FLORENCE COPPER, INC.

UIC PERMIT APPLICATION

FLORENCE COPPER PROJECT – PRODUCTION TEST FACILITY

ATTACHMENT I – FORMATION TESTING PROGRAM

Table of Contents

List of Exhibits

I.1 Introduction

This Attachment has been prepared in support of an Application by Florence Copper, Inc. (Florence Copper) to the United States Environmental Protection Agency (USEPA) for issuance of an Underground Injection Control Class III (Area) Permit (UIC Permit) for the planned Production Test Facility (PTF), to be located at the Florence Copper Project (FCP) site in Pinal County, Arizona. Florence Copper is proposing to develop the PTF in order to demonstrate the feasibility of operating an in-situ copper recovery (ISCR) facility at the FCP site. The PTF will produce a limited amount of copper from a porphyry copper oxide deposit (oxide zone) located beneath the FCP site. The PTF proposed by Florence Copper will consist of a closely spaced array of Class III injection and recovery wells that will inject a dilute sulfuric acid based solution (lixiviant) into the copper oxide deposit (oxide zone) and recover the resulting copper-bearing pregnant leach solution (PLS).

Previous owners of the FCP site have included Continental Oil Company, Magma Copper Company, BHP Copper Inc. (BHP Copper), and Florence Copper. These previous owners have conducted extensive and thorough studies over a period spanning the last 40 years. Studies have included exploratory drilling and testing, pilot-scale underground mining and copper production, ISCR pre-feasibility and feasibility studies, and characterization of the FCP oxide zone and local aquifers.

In this Attachment, Florence Copper provides a summary of the formation testing work completed by others. Given the extensive body of high quality characterization data produced at the FCP site, Florence Copper does not propose to conduct new formation testing. Exhibit I-1 is a site characterization report prepared in 1996 in support of Aquifer Protection Permit (APP) and UIC Permit applications submitted at that time.

I.2 Background

In 1996, BHP Copper compiled data from studies conducted by BHP Copper and others from 1970 through 1995, in support of applications to the Arizona Department of Environmental Quality (ADEQ) for an Aquifer Protection Program Permit (1996 Application), and to the USEPA for a UIC Permit. The studies included extensive field investigations and laboratory studies for the purpose of characterizing the FCP oxide zone, aquifers, formation fluids, and other aspects of the FCP site. The extent of the studies and analyses conducted are listed in the next section and described in detail in Exhibit I-1.

In 1997, ADEQ and USEPA issued APP No. 101704 and UIC Permit No. AZ396000001, respectively, authorizing BHP Copper to operate a commercial-scale copper recovery operation at the FCP site using the ISCR method. In 1997 and 1998, and as required by USEPA in Part II.F.7 of UIC Permit No. AZ396000001, BHP Copper conducted a short-term injection and recovery test to demonstrate that hydraulic control could be maintained within the injection and recovery zone while fluids were being injected and recovered during ISCR operations. The successful completion of the test was reported to ADEQ in a letter dated April 6, 1998 (BHP Copper, 1998). Although fully permitted by ADEQ and USEPA, a combination of financial considerations prevented BHP Copper from advancing the FCP to commercial-scale copper production. The FCP was subsequently sold, and the UIC Permit transferred with amendments, to the subsequent owner.

Beginning the fourth quarter of 1997, BHP Copper began quarterly and biennial water quality monitoring programs in accordance with the requirements of the APP and the UIC Permit. Monitoring and quarterly reporting have continued since that time, except for 2009 due to a previous owner's financial difficulties.

No significant formation characterization activities have been conducted at the FCP site since successful completion of the BHP Copper hydraulic control test completed in early 1998. Given the extensive dataset generated by previous site owners, and the thorough nature of studies conducted previously at the site, Florence Copper does not plan to conduct any additional formation or aquifer testing prior to construction of the proposed PTF.

I.3 Description of Formation Testing Program Conducted to Date

The methods and results of the formation testing program were compiled by BHP Copper in 1996 (Exhibit I-1). Because no additional significant formation characterization activities have been conducted since 1996, Exhibit I-1 represents the most comprehensive collection of formation testing data available. Exhibit I-1 was submitted by BHP Copper as Volume II – Site Characterization Report of their 1996 Application.

Specifically, the Site Characterization Report summarizes:

- A review of data from publicly available documents. This information includes professional journal articles, government agency publications, Arizona Department of Water Resources (ADWR) well records, and mapping of the regional bedrock.
- Documentation of communications with the Towns of Florence and Coolidge in regards to municipal well locations, pumping rates, and water quality.
- A review of pumping records retained by the San Carlos Irrigation Project (SCIP) and San Carlos Irrigation and Drainage District (SCIDD).
- An assessment of bedrock properties, including fracture frequency and orientation, based on lithologic logs of approximately 700 core holes drilled at, or in the vicinity of, the FCP site.
- The drilling of 52 boreholes by mud rotary and reverse circulation methods to depths ranging from approximately 240 to 1,580 feet below ground surface (bgs).
- The geophysical logging of about 16,340 linear feet of rotary boreholes utilizing nuclear, acoustic, and electrical methods.
- The completion of 18 observation wells in six clusters in and around the designated oxide zone to depths ranging from 240 to 1,580 feet bgs.
- Results from a monthly sampling and water quality testing program, including a total of 98 water quality parameters measured.
- Fourteen hydraulic packer tests conducted in open boreholes.
- Results from monthly water level measurements in approximately 110 wells.
- Results from 26 aquifer tests using 14 test wells and four observation well clusters, measuring up to 15 observation wells during drawdown and recovery of the principal well.
- Completion of a specialized subsurface sampling program to evaluate the ambient geochemical and physical properties of the unsaturated zone.
- Completion of a geotechnical investigation of the foundation soils underlying the proposed surface facilities, including selected facilities to be used for managing process solutions, sediments and water.
- Completion of an environmental site assessment of the existing facilities on the FCP site to evaluate the presence of soil contaminants.

As described in Exhibit K-2 of this Application, prior to commencement of PTF operations, aquifer tests will be conducted in order to evaluate subsurface characteristics of the Bedrock Oxide Unit, overlying basin fill units, and the confining Middle Fine Grained Unit within the PTF Area of Review.

I.4 Formation Characterization Data

I.4.1 Fluid Pressure Data

The proposed injection is to occur in the saturated oxide zone of the bedrock underlying the FCP site. This bedrock oxide zone is in the upper part of the bedrock and consists of primarily Precambrian quartz monzonite and Tertiary granodiorite porphyry. The upper portion of the bedrock oxide zone consists of a weathered, rubbly mixture of fracture-filling minerals and angular bedrock fragments. Below this weathered zone, the oxide bedrock consists of extensively fractured quartz monzonite, granodiorite, and associated dikes. Movement of groundwater through the bedrock oxide zone is largely controlled by secondary permeability resulting from faults, fractures, and associated brecciation.

The bedrock oxide zone is in hydraulic communication with an overlying sedimentary deposit, the Lower Basin Fill Unit (LBFU). Both the bedrock oxide zone and LBFU behave as confined to semi-confined hydrostratigraphic units. Because of the confining to semi-confining conditions, fluid pressure within the bedrock oxide zone is sufficient to create a piezometric surface that was measured in 2010 at elevations between approximately 1,270 and 1,275 feet above mean sea level.

Potentiometric elevations observed in the bedrock oxide zone and other hydrostratigraphic units are summarized in Section 4.3, and are shown on Figures 4.3-9(II) through 4.3-13 (II) of Exhibit I-1.

I.4.2 Fracture Pressure Data

During 1995, BHP Copper conducted 14 hydraulic packer tests in open boreholes for the purpose of defining the fracture gradient of undisturbed bedrock within the oxide zone. The methods and results of the core hole packer testing are described in Sections 2.3.6 and 4.3.3.9, respectively, of Exhibit I-1. Fracture gradient packer testing data are included in electronic format as Exhibit I-2.

I.4.3 Physical and Chemical Characteristics of Formation Fluids

Data describing the physical and chemical characteristics of formation fluids in the region and at the FCP site are described in Sections 3.8 and 4.5 of Exhibit I-1, respectively.

EXHIBIT I-1

Volume II of January 1996 Aquifer Protection Permit Application
Site Characterization Report

VOLUME II OF V

SITE CHARACTERIZATION REPORT

MAGMA FLORENCE IN-SITU PROJECT

JANUARY 1996

Prepared by: Brown and Caldwell
3636 North Central Avenue
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Prepared for: Magma Copper Company
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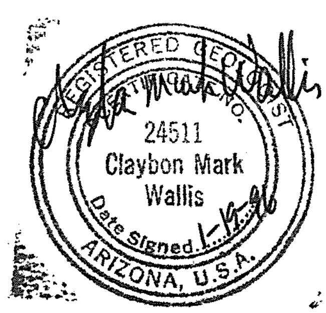

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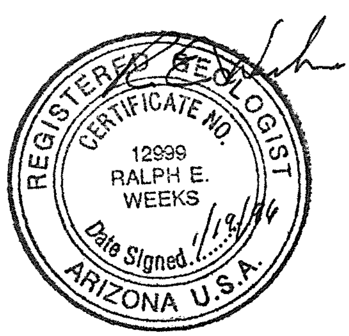

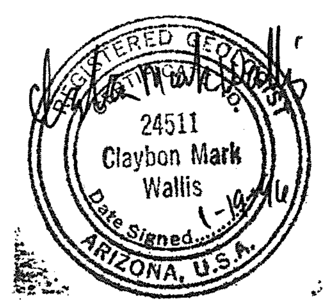

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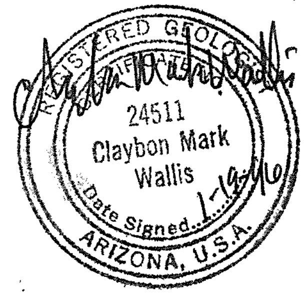


SECTION 1.0

INTRODUCTION

This report presents the findings of a hydrogeologic investigation of the site of the proposed Magma Copper Company (Magma) Florence in-situ copper leaching project. As shown on Figures 1.1-1[II] and 1.1-2[II] (II indicates figures are part of Volume II), the project is located in Pinal County, Arizona, approximately 2 miles northwest of the Town of Florence. This investigation was designed to provide sufficient technical data and interpretations to support the environmental permitting of the mining facility as required by the Arizona Aquifer Protection Permit (APP) program promulgated by Title 49 of the Arizona Revised Statutes (ARS) and Sections R18-9-101 through R18-9-203 of the Arizona Administrative Code (AAC). The following is a more detailed description of the objectives and scope of the investigative process, and the organization of this document.

1.1 PURPOSE AND SCOPE

Subsection C.1 of R18-9-108 of the AAC delineates the scope of the hydrogeologic study required as part of an APP application. Twelve technical items are listed in Subsection C.1, of which the first seven are addressed in this characterization report. The data presented herein have then become the basis for a regional and site-specific analysis of groundwater flow and contaminant transport as presented in Volume IV of the application. The content of Volume IV on groundwater modeling addresses the remaining items listed in Subsection C.1.

As mandated by regulation, the objectives of this study and of the analytical efforts that are supported by this site characterization are to define the discharge impact area (DIA) for the Magma Florence facility. This analytical process is designed to assure that the operation will not cause or contribute to a violation of Arizona Aquifer Water Quality Standards (AWQS) at the point(s) of compliance (POCs). Types of data acquired and analyzed, and the methods of data acquisition, have been tailored to define the hydrogeologic properties of the study area to a degree sufficient to demonstrate that the proposed operation will not adversely impact groundwater quality. The level of investigation associated with this study provides a sufficient hydrogeologic characterization of the area by incorporating a substantial amount of existing subsurface information with data collected specifically for this project.

This portion of the APP application is designed to provide an overview of the investigative methods used, the data acquired, and qualitative and quantitative findings and interpretations of the regional and local hydrogeologic conditions. The conceptual hydrogeologic model derived from this effort then served as the framework for subsequent simulations of groundwater flow behavior and solute transport under proposed operational and post-operational conditions.

As paraphrased from Subsection C.1 of AAC R18-9-108, the following are those portions of the required content of the APP hydrogeologic study that are provided in this document, with appropriate references to supporting information in other segments of the application:

- description of the surface and subsurface geology;
- location of perennial or ephemeral surface water bodies;
- characteristics of aquifer and geologic units with limited permeability;
- rates, volumes, and directions of surface water and groundwater flow;
- the location of the 100-year floodplain;
- existing aquifer water quality; and
- extent and degree of known soil contamination.

This information is combined with an assessment of the properties of the local, shallow soil profile, an evaluation of geologic hazards, a summary of regional groundwater usage, and a comprehensive analysis of the geochemical properties of the rock types of the Magma Florence oxide ore body and the overlying sedimentary units.

To satisfy the technical objectives of this appraisal, the following investigative activities were performed:

- A review and incorporation of data from published documents available to the public. This information included professional journal articles, governmental agency publications, Arizona Department of Water Resources (ADWR) well records, and mapping of the regional bedrock.

- Communications with representatives of the Towns of Florence and Coolidge in regards to pumping rates, water quality, and municipal well locations.

- A review of pumping records retained by the San Carlos Irrigation Project (SCIP) and San Carlos Irrigation and Drainage District (SCIDD).

- An assessment of bedrock properties, including fracture frequency and orientation based on lithologic logs of approximately 700 coreholes drilled into, or in the vicinity of the Magma Florence copper oxide ore body.

- The drilling of 52 boreholes by mud rotary and reverse circulation methods to depths ranging from approximately 240 to 1,580 feet.

- The geophysical logging of about 16,340 linear feet of rotary boreholes utilizing nuclear, acoustic, and electrical methods.

- The completion of 18 monitor wells in 6 clusters in and around the designated ore body to depths ranging from 240 to 1,580 feet.

- Monthly sampling and water quality testing program, with 4 rounds of sampling now complete and a total of 98 water quality parameters measured.

- The performance of 14 corehole hydraulic tests in open boreholes.

- Monthly water level measurements in approximately 110 wells.

- The performance of 26 aquifer tests utilizing 14 aquifer test and 4 monitor well clusters, measuring up to 15 observation wells during drawdown and recovery of the principal well.

- The completion of a specialized subsurface sampling program to evaluate the ambient geochemical and physical properties of the unsaturated zone.

- The completion of a geotechnical investigation of the foundation soils underlying the proposed surface facilities, including selected discharging facilities.

- The completion of an environmental site assessment of the existing mining facilities to evaluate the presence of soil contaminants.

A comprehensive analysis of the ambient geochemical properties of the regional bedrock units is presented in Volume IV of this application, with associated solute transport modeling presented in that document. Laboratory reports of groundwater quality and associated quality assurance/quality control (QA/QC) documentation are presented in Volume III of this application, with the interpretation of these results presented in Section 4.0 of Volume II.

In addition to the enabling legislation and its associated rulemaking, other state regulatory guidance manuals and federal documentation were utilized during the course of this investigative process. The manuals included three documents prepared by the Arizona Department of Environmental Quality (ADEQ), with federal guidance in the form of regulatory language and one guidance document. These items are as follows:

- Aquifer Protection Permit Guidance Manual (ADEQ, 1991);

- Arizona Mining Best Available Demonstrated Control Technology (BADCT) Guidance Manual - Preliminary Draft (ADEQ, 1995);

- ADEQ Quality Assurance Project Plan (ADEQ, 1991);

- U.S. Code of Federal Regulation (CFR) for Underground Injection Control (UIC); 40 CFR Chapter 1, Parts 144 through 146;

- Federal Safe Drinking Water Act of 1974; and

- EPA Aquifer Exemption Guidelines.

In completing the study, those comments received from the ADEQ (ADEQ, 1995a, 1995b) and the EPA (EPA, 1995) have been considered. Adjustments to the investigative process have occurred as a result of the project team's interaction with agency representatives, project meetings and written correspondence.

1.2 REPORT ORGANIZATION

This volume of the APP application is compiled in a fashion that allows its review largely independent of other portions of the application. However, reference is made to other volumes to provide the reader with additional guidance. The information contained herein begins with a summary of investigative methods, followed by a description of the hydrogeologic conditions of the region and the local proposed in-situ mine area. Supporting data and supplemental reports are presented in appendices at the end of the report text, along with sheets referenced in the report. Tables and figures referenced in the text are presented at the end of each chapter in the sequence found in the report text. As applicable, comments received from ADEQ and EPA representatives are referenced in the text.

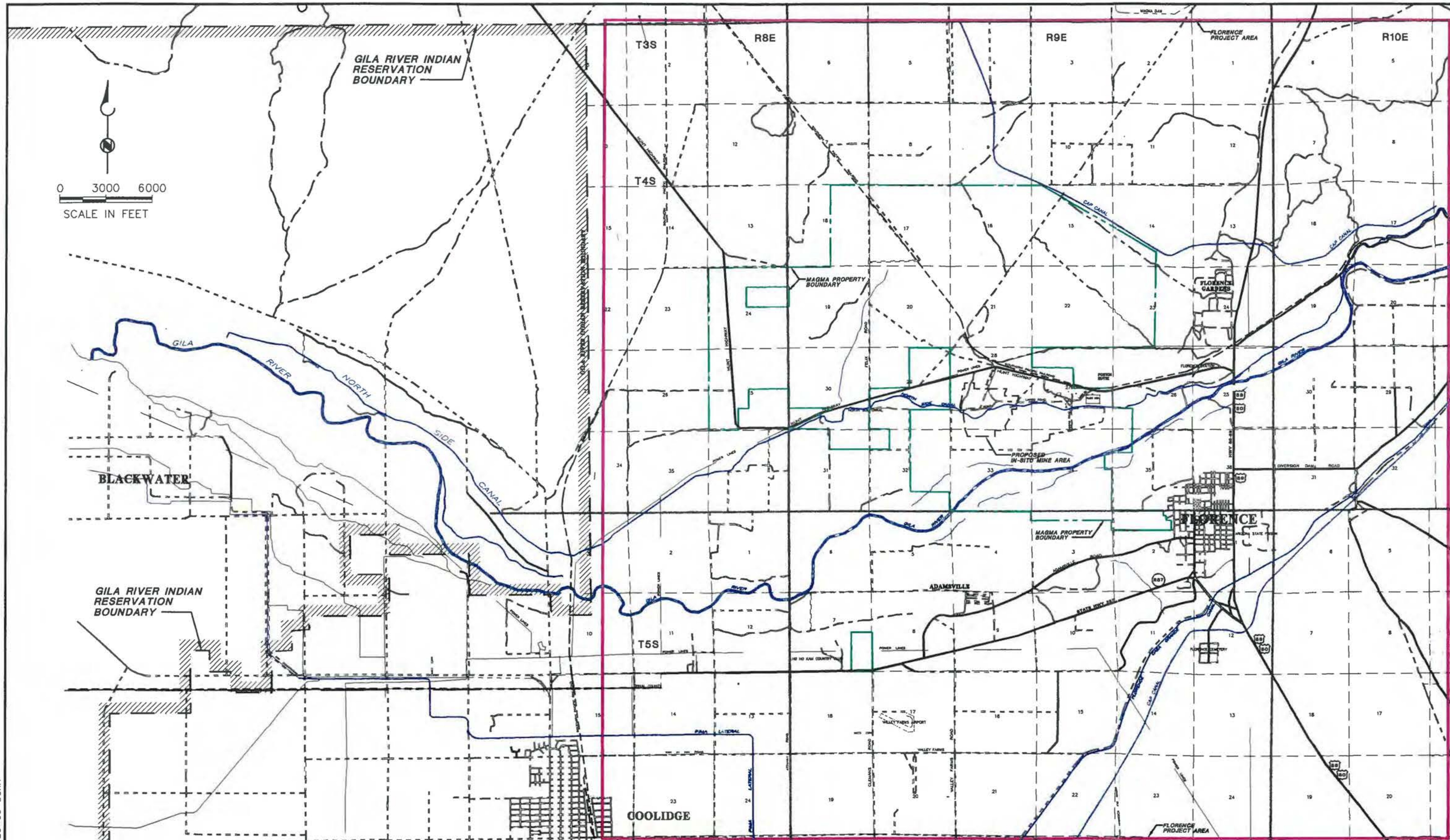
The following are three key maps used in this report to depict the general features of the proposed project area:

- A regional location map showing the geography of central Arizona (Figure 1.1-2[II]).
- A map showing a 100-square mile (approximately 10 miles by 10 miles) Florence Project Area which is coincidental with the groundwater flow and solute transport model domain (Sheet 1.2-1[II]).
- A map showing the proposed in-situ mine area (approximately 1.5 miles by 1 mile) and immediate vicinity (also referred to as the mine property) (Sheet 1.2-2[II]). This sheet also depicts other surface features and the location of borings and wells installed as part of this investigation.

