DOCKETED

Docket Number:	97-AFC-01C
Project Title:	High Desert Power Plant
TN #:	212824
Document Title:	High Desert Update of Groundwater Model Mesh - Dec. 2002
Description:	N/A
Filer:	AbdelKarim Abulaban
Organization:	LDBond & Associates
Submitter Role:	Applicant Consultant
Submission Date:	8/17/2016 2:44:58 PM
Docketed Date:	8/17/2016

HIGH DESERT POWER PROJECT LLC

www.HIGHDESERTPOWER.com

HIGH DESERT POWER PROJECT
UPDATE OF GROUNDWATER MODEL MESH

December 2002

Prepared for
High Desert Power Project, LLC

Prepared by
Timothy J. Durbin, Inc.
5330 Primrose Drive, Suite 228
Fair Oaks, CA 95628

TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

TABLE OF CONTENTS

1.0 Introduction **1**
2.0 Hydrogeology of Study Area **3**
2.1 Non-water-bearing rocks 3
2.2 Water-bearing deposits 3
3.0 Groundwater-Model Mesh **7**
3.1 Construction of mesh 7
3.2 Assignment of aquifer-parameter values 8
3.3 Specification of boundary conditions 10
4.0 References Cited **12**

LIST OF FIGURES

Figure 1-1 Map showing location of HDPP plant and well field.
1-2 Map showing hydrologic subareas within the Mojave River basin.
1-3 Map showing hydrogeologic features within the Mojave River basin.
1-4 Map showing location of study area within the Mojave River basin.
2-1 Map showing alluvial geology within study area.
2-2 Map showing hydrogeology and section locations within study area.
2-3 Sections showing hydrogeologic units.
2-4 Map showing thickness of river alluvium.
2-5 Map showing base elevation of river alluvium.
2-6 Map showing thickness of upper alluvium.
2-7 Map showing base elevation of upper alluvium.
2-8 Map showing thickness of middle aquitard.
2-9 Map showing base elevation of middle aquitard.
2-10 Map showing thickness of lower alluvium.
2-11 Map showing base elevation of lower alluvium.
2-12 Map showing thickness of deep alluvium.
2-13 Map showing base elevation of deep alluvium.
3-1 Map showing finite-element mesh for groundwater model.
3-2 Map showing elevation of groundwater table.
3-3 Diagram showing layering scheme and typical node columns within the groundwater-model mesh.
3-4 Fence diagram showing perspective view of groundwater-model mesh.
3-5 Map showing outcrops of hydrogeologic units on top surface of groundwater model mesh.
3-6 Map showing boundary conditions.

LIST OF TABLES

Table 2-1 Geologic units within study area.
2-2 Assignment of geologic units to hydrogeologic units.
3-1 Assignment of aquifer-parameter values to hydrogeologic units:
a. Northern area.
b. Southern area.
c. Eastern area and faults.

2.0 HYDROGEOLOGY OF STUDY AREA

The study area is underlain by both non-water-bearing and water-bearing rocks and deposits (California Department of Water Resources, 1967). The non-water-bearing rocks include crystalline and sedimentary basement rocks. These rocks are exposed on the mountains and hills surrounding the study area (Figure 1-3). The water-bearing deposits consist principally of alluvial material (Figure 2-1). These deposits underlie the entire study area. The alluvial deposits in the study area are part of the regional groundwater system. The non-water-bearing rocks form the base and lateral boundaries of that groundwater system.

2.1 Non-Water-Bearing Rocks

The non-water-bearing rocks are Tertiary and pre-Tertiary in age. They include volcanic rocks, continental deposits, and a basement complex. However, within the study area the basement-complex rocks predominate. The volcanic rocks include extrusive and intrusive rhyolite, andacite, and basalt. The continental deposits include conglomerate, sandstone, siltstone, and fresh-water limestone. The basement complex includes intrusive and metamorphic rocks. Granite is the predominant intrusive rock.

2.2 Water-Bearing Deposits

Principal Geologic Units within Study Area

The water-bearing deposits in the study area are shown on Figure 2-1 and are listed in Table 2-1. The units of primary importance are (with increasing age from late Holocene to early Pleistocene) river deposits (Qra), older alluvium (Qoa), older fan deposits (Qof), and the Harold Formation (Qh). Other deposits of minor importance include dune sand (Qds), younger alluvium (Qal), younger fan deposits (Qyf), old lake deposits (Qol), and the Shoemaker Gravel (Qs).

The river deposits consist of unweathered unconsolidated deposits of boulders, gravel, and silt, and are late Holocene in age. These deposits occur along the Mojave River channel (Figure 2-1). The maximum thickness is only about 100 ft. However, throughout the study area, the river deposits are highly permeable.

The older alluvium consists of unconsolidated and partially consolidated interbedded deposits of gravel, sand, silt, and clay. The older alluvium is late Pleistocene in age. These deposits underlie the central and northern parts of the study area, and they crop out over their geographic extent, except where overlain by small areas of younger deposits. The maximum thickness is about 700 ft. The older alluvium is moderately permeable.

The older fan deposits consist of weathered moderately-consolidated gravel, sand, and silt. In some areas, these deposits are cemented with caliche deposits. The older fan deposits are middle Pleistocene in age. These deposits occur throughout the study area, except where the Harold Formation crops out along the southern margin of that study area. The older fan deposits crop out principally within the southern part of the study area. The maximum thickness is about 1300 ft. The older fan deposits are moderately to poorly permeable.

The Harold Formation consists of consolidated and moderately-consolidated silty sandstone, with lenses of gravel and clayey silt. The Harold Formation is early Pleistocene in age. The formation occurs throughout the study area. The Harold Formation crops out as a band across the southern part of the study area. The maximum thickness is about 800 ft. The Harold formation is poorly permeable.

Hydrogeologic Units within Groundwater Model

The hydrogeologic units within the study area were grouped into five hydrogeologic units (Figures 2-2 and 2-3). From upper most to lower most, the hydrogeologic units are identified as the river alluvium, upper alluvium, middle aquitard, lower alluvium, and deep alluvium (Table 2-2).

The river alluvium is comprised solely of the river deposits. The river alluvium has the same geographic extent as the river deposits (Figure 2-2). The river alluvium is as much as 100 ft in thickness. Figure 2-3 shows hydrogeologic cross sections through the study area, and Figure 2-4 and 2-5 respectively show the thickness and base elevation of the river deposits. The thickness and base elevation are based on geologic sections prepared by the California Department of Water Resources (1967, Plate 3) and U. S. Geological Survey (2001, Figures 8 and 9).

The upper alluvium includes the older alluvium and the upper coarse-grained portion of the older fan deposits. It additionally includes the dune sand, younger alluvium, younger fan deposits, and old lake deposits. The upper alluvium has a geographic extent that is larger than the older alluvium but smaller than the older fan deposits (Figure 2-2). The upper alluvium crops out over its geographic extent, except where it is overlain by the river alluvium. The upper alluvium is as much as 800 ft in thickness. Figure 2-3 shows hydrogeologic cross sections through the study area, and Figures 2-6 and 2-7 respectively show the thickness and base elevation of the upper alluvium deposits. The thickness and base elevation are based on geologic sections prepared by the California Department of Water Resources (1967, Plate 3) and the U. S. Geological Survey (2001, Figures 8 and 9). They are based additionally on driller's and geophysical logs for HDPP wells, VVWD wells, and City of Adelanto wells (Richard Slade & Associates, written communication, 2002).

The middle aquitard includes the middle fine grained portion of the older fan deposits. The middle aquitard has a geographic extent that is smaller than the upper alluvium (Figure 2-2). The middle aquitard occurs as a lenticular body that has no outcrop. The middle aquitard is as much as 200 ft in thickness. Figure 2-3 shows hydrogeologic cross sections through the study area, and Figures 2-8 and 2-9 respectively show the thickness and base elevation of the middle aquitard. The thickness and base elevation are based on geologic sections prepared by the California Department of Water Resources (1967, Plate 3). They are based additionally on driller's and geophysical logs for HDPP wells, VVWD wells, and City of Adelanto wells (Richard Slade & Associates, written communication, 2002).

The lower alluvium includes the lower thickness of the older fan deposits. The lower alluvium has a geographic extent that is the same as the older fan deposits (Figure 2-2). The lower alluvium crops out in the southern part of the study area (Figure 2-1). Elsewhere, it is overlain by the middle aquitard, except where the middle aquitard is absent. In those locations, the lower alluvium is overlain directly by the upper alluvium. The lower alluvium is as much as 1000 ft in thickness. Figure 2-3 shows hydrogeologic cross sections through the study area, and Figures 2-10 and 2-11 respectively show the thickness and base elevation of the lower alluvium. The thickness and base elevation are based on geologic sections prepared by the California Department of Water Resources (1967, Plate 3). They are based additionally on driller's and geophysical logs for HDPP wells, VVWD wells, and City of Adelanto wells (Richard Slade & Associates, written communication, 2002).

The deep alluvium is comprised primarily of the Harold Formation. It additionally includes a minor geologic unit (Shoemaker Gravel) that is older than the older fan deposits but younger than the Harold Formation. The deep alluvium has the same geographic extent as the Harold Formation. The deep alluvium crops out as a narrow band across the southern part of the study area. Elsewhere, it is overlain by the lower alluvium, and it is underlain everywhere by the basement-complex rocks. The deep alluvium is as much as 800 ft in thickness. Figure 2-3 shows hydrogeologic cross sections through the study area, and Figures 2-12 and 2-13 respectively show the thickness and base elevation of the deep alluvium. The thickness and base elevation are based on maps and geologic sections prepared by the California Department of Water Resources (1967, Plates 3 and 4).

3.0 GROUNDWATER-MODEL MESH

3.1 Construction of Mesh

A three-dimensional groundwater-model mesh was constructed to represent the five hydrogeologic units described above. The river alluvium, upper alluvium, middle aquitard, lower alluvium, and deep alluvium are represented respectively as separate layers within the mesh. The mesh is constructed from wedge-shaped elements. The elements are oriented such that the top and bottom faces of the elements are triangular and the vertical faces are rectangular. Correspondingly, the elements within a mesh layer form a pattern of triangles on a map of the mesh.

A plan view of the groundwater-model mesh is shown on Figure 3-1. A single mesh layer contains 1537 elements, which is the number of triangles shown on Figure 3-1. The mesh in total contains 7685 elements and 5016 nodes. Each wedge-shaped element has six corners, which are referred to as nodes. Because laterally and vertically adjacent elements share nodes, the total number of nodes is less than number of elements multiplied by six. The three-dimensional character of the mesh is described in *FEMFLOW3D* by specifying the Cartesian coordinates of each node and by identifying the nodes that define the corners of each respective element. The list of nodes for an element is referred to as the incidences for the element. The computer file Grid.dat contains the node coordinates and element incidences in a format for use within *FEMFLOW3D*.

The grid is constructed such that nodes occur as vertical columns. Each column has six nodes corresponding to the five hydrogeologic units. The elevation of the upper most node in a column represents the elevation of the groundwater table (Figure 3-2). The elevation of the lower most node represents the base elevation of the deep alluvium. The intermediate nodes represent either the base of a hydrologic unit or a point within a hydrologic unit, depending on the local presence or absence of particular hydrogeologic units. For example, where the lower alluvium crops out at the groundwater table, the fifth node down a column represents the base of the lower alluvium. The second through fourth nodes down represent points within the lower alluvium. These relationships are shown on Figure 3-3, which is a diagrammatic cross section through the groundwater system that illustrates the layering scheme within the groundwater-model mesh. That scheme is depicted also on Figure 3-4, which is a fence diagram that shows the three-dimensional character of the mesh.

The outcrop pattern on the top surface of the mesh (Figure 3-5) is different than the outcrop pattern at the land surface (Figure 2-2). This is the case because the groundwater table (which represents the top surface of the mesh) intersects the respective hydrogeologic units differently than the land surface intersects those units. Figure 3-5 shows the geographic extent for each hydrogeologic unit. Most notably, the middle aquitard appears on the top surface of the mesh, even though it does not crop out on the land surface.

The Turner Springs and Apple Valley Faults are represented in the groundwater-model mesh. The faults are represented by bands of narrow elements (Figure 3-5) that penetrate the entire thickness of the mesh (Figure 3-4). These faults are included in the mesh to represent vertical offsets across the faults. The sequence of hydrologic units on the north side of the Turner Springs Fault is dropped down relative to the sequence on the south side (Figures 2-3 and 3-4). Likewise, the sequence of hydrologic units on the west side of the Apple Valley Fault tends to be dropped down relative to the sequence on the east side.

3.2 Assignment of Aquifer-Parameter Values

Aquifer parameters include horizontal hydraulic conductivity, vertical hydraulic conductivity, specific storage, and specific yield. The hydraulic conductivities represent the ability of the hydrogeologic units to transmit water horizontally and vertically. The specific storage represents the capacity of a hydrogeologic unit to store or release water owing to the elastic compression or expansion of both water and the water-filled voids within the materials comprising the unit. The specific yield represents the capacity of a hydrogeologic unit to store or release water owing to the rise or fall of the groundwater table and the corresponding saturating or de-saturating of voids within the materials comprising the unit. While the specific storage represents a phenomenon that acts throughout the saturated thickness of the groundwater system, specific yield represents a phenomenon that acts just at the groundwater table.

Aquifer-parameter values are input to *FEMFLOW3D* by assigning values for hydraulic conductivity, specific storage, and specific yield to each element within the groundwater-model mesh. Separate parameter-value sets were assigned to each hydrogeologic unit for each of three regions of the study area. The southern region is the area south of the Turner Springs Fault and west of the Apple Valley Fault. The northern region is the area north of the Turner Springs Fault. The eastern region is the area east of the Apple Valley Fault. The assigned aquifer-parameter values are listed in Table 3-1. Listed also in the table are the hydraulic characteristics assigned to the Turner Springs and Apple Valley faults.

Aquifer-parameter values are assigned to hydrologic units based on the aquifer-test results for the HDPP wells F and G (Richard C. Slade & Associates, LLC, 2003a and 2003b) and on values used in the groundwater model that were developed by the U. S. Geological Survey (2001). Where parameter values were not available from these sources, reference was made to the generalized values tabulated in Maidment (1993). The reference for a particular parameter value is listed in Tables 3-1a, 3-1b, and 3-1c.

