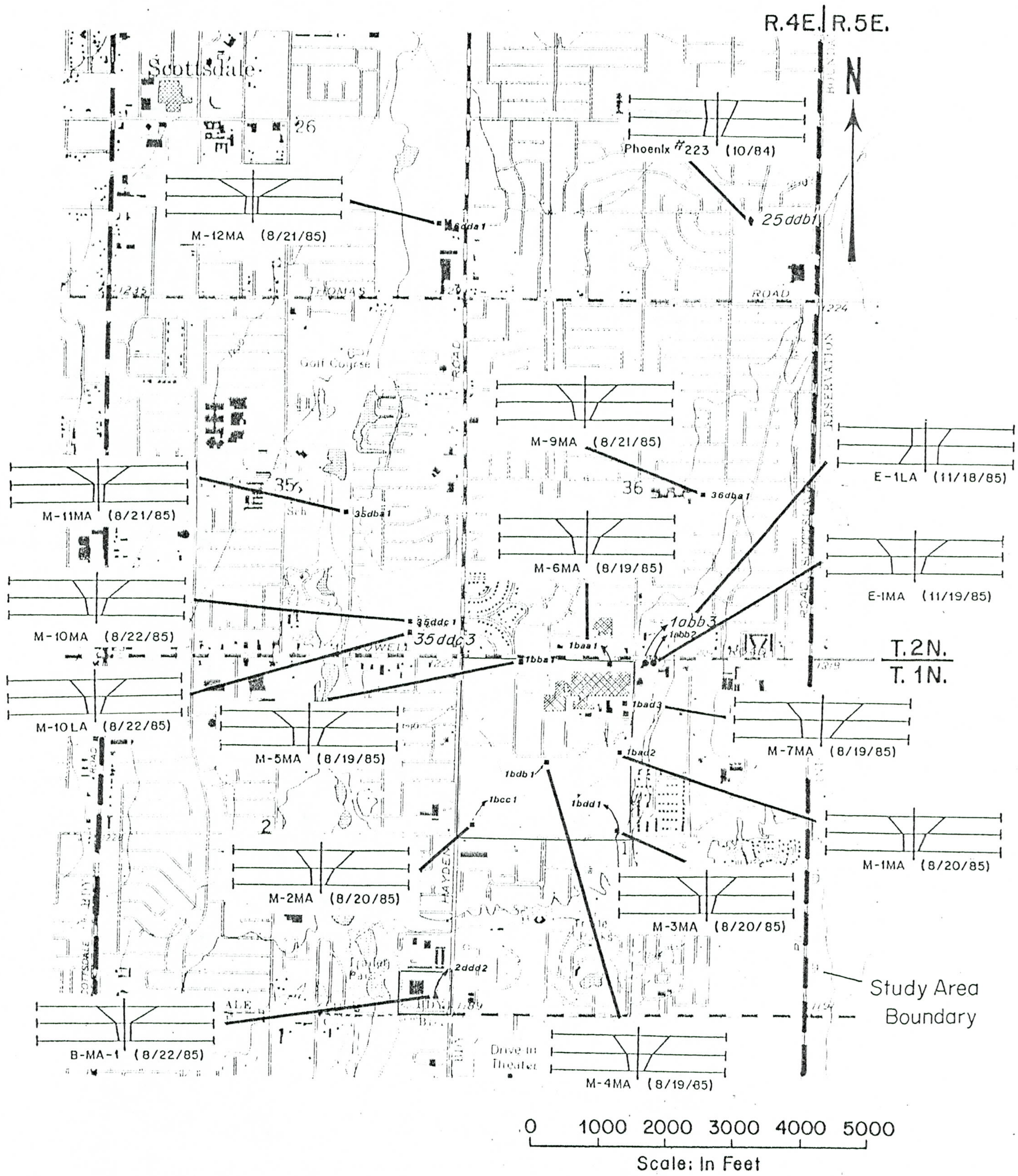
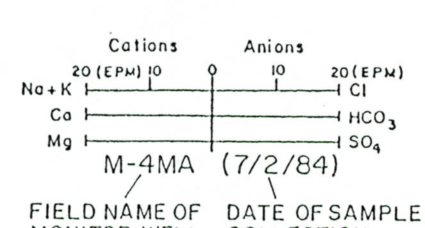


Figure 5.2 Stiff Diagrams for Middle and Lower Alluvium Unit Monitor Wells

LEGEND

- ▪ Motorola Monitor Well
- ▴ Beckman Monitor Well
- • EPA Monitor Well



of the three wells exhibits a different water type. The water sample collected in August 1985 from Motorola monitor well (A-2-4)35dcc3 [M-10LA], screened (effectively) from 650 to 700 feet, exhibited a sodium chloride water type, while the sample collected in August 1985 from EPA monitor well (A-1-4)abb3[E-1LA], screened from 695 to 749 feet, exhibited a magnesium chloride water type. Production well (A-2-4)25ddb2[Phoenix #223] is screened from 800 to 1200 feet, entirely in the LAU. A sample collected in October 1984 from this well exhibited a sodium-magnesium chloride water type. It is assumed that the water type in the Lower Alluvium unit at these wells would remain relatively constant over time and therefore it is reasonable to compare water sample analyses collected in 1984 with those collected in 1985. (Water types are presented in Appendix L) The Stiff diagrams of the LAU wells (Figure 5.2) graphically depict the different relationship among the principal constituents making up the water at each well.

5.2 Distribution of Contaminants in Groundwater of Indian Bend Wash

Analytical results of samples collected from the IBW monitor wells are presented in Appendix M. Analytical results of the community well sampling program conducted in 1984 are presented in the Sample Documentation Report (January, 1985). These results are summarized on Plates 11, 12 and 13. The most frequently found organic contaminants in wells of the Indian Bend Wash study area and vicinity are trichloroethylene (TCE); 1,1,1-trichloroethane (TCA); tetrachloroethylene (also denoted as 1,1,2,2-tetrachloroethylene) (PCE); 1,1-dichloroethylene (DCE); chloroform (CFM) and minor amounts of toluene (TOL). TCE concentrations are usually higher than any other contaminant reported in the sample analyses.

5.2.1 Upper Alluvium Unit

The most pervasive contaminants found in the Upper Alluvium unit in the vicinity of the monitor wells are trichloroethylene (TCE); 1,1,1-trichloroethane (TCA); tetrachloroethylene (or 1,1,2,2-tetrachloroethylene) (PCE); chloroform (CFM) and toluene. Small concentrations of other organic compounds are also found (Appendix M). During

August 1985, TCE concentrations above the State of Arizona's 5 parts per billion (ppb) "action limit" were found in IBW monitor wells at the Motorola plant, to the northwest of the Motorola plant and southward along Indian Bend Wash to Beckman monitor well (A-2-4)2dbd[B-J]. DCE and PCE were also observed at these monitor wells, except (A-2-4) 35abb2[E-3UA] where only chloroform and toluene were found in addition to TCE (Plate 11). Wells to the north, (A-2-4)36dba2[M-9UA] and (A-2-4)25ddb2[E-4UA] and north-northwest, (A-2-4)26dda2[M-12UA], of the Motorola plant site do not exhibit TCE concentrations above 5 ppb. Monitor wells (A-1-4)bcc2[M-2UA], (A-1-4)1bdd2[M-3UA], (A-1-4)1acd [M-8UA], (A-1-4) 2ddd3[B-UA-1] and (A-1-4)2ddd1[B-UA-3] located to the south, southeast and southwest of the Motorola site also do not exhibit TCE concentrations above 5 ppb.

5.2.2 Middle Alluvium Unit

The principal contaminants found in the Middle Alluvium unit in the vicinity of the monitor wells are TCE, PCE, DCE, chloroform and toluene. Plate 12 shows the distribution of principal contaminants in the MAU. Water samples collected in August 1985 from monitor wells on the Motorola plant site (except (A-1-4)1bdb1[M-4MA] and (A-4-1) 1bdd1[M-3MA]) and to the north-northeast of the plant at (A-2-4)36dba1 [M-9MA] contained TCE concentrations greater than or equal to 5 ppb. The water sample from Motorola on-site monitor well (A-1-4)1bdd1 [M-3MA] contained only toluene. Small concentrations of other organics have also been observed in samples collected from MAU monitor wells (See Appendix M for a summary of all organic compounds found in these samples.)

5.2.3 Lower Alluvium Unit

The principal contaminants found in the Lower Alluvium unit to date include TCE, TCA, PCE and chloroform. August 1985 samples collected from the two LAU monitor wells showed 68 ppb of TCE in monitor well (A-2-4)35ddc3[M-10LA] and 1 ppb TCA and 2 ppb chloroform in monitor well (A-1-4)1abb3[E-1LA]. Analytical results from a November 1984 sample collected at well (A-2-4)25ddb[Phoenix #223] showed no detectable organic contaminants. The extent of contamination by organic compounds in the LAU cannot be determined at this time due to the few number of unit-specific wells in the Lower Alluvium unit.

5.2.4 Wells Screened in Multiple Units

Plate 13 summarizes the well construction details and contaminant concentrations for community wells in the IBW area, most of which are screened in more than one water-bearing unit. Sample results from October or November 1984 were collected by Ecology and Environment during the community well sampling program and are designated "(FIT)". (See Sample Documentation Report, 1985 for details). Other sample results were obtained from Arizona Department of Health Services or the respective well owners. In addition to the TCE contamination found in the vicinity of the monitor wells, examination of water quality results for community wells open to both the MAU and LAU indicates TCE contamination extended to the northern, (A-2-4) Sections 23 and 25, and southwestern, (A-1-4) Section 11, portions of the IBW area in 1984. The contaminant concentrations west of the IBW study area have not been established, as there are few, if any, wells available for sampling.

6.0 SUMMARY

At the completion of the Indian Bend Wash RI/FS Phase I monitor well installation program a total of thirty-seven monitor wells had been installed in the Indian Bend Wash area. Twenty monitor wells were installed during Phase I of the RI/FS; the others were installed separately from the RI/FS by the potentially responsible parties .

The monitor wells were designed and installed to yield hydrogeologic and water quality data from a single stratigraphic unit. The alluvial deposits underlying the Indian Bend Wash area can be divided into three units, based on contrasting lithologic characteristics; the Upper Alluvium unit, the Middle Alluvium unit, and the Lower Alluvium unit. The thirty-seven monitor wells include twenty-two Upper Alluvium unit monitor wells, thirteen Middle Alluvium unit monitor wells, and two Lower Alluvium unit monitor wells.

HYDROGEOLOGY

Upper Alluvium Unit

The Upper Alluvium unit consists of a relatively thin (10-30 feet) near-surface fine-grained zone and a very coarse-grained lower zone. The near-surface zone consists largely of silt and clay, however, sand gravel, and caliche also occur. The lower zone consists predominantly of unconsolidated, typically well-rounded, cobbles and boulders with coarse sand and fine gravel.

Groundwater in the Upper Alluvium unit occurs at depths ranging from approximately 70 to 135 feet. Groundwater flow appears to be to the west-northwest. The average horizontal gradient in the vicinity of the monitor wells is about 28 feet per mile. The saturated thickness of the unit varies across the area and generally decreases to the north.

The transmissivity of the Upper Alluvium unit, as determined from analysis of monitor well pumping test data, appears to range from 6,300 gpd/ft at monitor well (A-2-4)25dbb2[E-4VA] to 76,000 gpd/ft at monitor well (A-1-4)1abb4[E-1UA]. The average transmissivity is about 30,000 gpd/ft. The hydraulic conductivity of the Upper Alluvium unit ranges from about 400 gpd/ft^2 at monitor well (A-2-4)2acd[E-5UA] to 4,000 gpd/ft^2 at monitor well (A-2-4)35abb2[E-3UA] and averages about 1,700 gpd/ft^2. The transmissivities and hydraulic conductivities suggest that the more permeable portions of the Upper Alluvium unit in the vicinity of the monitor wells are T.2N,R.4E Section 36 and the northeast portion of Section 35.

Middle Alluvium Unit

Groundwater flow in the Middle Alluvium unit appears to vary from the west-northwest in the southwestern portion of the IBW area to the north-northwest elsewhere. The horizontal gradients range from approximately 15 feet per mile to 30 feet per mile.

The transmissivity of the MAU, as determined from analyses of monitor well pumping test data, appears to range from 360 gpd/ft at (A-2-4)35dba1[M-11MA] to 36,000 gpd/ft at (A-2-4)36dba1[M-9MA]. The average transmissivity appears to be approximately 11,000 gpd/ft. The transmissivities of monitor wells (A-2-4)35dba1[M-11MA], 360 gpd/ft., and (A-2-4)26dda1[M-12MA], 700 gpd/ft, were approximately an order of magnitude or more lower than the other MAU monitor wells. The hydraulic conductivity of the MAU ranges from 7.2 gpd/ft^2 at (A-2-4)35dba1[M-11MA] to 700 gpd/ft^2 at (A-2-4)36dba1[M-9MA]. The average hydraulic conductivity averages about 220 gpd/ft^2.

Lower Alluvium Unit

Only two monitor wells have been installed into the Lower Alluvium unit. As a result, the groundwater flow direction could not be accurately determined. The pumping test of monitor well (A-2-4) 35ddc3[M-10LA] yielded a transmissivity of 16,000 gpd/ft with a corresponding hydraulic conductivity of 320 gpd/ft^2 opposite the 50-foot screened section of the monitor well. Transmissivity and hydraulic conductivity could not be calculated from the pumping test data of monitor well (A-1-4)1abb3[E-1LA].

Vertical Gradients

The vertical gradient between the Upper Alluvium unit and the Middle Alluvium unit are downward and with the exception of monitor well site M-12, fairly uniform throughout the area. The vertical gradient, with the exception of M-12, ranges from 0.46 to 0.52; the vertical gradient at M-12 is 0.68. The vertical gradient between the Middle Alluvium unit and the Lower Alluvium unit could only be determined at two sites. At site E-1 the vertical gradient was 0.12; at M-10 the vertical gradient was 0.11.

DISTRIBUTION OF CONTAMINANTS

The principal contaminants found in the monitor wells in the vicinity of Indian Bend Wash are trichloroethylene (TCE), 1,1,1-trichloroethane (TCA), tetrachloroethylene (PCE), 1,1-dichloroethylene (DCE), chloroform (CFM), and small quantities of toluene (TOL). Contaminants have been found in all three alluvial units underlying the area. In general contaminants are most abundant and appear to be most widespread in the Upper Alluvium unit and Middle Alluvium unit. TCE is the most abundant and widespread contaminant.

The highest concentrations of contaminants in the Upper Alluvium unit at the present time are found at the Motorola facility, to the northwest of the facility, and along Indian Bend Wash. Contamination in the Middle Alluvium unit has been detected in the monitor wells in the northwest half of the Motorola facility, to the northeast of the site at (A-2-4)36dba1[M-9MA] and to the east of the site at (A-1-4)1abb2[E-1MA]. TCE contamination has been found in the Lower Alluvium unit at monitor well (A-2-4)35ddc3[M-10LA] and TCA and chloroform contamination have been detected at monitor well (A-1-4)1abb3[E-1LA].

7.0 REFERENCES

Arteaga, F.E. White, N.D., Cooley, M.E., and Sutheimer, A.F., 1968, Groundwater in Paradise Valley, Maricopa County, Arizona. Arizona State Land Department Water Resources Report Number 35.

Eberly, L.D. and Stanley, Jr., T.D., 1978, Cenozoic Stratigraphic and Geologic History of Southwestern Arizona. Geological Society of America Bulletin, v.89, p.921-940.

Ecology & Environment, Inc., 1984, Final Workplan RI/FS, Indian Bend Wash Site, Phoenix, Arizona; June, 1984.

Ecology & Environment, Inc., 1984, Phase I Drilling, Well Installation, and Aquifer Testing Sampling Plan; July, 1984.

Ecology & Environment, Inc., 1984, Quality Assurance Project Plan; November, 1984.

Ecology & Environment, Inc., 1984, Bid Specifications for the Installation of Monitoring Wells at Indian Bend Wash; December, 1984.

Errol L. Montgomery & Associates, Inc. 1985, Phase II Results of Motorola, Inc. Hydrogeologic Investigation, On-Site Monitor Wells, Motorola, Inc. Government Electronics Group, Scottsdale Plant, Maricopa County, Arizona.

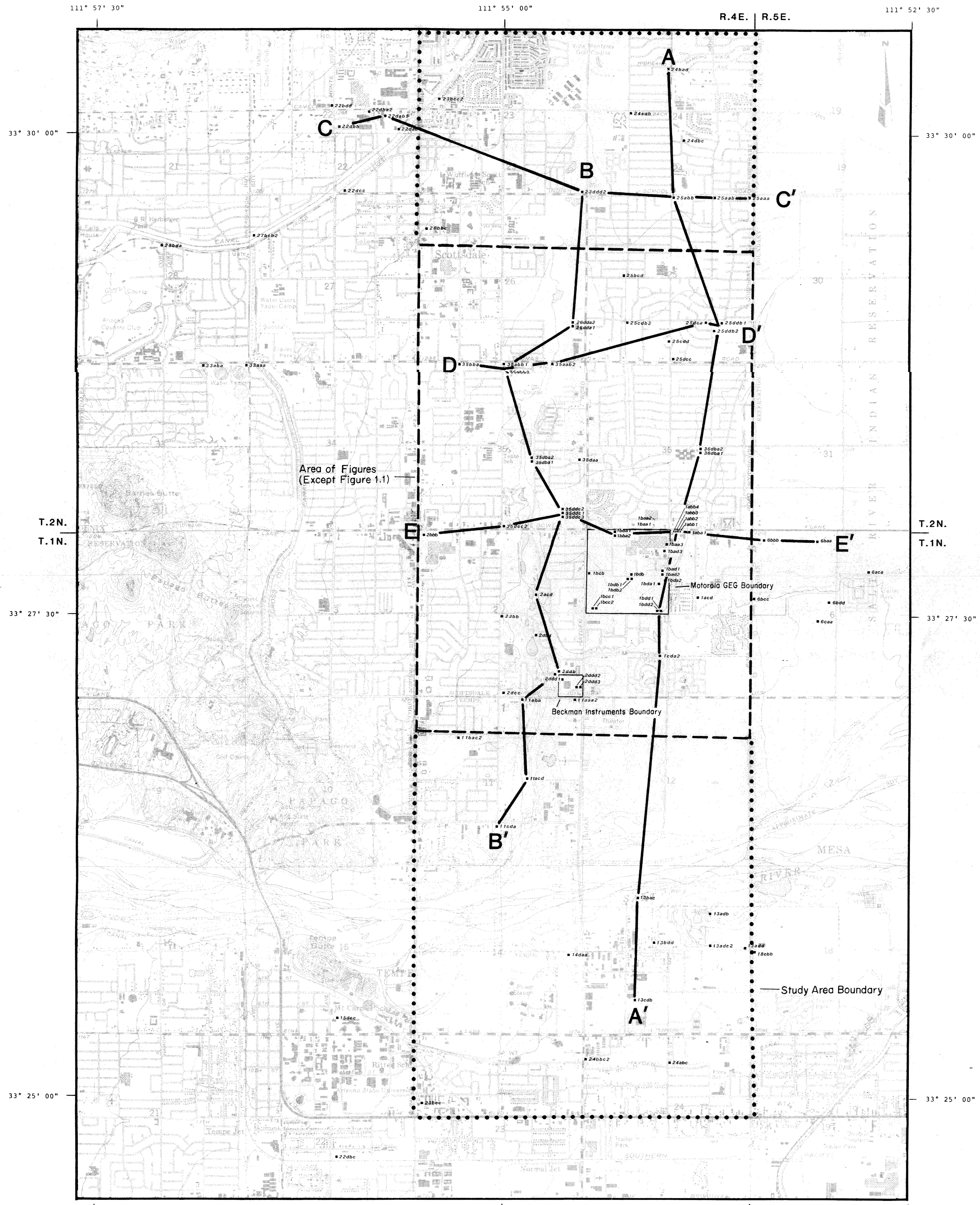
Freeze, R.A. and Cherry, J.A., 1979, Groundwater; Prentice Hall, New Jersey, 604p.

Halpenny, L.C., Harshbarger, J.W., and Greene, D.K., 1967, Evaluation of Groundwater Resources and Long Term Water Development, Paradise Vally, Arizona; Water Development Corporation, Tucson, Arizona, Consulting report for City of Scottsdale.

Hargis and Montgomery, 1983, Preliminary Report, Phase I, Results of Hydrogeologic Investigation, Motorola, Inc. Government Electronics Group, Scottsdale Plant Area, Maricopa County, Arizona.

Hem, J.D., 1970, Study and Interpretation of the Chemical Characteristics of Natural Waters; U.S. Geological Survey Water Supply Paper 1473.