1.3 PROJECT DESCRIPTION

The proposed Magma Florence Project involves the recovery of copper reserves from the oxide portion of a porphyry ore body (Nason and others, 1982). In-situ leaching is the the preferred technology for development, based on investigations conducted by Magma and others, including a pre-feasibility study (Magma, 1994). The in-situ leaching mining method involves the injection of a solution consisting primarily of a weak solution of sulfuric acid and water into the oxide bedrock zone approximately 500 to 1,200 feet below ground surface (bgs). The ensuing copper rich solution is then retrieved, and copper cathode and other copper metal products are produced using solvent extraction and electrowinning (SX/EW) processes. The total projected area of the proposed mining operations, including the in-situ leach production field and surface extraction facilities, is approximately 450 acres, approximately 213 of which are a part of the proposed in-situ leaching area.

An exhaustive description of the proposed in-situ operation is presented in Volumes I and V of this application. The conceptual design and siting of these facilities was fully considered in developing and executing the scope of investigative tasks outlined herein. Each action was critiqued as to its usefulness in evaluating and demonstrating the environmental compatibility of the proposed operation.



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BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

Figure 1.1-1 (II)
LOCATION MAP

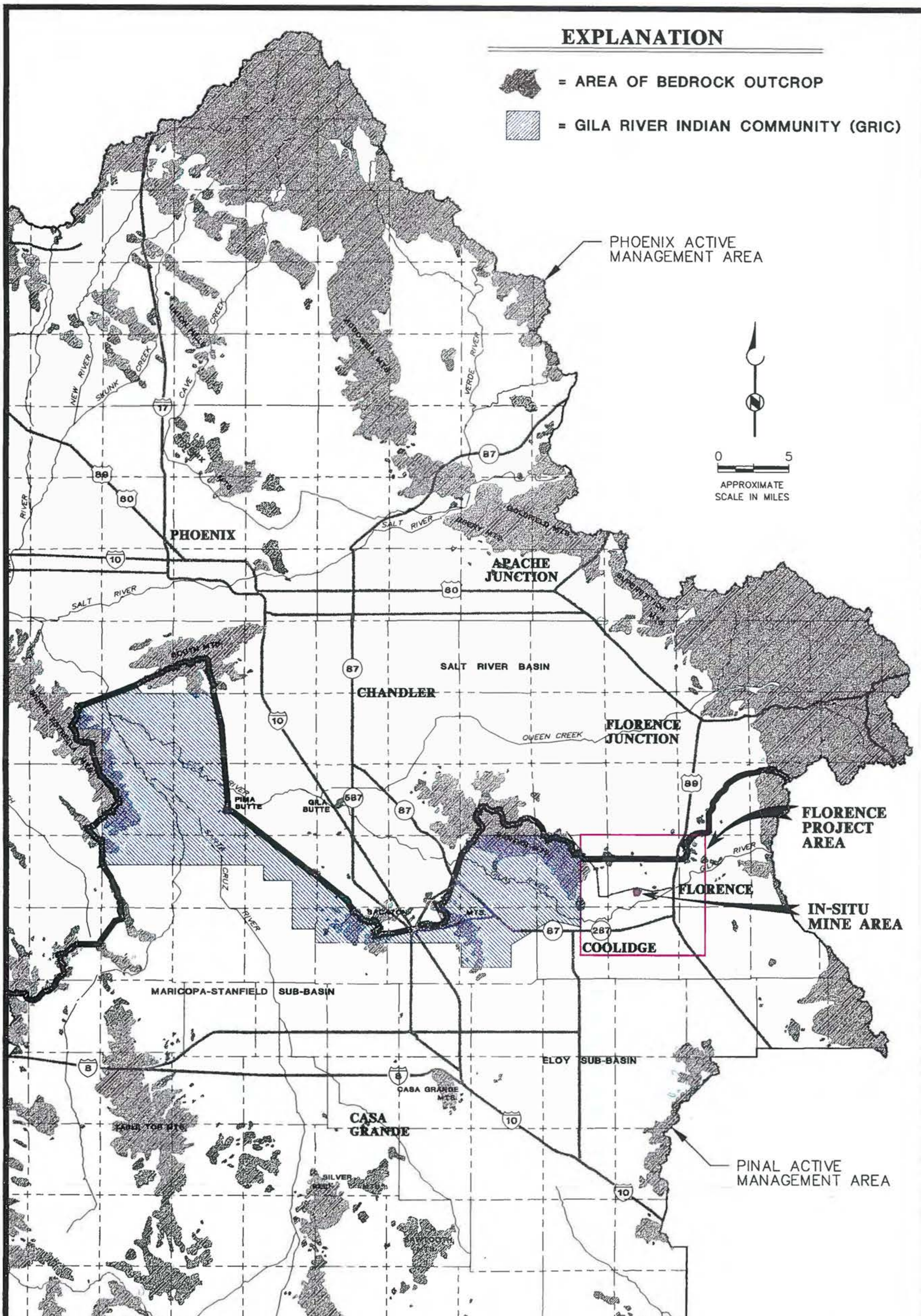

Figure 1.1-2 (II)

CENTRAL ARIZONA LOCATION MAP

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

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SECTION 2.0

METHODS OF INVESTIGATION

The following subsections summarize the investigative methods used to acquire field data, and the compilation, analysis, and interpretation techniques utilized to evaluate that data. The rationale and ultimate selection of appropriate methods of data acquisition and manipulation has been an interactive and flexible process. The expression of this process is a series of work plans, interspersed with agency comments and suggestions. The content of each of the work plans previously submitted to the Arizona Department of Environmental Quality (ADEQ) and the Environmental Protection Agency (EPA) is hereby incorporated into this application by reference. The various work plans, agency comment letters, and responses to those comments are as follows:

- Aquifer Protection Permit (APP) Application Work Plan (Brown and Caldwell [BC], 1995a).
- ADEQ comments on the APP Application Work Plan and other submittals (ADEQ, 1995a).
- Response to ADEQ Work Plan comments (BC, 1995e).
- Groundwater Sampling and Analysis Plan (BC, 1995b).
- Corehole Abandonment Work Plan (BC, 1995c).
- Vadose Zone Sampling and Analysis Plan (BC, 1995d)
- ADEQ comments on various technical submittals (ADEQ, 1995b).
- EPA comments on the Groundwater Sampling and Analysis Plan (USEPA, 1995).
- Response to ADEQ comments on various technical submittals (BC, 1995f).
- Response to EPA comments on the Groundwater Sampling and Analysis Plan (BC, 1995g).

2.1 INVESTIGATION RATIONALE

This subsection presents a detailed discussion of the rationale utilized to design and execute the various components of the process. Details relevant to investigation methods used are presented in Section 2.3.

2.1.1 Vadose Zone Characterization

Characterization of the shallow subsurface beneath the in-situ mine area involved the following investigations:

- A baseline characterization of the unsaturated profile as support to the environmental permit applications for the project. Rationale for this element is included in this section.

- Investigations assessing any existing impacts to soil quality. Rationale for this element is included in Appendix G of this volume of the application.

- Geotechnical investigations to support design of proposed project surface facilities. Rationale for this element is included in Appendix C of Volume V of the application.

The purpose of the baseline vadose zone investigation was to characterize the soils between the land surface and the water table in sufficient detail to establish baseline conditions (geochemistry, attenuation characteristics, physical and lithologic properties). Emphasis was placed on fine-grained deposits in the vadose zone which generally exhibit, to a greater extent, hydraulic conductivity and chemical attenuation properties which are important in retarding pollutant migration. Results of the baseline vadose zone investigation also influenced the selection of control technologies for the surface facilities and the in-situ well field. Vadose investigation borings and wells were located to avoid surface archeological features. The locations of baseline and geotechnical vadose data acquisitions are shown on Figure 2.1-1[II].

The initial element of the baseline vadose zone investigation consisted of advancing 4 borings equally distributed across the proposed in-situ mine area to evaluate general subsurface conditions, including the character and lateral continuity of representative soil types. Where possible, borings were located to coincide with the proposed locations of key surface and well field facility components, including the proposed evaporation pond, the in-situ tank farm, the pipeline channel corridor from the new processing facility to the in-situ tank farm, and the in-situ leaching area.

The initial borings were advanced to a depth of approximately 95 feet (water level data obtained in the area indicates that the minimum depth to water is 100 feet). Subsequent to the evaluation of data obtained from the initial 4 boreholes, additional borings were advanced in areas to further define the lateral and vertical continuity of subsurface materials.

The number and location of field and laboratory hydraulic conductivity tests performed during the baseline vadose investigation were selected based on soil characterization data. Test locations and subsurface intervals were chosen to represent the major soil types, with an emphasis on fine-grained materials. Temporary piezometers (permeameters) constructed with 2-inch diameter polyvinyl chloride (PVC) were installed in 4 borings (see Figure 2.1-1[II]). The piezometers were screened at various depths to conduct field hydraulic conductivity tests. A summary of boring and piezometer information for the baseline vadose zone investigation is presented in Table 2.3-1. Lithologic logs and piezometer construction details are presented in Appendix A.

2.1.2 Groundwater Quality and Water Level Monitoring

The primary objective of the groundwater quality sampling and monitoring program was to obtain hydraulic head distribution and baseline groundwater quality data to support the permitting effort.

This effort was designed to detect both the spatial and temporal variations in head distribution and water quality. The data gathered as part of this investigation were used for the following purposes:

- To provide a basis for simulating and subsequently monitoring the effects of the proposed mine operations on the physical and chemical behavior of the regional and local groundwater systems.

- To identify areas with anomalous conditions, where adjustments to the groundwater monitoring program or facility design would ensure adequate coverage and/or selection of appropriate control technologies.

Water levels were measured using an electric sounder or pressure/transducer with a data logger. Water levels were obtained as part of the well inventory, groundwater sampling, monitor well construction, water level monitoring, and aquifer testing activities. Resulting data were used with existing groundwater level data to construct water level contour maps for the hydrogeologic units of interest. These maps were then used in the interpretation of groundwater conditions and delineation of hydrogeologic units associated with the proposed in-situ mine area. These data were also used for analyses associated with groundwater flow and transport simulations, and for other assessments related to the design of the in-situ leaching operation.

Water level measurements were taken on regional and local scales in order to construct a water elevation contour maps. These maps were then used in developing a regional conceptual groundwater flow model and performing groundwater flow simulations. Approximately 60 wells in a 10-mile by 10-mile Florence Project Area were selected for water level measurement based on accessibility and spatial distribution. Monthly water level measurements obtained from selected wells in the Florence Project Area were combined with measurements from wells and the wells installed by Brown and Caldwell in the 1.5 mile by 1 mile proposed in-situ mine area to assess the impact of groundwater pumping and seasonal fluctuations.

Wells used for water level measurements, in addition to other existing wells, are shown on Sheets 1.2-1[II] and 1.2-2[II], and Figures 2.1-2[II]. Water levels obtained during this investigation are presented in Table B-1 in Appendix B. Existing water level data for the Florence Project Area are presented in Tables B-2 and B-3 in Appendix B.

Groundwater quality sampling and analyses were performed during this investigation to characterize the hydrogeologic regime to the degree necessary to characterize baseline conditions. The following criteria was used to evaluate the locations for groundwater quality sampling:

- To utilize existing wells as much as possible for providing representative single or multiple aquifer groundwater samples. Only wells with known construction details were considered.

- To provide sufficient data to characterize groundwater conditions hydraulically upgradient and downgradient of the proposed in-situ mine area, with more emphasis on the downgradient direction between the mine property and any domestic or municipal groundwater withdrawal areas.

- To provide sufficient data to characterize groundwater conditions spatially across the proposed in-situ mine area.

- To provide sufficient data to characterize groundwater in the 4 identified hydrogeologic units, with emphasis on the oxide bedrock zone and the overlying basin-fill units.

- To avoid surface archeological features.

- To incorporate potential points of compliance (POC) associated with the APP.

- To provide data for both baseline conditions and initial characterization efforts.

Based on the criteria listed above, a groundwater quality sampling program was implemented which included monitor, aquifer test and existing wells. Results of initial sampling efforts during the investigation were used to adjust the program as necessary. Decisions regarding sample locations, sample frequency and the selection of chemical parameters were based on factors which included the following:

- Possibly omitting a sample location during a given sampling event if it was impractical to operate the well.

- Possibly omitting a sampling location if it provided redundant data. Sample locations could also be added to the program if data gaps become apparent.

- Possibly reducing, increasing, or otherwise changing the amount, or kinds of, chemical parameters in the laboratory testing program based on observations of consistently low or high concentrations of indicator constituents, such as sulfate and bicarbonate.

Figure 2.1-3[II] depicts the locations of wells included in the groundwater sampling program based on the criteria presented above. The monitoring program utilizes the groups of wells listed below.

Monitor Wells M-1 through M-18

These wells were installed as part of this investigation in 6 clusters consisting of 2 or 4 wells to provide sampling points in different aquifer components at 1 location. This provides a comparison of chemistry and head distribution at discrete elevations, as well as providing a spatial comparison between clusters. The well clusters were located to provide spatial coverage across the proposed in-situ mine area (in association with existing wells) with emphasis on areas upgradient and downgradient of the mine property.

The 3 well clusters, consisting of 4 wells each, were located sub-parallel to the groundwater gradient across the area (to the north-northwest). These well clusters were installed to monitor local groundwater conditions in 4 hydrogeologic units.

The monitor wells constructed to observe aquifer conditions in the basin-fill deposits were designed to characterize groundwater near the lower basin-fill/oxide bedrock contact and somewhat above this contact. The purpose for monitoring this interval of the hydrogeologic section is to provide baseline information on that segment of the local aquifer most susceptible to an excursion of process solution from the injection-recovery operation within the oxide bedrock. Because the top of the oxide bedrock occurs at variable elevations across the proposed in-situ mine area, the screened intervals of the GU and GL monitor wells do not necessarily correspond to the upper and lower basin-fill depositional units described in Sections 3.0 and 4.0. The GU and GL screened intervals vary in elevation and rock/soil type in different areas across the proposed in-situ mine area.

Aquifer Test Wells

Four aquifer test wells installed as part of the current investigation were included in the groundwater sampling program. Referring to Figure 2.1-3[II], these sampling points consist of the following wells in 2 aquifer test well clusters located in the north (cluster 8) and east (cluster 28) portions of the proposed in-situ mine area:

- P8-GU screened in the upper basin-fill;
- P8.1-O and P28.1-O screened in the oxide bedrock zone; and
- P28-GL screened in the lower basin-fill.

The aquifer test wells are discussed in more detail in Section 2.1.3. All 4 aquifer test wells are scheduled to be sampled on at least two occasions for groundwater characterization purposes.

Existing Wells

Five existing wells shown on Figure 2.1-3[II] were included in the current groundwater sampling program. These wells were selected because their construction was known and their locations contribute to a representative spatial distribution across the proposed in-situ mine area. The sample points consist of the following:

- England No. 3: An irrigation well which is screened in the basin-fill and oxide bedrock aquifer components.

- Magma water supply No. 1: Used for non-potable purposes, screened in the basin-fill and oxide bedrock aquifer components. Samples are retrieved from this source through a water storage tank.

- BIA-10B and WW-3: Irrigation wells which are screened in the basin-fill and oxide bedrock aquifer components.

- BIA-9: An irrigation well which is screened in the basin-fill aquifer component.

All 5 existing wells are scheduled to be sampled on at least two occasions for groundwater characterization purposes.

Well installation activities, laboratory analyses and sampling schedule are discussed in Sections 2.3.2 and 2.3.4, respectively. Both the analytes tested and decisions regarding the sequence of sampling were dictated by the objective of achieving adequate spatial coverage and baseline water quality characterization.

2.1.3 Aquifer Testing

The objectives of the aquifer testing program were as follows:

- To characterize the hydrogeologic properties of the 4 hydrogeologic units identified in the proposed in-situ mine area.

- To evaluate more specifically the hydraulic characteristics in areas where the potential for lateral and vertical movement of mine solutions may exist.

- To provide aquifer parameters for use in groundwater flow simulations and process optimization during in-situ leaching operations.

Factors that influenced the selection of specific aquifer test locations and subsurface test intervals were formulated on the basis of a review of existing hydrogeologic information, and included the following:

- To evaluate areas susceptible to potential excursion, particularly areas hydraulically downgradient from the proposed in-situ mine area at the northern and western edges of the property.

- To evaluate the distribution of hydraulic properties across the proposed in-situ mine area and surrounding areas in the basin-fill deposits, and the oxide and sulfide bedrock zones. Of particular interest is the extent to which the oxide bedrock zone (the zone to be mined using leaching techniques) exhibits isotropic characteristics.

- To evaluate the degree of hydraulic connection existing between the Upper Basin-Fill Unit (UBFU), the Lower Basin-Fill Unit (LBFU), the oxide bedrock zone, and the sulfide bedrock zone.