For the southern region, the horizontal hydraulic conductivity, vertical hydraulic conductivity, and specific storage for the middle aquitard, lower alluvium, and deep alluvium are based on the aquifer-testing results (Richard C. Slade & Associates, LLC, 2003a and 2003b). The specific yield for those units is based on Maidment (1993, Table 6.3.4). The horizontal hydraulic conductivity, vertical hydraulic conductivity, and specific yield for the river alluvium and upper alluvium are based on the values used in U. S. Geological Survey groundwater model (U. S. Geological Survey, 2001, Figures 19, 20, and 21). The specific storage for those units is based on Maidment (1993, Table 6.3.3).

For the northern and eastern regions, horizontal and vertical hydraulic conductivity values are based on the U. S. Geological Survey groundwater model (U. S. Geological Survey, 2001, Figure 19), except for the middle aquitard. The horizontal and vertical hydraulic conductivity of the middle aquitard are based on the aquifer-testing results (Richard C. Slade & Associates, LLC, 2003a and 2003b). The specific storage is based on Maidment (1993, Table 6.3.3), also except for the middle aquitard. The specific storage of the middle aquitard is based on the aquifer-testing results (Richard C. Slade & Associates, LLC, 2003a and 2003b). The specific yield of the river alluvium and upper alluvium are based on the U. S. Geological Survey groundwater model (U. S. Geological Survey, 2001, Figure 20). The specific yield of the middle aquitard, lower alluvium, and deep alluvium are based on Maidment (1993, 6.3.4)

Aquifer-parameter values are assigned to the Turner Springs Fault and Apple Valley Fault based on the fault-leakance values used in the U. S. Geological Survey model (U. S. Geological Survey, 2001, Table 6). The leakance assigned within that model represent the groundwater discharge across a one-foot length of a fault given a one-foot difference in groundwater level across the fault. The equivalent horizontal hydraulic conductivity for a fault, which are the values listed in Table 3-1 for the faults, was derived by considering the fault width assigned within the groundwater-model mesh (Figure 3.1).

3.3 Specification of Boundary Conditions

Three boundary-condition types are specified for the groundwater-model mesh. They are the following: a no-flow boundary, a variable-flux boundary, and a specified-head boundary. Figure 3-6 shows the boundary segments to which these conditions are applied. Boundary types describe how groundwater conditions within the study area relate to the groundwater conditions outside the study area, above the groundwater table, and below the groundwater-system base.

Where groundwater within the study area is isolated from conditions outside the study area, a no-flow boundary is applicable. A no-flow condition is applied where the alluvium within the study area contacts non-water-bearing rocks on the study-area boundary (Figure 3-6). A no-flow condition is applied also where a significant fault defines a study-area boundary that is distant from the HDPP well field. Groundwater does not flow across the alluvial contacts with non-water-bearing rocks, except in very small quantities. Likewise, groundwater does not flow across the alluvial contacts with boundary faults, except in small quantities. If the operation of the HDPP well field were to produce a change in groundwater level at such contacts, the change will not induce groundwater flow across the boundary. The no-flow condition properly represents that situation.

Where groundwater within the study area interacts with groundwater outside the study area, a variable-boundary condition is applicable (U. S. Geological Survey, 1998, pp. 42-47). A variable-flux condition is applied where the alluvium within the study area extends uninterrupted across the study-area boundary (Figure 3-6). This occurs along the boundary segment that separates the Alto Subarea from the Oeste Subarea, and it occurs along the boundary segment that separates the Alto Subarea from the Este Subarea. Groundwater exchanges occur across these boundaries. If the operation of the HDPP well field were to produce a change in groundwater level at such a boundary, the change would induce groundwater flow across the boundary. The variable-flux condition properly represents that situation.

Where groundwater within the study area interacts with the Mojave River, a specified-head boundary condition is applicable (U. S. Geological Survey, 1998, pp. 27-31). A specified-head condition is applied along the Mojave River where the elevation of the groundwater table is at the elevation of the riverbed (Figure 3-6). This occurs along the Mojave River within the middle and northern parts of the study area. Along other river reaches, the groundwater table is substantially below the riverbed, and a direct hydraulic connection does not occur between the groundwater system and the river. Correspondingly, a boundary-condition specification is not required for those reaches.

4.0 REFERENCES CITED

Bookman-Edmonston Engineering, Inc., 1999, Addendum number 2 to the evaluation of alternative water supplies for the High Desert Power Project: Consulting report prepared for High Desert Power Project, LLC.

California Department of Water Resources, 1967, Mojave River ground water basins investigation: Bulletin No. 84.

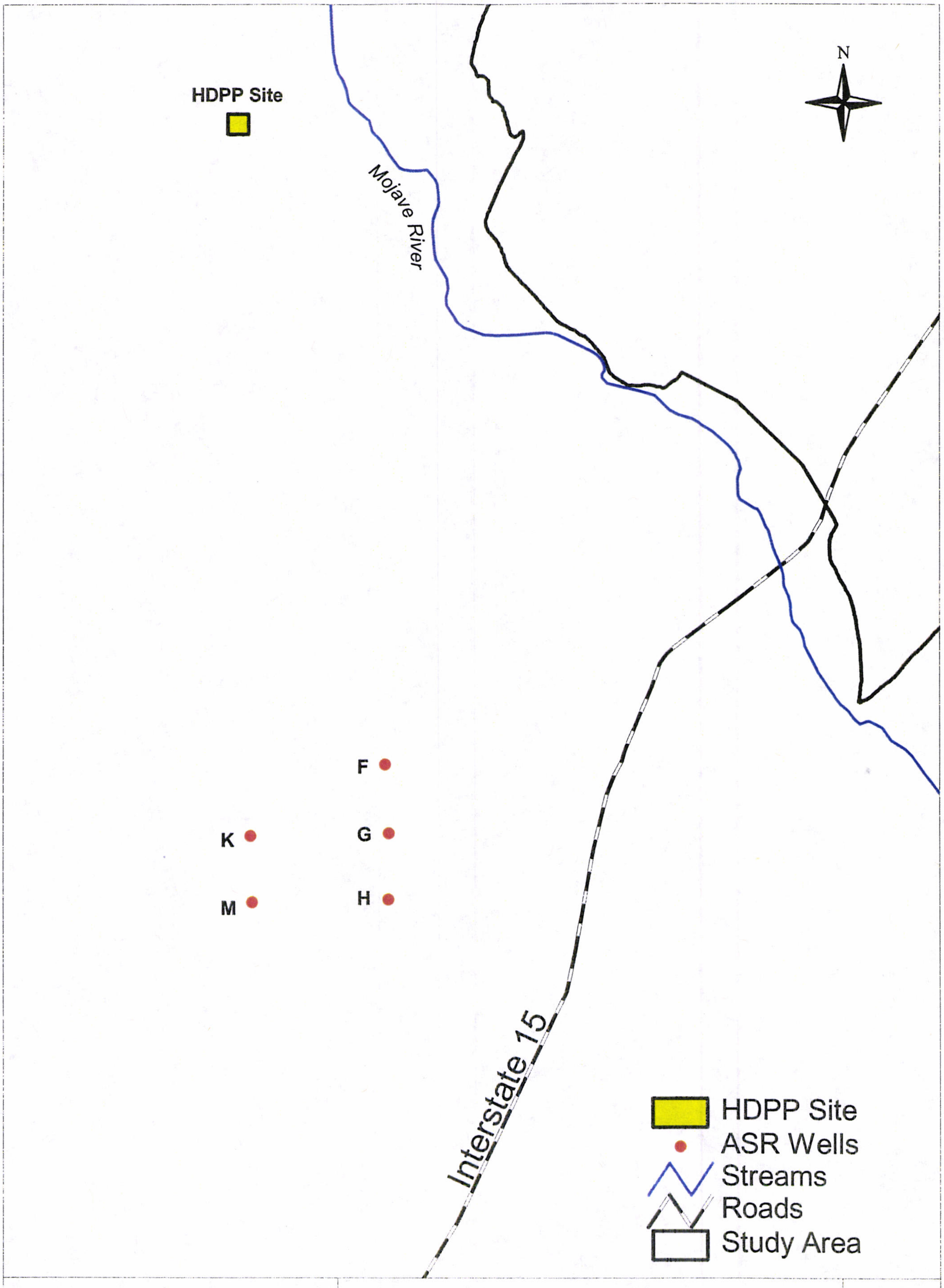
Maidment, D. R., 1993, Handbook of hydrology: New York, McGraw-Hill.

Richard C. Slade & Associates, LLC, 2003a, Report of aquifer testing and injection testing, Aquifer storage and recovery well G, High desert Power Project, Victorville area, California: Consulting report prepared for High Desert Power Project, LLC.

Richard C. Slade & Associates, LLC, 2003b, Report of aquifer testing and injection testing, Aquifer storage and recovery well F, High desert Power Project, Victorville area, California: Consulting report prepared for High Desert Power Project, LLC.

U. S. Geological Survey, 1998, FEMFLOW3D: A finite-element program for the simulation of three-dimensional aquifers, Version 1.0.

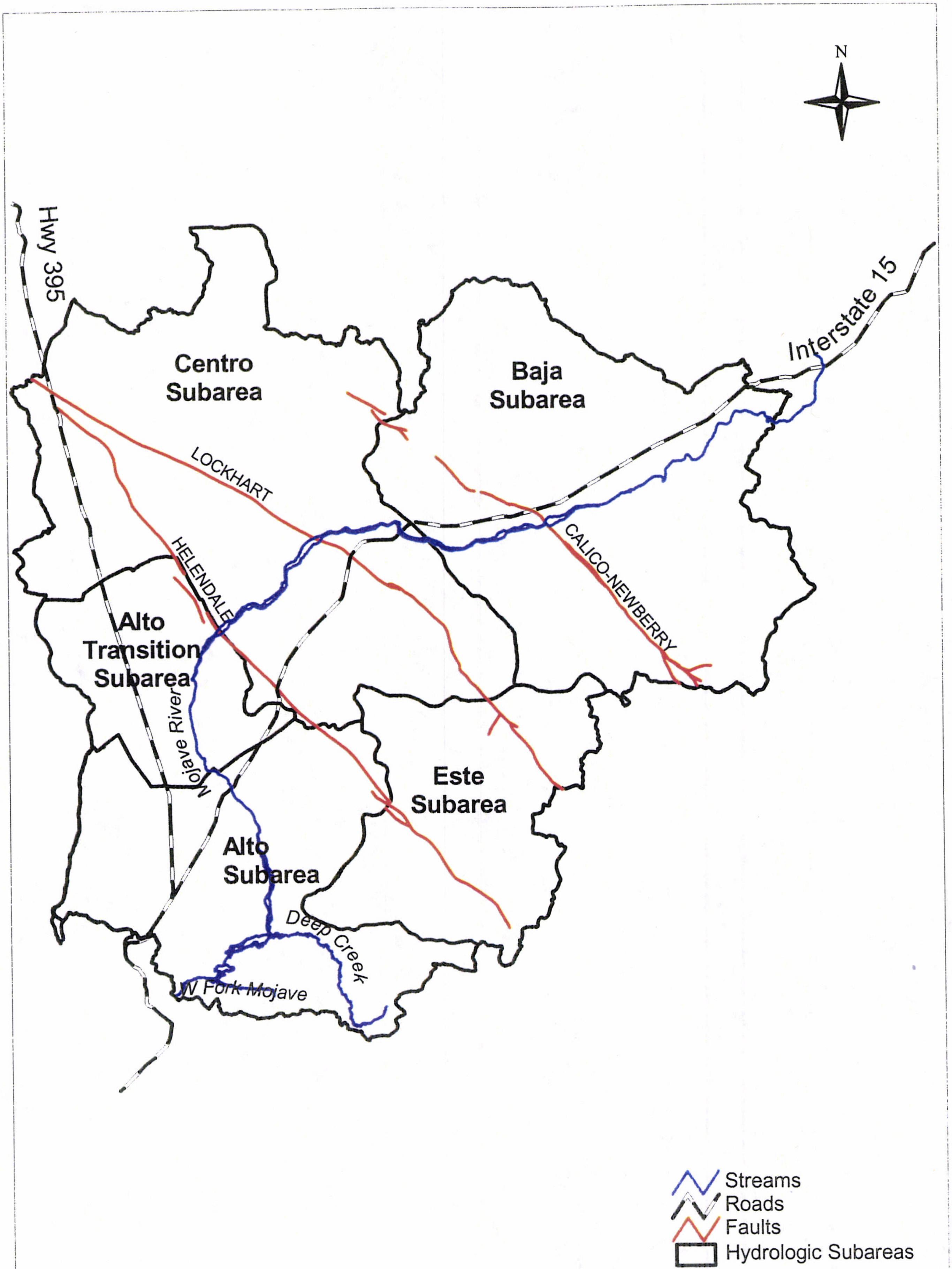
U. S. Geological Survey, 2001, Simulation of ground-water flow in the Mojave River Basin, California: Water-Resources Investigations Report 01-4002, Version 3.