(A-1-4)1aba1	SRP 23.6E,6N	33 27 56	111 53 52
(A-1-4)1abb1	E-1MP	33 27 56	111 53 57
(A-1-4)1abb2	E-1MA	33 27 56	111 53 57
(A-1-4)1abb3	E-1LA	33 27 56	111 53 57
(A-1-4)1abb4	E-1UA	33 27 56	111 53 57
(A-1-4)1acd	M-8UA	33 27 31	111 53 47
(A-1-4)1baa1	M-6MA	33 27 56	111 54 04
(A-1-4)1baa2	M-6UA	33 27 56	111 54 03
(A-1-4)1baa3	M-7UA	33 27 52	111 54 00
(A-1-4)1bad1	ST-1	33 27 44	111 54 01
(A-1-4)1bad2	M-1MA	33 27 43	111 54 01
(A-1-4)1bad3	M-7MA	33 27 50	111 54 01
(A-1-4)1bba1	M-5MA	33 27 56	111 54 19
(A-1-4)1bba2	M-5UA	33 27 55	111 54 19
(A-1-4)1bcb	Motorola	33 27 43	111 54 28
(A-1-4)1bcc1	M-2MA	33 27 32	111 54 27
(A-1-4)1bcc2	M-2UA	33 27 32	111 54 26
(A-1-4)1bda1	ST-2	33 27 39	111 54 03
(A-1-4)1bda2	ST-3	33 27 41	111 54 00
(A-1-4)1bdb	Motorola	33 27 42	111 54 13
(A-1-4)1bdb1	M-4MA	33 27 41	111 54 14
(A-1-4)1bdb2	M-4UA	33 27 41	111 54 13
(A-1-4)1bdd1	M-3MA	33 27 31	111 54 02
(A-1-4)1bdd2	M-3UA	33 27 31	111 54 03
(A-1-4)1cda2	SRP 23.5E,5.25N	33 27 17	111 54 01
(A-1-4)2acd	E-5UA	33 27 32	111 54 47
(A-1-4)2bbb	Boehm	33 27 55	111 55 30
(A-1-4)2dbb	SRP 22.5E,5.5N	33 27 29	111 55 02
(A-1-4)2dbd	B-J	33 27 23	111 54 48
(A-1-4)2dcc	MM-1	33 27 05	111 55 00
(A-1-4)2ddb	Scottsdale #25	33 27 12	111 54 39
(A-1-4)2ddd1	B-onsite	33 27 10	111 54 38
(A-1-4)2ddd2	B-MA-1	33 27 07	111 54 33
(A-1-4)2ddd3	B-UA-1	33 27 07	111 54 32
(A-1-4)11aaa2	Gregg	33 27 03	111 54 33
(A-1-4)11aba	Tempe #6	33 27 03	111 54 53
(A-1-4)11acd	SRP 22.75E,4.5N	33 26 38	111 54 51
(A-1-4)11bac2	Laird #1	33 26 51	111 55 17
(A-1-4)11bdb	unknown	unknown	unknown
(A-1-4)11cda	SRP	33 26 23	111 55 02
(A-1-4)13adb	Century Paving	33 25 57	111 53 42
(A-1-4)13adc2	AAA Auto	33 25 47	111 53 42
(A-1-4)13add	Nesbitt	33 25 46	111 53 29
(A-1-4)13bac	Kachina Redimix	33 26 02	111 54 09
(A-1-4)13bdd	APS-2	33 25 48	111 54 03
(A-1-4)13cdb	Black	33 25 30	111 54 10
(A-1-4)14daa	APS-1	33 25 44	111 54 35
(A-1-4)15dcc	Tempe #3	33 25 24	111 56 02
(A-1-4)22dbc	Tempe #1	33 24 40	111 56 02
(A-1-4)23bcc	Tempe #4	33 24 57	111 55 30
(A-1-4)24abc	Tempe #7	33 25 10	111 53 58
(A-1-4)24bbc2	SRP 23E,2.9N	33 25 11	111 54 30
(A-1-5)6aca	SRIR	33 27 43	111 52 43
(A-1-5)6baa	SRIR	---	---
(A-1-5)6bbb	SRIR	---	---
(A-1-5)6bcc	SRIR	33 27 36	111 53 26
(A-1-5)6bdd	IND-1	33 27 34	111 52 58
(A-1-5)6caa	BIA #10	33 27 28	111 53 02
(A-1-5)18cbb	APS-3	33 25 45	111 53 28
(A-1-5)19bcd	Tempe #8	---	---
(A-2-4)22bdd	Borg	33 30 09	111 56 03
(A-2-4)22dab4	Arcadia #9A	33 30 02	111 55 39
(A-2-4)22dab5	Arcadia #7	33 30 06	111 55 46
(A-2-4)22dba2	Arcadia	33 30 07	111 55 39
(A24)22dbb	Arcadia #10	33 30 02	111 56 02
(A-2-4)22dcc	SRP 21.5E,8N	33 29 42	111 56 02
(A-2-4)23bcc2	SRP 22.1E,8.5N	33 30 11	111 55 24
(A-2-4)23ddd2	Phoenix #34	33 29 42	111 54 31
(A-2-4)24bad	SRP 23.5E,8.8N	33 30 21	111 53 59
(A-2-4)24cab	Scottsdale #2	33 30 07	111 54 13
(A-2-4)24dbc	Scottsdale #1	33 29 58	111 53 53
(A-2-4)25aaa	Phoenix #18	33 29 41	111 53 28
(A-2-4)25aab	Phoenix #19	33 29 40	111 53 42
(A-2-4)25abb	Phoenix #20	33 29 40	111 53 58
(A-2-4)25bcd	Scottsdale #6	33 29 15	111 54 15
(A-2-4)25cdb2	Scottsdale #31	33 29 01	111 54 14
(A-2-4)25cdd	Phoenix #23	33 28 55	111 53 58
(A-2-4)25dca	Phoenix #24	33 29 03	111 53 44
(A-2-4)25d[illegible]	------	---	---
(A-2-4)25ddb1	Phoenix #223	33 29 02	111 53 43
(A-2-4)25ddb2	E-4UA	33 29 05	111 53 42
(A-2-4)26bbc	Brown	33 29 30	111 55 29
(A-2-4)26dda1	M-12MA	33 30 01	111 54 35
(A-2-4)26dda2	M-12UA	33 30 00	111 54 35
(A-2-4)2[illegible]cb2	Phoenix #39	33 29 27	111 56 33
(A-2-4)28bda	AZCC	33 29 25	111 57 07
(A-2-4)33aaa	Phoenix #40	33 28 48	111 56 35
(A-2-4)33aba	Pease	33 28 48	111 56 52
(A-2-4)35aab2	Phoenix #35	33 28 48	111 54 42
(A-2-4)35abb1	Phoenix #36	33 28 48	111 55 00
(A-2-4)35abb2	E-3UA	33 28 51	111 54 59
(A-2-4)35bba	SRP 22.3E,7N	33 28 48	111 55 16
(A-2-4)35daa	E-2UA	33 28 18	111 54 32
(A-2-4)35dba1	M-11MA	33 28 19	111 54 50
(A-2-4)35dba2	M-11UA	33 28 18	111 54 50
(A-2-4)35dcc2	SRP 22.5E,6N	33 27 57	111 55 01
(A-2-4)35ddc1	M-10MA	33 28 03	111 54 38
(A-2-4)35ddc2	M-10UA	33 28 02	111 54 38
(A-2-4)35ddc3	M-10LA	33 28 01	111 54 38
(A-2-4)36dba1	M-9MA	33 28 22	111 53 48
(A-2-4)36dba2	M-9UA	33 28 21	111 53 48



INDIAN BEND WASH

SCOTTSDALE AND TEMPE, ARIZONA

PLATE 1: WELL AND CROSS SECTION LOCATION MAP

0 1000 2000 3000 4000 5000

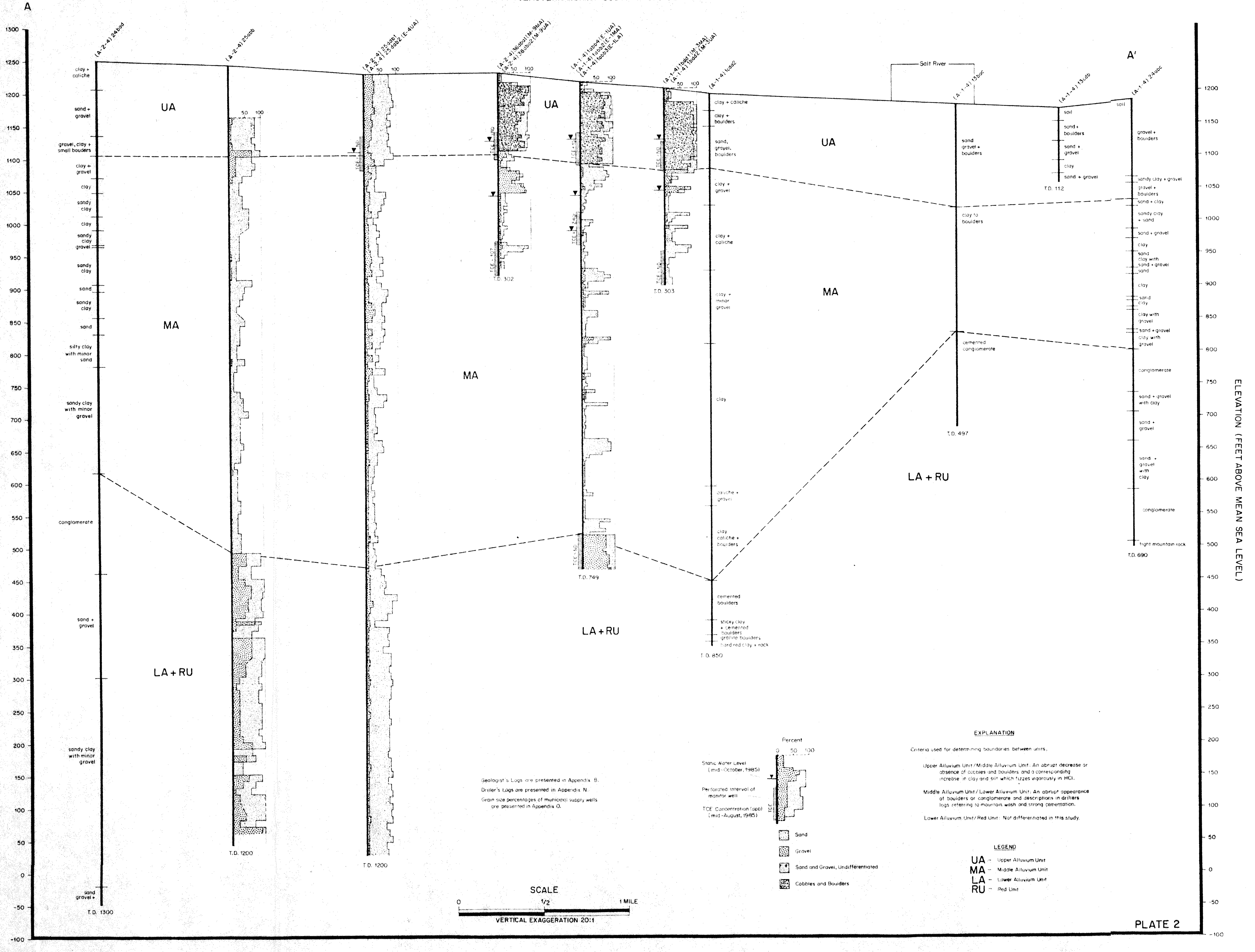
SCALE: IN FEET

HYDROGEOLOGIC CROSS SECTION A-A'

(EASTERN NORTH-SOUTH CROSS SECTION)

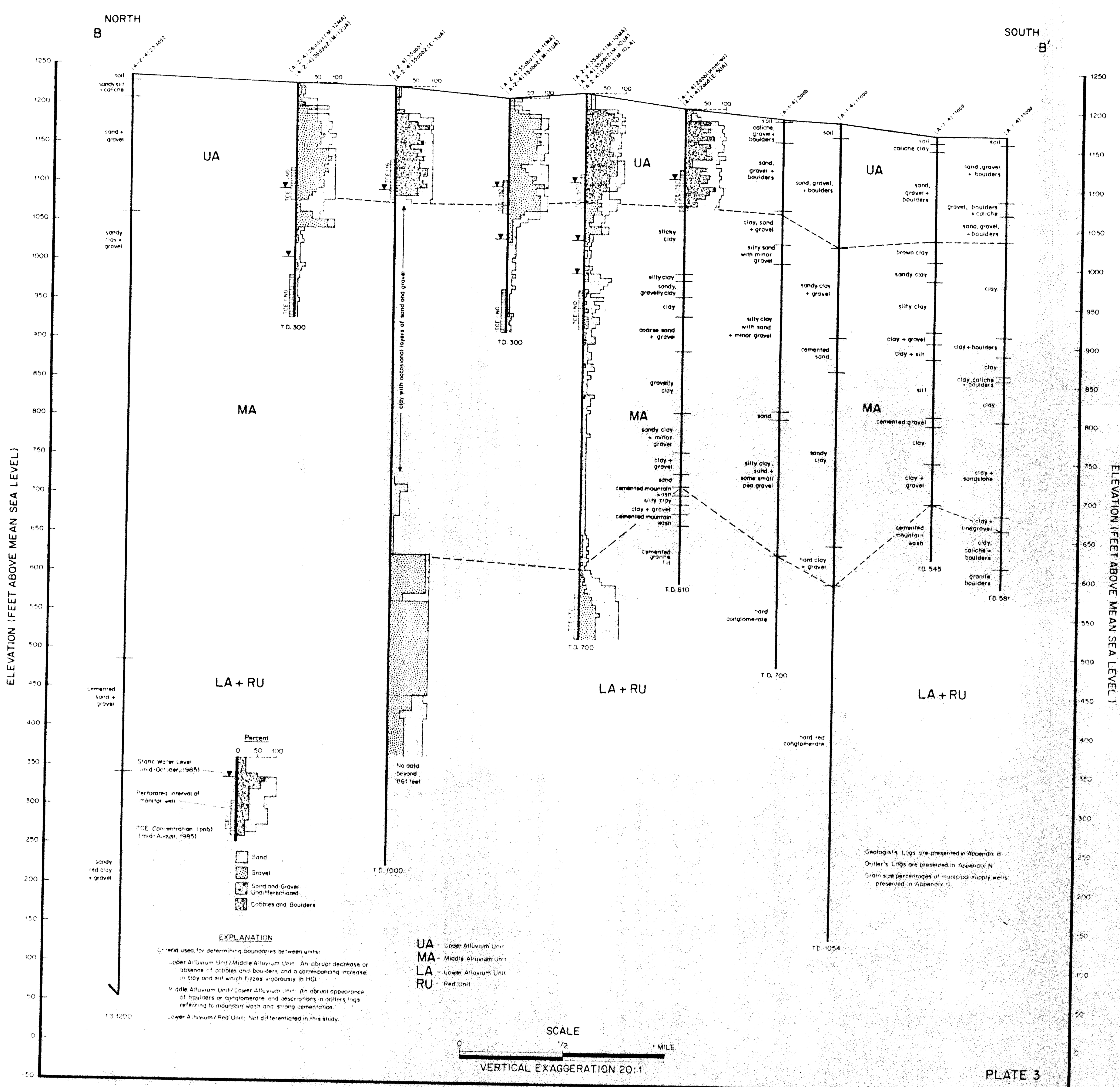
NORTH

SOUTH



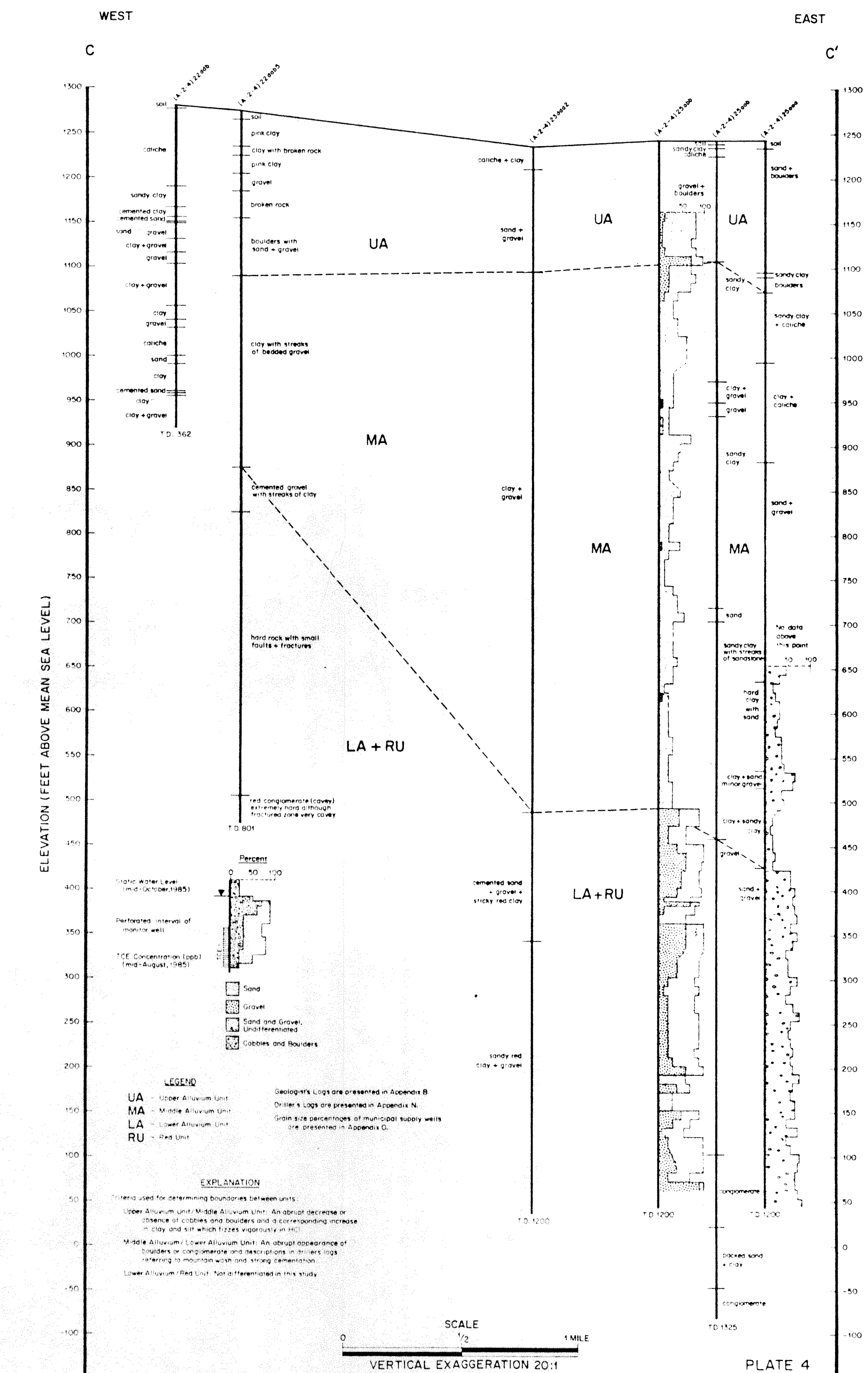
HYDROGEOLOGIC CROSS SECTION B-B′

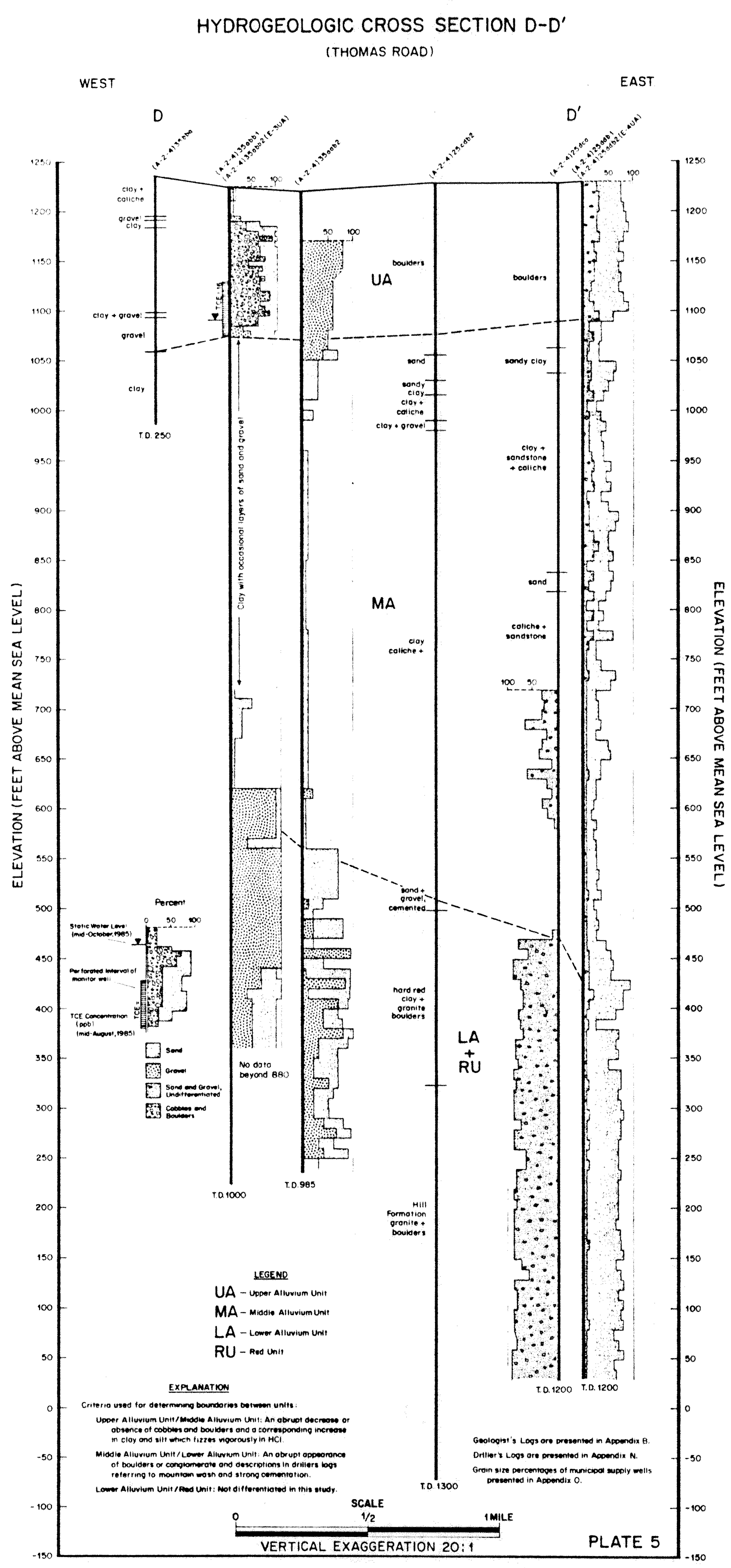
(WESTERN NORTH-SOUTH CROSS SECTION)

