APPENDIX A

SCOPE OF WORK MOJAVE RIVER TRANSITION ZONE

RECHARGE PROJECT PHASE I

Phase I.
Define Transition Zone Hydrogeology

This Phase will focus on three specific aspects of the study: (1) compiling information and describing the hydrogeologic conditions within the Transition Zone; (2) determining how those conditions control its function as a "water bridge;" and (3) describing the impact potential for artificial recharge programs. The nature of the project will require that the work be performed in an interactive manner. We will work closely with MWA during the project to make maximum benefit of MWA's knowledge of the area. Various meetings with MWA are planned at key points during the project.

Beginning with the review of the data collected at the start of the project, URS will be developing and refining a conceptual model of the baseline hydrogeology of the Transition Zone. At first the model will be based on the available data, and input from the MWA. As the project progresses, we will refine our conceptual model as we collect information about the stratigraphy, geologic structure, aquifers, water flows, and other information for the area.

As the model becomes more refined, data gaps and areas where additional data are needed will become more apparent. During the project, we anticipate some overlap between tasks as our understanding of the Transition Zone is developed and refined. The various tasks and our approach to completing them are discussed below.

Task I-1.

> **Compile existing data and technical reports prepared by MWA, the Mojave Basin Area Watermaster, the United States Geological Survey (USGS), the Lahontan Regional Water Quality Control Board (LRWQCB), the Victor Valley Regional Wastewater Reclamation Authority (VVRWRA) and other sources as may be determined.**

Approach to Task I-1. Through our extensive experience in conducting projects similar to this, URS has developed efficient and effective techniques for acquiring, compiling, and documenting existing data and information pertinent to the study. We will begin, of course, with the publications list provided by MWA and other documents that are available in storage in the MWA annex. We will contact the agencies listed in Task I-1, and acquire additional information that may be appropriate to this study. We will also contact Mr. Robert Wagner of Wagner & Bonisgnore, to obtain data or current water demand and protections of water use in the study area.

Our project team has access to our in-house library of reference documents, reports, and treaties, which we believe includes unpublished reports and data that may be of use. Our project team members also have personal documents that may be of use, and these will also be incorporated into our overall data-acquisition program, as appropriate.

As we acquire pertinent documents, we will maintain and update a bibliography of the documents, with appropriate citations for later referencing. Both hard copies and electronic copies of this bibliography will be made available to MWA, and will be incorporated into our final report.

We anticipate that the types of data to be acquired include lithologic logs of wells and borings in the area, geological reports, soils and sediment studies, historical data from the gauging station, historical water quality data, information on water supply systems, agricultural water data, and other types of information needed for the study. As we acquire data and information, we will make an assessment of its quality, its reliability, and its usefulness to the Transition Zone project. We will also identify data gaps, and continue to monitor the data gaps as we conduct subsequent tasks. We expect that additional work conducted as part of this project will fill some of the data gaps. The areas where there are data-gaps and our recommendations for filling pertinent data gaps will be identified and addressed under Task I-11, below.

Task I-2.

Identify and quantify water supply sources and sinks.

Approach to Task I-2. Under this task, URS will identify all current and potential water sources and sinks in the study area, and compile this information for later use in developing a water budget for the Transition Zone, as described under subsequent tasks.

Water supply sources, and potential sources, to the study area may include:

- precipitation and runoff into the Mojave River;
- inflows of water from upstream surface-water reservoirs;
- subsurface inflow of groundwater into the Transition Zone;
- inflows of water from the California Aqueduct;
- inflows of reclaimed wastewater from VVWRA facilities;
- irrigation return flows; and
- other incidental wastewater discharges.

Water supply sinks, and potential sinks, in the study area may include:

- natural evaporation from water surfaces;
- natural evapotranspiration from native vegetation along the Mojave River;
- evapotranspiration and crop uptake from agricultural activities;
- pumping of groundwater through wells for domestic, municipal, industrial, and agricultural purposes;
- discharge of surface water across the Helendale Fault to lower reaches of the Mojave River; and
- subsurface outflow of groundwater downgradient across the fault to lower sub-basins.

URS will use available existing information developed in Task I-1 to quantify the water supply quantities and temporal aspects of each of the key sources and sinks.

<u>Task I-3</u>.
Perform volumetric calculations of water-bearing sediments within the Transition Zone to assess and quantify the ability to store imported water under current and future conditions.

Approach to Task I-3. Our preliminary review of available data indicates that some good data exist concerning the subsurface geometry of the Transition Zone; however, we believe that the available data are not currently sufficient to provide an adequate basis for use in performing volumetric calculations. Of particular interest is the subsurface geometry near the Helendale Fault. The geometry and hydrogeology of this area is significant in that it controls the subsurface outflow from the Transition Zone. Subsurface outflow is a key component in the overall water budget for the area.

Additional test drilling at numerous locations would, of course, provide additional data; however, additional test drilling is both expensive and time-consuming. In our opinion, additional test drilling is not warranted as part of Phases I and II of this study.

Another effective, and much less expensive, means for obtaining suitable subsurface data is to conduct geophysical surveys along selected transects in the Transition Zone. Refraction seismic profiling is a commonly used geophysical technique for this purpose. The results of geophysical surveys using refraction seismic profiling can provide the subsurface hydrogeological characteristics and basin geometry needed to perform volumetric calculations of the water-bearing sediments within the Transition Zone. These data are necessary to allow us to assess and quantify the ability of the Transition Zone to store imported water under both current and future conditions. Thus, URS proposes to conduct geophysical studies under this task. The scope of the geophysical studies are described below.

URS proposes to perform refraction seismic profiling along two (2) transects across the Transition Zone. Figure 2 (of the proposal) shows preliminary locations for the transects; however, final locations will be selected based on our understanding of the Transition Zone and with approval of MWA. Each of the transects are expected to define the depth to the bottom of the water-bearing sediments (top of competent bedrock) and the variations in density of materials in the sediments above bedrock. These geophysical data can be interpreted, along with available lithologic data, to estimate differences in actual and effective porosity of the sediments. Together with available lithologic data, the results of the geophysical survey will allow the volumetric calculations required by this task.

The geophysical work will be done by Dr. Shawn Biehler, a California Registered Geophysicist, with Geo*Vision* Geophysical Services. Dr. Biehler was for many years a geophysics professor at University of Riverside, and is a recognized expert at characterizing groundwater basins for assessment of groundwater storage capacity. His experience characterizing desert basins in Southern California is unmatched. Review of the geophysical data interpretations will also be done under the direct supervision of Tom Sheahan, a Registered Geophysicist in California.

Based on the geophysical and lithologic data, and the other data collected under Tasks I-1 and I-2, URS will:

- define the subsurface geometry of the sediments within the Transition Zone,
- identify the saturated and unsaturated volumes, and
- quantify the ability of the Transition Zone to store imported water under current and future conditions.

As part of this task, Geo*Vision* will produce a summary report for the geophysical studies. This report will be an appendix to the Phase I report.

Task I-4.

Compile and review groundwater and surface water levels and water quality data.

Approach to Task I-4. Based on our knowledge of the Transition Zone, URS anticipates that several of the existing wells will have historical data for water levels. Similarly, based on US Geological Survey work in the area, we expect that there will be a reasonable number of wells for which inorganic chemical data are available. URS will acquire these data as part of Task I-1, and will develop a database for storage, retrieval, analysis, and presentation of these data. The selected database will also be used by URS to store historical data on precipitation, temperature, water production, and other information pertinent to analysis of the Transition Zone. The specific database platform to be used (e.g., Access, Foxpro, Excel, etc.) will be selected based on MWA's preferences, so that these data will be readily available to, and useable by, MWA following this study.

The database will be designed to indicate which aquifer is represented by each well and/or water level, and whether or not the aquifers are water table or confined. If sufficient data are available, the water level data will be correlated, to the extent possible, with other factors, such as precipitation, temperature, water production, etc. Water level data will be presented in both graphical and tabular form for inclusion in the draft and final reports. Electronic copies of the database, the graphics, and the tables will also be provided.

Task I-5.

Perform basic hydrogeologic interpretation of stratigraphic sections to determine aquifer system(s) number, areal and vertical extent, confined or free, and recharge forebay location.

Approach to Task I-5. URS hydrogeologists will use the information developed in Tasks I-1, I-2, I-3, and I-4 as the basis for interpretation of the stratigraphy and aquifer conditions in the Transition Zone. Previous interpretations of the aquifer system in the area will also be considered, along with other data collected for this study in interpreting the stratigraphy of the area. Well logs and published geologic maps for the area will be used to develop an understanding of the stratigraphy in the area. We anticipate that the results of the geophysical surveys performed for Task I-3 will provide important information regarding the stratigraphy and the occurrence of older and younger alluvial units which may have differing permeabilities. The geophysical data will help in defining the “bottom of the bucket” and the practical limits to the groundwater reservoir.

The well logs and geophysical surveys and other geologic and hydrogeologic information will be used to prepare stratigraphic columns or profiles for different areas of the Transition Zone. The individual stratigraphic profiles will be combined to develop cross-sections as part of Task I-6, discussed below.

In addition to the stratigraphic data, water level data will be used, where possible, to help understand the interconnection and degree of separation between aquifers. In addition, the data concerning the occurrence of surface water flows in the Mojave River will provide important information regarding the interconnection between surface water and groundwater in the area. This will help us to determine which aquifers may be confined, and how the local stratigraphy may control groundwater flow.

Task I-6

> **Prepare one (1) longitudinal geologic cross-section and three (3) geologic transects at locations acceptable to MWA showing hydrologically significant stratigraphic units and controlling faults and other geologic and surface features.**

Approach to Task I-6. The stratigraphic profiles developed as part of Task I-5 will be combined into geologic cross-sections and transects. The cross-sections and transects will also incorporate other well data and the results of the geophysical surveys. Initially, URS will select locations of the sections and transects based on the availability of data and locations where the hydrogeology of the area is critical to an overall understanding of the Transition Zone. This may include cross-sections in the vicinity of the Helendale Fault, in the central portion of the area, in the upper portion of the area where natural recharge occurs, areas where faults may control the local hydrogeology, and in areas where artificial recharge may be considered. Once possible locations for the cross-sections and transects are selected, we will review them with MWA and revise the locations as needed. If conditions warrant, additional cross-section locations will be selected, and their usefulness discussed with MWA.

Task I-7.

> **Prepare water level hydrographs of key wells.**

Approach to Task I-7. Following the collection and review of available data in Task I-1, URS will tentatively identify key wells in the Transition Zone area. As part of the selection process, we will contact the Watermaster, Ms. Valerie Wiegenstein, and her engineer, Mr. Robert Wagner of Wagner & Bonisgnore, and incorporate any suggestions they have regarding key wells in the area. The wells will be selected based on the length and quality of their water level records, their locations, aquifer units penetrated, and their use. The selection of key wells will also be supported by the work performed for Task I-4, where water level and water quality data will be collected and reviewed. Following our key well selections, we will review the wells and their locations with MWA. Based on MWA's input we will prepare water level hydrographs for the selected key wells. To the degree possible, the hydrographs will be incorporated into a database prepared for the project.

Task I-8.

Prepare a potentiometric map encompassing the entire Transition Zone and depicting the water table aquifer and any confined aquifer supplying well fields.

Approach to Task I-8. URS will prepare one or more potentiometric maps for the entire Transition Zone area. We will select the date or dates for the maps based on the available data. Considerations will include short and long term historic water level fluctuations (as understood from the hydrographs). If data permit, other potentiometric maps will be prepared; for example, a map representing historic conditions, and one representing more recent conditions. For these maps, the water levels will represent the same time of year, if possible, or different times of year as needed to present the information clearly. The maps will allow for evaluation of changes in the volume of water in storage over time. URS will show on the maps the areas where the aquifers are believed to be confined, semi-confined, or unconfined. Additionally, the selection of dates for the potentiometric maps will consider water years such as 1968-1969 or 1997-1998 (El Nino year) when there was greater-than-average precipitation. This information, along with the volume of sediment calculations made for Task I-3, will be used to determine the volume of water in storage.

If the hydrographs prepared as Task I-8 indicate that water levels show significant seasonal fluctuations as the result of pumping, additional potentiometric maps may be prepared for localized areas to better understand the extent of the areas affected by seasonal pumping. These maps may provide important information insights regarding relationships between pumping, groundwater levels, and surface water flows in the Transition Zone.

Task I-9.

Describe how existing hydrogeologic conditions control the function of the Transition Zone as a "water bridge" and impact potential for artificial recharge programs.

Approach to Task I-9. For this task, URS will combine the work from the previous tasks to further develop the conceptual model of the Transition Zone. The conceptual model will then be used to understand how the Transition Zone functions as a "water bridge" to convey both surface and subsurface flows to lower portions of the Mojave River watershed. Key components of the model include an understanding of:

1. The aquifer units in the area, their nature and lateral and vertical extent, and their degree of confinement and interconnection;
2. The occurrence and movement of groundwater in the area, particularly subsurface outflow across the Helendale Fault;
3. How other faulting in the area may control subsurface groundwater flow within the area;
4. The occurrence and movement of surface water in the area, particularly areas where the Mojave River gains and loses flow to the underlying groundwater; and
5. The groundwater budget for the area.

An example of a basin conceptual model prepared by URS for the Upper Chuckwalla Valley is included in Appendix B to this proposal. The Chuckwalla conceptual model was prepared to provide a basis for decision making for seasonal water storage and retrieval in this basin.

Understanding the nature and extent of the aquifer units provides the framework to understand how they are interconnected. This aquifer framework is developed by reviewing the stratigraphic profiles, cross-sections, and transects prepared in previous tasks. The aquifers themselves may extend laterally beyond the limits of the Transition Zone. The practical depth of the aquifers and groundwater basin will be estimated based on the geophysical work performed in Task I-3 and available lithologic logs.

Once the aquifer framework is established, the flow of groundwater through the subsurface framework can be understood. An understanding of the general flow of groundwater in the Transition Zone will be based on the potentiometric maps and the water level data developed in earlier tasks. To some degree, water quality data may also indicate how aquifers are connected or separated. The information on groundwater flows and aquifer conditions will be used, along with surface water flow data, to develop an understanding of the relationship between flows of surface water and groundwater in the area. This information is key to how the Transition Zone acts as a “water bridge” and how artificial recharge would affect water levels and movement of water in the Transition Zone.

Movement of surface water and groundwater out of the Transition Zone into lower portions of the watershed will depend to a large degree on how the Helendale Fault affects subsurface groundwater flow. Developing a clear understanding of this fault zone and its groundwater barrier effect will be an important part of this task.

To the degree possible, this task will also include development of a water balance for the Transition Zone. The water balance will provide an important check on the overall understanding of how groundwater and surface water occurs in the area, and how the various water balance components relate to each other. The water balance will provide information on the relative volumes of water recharged, in storage, extracted, and entering and leaving the area as surface and subsurface flows. Based on our understanding of the area and conversations with Mr. Greg Middleton of MWA, we recognize the sparse nature of some of the hydrologic and hydrogeologic data for the Mojave River watershed. We anticipate that the water balance will be general in nature and that adequate data do not exist to refine it to a precise level. As URS prepares the water balance, and refines it during the project, the balance will help illustrate where some of the data gaps are, and what data is needed for MWA to have a better understanding of the Transition Zone. Examples of two water balances prepared for similar projects are presented in Appendix B to this proposal. The water balance examples, for the Burney Basin and the upper portion of the Coachella Valley, illustrate the various components and considerations that may be considered for the Transition Zone project.

Task I-10.

> **Determine the average annual water supply of the Transition Zone as defined by the Judgment and assuming differing future inputs from the VVWRA and well field withdrawals at the Lower Narrows and near Helendale.**

Approach to Task I-10. URS will review the Judgement to determine how the average annual water supply was defined. We will discuss our findings with MWA to confirm our understanding of the average annual water supply. This information will be compared to the water supply components developed in the water balance (Task I-9) to see if the values are comparable, and if there are any large discrepancies.

Several annual water supply scenarios will be developed based on differing future inputs from the VVWRA and well field withdrawals. The scenarios will be developed in consultation with MWA and will consider past trends and projected future rates of wastewater discharges and pumping at the Lower Narrows and near Helendale. More detailed projections of water use and disposal in the area will be developed as part of Task I-2 of the project.

Task I-11.

> **Identify data gaps and provide specific recommendations to eliminate those gaps, including, but not limited to, locations and basic construction criteria for additional monitor wells that may be needed. if any.**

Approach to Task I-11. The identification of data gaps and key information required to better understand the hydrogeology of the Transition Zone will begin with Task I-1 and continue throughout the project. During the project, URS will keep MWA appraised of major data gaps that are apparent. We will also provide recommendations to MWA regarding options for how data gaps can be economically filled, and the advantages of addressing the various gaps in the existing data. A table summarizing the gaps and recommending solutions and benefits will be prepared and included in the Task I-12 summary report.

Task I-12.

> **Prepare a Phase I summary report consisting of the findings from Tasks I-1 through I-11 above. Provide ten copies of the report, an electronic file for the entire report (Adobe format) and individual electronic files for all figures or graphics.**

- **Approach to Task I-12.** Early in the course of the project, URS will provide MWA with an outline of the proposed report. The outline will include sufficient information for MWA to understand the main components of the report, figures and tables, and the information included as appendices.

URS will submit three hard copies of a Draft Report for review by MWA. Following MWA review, URS will address all comments and prepare a Final Report. Ten hard copies of the Final Report and appendices will be submitted, along with electronic copies of all graphics, and an Adobe format electronic copy of the entire report.

APPENDIX B

SUMMARY OF PREVIOUS INVESTIGATIONS

SUMMARY OF PREVIOUS INVESTIGATIONS

The following paragraphs summarize a few of the reports reviewed in the course of the current Transition Zone (TZ) evaluation. Many more reports were reviewed than are summarized here. Those summarized represent a limited history of modern water development and exploration in the TZ. In addition to these references, three reports of interest: *Pleistocene Lakes and Drainage of the Mojave Region* (California Division of Mines and Geology, 1954), *Mojave River Investigation, Victorville to Barstow* (DWR, 1955), and *Report on Review of the Overdraft of the Mojave River Basin for the Mojave Water Agency* (Stetson, 1974) were identified but could not be located for the current TZ evaluation. These reports may provide some insight into TZ geology and groundwater conditions but were not deemed critical as the material contained in them is dated and is likely cited in subsequent reports. The reports are

Ground Water Conditions Along the Mojave River (Thompson, 1921) was the earliest work reviewed in the course of the current evaluation. Thompson (1921) describes groundwater and soil conditions for the sub-basins along the Mojave River with the intent of identifying potential location of future agricultural development. In keeping with that intent, Thompson (1921) describes irrigation infrastructure and agricultural production at the time. While Thompson (1921) provides a valuable narrative of conditions in the early 1900s, the work is now dated and very little was utilized in this report.

The Mojave River Investigation was prepared by California Department of Water Resources (DWR, 1934) with objectives similar to that of Thompson (1921). The major difference is DWR made a concerted effort to record all available water levels and stream flow data. DWR (1934) is a good source for late 1920s to early 1930s water level and stream flow data. The DWR also made an effort to identify arable soils by soil quality and areal extent to identify the potential for future agriculture along the Mojave River.

Report on Victor Project was prepared by United States Bureau of Reclamation (USBR) in 1952 to assess the feasibility of developing an irrigation project in the Mojave River Basin. In the course of the investigation, USBR studied water use patterns, consumptive use by crops and riparian vegetation, consumptive use by domestic and industrial water users, flood characteristics, evaporation, and water quality. USBR determined conditions in the Mojave River Basin would not support the development of a large irrigation project.

Data on Wells in the West Part of the Middle Mojave Valley Area, San Bernardino County, California, Bulletin 91-1, (DWR, 1960b) is one of two reports produced in 1960 by DWR regarding the Mojave River Basin. Bulletin 91-1 provides tabular lithologic logs for much of what is today known as the TZ. Several of the well logs included in this report were used to construct the cross sections presented in the current TZ evaluation. Bulletin 91-1 included a map of well locations and water bearing deposits. The map was used as a base map in the current TZ evaluation.

The second report, *Data on Wells in the Eastern Part of the Middle Mojave Valley Area, San Bernardino County, California, Bulletin 91-3* (DWR, 1960a) provides similar data, but predominately for wells to the northeast in the Centro Subarea outside the TZ.

Gravity Survey of the Western Mojave Desert, California, USGS Professional Paper 316-D, 1960, includes a gravity survey of portions of the Mojave Desert including the Mojave River Basin. The paper includes a Bouger anomaly map indicating locations of deep sediment filled basins. The gravity stations used in this report were established based on road accessibility. Gravity measurements were taken at ground level rather than by air. The data were later supplemented and reinterpreted by Subsurface Surveys Inc. (1990) and interpreted for depth to bedrock.

Aereal Geology of the Western Mojave Desert, California, USGS Professional Paper 522 (USGS, 1967), authored by Thomas W. Dibblee describes surficial geology of portions of the Mojave Desert. The paper focused on the geologic history and mineral resources of the Mojave Desert based on surficial geology and available subsurface data. This report does not address groundwater directly.

Mojave River Groundwater Basins Investigation, Bulletin 84 (DWR, 1967) has become in many ways a benchmark for hydrologic and hydrogeologic studies of the Mojave River Basin. Bulletin 84 combines conclusions and data from many earlier reports and represents the state of knowledge of the Mojave River Basin at the time of publication. It includes groundwater production data, water level data, water quality data, precipitation data, surface water flow data, water use projections, hydrographs, a basin scale water balance, riparian water use estimates, aquifer property data, geologic history, geologic maps, and geologic cross sections. Many subsequent reports refer to, and rely on data and interpretations of this report. The geologic map included in Bulletin 84 is in agreement with the USGS mapping published in the same year (USGS, 1967).

Mojave River Basin Ground Water Recharge with Particular Reference to the California Floods of January and February (USGS, 1969) provides insight into the potential recharge of storm flows in the Mojave River. USGS reduced recorded storm flow data from stream gages on the Mojave River. The resulting data gives an indication of potential recharge to the floodplain and regional aquifers.

Aquifer Recharge From Floods in 1969 and 1978 in the Mojave River Basin (USGS, 1980) supplemented data and updated interpretations of USGS 1969 following the large floods of 1978. The updated report concluded that flood flows rapidly infiltrate into a dry Mojave River channel attenuating flood flows downstream.

Hydrologic Analysis of the Mojave River Basin, California, Using Electric Analog Model, Report No.72-08 (USGS, 1971) presents the results of the first published groundwater model of the Mojave River Basin. Many of the parameters estimated for use in this model are cited in later groundwater studies and models. Some of the parameters estimated for this model are still held as representative of Mojave River Basin conditions today.

Hydrologic Analysis of the Mojave River, California Using a Mathematical Model (USGS, 1974) presents a model used to simulate use of the Mojave River channel to transport State Water Project water released from Silverwood Lake to the Barstow area. The model demonstrated that the channel is an effective conduit only when it has been wetted prior to release of water for transport. This report provides infiltration characteristics of the Mojave River channel.

Historic and Present Conditions, Helendale Fault to Calico Newberry Fault, 1983, produced by CM Engineering Associates and Leroy Crandall & Associates for MWA, is a comprehensive report that addresses groundwater basin conditions in the subbasin immediately down gradient of the TZ. This report includes groundwater production data, riparian water use data, surface water flow data, water quality data, a well location map, and geologic cross sections.

Historic and Present Conditions, Upper Mojave River Basin, 1985, produced by J.S. Murk Engineers and Leroy Crandall & Associates for MWA, addresses groundwater conditions in the area now referred to as the Alto Subarea and includes information specific to the TZ. This report includes groundwater production data, riparian water use data, surface water flow data, water quality data, a well location map, geologic maps, and geologic cross sections.

Mojave River Basin Groundwater Recharge Study, Volumes 1 and 2, 1988, produced by Malcom Pirnie for MWA, explores the potential for artificial recharge programs and select candidate sites for recharge facilities. This report includes geologic maps, cross sections, and land use maps.

Inventory of Groundwater Stored in the Mojave River Basins, by Subsurface Surveys, Inc. (1990) used magnetic data, Bouguer gravity anomaly data to estimate depth to bedrock and water level data to estimate groundwater storage volumes in basins throughout the MWA jurisdictional area. Geophysical data were collected by SSI to supplement the gravity data set of USGS (1960). During the course of the current TZ evaluation, URS contacted SSI to obtain the raw gravity data for correlation with new seismic data. Unfortunately, SSI could not locate the original data set. Bedrock contours from the SSI report were used in the current TZ evaluation during construction of cross sections and estimation of groundwater storage.

Precipitation/Evaporation Climatology of the Mojave Water Agency (MWA, 1992b) presents long-term averages of precipitation and evaporation for several weather stations within the MWA boundaries. This report includes a map showing contours of average precipitation.

In 1992, 1996 and 1998 the USGS published water table maps and water level data for several of the basins within MWA boundaries. They include: *Data and Water Table Map of the Mojave River Basin, San Bernardino County, California* (1992), *Regional Water Table and Water Level Changes in the Mojave River, The Morongo, and The Fort Irwin*

Groundwater Basins, San Bernardino County, California (USGS, 1996b), and *Regional Water Table and Groundwater Level Changes in The Mojave River and the Morongo Groundwater Basins, San Bernardino County, California* (USGS, 1998). Each of theses reports provide water level data and contours for selected wells located throughout the MWA for the stated years. The contour maps presented in these reports do not differentiate water levels in the Regional aquifer from the Floodplain aquifer. Water level data from the 1998 report were used to generate contours for the current study.