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Location of HDPP Plant and Wellfield

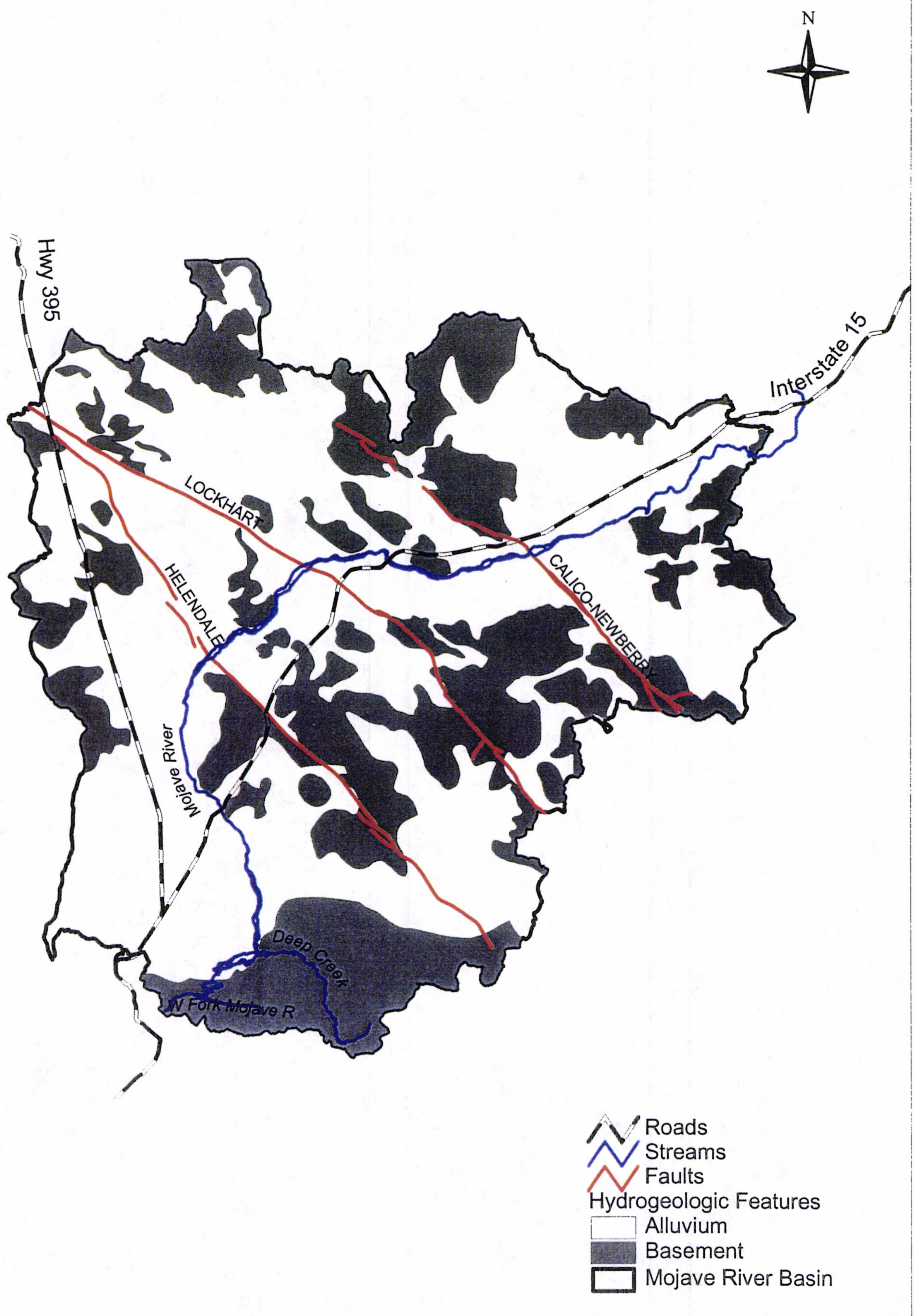
Figure 1-1



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Hydrologic Subareas within the Mojave River Basin

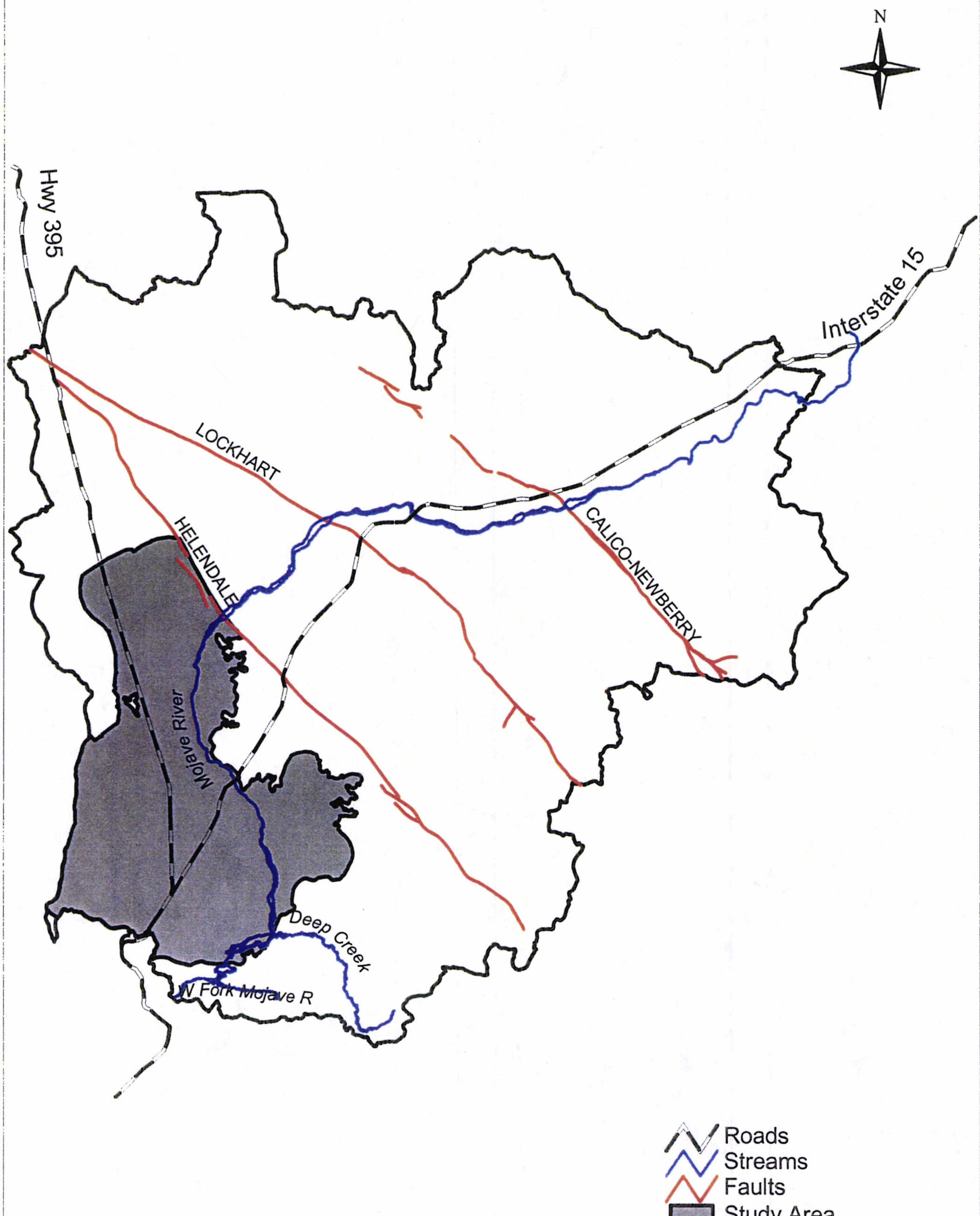
Figure 1-2



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Hydrogeologic Features within the Mojave River Basin

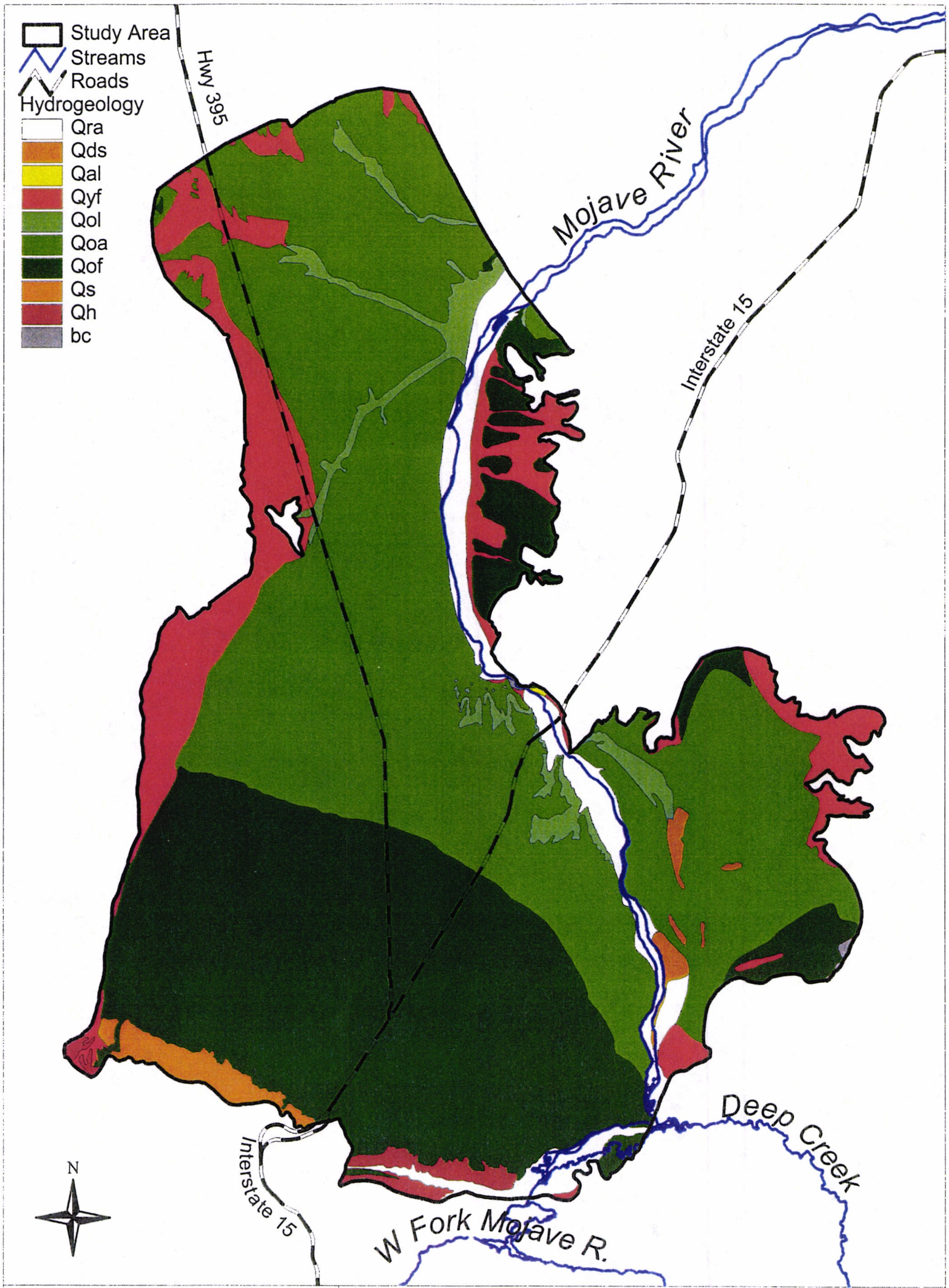
Figure 1-3



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Location of Study Area within the Mojave River Basin

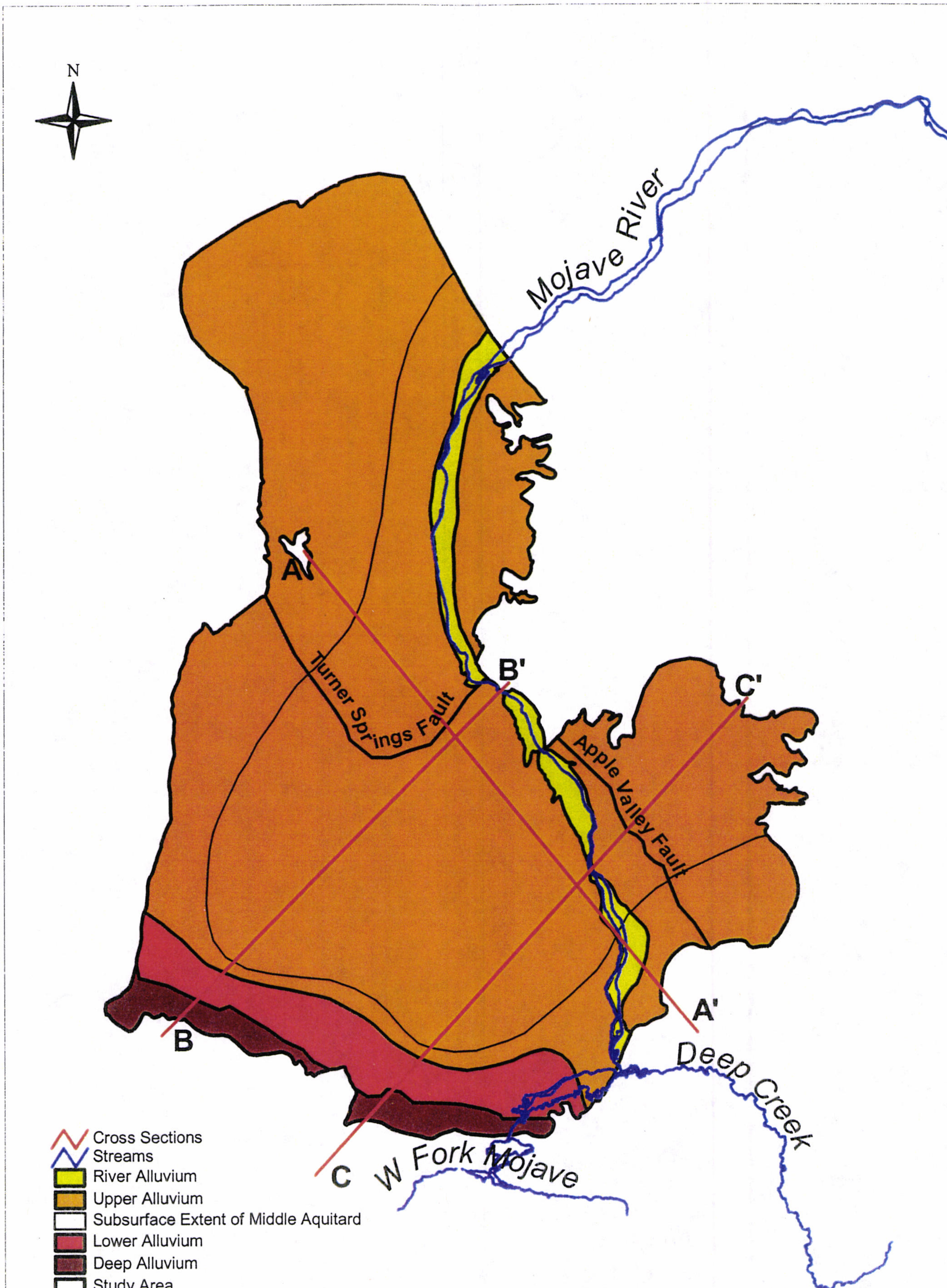
Figure 1-4



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Alluvial Geology within Study Area