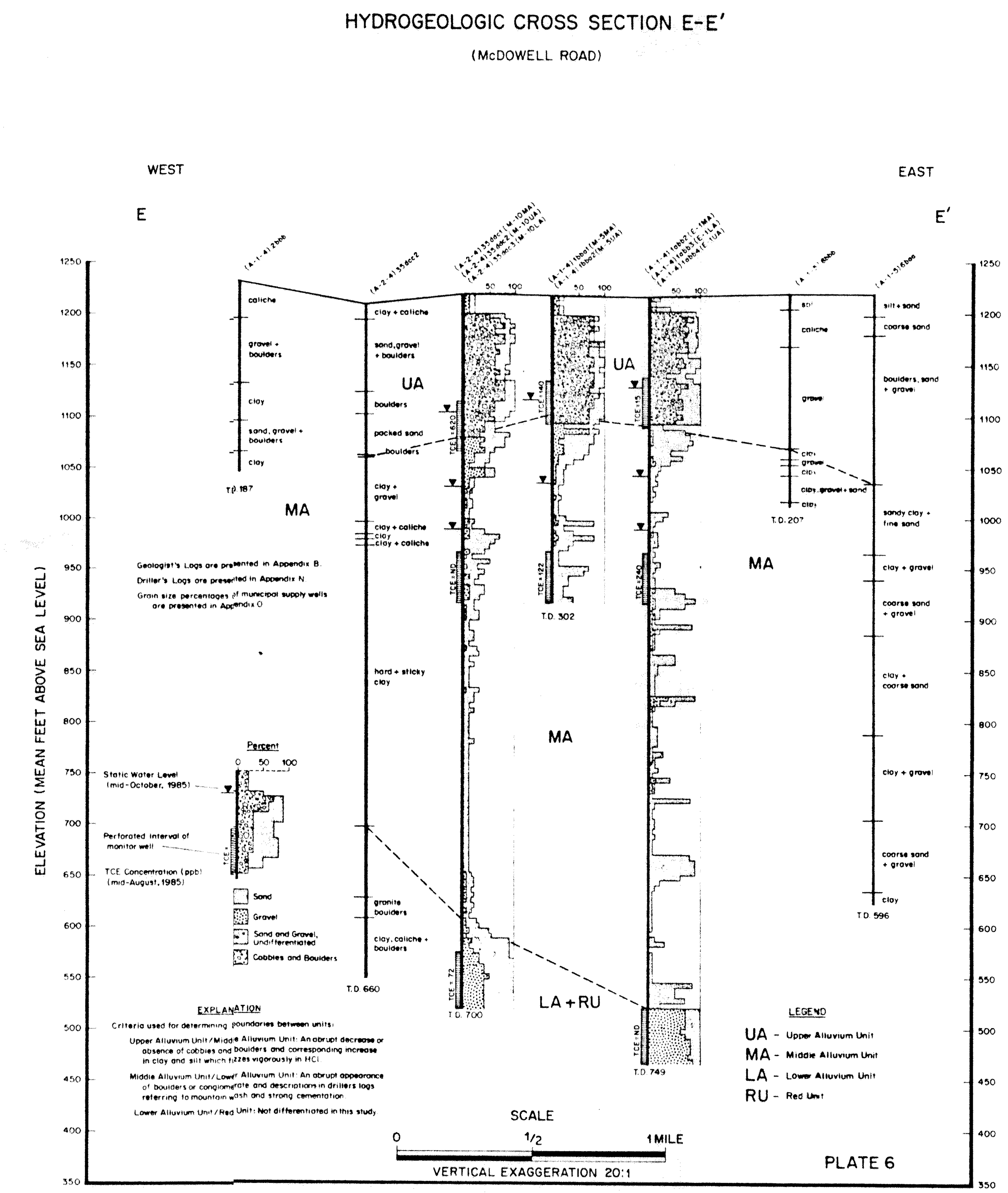


HYDROGEOLOGIC CROSS SECTION C-C′

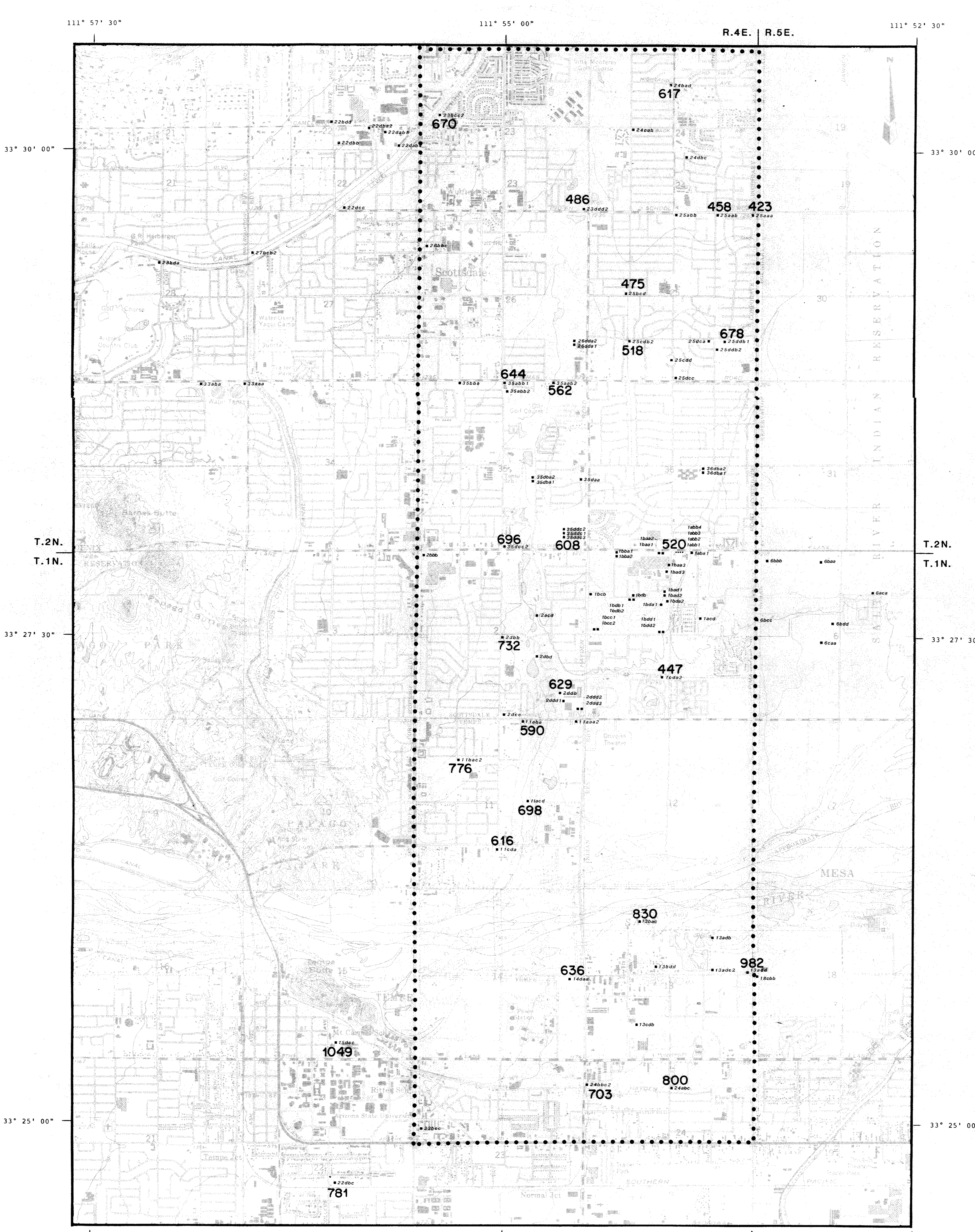
(INDIAN SCHOOL ROAD)




HYDROGEOLOGIC CROSS SECTION D-D'
(THOMAS ROAD)
WEST
EAST
D
D'
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
UA
MA
LA + RU
Clay with occasional layers of sand and gravel
No data beyond 883
T.D. 250
T.D. 1000
T.D. 985
T.D. 1300
T.D. 1200
Hill Formation granite + boulders
Percent
Static Water Level (mid-October, 1985)
Perforated interval of monitor well
TCE Concentration (ppb) (mid-August, 1985)
Sand
Gravel
Sand and Gravel, Undifferentiated
Cobbles and Boulders
LEGEND
UA - Upper Alluvium Unit
MA - Middle Alluvium Unit
LA - Lower Alluvium Unit
RU - Red Unit
EXPLANATION
Criteria used for determining boundaries between units:
Upper Alluvium Unit/Middle Alluvium Unit: An abrupt decrease or absence of cobbles and boulders and a corresponding increase in clay and silt which fizzes vigorously in HCl
Middle Alluvium Unit/Lower Alluvium Unit: An abrupt appearance of boulders or conglomerate and descriptions in drillers logs referring to mountain wash and strong cementation.
Lower Alluvium Unit/Red Unit: Not differentiated in this study.
Geologist's Logs are presented in Appendix B.
Driller's Logs are presented in Appendix N.
Grain size percentages of municipal supply wells presented in Appendix O.
SCALE
0
1/2
1 MILE
VERTICAL EXAGGERATION 20:1
PLATE 5


HYDROGEOLOGIC CROSS SECTION E-E'
(McDOWELL ROAD)
WEST
EAST
E
E'
ELEVATION (MEAN FEET ABOVE SEA LEVEL)
UA
MA
LA + RU
T.D. 187
T.D. 660
T.D. 700
T.D. 302
T.D. 749
T.D. 207
T.D. 596
Geologist's Logs are presented in Appendix B.
Driller's Logs are presented in Appendix N.
Grain size percentages of municipal supply wells are presented in Appendix O.
Percent
Static Water Level (mid-October, 1985)
Perforated interval of monitor well
TCE Concentration (ppb) (mid-August, 1985)
Sand
Gravel
Sand and Gravel, Undifferentiated
Cobbles and Boulders
EXPLANATION
Criteria used for determining boundaries between units:
Upper Alluvium Unit/Middle Alluvium Unit: An abrupt decrease or absence of cobbles and boulders and corresponding increase in clay and silt which fizzes vigorously in HCl
Middle Alluvium Unit/Lower Alluvium Unit: An abrupt appearance of boulders or conglomerate and descriptions in drillers logs referring to mountain wash and strong cementation.
Lower Alluvium Unit/Red Unit: Not differentiated in this study.
LEGEND
UA - Upper Alluvium Unit
MA - Middle Alluvium Unit
LA - Lower Alluvium Unit
RU - Red Unit
SCALE
0
1/2
1 MILE
VERTICAL EXAGGERATION 20:1
PLATE 6

(A-1-4)1aba1	SRP 23.6E,6N	33 27 56	111 53 52
(A-1-4)1abb1	E-1MP	33 27 56	111 53 57
(A-1-4)1abb2	E-1MA	33 27 56	111 53 57
(A-1-4)1abb3	E-1LA	33 27 56	111 53 57
(A-1-4)1abb4	E-1UA	33 27 56	111 53 57
(A-1-4)1acd	M-8UA	33 27 31	111 53 47
(A-1-4)1baa1	M-6MA	33 27 56	111 54 04
(A-1-4)1baa2	M-6UA	33 27 56	111 54 03
(A-1-4)1baa3	M-7UA	33 27 52	111 54 00
(A-1-4)1bad1	ST-1	33 27 44	111 54 01
(A-1-4)1bad2	M-1MA	33 27 43	111 54 01
(A-1-4)1bad3	M-7MA	33 27 50	111 54 01
(A-1-4)1bba1	M-5MA	33 27 56	111 54 19
(A-1-4)1bba2	M-5UA	33 27 55	111 54 19
(A-1-4)1bcb	Motorola	33 27 43	111 54 28
(A-1-4)1bcc1	M-2MA	33 27 32	111 54 27
(A-1-4)1bcc2	M-2UA	33 27 32	111 54 26
(A-1-4)1bda1	ST-2	33 27 39	111 54 03
(A-1-4)1bda2	ST-3	33 27 41	111 54 00
(A-1-4)1bdb	Motorola	33 27 42	111 54 13
(A-1-4)1bdb1	M-4MA	33 27 41	111 54 14
(A-1-4)1bdb2	M-4UA	33 27 41	111 54 13
(A-1-4)1bdd1	M-3MA	33 27 31	111 54 02
(A-1-4)1bdd2	M-3UA	33 27 31	111 54 03
(A-1-4)1cda2	SRP 23.5E,5.25N	33 27 17	111 54 01
(A-1-4)2acd	E-5UA	33 27 32	111 54 47
(A-1-4)2bbb	Boehm	33 27 55	111 55 30
(A-1-4)2dbb	SRP 22.5E,5.5N	33 27 29	111 55 02
(A-1-4)2dbd	B-J	33 27 23	111 54 48
(A-1-4)2dcc	MM-1	33 27 05	111 55 00
(A-1-4)2ddb	Scottsdale #25	33 27 12	111 54 39
(A-1-4)2ddd1	B-onsite	33 27 10	111 54 38
(A-1-4)2ddd2	B-MA-1	33 27 07	111 54 33
(A-1-4)2ddd3	B-UA-1	33 27 07	111 54 32
(A-1-4)11aaa2	Gregg	33 27 03	111 54 33
(A-1-4)11aba	Tempe #6	33 27 03	111 54 53
(A-1-4)11acd	SRP 22.75E,4.5N	33 26 38	111 54 51
(A-1-4)11bac2	Laird #1	33 26 51	111 55 17
(A-1-4)11bdb	unknown	unknown	unknown
(A-1-4)11cda	SRP	33 [illegible]	111 55 02
(A-1-4)13adb	Century Paving	33 25 57	111 53 42
(A-1-4)13adc2	AAA Auto	33 25 47	111 53 42
(A-1-4)13add	Nesbitt	33 25 46	111 53 29
(A-1-4)13bac	Kachina Redimix	33 26 02	111 54 09
(A-1-4)13bdd	APS-2	33 25 48	111 54 03
(A-1-4)13cdb	Black	33 25 30	111 54 10
(A-1-4)14daa	APS-1	33 25 44	111 54 35
(A-1-4)15dcc	Tempe #3	33 25 24	111 56 02
(A-1-4)22dbc	Tempe #1	33 24 40	111 56 02
(A-1-4)23bcc	Tempe #4	33 24 57	111 55 30
(A-1-4)24abc	Tempe #7	33 25 10	111 53 58
(A-1-4)24bbc2	SRP 23E,2.9N	33 25 11	111 54 30
(A-1-5)6aca	SRIR	33 27 43	111 52 43
(A-1-5)6baa	SRIR	---	---
(A-1-5)6bbb	SRIR	---	---
(A-1-5)6bcc	SRIR	33 27 36	111 53 26
(A-1-5)6bdd	IND-1	33 27 34	111 52 58
(A-1-5)6caa	BIA #10	33 27 28	111 53 02
(A-1-5)18cbb	APS-3	33 25 45	111 53 28
(A-1-5)19bcd	Tempe #8	---	---
(A-2-4)22bdd	Borg	33 30 09	111 56 03
(A-2-4)22dab4	Arcadia #9A	33 30 02	111 55 39
(A-2-4)22dab5	Arcadia #7	33 30 06	111 55 46
(A-2-4)22dba2	Arcadia	33 30 07	111 55 39
(A24)22dbb	Arcadia #10	33 30 02	111 56 02
(A-2-4)23dcc	SRP 21.5E,8N	33 29 42	111 56 02
(A-2-4)23bcc2	SRP 22.1E,8.5N	33 30 11	111 55 24
(A-2-4)23ddd2	Phoenix #34	33 29 42	111 54 31
(A-2-4)24bad	SRP 23.5E,8.8N	33 30 21	111 53 59
(A-2-4)24cab	Scottsdale #2	33 30 07	111 54 13
(A-2-4)24dbc	Scottsdale #1	33 29 58	111 53 53
(A-2-4)25aaa	Phoenix #18	33 29 41	111 53 28
(A-2-4)25aab	Phoenix #19	33 29 40	111 53 42
(A-2-4)25abb	Phoenix #20	33 29 40	111 53 58
(A-2-4)25bcd	Scottsdale #6	33 29 15	111 54 15
(A-2-4)25cdb2	Scottsdale #31	33 29 01	111 54 14
(A-2-4)25cdd	Phoenix #23	33 28 55	111 53 58
(A-2-4)25dca	Phoenix #24	33 29 03	111 53 44
(A-2-4)25d[illegible]	------	---	---
(A-2-4)25ddb1	Phoenix #223	33 29 02	111 53 43
(A-2-4)25ddb2	E-4UA	33 29 05	111 53 42
(A-2-4)26bbc	Brown	33 29 30	111 55 29
(A-2-4)26dda1	M-12MA	33 30 01	111 54 35
(A-2-4)26dda2	M-12UA	33 30 00	111 54 35
(A-2-4)2[illegible]cb2	Phoenix #39	33 29 27	111 56 33
(A-2-4)28bda	AZCC	33 29 25	111 57 07
(A-2-4)33aaa	Phoenix #40	33 28 48	111 56 35
(A-2-4)33aba	Pease	33 28 48	111 56 52
(A-2-4)35aab2	Phoenix #35	33 28 48	111 54 42
(A-2-4)35abb1	Phoenix #36	33 28 48	111 55 00
(A-2-4)35abb2	E-3UA	33 28 51	111 54 59
(A-2-4)35bba	SRP 22.3E,7N	33 28 48	111 55 16
(A-2-4)35daa	E-2UA	33 28 18	111 54 32
(A-2-4)35dba1	M-11MA	33 28 19	111 54 50
(A-2-4)35dba2	M-11UA	33 28 18	111 54 50
(A-2-4)35dcc2	SRP 22.5E,6N	33 27 57	111 55 01
(A-2-4)35ddc1	M-10MA	33 28 03	111 54 38
(A-2-4)35ddc2	M-10UA	33 28 02	111 54 38
(A-2-4)35ddc3	M-10LA	33 28 01	111 54 38
(A-2-4)36dba1	M-9MA	33 28 22	111 53 48
(A-2-4)36dba2	M-9UA	33 28 21	111 53 48



INDIAN BEND WASH

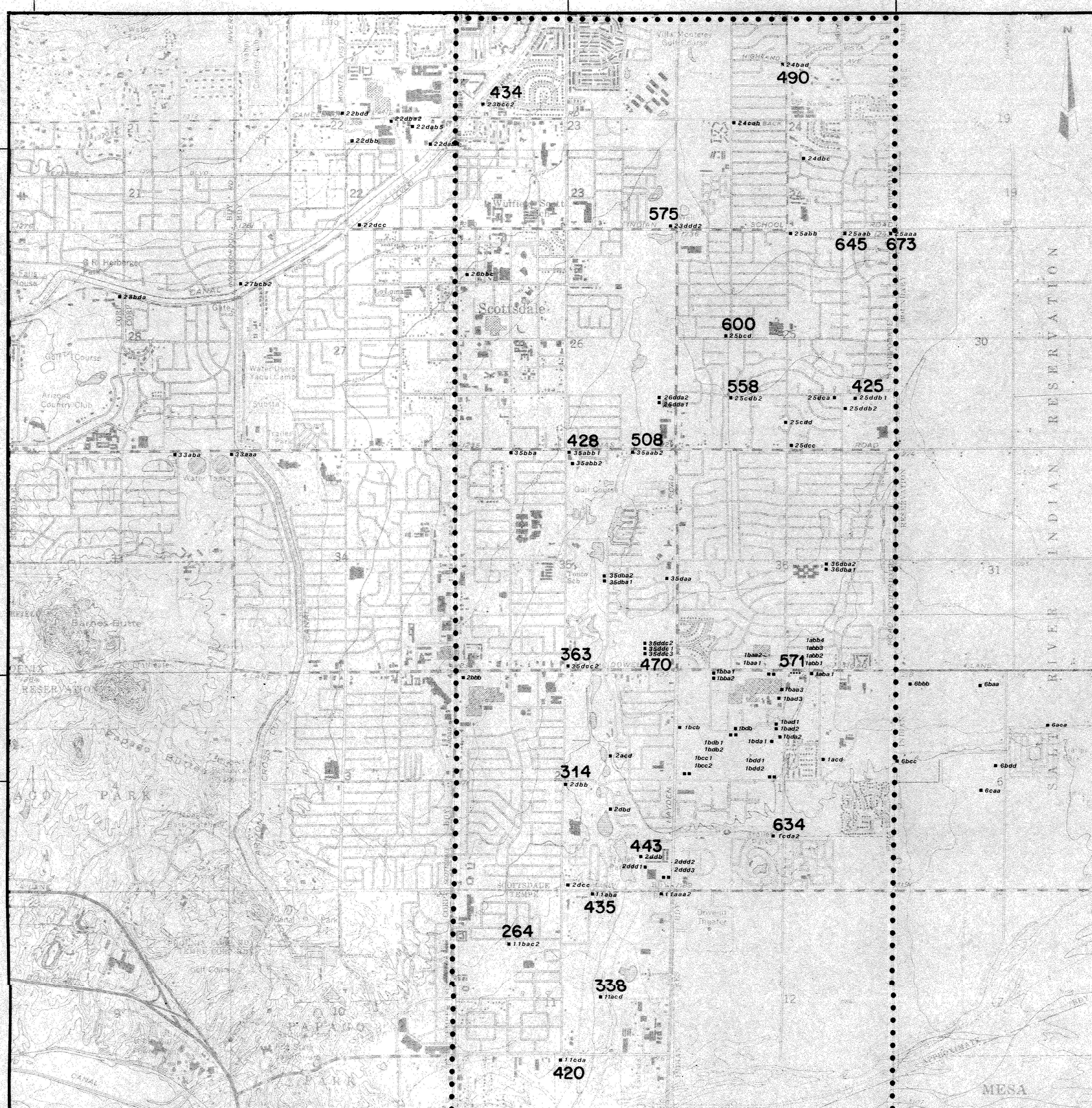
SCOTTSDALE AND TEMPE, ARIZONA

PLATE 7: ELEVATION OF THE TOP OF THE LOWER ALLUVIUM UNIT

(Elevations are in feet above mean sea level. Lithostratigraphic data are presented in Appendices B, C, N and O.)