Groundwater and Surface Water Relations Along the Mojave River (USGS, 1996a) defines relationships between surface water in the Mojave River Channel and groundwater beneath the banks of the River utilizing groundwater production data, precipitation data, and riparian vegetation water use data.

Judgment After Trial (Riverside County Superior Court, 1996) was entered on January 10, 1996. The Judgment governs the use, transfer, and discharge of groundwater within the Mojave River Basin and sets forth the methodology by which the free pumping allowance and make up water obligations are calculated. The judgment also establishes the surface and subsurface flow obligations of each hydrologic subarea to the adjoining downstream subarea.

Riparian Vegetation and its Water Use During 1995 Along the Mojave River (USGS, 1996c) includes detailed mapping identifying the locations and sizes of various riparian plant communities. Plant-specific water use values are applied to the acreage to estimate water use. Transpiration and evaporation data from this report are utilized in the water budget produced under the current TZ evaluation.

Hydrologic Analysis of the Mojave River Basin in the Alto Sub-area, 1999, conducted by Todd Engineers for MWA, includes a detailed review of the "scalping" method used to separate storm flow and base flow components of surface water flowing across the Lower Narrows into the TZ in 1999. Todd Engineers determined that the method used by the Watermaster as set forth in Appendix C of the Judgment is adequate.

Annual Groundwater Level Monitoring Report (MWA, 1999b, 2000a, 2001a, 2002) summarizes water levels in the Mojave Basin for the previous year. These reports include depth to water, casing elevation and screened interval data. Hydrographs are included of the entire period record for each monitored well.

Consumptive Water Use and Update of Production Safe Yield Calculations for the Mojave Basin Area, 2000, prepared by Albert A. Webb Associates, updates safe yield calculations consistent with requirements of the Judgment. This report includes values for surface water flow across the Helendale Fault, subsurface flow from the Alto Sub-area to the TZ and TZ specific consumptive use. Values presented are accepted and used by the Watermaster. Surface water flow values, subsurface flow values, and consumptive use vales from Webb (2000) were considered in assembling the water budget for the current TZ evaluation.

Data From a Thick Unsaturated Zone Underlying Oro Grande and Sheep Creek Washes in the Western Part of the Mojave Desert, Near Victorville, California (USGS, 2000a) includes water level data, lithologic logs, and wireline logs from borings drilled by USGS to investigate alluvial material in the unsaturated zone beneath the Victorville alluvial fan. The borings were drilled in the Alto Subarea some distance south of the TZ but offer insight into properties of the alluvial aquifers of the TZ.

Pliocene and Pleistocene Evolution of the Mojave River, and Associated Tectonic Development of the Transverse Ranges and Mojave Desert, Based on Borehole Stratigraphy Studies Near Victorville, California (USGS, 2000b) provides a detailed description of the sedimentary and tectonic processes responsible for deposition of the alluvial valley fill units within the TZ.

Subsurface Structure and Seismic Velocities as Determined from high Resolution Seismic Imaging in the Victorville, California Area (USGS, 2000c) presents data from three seismic lines in the vicinity of the Lower Narrows. The data reveal depth to bedrock in the Mojave River Channel immediately below the Lower Narrows and reveal potential paleo-channels in the area of the Lower Narrows. Data from this report were considered in constructing the cross sections in the current TZ evaluation.

Simulation of Groundwater Flow in the Mojave River Basin, California (USGS, 2001a), provides an extensive review of published aquifer parameters and which of those parameters are most representative. The report includes estimates of subsurface groundwater flow across the Helendale Fault in both the Floodplain and Regional aquifers.

Stratigraphic and Structural Characterization of the OU-1 Area at the Former George Air Force Base, Adelanto, Southern California (USGS, 2001b) presents data from a series of three seismic reflection lines conducted in conjunction with EPA and United States Air Force cleanup activities at the former George Air Force Base. The seismic reflection line maps the shallow subsurface in great detail but do not extend deep enough to indicate the nature of bedrock contacts in the area. Under the current study, URS conducted a seismic refraction line 2 miles north of the base that mapped bedrock contacts greater than 2,000 feet beneath the surface.

APPENDIX C

REFERENCES MATRIX

Author	Year	Reference Title	REVIEWED	Quoted in Phase I Report	Aquifer and Bedrock Lithologic Description	Aquifer Parameters	Aquifer Physical Characteristics (thickness, boundaries, aerial extent, etc.)	Artificial Recharge Data	Cross Sections	Evaporation Data	Geologic History	Geologic Maps	Geophysical Surveys	Groundwater Flow Modeling	Groundwater Production Data
ALBERT A. WEBB ASSOCIATES	2000	CONSUMPTIVE WATER USE STUDY AND UPDATE OF PRODUCTION SAFE YIELD CALCULATIONS FOR THE MOJAVE BASIN AREA	Y	Y				X							X
BECHTEL	1992	MOJAVE RIVER GROUNDWATER BASIN DEMONSTRATION PROJECT	Y												
BECHTEL	1995	POTENTIAL BENEFITS OF THE PROPOSED MOJAVE RIVER PIPELINE PROJECT ON THE GROUNDWATER RESOURCES OF THE MOJAVE RIVER REGION	Y	Y	X		X	X							
BOOKMAN-EDMONSTON	1994	REGIONAL WATER MANAGEMENT PLAN	Y	Y				X							X
BOYLE ENGINEERING	1993	REGIONAL WATER MANAGEMENT PLAN	N												
BROSE REPORT	1987	HYDROGEOLOGIC INVESTIGATION OF THE LUCERNE VALLEY GROUNDWATER BASIN	N												
BROWN AND CALDWELL	1973	LOWER MOJAVE RIVER BASIN WATER QUALITY MANAGEMENT STUDY	Y												
CAL POLY REPORT	1987	MOJAVE RIVER BASIN DESIGN FOR DESERT WATER MANAGEMENT	Y					X							
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1934	MOJAVE RIVER INVESTIGATION, DIVISION OF WATER RESOURCES, BULLETIN NO 47	Y	Y											
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1955	MOJAVE RIVER VALLEY INVESTIGATION, VICTORVILLE TO BARSTOW, LAHONTAN REGION, PROJECT NO. 55-6-2	N	Y											
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1960a	DATA ON WATER WELLS IN THE EASTERN PART OF THE MIDDLE MOJAVE VALLEY AREA, SAN BERNARDINO COUNTY, CALIFORNIA, BULLETIN NO. 91-3	Y	Y	X							X			X

Author	Year	Groundwater Quality Data	Groundwater Quality Modeling	Hydrographs	The Judgement / Legal Information	Land Use Maps	Monitoring Well Logs	Natural Recharge Data	Per Capita Water Consumption	Population Growth Projections	Precipitation Data	Riparian Water Use / Riparian Vegetation	Surface Water Flow Values	Surface Water Quality Data	Water Budget	Water Level Data	Water Use Projections	Water Well Logs	Well Location Maps
ALBERT A. WEBB ASSOCIATES	2000										X	X	X		TZ Specific				
BECHTEL	1992										X				X		X		
BECHTEL	1995	X														X			
BOOKMAN-EDMONSTON	1994							X	X	X	X		X		X	X	X		
BOYLE ENGINEERING	1993																		
BROSE REPORT	1987																		
BROWN AND CALDWELL	1973														X				
CAL POLY REPORT	1987							X		X							X		
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1934										X	X	X		X	X			
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1955																		
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1960a	X														X		X	X

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CALIFORNIA DEPARTMENT OF WATER RESOURCES	1960b	DATA ON WELLS IN THE WEST PART OF THE MIDDLE MOJAVE VALLEY AREA, SAN BERNARDINO COUNTY, CALIFORNIA, BULLETIN NO. 91-1	Y	Y	X							X			X
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1963	WELLS AND SPRINGS IN THE LOWER MOJAVE VALLEY AREA, SAN BERNARDINO COUNTY, CALIFORNIA, BULLETIN 91-10	N												
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1965	FEASIBILITY OF SERVING THE MOJAVE WATER AGENCY FROM THE STATE WATER PROJECT, BULLETIN 199-112	N												
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1967	MOJAVE RIVER GROUNDWATER BASINS INVESTIGATION, BULLETIN 84	Y	Y	X		X		X		X	X			X
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1972	HYDROLOGIC DATA 1970, VOLUME V, SOUTHERN CALIFORNIA, BULLETIN 130-70	Y												
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1973	HYDROLOGIC DATA 1972, VOLUME V, SOUTHERN CALIFORNIA, BULLETIN 130-72	Y												
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1978a	PRELIMINARY EVALUATION OF HISTORICAL AND PROJECTED WATER USE IN THE MOJAVE WATER AGENCY AREA	N												
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1978b	SUMMARY OF THE PRELIMINARY PHASE OF THE MOJAVE WATER AGENCY COOPERATIVE STUDY	N												
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1979	PRELIMINARY EVALUATION OF FIVE ITEMS OF CONCERN TO THE MOJAVE WATER AGENCY, SOUTHERN DISTRICT PLANNING BRANCH	N												
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1988	HYDROLOGIC DATA 1985, VOLUME V, SOUTHERN CALIFORNIA, BULLETIN 130-85	Y												
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1994	URBAN WATER USE IN CALIFORNIA, BULLETIN 166-4	Y							X					X

Author	Year	Groundwater Quality Data	Groundwater Quality Modeling	Hydrographs	The Judgement / Legal Information	Land Use Maps	Monitoring Well Logs	Natural Recharge Data	Per Capita Water Consumption	Population Growth Projections	Precipitation Data	Riparian Water Use / Riparian Vegetation	Surface Water Flow Values	Surface Water Quality Data	Water Budget	Water Level Data	Water Use Projections	Water Well Logs	Well Location Maps
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1960b	X														X		X	X
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1963																		
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1965																		
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1967	X		X				X	X	X	X	X	X		X	X	X		
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1972	X									X		X	X					
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1973	X									X		X	X					
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1978a																		
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1978b																		
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1979																		
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1988	X									X		X	X					
CALIFORNIA DEPARTMENT OF WATER RESOURCES	1994								X	X	X						X		

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CALIFORNIA DEPARTMENT OF WATER RESOURCES	1996	APPENDIX B DATA AND COMPUTATIONS USED TO DETERMINE 1997 WATER CHARGES, BULLETIN 132-96	Y												
CALIFORNIA DIVISION OF MINES AND GEOLOGY	1954	PLEISTOCENE LAKES AND DRAINAGE IN THE MOJAVE REGION, BULLETIN 170, BLACKWELDER, E.	N	Y											
CALIFORNIA DIVISION OF MINES AND GEOLOGY	1986	GEOLOGIC MAP OF CALIFORNIA, SAN BERNARDINO SHEET, 1:250,000	Y	Y					X		X	X			
CALIFORNIA DIVISION OF MINES AND GEOLOGY	1988	AEROMAGNETIC MAP OF THE SAN BERNARDINO QUADRANGLE, CALIFORNIA, 1:250.000 MAP SERIES NO 3D, YOUNGER, L. G.	N												
CALIFORNIA WATER QUALITY CONTROL BOARD		WATER QUALITY CONTROL PLAN REPORT SOUTH LAHONTAN BASIN	N												
CALIFORNIA, THE STATE OF		MOJAVE WATER AGENCY LAW	Y												
CM ENGINEERING ASSOCIATES	1976	WATER STUDY FOR HESPERIA COUNTY WATER DISTRICT IMMEDIATE AND LONG RANGE IMPROVEMENTS TO WATER SYSTEM	N												
CM ENGINEERING ASSOCIATES AND LEROY CRANDALL & ASSOCIATES	1983	HISTORIC AND PRESENT CONDITIONS, HELENDALE FAULT TO CALICO-NEWBERRY FAULT	Y	Y	X				X						X
CM ENGINEERING ASSOCIATES INC.	1998	MAKEUP WATER LEVEL PRESENTATION	Y												
DIBLEE JR., T.W.	1960	PRELIMINARY GEOLOGIC MAP OF THE VICTORVILLE QUADRANGLE, CALIFORNIA MINERAL INVESTIGATIONS FIELD STUDIES MAP MF-229,	N												
J.S. MURK ENGINEERS AND LEROY CRANDALL & ASSOCIATES	1985	HISTORIC & PRESENT CONDITIONS UPPER MOJAVE RIVER BASIN, AUGUST	Y	Y					X						X

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CALIFORNIA DEPARTMENT OF WATER RESOURCES	1996																		
CALIFORNIA DIVISION OF MINES AND GEOLOGY	1954																		
CALIFORNIA DIVISION OF MINES AND GEOLOGY	1986																		
CALIFORNIA DIVISION OF MINES AND GEOLOGY	1988																		
CALIFORNIA WATER QUALITY CONTROL BOARD																			
CALIFORNIA, THE STATE OF					X														
CM ENGINEERING ASSOCIATES	1976																		
CM ENGINEERING ASSOCIATES AND LEROY CRANDALL & ASSOCIATES	1983								X	X	X	X	X	X	X				X
CM ENGINEERING ASSOCIATES INC.	1998										X		X						
DIBLEE JR., T.W.	1960																		
J.S. MURK ENGINEERS AND LEROY CRANDALL & ASSOCIATES	1985			X					X	X	X	X	X		X		X		X

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JOHNSON, NICHOLAS M.	1999	BASE FLOW ESTIMATION BY HYDROGRAPH SEPARATION, MOJAVE RIVER AT LOWER NARROWS, NICHOLAS M. JOHNSON	Y												
JONES AND STOKES	1994	REGIONAL WATER MGMT. PLAN FINAL ENVIRONMENTAL IMPACT REPORT	N												
MALCOM PIRNIE	1988	MOJAVE RIVER BASIN GROUNDWATER RECHARGE STUDY, VOLUME 1 & VOLUME 2	Y	Y				X	X			X			
MALCOM PIRNIE	1990	MASTER PLAN FOR DELIVERY OF IMPORTED WATER	Y												
MAXWELL, CHRISTOPHER	2000	A WATERSHED MANAGEMENT APPROACH TO ASSESSMENT OF WATER QUALITY AND DEVELOPMENT FOR REVISED WATER QUALITY STANDARDS OF THE GROUND WATERS OF THE MOJAVE RIVER FLOODPLAIN													
MOJAVE RIVER COUNTY WATER DISTRICT	1974	MOJAVE RIVER COUNTY WATER DISTRICT, BASIC HYDROLOGIC DATA, 6TH EDITION, DIBBLE, EDWARD F.	N												
MOJAVE WATER AGENCY	1967	WATER PRODUCTION VERIFICATION	Y												X
MOJAVE WATER AGENCY	1970	PRELIMINARY REPORT ON THE WATER QUALITY PROBLEMS IN THE AREA OF INFLUENCE, MOJAVE WATER AGENCY, MANN, JOHN F. JR.	N												
MOJAVE WATER AGENCY	1981	ALTERNATIVE WATER SUPPLY FOR MOJAVE WATER AGENCY	Y												limited
MOJAVE WATER AGENCY	1982	HISTORIC & PRESENT CONDITIONS M.R. GROUNDWATER BASIN-NEWBERRY, CM ENGINEERING ASSOCIATES	N												
MOJAVE WATER AGENCY	1988	DIVISION 2 GROUNDWATER REPORT, JULY 1988	Y												

Reference Matrix

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JOHNSON, NICHOLAS M.	1999												X						
JONES AND STOKES	1994																		
MALCOM PIRNIE	1988					X		X					X						
MALCOM PIRNIE	1990								X	X							X		
MAXWELL, CHRISTOPHER	2000																		
MOJAVE RIVER COUNTY WATER DISTRICT	1974																		
MOJAVE WATER AGENCY	1967																		
MOJAVE WATER AGENCY	1970																		
MOJAVE WATER AGENCY	1981	X							X								X		
MOJAVE WATER AGENCY	1982																		
MOJAVE WATER AGENCY	1988									X					X				

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MOJAVE WATER AGENCY	1990	UPDATE OF GROUNDWATER CONDITIONS IN LUCERNE VALLEY	N												
MOJAVE WATER AGENCY	1991a	BOUNDARY MAP MWA, COLOR	N												
MOJAVE WATER AGENCY	1991b	SMALL BOUNDARY MAP	N												
MOJAVE WATER AGENCY	1992a	MORONGO BASIN PIPELINE PROJECT BOND ISSUE PROSPECTUS 1992 ISSUE	N												
MOJAVE WATER AGENCY	1992b	PRECIPITATION/EVAPORATION CLIMATOLOGY OF THE MOJAVE WATER AGENCY	Y	Y						X					
MOJAVE WATER AGENCY	1994	JOINT ENGINEERING MEETINGS	Y												X
MOJAVE WATER AGENCY	1996	ENGINEER'S FIRST ANNUAL REPORT ON WATER SUPPLY FOR WATER YEAR 1994-1995, VICTORVILLE CA, 55P	N												
MOJAVE WATER AGENCY	1997	ENGINEER'S SECOND ANNUAL REPORT ON WATER SUPPLY FOR WATER YEAR 1995-1996	Y												
MOJAVE WATER AGENCY	1998	ENGINEER'S THIRD ANNUAL REPORT ON WATER SUPPLY FOR WATER YR. 1996-1997	Y												X
MOJAVE WATER AGENCY	1999a	ANNUAL GROUNDWATER-LEVEL MONITORING PROGRAM FOR 1998	Y	Y											
MOJAVE WATER AGENCY	1999b	ENGINEER'S FOURTH ANNUAL REPORT ON WATER SUPPLY FOR WATER YR. 1997-1998, APPLE VALLEY CA, 77P	Y												

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MOJAVE WATER AGENCY	1990																		
MOJAVE WATER AGENCY	1991a																		
MOJAVE WATER AGENCY	1991b																		
MOJAVE WATER AGENCY	1992a																		
MOJAVE WATER AGENCY	1992b										X								
MOJAVE WATER AGENCY	1994								X	X					X		X		
MOJAVE WATER AGENCY	1996																		
MOJAVE WATER AGENCY	1997	X									X	X	X	X	X				
MOJAVE WATER AGENCY	1998	X									X		X	X	X				
MOJAVE WATER AGENCY	1999a			X												X			
MOJAVE WATER AGENCY	1999b	X									X		X	X	X				

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MOJAVE WATER AGENCY	2000a	ANNUAL GROUNDWATER-LEVEL MONITORING PROGRAM FOR 1999	Y	Y											
MOJAVE WATER AGENCY	2001a	ANNUAL GROUNDWATER-LEVEL MONITORING PROGRAM FOR 2000	Y	Y											
MOJAVE WATER AGENCY		BOUNDARY MAP MWA, BLUE LINE	N												
MOJAVE WATER AGENCY WATERMASTER	1995	WATERMASTER FIRST ANNUAL REPORT, WATER YEAR 1993-94	N	Y											
MOJAVE WATER AGENCY WATERMASTER	1996	WATERMASTER RULES & REGULATIONS	N												
MOJAVE WATER AGENCY WATERMASTER	1996	WATERMASTER SECOND ANNUAL REPORT, WATER YEAR 1994-95	N	Y											
MOJAVE WATER AGENCY WATERMASTER	1997	WATERMASTER THIRD ANNUAL REPORT, WATER YEAR 1995-96	Y	Y				X							X
MOJAVE WATER AGENCY WATERMASTER	1998	WATERMASTER FOURTH ANNUAL REPORT, WATER YEAR 1996-97	Y	Y				X							X
MOJAVE WATER AGENCY WATERMASTER	1999	WATERMASTER FIFTH ANNUAL REPORT, WATER YEAR 1997-98	Y	Y				X							X
MOJAVE WATER AGENCY WATERMASTER	2000	WATERMASTER SIXTH ANNUAL REPORT, WATER YEAR 1998-99	Y	Y				X							X
MOJAVE WATER AGENCY WATERMASTER	2001	WATERMASTER SEVENTH ANNUAL REPORT, WATER YEAR 1999-00	Y	Y				X							X

Reference Matrix

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MOJAVE WATER AGENCY	2000a			X												X			
MOJAVE WATER AGENCY	2001a			X												X			
MOJAVE WATER AGENCY																			
MOJAVE WATER AGENCY WATERMASTER	1995																		
MOJAVE WATER AGENCY WATERMASTER	1996																		
MOJAVE WATER AGENCY WATERMASTER	1996																		
MOJAVE WATER AGENCY WATERMASTER	1997				X			X			X		X			X			
MOJAVE WATER AGENCY WATERMASTER	1998				X			X			X		X			X			
MOJAVE WATER AGENCY WATERMASTER	1999				X			X			X		X			X			
MOJAVE WATER AGENCY WATERMASTER	2000				X			X			X		X			X			
MOJAVE WATER AGENCY WATERMASTER	2001				X			X			X		X			X			

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RIVERSIDE COUNTY SUPERIOR COURT	1993	APPENDIX A TO THE JUDGMENT – VOLUME II, MOJAVE BASIN AREA ADJUDICATION	Y	Y											
RIVERSIDE COUNTY SUPERIOR COURT	1996	JUDGMENT AFTER TRIAL	Y	Y											
SCOTT, MICHAEL L.	1999	CHANNEL INCISION AND PATTERNS OF COTTONWOOD STRESS AND MORTALITY ALONG THE MOJAVE RIVER, CALIFORNIA	Y												
STETSON, T.M.	1974	REPORT ON REVIEW OF OVERDRAFT OF THE MOJAVE RIVER BASIN FOR THE MOJAVE WATER AGENCY	N	Y											
SUBSURFACE SURVEYS, INC.	1990	INVENTORY OF GROUNDWATER STORED IN THE MOJAVE RIVER BASINS	Y	Y			Aq. Thickness				X	X	X		
SUPERIOR COURT OF THE STATE OF CALIFORNIA	1970	MOJAVE RIVER ADJUDICATION	Y	Y											X
THOMPSON, D.G.	1921	SPECIAL REPORT OF GROUNDWATER CONDITIONS ALONG MOJAVE RIVER , SAN BERNARDINO COUNTY	Y	Y	X		X								
TODD ENGINEERS	1999	HYDROLOGIC ANALYSIS OF THE MOJAVE RIVER BASIN IN THE ALTO SUBAREA	Y	Y											
U.S. BUREAU OF RECLAMATION	1952	REPORT ON THE VICTOR PROJECT	Y	Y						X					
U.S. GEOLOGICAL SURVEY	1921	ROUTES TO DESERT WATERING PLACES IN THE MOJAVE DESERT REGION, CALIFORNIA, US GEOLOGICAL SURVEY WATER SUPPLY PAPER 490-B, THOMPSON, D.G.	Y		general				X						
U.S. GEOLOGICAL SURVEY	1929	THE MOJAVE DESERT REGION, CALIFORNIA. USGS PAPER NO. 578, THOMPSON, D.G.	N												

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RIVERSIDE COUNTY SUPERIOR COURT	1993				X														
RIVERSIDE COUNTY SUPERIOR COURT	1996				X														
SCOTT, MICHAEL L.	1999										X	X							
STETSON, T.M.	1974																		
SUBSURFACE SURVEYS, INC.	1990																		
SUPERIOR COURT OF THE STATE OF CALIFORNIA	1970				X	X													
THOMPSON, D.G.	1921								X			X	X						
TODD ENGINEERS	1999										X		X						
U.S. BUREAU OF RECLAMATION	1952								X	X	X	X	X		X				X
U.S. GEOLOGICAL SURVEY	1921												estimates						
U.S. GEOLOGICAL SURVEY	1929																		

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U.S. GEOLOGICAL SURVEY	1960	GRAVITY SURVEY OF THE WESTERN MOJAVE DESERT, CALIFORNIA , USGS PROFESSIONAL PAPER 316-D, MABEY, D.R.	Y	Y	X				X			X	X		
U.S. GEOLOGICAL SURVEY	1961	DATA ON WATER WELLS IN THE UPPER MOJAVE VALLEY AREA, SAN BERNARDINO, CAL. USGS OPEN FILE REPORT 59-8, BADER, J.S.	N												
U.S. GEOLOGICAL SURVEY	1967	AREAL GEOLOGY OF THE WESTERN MOJAVE DESERT, CALIFORNIA, USGS PAPER 522, 153P, DIBBLEE, T.W. JR.	Y	Y	X		X		X		X	X			
U.S. GEOLOGICAL SURVEY	1969	MOJAVE RIVER BASIN GROUND WATER RECHARGE WITH PARTICULAR REFERENCE TO THE CALIFORNIA FLOODS OF JANUARY & FEBRUARY, 1969 USGS, HARDT, W., OPEN FILE REPORT, 13P	Y	Y				X							
U.S. GEOLOGICAL SURVEY	1971	HYDROLOGIC ANALYSIS OF THE MOJAVE RIVER BASIN, CALIFORNIA, USING ELECTRIC ANALOG MODEL, REPORT No. 72-08, 84P	Y	Y	X	X	X	X						X	
U.S. GEOLOGICAL SURVEY	1974	HYDROLOGIC ANALYSIS OF THE MOJAVE RIVER, CALIFORNIA, USING A MATHEMATICAL MODEL, USGS WATER RESOURCES INVESTIGATIONS 17-74, DURBIN T.J. & HARDT, W.F.	Y	Y				X							
U.S. GEOLOGICAL SURVEY	1976	PHOTORECONNAISSANCE MAPS SHOWING YOUNG LOOKING FAULT FEATURES IN THE SOUTHERN MOJAVE DESERT, CALIFORNIA MF-1051	N												
U.S. GEOLOGICAL SURVEY	1980	AQUIFER RECHARGE FROM FLOODS IN 1969 & 1978 IN THE MOJAVE RIVER BASIN, ANTHONY BUONO & DAVID J. LANG	Y	Y											
U.S. GEOLOGICAL SURVEY	1982a	TOPOGRAPHIC MAP OF SAN BERNARDINO CALIFORNIA, 1:100 000-SCALE METRIC	Y	Y											
U.S. GEOLOGICAL SURVEY	1982b	TOPOGRAPHIC MAP OF VICTORVILLE CALIFORNIA, 1:100 000-SCALE METRIC	Y	Y											
U.S. GEOLOGICAL SURVEY	1992	DATA AND WATER TABLE-MAP OF THE MOJAVE RIVER GROUNDWATER BASIN, SAN BERNARDINO COUNTY, CA NOVEMBER 1992, WRI 95-4148	Y	Y											