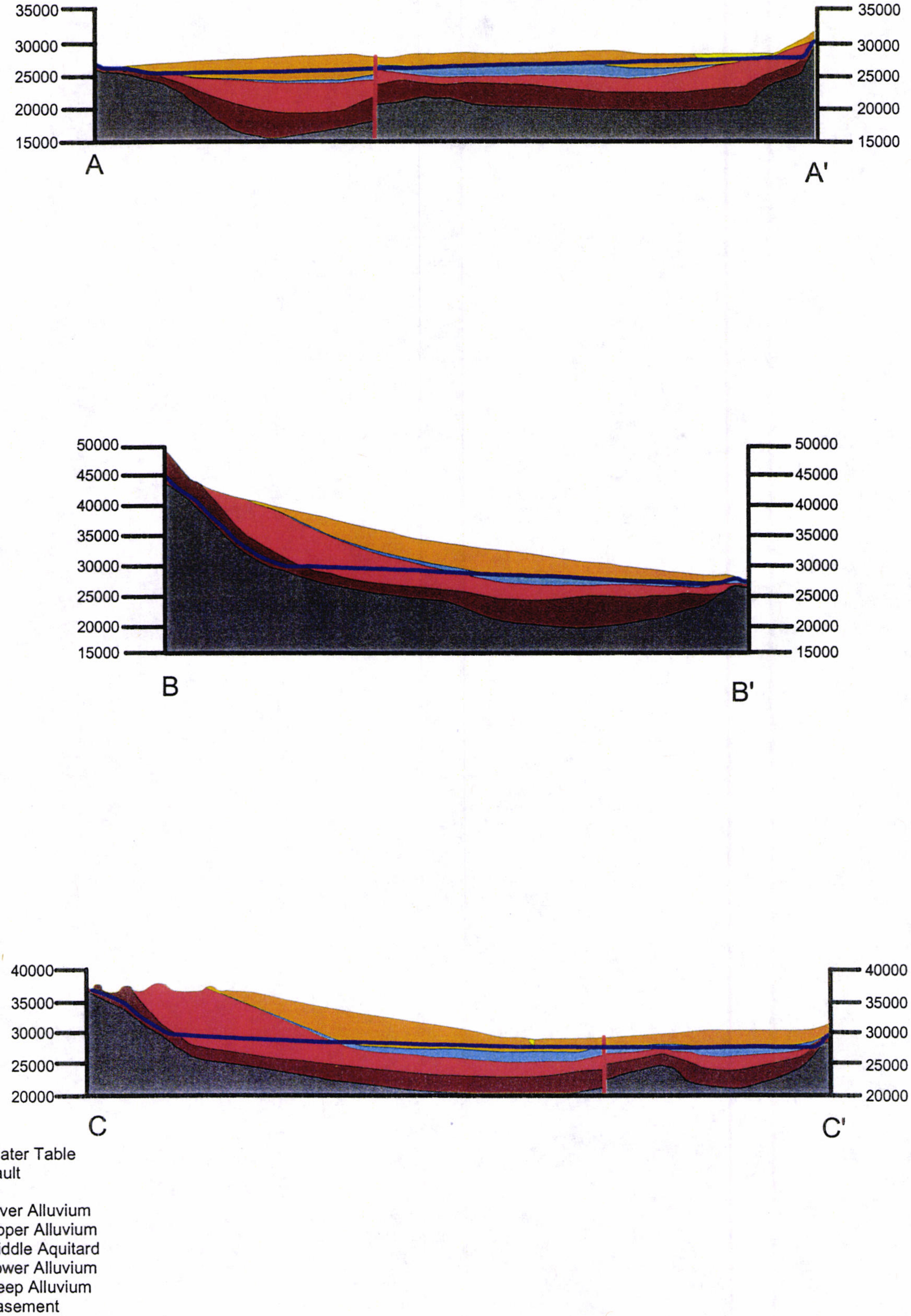
Figure 2-1



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Hydrogeology and Section Locations

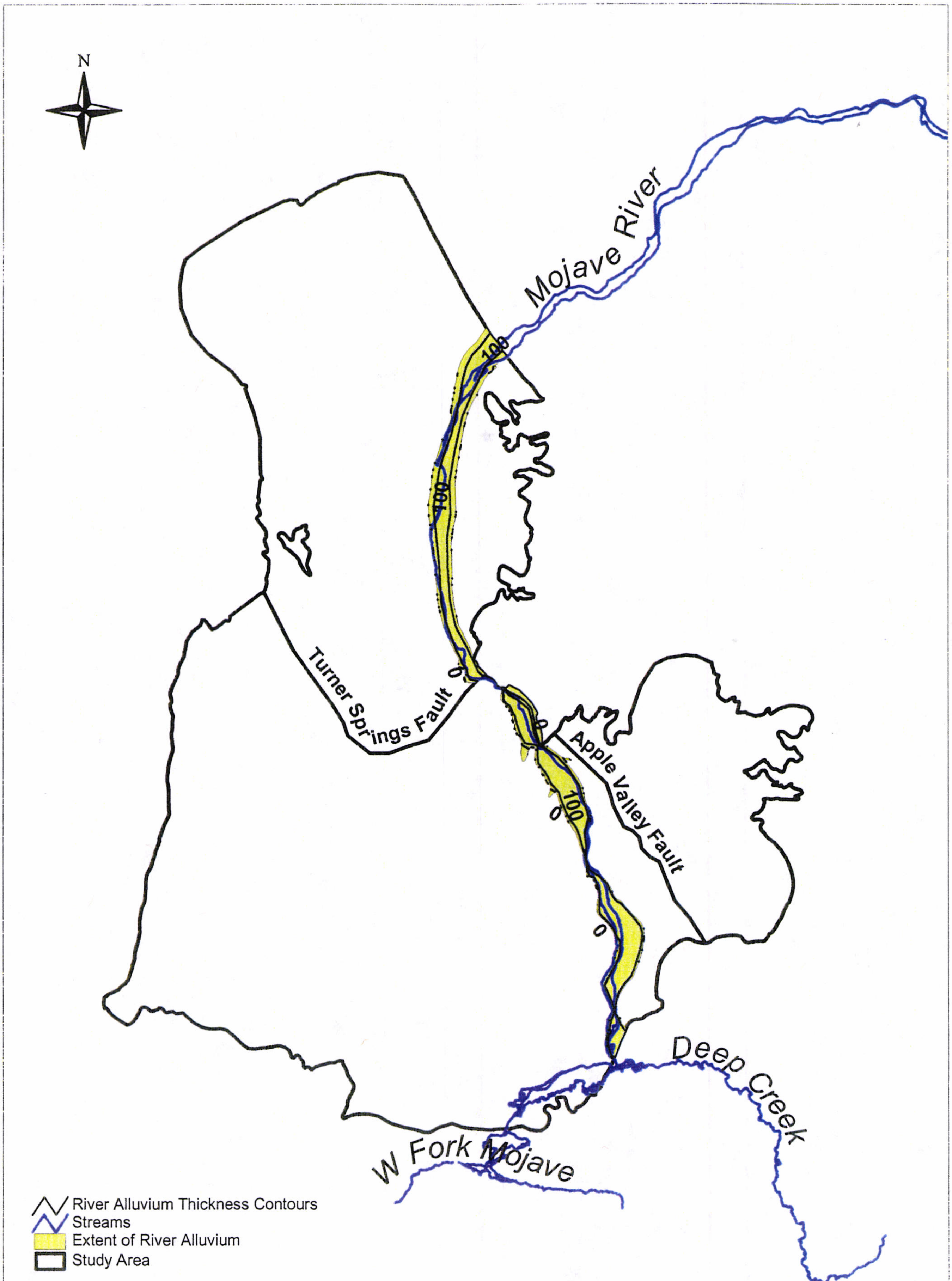
Figure 2-2



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Cross Sections

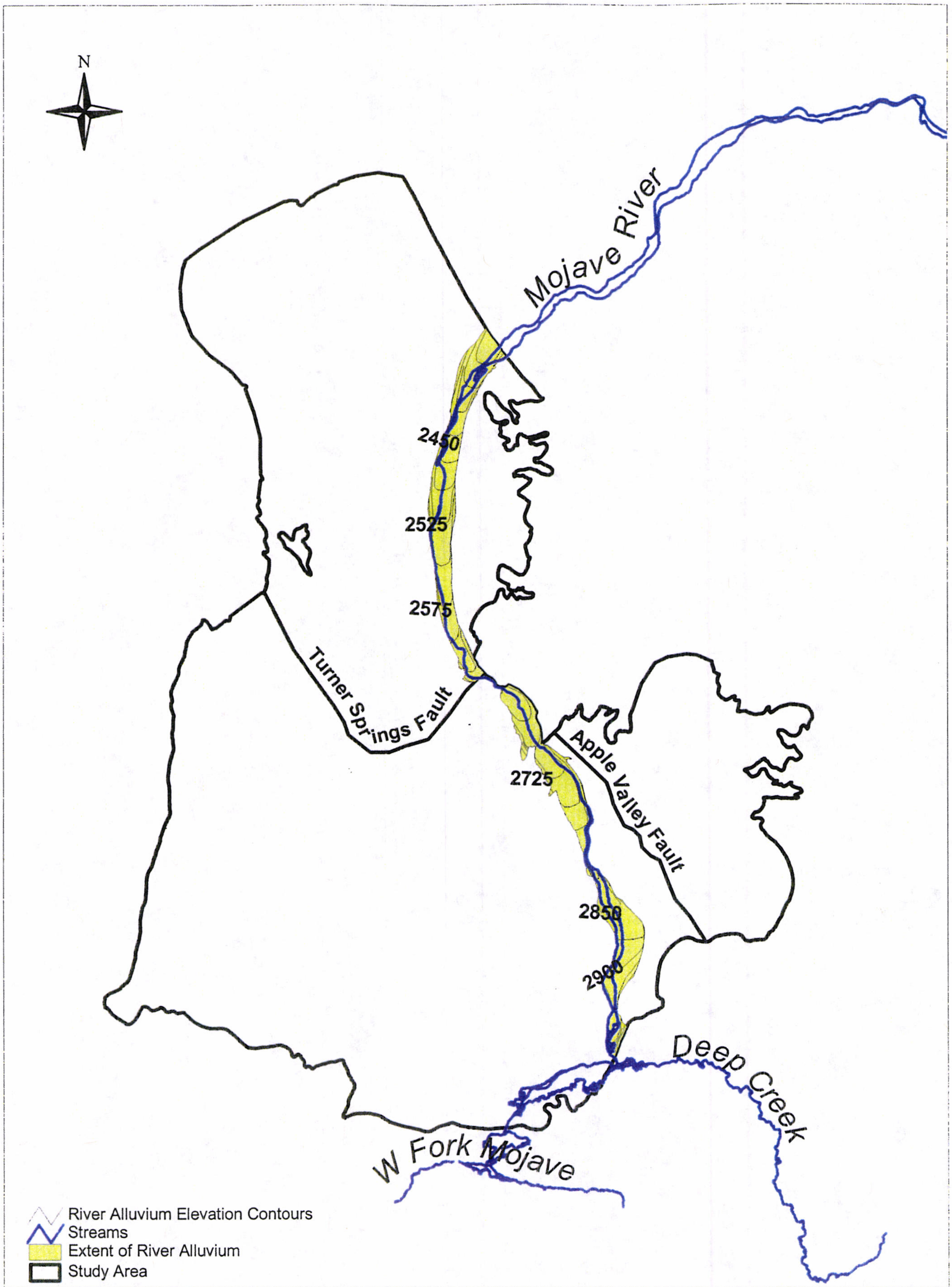
Figure 2-3



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Thickness of River Alluvium

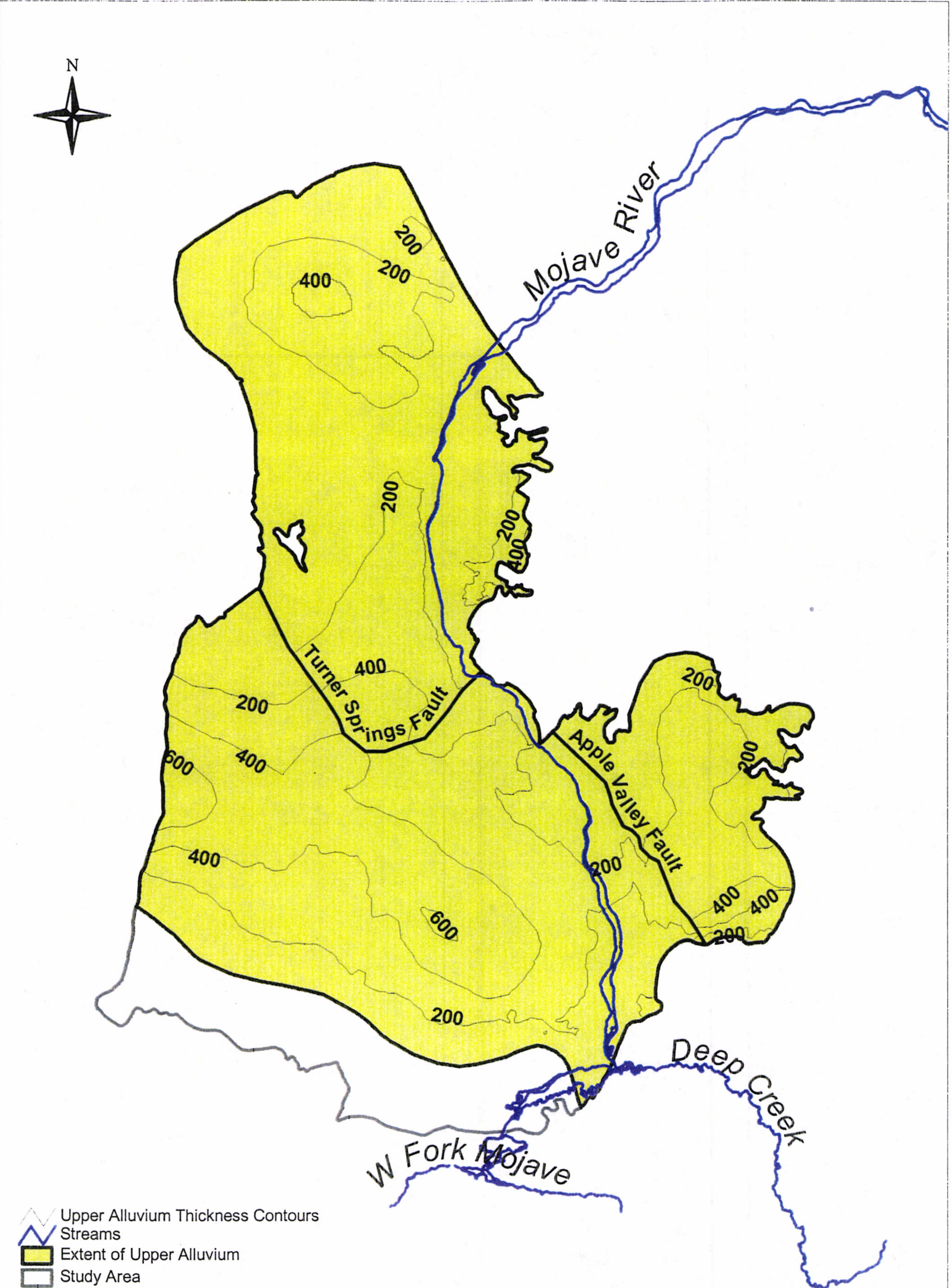
Figure 2-4



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Base Elevation of River Alluvium