- To evaluate the influence geologic structures have on the hydrogeologic regime of the area.

A substantial amount of existing subsurface data from exploratory coreholes were used in conjunction with data generated as part of this investigation. These data were used to select aquifer test locations that are representative of various hydrogeologic conditions within the oxide bedrock zone. Fracture intensity data of the oxide and sulfide bedrock zones derived from previous exploration activities was included in this assessment. These data were statistically evaluated as part of this investigation by Applied Research Associates (ARA) of Albuquerque, New Mexico. The results of ARA's analysis is presented in Volume II, Appendix D.

Locations of aquifer tests were selected to represent typical fracture conditions that will to be encountered during mining. Based on ARA's study, aquifer test clusters were located to be representative of a group of mine blocks with similar fracture distribution. Aquifer test clusters were located to complement other test locations, and to provide new information relating to structure and the degree of interconnection between aquifer components. All aquifer test clusters were located to avoid surface archeological features.

During this investigation, a total of 34 wells were installed for aquifer testing. Combined with existing wells in the proposed in-situ mine area, a total of 10 aquifer test clusters were utilized. These wells are depicted on Sheet 1.2-2[II] and Figure 2.1-2[II], along with the existing wells. Aquifer testing was also performed using selected monitor well clusters in and around the proposed in-situ mine area.

In addition to aquifer tests performed using the aquifer test and monitor well clusters, 2 regional aquifer tests were performed using existing irrigation wells WW-3 and BIA-9 (see Figure 2.1-2[II]). These tests were performed using the relatively high discharge of the 2 irrigation wells, with groundwater levels measured at 15 locations surrounding the wells that were pumping. The results of these tests were used to evaluate the more regional effects of aquifer pumping, and to form a basis for removing the effects of the irrigation wells when they operated during other aquifer tests.

2.1.4 Hydraulic Corehole Testing

A hydraulic corehole testing program was conducted to evaluate the characteristics of the oxide bedrock zone to supplement test data obtained from the aquifer testing program. The investigative goals included the following:

- Measure the hydraulic properties of the representative lithologic units in key areas to complement the existing database.

- Estimate the hydraulic fracture gradient values.

- Approximate the hydraulic conductivity values of specific fracture conditions within the oxide bedrock.

Slug tests were performed in selected corehole intervals to estimate hydraulic conductivity prior to performing the fracture gradient tests. The test parameters included injection rates and pressures. Corehole locations were chosen by Magma based on an evaluation of existing subsurface information in areas representative of the lithologic and structural conditions typical of the ore body.

2.2 COLLECTION AND MANAGEMENT OF FIELD DATA

A data management plan was developed specifically for this project to ensure that the extensive amounts of engineering, geological and hydrogeological data acquired were properly verified and stored for future access. This section describes the type and amount of data collected, the initial format of the data, data quality assurance/quality control (QA/QC) protocols, information goals and data storage procedures. Users of the data management plan include Magma, Brown and Caldwell and others involved with the completion of the environmental permit support investigations.

Purposes of the data management plan include: (1) to ensure that the necessary information is collected; (2) to provide a means of communication between individuals involved in the project; (3) to optimize time spent on data management; and (4) to ensure that different types of data can be combined to meet information goals.

As shown on Figure 2.2-1[II], the data management and analysis system consists of a number of components, including statistics, graphical data analysis and data presentation modules. All modules are accessible from a central database (Microsoft ACCESS).

Two types of QA/QC, technical and accuracy, are performed on all data types. Technical QA consists of a review to ensure that data is consistent, both with expectations and with other data. Accuracy QA is a review to ensure that the data are transferred correctly from the raw data format into the data management and analysis system. Generalized procedures for lithologic, water quality, aquifer test, packer test and other data sets include the following elements:

- Manual measurements are obtained, when possible, to verify data collected on data loggers.
- Field data hard copies are generated and reviewed by qualified personnel.
- Field data are compiled, edited and summarized. Hard copies are then signed, dated and stored.
- Electronic copies of the data are used for input into the database system, and subsequently verified.
- Any unusual findings are identified and discussed with the appropriate parties.

Further discussions of QA protocols concerning groundwater quality sampling are presented in Volume III of this application. Further details concerning data management are presented in the project-specific Data Management Plan (BC, 1995h).

2.3 INVESTIGATION DESIGN AND PROCEDURES

This section describes the design of the field investigation, including scope of work, and field and laboratory procedures, where appropriate.

2.3.1 Vadose Zone Characterization

As discussed in Section 2.1.1, the following aspects of the vadose zone in the proposed in-situ mine area were investigated: (1) the general physical and chemical baseline conditions; (2) the geotechnical conditions; and (3) the soil quality. This section addresses the general baseline characterization. Potential soil quality impacts are discussed in Section 4.4.2 and Appendix G of this volume, and the geotechnical results are presented and discussed in Volume V of this application. Geochemical discussions relative to vadose zone baseline conditions are presented in Volume IV of this application.

The vadose zone baseline characterization investigation was conducted in September and October 1995. The vadose zone baseline field work included advancing a total of eight soil borings. Piezometers (permeameters) P1-80, P2-90, P3-60, and P4-40 were installed in 4 of the borings in order to conduct field hydraulic conductivity tests. A summary of vadose characterization boring and piezometer construction details is presented in Table 2.3-1. Locations of vadose zone baseline and geotechnical borings are illustrated on Figure 2.1-1[II]. Vadose characterization boring logs and piezometer construction details are presented in Appendix A.

2.3.1.1 Drilling Methods

Percussion hammer drilling techniques were employed to advance borings for soil sampling and hydraulic conductivity testing. A Becker AP-1000 dual-tube percussion hammer drilling rig was used to advance borings to a maximum depth of 95 feet below ground surface (bgs). Piezometer construction details are presented in Table 2.3-1.

The borings were advanced using 10-inch outside diameter, dual-tube drill pipe driven into the subsurface with a hydraulic hammer. The pipe was marked every foot to measure rate of penetration. The rate of penetration was recorded on the boring log as hammer blows per foot (usually at 1-foot intervals). The boring cuttings were brought to the surface by a pressurized pipe and discharged to a cyclone next to the rig. The cuttings were used to backfill the borehole in cases where a piezometer was not installed. If water was encountered, the hole was backfilled with bentonite grout, followed by a Portland cement cap.

2.3.1.2 Soil Sampling Procedures

Soil samples were collected from the vadose zone borings at depths ranging from ground surface to 95 feet bgs. Soil samples were collected at depths of 2 feet bgs and at 5-foot intervals beginning at 5 feet bgs to the total depth of each soil boring. Four soil borings, B1, B2, B3, and B4 were advanced to a maximum depth of 95 feet bgs. The borings for piezometers P3-60 and P4-40 were not sampled as they were installed approximately 10 feet from B3 and B4, respectively.

Soil Sampling Equipment:

- The soil samples were collected using a California-modified, split-spoon 2.5-inch diameter sampler that was 18 inches in length.

- Sample rings were 2.5 inches in diameter and 6 inches in length, and were constructed of brass.

Soil Sampling Procedures:

- The clean sampler was opened and clean sample collection rings and sand retainer were inserted.
- The sampler was closed and the end cap and drive shoe were hand tightened. No grease was used on the end cap or drive shoe threads.
- The clean, loaded sampler was attached to the downhole 140-pound sample hammer, and lowered into the boring.
- The sampler was driven ahead of the bit into undisturbed soil using a standard 140-pound weight that was allowed to drop 30 inches per blow.
- The number of blows required to drive the sampler 18 inches past the end of the drill bit was recorded on the boring logs.
- The sampler was then retrieved from the borehole, removed from the hammer, and opened.
- Teflon sheets were placed over the 2 exposed ends of the middle sample ring. Plastic endcaps were placed over the Teflon sheets. The sample was labeled, placed in a zip-lock bag and stored in a cooler maintained at approximately 4 degrees Celsius.
- To detect any potential volatile organic presence in the soil samples in the field, a portion of the sample was placed in a zip-lock bag and the bag was sealed. The sample was allowed to be heated by the sun for a few minutes to allow any volatile substances in the soil sample to volatilize. The presence of volatile organics was measured by placing the probe of an Organic Vapor Analyzer (OVA) into the bag. The OVA reading was recorded on the boring log.
- A soil sample was collected from the drive shoe, and described on the lithologic log form using American Society for Testing and Materials (ASTM) Methods D-1452, D-2487, and D-2488.

2.3.1.3 Hydraulic Conductivity Testing

Each of the 4 vadose zone piezometers (permeameters) listed in Table 2.3-1 was constructed using 2 3/8-inch (outside diameter) Schedule 80 PVC pipe, with a 10-foot screened section at the indicated depth interval in each boring. A filter pack consisting of No. 69 Colorado silica sand was installed to a depth of 5 feet above the top of the screen. One 100-pound bag of No. 30 silica sand (approximately 3 feet of annular length) was installed on top of the No. 6 - No. 9 mesh sand. Bentonite grout was installed to within 1 to 2 feet of the surface, followed by a Portland cement cap.

In October 1995, soil hydraulic conductivity tests were conducted in the piezometers (permeometers) installed during this investigation. The field permeability tests were performed in accordance with U.S. Bureau of Reclamation E-18 test methods, (Bureau of Reclamation [BOR], 1974). Hydraulic conductivity values were calculated using Method E-18 (BOR, 1974) and procedures described in Lamb and Whitman (1969). This test method assumes saturated conditions while testing, therefore pre-wetting was performed prior to conducting each of the tests. The tests were performed using constant head conditions.

Each field piezometer installation was pre-soaked for 24 to 48 hours prior to testing by filling the casings with water from a truck-mounted 1,000-gallon water tank. The piezometers were filled by pumping the water with a centrifugal pump until all air inside the casing was expelled and water spilled over the top of the casing. A flow meter pressure gauge and an air escape valve were connected to the top of the field piezometers using a well head attachment. A hose was connected from the attachment to the centrifugal pump and a hose was connected from the pump to the water tank. The water was pumped into the piezometer with the air escape valve opened until all air was expelled from the system. The air escape valve was closed, pressurizing the well. The pump rate was regulated to prevent the pressure from exceeding a static pressure level of 10 pounds per square inch (psi). The amount of water pumped into the well to maintain a static pressure was monitored using the flow meter. This procedure was repeated several times, providing results at several static pressure levels. Results of the soil hydraulic conductivity tests are discussed in Section 4.0. A report summarizing the field hydraulic conductivity vadose zone investigation conducted by AGRA E&E is presented in Appendix F of this volume.

2.3.1.4 Laboratory Analyses

Selected soil samples retrieved during the baseline vadose zone investigation were chemically and physically tested to measure background geochemical and attenuation properties, and assist in the description of the various soil types. Laboratory analyses were performed by Core Laboratories in Denver, Colorado on 13 soil samples collected as part of the vadose zone baseline investigation. The samples chosen for analyses were fine-grained soils such as clay, silt, and sandy silts. A summary of the vadose zone laboratory testing program is presented in Table 2.3-2. Soil samples selected for laboratory analyses included the following:

P1-80: 2 samples from 55 and 80 feet bgs;
P2-90: 2 samples from 45 and 70 feet bgs;
B1: 2 samples from 35 and 90 feet bgs;
B2: 2 samples from 55 and 75 feet bgs;
B3: 3 samples from 10, 45, and 65 feet bgs; and
B4: 2 samples from 55 and 80 feet bgs.

Each sample submitted was analyzed for each of the chemical constituents or properties listed on Table 2.3-2, except for triaxial permeability. One sample from each boring was analyzed for triaxial permeability. Physical laboratory results from Core Laboratories are presented in Appendix F and are discussed in Section 4.0. Chemical laboratory results associated with the vadose zone investigation are presented and discussed in Volume IV of the application.

2.3.2 Monitor and Aquifer Test Well Installations

As a supplement to the existing geologic database for the proposed in-situ mine area, a drilling and well installation program was conducted to further assess the geologic and hydrogeologic conditions throughout the in-situ mine area. Monitor and aquifer test wells were installed to: (1) obtain groundwater samples for laboratory analyses; (2) acquire groundwater level measurements; and (3) determine the hydrogeologic properties of the oxide zone and overlying basin-fill units. For each borehole, a lithologic log of the drill cuttings was prepared for the purpose of identifying each geologic unit and its physical characteristics. Geophysical logs were obtained by Welenco of Chandler, Arizona in selected boreholes.

A total of 18 monitor wells were installed at the proposed in-situ mine area, in three 4-well clusters and three 2-well clusters as shown on Sheet 1.2-2[II] and Figure 2.1-2[II]. The monitor wells ranged in depth from approximately 270 to 1,580 feet bgs. The monitor well clusters include 12 wells completed in the basin-fill and 6 wells completed in the oxide and sulfide zones of the bedrock complex. Monitor wells completed in the UBFU are constructed with a 60-foot screened interval with 3 exceptions. These exceptions are completed in regions of higher conductivity, and are constructed with a 40-foot screened interval. Wells completed in the LBFU are constructed with a 60-foot screened interval with the bottom of the screen located approximately 50 feet above the basin-fill/oxide bedrock contact. The depth of these screened intervals vary due to the basin-fill/oxide bedrock contact occurring at differing elevations across the proposed in-situ mine area. The oxide and sulfide zones are intercepted by wells in the upgradient, middle, and downgradient well clusters. These wells are constructed with a 60-foot screened interval at varying depths in response to the variable elevation of lithologic contacts.

Each of the 4-well monitor clusters contain wells completed within the UBFU, the LBFU, the oxide bedrock zone, and the sulfide bedrock zone. The arrangement consists of three 4-well clusters located across the proposed in-situ mine area aligned in a southeast-northwest direction sub-parallel to the groundwater flow direction. The southeast cluster (wells M2 through M5) monitors groundwater conditions upgradient of the proposed in-situ mine area and all associated facilities. The middle cluster (wells M10 through M13) monitors aquifer conditions within the in-situ leaching area. The northwest cluster (wells M6 through M9) monitors aquifer conditions downgradient of proposed mine facilities.

The 2-well clusters are comprised of wells completed only in the UBFU and LBFU in proximity to the western boundary of the proposed in-situ mine area. The west (wells M14 and M15) and southwest (Wells M16 and M17) clusters were located to monitor groundwater conditions within the basin-fill deposits at the western edge of the property, where the top of crystalline bedrock plunges dramatically to the west. The south (wells M1 and M18) cluster monitors groundwater conditions in the basin-fill deposits, and is located to characterize groundwater conditions along the southern perimeter of the proposed in-situ mine area.

A total of 34 aquifer test well (designated as pumping or observation wells) installations were completed in 10 separate clusters. Depths of the aquifer test wells range from approximately 270 to 1,470 feet bgs. These well clusters were used to: (1) supplement existing information; (2) determine lateral hydraulic characteristics; and (3) determine vertical hydraulic characteristics in unique structural settings. Aquifer test wells are completed in the UBFU and LBFU, and in the oxide bedrock zone.

A summary of monitor and aquifer test well construction details is presented in Table 2.3-3. Boring logs, well completion diagrams and geophysical logs are presented in Appendix A. Well locations are shown on Sheet 1.2-2[II] and Figures 2.1-2[II] and 2.1-3[II].

2.3.2.1 Drilling and Well Installations

Monitor wells were completed in 9 7/8-inch, 9 5/8-inch and 8 3/4-inch diameter boreholes drilled by conventional mud rotary methods with bentonite-based drilling fluid. Aquifer test wells were advanced by conventional mud rotary or reverse circulation drilling techniques and were completed in boreholes ranging in diameter from 8 3/4 to 12 1/4 inches. Typically, the smaller diameter observation wells (see Table 2.3-3) were associated with smaller diameter borings. Conventional mud rotary methods were used exclusively for monitor well drilling to minimize drilling fluid loss to the surrounding formation. Drilling contractors retained for well construction included Stewart Brothers Drilling Company, Inc., Grants, New Mexico and Arizona Beeman Drilling, Apache Junction, Arizona. Drilling rigs consisted of a Failing CF 2500 (Stewart Brothers), a Gardner-Denver 15-W (Beeman), and a Gardner-Denver 2000 (Beeman).

During the drilling of each well, the drilling contractor was required to maintain a daily driller's report, penetration rate log, driller's log, and a drilling fluid record. These reports included notation on the formations encountered, the number of feet drilled, actual time required to drill each foot of borehole, length of casing set, annular materials installed, and other such pertinent data. The driller's log was prepared in compliance with the requirements of the Arizona Department of Water Resources (ADWR). The drilling fluid program was monitored by a drilling fluid engineer from Desert Drilling Fluids of Phoenix, Arizona utilized throughout the drilling program. All borehole and well depth measurements were referenced from ground level. Duplicate samples of the drill cuttings were collected at 10-foot intervals during the drilling of each well. The samples were described during or shortly after collection according to methods described in ASTM Methods D-1452, D-2487, and D-2488.

The surface (conductor) casing borehole for each well was a minimum 14 1/2-inch diameter to a minimum depth of 20 feet. The surface casing consisted of 10 3/4-inch or 12 1/4-inch diameter low-carbon steel (LCS) pipe, and was cemented throughout the well annulus to the ground surface. A period of 6 to 8 hours was allowed for the cement grout to set before drilling below the surface casing commenced.

All borings were advanced using fluids capable of stabilizing the borehole wall and providing representative drill cuttings of the formations. Conventional mud rotary drilling utilized a drilling mud with a Marsh funnel viscosity of approximately 40 to 50 cubic centimeters per second (cm^3/sec). During reverse circulation drilling, the Marsh funnel viscosity of the drilling fluid ranged from about 28 to 30 cm^3/sec. On occasion, an inorganic polymer, lost circulation material (LCM), or a high viscosity mud was utilized in the drilling fluid system to address specific drilling conditions such as loss of drill fluid circulation or borehole destabilization.

The monitor and aquifer test wells were designed specific to their location in and around the proposed in-situ mine area. The well depths and screened intervals listed in Table 2.3-3 for each hydrogeologic unit varied significantly because of subsurface structure.

Monitor wells were designed relative to anticipated yields, well development methods applied, and groundwater sampling requirements. The monitor wells were completed with 5-inch nominal diameter casing and screen to facilitate well development and installation of a submersible pump. Monitor wells M-2, M-10, and M-18 are installed in the UBFU and are constructed with approximately 40 feet of screen. The remaining monitor wells are constructed with approximately 60 feet of screen. These screen lengths are directly related to the ability of the specific hydrogeologic units to yield groundwater to the completed well. With the exception of well M-9, the screened interval consisted of Schedule 80 PVC slotted casing with 0.080-inch slots. Stainless steel (SS), wire-wrap screen was utilized for well M-9 because of its depth. Blank casing for the monitor wells consisted of PVC and/or LCS.