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U.S. GEOLOGICAL SURVEY	1960																		
U.S. GEOLOGICAL SURVEY	1961																		
U.S. GEOLOGICAL SURVEY	1967																		
U.S. GEOLOGICAL SURVEY	1969							X			X	X	X						
U.S. GEOLOGICAL SURVEY	1971							X			X		X						
U.S. GEOLOGICAL SURVEY	1974							X			X	X	X		X				
U.S. GEOLOGICAL SURVEY	1976																		
U.S. GEOLOGICAL SURVEY	1980										avg 1944-1973	X	X			X			
U.S. GEOLOGICAL SURVEY	1982a																		
U.S. GEOLOGICAL SURVEY	1982b																		
U.S. GEOLOGICAL SURVEY	1992															X			

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U.S. GEOLOGICAL SURVEY	1993	CHEMICAL, ISOTOPIC, AND MICROBIOLOGICAL EVIDENCE FOR DENITRIFICATION DURING TRANSPORT OF DOMESTIC WASTEWATER THROUGH A THICK UNSATURATED ZONE IN THE MOJAVE DESERT, SAN BERNARDINO COUNTY, CALIFORNIA. OPEN FILE REPORT 93-414	Y			X									
U.S. GEOLOGICAL SURVEY	1993	GEOHYDROLOGY AND WATER QUALITY AND NITROGEN GEOCHEMISTRY, RIVERSIDE AND SAN BERNARDINO COUNTIES, REPORT #94-4127,1991-93	Y												
U.S. GEOLOGICAL SURVEY	1995	POTENTIAL FOR GROUNDWATER CONTAMINATION FROM MOVEMENT OF WASTEWATER THROUGH THE UNSATURATED ZONE, UPPER MOJAVE RIVER BASIN, REPORT # 93-4137	Y		X			X							
U.S. GEOLOGICAL SURVEY	1996a	GROUNDWATER AND SURFACE WATER RELATIONS ALONG THE MOJAVE RIVER, REPORT # 95-4189	Y	Y	X		X	X							X
U.S. GEOLOGICAL SURVEY	1996b	REGIONAL WATER TABLE (1996) AND WATER-LEVEL CHANGES IN THE MOJAVE RIVER, THE MORONGO, AND THE FORT IRWIN GROUNDWATER BASINS, SAN BERNARDINO COUNTY, REPORT # 97-4160	Y	Y											
U.S. GEOLOGICAL SURVEY	1996c	RIPARIAN VEGETATION AND ITS WATER USE DURING 1995 ALONG THE MOJAVE RIVER, REPORT # 96-4241	Y	Y											
U.S. GEOLOGICAL SURVEY	1997	GEOHYDROLOGY AND WATER QUALITY OF MARINE CORPS LOGISTICS BASE, NEBO AND YERMO ANNEXES, NEAR BARSTOW CA, REPORT #96-4301, DENSMORE, J.N. & COX, B.F. & CRAWFORD,S.M.	N												
U.S. GEOLOGICAL SURVEY	1998	REGIONAL WATER TABLE (1998) AND GROUND-WATER-LEVEL CHANGES IN THE MOJAVE RIVER AND THE MORONGO GROUND-WATER BASINS, SAN BERNARDINO COUNTY, REPORT # 00-4090	Y	Y											
U.S. GEOLOGICAL SURVEY	2000a	DATA FROM A THICK UNSATURATED ZONE UNDERLYING ORO GRANDE AND SHEEP CREEK WASHES IN THE WESTERN PART OF THE MOJAVE DESERT, NEAR VICTORVILLE 1994-99, REPORT #00-262, 2000	Y		X								down hole		
U.S. GEOLOGICAL SURVEY	2000b	PLIOCENE AND PLEISTOCENE EVOLUTION OF THE MOJAVE RIVER, AND ASSOCIATED TECTONIC DEVELOPMENT OF THE TRANSVERSE RANGES AND MOJAVE DESERT, BASED ON BOREHOLE STRATIGRAPHY STUDIES NEAR VICTORVILLE, CALIFORNIA, REPORT #00-147	Y		X		X		X		X				
U.S. GEOLOGICAL SURVEY	2000c	SUBSURFACE STRUCTURE AND SEISMIC VELOCITIES AS DETERMINED FROM HIGH RESOLUTION SEISMIC IMAGING IN THE VICTORVILLE, CALIFORNIA AREA: IMPLICATIONS FOR WATER RESOURCES AND EARTHQUAKE HAZARDS. OPEN FILE REPORT 00-123	Y		X				X		X		X		

Author	Year	Groundwater Quality Data	Groundwater Quality Modeling	Hydrographs	The Judgement / Legal Information	Land Use Maps	Monitoring Well Logs	Natural Recharge Data	Per Capita Water Consumption	Population Growth Projections	Precipitation Data	Riparian Water Use / Riparian Vegetation	Surface Water Flow Values	Surface Water Quality Data	Water Budget	Water Level Data	Water Use Projections	Water Well Logs	Well Location Maps
U.S. GEOLOGICAL SURVEY	1993	X																	
U.S. GEOLOGICAL SURVEY	1993																		
U.S. GEOLOGICAL SURVEY	1995							X											
U.S. GEOLOGICAL SURVEY	1996a							X			X	X	X						
U.S. GEOLOGICAL SURVEY	1996b															X			
U.S. GEOLOGICAL SURVEY	1996c											X							
U.S. GEOLOGICAL SURVEY	1997																		
U.S. GEOLOGICAL SURVEY	1998															X			
U.S. GEOLOGICAL SURVEY	2000a						X									X			
U.S. GEOLOGICAL SURVEY	2000b																		
U.S. GEOLOGICAL SURVEY	2000c																		

Author	Year	Reference Title	REVIEWED	Quoted in Phase I Report	Aquifer and Bedrock Lithologic Description	Aquifer Parameters	Aquifer Physical Characteristics (thickness, boundaries, aerial extent, etc.)	Artificial Recharge Data	Cross Sections	Evaporation Data	Geologic History	Geologic Maps	Geophysical Surveys	Groundwater Flow Modeling	Groundwater Production Data
U.S. GEOLOGICAL SURVEY	2001a	SIMULATION OF GROUNDWATER FLOW IN THE MOJAVE RIVER BASIN, CALIFORNIA, REPORT # 01-4002	Y	Y	X	X	X	X	D-D' transition zone					X	
U.S. GEOLOGICAL SURVEY	2001b	STRATIGRAPHIC AND STRUCTURAL CHARACTERIZATION OF THE OU-1 AREA AT THE FORMER GEORGE AIR FORCE BASE, ADELANTO, SOUTHERN CALIFORNIA. OPEN FILE REPORT 01-60	Y		X		X		X		X		X		
U.S. GEOLOGICAL SURVEY		GROUNDWATER STORAGE IN THE JOHNSON VALLEY AREA, INVESTIGATION # 77-130	N												
U.S. GEOLOGICAL SURVEY		HEALTH OF NATIVE RIPARIAN VEGETATION	Y							X					
	1984	FINAL MANAGEMENT ALTERNATIVES-BARSTOW & NEWBERRY	Y												
	1986	FINAL MANAGEMENT ALTERNATIVES-UPPER MOJAVE	Y												
	1988	MANAGEMENT OF WATER IN CALIFORNIA, SEPTEMBER 1988	Y												
	2000	GROUNDWATER AND SURFACE WATER IN SOUTHERN CALIFORNIA, A GUIDE TO CONJUCTIVE USE	Y												

Author	Year	Groundwater Quality Data	Groundwater Quality Modeling	Hydrographs	The Judgement / Legal Information	Land Use Maps	Monitoring Well Logs	Natural Recharge Data	Per Capita Water Consumption	Population Growth Projections	Precipitation Data	Riparian Water Use / Riparian Vegetation	Surface Water Flow Values	Surface Water Quality Data	Water Budget	Water Level Data	Water Use Projections	Water Well Logs	Well Location Maps
U.S. GEOLOGICAL SURVEY	2001a							X		X		X	annual '31-'94		X				X
U.S. GEOLOGICAL SURVEY	2001b																		
U.S. GEOLOGICAL SURVEY																			
U.S. GEOLOGICAL SURVEY											X	X							
	1984								General										
	1986								General										
	1988								General										
	2000																		

APPENDIX D

REGIONAL AQUIFER SEISMIC REFRACTION PROFILE

APPENDIX D

SEISMIC REFRACTION STUDIES

GEORGE BASIN, SAN BERNARDINO COUNTY, CA

MOJAVE RIVER TRANSITION ZONE

RECHARGE PROJECT

MOJAVE WATER AGENCY

Prepared for

URS Corporation
10723 Bell Court
Rancho Cucamonga, CA 91730

July 30, 2002

Prepared by

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GEOVision

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Corona, CA 92882

SEISMIC REFRACTION STUDIES
MOJAVE TRANSITION ZONE, GEORGE BASIN

INTRODUCTION

As part of a hydrogeological study of the Transition Zone, seismic refraction investigations were undertaken north of the former George Air Force Base to delineate the buried sediment-basement interface and sediment thickness and velocities within the basin. A sedimentary basin structure is defined primarily by a 20-mGal minimum gravity anomaly with the center located about 4 miles south of Adelanto (Figure 1). This basin has been referred to as the George Basin (Subsurface Surveys, Inc., 1990). The seismic refraction profile was located in the northern part of the structure.

Depth to basement is poorly known and knowledge of major aquifer-aquitard layering, if any, is lacking. Seismic refraction studies were carried out and an attempt was made to combine the results with the geology, well, and gravity data. Unfortunately the principal facts for the gravity survey in this area where unavailable and the contour map is on a regional scale, which prohibits an analysis of the detail structure as determined by the seismic refraction study. The gravity data that are available (Figure 1) do not have sufficient data coverage in the area of the seismic refraction profile.

The Attachments to this appendix include all of the principal facts for the seismic refraction profile and the model.

SEISMIC REFRACTION

A. Seismic Field Procedures

A reversed seismic refraction profile was established within the sedimentary area of the northern part of the George Basin in order to obtain basement depth control and velocity-depth information. The refraction profile with shot point, geophone locations, and selected depths to seismic basement is shown on Figure 2. The ray-traced depth model is shown on Figure 3. The profile was recorded in two setups (1N and 1S) each approximately 5,000 feet long. Each segment was recorded in the forward and reverse directions with a mid source point and a step-out source point 2,000 feet to the north. The seismic refraction data were collected using two 24-channel RS44 system designed by Dresser Industries. The lengths of the spreads were 4,600 feet with geophone spacing of 200 feet. This geophone spacing is useful for rapid determination of basement depths but is not designed to detail changes in the near surface velocities. A third unit using a Geometrics Strataview with a length of 575 feet and geophone spacing of 25 feet was used to obtain the near surface velocities. Contained sources in 20- to 30-foot deep drill holes were located at either end of the lines with charges of from 15 to 40 lbs. of Tovex Extra. The sources were detonated by electric blasting caps, which were tied into a radio time tone circuit and recorded on each unit. The time tone circuit has an overall accuracy of ±2.5 milliseconds.

Elevation data along the profile was interpolated from the USGS quadrangle map contours. As shown on Figure 2, the quadrangle map has surface elevation contours at 10-foot intervals in the area of the profile. Accurate deduction of the seismic data require surface elevation data to be at better than 10-foot precision, which is obtainable from the quadrangle map.

B. Seismic Data Reduction

The data reduction consisted of picking the records by hand using a magnifying lens and variable scale ruler to obtain first breaks. On most records, the initial breaks were easily picked to within one millisecond. In places where the data were poor or traces were dead no picks were used. Dead traces can be caused by human or animal interference (i.e. off road vehicles running across the line and rodents eating the wires) and an occasionally malfunctioning geophone. The Strataview digital records were picked using SIPWIN (2000). These data were entered into a computer program (SRIACP; Biehler, 1988) along with topographic data for each profile, which enabled elevations at each geophone and source point to be computed. The data were reduced using an elevation and weathering correction formulas given in Dobrin and Savit (1988).

These corrections were applied assuming a datum plane above the maximum elevation encountered along the profile (see dashed line on Figure 3). This effectively fills in the topography with material equal to the near surface velocity.

After the correction for elevation and weathering the computer program applies a least-squares fit straight line for each set of data points and attempts to model the seismic velocity interfaces by obtaining true velocities from the apparent velocities and the intercept times. These fitted velocity segments were determined in advance by assigning layer numbers for each branch of the travel time curve. These data were then plotted along with the interpreted model that was developed using plane dipping interfaces. The data for all plots are presented in Attachment D1 . Although the values produced by the program are given to the nearest foot, the overall accuracy is probably no better than ±10% of the total depths.

On Figure 3 the calculated depths were plotted on the cross sections and ray-path analysis was used to determine the basement geometry. The portion of the basement interface that is well controlled by both forward and reverse arrivals is indicated by a thickened line segment. Selected ray paths are shown on Figure 3 as lines with arrowheads which indicate the direction of seismic interrogation. The depths at the ends of the profiles, beyond the last ray path, are extrapolated assuming a uniform dipping layer. Care should be exercised in placing too much emphasis on these extrapolated values. It should be noted that along some of the refraction spreads, variations in delay times from the basement refractor indicate an undulating interface, with vertical relief on the order of tens of feet. The depths, as presented on the interpreted cross section, are considered most reliable where the data points fit closely with the least squares fit line and the layer is interrogated in both the forward and reverse directions. Figure 2 shows the calculated depths of seismic basement at selected points along the seismic profile.

C. Seismic Interpretation

Helendale Road - Profiles 1N and 1S:

Profile 1 (Figures 2 and 3) was established north-south along Helendale road. The total length of the line is 10,024 feet. The interpreted model consists of five successively deeper layers. The first layer is about 125-feet thick with an average velocity 2,450 feet per second (ft/sec) and corresponds to the dry recent alluvium observed at the surface. The second layer is about 125-feet thick with velocity of 5,700 ft/sec and corresponds to the dry older alluvium. The third layer is about 850-feet thick with an average velocity of 7,300-ft/sec and corresponds with saturated sediments. The interface between these dry and saturated layers, inferred to be the water table, is constrained by both forward and reverse arrivals across the entire profile. The average depth of this interface is about 250 feet with an elevation of approximately 2530 feet. The velocity of the third layer suggests the sediments are quite porous and may be similar in composition to the dry older alluvium of the second layer. If this is true then the porosity should be in the range of 20 to 30%. The fourth layer, which overlies basement, ranges in thickness from 650 to 1,600 feet with an average velocity 9,800 ft/sec and corresponds with very low porosity material either older saturated sediments or possibly volcanics.

The fifth layer is the seismic basement with a velocity of 14,800 ft/sec. This velocity is typical of the Mesozoic granitic rocks that outcrop in this area. The time-distance segments indicate that the basement dips from both the north and south ends of the profile towards a low point in the middle of the profile. Depth to bedrock varies from 1,820 feet in the north to 2,670 across the center to 1,630 feet in the south. The center portion of the model is constrained by both forward and reverse arrivals from basement. Because the basement is essentially concave, the far north and south ends only record arrivals in the up-dip direction. The calculated model is based on these apparent velocities, the total travel time and assumes the true velocity is the same across the profile in order to calculate the angle of dip and the depth to the interface. These calculated apparent dips are always less than the true dips of the basement unless the profile direction is perpendicular to the strike of the structure.

A comparison of the bedrock depths along Profile 1 with those calculated from the Bouguer gravity data (Subsurface Surveys, 1990) indicates that the average depth along the center of the profile is at least a 1,000 feet greater than indicated on the Bedrock Depth Map (Figure 4). In addition, there is no suggestion of a mapped trough in basement contours near SP3. The bedrock depth contours as shown on Figure 4 increase from about 1,000 feet near SP2 to about 1,800 feet at SP4. On Profile 1 (Figure 3), SP2 and SP4 have bedrock depths of 1,820 feet and 1,635 feet, respectively. In order to understand the possible reasons for this discrepancy, we must look at the distribution of the gravity data points and the assumptions used to make the regional Bedrock Depth Map (Figure 4 of this appendix and Plate III of Subsurface Surveys, 1990).

In Figure 5 the location of Profile 1 is plotted on the Bouguer Gravity Map (from Plate I, Subsurface Surveys, 1990). As can be seen by the station locations (marked by small closed circles) there are no observations along the seismic profile. The closest stations are about ¼ mile to the west and a ½ mile to the east with a north - south station spacing of ½ to 1 mile. There appears to be a small gravity minimum to the northeast of SP2. The map itself is contoured at an interval of 2 mGals. A simple 2 ½ d calculation indicates an expected anomaly of only 1 to 2 mGals from the structure observed in Profile 1 assuming reasonable densities based on the measured seismic velocities (Figure 6). Thus it is possible that the station density and contour interval is not fine enough to resolve the structure seen in Profile 1.

The problem in matching the total depths along the profile is probably caused by the selection of densities used in the inversion of the Bouguer Gravity to bedrock depths. The following parameters were used by Subsurface Surveys (1990, page 26). "The default model parameters for this work is granite density, 2.68 gm/cc for the bedrock, density 2.13 gm/cc for sediment to a depth of 2,500 feet, and density 2.23 gm/cc for sediment below 2,500 feet and above bedrock". As can be seen from Profile 1 (Figure 3) at a depth of about 1,050 feet, a layer with a seismic velocity of 9,800 ft/sec was encountered. The density of this layer, based on accepted velocity-density curves (Dobrin, 1988; Woollard, 1962), should be about 2.45 gm/cc. Using 2.13 gm/cc instead of the more appropriate density of 2.45 gm/cc would result in a bedrock depth which is about 800 to 1,600 feet too shallow based on the measured gravity anomaly in this area. With the correct density the calculated gravity bedrock depths agree with the measured seismic refraction depths.

It is apparent from this study that the George Basin may be more complex in both the shallow and deep structure then was determined by the regional analysis of Subsurface Surveys. Caution should be exercised in making a conceptual model of a single basin based solely on such broad-based regional data and interpretations. A detailed gravity map with an overall accuracy of a tenth of a mGal and some additional velocity-depth control would permit a more definitive interpretation of the basement and layering within the basin.

The geophysical analysis in this appendix is based on the usual assumptions that there are no velocity reversals with depth or blind zones, which were not detected with the seismic refraction method. It is also assumed that the water table is associated with the increase in velocity from below 5,700 ft/sec to over 7,300 ft/sec and that no perched water tables were encountered.

REFERENCES

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Dobrin, M.S., and Savit, J., 1988, Introduction to Geophysical Prospecting, Mc Graw-Hill Co., New York

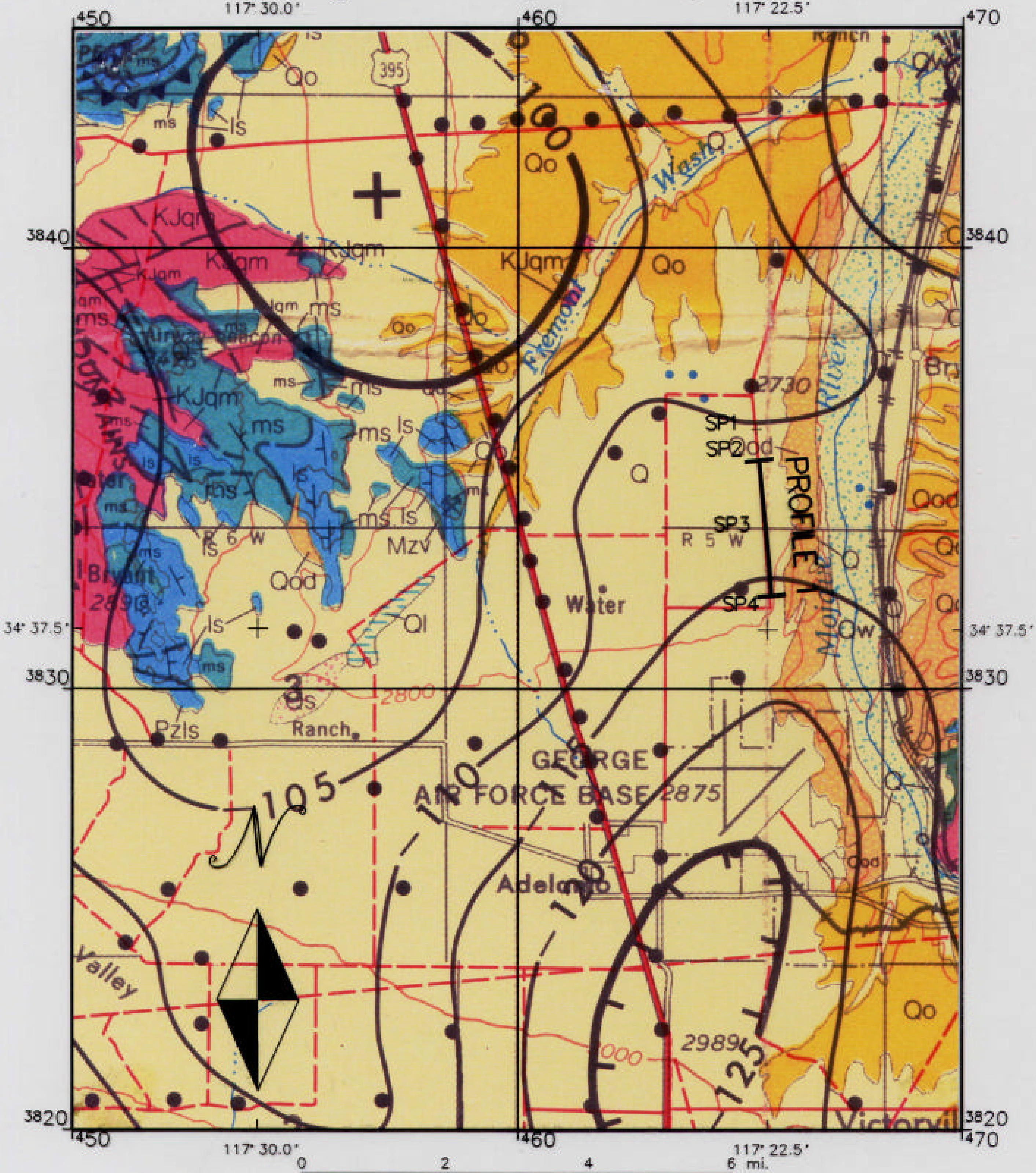
Rotstein, Y., Combs, J. and Biehler, S., 1976. Gravity investigations in the southeastern Mojave Desert, California, Geological Society of America Bulletin, vol 87, pp.981-993.

Subsurface Surveys, Inc., 1990, Inventory of Groundwater Stored In The Mojave River Basins.

Woollard G. P., 1962, The relation of gravity anomalies to surface elevation, crustal structure, and Geology. University of Wisconsin, Report 62-9.

LIST OF FIGURES

Geologic and Bouguer Gravity Map



Contour Interval 5 mGals.

Figure 1. Geologic and Bouguer gravity map of the George Basin area (from Biehler et al, 1988). Seismic refraction Profile 1 and Shot points indicated by heavy line and SP.