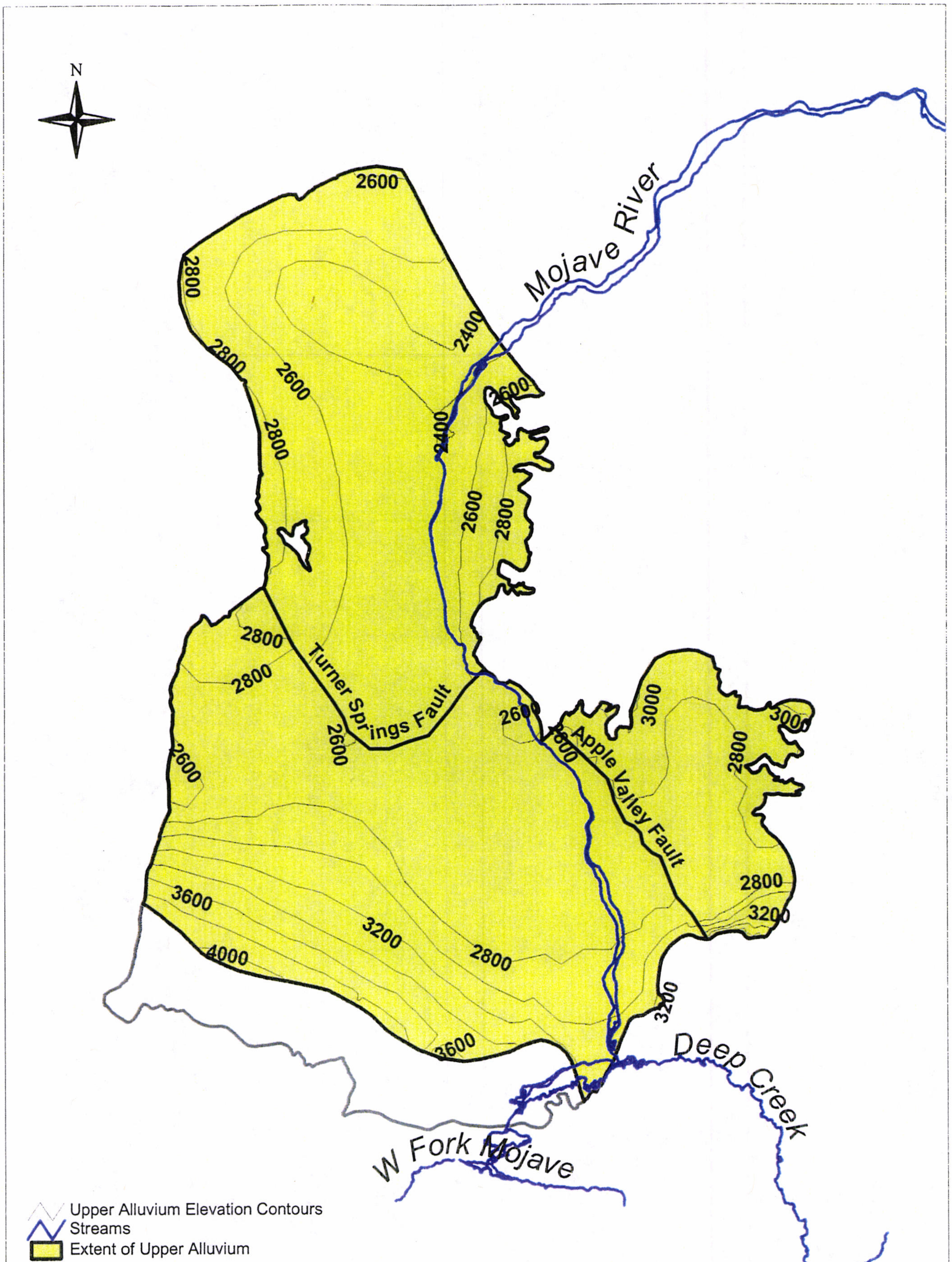
Figure 2-5



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Thickness of Upper Alluvium

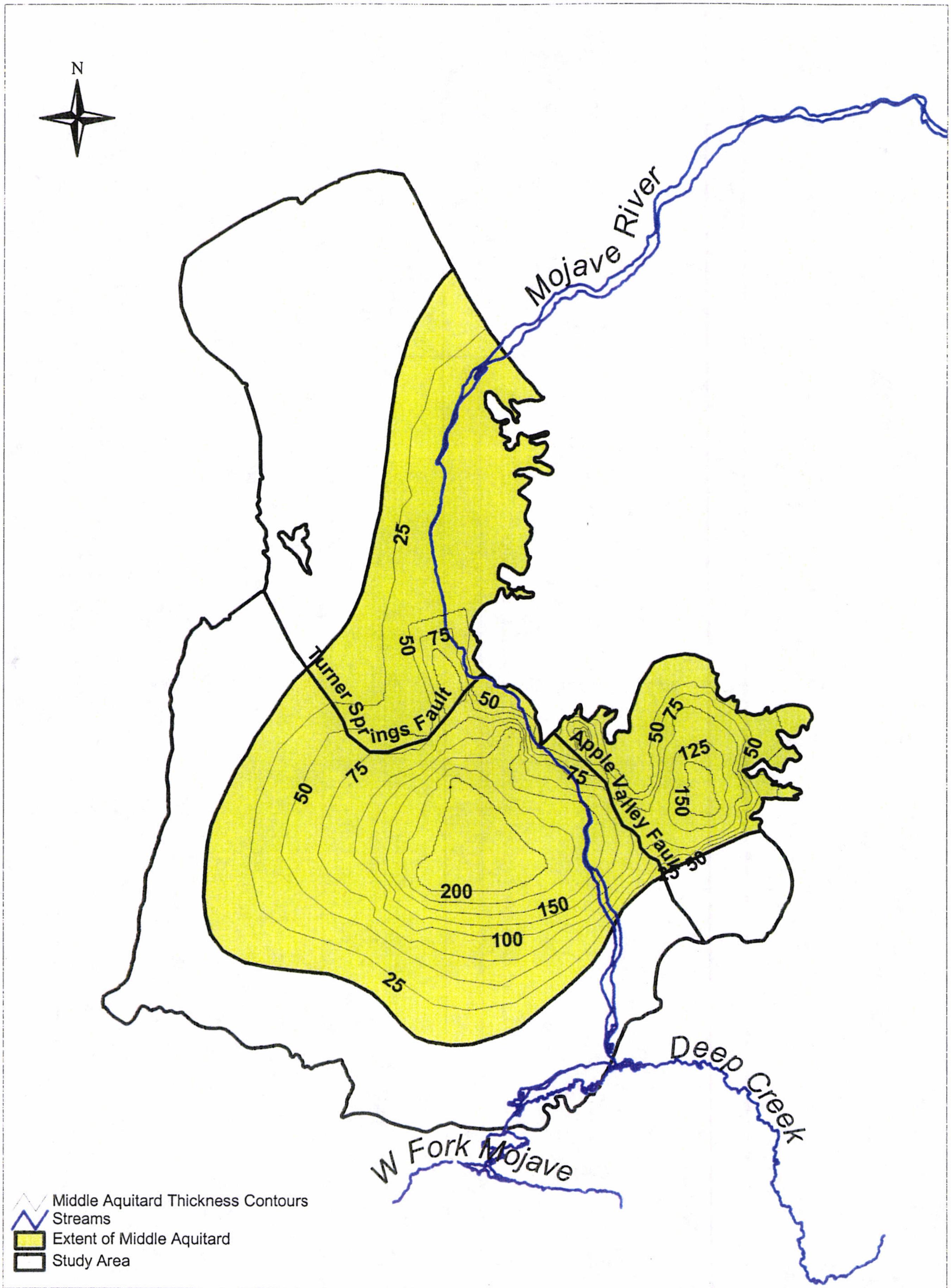
Figure 2-6



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Base Elevation of Upper Alluvium

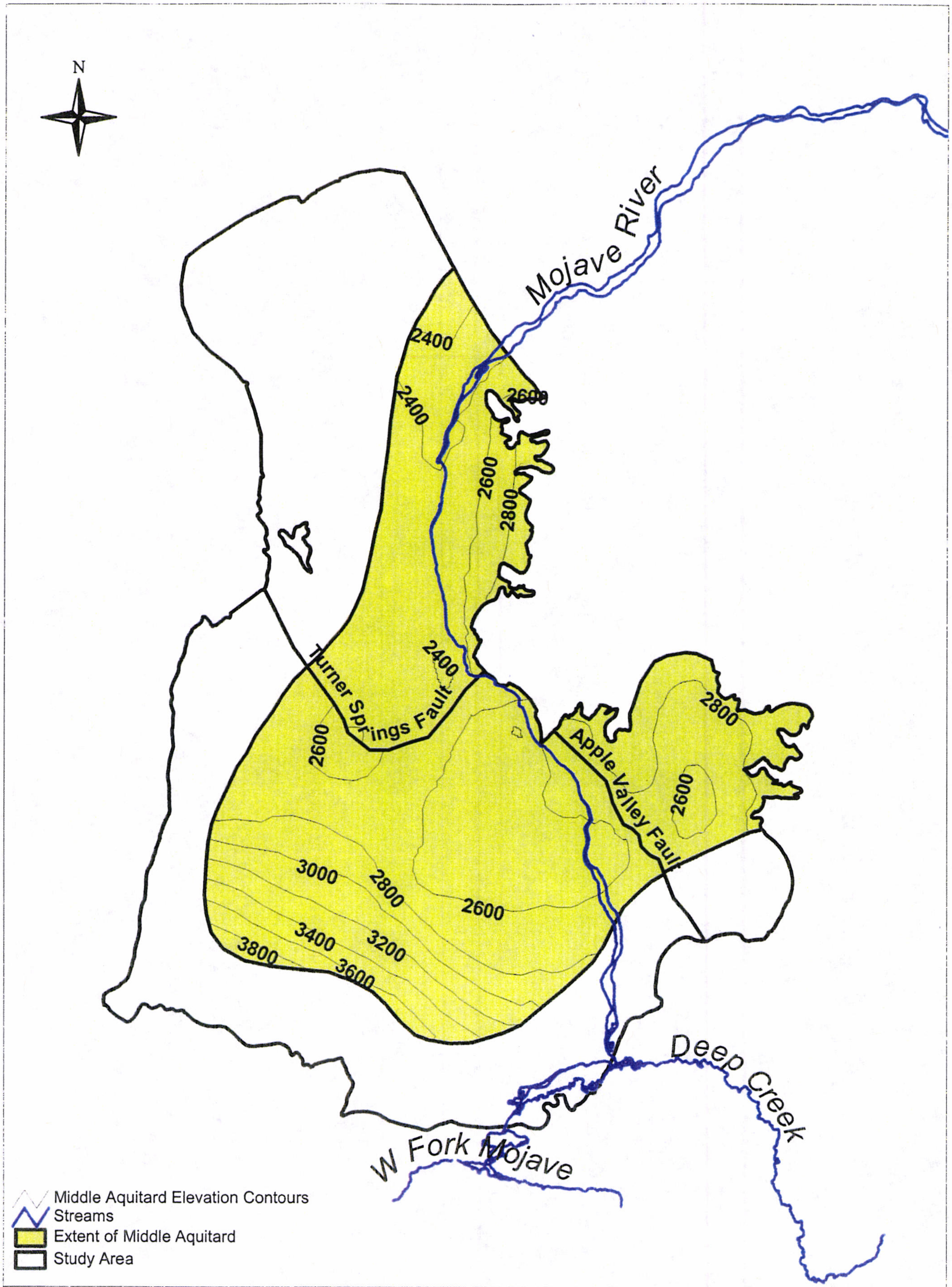
Figure 2-7



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Thickness of Middle Aquitard

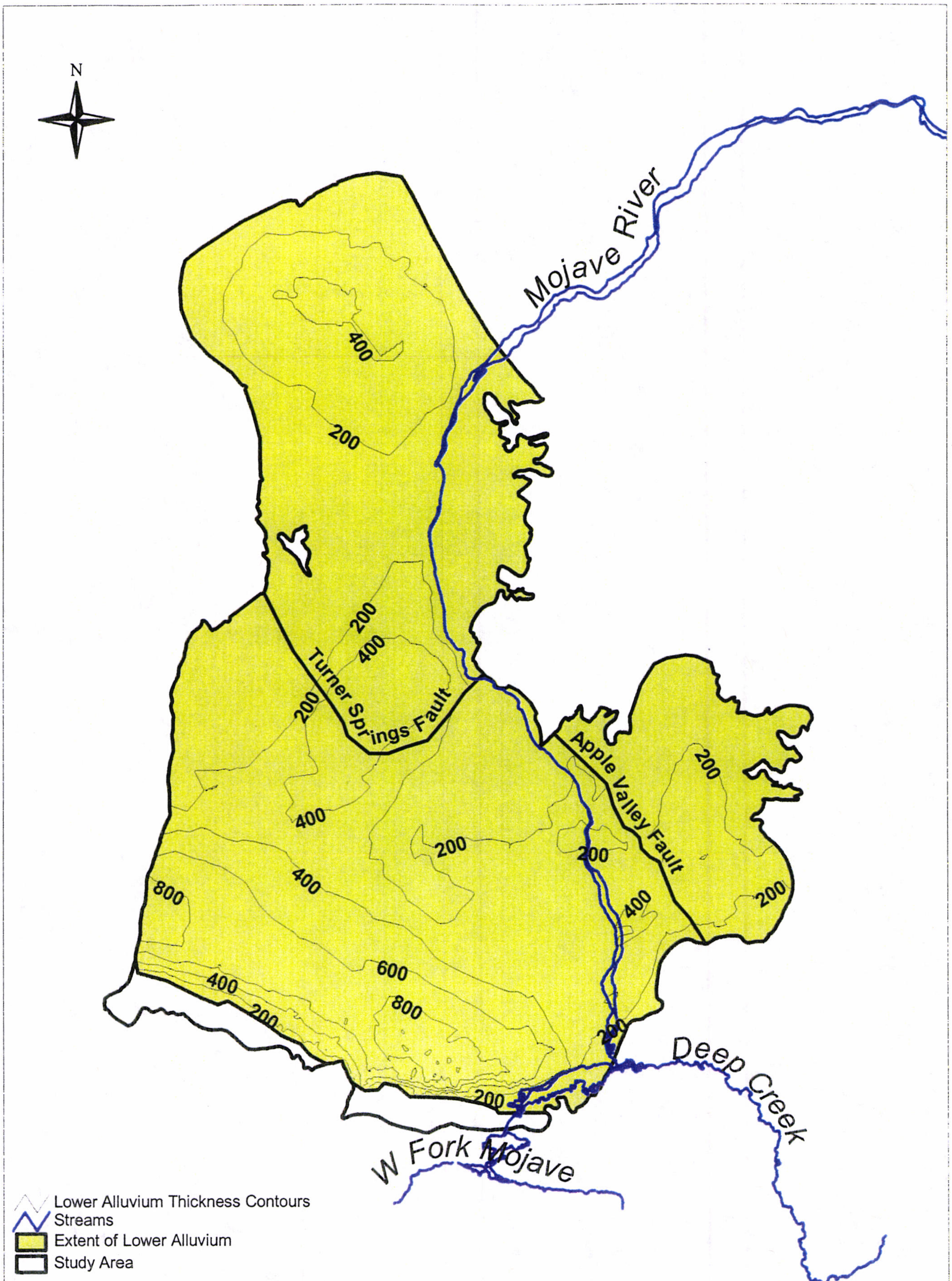
Figure 2-8



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Base Elevation of Middle Aquitard