Aquifer test wells were designed to evaluate the hydraulic characteristics of the oxide zone and the LBFU in close proximity to the basin-fill/oxide bedrock interface. Pumping wells were typically completed with 6-inch nominal diameter casing. Observation wells were typically completed with 4-inch nominal diameter casing. The screened interval for each type of well consisted of slotted PVC or LCS (see Table 2.3-3) casing with 0.080-inch or 0.020-inch slots.

Monitor and aquifer test wells were installed by the drilling contractor under the direction of Brown and Caldwell. Subsequent to the completion of borehole drilling and geophysical surveys, the well casing and screen were installed to the appropriate depth. The casing string was centered in the borehole with casing centralizers placed at 80- to 100-foot intervals. Centralizers were placed at each joint of slotted casing in wells with shorter screen intervals. Casing centralizers resulted in a uniform alignment of the casing string within the borehole to permit proper installation of filter pack and grout materials.

A 10- or 20-foot section of blank PVC casing with a threaded end cap was placed at the bottom of the casing string of each well to act as a sediment trap. The casing string was generally installed to a depth of approximately 10 feet above the total depth of the borehole.

Filter pack, consisting of No. 6 to No. 9 mesh silica sand, was placed by the tremie pipe method to completely fill the annulus surrounding the screened interval. The wellbore was full of drilling fluid and the casing string was held in tension during filter pack installation. The level of the filter pack was measured periodically during installation. A log of the volume of filter pack installed, and the depth interval it covered was maintained by the drilling contractor.

Following filter pack installation, an intermediate seal consisting of No. 30 mesh silica sand was installed in the well annulus through the tremie pipe. This intermediate seal was installed as a barrier to preclude the infiltration of grouting material into the coarser-grained filter pack. The annulus above the intermediate seal was grouted by the tremie pipe method with a low permeability, bentonite-based grout slurry, or with Type V neat cement. As grouting operations proceeded, the bottom of the tremie pipe was maintained at a level below the top of the grout slurry placed in the annulus. The bentonite slurry contained approximately 30-percent solids by weight. The Type V neat cement slurry was blended at a ratio of 6 gallons of water per 94-

pound sack of cement. The grout slurries were mixed on site by the drilling contractor utilizing jet-hopper mixers or recirculating mud pumps.

Bentonite grout was installed in most of the wells and was circulated to the ground surface. The string of tremie pipe was then pulled to a depth of no less than 20 feet below ground level. This 20-foot interval was sealed with a cement grout slurry.

2.3.2.2 Geophysical Logging

Geophysical logs were obtained by Welenco of Chandler, Arizona in selected wells drilled within the proposed in-situ mine area. The geophysical logging suite included caliper, electric (resistivity and spontaneous potential), gamma ray-neutron, and sonic logs. Gamma-gamma (density), and temperature logs were obtained in selected wells for additional background information. A total of approximately 6,340 linear feet of geophysical logging was performed in 18 wells. Geophysical logs are included with this volume of the application in Appendix A.

The geophysical surveys were conducted in the deepest well at each monitor and aquifer test well cluster. In addition, geophysical logs were obtained in offset pumping or observation wells at selected aquifer test clusters to assist in delineating subsurface structure and aquifer properties. The geophysical logs and lithologic logs were used to design each well at a specific cluster. Geophysical logs were also used to provide information relevant to subsurface structure, fracturing, permeability, alteration, and porosity.

The caliper log provided a measurement of the average borehole diameter. It was used to determine if other geophysical log responses may be influenced by variable borehole diameter. The caliper log was also used to estimate annular volumes used during well completion operations.

The electric log consisted of a spontaneous potential (SP) measurement, along with 2 or more resistivity readings at varying depths of lateral penetration into the formation. The electric log was utilized as a correlation tool to approximate lithologic boundaries. The electric log was also useful as an indication of relative porosity of the formations and the grain-size distribution of the alluvial sequence.

Gamma ray and neutron logs were recorded simultaneously with a single combination tool. Gamma ray soundings measured naturally occurring gamma emissions from the decay of unstable elements in the boreholes. The most significant of these elements are potassium 40, uranium 238 and 235, and thorium 232. This logging technique was generally used to differentiate rock types. The neutron probe also measured radioactive properties by bombarding the formation with neutrons from a radioactive source and measuring secondary effects. Because the response of the neutron curve can generally be related to hydrogen content, it was used as an indicator of the relative porosity of the formations.

A sonic log was used to measure the time it takes for a compressional soundwave to travel through the various geologic mediums. This time was then related to the lithology and porosity of a particular formation. Generally, sound waves travel faster through denser formations; therefore, an increase in travel time for a given lithology indicates an increase in porosity.

2.3.2.3 Deviation Surveys

Deviation surveys were conducted by the drilling contractor at intervals of 100 to 200 feet in each borehole. The surveys were performed using Totco™ Sureshot Model hole deviation survey equipment. By using proper drilling techniques (e.g., stabilizers and properly sized drill collars) a relatively vertical hole was advanced without difficulty. The surveys generally indicated a vertical inclination from the borehole collar of 1/4 to 3/4 of a degree which is acceptable for the intended use of the boreholes. Deviation survey data compiled during this investigation are on file at the Florence Project field office at the site.

2.3.2.4 Well Development

Well development operations were conducted at each well after the grout slurry had cured for no less than 72 hours. The wells were developed using bailing, air-lifting, and pumping techniques. Compressed air used for these operations was treated by routing the flow through a high-volume coalescing filter to remove potential organic contaminants. Well development was continued at each well until the discharged water was as free of sediment as possible. During well development, periodic measurements of parameters (pH, temperature, and specific electrical conductance [EC]) were obtained. Well development data compiled during this investigation are on file at the Florence Project field office.

2.3.2.5 Dedicated Groundwater Sampling Pumps

Dedicated pumps were installed in monitor wells 1 through 18 for the purpose of collecting water quality samples. Table 2.3-4 presents details of dedicated pump installations. All pumps installed are submersible Grundfos™, stainless steel (SS), 460 volt, 3-phase, 4-inch diameter units. The pump motors range in size from 1.5 to 5 horsepower (Hp) with the majority being 1.5 Hp. The pumps are generally designed to produce 10 gallons per minute (gpm) with a maximum performance range between 5 and 14 gpm. Installation depths range from 170 feet to 580 feet bgs and are based on pumping drawdown and specific capacity of the well.

Selected wells with low yields (M5-S, M9-S, and M13-S) necessitated installation of pumps near the top of the well screen. All other pumps were installed sufficiently below the pumping water level to permit continuous operation during groundwater sampling.

Each well was equipped with a dedicated well head assembly composed of PVC and SS. The well head assembly included a ball valve, sampling port and flowmeter. Electric control boxes for every pump were installed at ground surface.

2.3.3 Water Level Measurements and Well Inventory

As part of this investigation, a well inventory was performed in which all wells within a radius of approximately 1/2 mile of the proposed in-situ mine area were evaluated. Wells located within a 1/2-mile radius of the property were inventoried to verify well specifications, use, location, and condition. Sources of existing well information included ADWR (1995), Magma (1995), and E.L. Montgomery and Associates (Montgomery, 1994). Selected wells outside of the 1/2-mile radius program were also included in the inventory. Following a compilation of existing well data from various sources, the water level measurement program was initiated.

This section describes the methods used to acquire water level data. Locations of the wells described herein are shown on Sheets 1.2-1[II] and 1.2-2[II], and Figure 2.1-3[II]. Water level measurements are presented in Appendix B.

2.3.3.1 Field Procedures

Water levels were measured with a calibrated electric water level sounder. The water level sounder was equipped with standard 2-lead cable and marked in 1/100-foot increments. A standard weighted electrode was attached to the end of the sounder cable. The water level sounder was calibrated periodically by checking the distances between the sounder markings with a steel tape. In preparation for measuring water levels, the procedures listed below were followed:

- Identification of the established measuring point for each well. The same measuring point was used for all measurements taken at a particular well.

- Review of previous water level measurement for each well in order to detect anomalous measurements.

During the measurement of water levels, the procedures listed below were followed:

- Each well was sounded for depth to water until a difference of less that 0.02 feet between consecutive measurements was obtained.

- The depth to water and the date of measurement were recorded (refer to Volume III of this application). The previously measured water levels for the well were reviewed. If the difference between the current water level measurement and the previous measurement was greater than 1 foot, the current measurement was rechecked. Water level field measurement forms generated during this investigation are on file at the Florence Project field office at the site.

- A description of the measuring point at the wellhead was recorded. The same measuring point was used for subsequent measurements (measuring point elevations were surveyed following construction of new wells).

2.3.3.2 Spatial and Temporal Distribution of Measurements

Approximately 60 wells evenly distributed and representative of the Florence Project Area were previously measured annually in the spring of 1993 and 1994 by Montgomery (Montgomery 1994) (see Table B-2 in Appendix B). The locations of these wells used in the water level measurement program are shown on Sheet 1.2-1[II]. Monthly water level measurements from existing Conoco and Magma wells at various locations around the proposed in-situ mine area were also obtained by Montgomery (1994) from February through June of 1994. Brown and Caldwell obtained water level measurements at the 60 Florence Project Area locations in

November and December (see Table B-2 Appendix B). Fifty-two wells installed by Brown and Caldwell in and around the proposed in-situ mine area during this investigation, along with selected coreholes and existing wells, have also been monitored monthly by Brown and Caldwell beginning in April, 1995 (see Table B-1).

2.3.4 Groundwater Quality Monitoring

In order to achieve a more complete understanding of the geochemical system and background water quality in the Magma Florence Project Area, groundwater quality data were collected from monitor wells specifically designed to characterize the Upper and Lower Basin-fill Units, the oxide bedrock zone, and the sulfide bedrock zone. The groundwater sampling program described herein also incorporated existing locations in and around the proposed in-situ mine area to provide adequate spatial distribution of the characterization data.

The primary purpose for implementing this groundwater monitoring program was to evaluate the background water quality at the proposed in-situ mine area prior to the initiation of any activities that could alter groundwater composition. Background data acquired during this investigation will be used in the future to monitor potential groundwater quality changes during mine operation.

Groundwater sample locations used during this investigation are shown on Figure 2.3-3[II]. Results of the groundwater sampling program are discussed in Section 4.5. Sampling and analysis protocols are summarized in this section, with detailed procedures and laboratory reports included in Volume III. The groundwater quality information goals are presented in Section 2.1 of Volume III.

2.3.4.1 Field Procedures

All groundwater samples collected during the June, July, August, and September of 1995 sampling events were collected following the guidelines established in the project-specific Groundwater Sampling and Analysis Plan (SAP) (BC, 1995b). A revised SAP is included in Volume III of this application, with ADEQ and EPA comments, QA/QC information, and laboratory reports. Future sampling activities will follow the guidelines of the revised SAP in Volume III. This section presents an overview of the sampling protocols followed during this investigation.

Groundwater samples were collected from 18 monitor wells to evaluate water quality in the basin-fill units, the oxide bedrock zone, and the sulfide bedrock zone (see Figure 2.1-3[II]). These monitor well locations were systematically located after a geologic and hydrologic review of the in-situ mine area was completed, as described in the APP Application Work Plan (BC, 1995a). Twelve of these wells were installed in three 4-well clusters located at the southeast corner (upgradient), northwest corner (downgradient), and center of the in-situ mine area. These clustered wells are screened in discrete alluvial and bedrock intervals, specifically in the UBFU, the LBFU near its contact with the oxide crystalline bedrock, the oxide bedrock zone, and the sulfide bedrock zone (see Table 2.3-3[II]).

In addition, three 2-well clusters were installed in the basin-fill units; 2 are located to the west and 1 is located to the south of the proposed in-situ mine area (Figure 2.1-3[II]). Four aquifer test wells were added to this monitoring program in response to ADEQ comments concerning the need for additional coverage on the eastern portion of the in-situ mine area. The additional groundwater monitoring locations included: 4 agricultural wells (England No. 3, WW-3, BIA-9, and BIA-10B); the water tank that supplies the current Magma Florence Project facility make-up water to all drilling activities (Magma Water Supply Well No. 1); the San Carlos Irrigation and Drainage District (SCIDD) irrigation canal; and the abandoned air shaft that is connected to the underground mine workings.

The 18 monitoring wells were sampled using dedicated, submersible, SS pumps as described in Section 2.3.2. Sampling tubing and well head assemblies were dedicated to each well. The well head assemblies were sealed after use by closing all valves and by placing fitted plugs over any other opening so that each assembly was kept free of outside contamination. All materials used for collection of water samples were decontaminated prior to use by thorough washing with a phosphate-free detergent (Liquinox) solution and rinsing with deionized, distilled water. All samples were collected using disposable nitrile gloves. Filtered samples for dissolved metals were obtained using a disposable 0.45-micrometer in-line filter.

The water level within each well was recorded upon arrival at a particular cluster. The minimum purge volume for each well was equal to 3 times the borehole volumes, unless the well was low yield. The maximum purge volume was equal to 10 times the borehole volume plus 10 times the casing volume.

After purging began, field water quality parameters of the well discharge were monitored. These field parameters included pH, EC, oxidation-reduction potential (ORP), and temperature using a calibrated YSI Model 3500 water quality meter. The water quality field parameters were measured as follows: (1) a transfer container was rinsed 3 times with sample water prior to filling; (2) the temperature was measured and the manual temperature compensation was adjusted to reflect the observed temperature; (3) pH, ORP, and EC were recorded after stabilization of the values.

Field water quality parameters were monitored every 10 minutes for wells with purge times of 2 hours or less. The monitoring frequency was increased to every 5 minutes as the minimum purge volume was approached. For wells with purge times greater than 2 hours, the parameters were monitored every 30 minutes until 2 hours remained, then monitored every 10 minutes as above. Field water quality measuring devices were calibrated according to the manufacturer's recommendations. Following evacuation of the minimum purge volume, sampling proceeded only after the water quality field parameters stabilized to within $\pm$10 percent. Samples were then collected into appropriate bottles, which were provided by the selected laboratory. After sample collection, field water quality parameters were measured again and recorded to ensure consistency.

For wells completed in low-permeability (low yield) zones, purging caused drawdown to a point where the pump shut off due to lack of water, typically within 40 feet of the top of the screen. When this occurred, pumping ceased, and the well was sampled 24 hours after purging. In circumstances where field conditions prohibited the placement of a pump to within 40 feet from the top of the screen, the well was purged to the pump intake depth twice on consecutive days and sampled 24 hours following the second purge.

After sampling at a specific well was completed, the samples were placed in an ice chest or refrigerator and maintained at 4 degrees C. At the time of shipment, the samples were packed into ice chests with non-toxic Blue-Ice in double plastic bags and delivered to Federal Express for overnight shipment to the laboratory (BCA).

Table 2.3-5 presents the 1995 sampling schedule for baseline characterization efforts. Table 2.3-5 includes specific wells sampled, and analytical parameter suites analyzed (see Section 2.3.4.2) for each sampling effort. Sampling rounds listed for June through September, 1995 have been completed. Groundwater sampling efforts are planned to continue on a monthly basis at least through July, 1996. The groundwater sampling program schedule included sampling the 18 monitor wells on a monthly basis, and other selected wells or locations as discussed below.

Aquifer test wells that were included in this groundwater sampling and analysis program in response to ADEQ comments were P28.1-O, P28-GL, P8.1-O, and P8-GU. The wells were sampled using SS submersible pumps, galvanized steel tubing, and PVC well head assemblies identical to those used for the monitoring wells. All materials that were inserted into the well (including well head assemblies) were thoroughly steam cleaned prior to insertion. The pumps were installed by qualified personnel at least 1 day prior to the scheduled sampling. During the August groundwater sampling event, the aquifer test wells were operating and were sampled following the guidelines discussed herein.

Selected aquifer test wells were sampled. Some of this sampling occurred during aquifer testing. For each sampling effort, all temporary equipment, including pumps, tubing, and well heads were thoroughly decontaminated by steam cleaning. The sampling equipment was installed in the specified well(s) no less than 1 day prior to the scheduled sampling. Sampling then proceeded as described above.

The 4 irrigation wells that were included in this sampling and analysis program were England No. 3, Water Well 3 (WW3), BIA-9, and BIA-10B (see Figure 2.1-3[II]). Additional sampling equipment was not needed because the irrigation wells were commonly operating upon arrival and the existing equipment was sufficient for sample collection.

The water tank was sampled from a connecting hose that was used to supply water trucks with make-up water for drilling fluids. This location was included because all drilling operations for the investigation utilized this water. No additional equipment was needed at this location because the existing equipment was sufficient for sample collection.

The SCIDD north side irrigation canal samples were obtained by immersing the sample bottles into the flowing canal until full. Measurements required to estimate canal flow at the time of sampling were also acquired. Care was taken to minimize the overfilling of sample bottles. The air shaft was sampled by using new, disposable bailer(s). Sampling equipment was decontaminated using a solution containing Liquinox, as necessary (see Volume III].

For locations at which it was not possible to obtain purge measurements, such as operating irrigation wells, the north side SCIDD irrigation canal, the air shaft, and the water tank, the sampling procedure was as follows: (1) the depth to water was measured (conditions permitting) or the time the well had been running was estimated; (2) water quality field parameters were measured as described above prior to sampling; (3) samples were retrieved as described above; and (4) water quality field parameters were measured after the samples had been collected.

2.3.4.2 Methods of Analysis

Table 2.3-6 presents a list of chemical constituents to be laboratory tested as part of the baseline characterization. The following chemical parameter suites are included in Table 2.3-6:

- Suite A: Common Ions and Miscellaneous Analytes
- Suite B: Organics
- Suite C: Radiochemicals and Isotopes
- Suite I: Indicator Parameters

Parameter suites used during various sampling efforts as part of this investigation are presented with the Schedule Summary in Table 2.3-5. Brown and Caldwell Analytical Laboratory (BCA), in Glendale, California, conducted the analyses, with the exception of selected radiochemical constituents, which were tested by Controls for Environmental Pollution (CEP) of Albuquerque, New Mexico, or Lockheed Environmental Laboratories of Las Vegas, Nevada under BCA's supervision. Tritium and sulfur isotope testing was performed by the University of Arizona.

Additional information concerning laboratory chemical analyses are presented in Volume III of this application. Volume III also contains laboratory reports for the June through September 1995 sampling efforts.

2.3.4.3 Quality Assurance/Quality Control

The objective of the QA/QC program was designed to ensure that consistent high quality data are generated during water quality sampling and analysis program. QA/QC protocols have been established to meet the required level of assurance in data collection and analyses.

The field water quality parameters consisting of EC, pH, ORP, and temperature were measured at each sampling location to indicate the general water chemistry. The probes on the conductivity, pH, ORP, and temperature meter were thoroughly rinsed with deionized water prior to each use. The pH meter was calibrated using pH 4.00, pH 7.00, and pH 10.00 buffer solutions at the beginning and end of each sampling day. The temperature and conductivity meters were calibrated at the start of the sampling round and after the sampling was completed using an National Institute of Science and Technology (NIST) thermometer and standard conductivity solutions, respectively.