Shotpoint – Geophone Locations

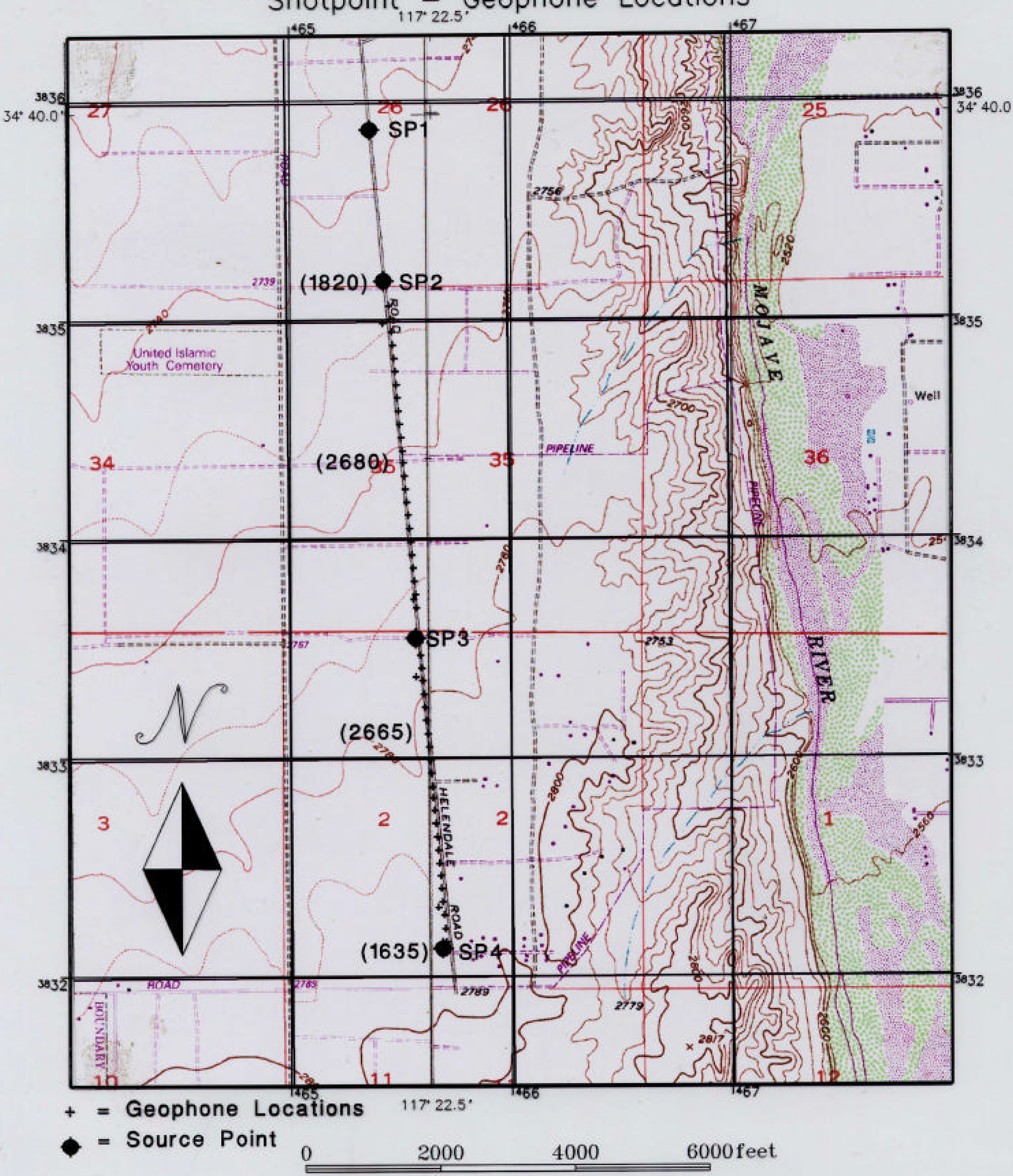


Figure 2. Source points and geophone locations for seismic Profile 1. Depth to basement (feet) at selected locations. Base map from USGS 7.5' quadrangles (Victorille, NW (1993) and Helendale (1993).

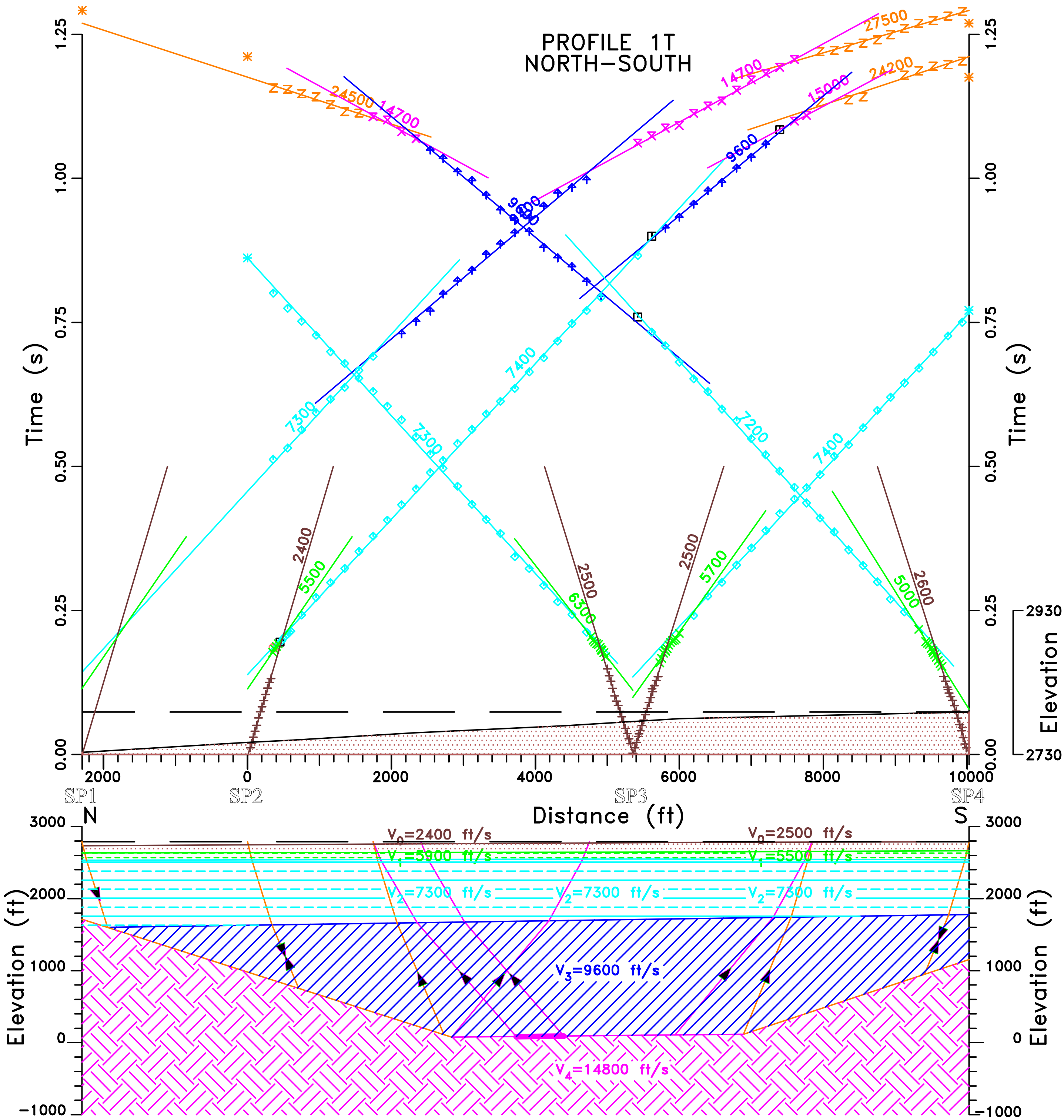
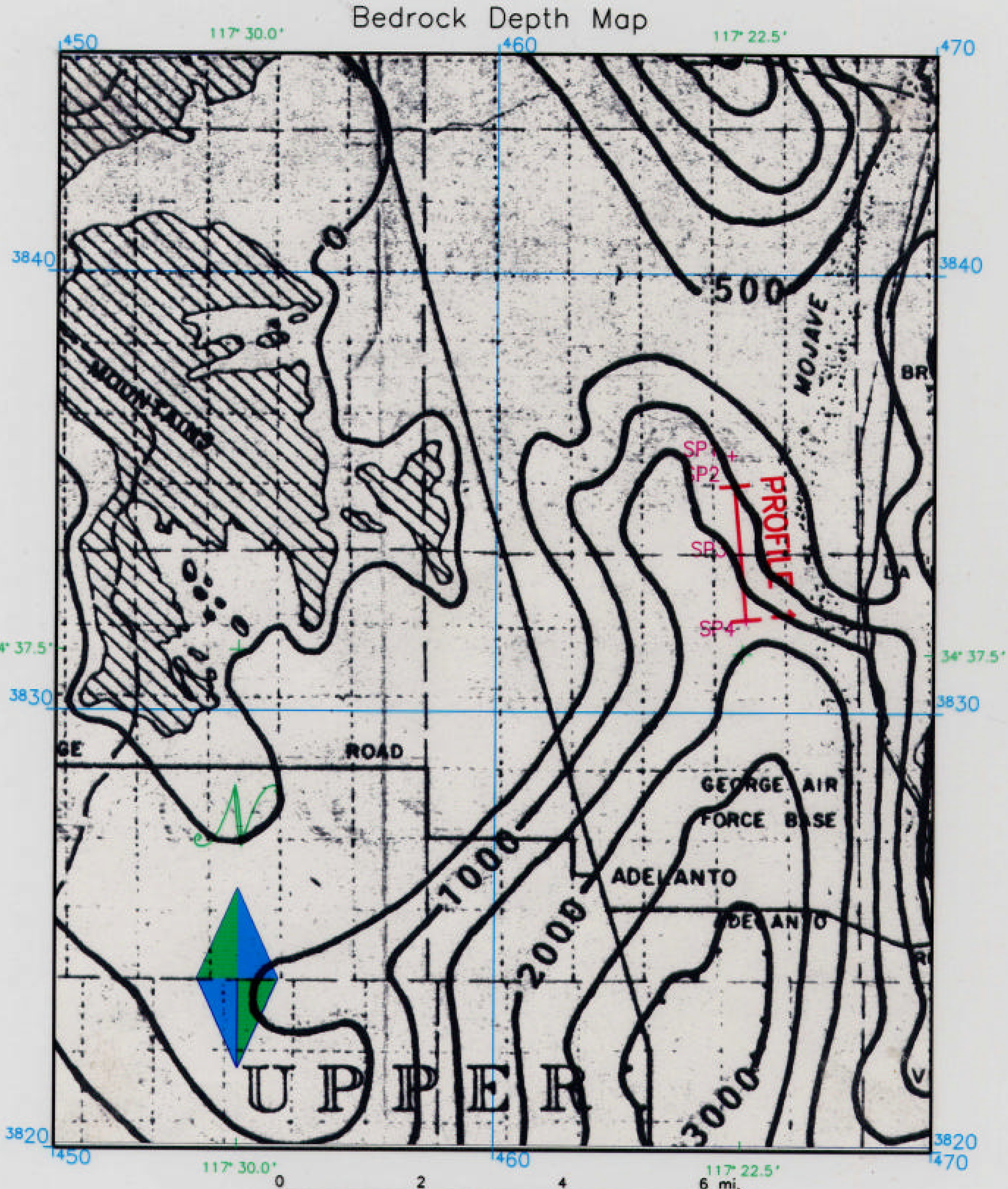


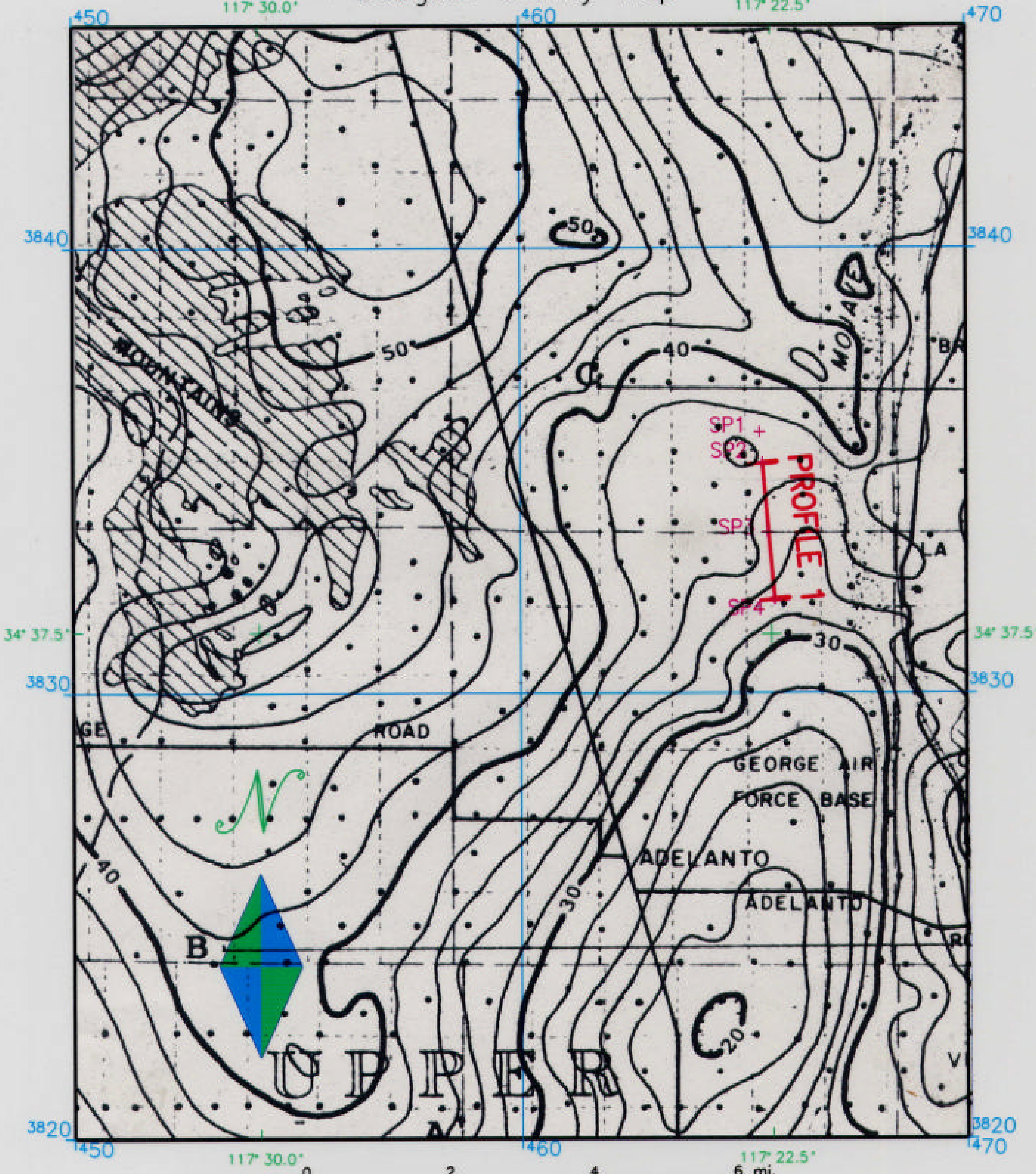
Figure 3. Time-distance plot and ray traced model for seismic refraction Profile 1, Helendale Road. Datum for elevation correction shown by dashed line. Shot Point locations marked by SP.



Contour Interval = 500 feet.

Figure 4. Bedrock depth map of the George Basin area (Subsurface Surveys, 1990). Seismic refraction Profile 1 and Shot Points shown by red line and SP.

Bouguer Gravity Map



Contour Interval = 2.0 mGals.

Figure 5. Bouguer Gravity and Basement Outcrop Map of the George Basin area (Subsurface Surveys, 1990). Seismic refraction Profile 1 and Shot Points shown by red line and SP. Gravity station = ● .

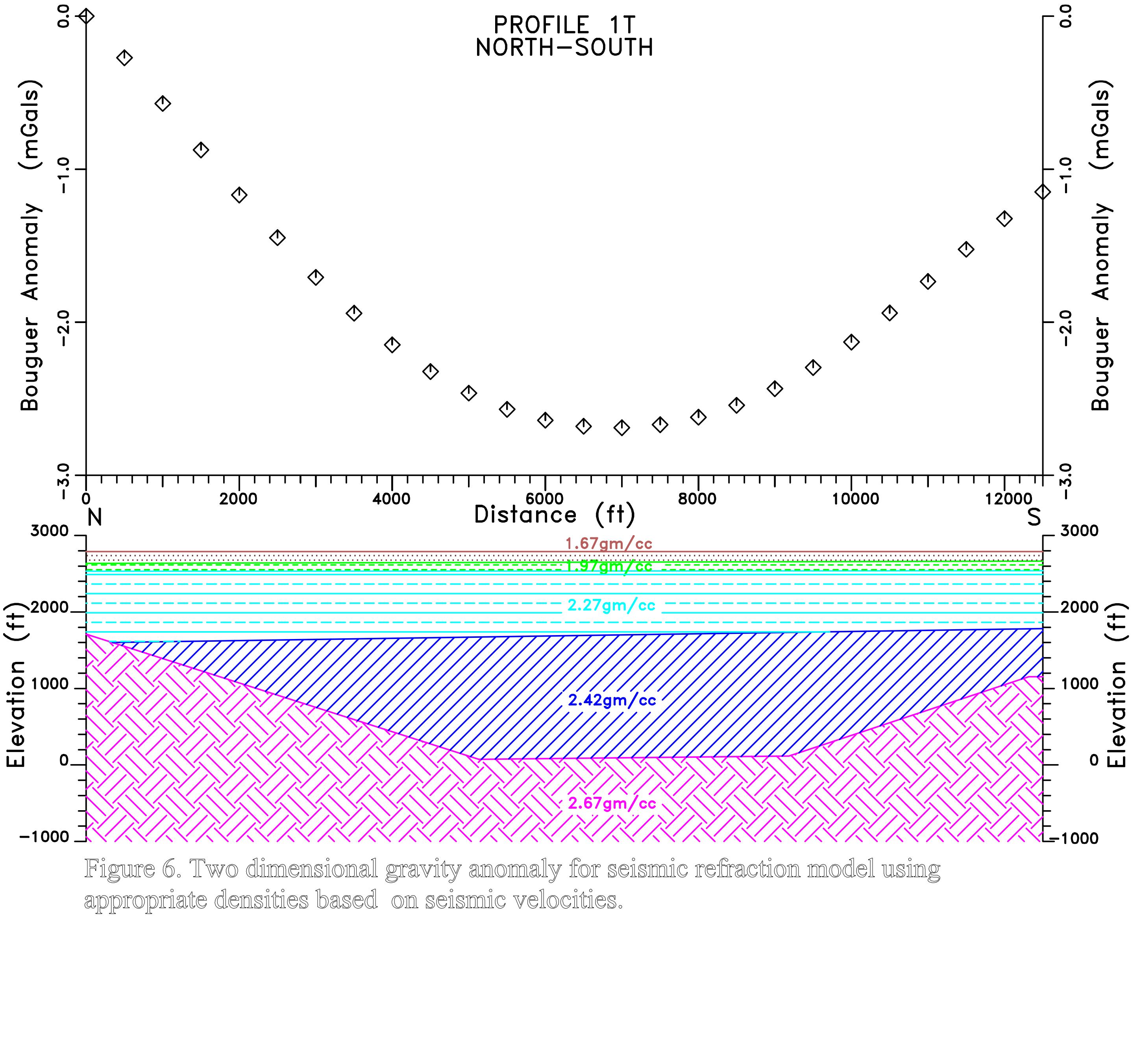


Figure 6. Two dimensional gravity anomaly for seismic refraction model using appropriate densities based on seismic velocities.

ATTACHMENT D1 - SEISMIC REFRACTION DATA AND MODELS

ATTACHMENT D1 - SEISMIC REFRACTION DATA AND MODELS

Column Heading Definitions for File ADELSEIS.DAT

Surveying and Elevation Time Corrections.

DISTANCE	Distance from first source point (feet).
INTERVAL	Interval between adjoining survey points (feet).
HI	Height of eye if done by hand leveling (feet).
DELTAE	Relative elevation to height of eye (feet).
ELEVATION	Elevation at a given distance from source point (feet).
N-S CORR	Elevation time correction forward direction (seconds).
S-N CORR	Elevation time correction reverse direction (seconds).
VF0	Velocity from source point to first forward geophone (ft/s).
VR0	Velocity from source point to first reverse geophone (ft/s).
V0	Average of VF0 and VR0 (ft/s).
V1	Approximate velocity of first refractor (ft/s).
V2	Approximate velocity of second refractor (ft/s).

Geophone Time-Distance Data.

GEO	Geophone number relative to source point.
DISTANCE	Distance to geophone from source point (feet).
INTERVAL	Interval distance between geophones (feet).
RAWTI	Raw time arrivals from records (seconds).
ELCOR	Time correction for elevation and source depth (seconds).
WECOR	Weathering correction if necessary (seconds).
CORTI	Corrected time = **RAWTI-ELCOR-WECOR** (seconds). (Applied to refracted arrivals only.)
IF/IR	Travel time branch number forward/reverse Suffix F = Forward, R = Reverse. If preceded by a minus sign used in calculating both layers. 1 = Direct wave. 2 = First refracted arrival (dry alluvium) 3 = Second refracted arrivals (water table?). 4 = Third refracted arrivals (older sediments/volcanics) 5 = Basement arrivals. 6 = Basement arrivals from bidirectional dips.

Elevation and Weathering Correction Formula.

The travel times were corrected to the datum (shown as a dashed line in Figure 3) using the following formulas (Dobrin, 1973).

$$\text{Elevation Correction} = \frac{(e - h + E - 2d)\sqrt{V_1^2 - V_0^2}}{V_1 V_0}$$

With a weathering correction the total correction is as follows:

$$\text{Total Correction} = (e - h + E - 2d - t)\ \frac{\sqrt{V_2^2 - V_1^2}}{V_2 V_1} + \frac{\sqrt{V_2^2 - V_0^2}}{V_2 V_0}$$

Where:
e = elevation at the top of the source point.
h = depth of the source point.
E = elevation of geophone.
d = elevation of datum.
t = thickness of weathered zone.
V_0 = velocity of the weathered zone.
V_1 = velocity of layer 1.
V_2 = velocity of layer 2.

HELENDALE ROAD - MTZ

***** PROFILE 1T   NORTH - SOUTH *****
04/27/02
DATUM ELEVATION = 2790. FEET

SURVEYING AND ELEVATION TIME CORRECTIONS

	DISTANCE	INTERVAL	HI	DELTAE	ELEVATION	N-S CORR	S-N CORR
* NORTH SHOT POINT *	.0	.0	.0	2747.0	2747.0	-.0428	-.0273
	600.0	600.0	.0	2750.0	2750.0	-.0416	-.0262
	2300.0	1700.0	.0	2760.0	2760.0	-.0380	-.0225
	4400.0	2100.0	.0	2770.0	2770.0	-.0343	-.0188
	6000.0	1600.0	.0	2780.0	2780.0	-.0306	-.0151
* SOUTH SHOT POINT *	10024.0	4024.0	.0	2789.0	2789.0	-.0273	-.0118

THE FOLLOWING VELOCITIES HAVE BEEN USED IN THE WEATHERING AND ELEVATION CORRECTIONS.