0 1000 2000 3000 4000 5000
SCALE: IN FEET

(A-1-4)1aba1	SRP 23.6E,6N	33 27 56	111 53 52
(A-1-4)1abb1	E-1MP	33 27 56	111 53 57
(A-1-4)1abb2	E-1MA	33 27 56	111 53 57
(A-1-4)1abb3	E-1LA	33 27 56	111 53 57
(A-1-4)1abb4	E-1UA	33 27 56	111 53 57
(A-1-4)1acd	M-8UA	33 27 31	111 53 47
(A-1-4)1baa1	M-6MA	33 27 56	111 54 04
(A-1-4)1baa2	M-6UA	33 27 56	111 54 03
(A-1-4)1baa3	M-7UA	33 27 52	111 54 00
(A-1-4)1bad1	ST-1	33 27 44	111 54 01
(A-1-4)1bad2	M-1MA	33 27 43	111 54 01
(A-1-4)1bad3	M-7MA	33 27 50	111 54 01
(A-1-4)1bba1	M-5MA	33 27 56	111 54 19
(A-1-4)1bba2	M-5UA	33 27 55	111 54 19
(A-1-4)1bcb	Motorola	33 27 43	111 54 28
(A-1-4)1bcc1	M-2MA	33 27 32	111 54 27
(A-1-4)1bcc2	M-2UA	33 27 32	111 54 26
(A-1-4)1bda1	ST-2	33 27 39	111 54 03
(A-1-4)1bda2	ST-3	33 27 41	111 54 00
(A-1-4)1bdb	Motorola	33 27 42	111 54 13
(A-1-4)1bdb1	M-4MA	33 27 41	111 54 14
(A-1-4)1bdb2	M-4UA	33 27 41	111 54 13
(A-1-4)1bdd1	M-3MA	33 27 31	111 54 02
(A-1-4)1bdd2	M-3UA	33 27 31	111 54 03
(A-1-4)1cda2	SRP 23.5E,5.25N	33 27 17	111 54 01
(A-1-4)2acd	E-5UA	33 27 32	111 54 47
(A-1-4)2bbb	Boehm	33 27 55	111 55 30
(A-1-4)2dbb	SRP 22.5E,5.5N	33 27 29	111 55 02
(A-1-4)2dbd	B-J	33 27 23	111 54 48
(A-1-4)2dcc	MM-1	33 27 05	111 55 00
(A-1-4)2ddb	Scottsdale #25	33 27 12	111 54 39
(A-1-4)2ddd1	B-onsite	33 27 10	111 54 38
(A-1-4)2ddd2	B-MA-1	33 27 07	111 54 33
(A-1-4)2ddd3	B-UA-1	33 27 07	111 54 32
(A-1-4)11aaa2	Gregg	33 27 03	111 54 33
(A-1-4)11aba	Tempe #6	33 27 03	111 54 53
(A-1-4)11acd	SRP 22.75E,4.5N	33 26 38	111 54 51
(A-1-4)11bac2	Laird #1	33 26 51	111 55 17
(A-1-4)11bdb	unknown	unknown	unknown
(A-1-4)11cda	SRP	33 2[illegible]	111 55 02
(A-1-4)13adb	Century Paving	33 25 57	111 53 42
(A-1-4)13adc2	AAA Auto	33 25 47	111 53 42
(A-1-4)13add	Nesbitt	33 25 46	111 53 29
(A-1-4)13bac	Kachina Redimix	33 26 02	111 54 09
(A-1-4)13bdd	APS-2	33 25 48	111 54 03
(A-1-4)13cdb	Black	33 25 30	111 54 10
(A-1-4)14daa	APS-1	33 25 44	111 54 35
(A-1-4)15dcc	Tempe #3	33 25 24	111 56 02
(A-1-4)22dbc	Tempe #1	33 24 40	111 56 02
(A-1-4)23bcc	Tempe #4	33 24 57	111 55 30
(A-1-4)24abc	Tempe #7	33 25 10	111 53 58
(A-1-4)24bbc2	SRP 23E,2.9N	33 25 11	111 54 30
(A-1-5)6aca	SRIR	33 27 43	111 52 43
(A-1-5)6baa	SRIR	---	---
(A-1-5)6bbb	SRIR	---	---
(A-1-5)6bcc	SRIR	33 27 36	111 53 26
(A-1-5)6bdd	IND-1	33 27 34	111 52 58
(A-1-5)6caa	BIA #10	33 27 28	111 53 02
(A-1-5)18cbb	APS-3	33 25 45	111 53 28
(A-1-5)19bcd	Tempe #8	---	---
(A-2-4)22bdd	Borg	33 30 09	111 56 03
(A-2-4)22dab4	Arcadia #9A	33 30 02	111 55 39
(A-2-4)22dab5	Arcadia #7	33 30 06	111 55 46
(A-2-4)22dba2	Arcadia	33 30 07	111 55 39
(A24)22dbb	Arcadia #10	33 30 02	111 56 02
(A-2-4)22dcc	SRP 21.5E,8N	33 29 42	111 56 02
(A-2-4)23bcc2	SRP 22.1E,8.5N	33 30 11	111 55 24
(A-2-4)23ddd2	Phoenix #34	33 29 42	111 54 31
(A-2-4)24bad	SRP 23.5E,8.8N	33 30 21	111 53 59
(A-2-4)24cab	Scottsdale #2	33 30 07	111 54 13
(A-2-4)24dbc	Scottsdale #1	33 29 58	111 53 53
(A-2-4)25aaa	Phoenix #18	33 29 41	111 53 28
(A-2-4)25aab	Phoenix #19	33 29 40	111 53 42
(A-2-4)25abb	Phoenix #20	33 29 40	111 53 58
(A-2-4)25bcd	Scottsdale #6	33 29 15	111 54 15
(A-2-4)25cdb2	Scottsdale #31	33 29 01	111 54 14
(A-2-4)25cdd	Phoenix #23	33 28 55	111 53 58
(A-2-4)25dca	Phoenix #24	33 29 03	111 53 44
(A-2-4)25d[illegible]	------	---	---
(A-2-4)25d[illegible]1	Phoenix #223	33 29 02	111 53 43
(A-2-4)25ddb2	E-4UA	33 29 05	111 53 42
(A-2-4)26bbc	Brown	33 29 30	111 55 29
(A-2-4)26dda1	M-12MA	33 30 01	111 54 35
(A-2-4)26dda2	M-12UA	33 30 00	111 54 35
(A-2-4)2[illegible]cb2	Phoenix #39	33 29 27	111 56 33
(A-2-4)28bda	AZCC	33 29 25	111 57 07
(A-2-4)33aaa	Phoenix #40	33 28 48	111 56 35
(A-2-4)33aba	Pease	33 28 48	111 56 52
(A-2-4)35aab2	Phoenix #35	33 28 48	111 54 42
(A-2-4)35abb1	Phoenix #36	33 28 48	111 55 00
(A-2-4)35abb2	E-3UA	33 28 51	111 54 59
(A-2-4)35bba	SRP 22.3E,7N	33 28 48	111 55 16
(A-2-4)35daa	E-2UA	33 28 18	111 54 32
(A-2-4)35dba1	M-11MA	33 28 19	111 54 50
(A-2-4)35dba2	M-11UA	33 28 18	111 54 50
(A-2-4)35dcc2	SRP 22.5E,6N	33 27 57	111 55 01
(A-2-4)35ddc1	M-10MA	33 28 03	111 54 38
(A-2-4)35ddc2	M-10UA	33 28 02	111 54 38
(A-2-4)35ddc3	M-10LA	33 28 01	111 54 38
(A-2-4)36dba1	M-9MA	33 28 22	111 53 48
(A-2-4)36dba2	M-9UA	33 28 21	111 53 48



INDIAN BEND WASH

SCOTTSDALE AND TEMPE, ARIZONA

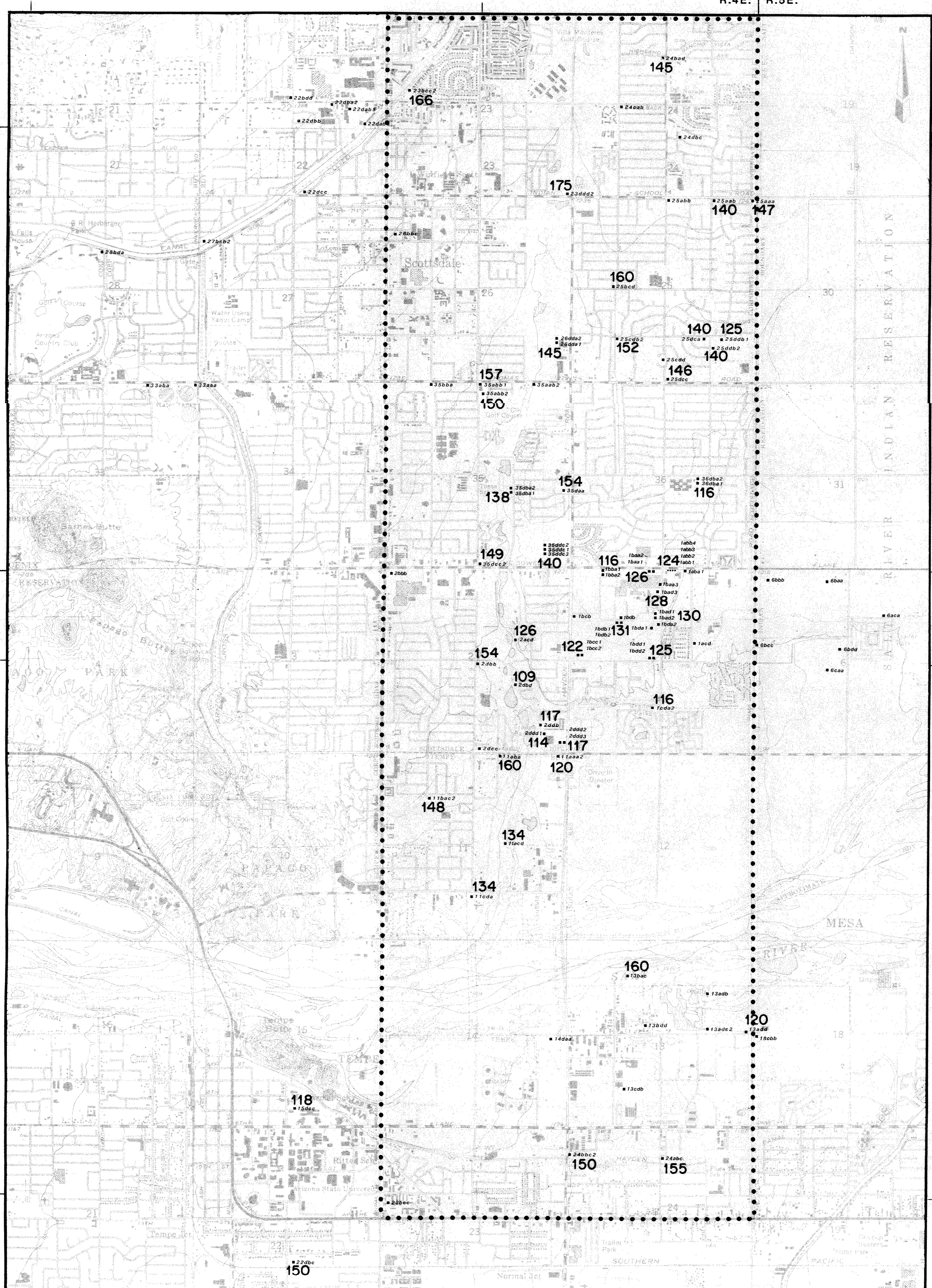
PLATE 8 : THICKNESS OF THE MIDDLE ALLUVIUM UNIT

(Thicknesses are in feet. Lithostratigraphic data are presented in Appendices B, C, N and O.)

0 1000 2000 3000 4000 5000

SCALE: IN FEET

(A-1-4)1aba1	SRP 23.6[illegible],6N	33 27 56	111 53 52
(A-1-4)1abb1	E-1MP	33 27 56	111 53 57
(A-1-4)1abb2	E-1MA	33 27 56	111 53 57
(A-1-4)1abb3	E-1LA	33 27 56	111 53 57
(A-1-4)1abb4	E-1UA	33 27 56	111 53 57
(A-1-4)1acd	M-8UA	33 27 31	111 53 47
(A-1-4)1baa1	M-6MA	33 27 56	111 54 04
(A-1-4)1baa2	M-6UA	33 27 56	111 54 03
(A-1-4)1baa3	M-7UA	33 27 52	111 54 00
(A-1-4)1bad1	ST-1	33 27 44	111 54 01
(A-1-4)1bad2	M-1MA	33 27 43	111 54 01
(A-1-4)1bad3	M-7MA	33 27 50	111 54 01
(A-1-4)1bba1	M-5MA	33 27 56	111 54 19
(A-1-4)1bba2	M-5UA	33 27 55	111 54 19
(A-1-4)1bcb	Motorola	33 27 43	111 54 28
(A-1-4)1bcc1	M-2MA	33 27 32	111 54 27
(A-1-4)1bcc2	M-2UA	33 27 32	111 54 26
(A-1-4)1bda1	ST-2	33 27 39	111 54 03
(A-1-4)1bda2	ST-3	33 27 41	111 54 00
(A-1-4)1bdb	Motorola	33 27 42	111 54 13
(A-1-4)1bdb1	M-4MA	33 27 41	111 54 14
(A-1-4)1bdb2	M-4UA	33 27 41	111 54 13
(A-1-4)1bdd1	M-3MA	33 27 31	111 54 02
(A-1-4)1bdd2	M-3UA	[illegible] 27 31	111 54 03
(A-1-4)1cda2	SRP 23.5E,5.25N	33 27 17	111 54 01
(A-1-4)2acd	E-5UA	33 27 32	111 54 47
(A-1-4)2bbb	Boehm	33 27 55	111 55 30
(A-1-4)2dbb	SRP 22.5E,5.5N	33 27 29	111 55 02
(A-1-4)2dbd	B-J	33 27 23	111 54 48
(A-1-4)2dcc	MM-1	33 27 05	111 55 00
(A-1-4)2ddb	Scottsdale #25	33 27 12	111 54 39
(A-1-4)2ddd1	B-onsite	33 27 10	111 54 38
(A-1-4)2ddd2	B-MA-1	33 27 07	111 54 33
(A-1-4)2ddd3	B-UA-1	33 27 07	111 54 32
(A-1-4)11aaa2	Gregg	33 27 03	111 54 33
(A-1-4)11aba	Tempe #6	33 27 03	111 54 53
(A-1-4)11acd	SRP 22.75E,4.5N	33 26 38	111 54 51
(A-1-4)11bac2	Laird #1	33 26 51	111 55 17
(A-1-4)11bdb	unknown	unknown	unknown
(A-1-4)11cda	SRP	33 [illegible]	111 55 02
(A-1-4)13adb	Century Paving	33 25 57	111 53 42
(A-1-4)13adc2	AAA Auto	33 25 47	111 53 42
(A-1-4)13add	Nesbitt	33 25 46	111 53 29
(A-1-4)13bac	Kachina Redimix	33 26 02	111 54 09
(A-1-4)13bdd	APS-2	33 25 48	111 54 03
(A-1-4)13cdb	Black	33 25 30	111 54 10
(A-1-4)14daa	APS-1	33 25 44	111 54 35
(A-1-4)15dcc	Tempe #3	33 25 24	111 56 02
(A-1-4)22dbc	Tempe #1	33 24 40	111 56 02
(A-1-4)23bcc	Tempe #4	33 24 57	111 55 30
(A-1-4)24abc	Tempe #7	33 25 10	111 53 58
(A-1-4)24bbc2	SRP 23E,2.9N	33 25 11	111 54 30
(A-1-5)6aca	SRIR	33 27 43	111 52 43
(A-1-5)6baa	SRIR	---	---
(A-1-5)6bbb	SRIR	---	---
(A-1-5)6bcc	SRIR	33 27 36	111 53 26
(A-1-5)6bdd	IND-1	33 27 34	111 52 58
(A-1-5)6caa	BIA #10	33 27 28	111 53 02
(A-1-5)18cbb	APS-3	33 25 45	111 53 28
(A-1-5)19bcd	Tempe #8	---	---
(A-2-4)22bdd	Borg	33 30 09	111 56 03
(A-2-4)22dab4	Arcadia #9A	33 30 02	111 55 39
(A-2-4)22dab5	Arcadia #7	33 30 06	111 55 46
(A-2-4)22dba2	Arcadia	33 30 07	111 55 39
(A24)22dbb	Arcadia #10	33 30 02	111 56 02
(A-2-4)22dcc	SRP 21.5E,8N	33 29 42	111 56 02
(A-2-4)23bcc2	SRP 22.1E,8.5N	33 30 11	111 55 24
(A-2-4)23ddd2	Phoenix #34	33 29 42	111 54 31
(A-2-4)24bad	SRP 23.5E,8.8N	33 30 21	111 53 59
(A-2-4)24cab	Scottsdale #2	33 30 07	111 54 13
(A-2-4)24dbc	Scottsdale #1	33 29 58	111 53 53
(A-2-4)25aaa	Phoenix #18	33 29 41	111 53 28
(A-2-4)25aab	Phoenix #19	33 29 40	111 53 42
(A-2-4)25abb	Phoenix #20	33 29 40	111 53 58
(A-2-4)25bcd	Scottsdale #6	33 29 15	111 54 15
(A-2-4)25cdb2	Scottsdale #31	33 29 01	111 54 14
(A-2-4)25cdd	Phoenix #23	33 28 55	111 53 58
(A-2-4)25dca	Phoenix #24	33 29 03	111 53 44
(A-2-4)25d[illegible]	------	---	---
(A-2-4)25ddb1	Phoenix #223	33 29 02	111 53 43
(A-2-4)25ddb2	E-4UA	33 29 05	111 53 42
(A-2-4)26bbc	Brown	33 29 30	111 55 29
(A-2-4)26dda1	M-12MA	33 30 01	111 54 35
(A-2-4)26dda2	M-12UA	33 30 00	111 54 35
(A-2-4)2[illegible]cb2	Phoenix #39	33 29 27	111 56 33
(A-2-4)28bda	AZCC	33 29 25	111 57 07
(A-2-4)33aaa	Phoenix #40	33 28 48	111 56 [illegible]
(A-2-4)33aba	Pease	33 28 48	111 56 52
(A-2-4)35aab2	Phoenix #35	33 28 48	111 54 42
(A-2-4)35abb1	Phoenix #36	33 28 48	111 55 00
(A-2-4)35abb2	E-3UA	33 28 51	111 54 59
(A-2-4)35bba	SRP 22.3E,7N	33 28 48	111 55 16
(A-2-4)35daa	E-2UA	33 28 18	111 54 32
(A-2-4)35dba1	M-11MA	33 28 19	111 54 50
(A-2-4)35dba2	M-11UA	33 28 18	111 54 50
(A-2-4)35dcc2	SRP 22.5E,6N	33 27 57	111 55 01
(A-2-4)35ddc1	M-10MA	33 28 03	111 54 38
(A-2-4)35ddc2	M-10UA	33 28 02	111 54 38
(A-2-4)35ddc3	M-10LA	33 28 01	111 54 38
(A-2-4)36dba1	M-9MA	33 28 22	111 53 48
(A-2-4)36dba2	M-9UA	33 28 21	111 53 48



INDIAN BEND WASH

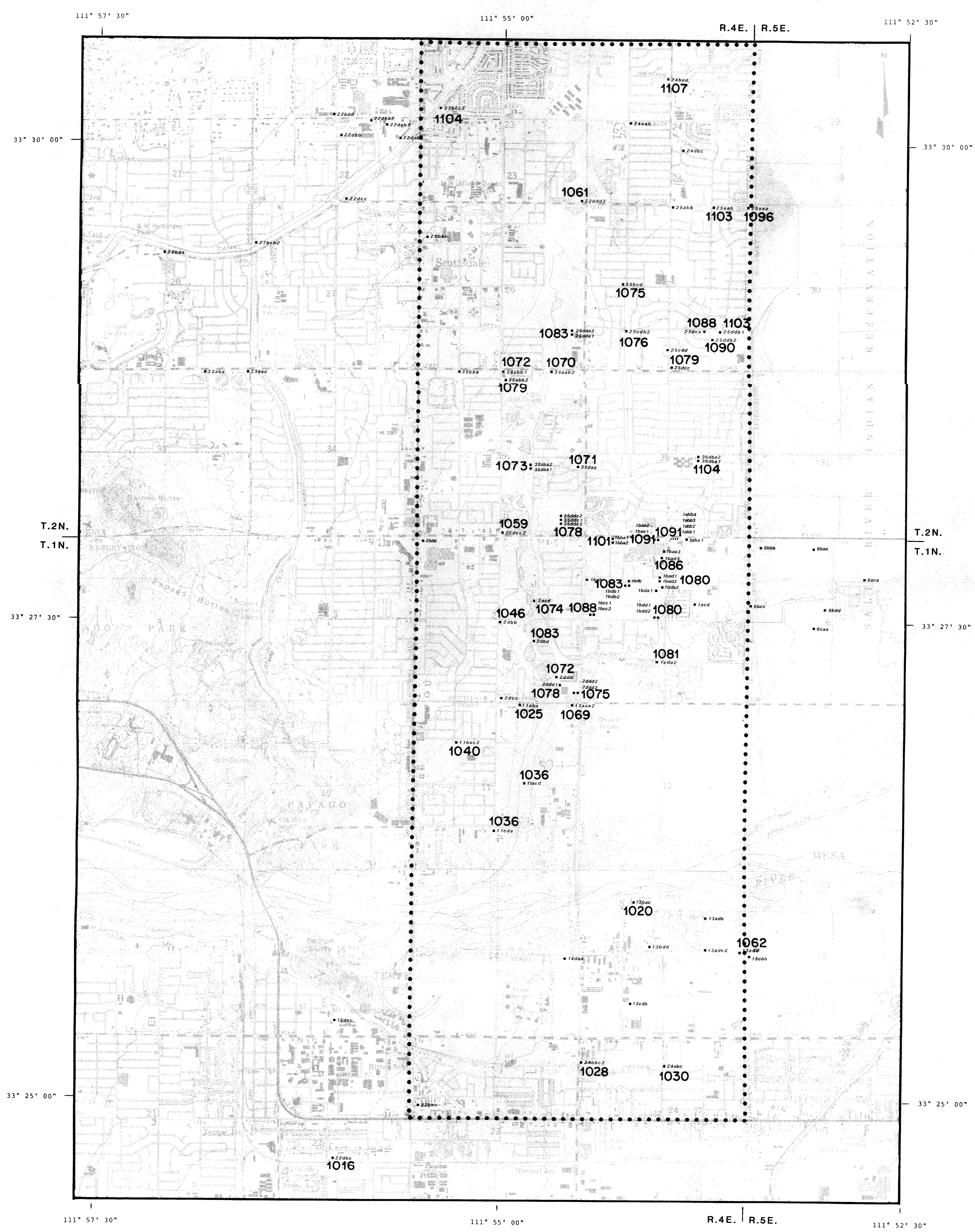
SCOTTSDALE AND TEMPE, ARIZONA

PLATE 9: THICKNESS OF THE UPPER ALLUVIUM UNIT

(Thicknesses are in feet. Lithostratigraphic data are presented in Appendices B, C, N and O.)