Duplicate samples are identical to the original sample. Duplicates were taken for every 10 of the samples collected, or once per day, whichever was greater. The identity of the duplicate samples was not made known to the laboratory until after the analytical results were received. Duplicate samples were analyzed for the same constituents as the original samples. The locations of duplicate samples were selected so as to minimize redundancy between sampling events.

Matrix spike and matrix spike duplicate (MS/MSD) samples were prepared for every 10 of the total samples collected. The locations of MS/MSD samples were selected prior to the sampling round so as to minimize repetition of locations between sampling events.

One set of trip blanks per sampling day was obtained, along with the groundwater samples, to check possible contamination associated with sample transportation. Trip blanks were composed of deionized, distilled or nanopure water and were prepared in the laboratory and delivered with all material from the laboratory. Trip blanks were analyzed for the same constituents as the groundwater samples.

One field blank was prepared for each sampling event by transferring the contents of trip blanks supplied by the laboratory into the corresponding acidified sample bottles in the field. Field blanks were used to identify possible atmospheric contamination.

Data quality objectives have been set with the contracted laboratories to meet acceptable levels of assurance for all analyzed parameters. These contracted laboratories report that the analytical methods and standard operating procedures (SOP) are in accordance with ADEQ guidance documents and EPA recommendations.

Groundwater samples from the Florence in-situ mine area were analyzed according to standard QC procedures. These procedures included: chain-of custody; holding time; method blank; matrix spike/spike duplicate summary; detection limits listed on all reports; ion balances; laboratory control samples/laboratory control sample duplicates; surrogate recoveries for GC volatiles; and GC/MS analysis.

Exceptions to quality control for every sampling event were reported by the contracted laboratory to Brown and Caldwell, as "Case Narratives." Analytical data that exceeded the acceptance limit criteria were flagged with a data qualifier, and an explanation was provided by the laboratory. Additional details concerning QA/QC protocols followed during this investigation are presented in Volume III.

2.3.5 Aquifer Testing

Aquifer tests were conducted as part of this investigation in existing and new wells from May through October, 1995. The aquifer tests were performed in sufficient areas to represent subsurface conditions within the in-situ mine area and to provide hydraulic parameters used in the groundwater flow simulations discussed in Volume IV of this application. The aquifer tests include 3 components: (1) local aquifer cluster tests, (2) regional tests utilizing irrigation wells in the proposed in-situ mine area, and (3) monitor well tests. Data acquired by Magma from previous aquifer testing (Magma, 1995) were also incorporated into the investigation as applicable.

A description of the aquifer tests, field measurements, data management and methods of analysis are presented below. A summary of the aquifer tests conducted during this investigation with associated information goals to date is presented in Table 2.3-7. Aquifer testing information goals consist of 3 primary categories as presented in Table 2.3-7: (1) evaluate, where appropriate, aquifer characteristics, including transmissivity, hydraulic conductivity, storage and leakage factor; (2) evaluate the hydrogeologic characteristics of geologic structures (faults) and oxide fracture intensity classifications; and (3) evaluate the degree of connection between the identified hydrogeologic units.

Locations of pump and observation wells utilized during the aquifer testing program are shown on Sheet 1.2-2[II] and on Figure 2.1-2[II]. Appendix E contains additional information concerning the aquifer testing program, including aquifer and monitor well cluster descriptions, a summary of the field testing program, and an aquifer test analysis summary report prepared by Golder Associates. Aquifer test data compiled during this investigation are on file at the Florence Project field office. A total of 26 aquifer tests were performed as part of this investigation.

2.3.5.1 Field Procedures

The localized tests included the pumping of wells screened in the oxide zone and the Upper and Lower Basin-fill Units using 30- to 90-gpm submersible pumps. The aquifer tests were conducted in a specific well cluster by pumping 1 well and monitoring other wells in the same cluster. Pressure sensitive transducers were used to monitor water levels. The transducers were allowed to stabilize for a minimum of 4 hours before a test was started. In addition, barometric pressure, temperature and conductivity transducers were also used in at least 1 observation well during each test. All transducers were connected to Hermit 1000™ or Hermit 2000™ dataloggers. The tests were conducted in 3 stages: (1) a static water level period; (2) a pumping period; and (3) a recovery period.

The typical duration of an aquifer test was approximately 7 days. During the first test period, static water levels in the selected test wells were monitored. The dataloggers were programmed with a reference water level, and responses in a static condition were measured for not less than 12 hours. The dataloggers were then initialized to record pumping data using the reference level programmed during the static water level period.

During the pumping period, the discharge was closely monitored and maintained at a constant rate. The pumping period continued until an equilibrium in the drawdown had been established as observed on the recorded drawdown data. Before the pump was turned off for the recovery period, the dataloggers were again initialized, using the reference level programmed during the static and pumping periods. The recovery period continued until the water level returned to the initial reference level, or until it was decided that outside influences, such as pumping irrigation wells, were affecting the recovery data.

The regional aquifer tests utilized irrigation wells with turbine-type pumps. These tests were performed using wells WW-3, which is screened both in the basin-fill deposits and the oxide bedrock zone, and BIA-9, which is screened only in the basin-fill deposits. The tests were conducted to assess the hydrogeologic responses to the pumping of high-yield irrigation wells. During the regional tests, monitoring was performed at up to 15 observation wells in 6 different well clusters in the area, (well clusters 28, 15, 19, 12, 7/3, and monitor wells M14 and M15 (see

Figure 2.1-2[II] and Sheet 1.2-2[II]). Well discharge during the test was measured using a velocity meter.

The regional tests using wells WW-3 and BIA-9 each lasted approximately 7 days. No other irrigation wells were operating in the area during the WW-3 test. A flow rate during the test of approximately 2,300 gpm was measured at well WW-3 using a velocity meter. The BIA-9 test was impacted by pumping at well BIA-10B, which was turned on 2 days into the pumping segment of the test, and again before total recovery had been achieved. A flow rate at well BIA-9 of approximately 2,300 gpm was measured. Water levels for both of the regional aquifer tests were recorded with pressure transducers and Hermit™ data loggers. It was not possible to place a transducer in either of the of the irrigation wells during the tests to monitor pumping water levels.

Monitor well tests were performed using the low-volume (5 to 15 gpm) dedicated pump systems. These short-term aquifer tests were performed using the selected 2-well and 4-well clusters (see Sheet 1.2-2[II] and Figure 2.1-2[II]). Each test consisted of operating the pump for approximately 24 hours in 1 well, while recording water level responses in the neighboring cluster wells. The pump in the selected well was then stopped and all wells in the cluster were monitored during the recovery period. The test was then repeated using each of the other wells in the cluster as the pumping well. All water levels were recorded with pressure transducers and Hermit™ data loggers.

Field measurements were performed during all aquifer tests, and included water levels, pumping rate (pH and EC), barometric pressure and field water quality parameters. The field measurements were recorded on aquifer test summary sheets, and in a logbook.

At the conclusion of each aquifer test, the data were downloaded from the data logger to a computer. Each test, including the static water level, pumping and recovery periods, were stored in an on-site computer with copies provided for analysis. Graphs of the data were produced and annotated on-site to assess the quality of the data. Hard copies of the data were prepared and placed into notebooks which were maintained on-site and at Brown and Caldwell's Phoenix, Arizona office. All aquifer test data are on file at the Florence Project field office.

2.3.5.2 Methods of Analysis

Quantitative assessment of aquifer characteristics from the aquifer tests was performed by Golder Associates (Golder) in Tucson, Arizona. The assessment included calculation of hydraulic conductivity, transmissivity, well skin factor, and storativity/specific yield for the aquifer tests performed at the proposed in-situ mine area. The analyses performed was based on standard methods for aquifer analysis developed in the oil and gas industry using proprietary software (FLOWDIM) developed by Golder Associates. The well test analyses methodology consisted of the following primary components.

- Dividing the data set into major components, such as drawdown period and shut-in or recovery period.

- Analyses of the major components separately using separate methods.

- Checking analyses results for the major components with each other for consistency.

Analysis of the drawdown test data was performed using constant discharge techniques if sufficient hydraulic head change was achieved. The analysis used type curves which correspond to a flow model incorporating the following elements:

- Inner boundary condition: wellbore storage and skin.
- Formation homogeneity.
- Outer boundary condition: infinite lateral extent.

The best fit of the data type curves involved finding the optimum set of hydraulic conductivity and wellbore skin analyses. Evaluation of the shut-in period assumed zero discharge following the constant discharge drawdown period.

The appropriate flow model was chosen based on the following elements:

- Inner boundary conditions: wellbore storage and skin effects, and fracture flow effects.

- Formation flow component: homogeneity, dual porosity and composite effects.

- Outer boundary conditions: infinite extent condition, no flow or constant pressure conditions.

Recognition of a suitable model was performed using diagnostic plots. The derivative of the recorded pressure response with respect to time was also plotted and is used as a diagnostic tool which was very sensitive to pressure variations.

Subsequent to variable selection and data analyses, a sensitivity analyses was performed. This exercise served to quantify uncertainty in estimated hydraulic conductivity values obtained during the analyses, based on an evaluation of input parameter range corresponding to a reasonable fit between the model and test data. Parameter estimation was based on regression analyses of the pressure and the pressure derivative curves. Results of the Golder analyses and a complete description of the mathematical rationale for the FLOWDIM model is presented in Appendix E.

A summary of the calculated hydraulic conductivity values is presented in Section 4.3. The aquifer test analyses were complicated due to the transient irrigation well pumping responses that occurred in the region during the time of the aquifer testing. The aquifer test well responses were adjusted to account for the regional effects. Because of unknown distribution of irrigation pumping in separate geologic units, the adjustments were subjective. The irrigation pumping interference increased the potential error in the calculation; however, all hydraulic conductivity calculations were found to be suitable for use in the numerical simulation model.

Due to the rapid drawdown and extremely slow recovery response in sulfide wells M13-S and M5-S, hydraulic conductivity values were calculated using slug-test methods developed for a partially screened well in a unconfined aquifer (Bouwer, 1989). Results of the analyses for wells M5-S and M13-S are presented in Appendix E and summarized in Section 4.3.

In addition to the quantitative assessment, a semi-qualitative evaluation was performed by comparing general hydraulic pressure response. The assessment included data relative to response from hydraulic stresses applied to selected hydrogeologic units and at monitoring points at different distances and directions from a given pumping well. General assessments were made concerning the anisotropic flow and/or influence of geologic structures on hydraulic response.

2.3.6 Hydraulic Corehole Testing

Hydraulic fracturing and slug tests were conducted in selected coreholes at the in-situ mine area to obtain fracture gradient values of the oxide bedrock zone. A summary of the corehole testing program is included in Table 2.3-7. These tests were conducted to establish wellhead injection pressure criteria as a requirement of the Underground Injection Control (UIC) program and for future development of the ore body. The fracture gradient values obtained represent the pressure per foot of depth required to initiate a fracture in the host bedrock. A total of 5 coreholes were tested that were considered representative of the lithologic conditions found throughout the oxide zone. These included a 6-inch diameter corehole (MCC-533), and 4 HX (approximately 3-inch diameter) coreholes (MCC-537, MCC-540, MCC-541, and MCC-544). The location of these coreholes are shown on Sheet 1.2-2[II]. Coreholes in the Florence Project Area are discussed further in Section 4.1.2. Lithologic and geophysical logs compiled for the coreholes during this investigation, as well as analyses results, are on file at the Florence Project field office.

2.3.6.1 Field Procedures

After completion of coring activities, a geophysical logging survey was conducted by Welenco, Inc., Chandler, Arizona. The geophysical logs and the corehole log descriptions were used to select test intervals based on characteristics such as lithology, fracture intensity, rock competency, and hole roughness. Geophysical logs obtained for the coreholes included caliper, electric, gamma ray-neutron, sonic, and borehole televiewer (BHT) logs. The BHT tool is an acoustic scanner. The BHT log displays an oriented, 360-degree acoustic image of the corehole wall as if it were split vertically and laid flat. Features that can be identified include fractures, faults, vugs, and intrusions. Fractures dipping between vertical and horizontal appear as sinusoidal images.

After the geophysical surveys were completed, the drilling fluid remaining in the coreholes was displaced with clean water. A Failing 1500 workover rig was used to install a workstring of 2 7/8-inch diameter steel tubing into the corehole. Water was pumped down the tubing and up the annulus until the drilling fluid was displaced. Circulation was continued after reaching total depth until the returning water at the surface was as free of sediment as possible. Because of unstable hole conditions, coreholes MCC-533, MCC-537, and MCC-541 could not be developed to their total depth.

The test intervals selected for each corehole were isolated using a balanced piston (BP) straddle washtool operated by TAM International, Houston, Texas. The BP straddle washtool consisted of 2 inflatable rubber packers mechanically connected to form a single unit. The packer elements were approximately 2 1/2 feet in length and hydraulically actuated to produce a positive seal on the corehole wall. Perforated tubing was installed between the packers to straddle the selected depth interval and control fluid injection. A pressure transducer, rated to 2,000 psi, was installed to the top of the test interval to record hydraulic pressure and temperature. Two turbine flow meters, with ranges of 3 to 15 gpm and 5 to 50 gpm, were used to measure water injection rates.

2.3.6.2 Methods of Analysis

Fracture gradient values obtained for the oxide bedrock zone were determined from pressure buildup and step-rate injection tests. Prior to conducting either of these tests, slug tests were run on most of the test intervals for background hydraulic conductivity data. The results of all the tests are discussed in Section 4.0.

The pressure build-up test involved the raising of the fluid pressure in the sealed-off interval between the 2 packers by injecting water at a constant rate until the corehole wall rock was fractured. Then, as water continued to be injected into the zone, the pressure stabilized, at which time the fracture continued to be extended. When injection was stopped, the pressure quickly stabilized to the instantaneous shut-in pressure (ISIP); the pressure reached when the induced fracture closes. The fracturing (breakdown) pressure of the formation is represented by the peak of the pressure-time curve. The fracture gradient was determined by the ratio of the breakdown pressure (the applied hydraulic pressure plus the pressure exerted by the water column) and the depth interval given in pounds per square inch per foot (psi/ft). Pressure buildup tests were run on 4 zones in corehole MCC-533 within the quartz monzonite porphyry of the oxide bedrock zone. The fracture gradient values ranged from 0.71 psi/ft to 0.82 psi/ft.

Step-rate injection testing consisted of injecting fluid in an isolated interval between the packers at a series of increasing rates, with each rate lasting approximately the same length of time. The bottom hole injection pressure at the end of each rate versus the injection rate was plotted. The plot consisted of 2 straight-line segments with different slopes, with the point where the 2 lines intersect indicating formation fracture pressure. The fracture gradient was determined by dividing the fracture pressure by the depth. A total of 12 step-rate injection tests were conducted in coreholes MCC-537, MCC-540, MCC-541, and MCC-544. The fracture gradient values for the step-rate injection tests ranged from 0.71 psi/ft. to 1.19 psi/ft.

Slug tests were conducted prior to performance of the fracture gradient tests in the coreholes to establish background hydraulic conductivity values for the oxide bedrock zone. These tests were also used as a guideline in establishing injection rates at the beginning of the fracture tests. The slug test method consisted of quickly adding a known volume of water to the formation, and monitoring the rate of water level decline as indicated by change in hydrostatic head. The tests were analyzed using the Hvorslev method (1951) as presented in Fetter (1994). The slug test results are discussed in Section 4.0.

The Hvorslev method consists of computing the ratio of the water levels during the test and plotting that versus time on semi-logarithmic paper. The time fall-off plot will yield a straight line. Because the length of the test interval was significantly greater than the radius of the corehole (L/R>8), the following formula presented by Hvorslev was applied.

$$K = \frac{r^2 \ln (L/R)}{2LT_0}$$

where:

K = hydraulic conductivity (ft/day);
r = radius of tubing (ft);
R = radius of corehole (ft);
L = length of test interval (ft); and
T_0 = time for the water level to fall 37 percent of the initial value (day).