VFO = 2450. VR0 = 2450. VO = 2450. V1 = 2450. V2 = 5700. FT/SEC

HELENDALE ROAD - MTZ
***** PROFILE 1T NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *
REL. LOCATION 0.
SHOT NUMBER = 3
DEPTH (FT)= 30.0
ELEVATION(FT)= 2747.
TIME = 1237
NORTH TC(SEC)= .0117

* SOUTH SHOT POINT *
REL. LOCATION 10024.
SHOT NUMBER =
DEPTH (FT)= .0
ELEVATION(FT)= 2789.
TIME =
SOUTH TC(SEC)= .0000

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2747.0	.0000	.0000	.0000	.0000	1	.0	39.1	2747.0	.0000	.0000	.0000	.0000	0
1	39.1	39.1	2747.2	.0118	-.0427	.0000	.0118	1	39.1	19.3	2747.2	.0000	-.0161	.0000	.0000	0
2	58.4	19.3	2747.3	.0192	-.0426	.0000	.0192	1	58.4	22.5	2747.3	.0000	-.0161	.0000	.0000	0
3	80.9	22.5	2747.4	.0304	-.0426	.0000	.0304	1	80.9	23.6	2747.4	.0000	-.0161	.0000	.0000	0
4	104.5	23.6	2747.5	.0407	-.0426	.0000	.0407	1	104.5	24.1	2747.5	.0000	-.0160	.0000	.0000	0
5	128.6	24.1	2747.6	.0507	-.0425	.0000	.0507	1	128.6	24.4	2747.6	.0000	-.0160	.0000	.0000	0
6	153.0	24.4	2747.8	.0637	-.0425	.0000	.0637	1	153.0	24.6	2747.8	.0000	-.0159	.0000	.0000	0
7	177.6	24.6	2747.9	.0742	-.0424	.0000	.0742	1	177.6	24.7	2747.9	.0000	-.0159	.0000	.0000	0
8	202.3	24.7	2748.0	.0827	-.0424	.0000	.0827	1	202.3	24.9	2748.0	.0000	-.0158	.0000	.0000	0
9	227.2	24.9	2748.1	.0934	-.0423	.0000	.0934	1	227.2	24.9	2748.1	.0000	-.0158	.0000	.0000	0
10	252.1	24.9	2748.3	.1042	-.0423	.0000	.1042	1	252.1	24.9	2748.3	.0000	-.0158	.0000	.0000	0
11	277.0	24.9	2748.4	.1154	-.0422	.0000	.1154	1	277.0	25.0	2748.4	.0000	-.0157	.0000	.0000	0
12	302.0	25.0	2748.5	.1252	-.0422	.0000	.1252	1	302.0	25.0	2748.5	.0000	-.0157	.0000	.0000	0
13	327.0	25.0	2748.6	.1317	-.0421	.0000	.1317	1	327.0	25.0	2748.6	.0000	-.0156	.0000	.0000	0
14	352.0	25.0	2748.8	.1352	-.0421	.0000	.1773	2	352.0	25.0	2748.8	.0000	-.0156	.0000	.0000	0
15	377.0	25.0	2748.9	.1407	-.0421	.0000	.1828	2	377.0	25.0	2748.9	.0000	-.0155	.0000	.0000	0
16	402.0	25.0	2749.0	.1459	-.0420	.0000	.1879	2	402.0	25.0	2749.0	.0000	-.0155	.0000	.0000	0
17	427.0	25.0	2749.1	.1502	-.0420	.0000	.1922	2	427.0	25.0	2749.1	.0000	-.0154	.0000	.0000	0
18	452.0	25.0	2749.3	.1534	-.0419	.0000	.1953	-2	452.0	25.0	2749.3	.0000	-.0154	.0000	.0000	0
19	477.0	25.0	2749.4	.1559	-.0419	.0000	.1978	3	477.0	25.0	2749.4	.0000	-.0153	.0000	.0000	0
20	502.0	25.0	2749.5	.1602	-.0418	.0000	.2020	3	502.0	25.0	2749.5	.0000	-.0153	.0000	.0000	0
21	527.0	25.0	2749.6	.1642	-.0418	.0000	.2060	3	527.0	25.0	2749.6	.0000	-.0152	.0000	.0000	0
22	552.0	25.0	2749.8	.1664	-.0417	.0000	.2081	3	552.0	25.0	2749.8	.0000	-.0152	.0000	.0000	0
23	577.0	25.0	2749.9	.1699	-.0417	.0000	.2116	3	577.0	25.0	2749.9	.0000	-.0152	.0000	.0000	0
24	602.0	25.0	2750.0	.1727	-.0416	.0000	.2143	3	602.0	9422.0	2750.0	.0000	-.0151	.0000	.0000	0
0	10024.0	9422.0	2789.0	.0000	.0000	.0000	.0000	0	10024.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1T   NORTH - SOUTH *****
04/27/02
UNIT = 2
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	10024.
SHOT NUMBER =	3	SHOT NUMBER =	5
DEPTH (FT)=	30.0	DEPTH (FT)=	25.0
ELEVATION(FT)=	2747.	ELEVATION(FT)=	2789.
TIME =	1237	TIME =	1510
NORTH TC(SEC)=	.0230	SOUTH TC(SEC)=	.0000

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2747.0	.0000	.0000	.0000	.0000	0	.0	358.0	2747.0	.0000	.0000	.0000	.0000	0
1	358.0	358.0	2748.8	.1430	-.0421	.0000	.1851	0	358.0	201.0	2748.8	1.1320	-.0248	.0000	1.1568	6
2	559.0	201.0	2749.8	.1670	-.0417	.0000	.2087	3	559.0	194.0	2749.8	1.1300	-.0244	.0000	1.1544	6
3	753.0	194.0	2750.9	.2010	-.0413	.0000	.2423	3	753.0	200.0	2750.9	1.1230	-.0240	.0000	1.1470	6
4	953.0	200.0	2752.1	.2320	-.0409	.0000	.2729	3	953.0	201.0	2752.1	1.1180	-.0236	.0000	1.1416	6
5	1154.0	201.0	2753.3	.2580	-.0404	.0000	.2984	3	1154.0	197.0	2753.3	1.1050	-.0231	.0000	1.1281	6
6	1351.0	197.0	2754.4	.2830	-.0400	.0000	.3230	3	1351.0	197.0	2754.4	1.0930	-.0227	.0000	1.1157	6
7	1548.0	197.0	2755.6	.3130	-.0396	.0000	.3526	3	1548.0	197.0	2755.6	1.0910	-.0223	.0000	1.1133	6
8	1745.0	197.0	2756.7	.3400	-.0392	.0000	.3792	3	1745.0	198.0	2756.7	1.0850	-.0218	.0000	1.1068	5
9	1943.0	198.0	2757.9	.3680	-.0387	.0000	.4067	3	1943.0	198.0	2757.9	1.0800	-.0214	.0000	1.1014	5
10	2141.0	198.0	2759.1	.3950	-.0383	.0000	.4333	3	2141.0	201.0	2759.1	1.0600	-.0210	.0000	1.0810	5
11	2342.0	201.0	2760.2	.4230	-.0379	.0000	.4609	3	2342.0	198.0	2760.2	1.0480	-.0206	.0000	1.0686	5
12	2540.0	198.0	2761.1	.4520	-.0375	.0000	.4895	3	2540.0	178.0	2761.1	1.0290	-.0202	.0000	1.0492	4
13	2718.0	178.0	2762.0	.4730	-.0372	.0000	.5102	3	2718.0	201.0	2762.0	1.0150	-.0199	.0000	1.0349	4
14	2919.0	201.0	2762.9	.5030	-.0369	.0000	.5399	3	2919.0	200.0	2762.9	.9920	-.0196	.0000	1.0116	4
15	3119.0	200.0	2763.9	.5280	-.0365	.0000	.5645	3	3119.0	198.0	2763.9	.9770	-.0192	.0000	.9962	4
16	3317.0	198.0	2764.8	.5550	-.0362	.0000	.5912	3	3317.0	198.0	2764.8	.9520	-.0189	.0000	.9709	4
17	3515.0	198.0	2765.8	.5770	-.0358	.0000	.6128	3	3515.0	198.0	2765.8	.9270	-.0185	.0000	.9455	4
18	3713.0	198.0	2766.7	.6000	-.0355	.0000	.6355	3	3713.0	201.0	2766.7	.9090	-.0182	.0000	.9272	4
19	3914.0	201.0	2767.7	.6290	-.0351	.0000	.6641	3	3914.0	201.0	2767.7	.8900	-.0178	.0000	.9078	4
20	4115.0	201.0	2768.6	.6540	-.0348	.0000	.6888	3	4115.0	194.0	2768.6	.8630	-.0175	.0000	.8805	4
21	4309.0	194.0	2769.6	.6830	-.0344	.0000	.7174	3	4309.0	198.0	2769.6	.8450	-.0171	.0000	.8621	4
22	4507.0	198.0	2770.7	.7140	-.0340	.0000	.7480	3	4507.0	204.0	2770.7	.8300	-.0167	.0000	.8467	4
23	4711.0	204.0	2771.9	.7370	-.0336	.0000	.7706	3	4711.0	201.0	2771.9	.8050	-.0162	.0000	.8212	4
24	4912.0	201.0	2773.2	.7600	-.0331	.0000	.7931	3	4912.0	5112.0	2773.2	.7800	-.0158	.0000	.7958	4
0	10024.0	5112.0	2789.0	.0000	.0000	.0000	.0000	0	10024.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1T NORTH - SOUTH *****
04/27/02
UNIT = 1
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	10024.
SHOT NUMBER	= 3	SHOT NUMBER	= 4
DEPTH (FT)=	30.0	DEPTH (FT)=	30.0
ELEVATION(FT)=	2747.	ELEVATION(FT)=	2789.
TIME =	1237	TIME =	1342
NORTH TC(SEC)=	.8330	SOUTH TC(SEC)=	.0050

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2747.0	.0000	.0000	.0000	.0000	0	.0	5422.0	2747.0	.0000	.0000	.0000	.0000	0
1	5422.0	5422.0	2776.4	.8340	-.0319	.0000	.8659	3	5422.0	194.0	2776.4	.7430	-.0164	.0000	.7594	-3
2	5616.0	194.0	2777.6	.8680	-.0315	.0000	.8995	-3	5616.0	188.0	2777.6	.7170	-.0160	.0000	.7330	3
3	5804.0	188.0	2778.8	.8830	-.0310	.0000	.9140	4	5804.0	194.0	2778.8	.6940	-.0156	.0000	.7096	3
4	5998.0	194.0	2780.0	.9020	-.0306	.0000	.9326	4	5998.0	201.0	2780.0	.6660	-.0151	.0000	.6811	3
5	6199.0	201.0	2780.4	.9250	-.0304	.0000	.9554	4	6199.0	198.0	2780.4	.6370	-.0149	.0000	.6519	3
6	6397.0	198.0	2780.9	.9480	-.0303	.0000	.9783	4	6397.0	194.0	2780.9	.6150	-.0148	.0000	.6298	3
7	6591.0	194.0	2781.3	.9630	-.0301	.0000	.9931	4	6591.0	205.0	2781.3	.5850	-.0146	.0000	.5996	3
8	6796.0	205.0	2781.8	.9880	-.0299	.0000	1.0179	4	6796.0	204.0	2781.8	.5650	-.0145	.0000	.5795	3
9	7000.0	204.0	2782.2	1.0070	-.0298	.0000	1.0368	4	7000.0	201.0	2782.2	.5340	-.0143	.0000	.5483	3
10	7201.0	201.0	2782.7	1.0300	-.0296	.0000	1.0596	4	7201.0	194.0	2782.7	.5060	-.0141	.0000	.5201	3
11	7395.0	194.0	2783.1	1.0550	-.0294	.0000	1.0844	-4	7395.0	204.0	2783.1	.4780	-.0140	.0000	.4920	3
12	7599.0	204.0	2783.6	1.0700	-.0293	.0000	1.0993	5	7599.0	168.0	2783.6	.4500	-.0138	.0000	.4638	3
13	7767.0	168.0	2784.0	1.0800	-.0291	.0000	1.1091	5	7767.0	188.0	2784.0	.4230	-.0137	.0000	.4367	3
14	7955.0	188.0	2784.4	1.1030	-.0290	.0000	1.1320	6	7955.0	196.0	2784.4	.3970	-.0135	.0000	.4105	3
15	8151.0	196.0	2784.8	.0000	-.0288	.0000	.0000	6	8151.0	201.0	2784.8	.3730	-.0133	.0000	.3863	3
16	8352.0	201.0	2785.3	1.1080	-.0286	.0000	1.1366	6	8352.0	201.0	2785.3	.3420	-.0132	.0000	.3552	3
17	8553.0	201.0	2785.7	1.1130	-.0285	.0000	1.1415	6	8553.0	198.0	2785.7	.3150	-.0130	.0000	.3280	3
18	8751.0	198.0	2786.2	.0000	-.0283	.0000	.0000	6	8751.0	182.0	2786.2	.2870	-.0128	.0000	.2998	3
19	8933.0	182.0	2786.6	.0000	-.0282	.0000	.0000	6	8933.0	194.0	2786.6	.2570	-.0127	.0000	.2697	3
20	9127.0	194.0	2787.0	1.1510	-.0280	.0000	1.1790	6	9127.0	201.0	2787.0	.2350	-.0125	.0000	.2475	3
21	9328.0	201.0	2787.4	1.1590	-.0278	.0000	1.1868	6	9328.0	198.0	2787.4	.2050	-.0124	.0000	.2174	2
22	9526.0	198.0	2787.9	1.1670	-.0277	.0000	1.1947	6	9526.0	207.0	2787.9	.1650	-.0122	.0000	.1772	2
23	9733.0	207.0	2788.3	1.1700	-.0275	.0000	1.1975	6	9733.0	198.0	2788.3	.1130	-.0120	.0000	.1130	1
24	9931.0	198.0	2788.8	1.1760	-.0273	.0000	1.2033	6	9931.0	93.0	2788.8	.0470	-.0119	.0000	.0470	1
0	10024.0	93.0	2789.0	.0000	.0000	.0000	.0000	0	10024.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1T NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	10024.
SHOT NUMBER =		SHOT NUMBER =	4
DEPTH (FT)=	.0	DEPTH (FT)=	30.0
ELEVATION(FT)=	2747.	ELEVATION(FT)=	2789.
TIME =		TIME =	1342
NORTH TC(SEC)=	.0000	SOUTH TC(SEC)=	.0114

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2747.0	.0000	.0000	.0000	.0000	0	.0	9423.0	2747.0	.0000	.0000	.0000	.0000	0
1	9423.0	9423.0	2787.7	.0000	-.0167	.0000	.0000	0	9423.0	25.0	2787.7	.1836	-.0123	.0000	.1959	2
2	9448.0	25.0	2787.7	.0000	-.0167	.0000	.0000	0	9448.0	25.0	2787.7	.1811	-.0123	.0000	.1934	2
3	9473.0	25.0	2787.8	.0000	-.0167	.0000	.0000	0	9473.0	25.0	2787.8	.1784	-.0122	.0000	.1906	2
4	9498.0	25.0	2787.8	.0000	-.0166	.0000	.0000	0	9498.0	25.0	2787.8	.1721	-.0122	.0000	.1843	2
5	9523.0	25.0	2787.9	.0000	-.0166	.0000	.0000	0	9523.0	25.0	2787.9	.1681	-.0122	.0000	.1803	2
6	9548.0	25.0	2787.9	.0000	-.0166	.0000	.0000	0	9548.0	25.0	2787.9	.1616	-.0122	.0000	.1738	2
7	9573.0	25.0	2788.0	.0000	-.0166	.0000	.0000	0	9573.0	24.9	2788.0	.1569	-.0122	.0000	.1691	2
8	9597.9	24.9	2788.0	.0000	-.0166	.0000	.0000	0	9597.9	24.9	2788.0	.1509	-.0121	.0000	.1630	2
9	9622.8	24.9	2788.1	.0000	-.0165	.0000	.0000	0	9622.8	24.9	2788.1	.1456	-.0121	.0000	.1577	2
10	9647.7	24.9	2788.2	.0000	-.0165	.0000	.0000	0	9647.7	24.9	2788.2	.1411	-.0121	.0000	.1532	2
11	9672.6	24.9	2788.2	.0000	-.0165	.0000	.0000	0	9672.6	24.9	2788.2	.1356	-.0121	.0000	.1356	1
12	9697.5	24.9	2788.3	.0000	-.0165	.0000	.0000	0	9697.5	24.9	2788.3	.1274	-.0121	.0000	.1274	1
13	9722.4	24.9	2788.3	.0000	-.0165	.0000	.0000	0	9722.4	24.9	2788.3	.1169	-.0120	.0000	.1169	1
14	9747.3	24.9	2788.4	.0000	-.0164	.0000	.0000	0	9747.3	24.8	2788.4	.1069	-.0120	.0000	.1069	1
15	9772.1	24.8	2788.4	.0000	-.0164	.0000	.0000	0	9772.1	24.8	2788.4	.1006	-.0120	.0000	.1006	1
16	9796.9	24.8	2788.5	.0000	-.0164	.0000	.0000	0	9796.9	24.8	2788.5	.0941	-.0120	.0000	.0941	1
17	9821.7	24.8	2788.5	.0000	-.0164	.0000	.0000	0	9821.7	24.7	2788.5	.0849	-.0120	.0000	.0849	1
18	9846.4	24.7	2788.6	.0000	-.0164	.0000	.0000	0	9846.4	24.6	2788.6	.0754	-.0119	.0000	.0754	1
19	9871.0	24.6	2788.7	.0000	-.0163	.0000	.0000	0	9871.0	24.4	2788.7	.0631	-.0119	.0000	.0631	1
20	9895.4	24.4	2788.7	.0000	-.0163	.0000	.0000	0	9895.4	24.1	2788.7	.0519	-.0119	.0000	.0519	1
21	9919.5	24.1	2788.8	.0000	-.0163	.0000	.0000	0	9919.5	23.6	2788.8	.0414	-.0119	.0000	.0414	1
22	9943.1	23.6	2788.8	.0000	-.0163	.0000	.0000	0	9943.1	22.5	2788.8	.0294	-.0119	.0000	.0294	1
23	9965.6	22.5	2788.9	.0000	-.0163	.0000	.0000	0	9965.6	19.3	2788.9	.0181	-.0118	.0000	.0181	1
24	9984.9	19.3	2788.9	.0000	-.0162	.0000	.0000	0	9984.9	39.1	2788.9	.0115	-.0118	.0000	.0115	1
0	10024.0	39.1	2789.0	.0000	.0000	.0000	.0000	0	10024.0	.0	2789.0	.0000	.0000	.0000	.0000	1

HELENDALE ROAD - MTZ
***** PROFILE 1T   NORTH - SOUTH *****
04/27/02
DATUM ELEVATION = 2790. FEET

COMPUTED VELOCITY/INTERCEPTS

LAYER	FORWARD INTERCEPT	FORWARD VELOCITY	REVERSE INTERCEPT	REVERSE VELOCITY
1	-.003	2372.	.001	-2553.
2	.114	5502.	.079	-5016.
3	.139	7410.	.124	-7202.
4	.312	9621.	.267	-9552.
5	.592	15011.	.547	-14702.
6	.796	24156.	.766	-24491.

VELOCITY/DEPTH INTERPRETATION

LAYER	VELOCITY	THICKF	DEPTHF	ELEVF	THICKR	DEPTHR	ELEVR	VDIP	TDIP
1	2462.	159.	159.	2631.	110.	110.	2680.	1.4	.3
2	5246.	65.	224.	2566.	152.	262.	2528.	-1.8	-.2
3	7294.	936.	1160.	1630.	748.	1010.	1780.	-2.0	.9
4	9573.	1368.	2528.	262.	1416.	2426.	364.	-1.1	.6
5	14838.	1279.	3807.	-1017.	1442.	3868.	-1078.	-2.0	-.4
6	24291.								

HELENDALE ROAD - MTZ
***** PROFILE 1S23 NORTH - SOUTH *****
04/27/02
DATUM ELEVATION = 2790. FEET

SURVEYING AND ELEVATION TIME CORRECTIONS

	DISTANCE	INTERVAL	HI	DELTAE	ELEVATION	N-S CORR	S-N CORR
* NORTH SHOT POINT *	.0	.0	.0	2747.0	2747.0	-.0428	-.0265
	600.0	600.0	.0	2750.0	2750.0	-.0416	-.0254
	2300.0	1700.0	.0	2760.0	2760.0	-.0380	-.0217
	4400.0	2100.0	.0	2770.0	2770.0	-.0343	-.0181
* SOUTH SHOT POINT *	5355.0	955.0	.0	2776.0	2776.0	-.0321	-.0158

THE FOLLOWING VELOCITIES HAVE BEEN USED IN THE WEATHERING AND ELEVATION CORRECTIONS.
VFO = 2450. VR0 = 2450. VO = 2450. V1 = 2450. V2 = 5700. FT/SEC

HELENDALE ROAD - MTZ
***** PROFILE 1S23 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *
REL. LOCATION 0.
SHOT NUMBER = 3
DEPTH (FT)= 30.0
ELEVATION(FT)= 2747.
TIME = 1237
NORTH TC(SEC)= .0117

* SOUTH SHOT POINT *
REL. LOCATION 5355.
SHOT NUMBER =
DEPTH (FT)= .0
ELEVATION(FT)= 2776.
TIME =
SOUTH TC(SEC)= .0000

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2747.0	.0000	.0000	.0000	.0000	1	.0	39.1	2747.0	.0000	.0000	.0000	.0000	0
1	39.1	39.1	2747.2	.0157	-.0427	.0000	.0157	1	39.1	19.3	2747.2	.0000	-.0209	.0000	.0000	0
2	58.4	19.3	2747.3	.0192	-.0426	.0000	.0192	1	58.4	22.5	2747.3	.0000	-.0209	.0000	.0000	0
3	80.9	22.5	2747.4	.0304	-.0426	.0000	.0304	1	80.9	23.6	2747.4	.0000	-.0209	.0000	.0000	0
4	104.5	23.6	2747.5	.0407	-.0426	.0000	.0407	1	104.5	24.1	2747.5	.0000	-.0208	.0000	.0000	0
5	128.6	24.1	2747.6	.0507	-.0425	.0000	.0507	1	128.6	24.4	2747.6	.0000	-.0208	.0000	.0000	0
6	153.0	24.4	2747.8	.0637	-.0425	.0000	.0637	1	153.0	24.6	2747.8	.0000	-.0207	.0000	.0000	0
7	177.6	24.6	2747.9	.0742	-.0424	.0000	.0742	1	177.6	24.7	2747.9	.0000	-.0207	.0000	.0000	0
8	202.3	24.7	2748.0	.0827	-.0424	.0000	.0827	1	202.3	24.9	2748.0	.0000	-.0206	.0000	.0000	0
9	227.2	24.9	2748.1	.0934	-.0423	.0000	.0934	1	227.2	24.9	2748.1	.0000	-.0206	.0000	.0000	0
10	252.1	24.9	2748.3	.1042	-.0423	.0000	.1042	1	252.1	24.9	2748.3	.0000	-.0205	.0000	.0000	0
11	277.0	24.9	2748.4	.1154	-.0422	.0000	.1154	1	277.0	25.0	2748.4	.0000	-.0205	.0000	.0000	0
12	302.0	25.0	2748.5	.1252	-.0422	.0000	.1252	1	302.0	25.0	2748.5	.0000	-.0205	.0000	.0000	0
13	327.0	25.0	2748.6	.1317	-.0421	.0000	.1317	1	327.0	25.0	2748.6	.0000	-.0204	.0000	.0000	0
14	352.0	25.0	2748.8	.1352	-.0421	.0000	.1773	2	352.0	25.0	2748.8	.0000	-.0204	.0000	.0000	0
15	377.0	25.0	2748.9	.1407	-.0421	.0000	.1828	2	377.0	25.0	2748.9	.0000	-.0203	.0000	.0000	0
16	402.0	25.0	2749.0	.1459	-.0420	.0000	.1879	2	402.0	25.0	2749.0	.0000	-.0203	.0000	.0000	0
17	427.0	25.0	2749.1	.1502	-.0420	.0000	.1922	2	427.0	25.0	2749.1	.0000	-.0202	.0000	.0000	0
18	452.0	25.0	2749.3	.1534	-.0419	.0000	.1953	-2	452.0	25.0	2749.3	.0000	-.0202	.0000	.0000	0
19	477.0	25.0	2749.4	.1559	-.0419	.0000	.1978	3	477.0	25.0	2749.4	.0000	-.0201	.0000	.0000	0
20	502.0	25.0	2749.5	.1602	-.0418	.0000	.2020	3	502.0	25.0	2749.5	.0000	-.0201	.0000	.0000	0
21	527.0	25.0	2749.6	.1642	-.0418	.0000	.2060	3	527.0	25.0	2749.6	.0000	-.0200	.0000	.0000	0
22	552.0	25.0	2749.8	.1664	-.0417	.0000	.2081	3	552.0	25.0	2749.8	.0000	-.0200	.0000	.0000	0
23	577.0	25.0	2749.9	.1699	-.0417	.0000	.2116	3	577.0	25.0	2749.9	.0000	-.0199	.0000	.0000	0
24	602.0	25.0	2750.0	.1727	-.0416	.0000	.2143	3	602.0	4753.0	2750.0	.0000	-.0199	.0000	.0000	0
0	5355.0	4753.0	2776.0	.0000	.0000	.0000	.0000	0	5355.0	.0	2776.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S23 NORTH - SOUTH *****
04/27/02
UNIT = 2
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	5355.
SHOT NUMBER	= 3	SHOT NUMBER	= 1
DEPTH (FT)=	30.0	DEPTH (FT)=	15.0
ELEVATION(FT)=	2747.	ELEVATION(FT)=	2776.
TIME =	1237	TIME =	1035
NORTH TC(SEC)=	.0230	SOUTH TC(SEC)=	-.0150