0 1000 2000 3000 4000 5000
SCALE: IN FEET

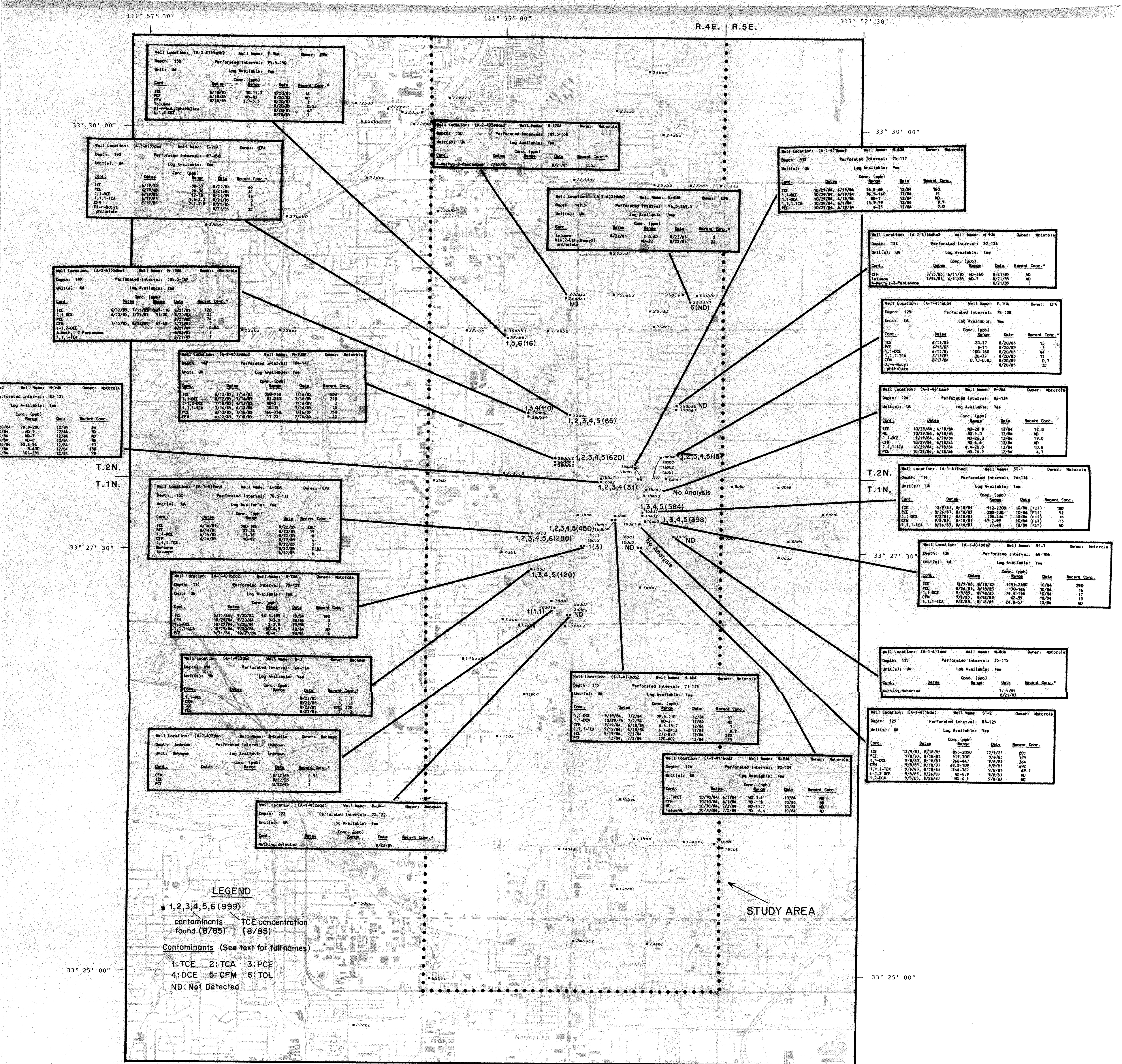
(A-1-4)1aba1	SRP 23.6E,6N	33 27 56	111 53 52
(A-1-4)1abb1	E-1MP	33 27 56	111 53 57
(A-1-4)1abb2	E-1MA	33 27 56	111 53 57
(A-1-4)1abb3	E-1LA	33 27 56	111 53 57
(A-1-4)1abb4	E-1UA	33 27 56	111 53 57
(A-1-4)1acd	M-8UA	33 27 31	111 53 47
(A-1-4)1baa1	M-6MA	33 27 56	111 54 04
(A-1-4)1baa2	M-6UA	33 27 56	111 54 03
(A-1-4)1baa3	M-7UA	33 27 52	111 54 00
(A-1-4)1bad1	ST-1	33 27 44	111 54 01
(A-1-4)1bad2	M-1MA	33 27 43	111 54 01
(A-1-4)1bad3	M-7MA	33 27 50	111 54 01
(A-1-4)1bba1	M-5MA	33 27 56	111 54 19
(A-1-4)1bba2	M-5UA	33 27 55	111 54 19
(A-1-4)1bcb	Motorola	33 27 43	111 54 28
(A-1-4)1bcc1	M-2MA	33 27 32	111 54 27
(A-1-4)1bcc2	M-2UA	33 27 32	111 54 26
(A-1-4)1bda1	ST-2	33 27 39	111 54 03
(A-1-4)1bda2	ST-3	33 27 41	111 54 00
(A-1-4)1bdb	Motorola	33 27 42	111 54 13
(A-1-4)1bdb1	M-4MA	33 27 41	111 54 14
(A-1-4)1bdb2	M-4UA	33 27 41	111 54 13
(A-1-4)1bdd1	M-3MA	33 27 31	111 54 02
(A-1-4)1bdd2	M-3UA	33 27 31	111 54 03
(A-1-4)1cda2	SRP 23.5E,5.25N	33 27 17	111 54 01
(A-1-4)2acd	E-5UA	33 27 32	111 54 47
(A-1-4)2bbb	Boehm	33 27 55	111 55 30
(A-1-4)2dbb	SRP 22.5E,5.5N	33 27 29	111 55 02
(A-1-4)2dbd	B-J	33 27 23	111 54 48
(A-1-4)2dcc	MM-1	33 27 05	111 55 00
(A-1-4)2ddb	Scottsdale #25	33 27 12	111 54 39
(A-1-4)2ddd1	B-onsite	33 27 10	111 54 38
(A-1-4)2ddd2	B-MA-1	33 27 07	111 54 33
(A-1-4)2ddd3	B-UA-1	33 27 07	111 54 32
(A-1-4)11aaa2	Gregg	33 27 03	111 54 33
(A-1-4)11aba	Tempe #6	33 27 03	111 54 53
(A-1-4)11acd	SRP 22.75E,4.5N	33 26 38	111 54 51
(A-1-4)11bac2	Laird #1	33 26 51	111 55 17
(A-1-4)11bdb	unknown	unknown	unknown
(A-1-4)11cda	SRP	33 2[illegible] [illegible]3	111 55 02
(A-1-4)13adb	Century Paving	33 25 57	111 53 42
(A-1-4)13adc2	AAA Auto	33 25 47	111 53 42
(A-1-4)13add	Nesbitt	33 25 46	111 53 29
(A-1-4)13bac	Kachina Redimix	33 26 02	111 54 09
(A-1-4)13bdd	APS-2	33 25 48	111 54 03
(A-1-4)13cdb	Black	33 25 30	111 54 10
(A-1-4)14daa	APS-1	33 25 44	111 54 35
(A-1-4)15dcc	Tempe #3	33 25 24	111 56 02
(A-1-4)22dbc	Tempe #1	33 24 40	111 56 02
(A-1-4)23bcc	Tempe #4	33 24 57	111 55 30
(A-1-4)24abc	Tempe #7	33 25 10	111 53 58
(A-1-4)24bbc2	SRP 23E,2.9N	33 25 11	111 54 30
(A-1-5)6aca	SRIR	33 27 43	111 52 43
(A-1-5)6baa	SRIR	---	---
(A-1-5)6bbb	SRIR	---	---
(A-1-5)6bcc	SRIR	33 27 36	111 53 26
(A-1-5)6bdd	IND-1	33 27 34	111 52 58
(A-1-5)6caa	BIA #10	33 27 28	111 53 02
(A-1-5)18cbb	APS-3	33 25 45	111 53 28
(A-1-5)19bcd	Tempe #8	---	---
(A-2-4)22bdd	Borg	33 30 09	111 56 03
(A-2-4)22dab4	Arcadia #9A	33 30 02	111 55 39
(A-2-4)22dab5	Arcadia #7	33 30 06	111 55 46
(A-2-4)22dba2	Arcadia	33 30 07	111 55 39
(A24)22dbb	Arcadia #10	33 30 02	111 56 02
(A-2-4)22dcc	SRP 21.5E,8N	33 29 42	111 56 02
(A-2-4)23bcc2	SRP 22.1E,8.5N	33 30 11	111 55 24
(A-2-4)23ddd2	Phoenix #34	33 29 42	111 54 31
(A-2-4)24bad	SRP 23.5E,8.8N	33 30 21	111 53 59
(A-2-4)24cab	Scottsdale #2	33 30 07	111 54 13
(A-2-4)24dbc	Scottsdale #1	33 29 58	111 53 53
(A-2-4)25aaa	Phoenix #18	33 29 41	111 53 28
(A-2-4)25aab	Phoenix #19	33 29 40	111 53 42
(A-2-4)25abb	Phoenix #20	33 29 40	111 53 58
(A-2-4)25bcd	Scottsdale #6	33 29 15	111 54 15
(A-2-4)25cdb2	Scottsdale #31	33 29 01	111 54 14
(A-2-4)25cdd	Phoenix #23	33 28 55	111 53 58
(A-2-4)25dca	Phoenix #24	33 29 03	111 53 44
(A-2-4)25d[illegible]	------	---	---
(A-2-4)25ddb1	Phoenix #223	33 29 02	111 53 43
(A-2-4)25ddb2	E-4UA	33 29 05	111 53 42
(A-2-4)26bbc	Brown	33 29 30	111 55 29
(A-2-4)26dda1	M-12MA	33 30 01	111 54 35
(A-2-4)26dda2	M-12UA	33 30 00	111 54 35
(A-2-4)2[illegible]cb2	Phoenix #39	33 29 27	111 56 33
(A-2-4)28bda	AZCC	33 29 25	111 57 07
(A-2-4)33aaa	Phoenix #40	33 28 48	111 56 [illegible]5
(A-2-4)33aba	Pease	33 28 48	111 56 52
(A-2-4)35aab2	Phoenix #35	33 28 48	111 54 42
(A-2-4)35abb1	Phoenix #36	33 28 48	111 55 00
(A-2-4)35abb2	E-3UA	33 28 51	111 54 59
(A-2-4)35bba	SRP 22.3E,7N	33 28 48	111 55 16
(A-2-4)35daa	E-2UA	33 28 18	111 54 32
(A-2-4)35dba1	M-11MA	33 28 19	111 54 50
(A-2-4)35dba2	M-11UA	33 28 18	111 54 50
(A-2-4)35dcc2	SRP 22.5E,6N	33 27 57	111 55 01
(A-2-4)35ddc1	M-10MA	33 28 03	111 54 38
(A-2-4)35ddc2	M-10UA	33 28 02	111 54 38
(A-2-4)35ddc3	M-10LA	33 28 01	111 54 38
(A-2-4)36dba1	M-9MA	33 28 22	111 53 48
(A-2-4)36dba2	M-9UA	33 28 21	111 53 48



INDIAN BEND WASH
SCOTTSDALE AND TEMPE, ARIZONA
PLATE 10: ELEVATION OF THE MAU/UAU CONTACT

(Elevations are in feet above mean sea level. Lithostratigraphic data are presented in Appendices B, C, N and O.)

0 1000 2000 3000 4000 5000
SCALE: IN FEET



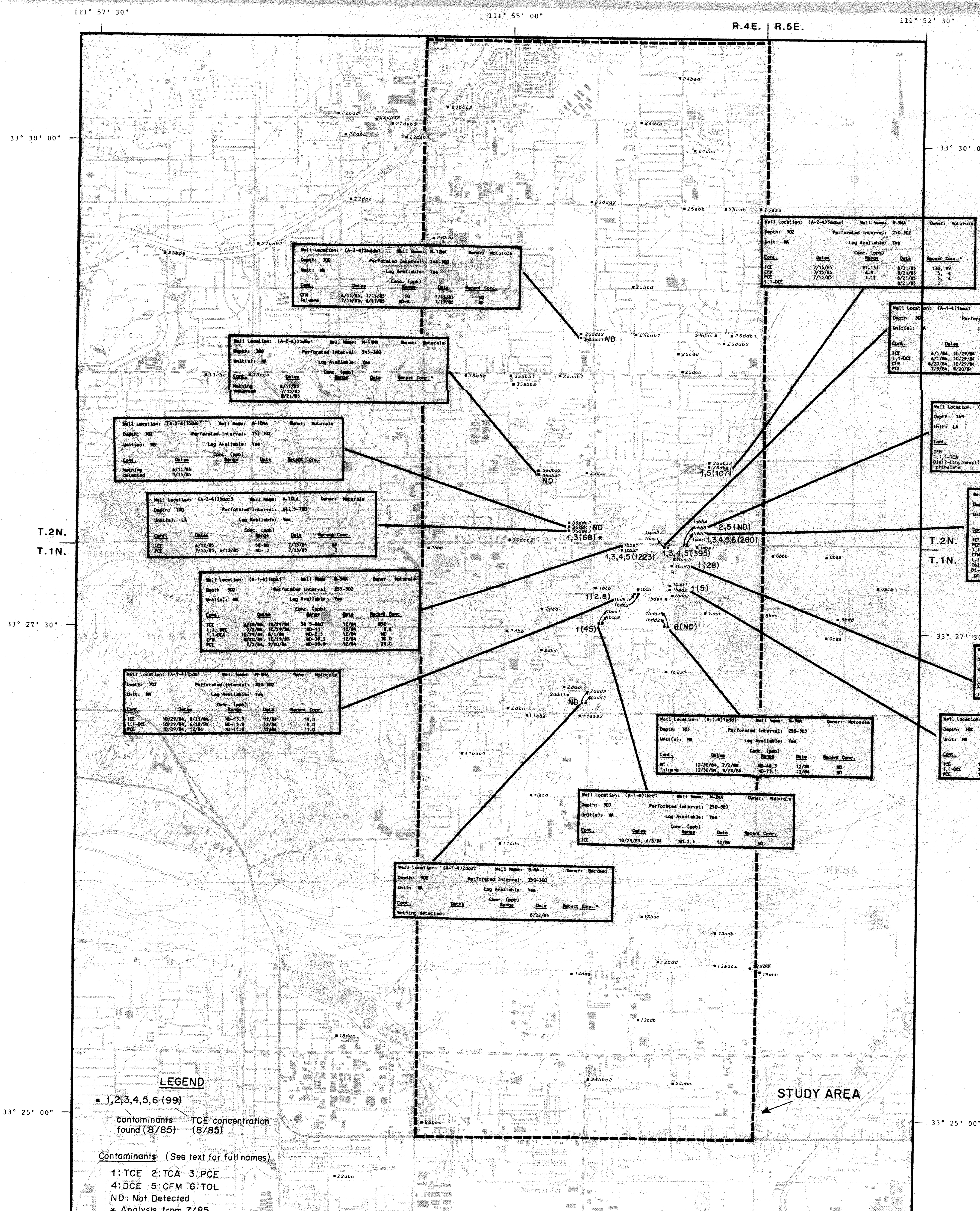
INDIAN BEND WASH

SCOTTSDALE AND TEMPE, ARIZONA

Plate 11 Distribution of Contaminants in Upper Alluvium Unit Monitor Wells

0 1000 2000 3000 4000 5000

SCALE IN FEET



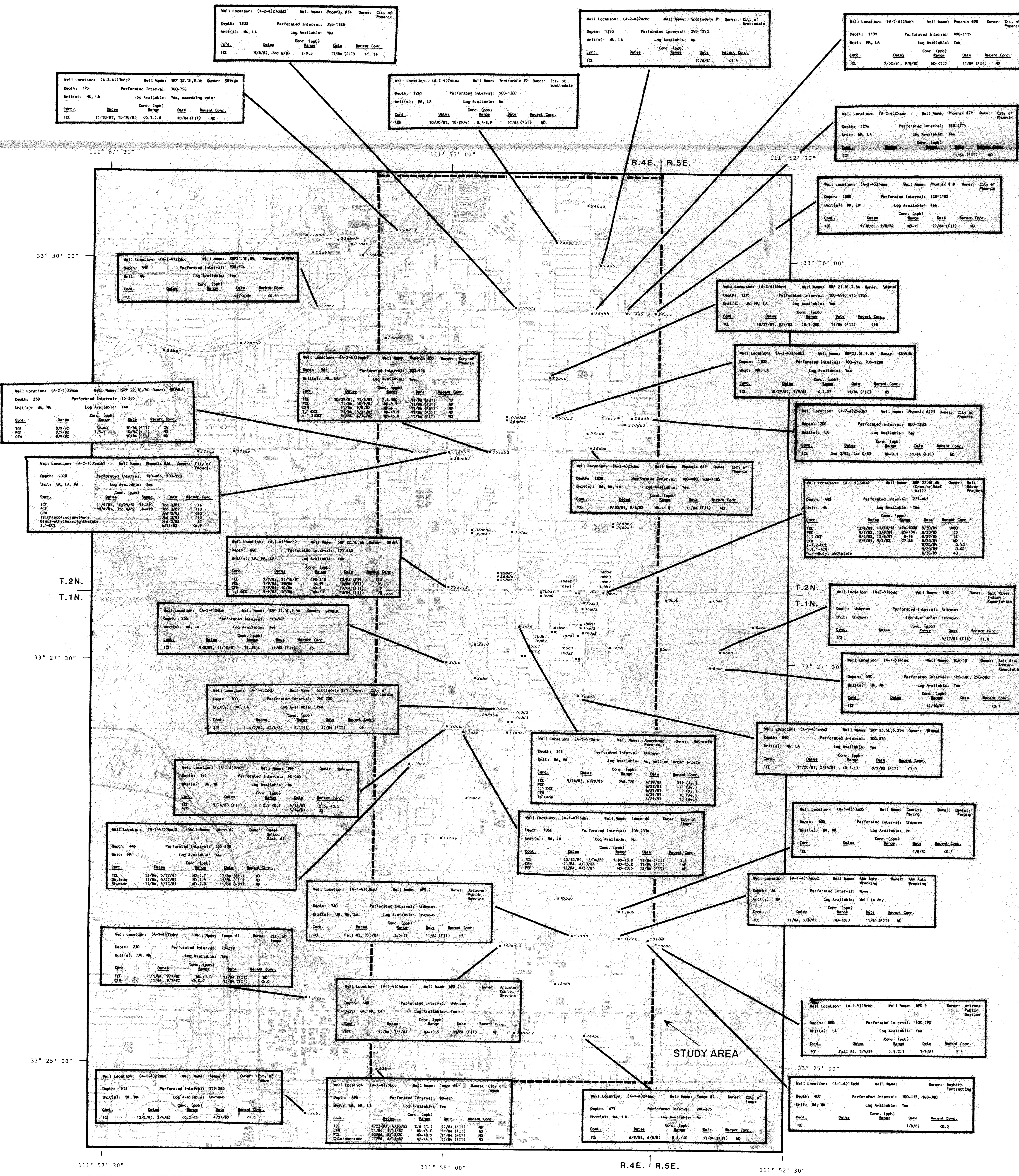
INDIAN BEND WASH

SCOTTSDALE AND TEMPE, ARIZONA

Plate 12 Distribution of Contaminants in Middle and Lower Alluvium Unit Monitor Wells

0 1000 2000 3000 4000 5000

SCALE: IN FEET



INDIAN BEND WASH

SCOTTSDALE AND TEMPE, ARIZONA

Plate 13 Summary of Contamination Found in Community Wells in the Indian Bend Wash Area

0 1000 2000 3000 4000 5000

SCALE: IN FEET

Indian Bend Wash Site

EPA INVESTIGATES GROUNDWATER CONTAMINATION; RELEASES PHASE I REMEDIAL INVESTIGATION REPORT

JULY 1986

Introduction

This fact sheet summarizes the findings of the recently completed Phase I Remedial Investigation for the Indian Bend Wash site, and provides an update on other site-related activities.