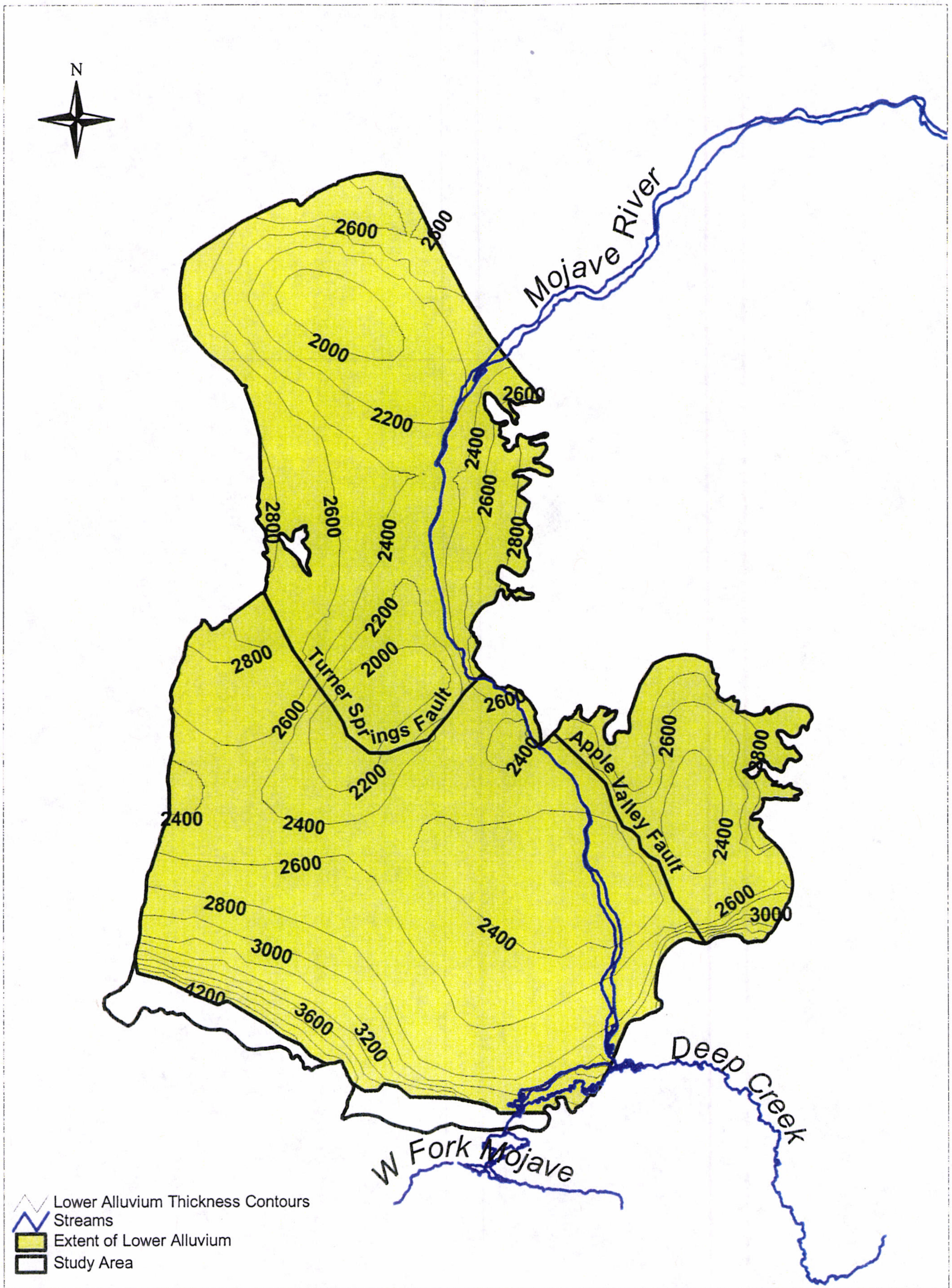
Figure 2-9



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Thickness of Lower Alluvium

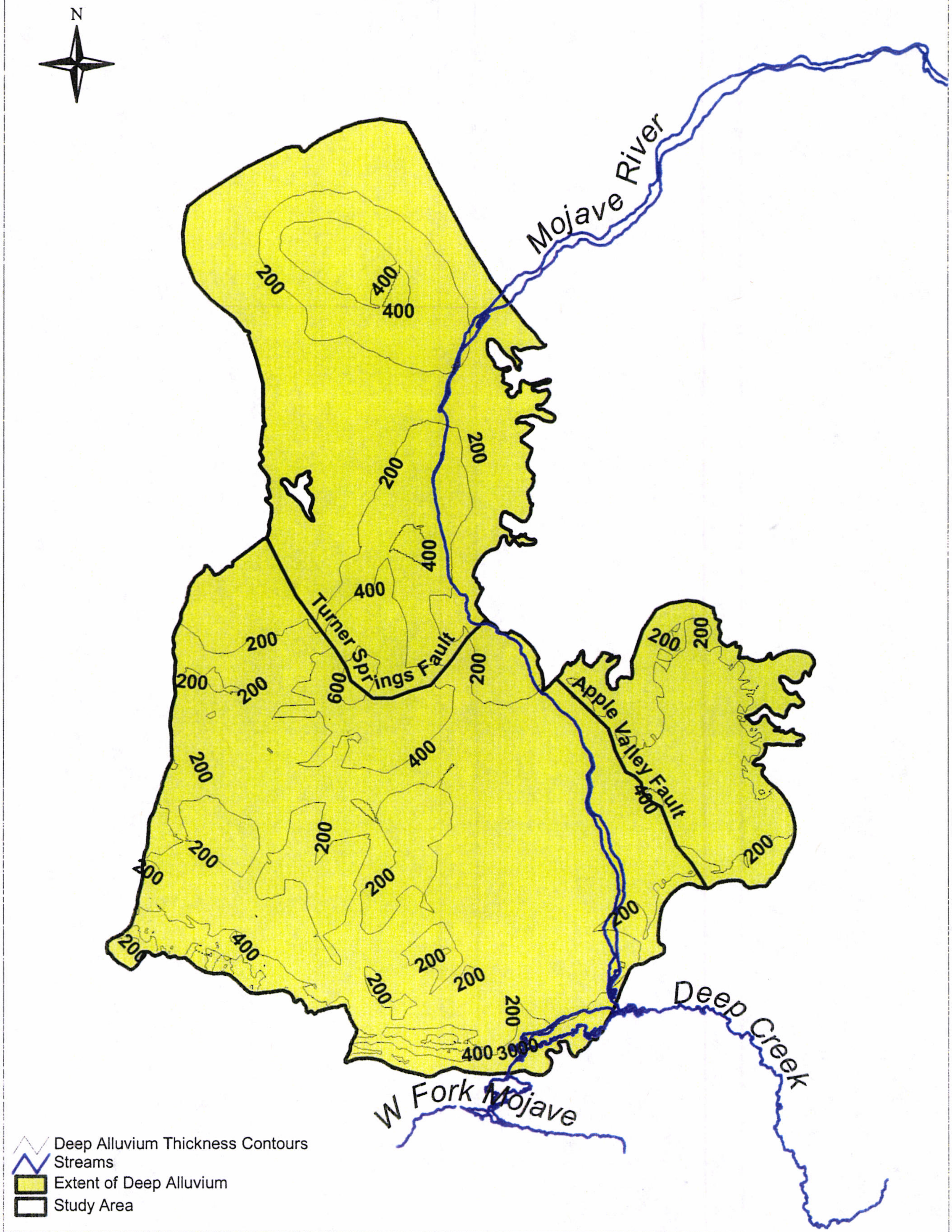
Figure 2-10



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Base Elevation of Lower Alluvium