Table 2.3-1 Summary of Vadose Zone Characterization Borings and Piezometer Construction Details			
Boring Identification	**Drilling Method**	**Total Depth (feet bgs)**	**Piezometer Screen Interval (feet bgs)**
B1	Percussion Hammer	95	NA
B2	Percussion Hammer	80	NA
B3	Percussion Hammer	80	NA
B4	Percussion Hammer	95	NA
P1-80	Percussion Hammer	80	70'to 80'
P2-90	Percussion Hammer	90	80' to 90'
P3-60	Percussion Hammer	60	50' to 60'
P4-40	Percussion Hammer	40	30' to 40'

NA - Not Applicable
Percussion Hammer Drilling Method - AP-1000 Drilling Rig
See Figure 2.1-1[II] for Boring and Piezometer Locations
Lithologic Logs and Piezometer Construction Diagrams are presented in Appendix A [II].
bgs - below ground surface

Table 2.3-2 Summary of Vadose Zone Investigation Laboratory Analysis Program			
Analyses	**Analytical Method**	**Detection Limit**	**Reporting Units**
Geochemical Parameters			
Acid Neutralization Potential (ANP)	EPA 600 3.2.3	0.1	tons $CaCO_3$/Kt
Cation Exchange Capacity (CEC)	SW-846 9081	0.01	meq/100gm
Exchangeable Cations: Sodium	USDA 60 18	0.01	meq/100gm
Total Organic Carbon (TOC)	Agronomy 90-3	0.01	Percent
Total Sulfur as S Total Sulfur	ASTM D4239-85C	0.01 0.3	Percent (Leco Furnace) tons $CaCO_3$/Kt
Total Metals[a]			
Mercury	SW-846 7471	0.02	mg/Kg
Arsenic (As) Beryllium (Be) Cadmium (Cd) Chromium (Cr) Copper (Cu) Lead (Pb) Selenium (Se) Silver (Ag) Zinc (Zn)	SW-846 6010	0.05 0.005 0.005 0.01 0.01 0.05 0.1 0.01 0.01	mg/Kg mg/Kg mg/Kg mg/Kg mg/Kg mg/Kg mg/Kg mg/Kg mg/Kg
Miscellaneous Geochemical Parameters[b]			
Alkalinity	EPA 310.1	5	mg/L $CaCO_3$
Bicarbonate	SM 2320 B	5	mg/L
Chloride	EPA 325.2	0.5	mg/L
Nitrate and Nitrite	EPA 353.2	0.05	mg/L
Sulfate	EPA 375.2	NA	NA
Soluble Metals Analyses Calcium (Ca) Magnesium (Mg) Sodium (Na)	SW-846 6010	 0.1 0.1 1	 mg/L mg/L mg/L

Table 2.3-2 Summary of Vadose Zone Investigation Laboratory Analysis Program			
Analyses	**Analytical Method**	**Detection Limit**	**Reporting Units**
Physical Parameters			
Particle Size Distribution	ASTM D4464	NA	NA
Triaxial Permeability	ASTM 5048	NA	NA
Plasticity Index	ASTM D4318	NA	NA

[a]Performed with Solids Acid Digestion preparation (SW-846-3050)
[b]Performed with Soluble Soil Paste preparation (USDA Method 60 2)
NA - Not Applicable
mg/Kg - milligrams per Kilogram
meq/100gm - milliequivalent per 100 grams
mg/L - milligrams per Liter
Kt - Kiloton
$CaCO_3$ - Calcium Carbonate

Table 2.3-3 Summary of Well Completion Details

Well ID	ADWR Registration Number	Total Depth[a]	Height of Measuring Point[b]	Casing Diameter[c]	Casing Interval[a]	Screen Diameter (o.d.-in)/Type	Screen Interval[a]	Top of Lithologic Unit[a] UBFU	MFGU	LBFU	O	S
M1-GL	55-547617	470	1.30	5 9/16 LCS 5 9/16 PVC	-1.5 to 19 19 to 315	5 9/16 PVC	315 to 355	75	266	294	380	NP
M2-GU	55-547814	270	1.80	5 9/16 LCS 5 9/16 PVC	-1.8 to 18 18 to 198	5 9/16 PVC	198 to 237	70	NP	NP	NP	NP
M3-GL	55-547614	370	1.94	5 9/16 LCS 5 9/16 PVC	-1.9 to 19 19 to 298	5 9/16 PVC	298 to 338	70	248	270	NP	NP
M4-O	55-547615	510	1.70	5 9/16 LCS 5 9/16 PVC	-1.7 to 19 19 to 405	5 9/16 PVC	405 to 464	70	248	270	370	500
M5-S	55-547616	613	1.37	5 9/16 LCS	-1.4 to 516	4 1/2 PVC	516 to 576	70	248	268	370	510
M6-GU	55-547815	590	1.22	5 9/16 PVC	-1.2 to 524	5 9/16 PVC	524 to 563	70	NE	280	NP	NP
M7-GL	55-547611	940	0.95	5 9/16 LCS 4 1/2 LCS	-1.0 to 593 593 to 859	4 1/2 PVC	859 to 918	70	NE	280	NP	NP
M8-O	55-547612	1,115	1.36	5 9/16 LCS 4 1/2 LCS	-1.4 to 591 591 to 1011	4 1/2 PVC	1,011 to 1,070	70	NE	280	940	NP
M9-S	55-547613	1,578	1.68	5 9/16 LCS 4 1/2 LCS	-1.7 to 502 502 to 1510	4 1/2 SS	1,510 to 1,570	70	NE	280	970	1520
M10-GU	55-547816	290	0.47	5 9/16 LCS 5 9/16 PVC	-0.5 to 18 18 to 218	5 9/16 PVC	218 to 258	75	NP	NP	NP	NP
M11-GL	55-547817	370	1.41	5 9/16 LCS 5 9/16 PVC	-1.4 to 14 14 to 290	5 9/16 PVC	290 to 330	75	255	280	350	NP
M12-O	55-547818	510	1.26	5 9/16 LCS 5 9/16 PVC	-1.3 to 14 14 to 420	5 9/16 PVC	420 to 480	75	255	280	350	NP
M13-S	55-547819	943	1.56	5 9/16 LCS 5 9/16 PVC	-1.6 to 832 832 to 852	5 9/16 PVC	852 to 911	75	255	280	360	820
M14-GL	55-549172	950	1.78	5 9/16 LCS	-1.8 to 778	5 9/16 PVC	778 to 838	83	263	284	880	NP
M15-GU	55-547813	630	1.41	5 9/16 LCS 5 9/16 PVC	-1.4 to 19 19 to 554	5 9/16 PVC	554 to 594	83	264	284	NP	NP
M16-GU	55-549159	690	1.75	5 9/16 LCS	-1.8 to 598	5 9/16 PVC	598 to 658	75	272	300	NP	NP
M17-GL	55-549162	1,130	1.76	5 9/16 LCS	-1.8 to 938	5 9/16 PVC	938 to 998	75	272	300	1080	NP
M18-GU	55-547809	240	0.75	5 9/16 LCS 5 9/16 PVC	-0.8 to 19 19 to 178	5 9/16 PVC	178 to 218	75	NP	NP	NP	NP
O3-GL	55-549153	395	1.25	5 9/16 LCS 5 9/16 PVC	-1.3 to 18 18 to 325	5 9/16 PVC	325 to 365	75	265	290	350	NP
P5-O[d]	55-549147	800	1.40	6 5/8 LCS 6 5/8 PVC	-1.4 to 20 20 to 414	6 5/8 PVC	414 to 770	75	257	283	375	NP

Table 2.3-3 Summary of Well Completion Details

Well ID	ADWR Registration Number	Total Depth[a]	Height of Measuring Point[b]	Casing Diameter[c]	Casing Interval[a]	Screen Diameter (o.d.-in)/Type	Screen Interval[a]	Top of Lithologic Unit[a] UBFU	MFGU	LBFU	O	S
O5-1-O	55-549144	880	1.24	5 9/16 LCS 4 1/2 LCS 4 1/2 PVC	-1.5 to 494 494 to 654 654 to 674	4 1/2 PVC	674 to 832	76	257	283	360	NP
O5-2-O	55-549145	880	1.27	4 1/2 LCS 4 1/2 PVC	-1.3 to 19 19 to 712	4 1/2 PVC	712 to 771	76	258	283	380	NP
P8-1-O	55-549166	616	0.85	6 5/8 LCS 6 5/8 PVC	-0.9 to 19 19 to 400	6 5/8 PVC	400 to 580	98	273	298	352	590
P8-2-O	55-549163	610	1.47	6 5/8 LCS 6 5/8 PVC	-1.5 to 19 19 to 396	6 5/8 PVC	396 to 576	98	273	298	375	NP
P8-GU	55-549167	270	2.05	6 5/8 LCS 6 5/8 PVC	-2.1 to 19 19 to 128	6 5/8 PVC	128 to 248	98	NP	NP	NP	NP
O8-GU	55-549165	270	1.79	4 1/2 LCS	-1.5 to 133	4 1/2 PVC	133 to 252	98	NE	NP	NP	NP
O8-O	55-549164	610	1.83	4 1/2 LCS	-1.5 to 402	4 1/2 PVC	402 to 579	98	273	298	355	NP
P12-O	55-549171	999	1.85	6 5/8 PVC	-2 to 440	6 5/8 PVC	440 to 940	82	271	298	380	970
O12-GL	55-549170	395	2.56	5 9/16 LCS 5 9/16 PVC	-1.6 to 18 18 to 325	5 9/16 PVC	325 to 365	82	271	298	380	NP
O12-O	55-549169	970	1.89	4 1/2 LCS 4 1/2 PVC	-1.9 to 18 18 to 434	4 1/2 PVC	434 to 929	82	271	298	380	NP
P13-1-O	55-547808	1,475	1.47	6 5/8 LCS	-1.5 to 772	6 5/8 LCS	772 to 1,449	104	282	300	720	1450
P13-2-O	55-547810	1,400	0.88	6 5/8 LCS	-1.5 to 781	6 5/8 LCS	781 to 1,379	104	282	300	645	1380
P13-GL	55-547811	770	1.89	6 5/8 LCS 6 5/8 PVC	-1.9 to 18 18 to 690	6 5/8 PVC	690 to 750	104	282	300	NP	NP
O13-O	55-547812	1,440	2.08	4 1/2 LCS	-1.5 to 770	4 1/2 PVC	770 to 1,393	104	282	300	650	1435
P15-GL	55-549161	500	0.01	6 5/8 PVC	-1.5 to 421	6 5/8 PVC	421 to 481	75	271	300	NP	NP
P15-O	55-549158	1,380	1.32	6 5/8 PVC	-1.5 to 580	6 5/8 PVC	580 to 1,301	75	271	300	485	1319
O15-O	55-549160	1,330	1.82	4 1/2 PVC	-.5 to 632	4 1/2 PVC	632 to 1,296	75	271	300	555	NP
P19-1-O	55-549151	680	1.72	6 5/8 PVC	-2 to 402	6 5/8 PVC	403 to 601	85	285	304	355	670
P19-2-O	55-549152	630	1.63	6 5/8 PVC	-1.5 to 405	6 5/8 PVC	405 to 602	85	285	304	420	NP
O19-GL	55-549150	460	1.58	5 9/16 LCS 5 9/16 PVC	-1.6 to 19 19 to 375	5 9/16 PVC	375 to 435	85	285	304	NP	NP
O19-O	55-549149	630	0.99	4 1/2 PVC	-3 to 410	4 1/2 PVC	410 to 608	85	285	304	400	600
P28-1-O	55-547802	520	1.58	6 5/8 LCS 6 5/8 PVC	-1.6 to 19 19 to 399	6 5/8 PVC	399 to 499	80	256	275	360	NP
P28-2-O	55-547806	519	1.28	6 5/8 LCS 6 5/8 PVC	-1.3 to 19 19 to 398	6 5/8 PVC	398 to 497	84	256	275	330	NP

Table 2.3-3 Summary of Well Completion Details

Well ID	ADWR Registration Number	Total Depth[a]	Height of Measuring Point[b]	Casing Diameter[c]	Casing Interval[a]	Screen Diameter (o.d.-in)/Type	Screen Interval[a]	Top of Lithologic Unit[a] UBFU	MFGU	LBFU	O	S
P28-GL	55-547807	320	1.48	5 9/16 LCS 5 9/16 PVC	-1.5 to 19 19 to 279	5 9/16 PVC	279 to 309	80	256	275	NP	NP
O28-1-O	55-547803	530	1.16	4 1/2 PVC	-1.2 to 395	4 1/2 PVC	395 to 494	80	253	276	360	NP
O28-2-O	55-547804	510	0.74	4 1/2 PVC	-1.5 to 454	4 1/2 PVC	454 to 494	82	252	275	340	445
O28-GL	55-547805	320	0.86	4 1/2 PVC	-1.1 to 277	4 1/2 PVC	277 to 307	80	252	275	NP	NP
P39-O	55-549176	916	1.15	6 5/8 PVC	-1.2 to 471	6 5/8 PVC	471 to 826	80	265	290	380	NP
O39-O	55-549174	917	1.19	5 9/16 LCS 5 9/16 PVC	-1.2 to 18 18 to 474	5 9/16 PVC	474 to 890	80	265	290	375	903
P49-O	55-549181	1,288	1.32	6 5/8 PVC	-2 to 808	6 5/8 PVC	808 to 1,222	64	270	300	765	NP
O49-GL	55-549180	740	0.88	5 9/16 LCS	-0.9 to 661	5 9/16 PVC	661 to 721	64	270	300	NP	NP
O49-O	55-549179	1,280	0.89	4 1/2 PVC	-1 to 833	4 1/2 PVC	833 to 1,228	64	270	300	810	NP

[a] -- feet below ground surface
Negative value indicates above ground surface material type:
[b] -- feet above ground surface
[c] -- Outside diameter (inches)
[d] -- Screen section for P5-O is composed of eleven 20-foot screen intervals separated by seven 20- foot blank intervals in the interval listed.

UBFU -- Upper Basin-Fill Deposit Unit
MFGU -- Middle Fine-Grained Unit
LBFU -- Lower Basin-Fill Unit
O -- Oxide Bedrock Zone
S -- Sulfide Bedrock Zone

PVC -- Polyvinylchloride
LCS -- Low Carbon Steel
SS -- Stainless Steel
NP -- Not Penetrated
NE -- Not Encountered

Well ID Prefixes
M = Monitor Well
P = Aquifer Test Pump Well
O = Aquifer Test Observation Well

Well ID Suffixes
GU, GL = Upper and Lower Basin Fill Units
O = Oxide bedrock Zone
S = Sulfide Bedrock Zone

Table 2.3-4 Summary of Monitor Well Pump Installation Data						
Well Identification	**ADWR Registration Number**	**Pump Model[a]**	**Motor Horsepower**	**Top Well Screen[b]**	**Static Water Level (September 1995)**	**Installed Pump Depth[b]**
M1-GL	55-547617	10S-10-15	1½	315	126.7	280
M2-GU	55-547814	10S-10-15	1½	198	112.7	180
M3-GL	55-547614	10S-10-15	1½	298	116.7	200
M4-O	55-547615	10S-15-21	1½	405	116.6	380
M5-S	55-547616	25S-50-26E	5	516	119.0	500
M6-GU	55-547815	5S-10-22	1½	524	152.8	500
M7-GL	55-547611	10S-10-15	1½	859	163.2	570
M8-O	55-547612	7S-15-26	1½	1,011	154.1	580
M9-S	55-547613	10S-10-15	1½	1,510	168.5	500
M10-GU	55-547816	10S-10-15	1½	218	125.4	200
M11-GL	55-547817	10S-10-15	1½	290	128.6	260
M12-O	55-547818	10S-15-21	2	420	129.0	260
M13-S	55-547819	16S-50-38	5	852	130.0	488
M14-GU	55-549172	10S-10-15	1½	778	148.9	260
M15-GL	55-547813	10S-10-15	1½	554	148.2	260
M16-GU	55-549140	10S-10-15	1½	598	143.1	260
M17-GL	55-549141	10S-15-21	2	938	141.4	340
M18-GU	55-547809	10S-10-15	1½	178	118.7	170

[a]All pumps are SS Grundfos submersible; 460V, 3-Phase, 3.75-inch outside diameter
All installations with PVC or Fiberglass Reinforced Pipe (FRP) discharge pipe.
[b]Feet below ground surface

Table 2.3-5 Current Investigation Sampling Schedule

Sample Date[a]	Wells/Locations[c]	Parameters[d]	Comments
May 19, 1995	P39-O	Suite I	Samples retrieved during aquifer test
June 2 to June 5, 1995	P12-O	Suite I	Samples retrieved during aquifer test
June 16 to June 21, 1995	PW7-1	Suite I	Samples retrieved during aquifer test
June 22 to June 27, 1995	All M-series wells except:[b] M-1, M-5, M-6, M7, M8, M9, M-13, M-14, M-15, M-16, M-17, M-18	Suites A and C	418.1, 8015(m) added; Tritium and Sulfur Isotopes at M10 through M12; Total and dissolved metals
	Agricultural Wells BIA-9, BIA-10B, WW3, England No. 3	Suite A	Total and dissolved metals
	Water storage tank, irrigation canal, underground air shaft	Suite A	Total and dissolved metals
July 11 to July 24, 1995	All M-series wells except[b]: M7, M9, M13	Suites A and C	Tritium and Sulfur isotopes at M-2 through M-13
	Agricultural wells BIA-9, BIA-10B, WW3, England No. 3	Suite A	Total and dissolved metals
	Water storage tank, irrigation canal, underground air shaft	Suite A	Total and dissolved metals
August 14 to August 24, 1995	All M-series wells	Suites A, B, and C	Total and dissolved metals
	Agricultural wells BIA-9, BIA-10B, WW3, England No. 3	Suite A	Irrigation wells not operating during sampling event
	Water storage tank, irrigation canal, underground air shaft	Suite A	Total and dissolved metals

Table 2.3-5 Current Investigation Sampling Schedule

Sample Date[a]	Wells/Locations[c]	Parameters[d]	Comments
September 11 to September 22, 1995	All M-series wells	Suites A, B, and C	Dissolved metals only beginning in September 1995
	Agricultural wells BIA-9, BIA-10B, WW-3	Suite A	Well WW-3 not operating during sampling event
	Water storage tank, underground air shaft	Suite A	Irrigation canal now sampled quarterly
	Aquifer test wells P28.1-O, P28-GL, P8.1-O, P8-GU, England No. 3	Suites A and C	P28.1-O and P28-GL not sampled for Suite C
October 16 to October 20, 1995	All M-series wells	Suites A and C	NA
	Agricultural wells BIA-9, BIA-10B, WW3, England No. 3	Suite A	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA
	Aquifer test wells P28.1-O, P28-GL, P8.1-O, P8-GU	Suites A and C	NA
November 20 to November 28, 1995	All M-series wells	Suites A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA
	Irrigation wells D(4-9)17bcc and D(4-9)18ddd	Suite A (except phosphate and cyanide)	NA

Table 2.3-5 Current Investigation Sampling Schedule

Sample Date[a]	Wells/Locations[c]	Parameters[d]	Comments
December 11 to December 15, 1995	All M-series wells	Suites A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA
	Irrigation wells D(4-9)17bcc and D(4-9)18ddd	Suite A (except hosphate and cyanide)	
January, 1996	All M-series wells	Suites A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA
February, 1996	All M-series wells	Suites A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA
March, 1996	All M-series wells	Suites A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA
April, 1996	All M-series wells	Suites A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA

Table 2.3-5 Current Investigation Sampling Schedule

Sample Date[a]	Wells/Locations[c]	Parameters[d]	Comments
May, 1996	All M-series wells	Suites A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA
June, 1996	All M-series wells	Suites A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA
July, 1996	All M-series wells	Suite A and C	NA
	England No. 3	Suites A and C	NA
	Water storage tank, irrigation canal, underground air shaft	Suite A	NA

[a]Sample events listed for June through October 1995 have been performed. Analytical results from June through September, 1995, are discussed in this report.
[b]Wells not installed
[c]See Figure 2.1-2[II] for sampling locations
[d]See Table 2.3-6 for a description of parameter suites
NA Not applicable

Table 2.3-6 Summary of Analytical Parameters Used to Monitor Ambient Groundwater Quality		
Analyte	**Method (EPA unless otherwise indicated)**	**Detection Limit**
Suite A: Common Ions and Additional Analytes		
Alkalinity	310.1	10
Bicarbonate	310.1	10
Bromide	300	0.2
Carbonate	310.1	10
Calcium	200.7	2.0
Chloride	300	0.5
Fluoride	340.2	1.0
Hardness	SM2340B	2.0
Iodide	ASTMD3869	0.5
Magnesium	200.7	0.05
pH	150.1	NA
Phosphorous	365.4	0.07
Potassium	200.7	0.5
Sodium	200.7	0.5
Sulfate	300	0.5
Sulfide (as HS^-)	376.2	0.5
Total Dissolved Solids (TDS)	160.1	6.0
Turbidity	180.1	1.0 NTU
Nitrate-N	300	0.5
Nitrite-N	300	0.5
Cyanide (as Free Cyanide)	335.2	0.025
Trace Metals		
Aluminum	200.7	0.5
Antimony	200.7	0.006*
Arsenic	206.2	0.005
Barium	200.7	0.05
Beryllium	200.7	0.004*
Boron	200.7	0.05