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2747.0	.0000	.0000	.0000	.0000	0	.0	358.0	2747.0	.0000	.0000	.0000	.0000	0
1	358.0	358.0	2748.8	.1430	-.0421	.0000	.1851	0	358.0	201.0	2748.8	.7750	-.0259	.0000	.8009	3
2	559.0	201.0	2749.8	.1670	-.0417	.0000	.2087	3	559.0	194.0	2749.8	.7490	-.0255	.0000	.7745	3
3	753.0	194.0	2750.9	.2010	-.0413	.0000	.2423	3	753.0	200.0	2750.9	.7270	-.0251	.0000	.7521	3
4	953.0	200.0	2752.1	.2320	-.0409	.0000	.2729	3	953.0	201.0	2752.1	.7030	-.0247	.0000	.7277	3
5	1154.0	201.0	2753.3	.2580	-.0404	.0000	.2984	3	1154.0	197.0	2753.3	.6750	-.0242	.0000	.6992	3
6	1351.0	197.0	2754.4	.2830	-.0400	.0000	.3230	3	1351.0	197.0	2754.4	.6550	-.0238	.0000	.6788	3
7	1548.0	197.0	2755.6	.3130	-.0396	.0000	.3526	3	1548.0	197.0	2755.6	.6300	-.0234	.0000	.6534	3
8	1745.0	197.0	2756.7	.3400	-.0392	.0000	.3792	3	1745.0	198.0	2756.7	.6070	-.0229	.0000	.6299	3
9	1943.0	198.0	2757.9	.3680	-.0387	.0000	.4067	3	1943.0	198.0	2757.9	.5820	-.0225	.0000	.6045	3
10	2141.0	198.0	2759.1	.3950	-.0383	.0000	.4333	3	2141.0	201.0	2759.1	.5590	-.0221	.0000	.5811	3
11	2342.0	201.0	2760.2	.4230	-.0379	.0000	.4609	3	2342.0	198.0	2760.2	.5300	-.0217	.0000	.5517	3
12	2540.0	198.0	2761.1	.4520	-.0375	.0000	.4895	3	2540.0	178.0	2761.1	.5000	-.0213	.0000	.5213	3
13	2718.0	178.0	2762.0	.4730	-.0372	.0000	.5102	3	2718.0	201.0	2762.0	.4760	-.0210	.0000	.4970	3
14	2919.0	201.0	2762.9	.5030	-.0369	.0000	.5399	3	2919.0	200.0	2762.9	.4450	-.0207	.0000	.4657	3
15	3119.0	200.0	2763.9	.5280	-.0365	.0000	.5645	3	3119.0	198.0	2763.9	.4140	-.0203	.0000	.4343	3
16	3317.0	198.0	2764.8	.5550	-.0362	.0000	.5912	3	3317.0	198.0	2764.8	.3880	-.0200	.0000	.4080	3
17	3515.0	198.0	2765.8	.5770	-.0358	.0000	.6128	3	3515.0	198.0	2765.8	.3640	-.0196	.0000	.3836	3
18	3713.0	198.0	2766.7	.6000	-.0355	.0000	.6355	3	3713.0	201.0	2766.7	.3240	-.0193	.0000	.3433	3
19	3914.0	201.0	2767.7	.6290	-.0351	.0000	.6641	3	3914.0	201.0	2767.7	.3040	-.0189	.0000	.3229	3
20	4115.0	201.0	2768.6	.6540	-.0348	.0000	.6888	3	4115.0	194.0	2768.6	.2750	-.0186	.0000	.2936	3
21	4309.0	194.0	2769.6	.6830	-.0344	.0000	.7174	3	4309.0	198.0	2769.6	.2470	-.0182	.0000	.2652	3
22	4507.0	198.0	2770.7	.7140	-.0340	.0000	.7480	3	4507.0	204.0	2770.7	.2250	-.0178	.0000	.2428	3
23	4711.0	204.0	2772.0	.7370	-.0336	.0000	.7706	3	4711.0	201.0	2772.0	.1950	-.0173	.0000	.2123	3
24	4912.0	201.0	2773.2	.7600	-.0331	.0000	.7931	3	4912.0	443.0	2773.2	.1650	-.0169	.0000	.1819	2
0	5355.0	443.0	2776.0	.0000	.0000	.0000	.0000	0	5355.0	.0	2776.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S23 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	5355.
SHOT NUMBER =		SHOT NUMBER =	2
DEPTH (FT)=	.0	DEPTH (FT)=	3.0
ELEVATION(FT)=	2747.	ELEVATION(FT)=	2776.
TIME =		TIME =	1142
NORTH TC(SEC)=	.0000	SOUTH TC(SEC)=	.0013

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2747.0	.0000	.0000	.0000	.0000	0	.0	4775.0	2747.0	.0000	.0000	.0000	.0000	0
1	4775.0	4775.0	2772.4	.0000	-.0223	.0000	.0000	0	4775.0	25.0	2772.4	.1918	-.0128	.0000	.2046	2
2	4800.0	25.0	2772.5	.0000	-.0223	.0000	.0000	0	4800.0	25.0	2772.5	.1858	-.0127	.0000	.1985	2
3	4825.0	25.0	2772.7	.0000	-.0222	.0000	.0000	0	4825.0	25.0	2772.7	.1825	-.0127	.0000	.1952	2
4	4850.0	25.0	2772.8	.0000	-.0222	.0000	.0000	0	4850.0	25.0	2772.8	.1800	-.0126	.0000	.1926	2
5	4875.0	25.0	2773.0	.0000	-.0221	.0000	.0000	0	4875.0	25.0	2773.0	.1783	-.0125	.0000	.1908	2
6	4900.0	25.0	2773.1	.0000	-.0221	.0000	.0000	0	4900.0	25.0	2773.1	.1733	-.0125	.0000	.1858	2
7	4925.0	25.0	2773.3	.0000	-.0220	.0000	.0000	0	4925.0	25.0	2773.3	.1685	-.0124	.0000	.1809	2
8	4950.0	25.0	2773.5	.0000	-.0219	.0000	.0000	0	4950.0	25.0	2773.5	.1645	-.0124	.0000	.1769	2
9	4975.0	25.0	2773.6	.0000	-.0219	.0000	.0000	0	4975.0	25.0	2773.6	.1575	-.0123	.0000	.1698	2
10	5000.0	25.0	2773.8	.0000	-.0218	.0000	.0000	0	5000.0	25.0	2773.8	.1488	-.0122	.0000	.1488	1
11	5025.0	25.0	2773.9	.0000	-.0218	.0000	.0000	0	5025.0	25.0	2773.9	.1370	-.0122	.0000	.1370	1
12	5050.0	25.0	2774.1	.0000	-.0217	.0000	.0000	0	5050.0	25.0	2774.1	.1273	-.0121	.0000	.1273	1
13	5075.0	25.0	2774.2	.0000	-.0217	.0000	.0000	0	5075.0	25.0	2774.2	.1150	-.0121	.0000	.1150	1
14	5100.0	25.0	2774.4	.0000	-.0216	.0000	.0000	0	5100.0	25.0	2774.4	.1020	-.0120	.0000	.1020	1
15	5125.0	25.0	2774.6	.0000	-.0215	.0000	.0000	0	5125.0	25.0	2774.6	.0928	-.0120	.0000	.0928	1
16	5150.0	25.0	2774.7	.0000	-.0215	.0000	.0000	0	5150.0	25.0	2774.7	.0853	-.0119	.0000	.0853	1
17	5175.0	25.0	2774.9	.0000	-.0214	.0000	.0000	0	5175.0	25.0	2774.9	.0750	-.0118	.0000	.0750	1
18	5200.0	25.0	2775.0	.0000	-.0214	.0000	.0000	0	5200.0	25.0	2775.0	.0658	-.0118	.0000	.0658	1
19	5225.0	25.0	2775.2	.0000	-.0213	.0000	.0000	0	5225.0	25.0	2775.2	.0568	-.0117	.0000	.0568	1
20	5250.0	25.0	2775.3	.0000	-.0212	.0000	.0000	0	5250.0	25.0	2775.3	.0453	-.0117	.0000	.0453	1
21	5275.0	25.0	2775.5	.0000	-.0212	.0000	.0000	0	5275.0	25.0	2775.5	.0365	-.0116	.0000	.0365	1
22	5300.0	25.0	2775.7	.0000	-.0211	.0000	.0000	0	5300.0	24.9	2775.7	.0273	-.0116	.0000	.0273	1
23	5324.9	24.9	2775.8	.0000	-.0211	.0000	.0000	0	5324.9	24.3	2775.8	.0193	-.0115	.0000	.0193	1
24	5349.2	24.3	2776.0	.0000	-.0210	.0000	.0000	0	5349.2	5.8	2776.0	.0023	-.0114	.0000	.0023	1
0	5355.0	5.8	2776.0	.0000	.0000	.0000	.0000	0	5355.0	.0	2776.0	.0000	.0000	.0000	.0000	1

HELENDALE ROAD - MTZ
***** PROFILE 1S23 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

COMPUTED VELOCITY/INTERCEPTS

LAYER	FORWARD INTERCEPT	FORWARD VELOCITY	REVERSE INTERCEPT	REVERSE VELOCITY			
1	-.002	2393.	.003	-2474.			
2	.114	5502.	.112	-6252.	1.087	.968	RECIPROCITY ERROR
3	.139	7406.	.129	-7310.			

VELOCITY/DEPTH INTERPRETATION

LAYER	VELOCITY	THICKF	DEPTHF	ELEVF	THICKR	DEPTHR	ELEVR	VDIP	TDIP
1	2433.	153.	153.	2637.	149.	149.	2641.	-1.7	.0
2	5850.	100.	252.	2538.	64.	213.	2577.	5.2	.4
3	7309.								

HELENDALE ROAD - MTZ
***** PROFILE 1S34 NORTH - SOUTH *****
04/27/02
DATUM ELEVATION = 2790. FEET

SURVEYING AND ELEVATION TIME CORRECTIONS

	DISTANCE	INTERVAL	HI	DELTAE	ELEVATION	N-S CORR	S-N CORR
* NORTH SHOT POINT *	.0	.0	.0	2773.0	2773.0	-.0181	-.0195
	646.0	646.0	.0	2780.0	2780.0	-.0155	-.0170
* SOUTH SHOT POINT *	4670.0	4024.0	.0	2789.0	2789.0	-.0122	-.0136

THE FOLLOWING VELOCITIES HAVE BEEN USED IN THE WEATHERING AND ELEVATION CORRECTIONS.
VFO = 2450. VR0 = 2450. VO = 2450. V1 = 2450. V2 = 5700. FT/SEC

HELENDALE ROAD - MTZ
***** PROFILE 1S34 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	4670.
SHOT NUMBER =	1	SHOT NUMBER =	
DEPTH (FT)=	15.0	DEPTH (FT)=	.0
ELEVATION(FT)=	2773.	ELEVATION(FT)=	2789.
TIME =	1135	TIME =	
NORTH TC(SEC)=	.0060	SOUTH TC(SEC)=	.0000

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2773.0	.0000	.0000	.0000	.0000	1	.0	29.2	2773.0	.0000	.0000	.0000	.0000	0
1	29.2	29.2	2773.3	.0115	-.0179	.0000	.0115	1	29.2	23.0	2773.3	.0000	-.0065	.0000	.0000	0
2	52.2	23.0	2773.6	.0210	-.0178	.0000	.0210	1	52.2	24.3	2773.6	.0000	-.0064	.0000	.0000	0
3	76.5	24.3	2773.8	.0315	-.0178	.0000	.0315	1	76.5	24.6	2773.8	.0000	-.0063	.0000	.0000	0
4	101.1	24.6	2774.1	.0417	-.0177	.0000	.0417	1	101.1	24.8	2774.1	.0000	-.0062	.0000	.0000	0
5	125.9	24.8	2774.4	.0502	-.0176	.0000	.0502	1	125.9	24.9	2774.4	.0000	-.0061	.0000	.0000	0
6	150.8	24.9	2774.6	.0600	-.0175	.0000	.0600	1	150.8	24.9	2774.6	.0000	-.0060	.0000	.0000	0
7	175.7	24.9	2774.9	.0695	-.0174	.0000	.0695	1	175.7	24.9	2774.9	.0000	-.0059	.0000	.0000	0
8	200.6	24.9	2775.2	.0800	-.0173	.0000	.0800	1	200.6	24.9	2775.2	.0000	-.0058	.0000	.0000	0
9	225.5	24.9	2775.4	.0902	-.0172	.0000	.0902	1	225.5	24.9	2775.4	.0000	-.0057	.0000	.0000	0
10	250.4	24.9	2775.7	.0990	-.0171	.0000	.0990	1	250.4	24.9	2775.7	.0000	-.0056	.0000	.0000	0
11	275.3	24.9	2776.0	.1092	-.0170	.0000	.1092	1	275.3	24.9	2776.0	.0000	-.0055	.0000	.0000	0
12	300.2	24.9	2776.3	.1195	-.0169	.0000	.1195	1	300.2	24.9	2776.3	.0000	-.0054	.0000	.0000	0
13	325.1	24.9	2776.5	.1287	-.0168	.0000	.1287	1	325.1	24.9	2776.5	.0000	-.0053	.0000	.0000	0
14	350.0	24.9	2776.8	.1352	-.0167	.0000	.1352	1	350.0	25.0	2776.8	.0000	-.0052	.0000	.0000	0
15	375.0	25.0	2777.1	.1427	-.0166	.0000	.1593	2	375.0	25.0	2777.1	.0000	-.0051	.0000	.0000	0
16	400.0	25.0	2777.3	.1505	-.0165	.0000	.1670	2	400.0	25.0	2777.3	.0000	-.0050	.0000	.0000	0
17	425.0	25.0	2777.6	.1595	-.0164	.0000	.1759	2	425.0	25.0	2777.6	.0000	-.0049	.0000	.0000	0
18	450.0	25.0	2777.9	.1647	-.0163	.0000	.1810	2	450.0	25.0	2777.9	.0000	-.0048	.0000	.0000	0
19	475.0	25.0	2778.1	.1677	-.0162	.0000	.1839	2	475.0	25.0	2778.1	.0000	-.0047	.0000	.0000	0
20	500.0	25.0	2778.4	.1740	-.0161	.0000	.1901	2	500.0	25.0	2778.4	.0000	-.0046	.0000	.0000	0
21	525.0	25.0	2778.7	.1782	-.0160	.0000	.1942	2	525.0	25.0	2778.7	.0000	-.0045	.0000	.0000	0
22	550.0	25.0	2779.0	.1817	-.0159	.0000	.1976	2	550.0	25.0	2779.0	.0000	-.0044	.0000	.0000	0
23	575.0	25.0	2779.2	.1827	-.0158	.0000	.1985	2	575.0	25.0	2779.2	.0000	-.0043	.0000	.0000	0
24	600.0	25.0	2779.5	.1852	-.0157	.0000	.2009	2	600.0	4070.0	2779.5	.0000	-.0042	.0000	.0000	0
0	4670.0	4070.0	2789.0	.0000	.0000	.0000	.0000	0	4670.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S34 NORTH - SOUTH *****
04/27/02
UNIT = 1
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *
REL. LOCATION 0.
SHOT NUMBER = 1
DEPTH (FT)= 15.0
ELEVATION(FT)= 2773.
TIME = 1035
NORTH TC(SEC)= .0040

* SOUTH SHOT POINT *
REL. LOCATION 4670.
SHOT NUMBER = 4
DEPTH (FT)= 25.0
ELEVATION(FT)= 2789.
TIME = 1342
SOUTH TC(SEC)= .0050

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2773.0	.0000	.0000	.0000	.0000	0	-17.0	86.0	2769.9	.0000	.0000	.0000	.0000	0
1	86.0	86.0	2773.9	.0360	-.0177	.0000	.0360	1	69.0	194.0	2773.7	.7430	-.0156	.0000	.7586	3
2	266.0	180.0	2775.9	.1140	-.0170	.0000	.1140	1	263.0	188.0	2775.8	.7170	-.0148	.0000	.7318	3
3	452.0	186.0	2777.9	.1630	-.0163	.0000	.1793	2	451.0	194.0	2777.9	.6940	-.0140	.0000	.7080	3
4	645.0	193.0	2780.0	.1950	-.0155	.0000	.2105	2	645.0	201.0	2780.0	.6660	-.0133	.0000	.6793	3
5	846.0	201.0	2780.4	.2260	-.0153	.0000	.2413	3	846.0	198.0	2780.4	.6370	-.0131	.0000	.6501	3
6	1044.0	198.0	2780.9	.2600	-.0152	.0000	.2752	3	1044.0	194.0	2780.9	.6150	-.0129	.0000	.6279	3
7	1238.0	194.0	2781.3	.2840	-.0150	.0000	.2990	3	1238.0	205.0	2781.3	.5850	-.0128	.0000	.5978	3
8	1443.0	205.0	2781.8	.3140	-.0148	.0000	.3288	3	1443.0	204.0	2781.8	.5650	-.0126	.0000	.5776	3
9	1647.0	204.0	2782.2	.3440	-.0147	.0000	.3587	3	1647.0	201.0	2782.2	.5340	-.0124	.0000	.5464	3
10	1848.0	201.0	2782.7	.3740	-.0145	.0000	.3885	3	1848.0	194.0	2782.7	.5060	-.0123	.0000	.5183	3
11	2042.0	194.0	2783.1	.4040	-.0143	.0000	.4183	3	2042.0	204.0	2783.1	.4780	-.0121	.0000	.4901	3
12	2246.0	204.0	2783.6	.4290	-.0142	.0000	.4432	3	2246.0	168.0	2783.6	.4500	-.0119	.0000	.4619	3
13	2414.0	168.0	2784.0	.4490	-.0140	.0000	.4630	3	2414.0	188.0	2784.0	.4230	-.0118	.0000	.4348	3
14	2602.0	188.0	2784.4	.4720	-.0139	.0000	.4859	3	2602.0	196.0	2784.4	.3970	-.0117	.0000	.4087	3
15	2798.0	196.0	2784.8	.5040	-.0137	.0000	.5177	3	2798.0	201.0	2784.8	.3730	-.0115	.0000	.3845	3
16	2999.0	201.0	2785.3	.5240	-.0135	.0000	.5375	3	2999.0	201.0	2785.3	.3420	-.0113	.0000	.3533	3
17	3200.0	201.0	2785.7	.5540	-.0134	.0000	.5674	3	3200.0	198.0	2785.7	.3150	-.0112	.0000	.3262	3
18	3398.0	198.0	2786.2	.5840	-.0132	.0000	.5972	3	3398.0	182.0	2786.2	.2870	-.0110	.0000	.2980	3
19	3580.0	182.0	2786.6	.6070	-.0131	.0000	.6201	3	3580.0	194.0	2786.6	.2570	-.0108	.0000	.2678	3
20	3774.0	194.0	2787.0	.6320	-.0129	.0000	.6449	3	3774.0	201.0	2787.0	.2350	-.0107	.0000	.2457	3
21	3975.0	201.0	2787.4	.6580	-.0127	.0000	.6707	3	3975.0	198.0	2787.4	.2050	-.0105	.0000	.2155	2
22	4173.0	198.0	2787.9	.6860	-.0126	.0000	.6986	3	4173.0	206.0	2787.9	.1650	-.0104	.0000	.1754	2
23	4379.0	206.0	2788.3	.7140	-.0124	.0000	.7264	3	4379.0	198.0	2788.3	.1130	-.0102	.0000	.1130	1
24	4577.0	198.0	2788.8	.7380	-.0122	.0000	.7502	3	4577.0	93.0	2788.8	.0470	-.0100	.0000	.0470	1
0	4670.0	93.0	2789.0	.0000	.0000	.0000	.0000	0	4670.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S34 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	4670.
SHOT NUMBER =		SHOT NUMBER =	4
DEPTH (FT)=	.0	DEPTH (FT)=	35.0
ELEVATION(FT)=	2773.	ELEVATION(FT)=	2789.
TIME =		TIME =	1342
NORTH TC(SEC)=	.0000	SOUTH TC(SEC)=	.0137

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2773.0	.0000	.0000	.0000	.0000	0	.0	4068.0	2773.0	.0000	.0000	.0000	.0000	0
1	4068.0	4068.0	2787.7	.0000	-.0071	.0000	.0000	0	4068.0	25.0	2787.7	.1859	-.0141	.0000	.2000	2
2	4093.0	25.0	2787.7	.0000	-.0071	.0000	.0000	0	4093.0	25.0	2787.7	.1834	-.0141	.0000	.1975	2
3	4118.0	25.0	2787.8	.0000	-.0071	.0000	.0000	0	4118.0	25.0	2787.8	.1807	-.0141	.0000	.1948	2
4	4143.0	25.0	2787.8	.0000	-.0071	.0000	.0000	0	4143.0	25.0	2787.8	.1744	-.0141	.0000	.1885	2
5	4168.0	25.0	2787.9	.0000	-.0070	.0000	.0000	0	4168.0	25.0	2787.9	.1704	-.0140	.0000	.1844	2
6	4193.0	25.0	2787.9	.0000	-.0070	.0000	.0000	0	4193.0	25.0	2787.9	.1639	-.0140	.0000	.1779	2
7	4218.0	25.0	2788.0	.0000	-.0070	.0000	.0000	0	4218.0	25.0	2788.0	.1592	-.0140	.0000	.1732	2
8	4243.0	25.0	2788.0	.0000	-.0070	.0000	.0000	0	4243.0	25.0	2788.0	.1532	-.0140	.0000	.1672	2
9	4268.0	25.0	2788.1	.0000	-.0070	.0000	.0000	0	4268.0	25.0	2788.1	.1479	-.0140	.0000	.1619	2
10	4293.0	25.0	2788.2	.0000	-.0069	.0000	.0000	0	4293.0	25.0	2788.2	.1434	-.0139	.0000	.1573	2
11	4318.0	25.0	2788.2	.0000	-.0069	.0000	.0000	0	4318.0	25.0	2788.2	.1379	-.0139	.0000	.1379	1
12	4343.0	25.0	2788.3	.0000	-.0069	.0000	.0000	0	4343.0	24.9	2788.3	.1297	-.0139	.0000	.1297	1
13	4367.9	24.9	2788.3	.0000	-.0069	.0000	.0000	0	4367.9	24.9	2788.3	.1192	-.0139	.0000	.1192	1
14	4392.8	24.9	2788.4	.0000	-.0069	.0000	.0000	0	4392.8	24.8	2788.4	.1092	-.0139	.0000	.1092	1
15	4417.6	24.8	2788.4	.0000	-.0068	.0000	.0000	0	4417.6	24.7	2788.4	.1029	-.0138	.0000	.1029	1
16	4442.3	24.7	2788.5	.0000	-.0068	.0000	.0000	0	4442.3	24.7	2788.5	.0964	-.0138	.0000	.0964	1
17	4467.0	24.7	2788.5	.0000	-.0068	.0000	.0000	0	4467.0	24.6	2788.5	.0872	-.0138	.0000	.0872	1
18	4491.6	24.6	2788.6	.0000	-.0068	.0000	.0000	0	4491.6	24.4	2788.6	.0777	-.0138	.0000	.0777	1
19	4516.0	24.4	2788.7	.0000	-.0068	.0000	.0000	0	4516.0	24.2	2788.7	.0654	-.0138	.0000	.0654	1
20	4540.2	24.2	2788.7	.0000	-.0067	.0000	.0000	0	4540.2	23.9	2788.7	.0542	-.0137	.0000	.0542	1
21	4564.1	23.9	2788.8	.0000	-.0067	.0000	.0000	0	4564.1	23.2	2788.8	.0437	-.0137	.0000	.0437	1
22	4587.3	23.2	2788.8	.0000	-.0067	.0000	.0000	0	4587.3	21.7	2788.8	.0317	-.0137	.0000	.0317	1
23	4609.0	21.7	2788.9	.0000	-.0067	.0000	.0000	0	4609.0	18.0	2788.9	.0204	-.0137	.0000	.0204	1
24	4627.0	18.0	2788.9	.0000	-.0067	.0000	.0000	0	4627.0	43.0	2788.9	.0172	-.0137	.0000	.0172	1
0	4670.0	43.0	2789.0	.0000	.0000	.0000	.0000	0	4670.0	.0	2789.0	.0000	.0000	.0000	.0000	1

HELENDALE ROAD - MTZ
***** PROFILE 1S34 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

COMPUTED VELOCITY/INTERCEPTS

LAYER	FORWARD INTERCEPT	FORWARD VELOCITY	REVERSE INTERCEPT	REVERSE VELOCITY
1	.001	2530.	.003	-2550.
2	.099	5700.	.087	-5308.
3	.135	7390.	.122	-7195.

VELOCITY/DEPTH INTERPRETATION

LAYER	VELOCITY	THICKF	DEPTHF	ELEVF	THICKR	DEPTHR	ELEVR	VDIP	TDIP
1	2540.	142.	142.	2648.	125.	125.	2665.	1.1	.2
2	5496.	125.	267.	2523.	125.	250.	2540.	-1.3	.2
3	7286.								