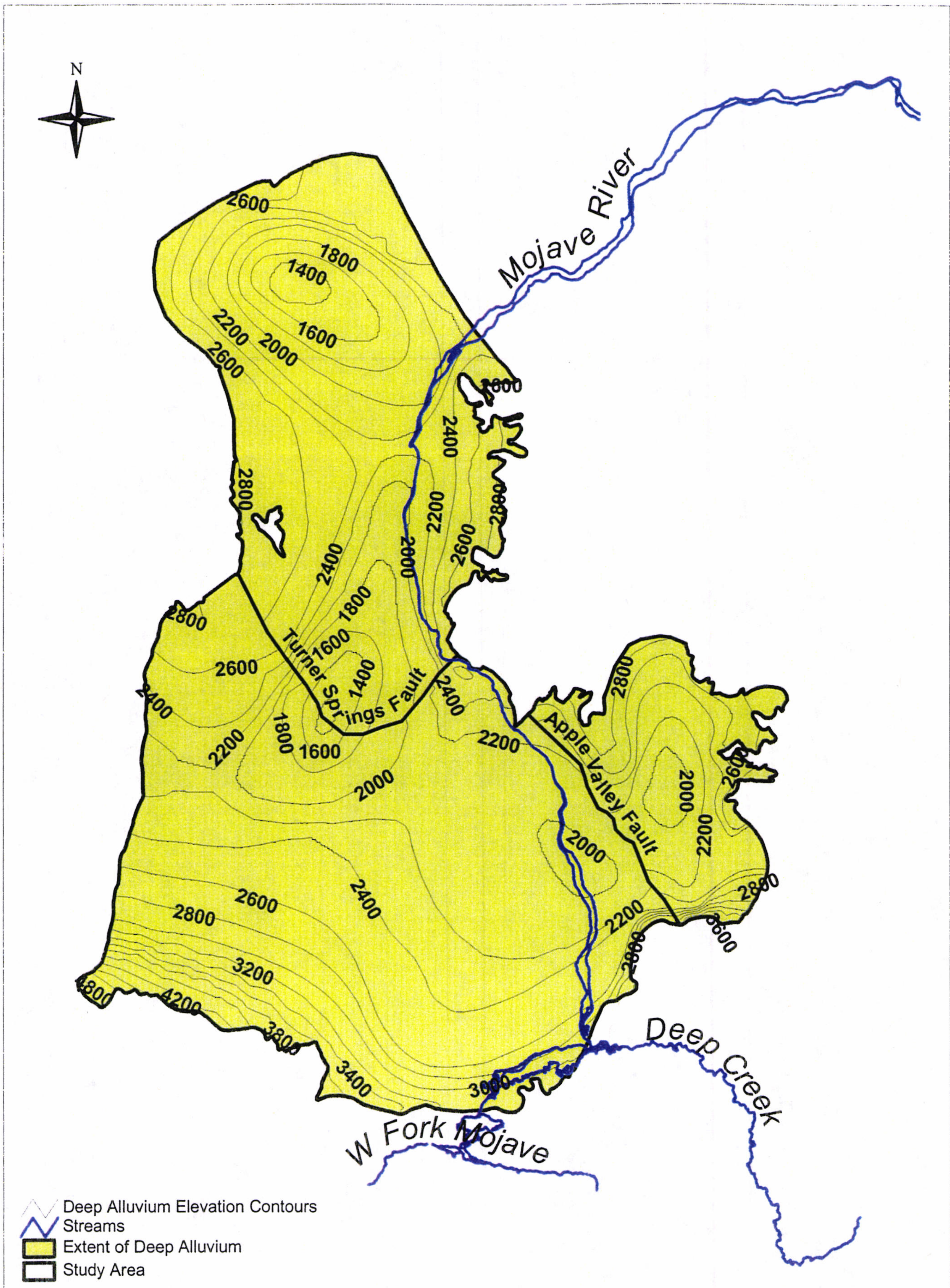
Figure 2-11



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Thickness of Deep Alluvium

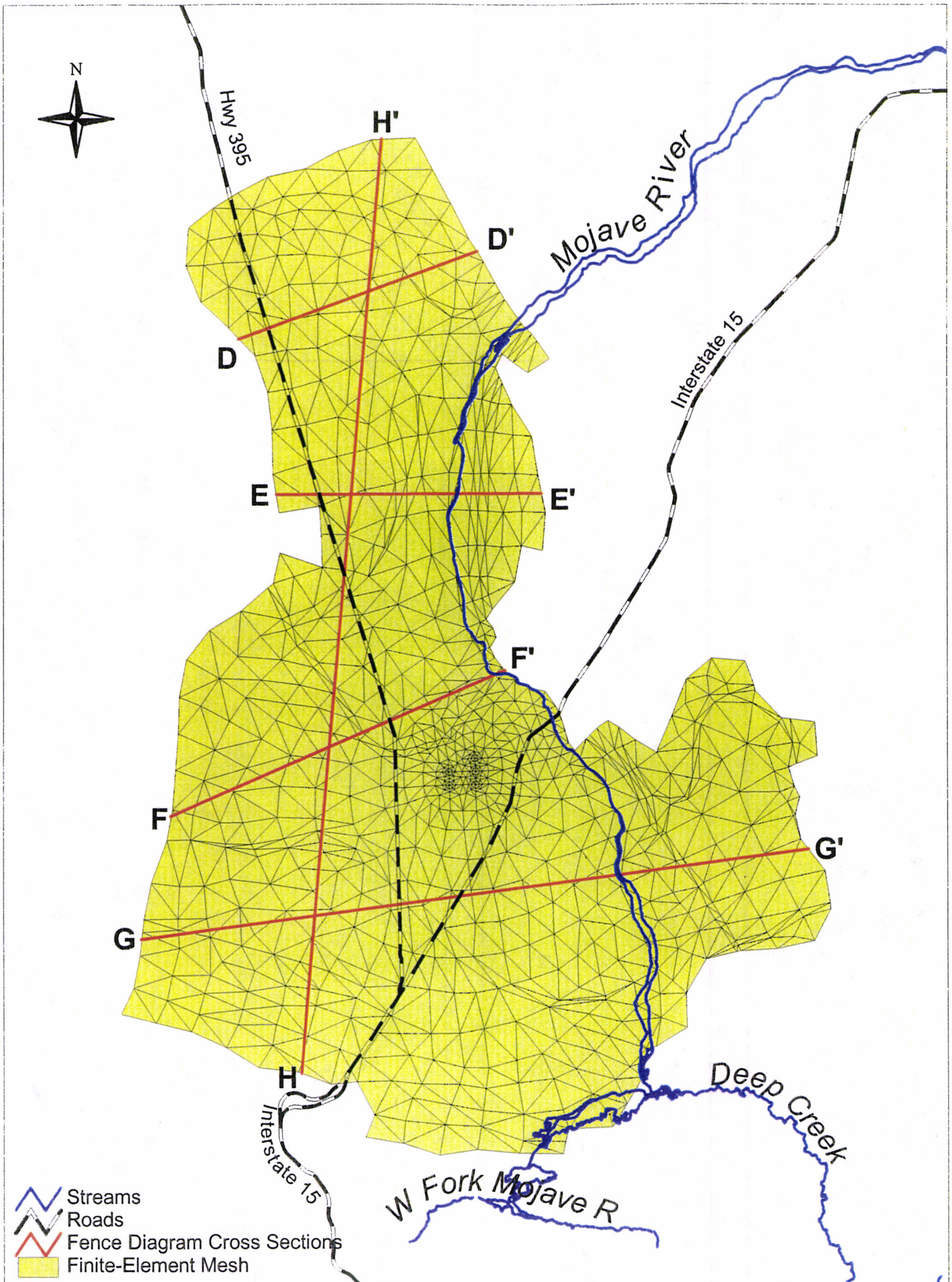
Figure 2-12



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Base Elevation of Deep Alluvium

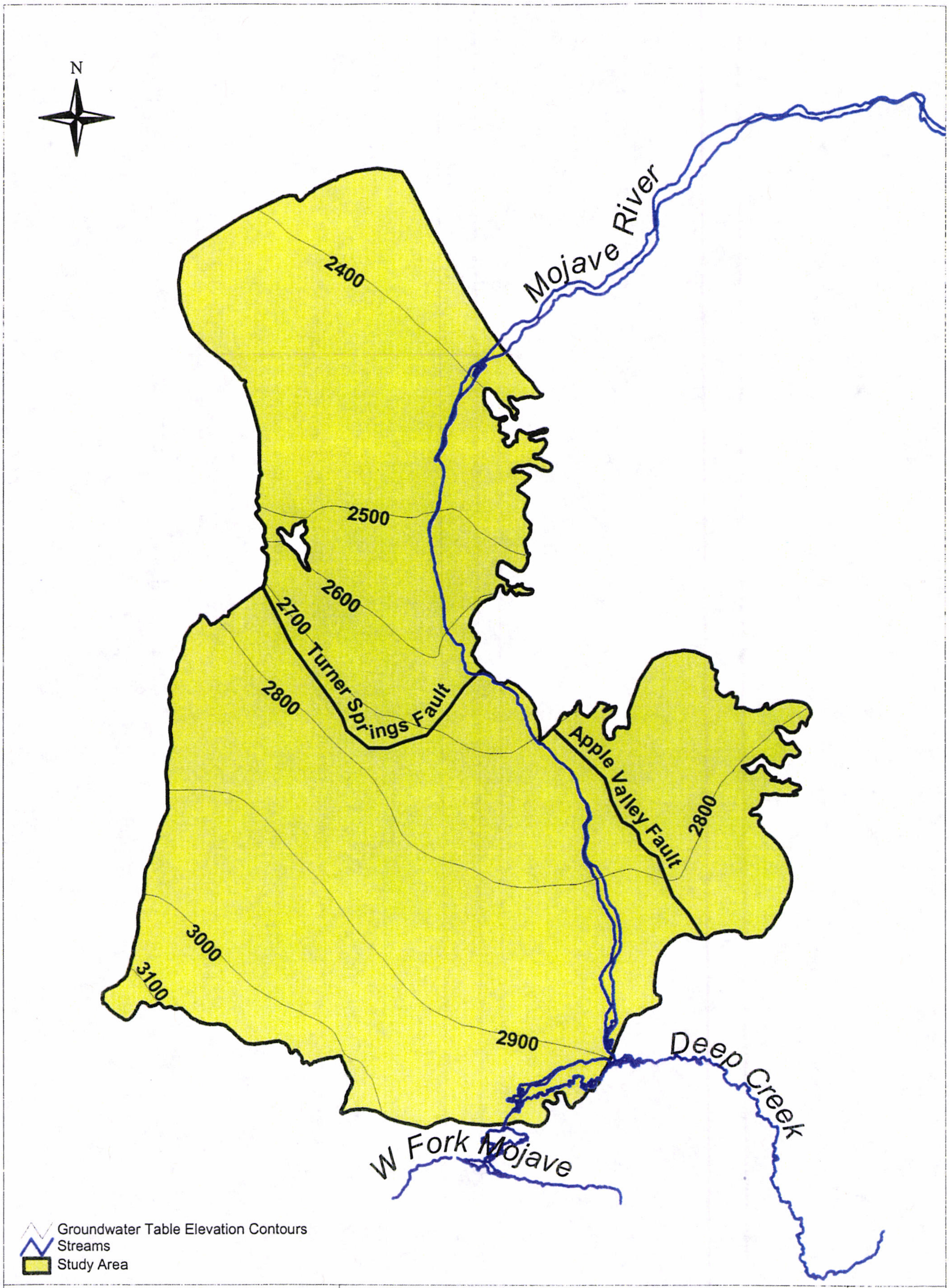
Figure 2-13



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Finite-Element Mesh for Groundwater Table

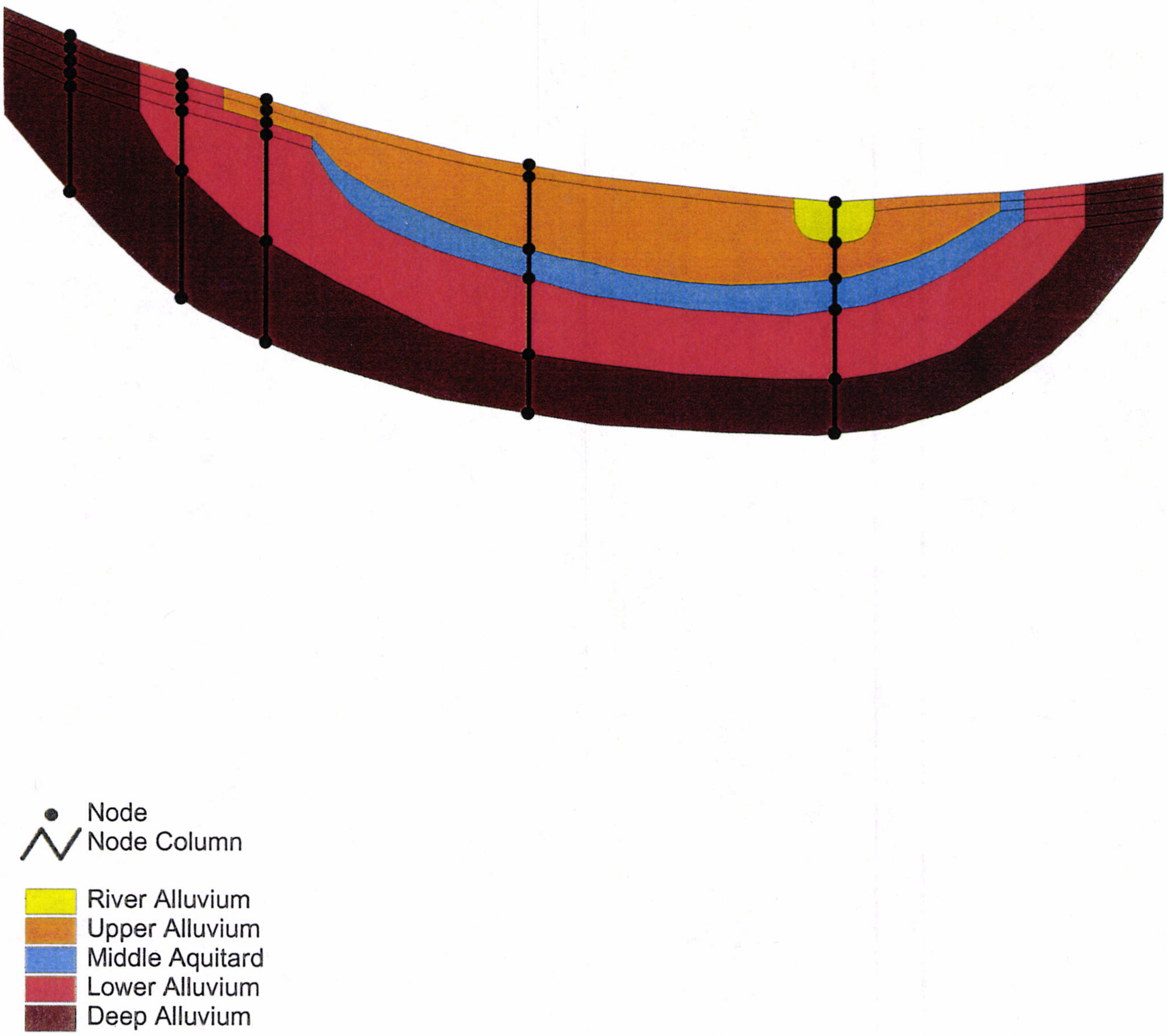
Figure 3-1



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Elevation of Groundwater Table within Study Area

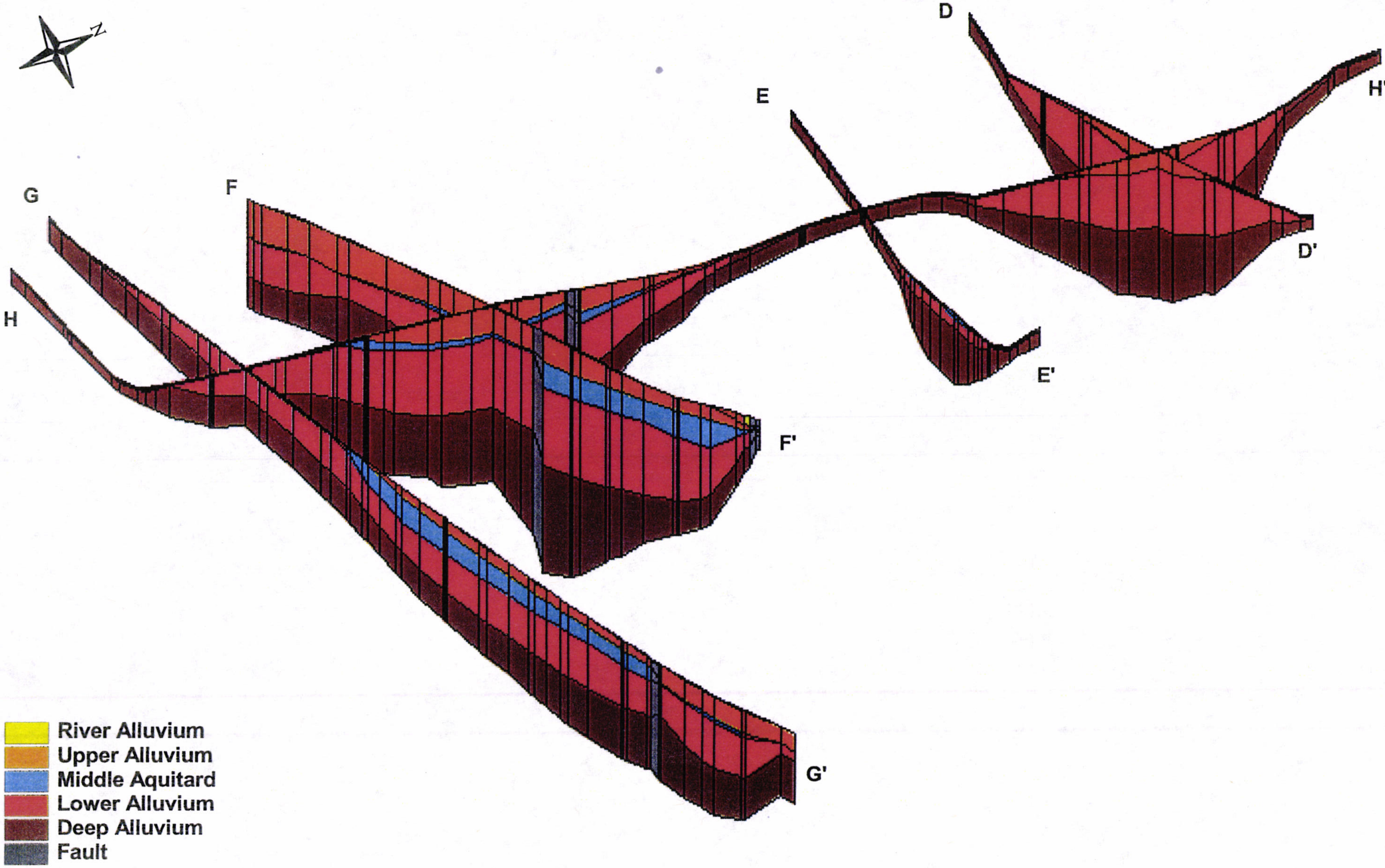
Figure 3-2



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Layering Scheme and Typical Node Columns within the Groundwater-Model Mesh