The Remedial Investigation is a part of ongoing studies being conducted by the U.S. Environmental Protection Agency (EPA) to better define and find solutions for *groundwater** contamination in the Indian Bend Wash area. These studies are a cooperative effort of Federal, State, and local agencies and private industry, under the lead of the EPA. Since the last fact sheet of February 1985, regular *Project Committee* meetings have been held to plan and coordinate project tasks, evaluate data, and monitor the progress and schedule of the work being done.

The Indian Bend Wash Site - An Overview

The Indian Bend Wash site encompasses an area of approximately 12 square miles in portions of Scottsdale and Tempe. (See Figure 1.) Organic solvents have been found in wells throughout this area. *Trichloroethylene* (TCE) is the primary contaminant. TCE has been used extensively as a degreasing agent in metal and electronic manufacturing industries (several of which operate or have operated within the area). **As a result of voluntary actions taken by the municipalities, no water exceeding *state action levels* for identified contaminants is being delivered to water consumers.**

Since the Indian Bend Wash site is on the *National Priorities List* of hazardous waste sites, it is eligible for funds under the Federal *Superfund* program. In July 1984, EPA and the other participants began a Remedial Investigation and Feasibility Study to address the contamination problem. The primary tasks include:

- A two-phased Remedial Investigation to further define the type and extent of groundwater contamination and to obtain necessary geological and *hydrogeological* information. Data gathered in the Remedial Investigation will be used to evaluate cleanup options in the Feasibility Study.
- A Feasibility Study to develop and evaluate possible solutions to the problem and recommend an appropriate *remedial action,* or combination of actions.
- Related studies, including a community well sampling program, computer modeling of groundwater contamination, and lake and fish sampling.

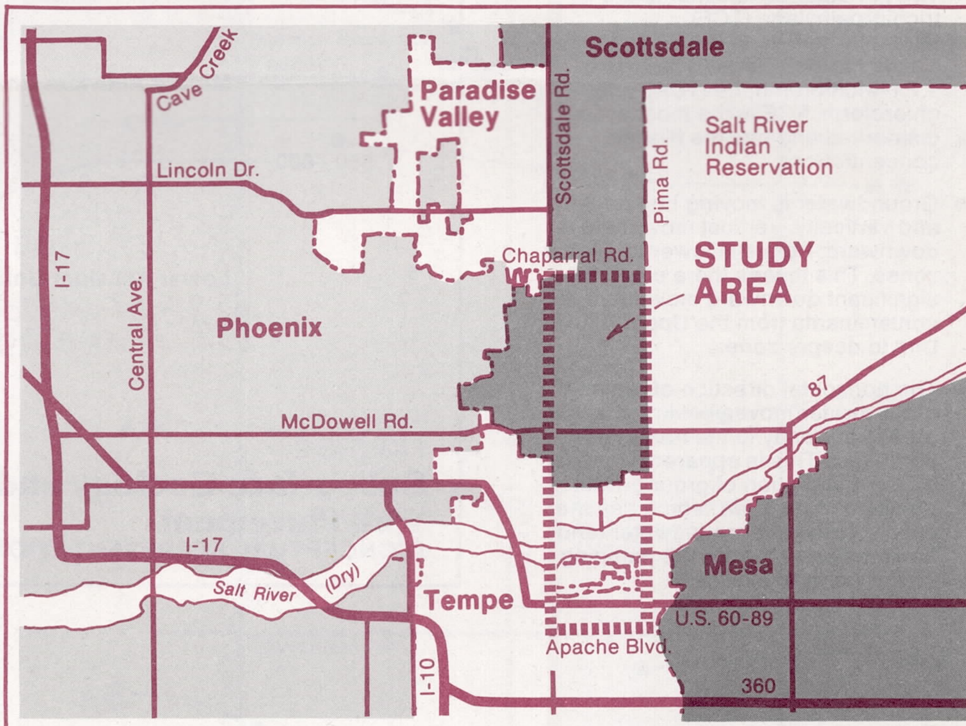


FIGURE 1
Site Location

* Terms in italics are included in the glossary on page 6.

Phase I Remedial Investigation Completed

The purpose of the Phase I Remedial Investigation was to gather information about the geology, hydrogeology, and water quality in the study area.

Between March and June 1985, 21 *monitor wells* were installed in the Indian Bend Wash study area by EPA and two *potentially responsible parties,* Motorola Government Electronics Group (GEG) and Beckman Instruments, Inc. Motorola GEG had also installed 16 monitor wells on its property before the Phase I Remedial Investigation began. Each of these wells sampled one of three *alluvium units,* as depicted on Figure 2.

Data were collected during Phase I to help define the type and thickness of the materials (such as gravel, cobbles, silt, and sand) that comprise each alluvium unit. Water level measurements were conducted to provide information about the direction of groundwater flow. Water samples were analyzed to estimate the vertical and areal distribution of contaminants in the groundwater. Based on the Phase I results, the following observations were made:

- Groundwater contamination has been found in each of the three alluvium units underlying the study area.
- The principal contaminants are trichloroethylene (TCE), tetrachloroethylene (PCE), 1,1-dichloroethylene (DCE), 1,1,1-trichloroethane (TCA), and chloroform. TCE is the most widely distributed and has the highest concentrations.
- Groundwater is moving horizontally and vertically. Vertical movement is downward, from shallower to deeper zones. This means there could be significant downward movement of contaminants from the Upper Alluvium Unit to deeper zones.
- The horizontal direction of regional groundwater movement in the study area is currently to the north and northwest. This is apparently caused by the distribution of groundwater pumping in the area, which has the effect of drawing groundwater (and contaminants) toward the pumping center north of the site.

Figure 3 shows the distribution of TCE as indicated by the Phase I sampling. It also shows the results of previous production well sampling that was conducted by various agencies from 1981 to 1983. (These were existing wells used to produce water for various purposes, such as drinking water supply, irrigation, and industrial use.) As shown, some of the production wells sampled more than one alluvium unit. The results are included in Figure 3 to provide supplemental information about the extent of TCE distribution.

The Phase I Task Report contains detailed information about the Phase I results. The report will be available for your review at the information repositories listed on page 7.

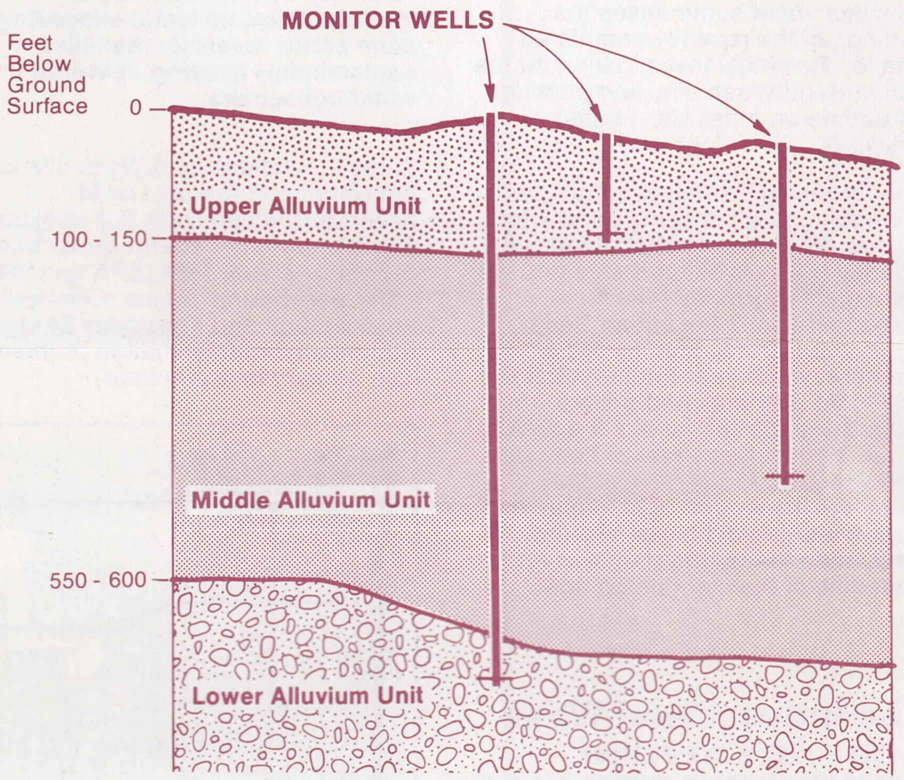


FIGURE 2
Subsurface Geology and Well Placement
(CONCEPTUAL REPRESENTATION)

FIGURE 3
TCE Distribution Indicated by Phase I Sampling*

Legend

- ● Well Location

ALLUVIUM UNIT SAMPLED

- ○ Upper Alluvium Unit
- ▲ Middle Alluvium Unit
- □ Lower Alluvium Unit
- Upper and Middle Alluvium Units
- Middle and Lower Alluvium Units
- Upper, Middle, and Lower Alluvium Units
- ? Unknown

TCE CONTAMINATION DETECTED

- **A** Not Detected
- **B** <5 Parts per Billion (ppb)
- **C** 5 - 100 ppb
- **D** 101 - 500 ppb
- **E** 501 - 1,000 ppb
- **F** >1,000 ppb

* Results available as of December 1985

0 1/4 1/2
SCALE IN MILES

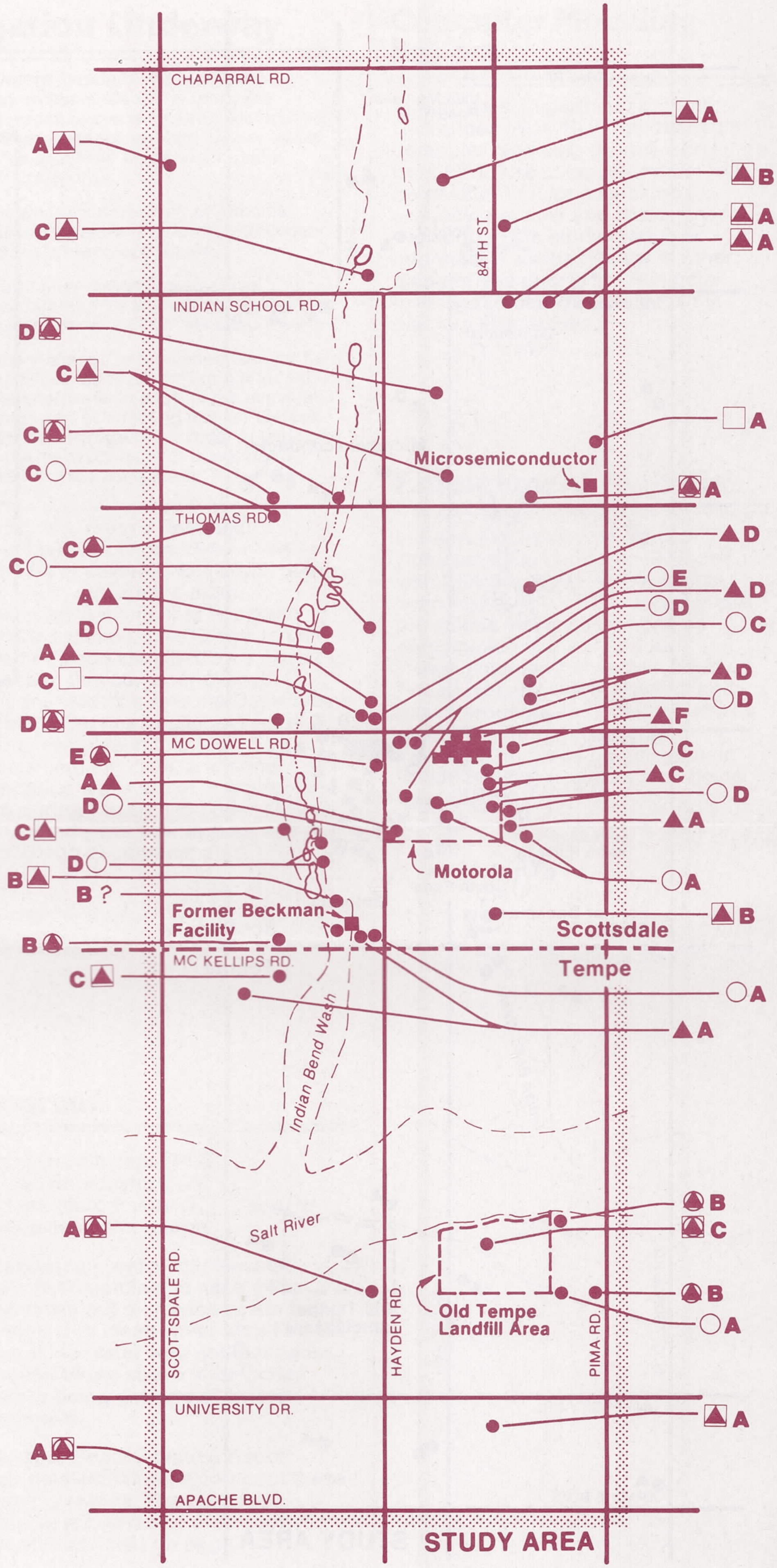
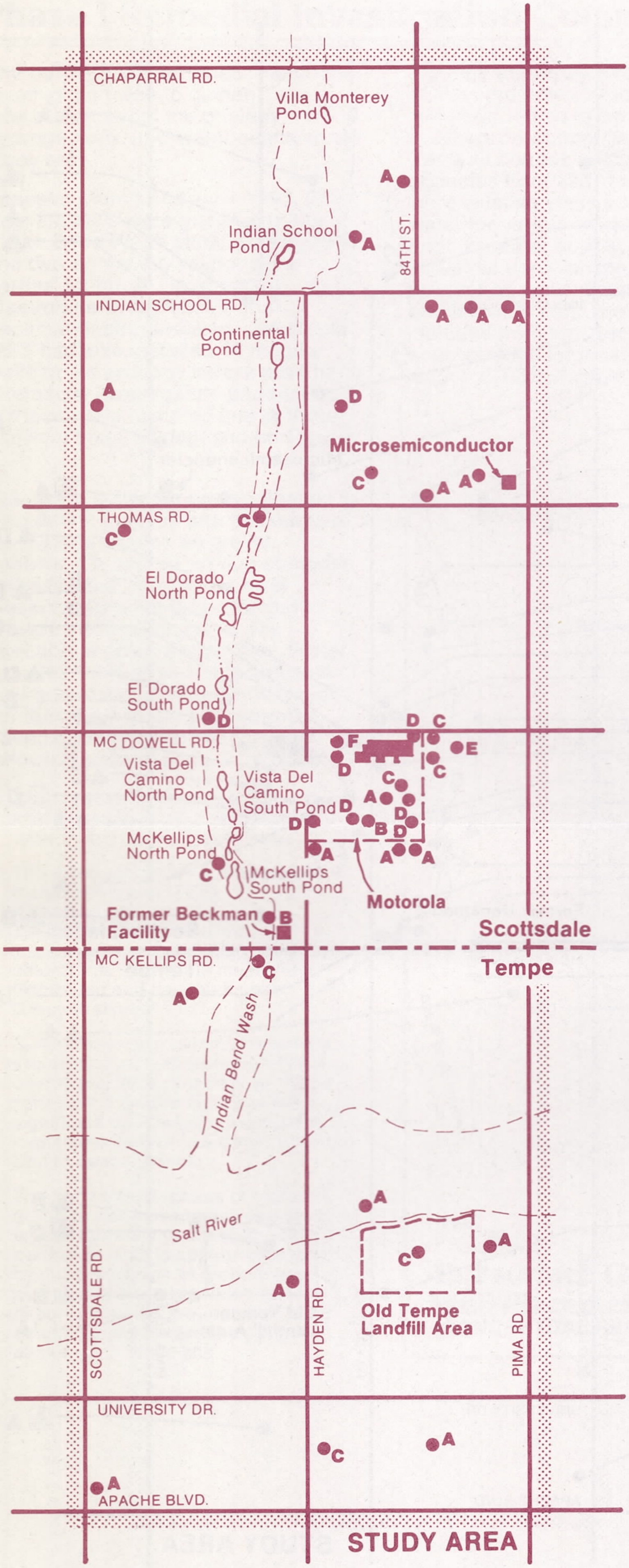


FIGURE 4

TCE Distribution Indicated by Community Well Sampling*



Legend

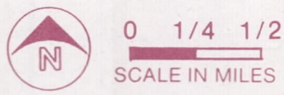
● Well Location

TCE CONTAMINATION DETECTED

- **A** Not Detected
- **B** <5 Parts per Billion (ppb)
- **C** 5 - 100 ppb
- **D** 101 - 500 ppb
- **E** 501 - 1,000 ppb
- **F** >1,000 ppb

* From October/November 1984 sampling results

NOTE: No water with TCE concentrations above the state action level (5 ppb) is being delivered to water consumers.



Phase II Remedial Investigation Underway

The results of the Phase I Remedial Investigation provided information needed to design the second phase of the Remedial Investigation. Phase II is currently underway to more fully determine the extent and magnitude of groundwater contamination in the study area. It has the following objectives:

- Better define the extent of contamination in the Upper Alluvium Unit. This unit is highly permeable and can therefore be a conduit for rapid movement of contamination.
- Establish the potential threat to water supply wells in the study area.
- Better define the extent of contamination in the Middle and Lower Alluvium Units.
- Better define the hydraulic properties that determine the vertical movement of groundwater among the *aquifers* in the alluvium units.

Major tasks to accomplish the Phase II objectives include:

- *Soil gas sampling* to help approximate the extent of contamination in the Upper Alluvium Unit. This will improve the placement of monitor wells installed later in this phase.
- *Spinner logging* and sampling at specific depths in existing production wells to help estimate the relative quantities of water and levels of contamination from the various aquifers.
- Assessment of the impacts that infiltration from area lakes has on the groundwater system, and initial computer modeling of the system.
- Determination of the remaining information needed to verify the sources of contamination, including an assessment of whether further onsite investigations would yield useful information.
- Preliminary screening of remedial action technologies and groundwater management techniques.
- Continued monthly water level measurements and collection of water quality samples from selected wells.
- Development of a detailed plan for field activities, such as drilling additional monitor wells in each of the alluvium units and conducting *aquifer tests* to obtain hydrogeologic data. At least one long-term (20 days or more) aquifer test may be conducted.

During the Phase I Remedial Investigation, contamination was detected in several wells south of the Salt River, outside the main *contaminant plume* that has been identified to date. The Tempe landfill area has been identified as a possible source of this contamination. In January 1986, the Arizona Department of Health Services collected water quality samples in this area. To supplement this data, additional monitoring wells are planned for this area during Phase II to better assess the groundwater flow system and the distribution of contaminants.

Community Well Sampling Program

In October and November 1984, EPA sampled 42 wells in the Indian Bend Wash area, including irrigation, industrial, public supply, monitor, fire, and unused wells. This program provided for the unified sampling of wells within a specific timeframe. Its purpose was to identify the extent of groundwater contamination in existing wells at the beginning of the Remedial Investigation.

Figure 4 shows the distribution of TCE detected during the community well sampling program. The pattern of contamination was similar for other *organic compounds,* which occur at relatively lower levels. These compounds include tetrachloroethylene (PCE); 1,1-dichloroethylene (DCE); 1,1,1-trichloroethane (TCA); and, to some extent, chloroform.

Public supply wells with elevated levels of contaminants have either been taken out of service or are being blended with clean water supplies. **As a result, no water with contaminant concentrations above state action levels is being delivered to water consumers.**

A Sample Documentation Report gives detailed information about these sampling results. The report is available for review in the information repositories listed on page 7.

Computer Modeling Project

The Arizona Department of Water Resources (ADWR) is conducting a computer modeling project with funds from EPA. The computer model will be another tool for assessing groundwater flow and contaminant transport in the study area. This information will be used with other data derived during the Remedial Investigation to evaluate possible cleanup alternatives.

Enforcement Activities

In February 1985, EPA signed *Administrative Orders on Consent* with Motorola GEG and Beckman Instruments, Inc. The orders contain provisions for these companies' participation in the Remedial Investigation and Feasibility Study. The companies have installed and tested groundwater monitor wells as part of the Phase I Remedial Investigation. Their participation in Phase II of the project is now being negotiated.

Lake and Fish Sampling

The City of Scottsdale recently conducted additional testing of water and sediments in six recreational lakes in the Indian Bend Wash area. The ponds are used for flood control and for recreational purposes such as fishing and boating. They are not used as a source of drinking water.

The test results showed that all but one of the lakes (McKellips Lake) are free of TCE contamination. An analysis of fish tissues also revealed no TCE contamination. Low levels of other contaminants were detected in the fish tissues; these levels are typical of bottom-feeding fish in lakes that receive urban runoff.

Earlier testing of the lakes by the City of Scottsdale and the Arizona Department of Health Services had shown elevated levels of TCE in water samples and fish tissues. As a result, the Cities of Scottsdale and Phoenix and the Salt River Project turned off several wells that were contributing TCE-contaminated water to the lake system. In addition, flooding in Indian Bend Wash has flushed and diluted lake waters.

Following the earlier detection of TCE in fish tissues, the City of Scottsdale banned fishing in the contaminated lakes and posted warning signs. The ban is still in effect only for McKellips Lake, since the recent sampling has shown an absence of contamination in the other lakes.

Scottsdale Treatment Tower

A City of Scottsdale drinking water well (located at 82nd Street and Osborne Road) that had been closed for 3 1/2 years because of TCE contamination was put back into service from June to October of last year. Water from the well was treated by an air stripping tower that reduced the contamination from about 200 parts per billion (ppb) to under 1 ppb.

After treatment, the water was blended with clean water in a 2-million-gallon reservoir, then further blended in the distribution system before delivery to the consumer.