HELENDALE ROAD - MTZ
***** PROFILE 1S14 NORTH - SOUTH *****
04/27/02
DATUM ELEVATION = 2790. FEET

SURVEYING AND ELEVATION TIME CORRECTIONS

	DISTANCE	INTERVAL	HI	DELTAE	ELEVATION	N-S CORR	S-N CORR
* NORTH SHOT POINT *	.0	.0	.0	2733.0	2733.0	-.0531	-.0324
	2293.0	2293.0	.0	2747.0	2747.0	-.0479	-.0273
	2893.0	600.0	.0	2750.0	2750.0	-.0468	-.0262
	4593.0	1700.0	.0	2760.0	2760.0	-.0431	-.0225
	6693.0	2100.0	.0	2770.0	2770.0	-.0394	-.0188
	8293.0	1600.0	.0	2780.0	2780.0	-.0357	-.0151
* SOUTH SHOT POINT *	12317.0	4024.0	.0	2789.0	2789.0	-.0324	-.0118

THE FOLLOWING VELOCITIES HAVE BEEN USED IN THE WEATHERING AND ELEVATION CORRECTIONS.
VFO = 2450. VR0 = 2450. VO = 2450. V1 = 2450. V2 = 5700. FT/SEC

HELENDALE ROAD - MTZ
***** PROFILE 1S14 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *
REL. LOCATION 0.
SHOT NUMBER = 3
DEPTH (FT)= 30.0
ELEVATION(FT)= 2733.
TIME = 1237
NORTH TC(SEC)= .0117

* SOUTH SHOT POINT *
REL. LOCATION 12317.
SHOT NUMBER =
DEPTH (FT)= .0
ELEVATION(FT)= 2789.
TIME =
SOUTH TC(SEC)= .0000

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2733.0	.0000	.0000	.0000	.0000	1	.0	39.1	2733.0	.0000	.0000	.0000	.0000	0
1	39.1	39.1	2733.2	.0118	-.0530	.0000	.0118	1	39.1	19.3	2733.2	.0000	-.0213	.0000	.0000	0
2	58.4	19.3	2733.4	.0192	-.0529	.0000	.0192	1	58.4	22.5	2733.4	.0000	-.0212	.0000	.0000	0
3	80.9	22.5	2733.5	.0304	-.0529	.0000	.0304	1	80.9	23.6	2733.5	.0000	-.0212	.0000	.0000	0
4	104.5	23.6	2733.6	.0407	-.0528	.0000	.0407	1	104.5	24.1	2733.6	.0000	-.0211	.0000	.0000	0
5	128.6	24.1	2733.8	.0507	-.0528	.0000	.0507	1	128.6	24.4	2733.8	.0000	-.0211	.0000	.0000	0
6	153.0	24.4	2733.9	.0637	-.0527	.0000	.0637	1	153.0	24.6	2733.9	.0000	-.0210	.0000	.0000	0
7	177.6	24.6	2734.1	.0742	-.0527	.0000	.0742	1	177.6	24.7	2734.1	.0000	-.0210	.0000	.0000	0
8	202.3	24.7	2734.2	.0827	-.0526	.0000	.0827	1	202.3	24.9	2734.2	.0000	-.0209	.0000	.0000	0
9	227.2	24.9	2734.4	.0934	-.0526	.0000	.0934	1	227.2	24.9	2734.4	.0000	-.0209	.0000	.0000	0
10	252.1	24.9	2734.5	.1042	-.0525	.0000	.1042	1	252.1	24.9	2734.5	.0000	-.0208	.0000	.0000	0
11	277.0	24.9	2734.7	.1154	-.0524	.0000	.1154	1	277.0	25.0	2734.7	.0000	-.0208	.0000	.0000	0
12	302.0	25.0	2734.8	.1252	-.0524	.0000	.1252	1	302.0	25.0	2734.8	.0000	-.0207	.0000	.0000	0
13	327.0	25.0	2735.0	.1317	-.0523	.0000	.1317	1	327.0	25.0	2735.0	.0000	-.0206	.0000	.0000	0
14	352.0	25.0	2735.1	.1352	-.0523	.0000	.1875	2	352.0	25.0	2735.1	.0000	-.0206	.0000	.0000	0
15	377.0	25.0	2735.3	.1407	-.0522	.0000	.1929	2	377.0	25.0	2735.3	.0000	-.0205	.0000	.0000	0
16	402.0	25.0	2735.5	.1459	-.0522	.0000	.1981	2	402.0	25.0	2735.5	.0000	-.0205	.0000	.0000	0
17	427.0	25.0	2735.6	.1502	-.0521	.0000	.2023	2	427.0	25.0	2735.6	.0000	-.0204	.0000	.0000	0
18	452.0	25.0	2735.8	.1534	-.0521	.0000	.2055	-2	452.0	25.0	2735.8	.0000	-.0204	.0000	.0000	0
19	477.0	25.0	2735.9	.1559	-.0520	.0000	.2079	3	477.0	25.0	2735.9	.0000	-.0203	.0000	.0000	0
20	502.0	25.0	2736.1	.1602	-.0519	.0000	.2121	3	502.0	25.0	2736.1	.0000	-.0202	.0000	.0000	0
21	527.0	25.0	2736.2	.1642	-.0519	.0000	.2161	3	527.0	25.0	2736.2	.0000	-.0202	.0000	.0000	0
22	552.0	25.0	2736.4	.1664	-.0518	.0000	.2182	3	552.0	25.0	2736.4	.0000	-.0201	.0000	.0000	0
23	577.0	25.0	2736.5	.1699	-.0518	.0000	.2217	3	577.0	25.0	2736.5	.0000	-.0201	.0000	.0000	0
24	602.0	25.0	2736.7	.1727	-.0517	.0000	.2244	3	602.0	11715.0	2736.7	.0000	-.0200	.0000	.0000	0
0	12317.0	11715.0	2789.0	.0000	.0000	.0000	.0000	0	12317.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S14 NORTH - SOUTH *****
04/27/02
UNIT = 2
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	12317.
SHOT NUMBER =	6	SHOT NUMBER =	
DEPTH (FT)=	30.0	DEPTH (FT)=	.0
ELEVATION(FT)=	2733.	ELEVATION(FT)=	2789.
TIME =	1620	TIME =	
NORTH TC(SEC)=	-.0030	SOUTH TC(SEC)=	.0000

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2733.0	.0000	.0000	.0000	.0000	0	.0	2651.0	2733.0	.0000	.0000	.0000	.0000	0
1	2651.0	2651.0	2748.8	.4650	-.0472	.0000	.5122	3	2651.0	201.0	2748.8	.0000	-.0156	.0000	.0000	0
2	2852.0	201.0	2749.8	.4850	-.0469	.0000	.5319	3	2852.0	194.0	2749.8	.0000	-.0152	.0000	.0000	0
3	3046.0	194.0	2750.9	.5170	-.0465	.0000	.5635	3	3046.0	200.0	2750.9	.0000	-.0148	.0000	.0000	0
4	3246.0	200.0	2752.1	.5470	-.0460	.0000	.5930	3	3246.0	201.0	2752.1	.0000	-.0143	.0000	.0000	0
5	3447.0	201.0	2753.3	.5710	-.0456	.0000	.6166	3	3447.0	197.0	2753.3	.0000	-.0139	.0000	.0000	0
6	3644.0	197.0	2754.4	.5920	-.0452	.0000	.6372	3	3644.0	197.0	2754.4	.0000	-.0135	.0000	.0000	0
7	3841.0	197.0	2755.6	.6220	-.0447	.0000	.6667	3	3841.0	197.0	2755.6	.0000	-.0131	.0000	.0000	0
8	4038.0	197.0	2756.7	.6470	-.0443	.0000	.6913	3	4038.0	198.0	2756.7	.0000	-.0126	.0000	.0000	0
9	4236.0	198.0	2757.9	.6740	-.0439	.0000	.7179	-3	4236.0	198.0	2757.9	.0000	-.0122	.0000	.0000	0
10	4434.0	198.0	2759.1	.6870	-.0435	.0000	.7305	4	4434.0	201.0	2759.1	.0000	-.0118	.0000	.0000	0
11	4635.0	201.0	2760.2	.7090	-.0430	.0000	.7520	4	4635.0	198.0	2760.2	.0000	-.0114	.0000	.0000	0
12	4833.0	198.0	2761.1	.7270	-.0427	.0000	.7697	4	4833.0	178.0	2761.1	.0000	-.0110	.0000	.0000	0
13	5011.0	178.0	2762.0	.7570	-.0424	.0000	.7994	4	5011.0	201.0	2762.0	.0000	-.0107	.0000	.0000	0
14	5212.0	201.0	2762.9	.7800	-.0420	.0000	.8220	4	5212.0	200.0	2762.9	.0000	-.0103	.0000	.0000	0
15	5412.0	200.0	2763.9	.7990	-.0417	.0000	.8407	4	5412.0	198.0	2763.9	.0000	-.0100	.0000	.0000	0
16	5610.0	198.0	2764.8	.8270	-.0413	.0000	.8683	4	5610.0	198.0	2764.8	.0000	-.0096	.0000	.0000	0
17	5808.0	198.0	2765.8	.8450	-.0410	.0000	.8860	4	5808.0	198.0	2765.8	.0000	-.0093	.0000	.0000	0
18	6006.0	198.0	2766.7	.8650	-.0406	.0000	.9056	4	6006.0	201.0	2766.7	.0000	-.0089	.0000	.0000	0
19	6207.0	201.0	2767.7	.8910	-.0403	.0000	.9313	4	6207.0	201.0	2767.7	.0000	-.0086	.0000	.0000	0
20	6408.0	201.0	2768.6	.9120	-.0399	.0000	.9519	4	6408.0	194.0	2768.6	.0000	-.0082	.0000	.0000	0
21	6602.0	194.0	2769.6	.9350	-.0396	.0000	.9746	4	6602.0	198.0	2769.6	.0000	-.0079	.0000	.0000	0
22	6800.0	198.0	2770.7	.9450	-.0392	.0000	.9842	4	6800.0	204.0	2770.7	.0000	-.0075	.0000	.0000	0
23	7004.0	204.0	2771.9	.9590	-.0387	.0000	.9977	4	7004.0	201.0	2771.9	.0000	-.0070	.0000	.0000	0
24	7205.0	201.0	2773.2	.9820	-.0383	.0000	1.0203	-4	7205.0	5112.0	2773.2	.0000	-.0066	.0000	.0000	0
0	12317.0	5112.0	2789.0	.0000	.0000	.0000	.0000	0	12317.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S14 NORTH - SOUTH *****
04/27/02
UNIT = 1
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *
REL. LOCATION 0.
SHOT NUMBER = 6
DEPTH (FT)= 30.0
ELEVATION(FT)= 2733.
TIME = 1620
NORTH TC(SEC)=-.0240

* SOUTH SHOT POINT *
REL. LOCATION 12317.
SHOT NUMBER =
DEPTH (FT)= .0
ELEVATION(FT)= 2789.
TIME =
SOUTH TC(SEC)= .0000

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2733.0	.0000	.0000	.0000	.0000	0	.0	7715.0	2733.0	.0000	.0000	.0000	.0000	0
1	7715.0	7715.0	2776.4	1.0240	-.0371	.0000	1.0611	5	7715.0	194.0	2776.4	.0000	-.0054	.0000	.0000	0
2	7909.0	194.0	2777.6	1.0370	-.0366	.0000	1.0736	5	7909.0	188.0	2777.6	.0000	-.0049	.0000	.0000	0
3	8097.0	188.0	2778.8	1.0510	-.0362	.0000	1.0872	5	8097.0	194.0	2778.8	.0000	-.0045	.0000	.0000	0
4	8291.0	194.0	2780.0	1.0560	-.0358	.0000	1.0918	5	8291.0	201.0	2780.0	.0000	-.0041	.0000	.0000	0
5	8492.0	201.0	2780.4	1.0770	-.0356	.0000	1.1126	5	8492.0	198.0	2780.4	.0000	-.0039	.0000	.0000	0
6	8690.0	198.0	2780.9	1.0900	-.0354	.0000	1.1254	5	8690.0	194.0	2780.9	.0000	-.0037	.0000	.0000	0
7	8884.0	194.0	2781.3	1.0990	-.0353	.0000	1.1343	5	8884.0	205.0	2781.3	.0000	-.0036	.0000	.0000	0
8	9089.0	205.0	2781.8	1.1180	-.0351	.0000	1.1531	5	9089.0	204.0	2781.8	.0000	-.0034	.0000	.0000	0
9	9293.0	204.0	2782.2	1.1360	-.0349	.0000	1.1709	5	9293.0	201.0	2782.2	.0000	-.0032	.0000	.0000	0
10	9494.0	201.0	2782.7	1.1470	-.0348	.0000	1.1818	5	9494.0	194.0	2782.7	.0000	-.0031	.0000	.0000	0
11	9688.0	194.0	2783.1	1.1580	-.0346	.0000	1.1926	5	9688.0	204.0	2783.1	.0000	-.0029	.0000	.0000	0
12	9892.0	204.0	2783.6	1.1720	-.0344	.0000	1.2064	5	9892.0	168.0	2783.6	.0000	-.0027	.0000	.0000	0
13	10060.0	168.0	2784.0	1.1790	-.0343	.0000	1.2133	-5	10060.0	188.0	2784.0	.0000	-.0026	.0000	.0000	0
14	10248.0	188.0	2784.4	1.1860	-.0341	.0000	1.2201	6	10248.0	196.0	2784.4	.0000	-.0024	.0000	.0000	0
15	10444.0	196.0	2784.8	1.1880	-.0340	.0000	1.2220	6	10444.0	201.0	2784.8	.0000	-.0023	.0000	.0000	0
16	10645.0	201.0	2785.3	1.1940	-.0338	.0000	1.2278	6	10645.0	201.0	2785.3	.0000	-.0021	.0000	.0000	0
17	10846.0	201.0	2785.7	1.2010	-.0336	.0000	1.2346	6	10846.0	198.0	2785.7	.0000	-.0019	.0000	.0000	0
18	11044.0	198.0	2786.2	1.2070	-.0335	.0000	1.2405	6	11044.0	182.0	2786.2	.0000	-.0018	.0000	.0000	0
19	11226.0	182.0	2786.6	1.2160	-.0333	.0000	1.2493	6	11226.0	194.0	2786.6	.0000	-.0016	.0000	.0000	0
20	11420.0	194.0	2787.0	1.2270	-.0332	.0000	1.2602	6	11420.0	201.0	2787.0	.0000	-.0015	.0000	.0000	0
21	11621.0	201.0	2787.4	1.2360	-.0330	.0000	1.2690	6	11621.0	198.0	2787.4	.0000	-.0013	.0000	.0000	0
22	11819.0	198.0	2787.9	1.2410	-.0328	.0000	1.2738	6	11819.0	207.0	2787.9	.0000	-.0011	.0000	.0000	0
23	12026.0	207.0	2788.3	1.2490	-.0327	.0000	1.2817	6	12026.0	198.0	2788.3	.0000	-.0010	.0000	.0000	0
24	12224.0	198.0	2788.8	1.2570	-.0325	.0000	1.2895	6	12224.0	93.0	2788.8	.0000	-.0008	.0000	.0000	0
0	12317.0	93.0	2789.0	.0000	.0000	.0000	.0000	0	12317.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S14 NORTH - SOUTH *****
04/27/02
UNIT = 2
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *		* SOUTH SHOT POINT *	
REL. LOCATION	0.	REL. LOCATION	12316.
SHOT NUMBER =		SHOT NUMBER =	5
DEPTH (FT)=	.0	DEPTH (FT)=	25.0
ELEVATION(FT)=	2733.	ELEVATION(FT)=	2789.
TIME =		TIME =	1510
NORTH TC(SEC)=	.0000	SOUTH TC(SEC)=	.0000

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2733.0	.0000	.0000	.0000	.0000	0	-1.0	2651.0	-.2	.0000	.0000	.0000	.0000	0
1	2651.0	2651.0	2748.8	.0000	-.0362	.0000	.0000	0	2650.0	201.0	2748.8	1.1320	-.0248	.0000	1.1568	6
2	2852.0	201.0	2749.8	.0000	-.0358	.0000	.0000	0	2851.0	194.0	2749.8	1.1300	-.0244	.0000	1.1544	6
3	3046.0	194.0	2750.9	.0000	-.0354	.0000	.0000	0	3045.0	200.0	2750.9	1.1230	-.0240	.0000	1.1470	6
4	3246.0	200.0	2752.1	.0000	-.0350	.0000	.0000	0	3245.0	201.0	2752.1	1.1180	-.0236	.0000	1.1416	6
5	3447.0	201.0	2753.3	.0000	-.0345	.0000	.0000	0	3446.0	197.0	2753.3	1.1050	-.0231	.0000	1.1281	6
6	3644.0	197.0	2754.4	.0000	-.0341	.0000	.0000	0	3643.0	197.0	2754.4	1.0930	-.0227	.0000	1.1157	6
7	3841.0	197.0	2755.6	.0000	-.0337	.0000	.0000	0	3840.0	197.0	2755.6	1.0910	-.0223	.0000	1.1133	6
8	4038.0	197.0	2756.7	.0000	-.0333	.0000	.0000	0	4037.0	198.0	2756.7	1.0850	-.0218	.0000	1.1068	5
9	4236.0	198.0	2757.9	.0000	-.0328	.0000	.0000	0	4235.0	198.0	2757.9	1.0800	-.0214	.0000	1.1014	5
10	4434.0	198.0	2759.1	.0000	-.0324	.0000	.0000	0	4433.0	201.0	2759.1	1.0600	-.0210	.0000	1.0810	5
11	4635.0	201.0	2760.2	.0000	-.0320	.0000	.0000	0	4634.0	198.0	2760.2	1.0480	-.0206	.0000	1.0686	5
12	4833.0	198.0	2761.1	.0000	-.0316	.0000	.0000	0	4832.0	178.0	2761.1	1.0290	-.0202	.0000	1.0492	4
13	5011.0	178.0	2762.0	.0000	-.0313	.0000	.0000	0	5010.0	201.0	2762.0	1.0150	-.0199	.0000	1.0349	4
14	5212.0	201.0	2762.9	.0000	-.0310	.0000	.0000	0	5211.0	200.0	2762.9	.9920	-.0196	.0000	1.0116	4
15	5412.0	200.0	2763.9	.0000	-.0306	.0000	.0000	0	5411.0	198.0	2763.9	.9770	-.0192	.0000	.9962	4
16	5610.0	198.0	2764.8	.0000	-.0303	.0000	.0000	0	5609.0	198.0	2764.8	.9520	-.0189	.0000	.9709	4
17	5808.0	198.0	2765.8	.0000	-.0299	.0000	.0000	0	5807.0	198.0	2765.8	.9270	-.0185	.0000	.9455	4
18	6006.0	198.0	2766.7	.0000	-.0296	.0000	.0000	0	6005.0	201.0	2766.7	.9090	-.0182	.0000	.9272	4
19	6206.0	200.0	2767.7	.0000	-.0292	.0000	.0000	0	6206.0	201.0	2767.7	.8900	-.0178	.0000	.9078	4
20	6407.0	201.0	2768.6	.0000	-.0289	.0000	.0000	0	6407.0	194.0	2768.6	.8630	-.0175	.0000	.8805	4
21	6601.0	194.0	2769.6	.0000	-.0285	.0000	.0000	0	6601.0	198.0	2769.6	.8450	-.0171	.0000	.8621	4
22	6799.0	198.0	2770.7	.0000	-.0281	.0000	.0000	0	6799.0	204.0	2770.7	.8300	-.0167	.0000	.8467	4
23	7003.0	204.0	2771.9	.0000	-.0277	.0000	.0000	0	7003.0	201.0	2771.9	.8050	-.0162	.0000	.8212	4
24	7204.0	201.0	2773.2	.0000	-.0272	.0000	.0000	0	7204.0	5112.0	2773.2	.7800	-.0158	.0000	.7958	4
0	12316.0	5112.0	2789.0	.0000	.0000	.0000	.0000	0	12316.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S14 NORTH - SOUTH *****
04/27/02
UNIT = 1
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *
REL. LOCATION 0.
SHOT NUMBER =
DEPTH (FT)= .0
ELEVATION(FT)= 2733.
TIME =
NORTH TC(SEC)= .0000

* SOUTH SHOT POINT *
REL. LOCATION 12317.
SHOT NUMBER = 4
DEPTH (FT)= 30.0
ELEVATION(FT)= 2789.
TIME = 1342
SOUTH TC(SEC)= .0050

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2733.0	.0000	.0000	.0000	.0000	0	.0	7715.0	2733.0	.0000	.0000	.0000	.0000	0
1	7715.0	7715.0	2776.4	.0000	-.0260	.0000	.0000	0	7715.0	194.0	2776.4	.7430	-.0164	.0000	.7594	-3
2	7909.0	194.0	2777.6	.0000	-.0256	.0000	.0000	0	7909.0	188.0	2777.6	.7170	-.0160	.0000	.7330	3
3	8097.0	188.0	2778.8	.0000	-.0251	.0000	.0000	0	8097.0	194.0	2778.8	.6940	-.0156	.0000	.7096	3
4	8291.0	194.0	2780.0	.0000	-.0247	.0000	.0000	0	8291.0	201.0	2780.0	.6660	-.0151	.0000	.6811	3
5	8492.0	201.0	2780.4	.0000	-.0245	.0000	.0000	0	8492.0	198.0	2780.4	.6370	-.0149	.0000	.6519	3
6	8690.0	198.0	2780.9	.0000	-.0244	.0000	.0000	0	8690.0	194.0	2780.9	.6150	-.0148	.0000	.6298	3
7	8884.0	194.0	2781.3	.0000	-.0242	.0000	.0000	0	8884.0	205.0	2781.3	.5850	-.0146	.0000	.5996	3
8	9089.0	205.0	2781.8	.0000	-.0240	.0000	.0000	0	9089.0	204.0	2781.8	.5650	-.0145	.0000	.5795	3
9	9293.0	204.0	2782.2	.0000	-.0239	.0000	.0000	0	9293.0	201.0	2782.2	.5340	-.0143	.0000	.5483	3
10	9494.0	201.0	2782.7	.0000	-.0237	.0000	.0000	0	9494.0	194.0	2782.7	.5060	-.0141	.0000	.5201	3
11	9688.0	194.0	2783.1	.0000	-.0235	.0000	.0000	0	9688.0	204.0	2783.1	.4780	-.0140	.0000	.4920	3
12	9892.0	204.0	2783.6	.0000	-.0234	.0000	.0000	0	9892.0	168.0	2783.6	.4500	-.0138	.0000	.4638	3
13	10060.0	168.0	2784.0	.0000	-.0232	.0000	.0000	0	10060.0	188.0	2784.0	.4230	-.0137	.0000	.4367	3
14	10248.0	188.0	2784.4	.0000	-.0231	.0000	.0000	0	10248.0	196.0	2784.4	.3970	-.0135	.0000	.4105	3
15	10444.0	196.0	2784.8	.0000	-.0229	.0000	.0000	0	10444.0	201.0	2784.8	.3730	-.0133	.0000	.3863	3
16	10645.0	201.0	2785.3	.0000	-.0228	.0000	.0000	0	10645.0	201.0	2785.3	.3420	-.0132	.0000	.3552	3
17	10846.0	201.0	2785.7	.0000	-.0226	.0000	.0000	0	10846.0	198.0	2785.7	.3150	-.0130	.0000	.3280	3
18	11044.0	198.0	2786.2	.0000	-.0224	.0000	.0000	0	11044.0	182.0	2786.2	.2870	-.0128	.0000	.2998	3
19	11226.0	182.0	2786.6	.0000	-.0223	.0000	.0000	0	11226.0	194.0	2786.6	.2570	-.0127	.0000	.2697	3
20	11420.0	194.0	2787.0	.0000	-.0221	.0000	.0000	0	11420.0	201.0	2787.0	.2350	-.0125	.0000	.2475	3
21	11621.0	201.0	2787.4	.0000	-.0219	.0000	.0000	0	11621.0	198.0	2787.4	.2050	-.0124	.0000	.2174	2
22	11819.0	198.0	2787.9	.0000	-.0218	.0000	.0000	0	11819.0	207.0	2787.9	.1650	-.0122	.0000	.1772	2
23	12026.0	207.0	2788.3	.0000	-.0216	.0000	.0000	0	12026.0	198.0	2788.3	.1130	-.0120	.0000	.1130	1
24	12224.0	198.0	2788.8	.0000	-.0215	.0000	.0000	0	12224.0	93.0	2788.8	.0470	-.0119	.0000	.0470	1
0	12317.0	93.0	2789.0	.0000	.0000	.0000	.0000	0	12317.0	.0	2789.0	.0000	.0000	.0000	.0000	0

HELENDALE ROAD - MTZ
***** PROFILE 1S14 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

* NORTH SHOT POINT *
REL. LOCATION 0.
SHOT NUMBER =
DEPTH (FT)= .0
ELEVATION(FT)= 2733.
TIME =
NORTH TC(SEC)= .0000

* SOUTH SHOT POINT *
REL. LOCATION 12317.
SHOT NUMBER = 4
DEPTH (FT)= 30.0
ELEVATION(FT)= 2789.
TIME = 1342
SOUTH TC(SEC)= .0114