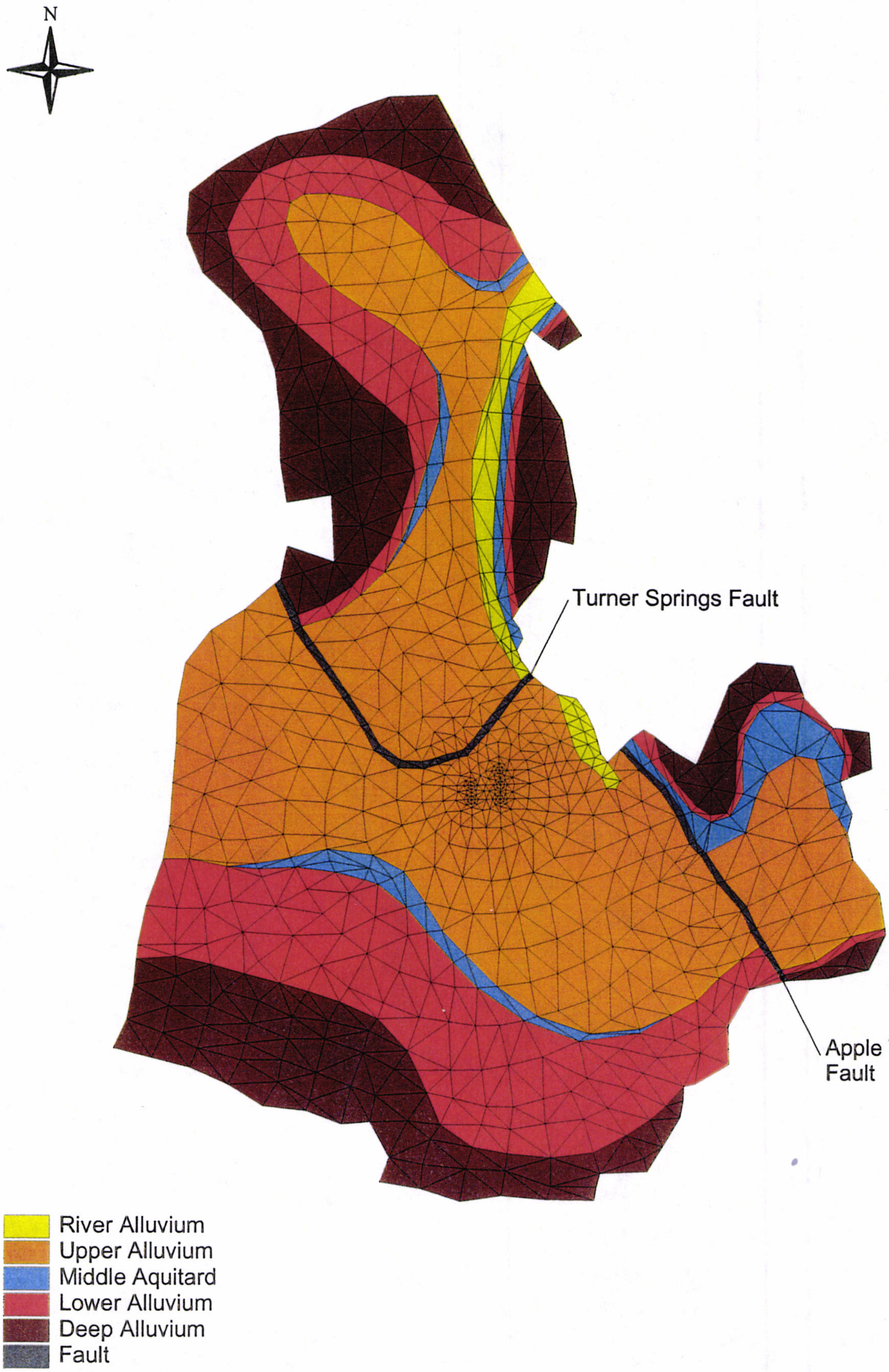
Figure 3-3



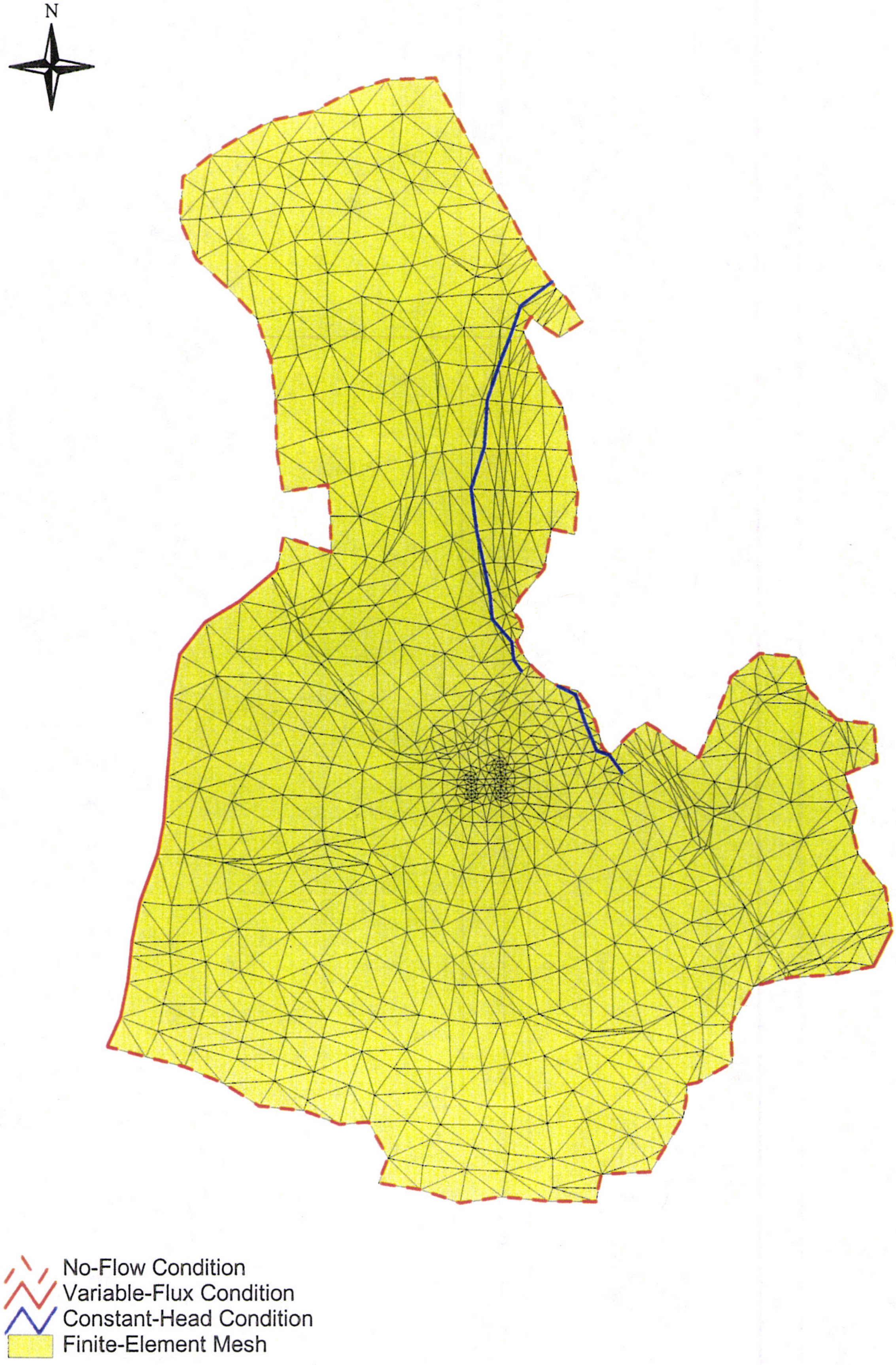
TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Perspective View of Groundwater-Model Mesh

Figure 3-4



TIMOTHY J. DURBIN, INC. CONSULTING HYDROLOGISTS	Outcrops of Hydrogeologic Units on Top Surface of Groundwater-Model Mesh	Figure 3-5



TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Boundary Conditions

Figure 3-6

Table 2-1
Geologic Units within Study Area

Geologic Unit	Symbol	Geologic Age	Thickness [Feet]
River Deposits	Qra	Late Holocene	100
Dune Sands	Qds	Late Holocene	Minor
Younger Fan deposits	Qya	Holocene	Minor
Older Lake Deposits	Qol	Late Pliestocene	Minor
Older Alluvium	Qoa	Late Pliestocene	700
Older Fan Deposits	Qof	Middle Pliestocene	1300
Shoemaker Gravel	Qs	Middle Pliestocene	Minor
Harold Formation	Qh	Early Pliestocene	800

Table 2-2
Assignment of Geologic Units to Hydrogeologic Units

Geologic Unit	Hydrogeologic Unit
River Deposits	River Alluvium
Dune Sands Younger Fan deposits Older Lake Deposits Older Alluvium upper Older Fan Deposits	Upper Alluvium
middle Older Fan Deposits	Middle Aquitard
lower Older Fan Deposits	Lower Alluvium
Shoemaker Gravel Harold Formation	Deep Alluvium

Table 3-1a
Assignment of Aquifer-Parameter Values to Hydrogeologic Units
Northern Area

Hydrogeologic Unit	Area	Parameter[1]	Value[2]	Primary Source
River Alluvium	North	Kh	150	U. S. Geological Survey (2001, Figure 19)
		Kv	15	U. S. Geological Survey (2001, Figure 21)
		Ss	0.000001	Maidment (1993, Table 6.3.3)
		Sy	0.23	U. S. Geological Survey (2001, Figure 20)
Upper Alluvium	North	Kh	3.2	U. S. Geological Survey (2001, Figure 19)
		Kv	0.32	U. S. Geological Survey (2001, Figure 21)
		Ss	0.00001	Maidment (1993, Table 6.3.3)
		Sy	0.12	U. S. Geological Survey (2001, Figure 20)
Middle Aquitard	North	Kh	0.01	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Kv	0.00001	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Ss	0.000036	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Sy	0.05	Maidment (1993, Table 6.3.4)
Lower Alluvium	North	Kh	13	U. S. Geological Survey (2001, Figure 19)
		Kv	1.3	U. S. Geological Survey (2001, Figure 21)
		Ss	0.00001	Maidment (1993, Table 6.3.3)
		Sy	0.1	Maidment (1993, Table 6.3.4)
Deep Alluvium	North	Kh	1.3	U. S. Geological Survey (2001, Figure 19)
		Kv	0.13	U. S. Geological Survey (2001, Figure 21)
		Ss	0.00001	Maidment (1993, Table 6.3.3)
		Sy	0.05	Maidment (1993, Table 6.3.4)

[1] Kh is horizontal hydraulic conductivity, Kv is vertical hydraulic conductivity, Ss is specific storage, and Sy is specific yield.

[2] Units are in feet and days.

[3] Value is geometric mean for wells F and G.

Table 3-1b
Assignment of Aquifer-Parameter Values to Hydrogeologic Units
Southern Area

Hydrogeologic Unit	Area	Parameter[1]	Value[2]	Primary Source
River Alluvium	South	Kh	150	U. S Geological Survey (2001, Figure 19)
		Kv	15	U. S. Geological Survey (2001, Figure 21)
		Ss	0.000001	Maidment (1993, Table 6.3.3)
		Sy	0.23	U. S. Geological Survey (2001, Figure 20)
Upper Alluvium	South	Kh	11	U. S. Geological Survey (2001, Figure 19)
		Kv	1.1	U. S. Geological Survey (2001, Figure 21)
		Ss	0.00001	Maidment (1993, Table 6.3.3)
		Sy	0.08	U. S. Geological Survey (2001, Figure 20)
Middle Aquitard	South	Kh	0.01	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Kv	0.00001	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Ss	0.000036	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Sy	0.05	Maidment (1993, Table 6.3.4)
Lower Alluvium	South	Kh	39	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Kv	5.3	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Ss	0.000012	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Sy	0.1	Maidment (1993, Table 6.3.4)
Deep Alluvium	South	Kh	3.8	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Kv	0.45	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Ss	0.000030	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Sy	0.1	Maidment (1993, Table 6.3.4)

[1] Kh is horizontal hydraulic condictivity, Kv is vertical hydraulic conductivity, Ss is specific storage, and Sy is specific yield.

[2] Units are in feet and days.

[3] Value is geometric mean for wells F and G.

Table 3-1c
Assignment of Aquifer-Parameter Values to Hydrogeologic Units
Eastern Area and Faults

Hydrogeologic Unit	Area	Parameter[1]	Value[2]	Primary Source
Upper Alluvium	East	Kh	28	U. S. Geological Survey (2001, Figure 19)
		Kv	2.8	U. S. Geological Survey (2001, Figure 21)
		Ss	0.00001	Maidment (1993, Table 6.3.3)
		Sy	0.12	U. S. Geological Survey (2001, Figure 20)
Middle Aquitard	East	Kh	0.01	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Kv	0.00001	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Ss	0.000036	Richard C. Slade & Associates, LLC (2003a and 2003b)[3]
		Sy	0.05	Maidment (1993, Table 6.3.4)
Lower Alluvium	East	Kh	43	U. S. Geological Survey (2001, Figure 19)
		Kv	4.3	U. S. Geological Survey (2001, Figure 21)
		Ss	0.00001	Maidment (1993, Table 6.3.3)
		Sy	0.1	Maidment (1993, Table 6.3.4)
Deep Alluvium	East	Kh	4.3	U. S. Geological Survey (2001, Figure 19)
		Kv	0.43	U. S. Geological Survey (2001, Figure 21)
		Ss	0.00001	Maidment (1993, Table 6.3.3)
		Sy	0.05	Maidment (1993, Table 6.3.4)
Turner Springs Fault	North-South	Kh	0.05	U. S. Geological Survey (2001, Table 6)
		Kv	0.05	
		Ss	0.00001	
		Sy	0.1	
Apple Valley Fault	South-East	Kh	0.01	U. S. Geological Survey (2001, Table 6)
		Kv	0.01	
		Ss	0.00001	
		Sy	0.1	

[1] Kh is horizontal hydraulic condictivity, Kv is vertical hydraulic conductivity, Ss is specific storage, and Sy is specific yield.

[2] Units are in feet and days.

[3] Value is geometric mean for wells F and G.