TCE is a *volatile organic compound,* meaning that it evaporates (volatilizes) readily when exposed to air. The air stripping tower works by forcing air through the contaminated water, removing or "stripping" the TCE. The cleanup was accomplished with no violation of air quality standards.

The air stripping tower was funded by the City of Scottsdale and a grant from the State Water Quality Assurance Revolving Fund. The total cost of the tower was approximately $400,000.

The Scottsdale production well is used for water supply during the summer months only, and was shut down for the winter in October 1985. The air stripping tower resumed operation again in May 1986 when the well was put into production for the summer.

Glossary

ADMINISTRATIVE ORDER ON CONSENT: A formal administrative order signed by EPA and the responsible party (ies), the terms of which are negotiated by the signatories.

ALLUVIUM UNIT: Layers of similar geologic materials (such as cobbles, gravel, sand, silt, and clay) that underlie the land surface.

AQUIFER: A particular zone or layer of rock or soil below the earth surface through which groundwater moves in sufficient quantity to serve as a source of water.

AQUIFER TEST: A test where water is pumped from one well, and the change in water level is examined in the pumping well and nearby observation wells. These observations provide information about the rate of groundwater flow through aquifers and the degree of inter-connection among the aquifers.

CONTAMINANT PLUME: An area of contaminants with measurable horizontal and vertical dimensions that is suspended within and moves with groundwater.

GROUNDWATER: Underground water that saturates pores in soils or openings in rocks.

HYDROGEOLOGY: The study of interrelationships between groundwater and geologic materials and processes.

MONITOR WELL: A well that is specifically designed to measure groundwater quality and quantity.

NATIONAL PRIORITIES LIST: A list of the top-priority hazardous waste sites in the country that are eligible for funds under Superfund.

ORGANIC COMPOUND: A compound containing carbon.

POTENTIALLY RESPONSIBLE PARTY: A party identified as potentially liable for releases of hazardous substances. Such parties may include generators, transporters, storers, and disposers of hazardous substances.

PROJECT COMMITTEE: The Project Committee, chaired by EPA, reviews and directs the progress of the Remedial Investigation/Feasibility Study. Members of the committee include the Arizona Department of Health Services, Arizona Department of Water Resources, Salt River Project, Cities of Scottsdale and Tempe, U.S. Geological Survey, Motorola, Beckman, and technical consultants. In addition, representatives from the Project Committee meet to discuss technical issues, and a modeling subcommittee (led by the Department of Water Resources) meets on a monthly basis.

REMEDIAL ACTION: A long-term effort to provide a permanent solution to a release or threatened release of hazardous substances. A remedial action follows the completion of the Remedial Investigation/ Feasibility Study.

SOIL GAS SAMPLING: Collection of gas samples from soils to determine if volatile constituents are present.

SPINNER LOGGING: Measurement of groundwater flow into or out of a well at various depths, using a flowmeter that is lowered into the well.

STATE ACTION LEVEL: The Arizona Department of Health Services has developed state action levels for 30 volatile organic compounds and pesticides sometimes found in public drinking water supplies. When contaminant concentrations in drinking water rise above the state action level, the Arizona Department of Health Services recommends against consuming the water and requests voluntary well closure or other measures to reduce contaminant concentrations in the water.

State action levels are based upon a one-in-one-million cancer risk. This means that a person exposed to that level of contamination throughout his or her lifetime (drinking 2 liters of water per day for 70 years) has a one-in-one-million chance of contracting cancer as a result of ingesting the contaminant. The state action level for TCE is 5 parts TCE per billion parts water.

SUPERFUND: Superfund is the name of the program that was established by Congress under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The Superfund program is designed to ensure that every potential uncontrolled hazardous waste site is investigated and, if necessary, cleaned up.

TRICHLOROETHYLENE (TCE): A colorless, nonflammable liquid that is primarily used as a solvent in vapor degreasing. TCE is a potential carcinogen in humans.

VOLATILE ORGANIC COMPOUND (VOC): An organic (carbon-containing) compound that evaporates (volatilizes) readily at room temperature.

COMMUNITY INFORMATION AND INVOLVEMENT

Community members have the opportunity to review and comment on project activities throughout the Indian Bend Wash studies. Fact sheets will continue to report on the study progress and findings. Major documents, including those mentioned in this fact sheet, will be made available to the community at the following information repositories:

Phoenix Public Library
12 East McDowell
Phoenix, AZ 85004

Scottsdale Public Library
3838 Civic Center Plaza
Scottsdale, AZ 85251

Tempe Public Library
3500 South Rural Road
Tempe, AZ 85282

If you have any questions or comments, please contact:

Sam Ziegler
Community Relations Coordinator
U.S. Environmental Protection Agency
215 Fremont Street (T-1-3)
San Francisco, CA 94105
(415) 974-7730

or

Julia Wolfe
Arizona Department of Health Services
2005 North Central Avenue
Phoenix, AZ 85004
(602) 257-2337

Community Meeting

A community meeting will be held in August 1986 to discuss the Indian Bend Wash project and answer any questions you may have.

Notice of the date and location for this meeting will be sent to all persons on the mailing list and announced in local newspapers.

Mailing List

If you did not receive this fact sheet through the mail and would like to be added to the mailing list to receive future information, please fill out this coupon and return it to Sam Ziegler at the address above.

Please add my name to the Indian Bend Wash mailing list:

Name ______________________________

Address ______________________________

City ____________________ Zip __________

United States
Environmental Protection
Agency

Region IX
215 Fremont Street
San Francisco, CA 94105

Official Business
Penalty for Private Use,
$300

FIRST CLASS MAIL
U.S. POSTAGE
PAID
San Francisco, CA
Permit No. G-35

INDIAN BEND WASH

SUPERFUND SITE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 9

COMMUNITY MEETING

AUGUST 19, 1986

EPA COMMUNITY MEETING

INDIAN BEND WASH
SUPERFUND SITE
August 19, 1986

AGENDA

Introduction – Sam Ziegler (Facilitator)
(5 MINUTES)
Community Relations Coordinator
EPA, Region 9

- Review Agenda

Background – Alexis Strauss
(5 MINUTES)
Section Chief
Enforcement Response Section
EPA, Region 9

- Site History & Superfund Process

Investigation Results – Jeff Rosenbloom
(20 MINUTES)
Project Manager
EPA, Region 9

- What We Know
- What Additional Information Is Needed
- How We'll Get The Needed Information

Health Effects Review – Don Hawkins
(5 MINUTES)
Public Health Advisor
Center for Disease Control

Comment, Questions & Answers

SUPERFUND PROCESS

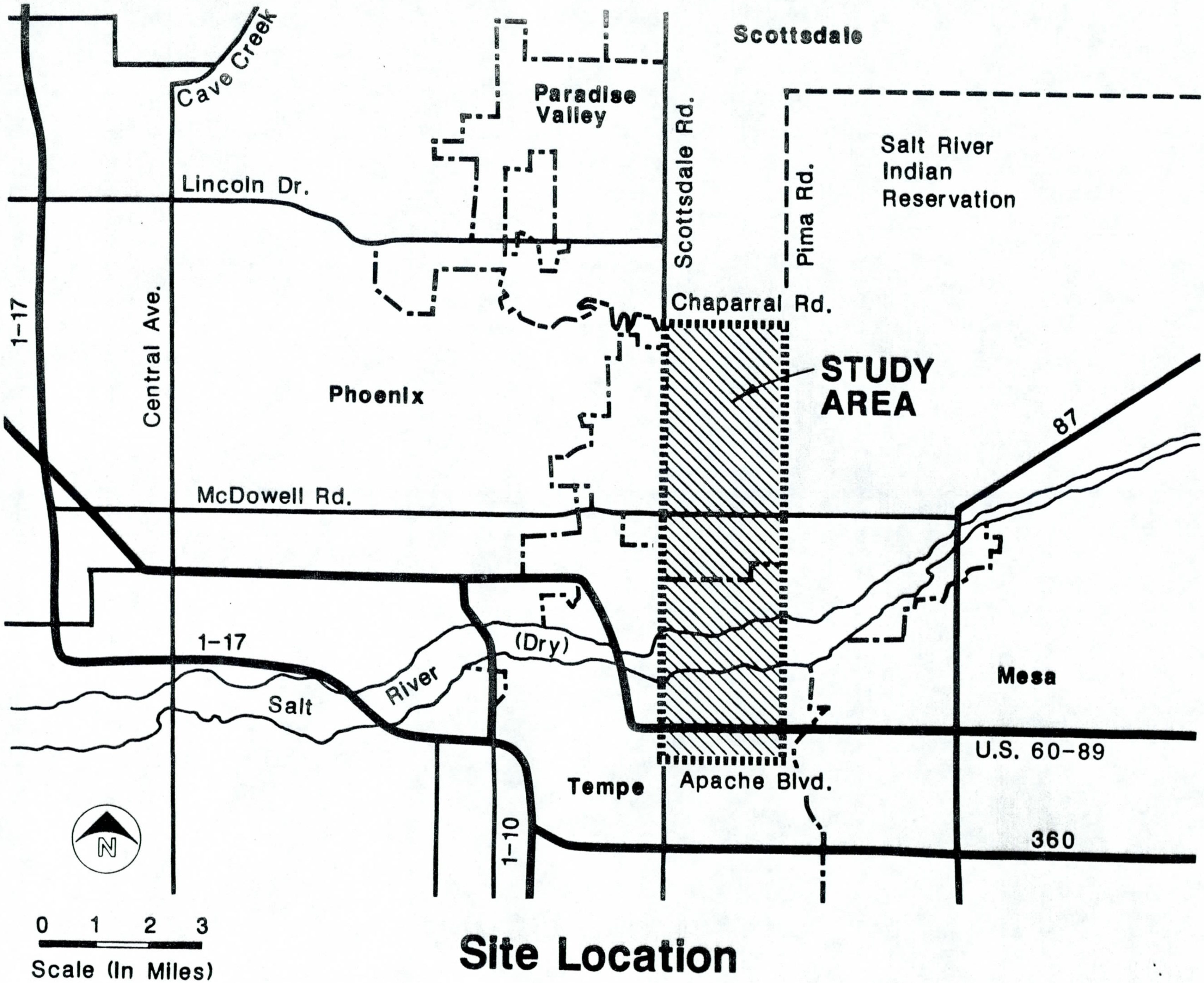
REMEDIAL INVESTIGATION

FEASIBILITY STUDY

RECORD OF DECISION

REMEDIAL DESIGN

REMEDIAL ACTION



Site Location

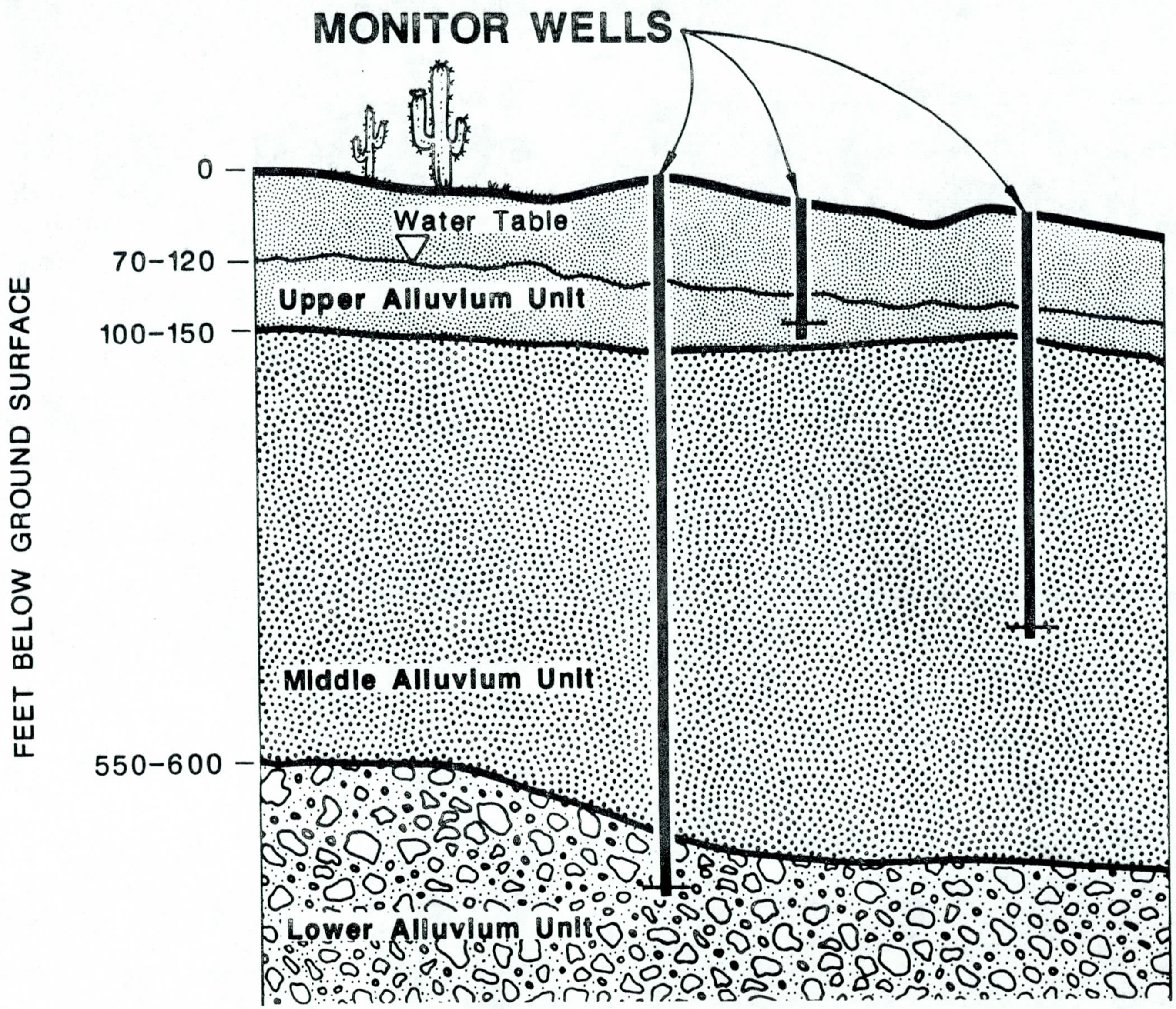
PHASE I–GOALS

* STUDY GEOLOGY AND HYDROLOGY

* UNDERSTAND VERTICAL EXTENT OF GROUND WATER CONTAMINATION

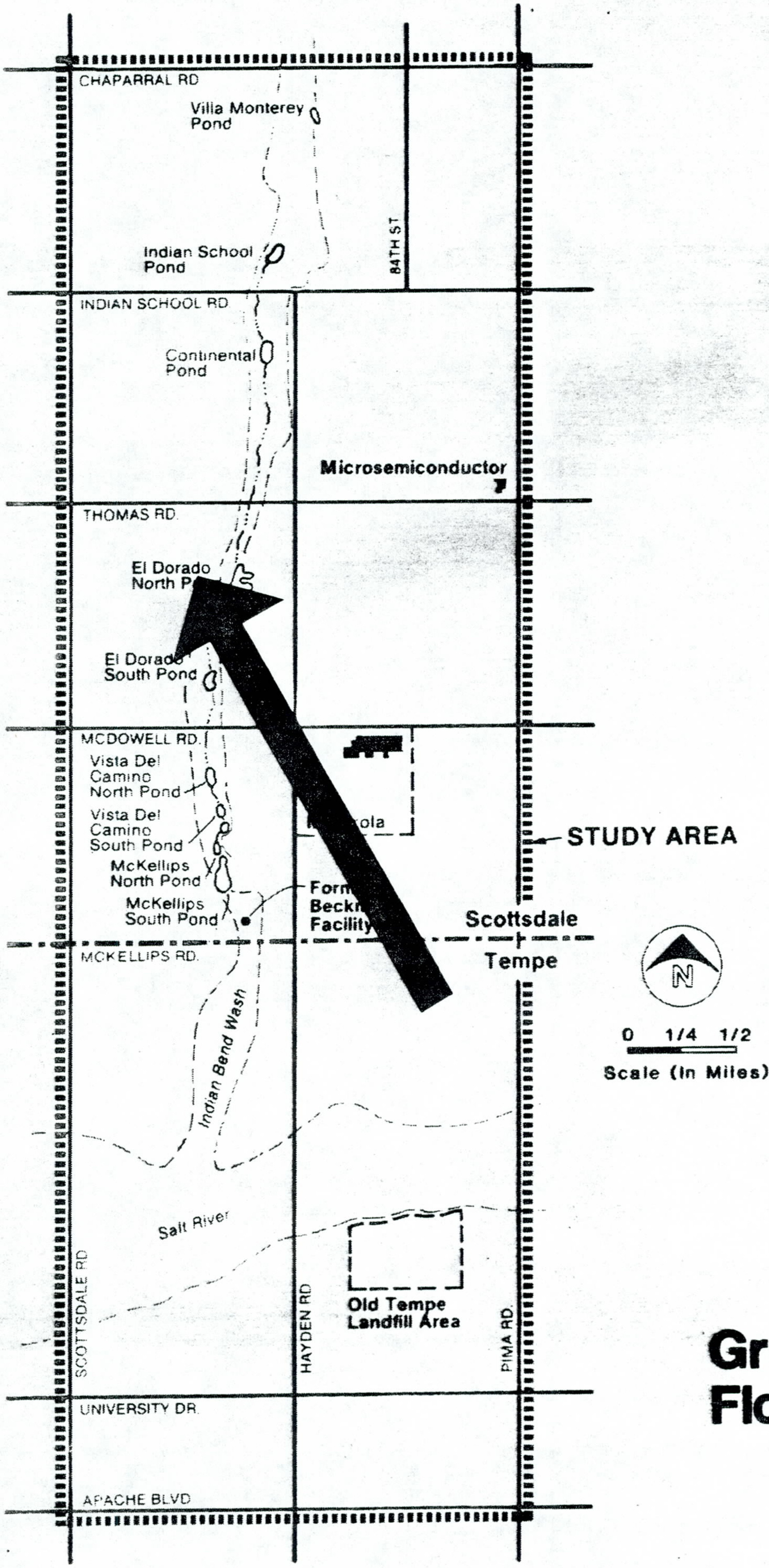
* INVESTIGATE SOURCES OF CONTAMINATION

* SAMPLE COMMUNITY SUPPLY WELLS



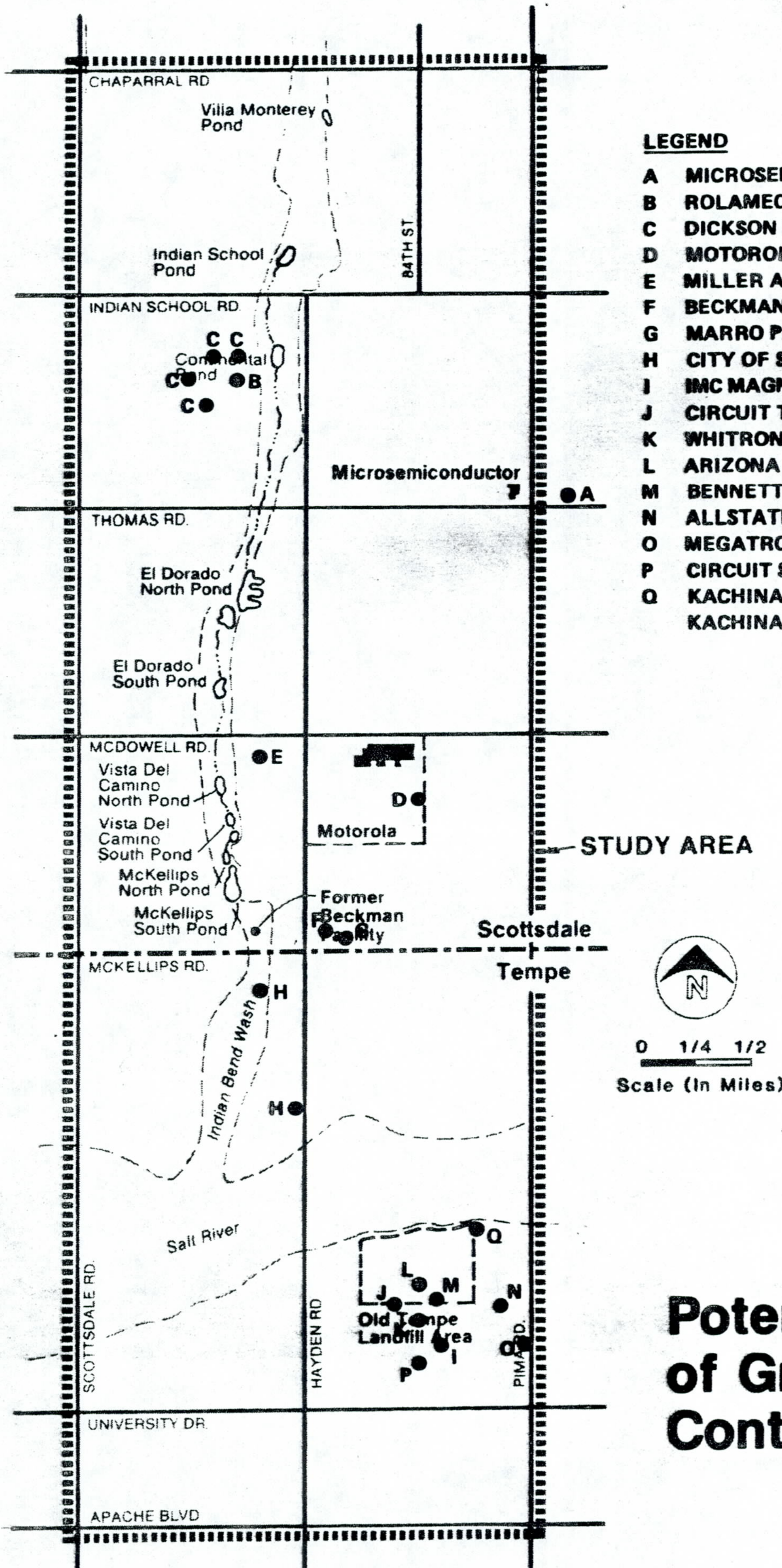
Subsurface Geology and Well Placement

(CONCEPTUAL REPRESENTATION)