Table 2.3-6 Summary of Analytical Parameters Used to Monitor Ambient Groundwater Quality		
Analyte	**Method (EPA unless otherwise indicated)**	**Detection Limit**
Cadmium	200.7	0.005*
Chromium	218.2	0.005
Cobalt	200.7	0.05
Copper	200.7	0.05
Iron	200.7	0.05
Lead	239.2	0.005
Manganese	200.7	0.05
Molybdenum	200.7	0.05
Mercury	245.1	0.0002
Nickel	200.7	0.05
Selenium	270.2	0.01
Silver	200.7	0.05
Strontium	200.7	0.05
Thallium	279.2	0.002[a]
Tin	200.7	0.5
Vanadium	200.7	0.05
Zinc	200.7	0.05
Suite B: Organics		
Total Petroleum Hydrocarbons (TPH)	8015 Modified	0.05
Total Recoverable Petroleum Hydrocarbons	418.1	0.5
Total Phenolics	420.2	0.02
Volatile Organics	8260	0.0005
Semi-Volatile Organics	8270	0.005
Chlorinated Pesticides and PCBs	8080	0.001
Chlorinated Herbicides	8150	0.006
Suite C: Radio and Stable Isotopes		
Gross Alpha, Gross Beta	900.0	1.0 pCi/l
Radium 226, 228	901.1 or 903/904	5.0 pCi/l[a]
Uranium 234, 235, 238	908.0	0.6 pCi/l

Table 2.3-6 Summary of Analytical Parameters Used to Monitor Ambient Groundwater Quality		
Analyte	**Method (EPA unless otherwise indicated)**	**Detection Limit**
Uranium Total (natural)	908.0 or SM 7500	0.001 mg/l
Radon 222	Emination 903 or Lucas Cell	4.0 pCi/l
Sulfur ($^{34}S/^{32}S$)	NA	NA
Tritium	NA	0.7 TU
Suite I: Indicator Parameters		
Alkalinity	310.0	10
Bicarbonate	310.0	10
Chloride	300	0.5
Fluoride	340.2	1.0
Carbonate	310.1	10
Sulfate	300	0.5
TDS	160.1	10.0
Total Metals		
Calcium	200.7	2.0
Copper	200.7	0.05
Iron	200.7	0.05
Potassium	200.7	0.5
Magnesium	200.7	0.05
Manganese	200.7	0.05
Sodium	200.7	0.5
Hardness	SM2340B	2.0
Nitrate and Nitrite combined (N)	353.2	0.05

[a] Detection Limit (PQL) must be below indicated value
Metal analyses are for dissolved (filtered) unless otherwise indicated here or in sample schedule (Table 2.3-5).
NA - Not Applicable
NTU - National Turbidity Unit
TU - Tritium Units

Table 2.3-7 Summary of Current Aquifer and Corehole Hydraulic Conductivity Testing Program

Well/Corehole ID[a]	Miscellaneous Well Information	Oxide Fracture Class[b]	Aquifer Characteristics of[c]	Oxide Structure Test	Hydrogeologic Unit Connection Between[d]
Aquifer Test Wells					
O3-GL	NA	B	LBFU, O	NA	NA
Note[e]	NA				
P8.1-O	NA	C	UBFU, O	NA	UBFU/LBFU LBFU/O
P8.2-O	NA				
O8-O	NA				
P8-GU	NA				
O8-GU	NA				
P12-O	NA	F	LBFU, O	NA	LBFU/O
O12-O	NA				
O12-GL	NA				
P13.1-O	Fault Zone	A	LBFU, O	Yes	LBFU/O
P13.2-O	Fault Zone				
O13-O	Fault Zone				
P13-GL	NA				
P15-O	Hanging Wall	H	LBFU, O	Yes	LBFU/O
O15-O	Foot Wall				
P15-GL	NA				
P19.1-O	Hanging Wall	E	LBFU, O	Yes	LBFU/O
P19.2-O	Hanging Wall				
O19-O	Hanging Wall				
O19-GL	NA				

Table 2.3-7 Summary of Current Aquifer and Corehole Hydraulic Conductivity Testing Program

Well/Corehole ID[a]	Miscellaneous Well Information	Oxide Fracture Class[b]	Aquifer Characteristics of[c]	Oxide Structure Test	Hydrogeologic Unit Connection Between[d]
P28.1-O	Hanging Wall				
P28.2-O	Fault Zone				
O28.1-O	Fault Zone	G	LBFU, O	Yes	LBFU/O
O28.2-O	Foot Wall				
P28-GL	NA				
O28-GL	NA				
P39-O	Fault Zone	D	O	Yes	NA
O39-O	Fault Zone				
P49-O	Hanging Wall	NA	LBFU, O	Yes	LBFU/O
O49-O	Hanging Wall				
O49-GL	NA				
Monitor Wells					
M2-GU	NA	NA	UBFU, LBFU O,S	NA	UBFU/LBFU LBFU/O O/S
M3-GL	NA				
M4-O	NA				
M5-S	NA				
M18-GU	NA	NA	UBFU, LBFU	NA	UBFU/LBFU
M1-GL	NA				
M14-GL	NA	NA	LBFU	NA	NA
M15-GU	NA				

Table 2.3-7 Summary of Current Aquifer and Corehole Hydraulic Conductivity Testing Program

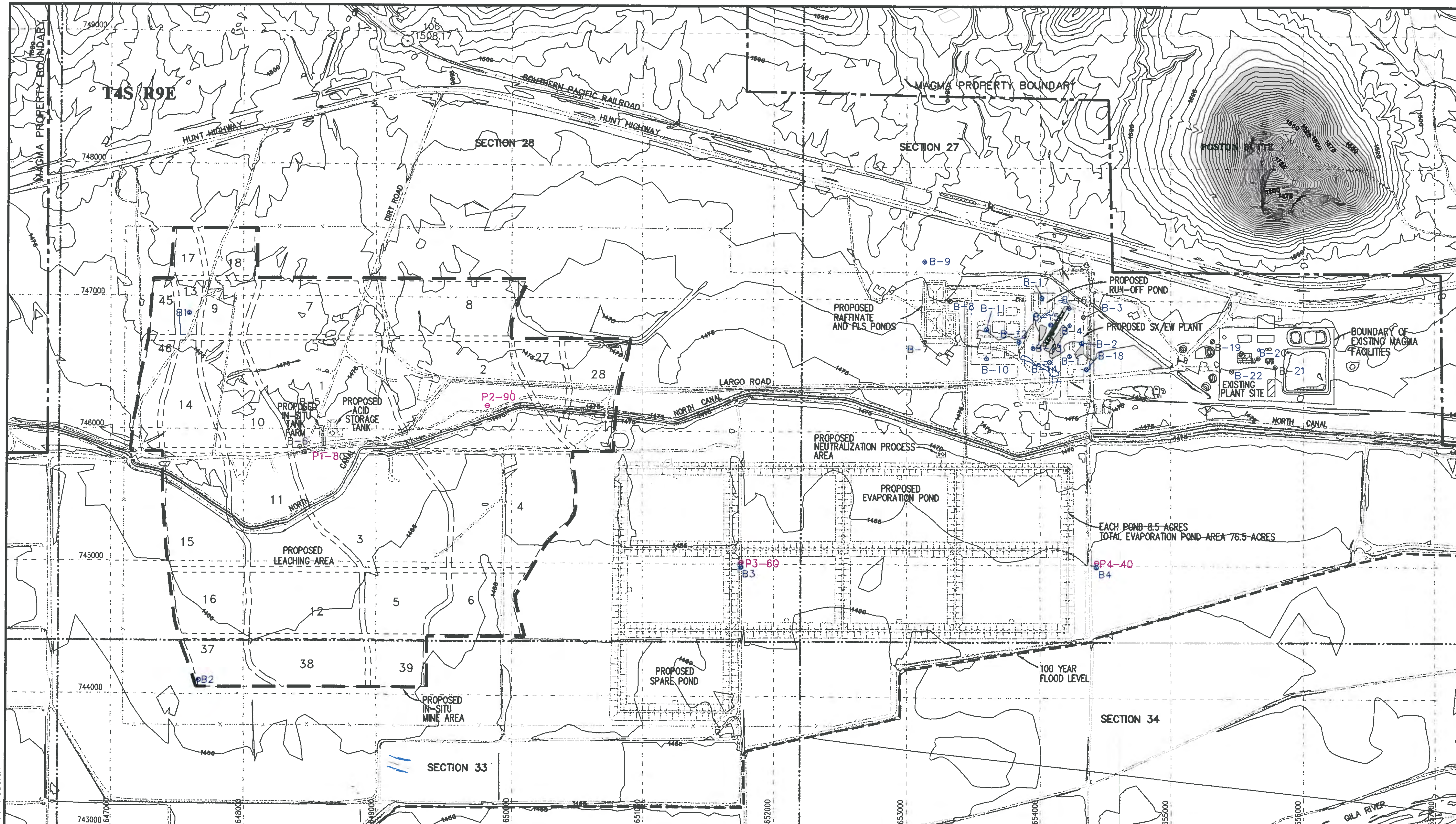
Well/Corehole ID[a]	Miscellaneous Well Information	Oxide Fracture Class[b]	Aquifer Characteristics of[c]	Oxide Structure Test	Hydrogeologic Unit Connection Between[d]
Irrigation Wells					
BIA-9	Note[f]	H	NA	NA	NA
WW-3	Note[f]	F/H	NA	NA	NA
Coreholes					
MCC-533	Oxide	F	O	NA	NA
MCC-537	Oxide	F	O	NA	NA
MCC-540	Oxide	F	O	NA	NA
MCC-541	Oxide	F	O	NA	NA
MCC-544	Oxide, Sulfide	A	O, S	NA	NA

[a]See Table 2.3-3 for well completion data, and Sheet 1.2-2 and Figure 2.1-2 for locations.
[b]Oxide Fracture Class Descriptions:
- A - Fracture Intensity Index 3 and 4 in various proportions.
- B - Fracture Intensity Index 1, 2, 3, 4 similar proportions.
- C - Fracture Intensity Index 2 near block centers and 3, 4, 5 on block edges.
- D - Fracture Intensity Index 3, 4 greater than 70 percent 3.
- E - Fracture Intensity Index 3 and 4 on west 3/4 of blocks and 2 on east 1/4.
- F - Fracture Intensity Index 4 primarily.
- G - Fracture Intensity Index 2, 3, 4 various proportions on east side of in-situ mine area.
- H - Fracture Intensity Index 2, 3, 4 various proportions on west side of in-situ mine area.

Fracture Intensity Index Descriptions
1 - 0 to 5 fractures per foot; 2 - 6 to 10 fractures per foot; 3 - 11 to 15 fractures per foot; 4 - More than 15 fractures per foot; 5 - Intensely fractured, brecciated, fault zone.

[c]Includes, where applicable: specific capacity (SC), transmissivity (T), hydraulic conductivity (K), and leakage factor (LF) for the following hydrogeologic units:
UBFU - Upper Basin-Fill Unit; LBFU - Lower Basin-Fill Unit; O - Oxide Bedrock Zone; S - Sulfide Bedrock Zone
[d]Test evaluates degree of connection across the following hydrogeologic units (see note C, for unit definitions): UBFU/LBFU, LBFU/O, O/S
[e]Test 3 design incorporates existing wells PW7-1, OB7-1, and OB-1.
[f]Large scale aquifer tests (BIA-9, WW-3, and BIA-10B) incorporate approximately 20 observation wells.

ID = Identification NA = Not Applicable Yes = Information is planned to be acquired for listed test



EXPLANATION

⊖ P1-80 = VADOSE ZONE CHARACTERIZATION PIEZOMETER

⊗ B1, B2, B3, B4 = VADOSE ZONE CHARACTERIZATION BORING

⊗ B-1 = GEOTECHNICAL BORING

0 350 700
SCALE IN FEET

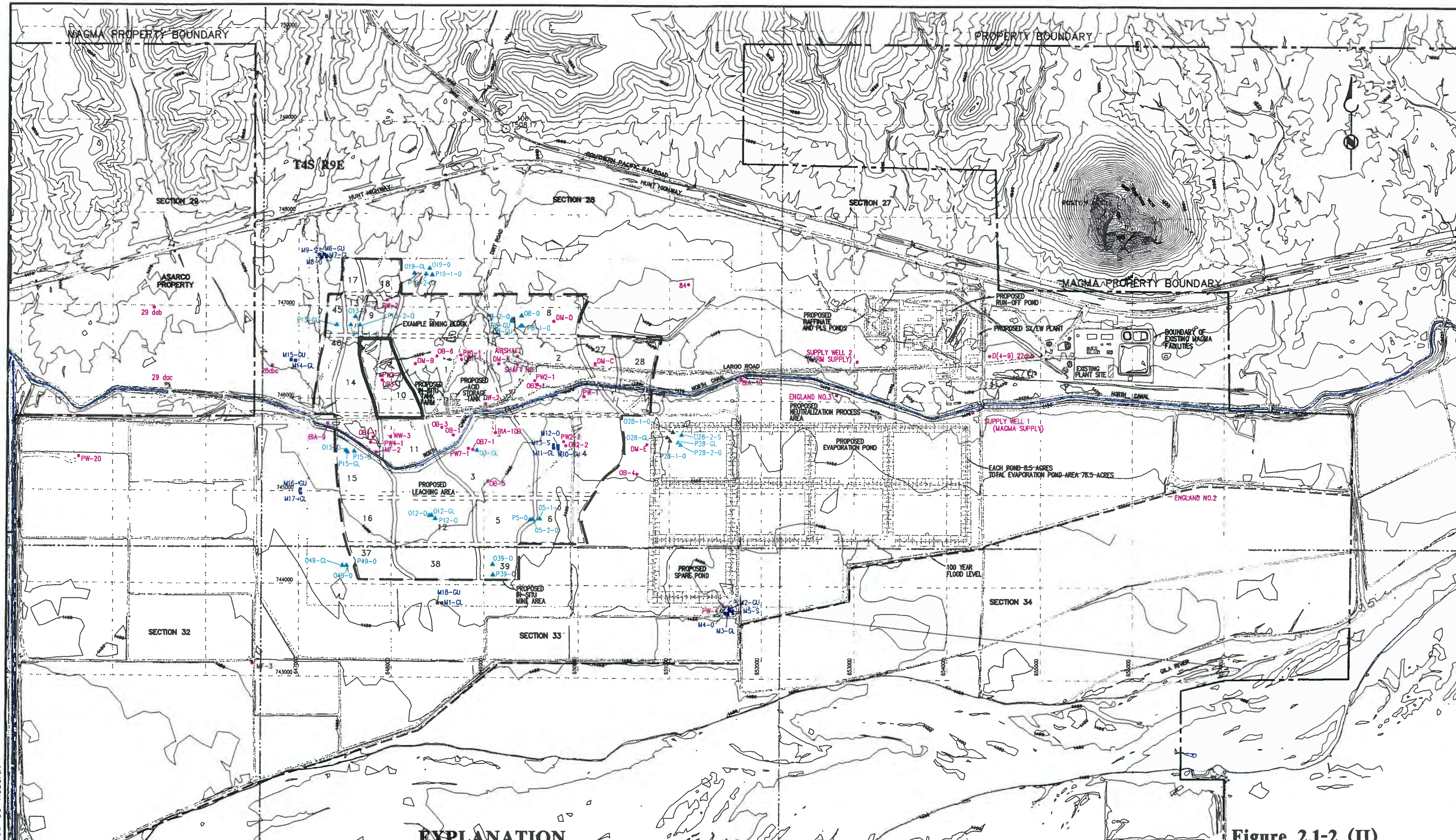
BROWN AND CALDWELL

F2-1-1_2 11-30-95 RobertK

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

Figure 2.1-1 (II)

VADOSE CHARACTERIZATION AND GEOTECHNICAL BORING LOCATIONS



EXPLANATION

- M1-GL ■ = MONITORING WELL LOCATION
  - GU = BASIN FILL UNIT
  - GL = BASIN FILL UNIT
  - O = OXIDE BEDROCK
  - S = SULFIDE BEDROCK
- O15-O ▲ = AQUIFER TEST (P) AND OBSERVATION (O) WELLS
- WW-3 ● = EXISTING WELL AND COREHOLE LOCATIONS (DM INDICATES COREHOLE)
- 26 = RESOURCE BLOCKS AND STRUCTURE LEVEL ELEVATION: 700 FEET

BROWN AND CALDWELL

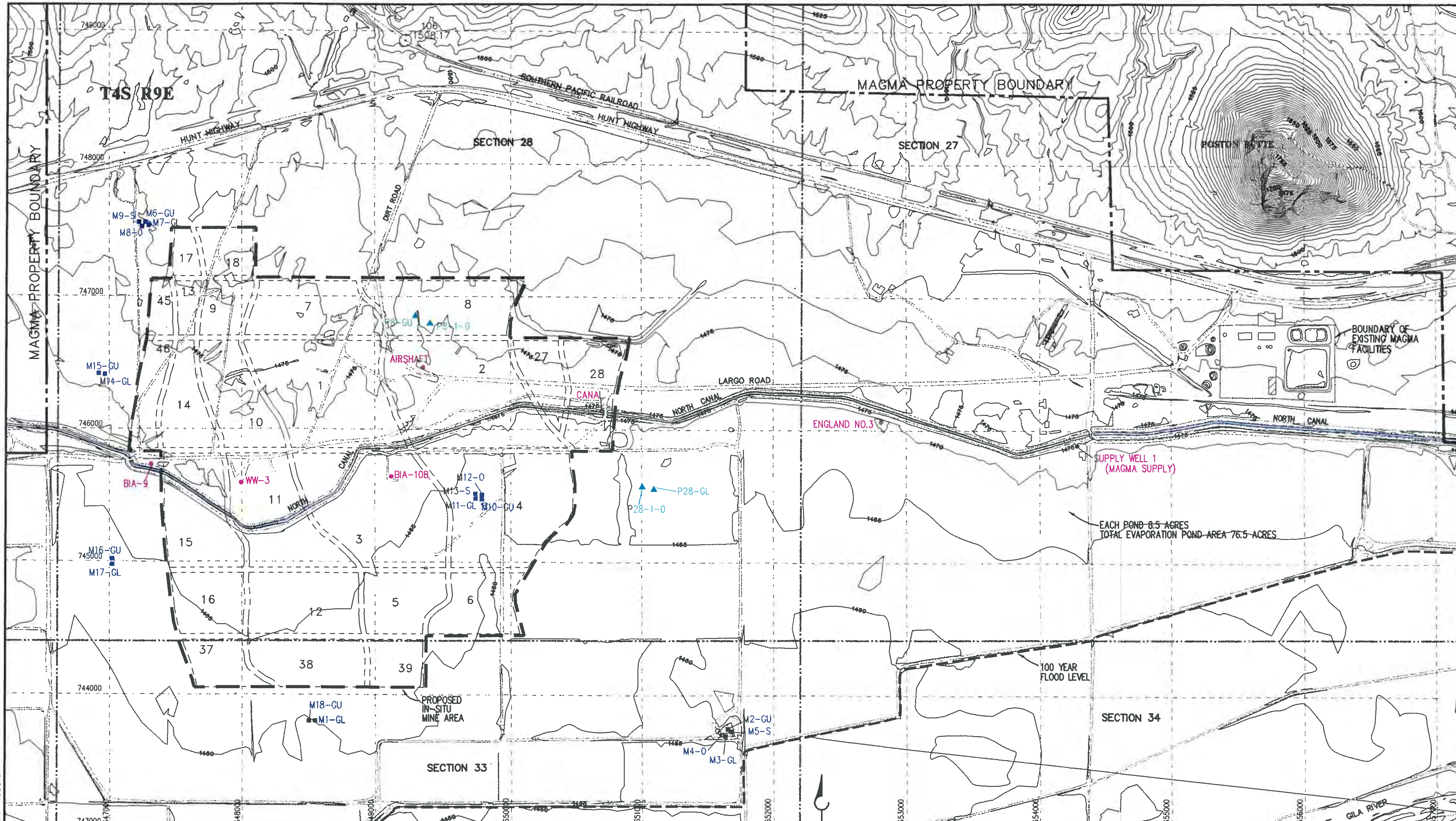
MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