GEOPHONE TIME - DISTANCE DATA

	NORTH - SOUTH			NORTH - SOUTH					SOUTH - NORTH			SOUTH - NORTH				
GEO	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IF	DISTANCE	INTERVAL	ELEVAT.	RAWTI	ELCOR	WECOR	CORTI	IR
0	.0	.0	2733.0	.0000	.0000	.0000	.0000	0	.0	11716.0	2733.0	.0000	.0000	.0000	.0000	0
1	11716.0	11716.0	2787.7	.0000	-.0219	.0000	.0000	0	11716.0	25.0	2787.7	.1836	-.0123	.0000	.1959	2
2	11741.0	25.0	2787.7	.0000	-.0218	.0000	.0000	0	11741.0	25.0	2787.7	.1811	-.0123	.0000	.1934	2
3	11766.0	25.0	2787.8	.0000	-.0218	.0000	.0000	0	11766.0	25.0	2787.8	.1784	-.0122	.0000	.1906	2
4	11791.0	25.0	2787.8	.0000	-.0218	.0000	.0000	0	11791.0	25.0	2787.8	.1721	-.0122	.0000	.1843	2
5	11816.0	25.0	2787.9	.0000	-.0218	.0000	.0000	0	11816.0	25.0	2787.9	.1681	-.0122	.0000	.1803	2
6	11841.0	25.0	2787.9	.0000	-.0218	.0000	.0000	0	11841.0	25.0	2787.9	.1616	-.0122	.0000	.1738	2
7	11866.0	25.0	2788.0	.0000	-.0217	.0000	.0000	0	11866.0	24.9	2788.0	.1569	-.0122	.0000	.1691	2
8	11890.9	24.9	2788.0	.0000	-.0217	.0000	.0000	0	11890.9	24.9	2788.0	.1509	-.0121	.0000	.1630	2
9	11915.8	24.9	2788.1	.0000	-.0217	.0000	.0000	0	11915.8	24.9	2788.1	.1456	-.0121	.0000	.1577	2
10	11940.7	24.9	2788.2	.0000	-.0217	.0000	.0000	0	11940.7	24.9	2788.2	.1411	-.0121	.0000	.1532	2
11	11965.6	24.9	2788.2	.0000	-.0217	.0000	.0000	0	11965.6	24.9	2788.2	.1356	-.0121	.0000	.1356	1
12	11990.5	24.9	2788.3	.0000	-.0216	.0000	.0000	0	11990.5	24.9	2788.3	.1274	-.0121	.0000	.1274	1
13	12015.4	24.9	2788.3	.0000	-.0216	.0000	.0000	0	12015.4	24.9	2788.3	.1169	-.0120	.0000	.1169	1
14	12040.3	24.9	2788.4	.0000	-.0216	.0000	.0000	0	12040.3	24.8	2788.4	.1069	-.0120	.0000	.1069	1
15	12065.1	24.8	2788.4	.0000	-.0216	.0000	.0000	0	12065.1	24.8	2788.4	.1006	-.0120	.0000	.1006	1
16	12089.9	24.8	2788.5	.0000	-.0216	.0000	.0000	0	12089.9	24.8	2788.5	.0941	-.0120	.0000	.0941	1
17	12114.7	24.8	2788.5	.0000	-.0215	.0000	.0000	0	12114.7	24.7	2788.5	.0849	-.0120	.0000	.0849	1
18	12139.4	24.7	2788.6	.0000	-.0215	.0000	.0000	0	12139.4	24.6	2788.6	.0754	-.0119	.0000	.0754	1
19	12164.0	24.6	2788.7	.0000	-.0215	.0000	.0000	0	12164.0	24.4	2788.7	.0631	-.0119	.0000	.0631	1
20	12188.4	24.4	2788.7	.0000	-.0215	.0000	.0000	0	12188.4	24.1	2788.7	.0519	-.0119	.0000	.0519	1
21	12212.5	24.1	2788.8	.0000	-.0215	.0000	.0000	0	12212.5	23.6	2788.8	.0414	-.0119	.0000	.0414	1
22	12236.1	23.6	2788.8	.0000	-.0214	.0000	.0000	0	12236.1	22.5	2788.8	.0294	-.0119	.0000	.0294	1
23	12258.6	22.5	2788.9	.0000	-.0214	.0000	.0000	0	12258.6	19.3	2788.9	.0181	-.0118	.0000	.0181	1
24	12277.9	19.3	2788.9	.0000	-.0214	.0000	.0000	0	12277.9	39.1	2788.9	.0115	-.0118	.0000	.0115	1
0	12317.0	39.1	2789.0	.0000	.0000	.0000	.0000	0	12317.0	.0	2789.0	.0000	.0000	.0000	.0000	1

HELENDALE ROAD - MTZ
***** PROFILE 1S14 NORTH - SOUTH *****
04/27/02
UNIT = 3
DATUM ELEVATION = 2790. FEET

COMPUTED VELOCITY/INTERCEPTS

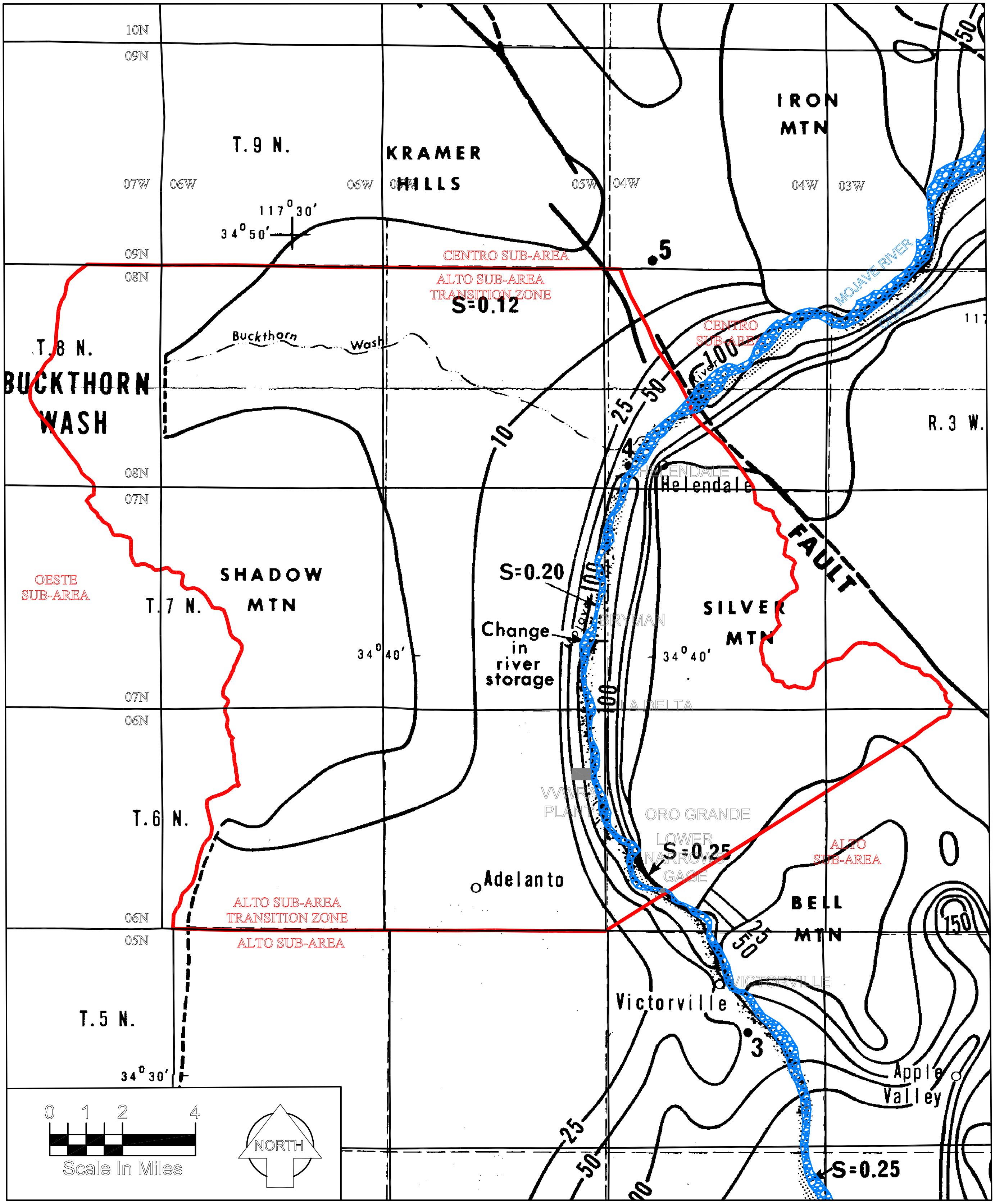
LAYER	FORWARD INTERCEPT	FORWARD VELOCITY	REVERSE INTERCEPT	REVERSE VELOCITY
1	-.003	2372.	.001	-2552.
2	.124	5514.	.078	-5007.
3	.144	7328.	.124	-7202.
4	.267	9446.	.267	-9554.
5	.534	14708.	.547	-14704.
6	.843	27469.	.766	-24494.

VELOCITY/DEPTH INTERPRETATION

LAYER	VELOCITY	THICKF	DEPTHF	ELEVF	THICKR	DEPTHR	ELEVR	VDIP	TDIP
1	2462.	173.	173.	2617.	109.	109.	2681.	1.5	.3
2	5247.	43.	217.	2573.	154.	264.	2526.	-2.3	-.2
3	7251.	661.	877.	1913.	747.	1010.	1780.	-2.5	-.6
4	9482.	1374.	2251.	539.	1398.	2408.	382.	-1.2	-.7
5	14684.	2161.	4413.	-1623.	1324.	3732.	-942.	1.2	3.2
6	25843.								

APPENDIX E

AQUIFER PROPERTY MAPS



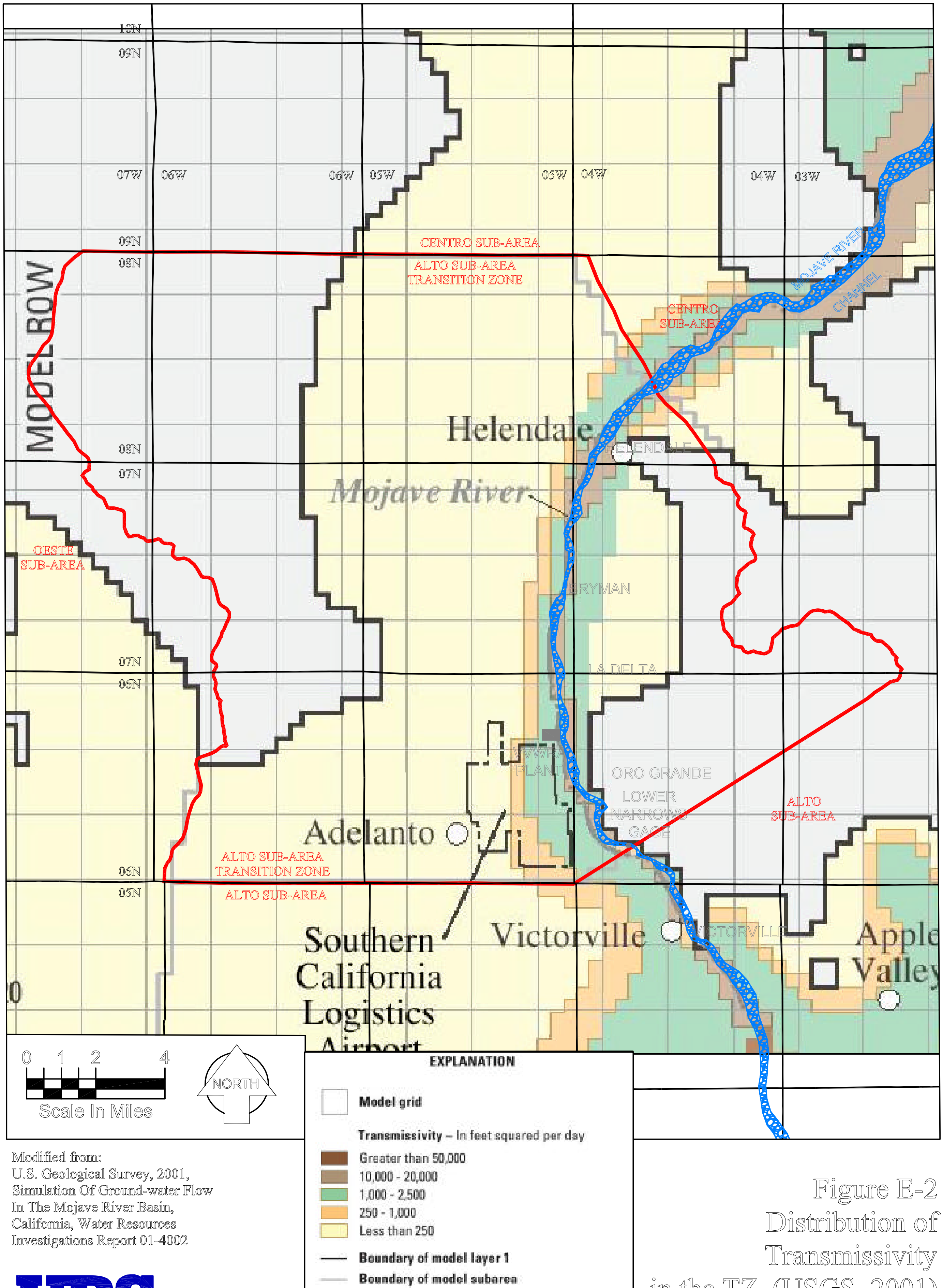
Modified from:
USGS, 1971, Hydrologic Analysis
of Mojave River Basin, California,
Using Electric Analog Model

S=0.25 STORAGE COEFFICIENT FROM TEST HOLE

— 150 — LINE OF EQUAL ESTIMATED TRANSMISSIVITY IN THOUSANDS OF GALLONS OER DAY PER FOOT

Figure E-1

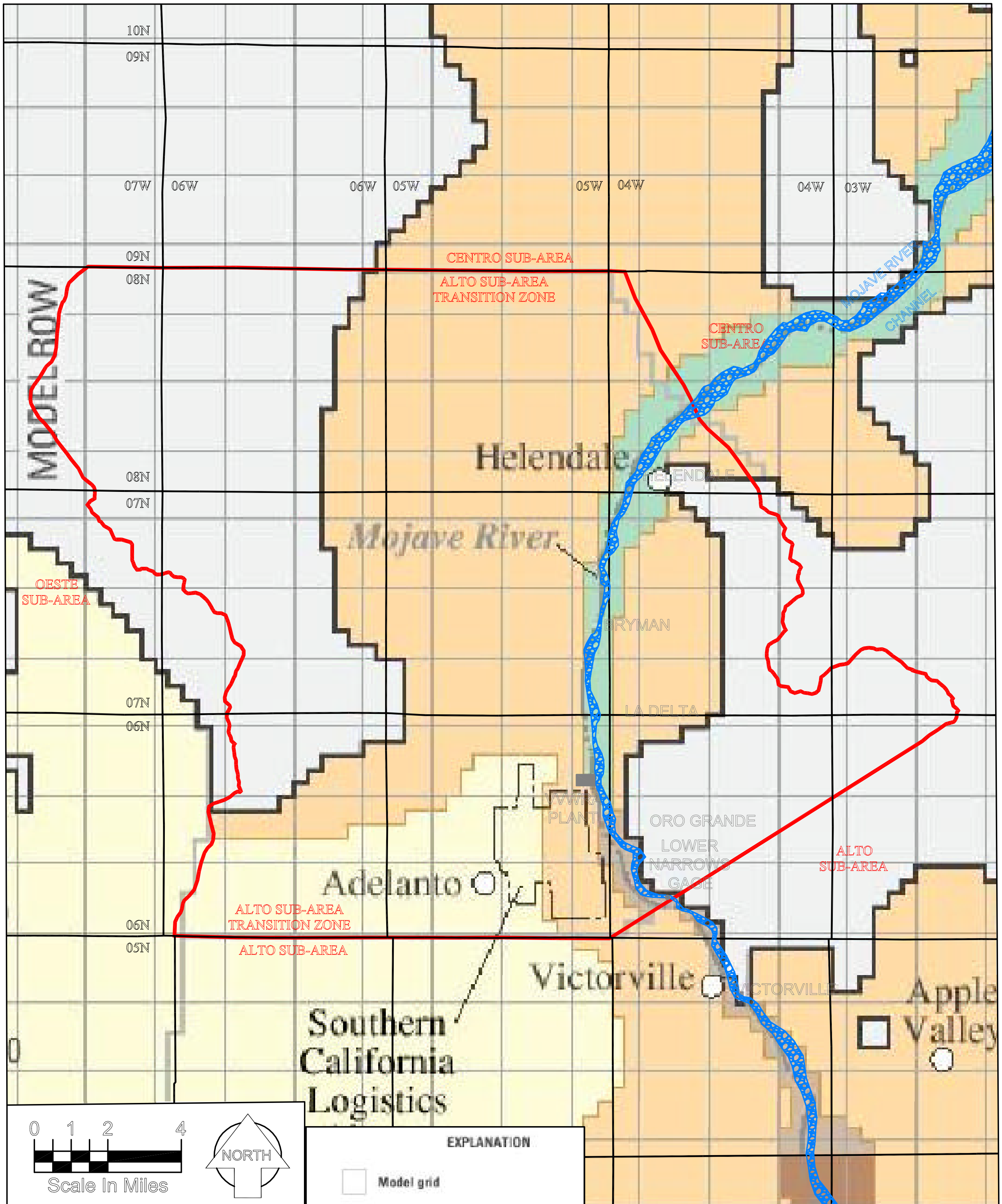
Map of the TZ Showing Aquifer Transmissivity and Storage Coefficient (USGS, 1971)

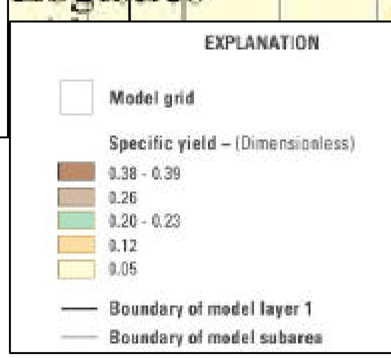


Modified from:
U.S. Geological Survey, 2001,
Simulation Of Ground-water Flow
In The Mojave River Basin,
California, Water Resources
Investigations Report 01-4002

URS

Figure E-2
Distribution of
Transmissivity
in the TZ (USGS, 2001)

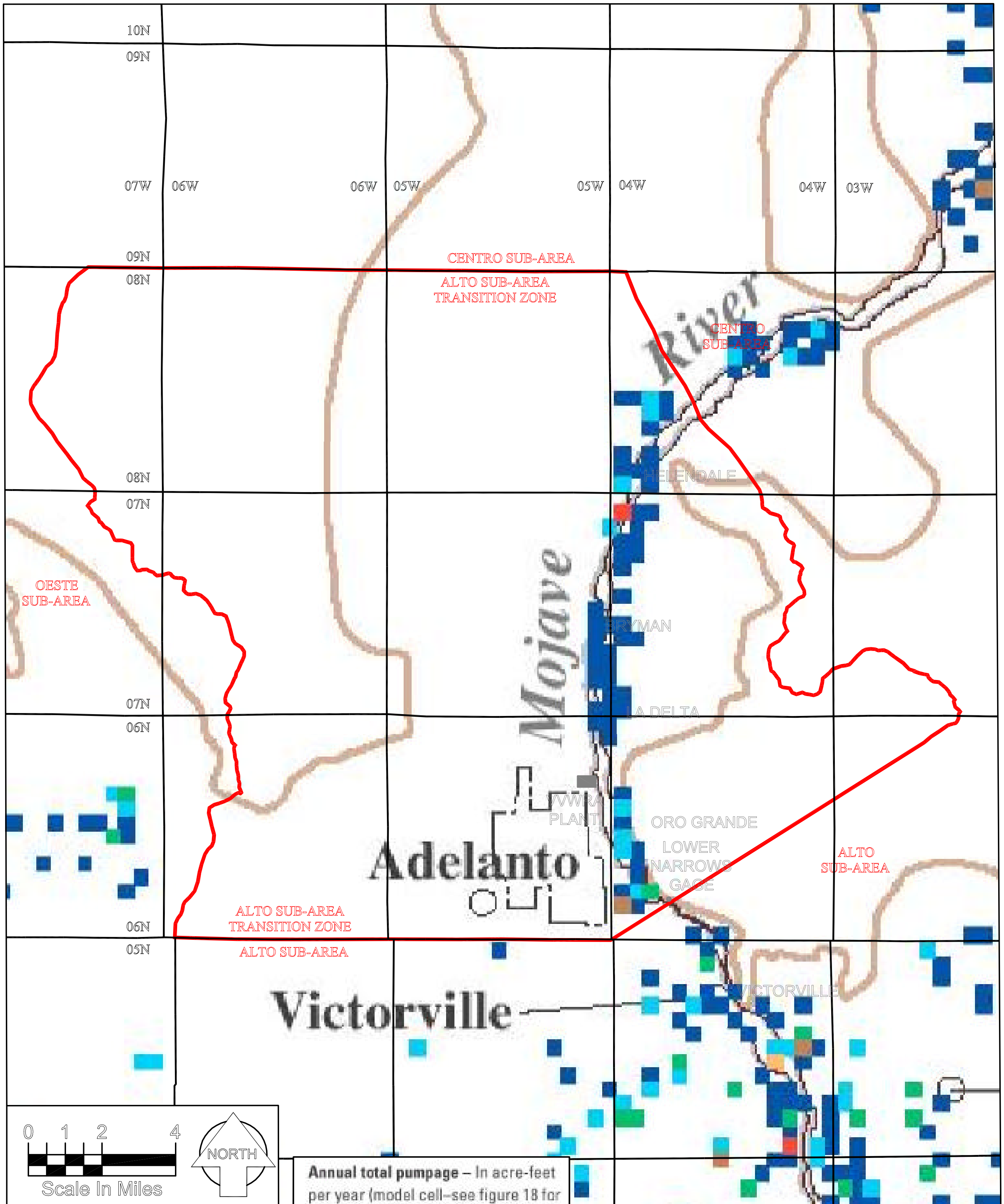




Modified from:
U.S. Geological Survey, 2001,
Simulation Of Ground-water Flow
In The Mojave River Basin,
California, Water Resources
Investigations Report 01-4002

URS

Figure E-3
Distribution of Specific Yield
in the TZ (USGS, 2001)



Annual total pumpage – In acre-feet per year (model cell–see figure 18 for location)

- > 2,500
- > 2,000 and ≤ 2,500
- > 1,500 and ≤ 2,000
- > 1,000 and ≤ 1,500
- > 500 and ≤ 1,000
- > 0 and ≤ 500

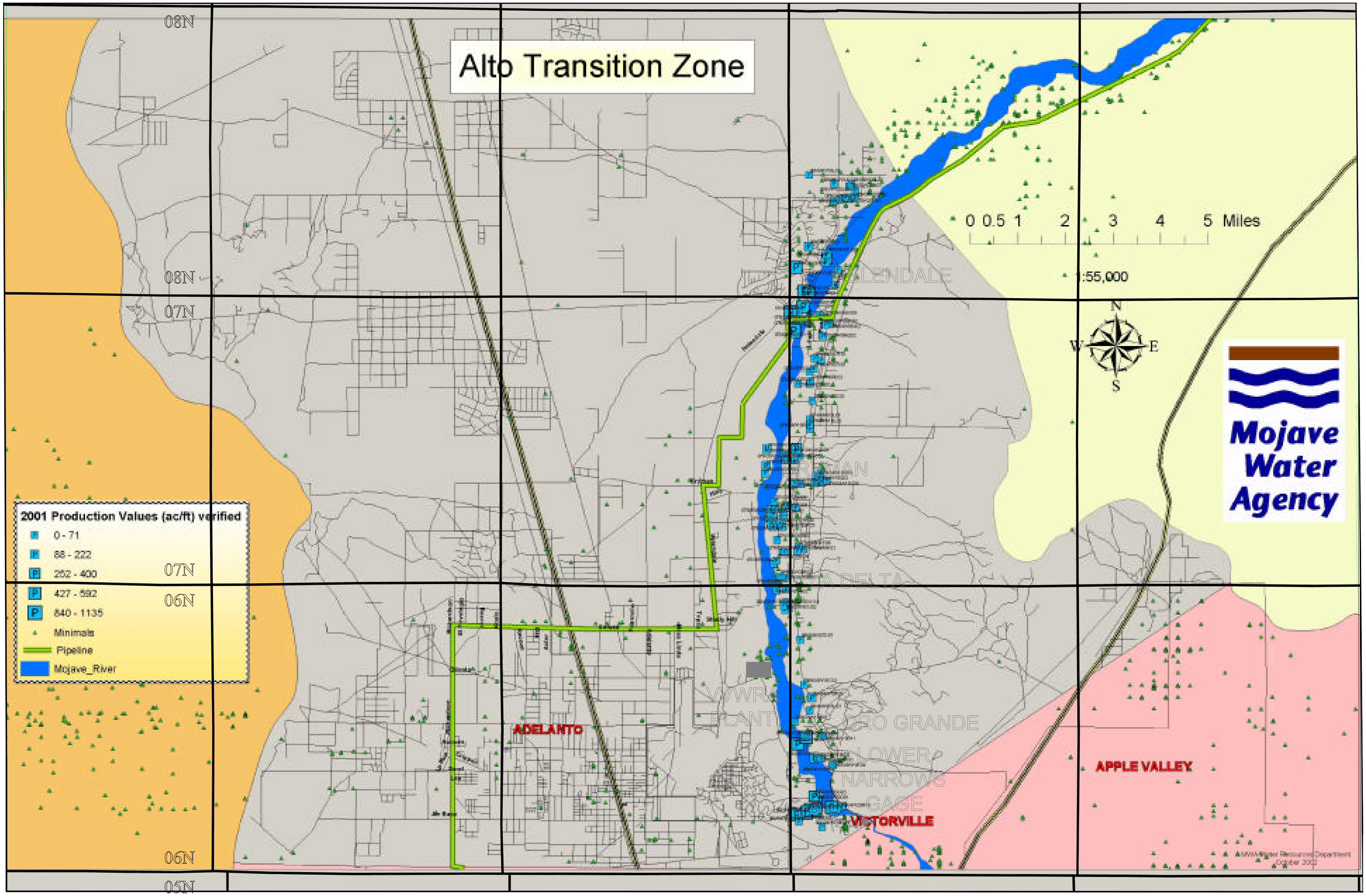
>, greater than

≤, less than or equal to

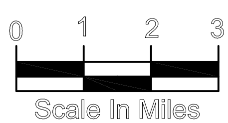
Modified from:
U.S. Geological Survey, 2001,
Simulation Of Ground-water Flow
In The Mojave River Basin,
California, Water Resources
Investigations Report 01-4002

URS

Figure E-4
Distribution of
1994 Annual Production
in the TZ (USGS, 2001)



URS



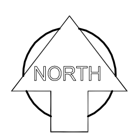


Figure E-5
Distribution of Minimal Producers
and 2001 Annual Production
in the TZ (USGS, 2001)