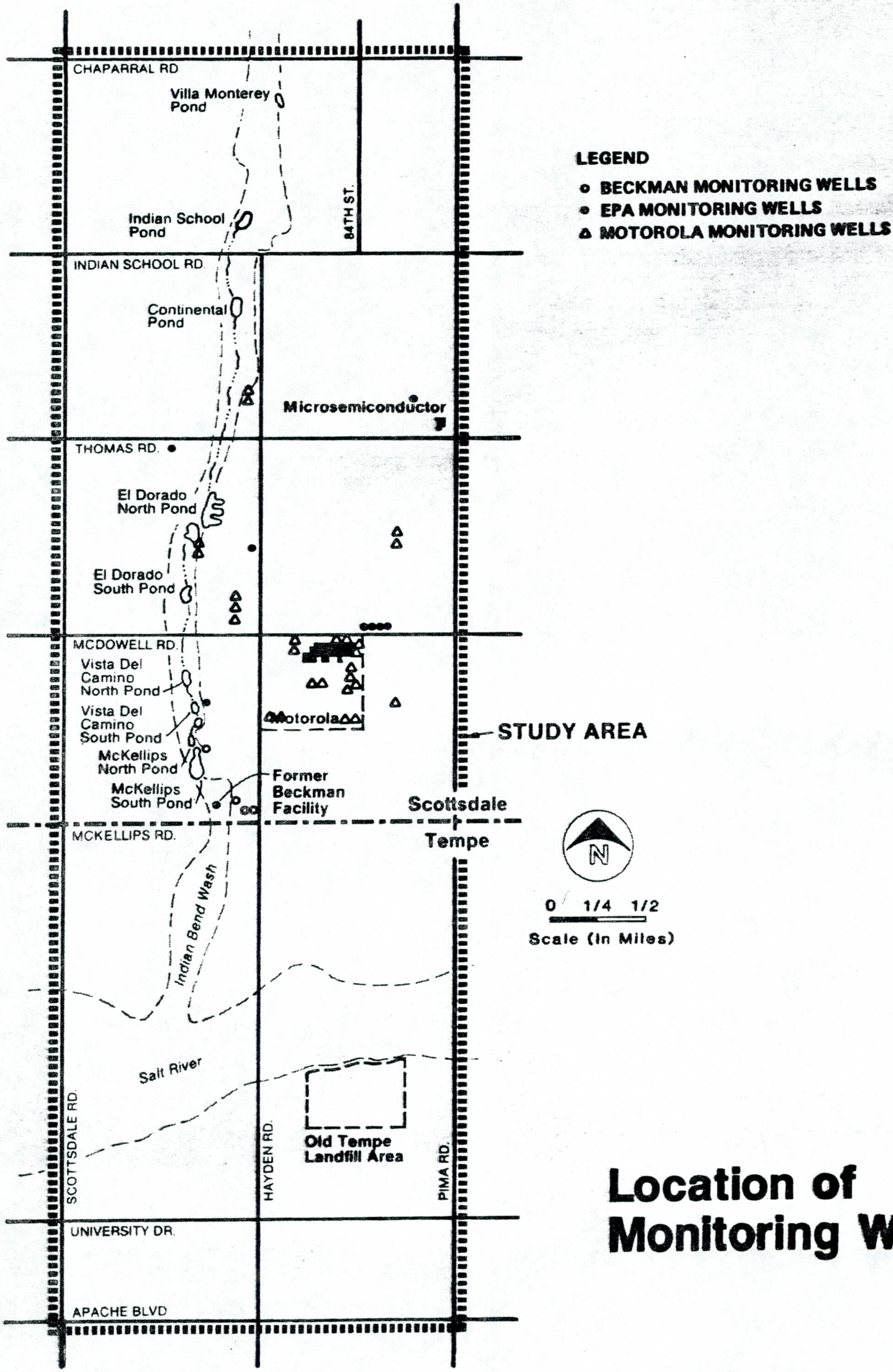
Groundwater Flow Direction

Potential Sources of Groundwater Contamination

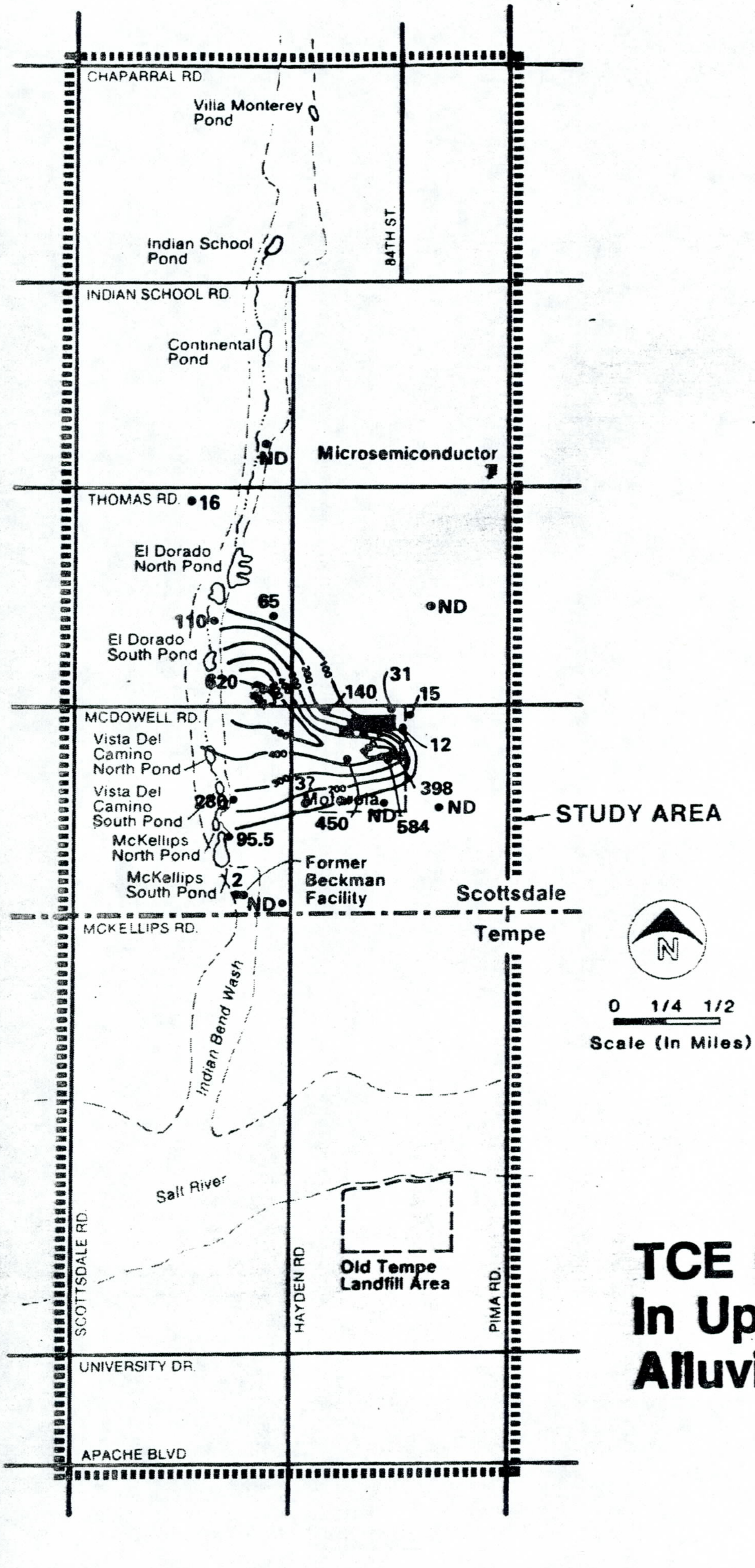


LEGEND

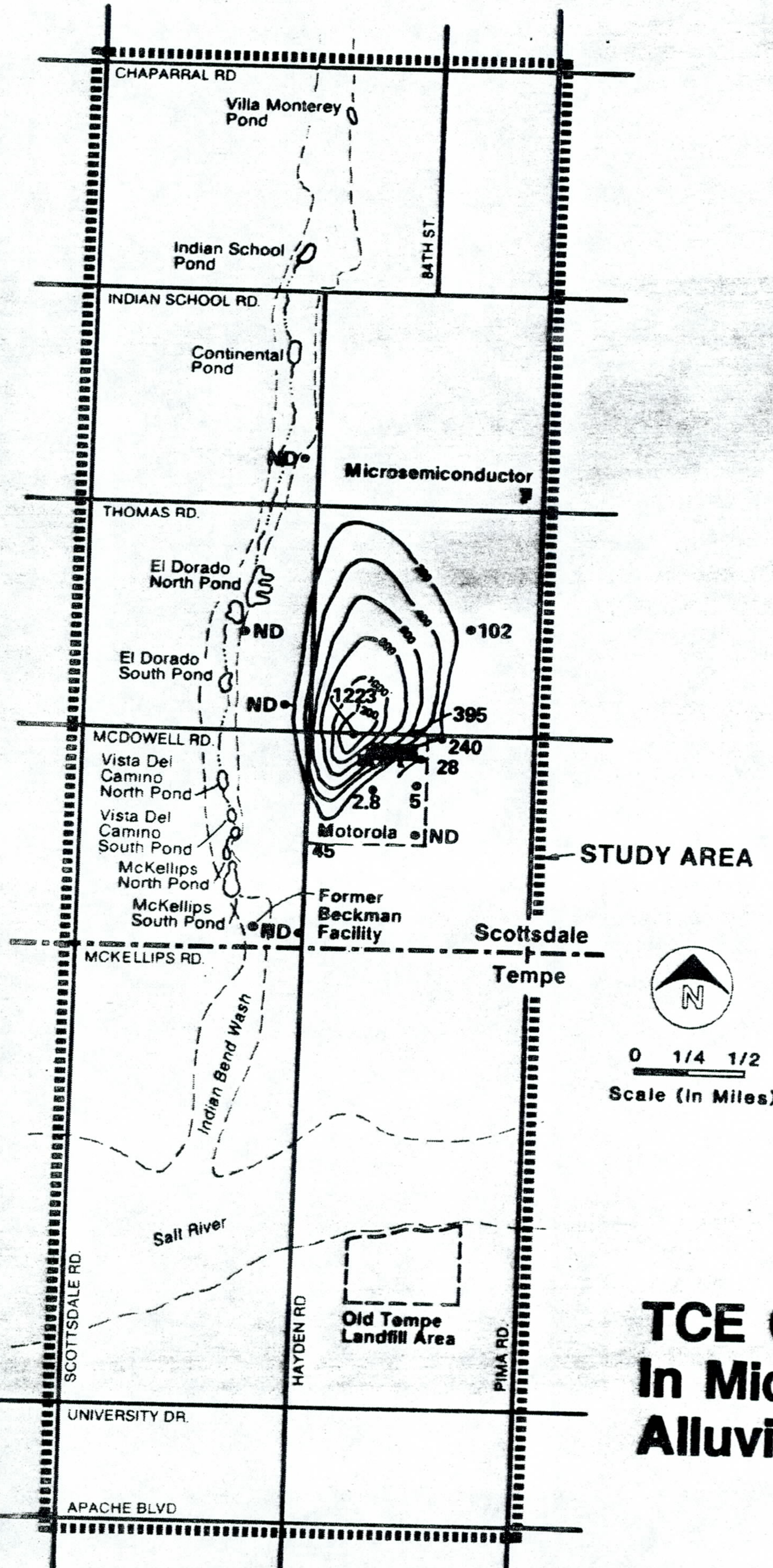
- **A** MICROSEMICONDUCTOR
- **B** ROLAMECH
- **C** DICKSON ELECTRONICS
- **D** MOTOROLA
- **E** MILLER AND MCDOWELL PROPERTY
- **F** BECKMAN INSTRUMENTS
- **G** MARRO PLATING
- **H** CITY OF SCOTTSDALE SEWAGE PONDS
- **I** IMC MAGNETICS
- **J** CIRCUIT TECHNOLOGY
- **K** WHITRONICS
- **L** ARIZONA CASTING
- **M** BENNETT BROTHERS RECYCLING
- **N** ALLSTATE MINE SUPPLY
- **O** MEGATRONICS
- **P** CIRCUIT SPECIALISTS
- **Q** KACHINA REDIMIX, TEMPE LANDFILL, KACHINA LANDFILL



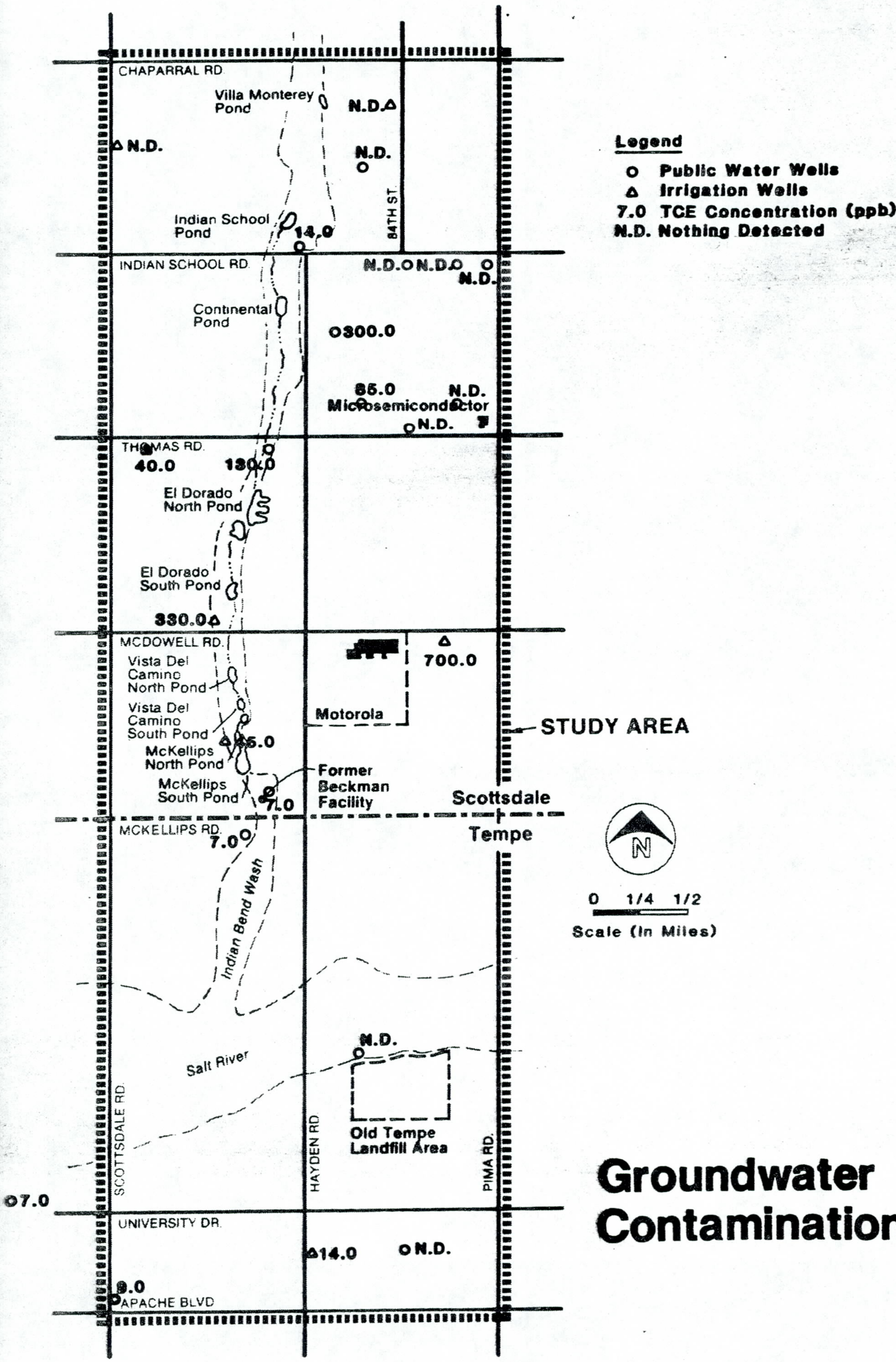
Location of Monitoring Wells



TCE Concentration In Upper Alluvium Unit



TCE Concentration In Middle Alluvium Unit



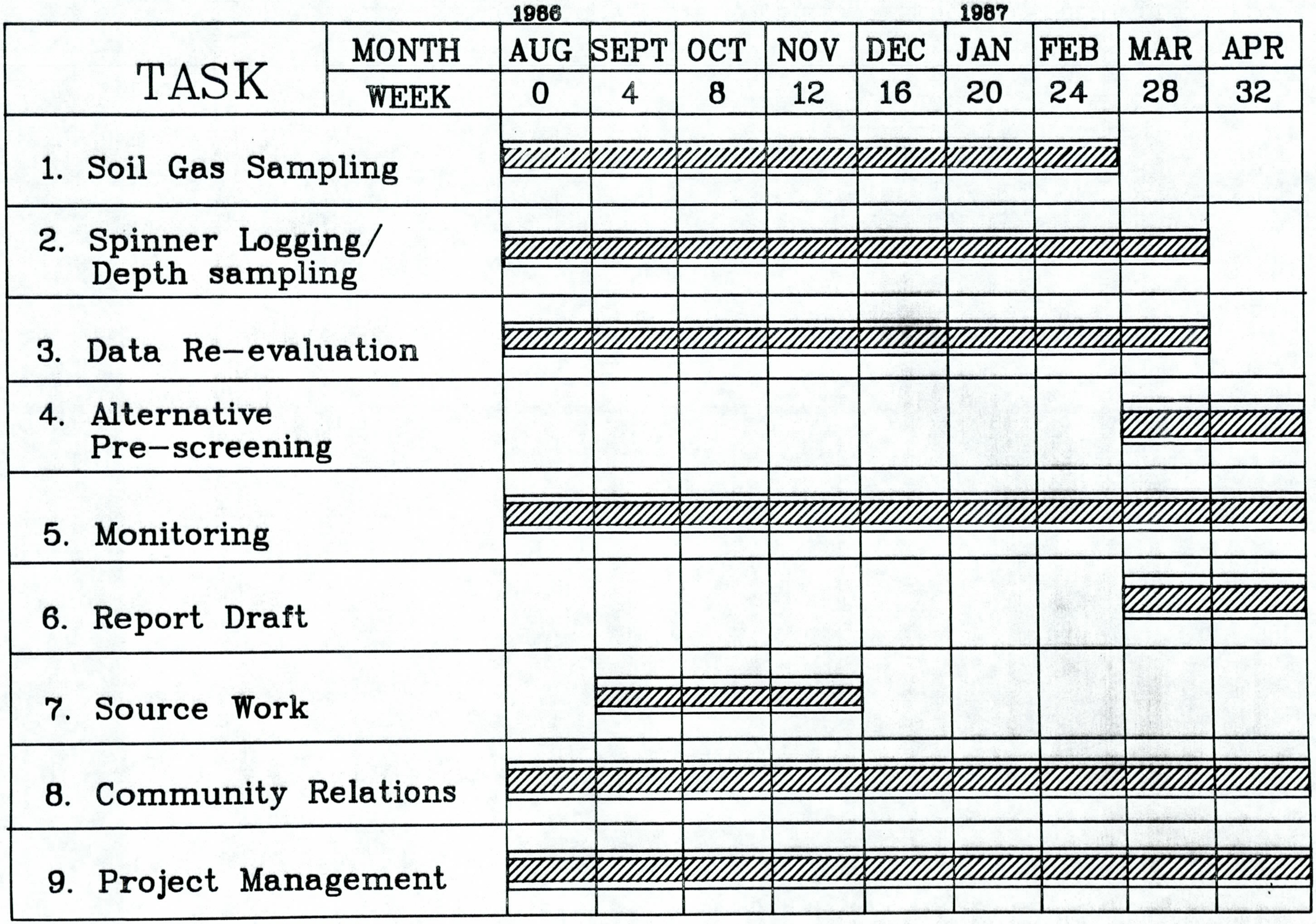
Groundwater Contamination Map

ADDITIONAL INFORMATION NEEDED

* DETERMINE HOW FAR THE GROUND WATER CONTAMINATION HAS SPREAD

* FURTHER DEFINE THE DISPOSAL ACTIVITIES IN THE INDIAN BEND WASH AREA

INDIAN BEND WASH
PHASE II/STAGE I SCHEDULE



FEASIBILITY STUDY

1. DEVELOP ALTERNATIVES

2. EVALUATE ALTERNATIVES

3. USING DATA FROM THE INVESTIGATION AND PUBLIC INPUT, DECIDE ON CLEAN-UP ALTERNATIVE

COMMUNITY MEETING EVALUATION

INDIAN BEND WASH

AUGUST 19, 1986

Please take a few minutes to complete this evaluation of tonight's meeting and leave it at the sign-in table as you depart. Your comments will help us shape future meetings and improve our interactions with you.

1. How did you learn about this meeting?

_____ Radio

_____ EPA flyer

_____ Newspaper announcement

_____ Community group flyer

_____ Neighbor/friend

_____ Television

_____ Other ______________________________

2. On a scale of 1 to 5 (5 being YES! and 1 being NO!, please rate the following items by circling the appropriate number and adding your comments:

	YES!				NO!
a. Did you find the presentation informative? What would make them better?	5	4	3	2	1
b. Did our use of graphics enhance your understanding of the Superfund process and site contamination? How could the graphics be improved?	5	4	3	2	1
c. Did the question and answer session meet your needs? How can we better communicate with you?	5	4	3	2	1
d. Do you like this meeting location? Where and when should the next meeting be held?	5	4	3	2	1

3. Are there any outstanding questions or issues you would like addressed in the next fact sheet or community meeting?