Figure 2.1-2 (II)

LOCATIONS OF WELLS AND SELECTED COREHOLES WITHIN 1/2 MILE AREA OF THE PROPOSED IN-SITU MINE AREA

F2-1-2_2 11-30-95 RobertK



EXPLANATION

- M1-GL ■ = MONITORING WELL LOCATION
  - GU = BASIN FILL UNIT
  - GL = BASIN FILL UNIT
  - O = OXIDE BEDROCK
  - S = SULFIDE BEDROCK
- 015-O ▲ = AQUIFER TEST (P) AND OBSERVATION (O) WELLS
- WW-3 ● = EXISTING WELL AND OTHER SAMPLE LOCATIONS
- 26 = RESOURCE BLOCKS PROJECTED FROM ELEVATION OF 700 FEET

0 350 700
SCALE IN FEET

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

Figure 2.1-3 (II)
GROUNDWATER SAMPLING PROGRAM LOCATIONS
(Current Investigation)

F2-1-3_2 11-30-95 RobertK

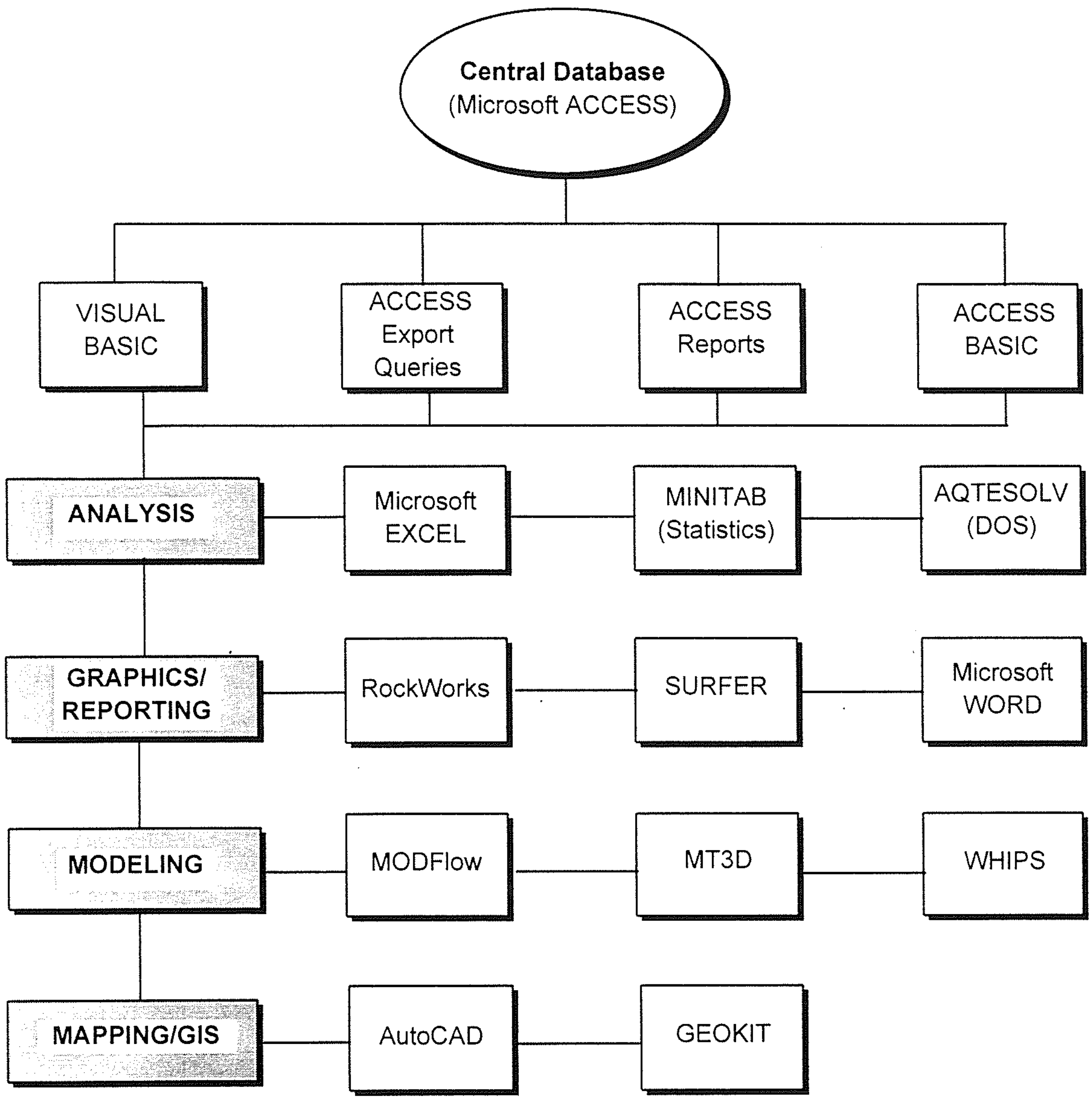


Figure 2.2-1 (II)
DATA MANAGEMENT AND ANALYSIS SYSTEM COMPONENTS

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

FIG221.XLS 12/29/95

SECTION 3.0

REGIONAL HYDROGEOLOGIC CONDITIONS

This section presents hydrogeologic and related information from a regional perspective for the area surrounding the immediate Florence Project Area. A summary of the information reviewed is followed by discussions of physiography, climate, surface water hydrology, geology, subsidence potential, seismicity, and groundwater.

3.1 REVIEW OF EXISTING INFORMATION

Several sources of data concerning the Florence Project Area were reviewed during this investigation. A considerable amount of data have been compiled by Magma as part of exploration and feasibility efforts. These data were used to aid in delineating the geology and groundwater flow characteristics within a several mile radius of the in-situ mine area. Where appropriate, these information sources are referenced in the following sections. These materials included:

- Conoco and Magma core logs (Magma, 1995).
- Well information logs, including lithology associated with drilling and completion of irrigation, municipal supply, and domestic wells, were obtained from ADWR (1995).
- Published geologic studies concerning the general area available from the United States Geological Survey (USGS).
- Mine feasibility studies completed by Conoco (1976) and Magma (1994).
- Project specific investigations performed by several authors as indicated in the text.
- Regional geophysical investigations.
- Exploration reports of neighboring properties (including the Aztec, Cholla Mountain, and the Santa Cruz properties).

The Aztec property is located northeast of Poston Butte about 1.5 mile from the Florence Project Area in Township 4 South, Range 9 East and is about 2 miles northwest of the Town of Florence (see Sheet 1.2-1[II]). The Aztec site is about 1 mile northwest of the in-situ mine area. Available information (Magma, 1995) indicates this area was investigated by the Getty Oil Company in 1972.

The Cholla Mountain property is located directly north of the Gila River and west of Attaway Road in portion of Sections 35 and 36 of Township 4 South, Range 8 East and Sections 2, 3, and 11 of Township 5 South, Range 8 East (see Sheet 1.2-1[II]). This property was drilled by

Conoco in 1976 and 1977. The Cholla Mountain site is about 4 miles west-southwest of the Florence In-situ Mine Area.

Core log, geophysical and other miscellaneous information supplied by Magma were invaluable in the evaluation of regional geologic conditions for the referenced project. Because exploratory emphasis was placed upon the bedrock complex, some core logs do not include descriptions of the sedimentary basin-fill units. In some cases, a core log will include a complete description for the sedimentary deposits. The core logs provided the basis for delineation of the basin-fill/bedrock contact in the project area. Basalt and evaporite deposits were also mentioned on several logs, but these areas were not cored.

Well data obtained from ADWR included lithologic logs showing major contacts, such as the basin-fill/bedrock interface and fine/coarse-grained basin-fill units. Details such as the occurrence of faulting and mineralogic changes within the bedrock are generally not reported to ADWR. Few water wells penetrate the basin-fill/bedrock contact.

Approximately 700 exploratory coreholes have been drilled during previous and current mining feasibility studies (Magma, 1995). The density of data points decreases significantly away from the in-situ mine area, and is discussed in greater detail in Section 4.0. For the purposes of the regional characterization, selected corehole information was reviewed related to 2 other properties in the area: the Cholla Mountain and Aztec sites. Sheet 1.2-1[II] shows the locations of selected coreholes used to characterize regional subsurface conditions.

Water well data (ADWR, 1995) are more concentrated east and west of the Florence Project Area where the thickness of the basin-fill units is greater. With the exception of the Gila River channel area, water well log coverage is significant south of the Florence Project Area. However, wells in this area are generally less than 500 feet deep and do not encounter bedrock. Very few water wells are located within 2 miles north of the Florence Project Area because basin-fill deposits are thin. This area does contain exploration coreholes. Sheet 1.2-1[II] shows the locations of water wells with available logs.

As part of this investigation, all wells within 1/2-mile of the proposed in-situ mine area were inventoried, and locations verified using a Global Positioning System (GPS). This inventory also included selected wells within a 5-mile radius. Information concerning wells within 1/2-mile of the property is presented in Table B-4 in Appendix B. Information concerning wells within 5 miles of the proposed in-situ mine area is presented in Table B-5 in Appendix B.

Regional studies and reports reviewed for this investigation include the following primary materials:

- "Geology of the Poston Butte Porphyry Copper Deposit" (Nason and others, 1982) which reported bedrock geology.

- A gravity survey completed in the area by West (1971), which identified a horst block beneath the proposed in-situ mine area. This survey was used to estimate the thickness of basin-fill. Basin-fill thicknesses in some areas did not compare well with drill hole results.

- A second gravity survey, completed by Cities Service Minerals Corporation (Cities, 1977). This survey was more regional in scope than the West survey. It covered an area of approximately 1,450 square miles, with the proposed in-situ mine area located near the center of the survey.

- Feasibility studies concerning the Florence Property performed by Conoco (1976).

3.2 PHYSIOGRAPHY AND CLIMATE

The following 2 sections discuss regional physiographic and climatic conditions of the Florence Project Area.

3.2.1 Physiographic Setting

As depicted on Figure 3.2-1[II], the Florence Project Area is located within the Sonoran Desert section of the Basin and Range physiographic province of south-central Arizona. The last major tectonic event left a topography of deep basins surrounded by mountain ranges. The basins are now sediment-filled valleys, and the mountains are low and rugged. Elevations range from 1,000 to 3,000 feet above mean sea level (msl). As shown on Figure 1.1-2[II], the Santan and Sacaton Mountains lie to the west/northwest of the Florence Project Area. To the east/northeast of the Florence Project Area are the Superstition Mountains. Erosion and sedimentation have isolated the mountain ranges, with basin-fill deposits extending to the mountain fronts, burying the lower reaches of the mountain flanks.

The Gila River traverses the region from east to west (Figure 1.1.-2[II]). The braided riverbed meanders through a broad valley averaging 2 to 3 miles in width in the vicinity of the Town of Florence. Past periods of relative erosional stability are evident from the existence of terraces. East of Florence, the valley floor slopes approximately 20 feet per mile to the southeast. Westward from Florence, the valley slopes to the west approximately 10 feet per mile (Beer, 1988). Tributary washes to the Gila River generally have dendritic drainage patterns.

Due to upstream control and diversions, the Gila River is generally dry, with the exception of brief flow following intense seasonal rainstorms and releases from upstream dams. Surface water is diverted through a system of canals for irrigation of approximately 7,000 acres of cropland operated by the San Carlos Irrigation Project (SCIP). SCIP consists of 2 primary elements: the San Carlos Irrigation and Drainage District (SCIDD) and the Gila River Indian Community (GRIC). These water users are discussed further in Sections 3.3 and 3.9.

The Gila River flows periodically in the vicinity of the Florence Project Area. Two notable periods of protracted surface water flow occurred in 1983 and again in 1993. These flow periods of the Gila River are discussed in detail in Sections 3.3 and 4.2. Groundwater is utilized when surface water supplies are limited.

3.2.2 Climate

The climate in the region inclusive of the Florence Project Area is typical of a semi-arid desert region with low precipitation and low humidity. Temperatures during the summer months regularly exceed 100 degrees Fahrenheit and average around 50 degrees to 80 degrees during the winter months (Sellers and Hill, 1975). Rainfall is seasonal with peaks in winter and summer. Winter rainfall occurs from December to March and is derived primarily from cold fronts originating in the northern Pacific Ocean.

Figure 3.2-2[II] shows annual precipitation recorded at Florence from 1908 through 1994. Figure 3.2-3[II] illustrates mean monthly precipitation recorded at Florence for the same period of record. Summer rainfall occurs from July to early September and is produced from convection of unstable, moist air derived from the Gulf of Mexico and the Gulf of California (Huckleberry, 1993). Data from the National Oceanic and Atmospheric Administration (NOAA, 1910-1994) indicates that the annual precipitation at Florence from 1909 through 1993 ranged between 2.4 inches in 1911 to 20.01 inches in 1978.

Winter precipitation is generally lighter than that occurring during the summer months and is steady and longer in duration (see Figure 3.2-3[II]). Summer rains are sporadic and heaviest during July and August and may cause flooding. The mean relative humidity ranges from about 19 percent in the summer to about 59 percent in the winter. Estimated potential evaporation in the area is about 65 inches per year (Montgomery and Harshbarger, 1989). Because of high evapotranspiration rates, only small amounts of precipitation are available for recharge to the aquifer. A small amount of recharge from precipitation may occur during the winter months when daily temperatures are lower.

As shown on Figure 3.2-2[II], a series of relatively wet years occurred during the periods from approximately 1982 to 1985 and 1990 to 1994. These trends are also evident in data evaluated for recording stations at Kelvin, and San Manuel, Arizona (information on file at Brown and Caldwell Phoenix office). These data show that a widespread wet period occurred which increased flows of the Gila River, and in turn influenced rising water levels in the Florence Project Area. Further discussions relative to this issue are presented in Section 3.3, 3.6, and 4.3.

3.3 SURFACE WATER HYDROLOGY

This section presents descriptions of watershed conditions and major surface water features in proximity to the Florence Project Area. Locations of pertinent surface water features in the region are depicted on Figure 3.3-1[II].

3.3.1 General Watershed Conditions

The principal surface water feature in the area is the Gila River, with a drainage area of approximately 57,900-square miles (USGS, 1994). The river traverses the central part of the 100-square mile Florence Project Area within the Pinal Active Management Area (AMA) and trends west-southwest (see Figure 1.1-2[II]) to the Colorado River. The section of the Gila River between the San Pedro and Gila Rivers (Figure 3.3-1) is referred to as the Middle Gila River (Huckleberry, 1993).

Coolidge Dam, located approximately 55 miles east of Florence (see Figure 3.3-1[II]), was completed in 1928 and began regulating runoff from 75 percent of the watershed above the Middle Gila River. The San Pedro River is the primary source of unregulated streamflow for the

Middle Gila River. All upstream flow is diverted into the Florence-Casa Grande Canal at the Ashurst-Hayden Diversion Dam shown on Figure 3.3-1. The Middle Gila River, which is situated just south of the proposed in-situ mine area, is usually dry except during times of seasonal rainfall.

The watershed area around Florence is not strongly influenced by spring snowmelt, since the San Pedro River does not flow through many high altitude areas. Therefore, snowmelt represents a small fraction of the annual streamflow, whereas warm season rains play a much greater role (Sellers and Hill, 1974). As a result of these seasonal variations, the Middle Gila River historically experiences 2 periods of increased discharge, 1 during the winter and another during late summer to early fall.

The Middle Gila River has undergone several hydrological and ecological changes in the last century. Vegetation along the Gila River is classified as Sonoran Desert Scrub. Outside of the Gila River floodplain, the vegetation is characterized by creosote, bursage, palo verde, ironwood, saguaro, and cholla. Prior to cultivation and upstream water diversion, mesquite, cottonwood and willow were dominant along the river. However, at the end of the 19th century, tamarisk, an exotic plant, was introduced to the area and has since become the dominant plant species. Tamarisk has played an important role in controlling sedimentation along the channel and has influenced channel flow patterns in some areas (Huckleberry, 1993).

3.3.2 Surface Discharges and Canals

The nearest USGS stream recording gage to the Florence Project Area is at Ashurst Hayden Dam (see Figure 3.3-1). Although Gila River diversion data are recorded by the USGS at Ashurst Hayden Dam, surface flow below the dam is not recorded on a regular basis. The next closest gaging station on the Gila River is located at Kelvin, Arizona (USGS No. 9474000) (see Figure 3.3-1). Surface flow records were obtained from this USGS gauging station (USGS, 1977 to 1994) and are summarized in this section.

Figure 3.3-2[II] illustrates annual discharge of the Gila River at Kelvin, Arizona for the 18-year period from 1977 to 1994. The highest annual discharge was 28,568,331 ac-ft, occurring in 1993. The lowest annual discharge during the period of record was 1,108,489 ac-ft, occurring in 1990. Years with comparatively high amounts of flow include the periods from 1983 to 1985 and 1992 to 1993. These periods of increased annual flow generally correspond with periods of increased precipitation as discussed in Section 3.2.

Mean daily discharge rate on a monthly basis for Kelvin is depicted in Figure 3.3-3[II]. The greatest amount of daily discharge occurs in the months of January and March. The greatest mean daily discharge during the 18-year period of record from 1977 to 1994 was 52,400 cfs, which occurred on January 21, 1993. Further discussion of the effects of Gila River surface flow in the vicinity of the Florence Project Area (Middle Gila) is presented in Section 4.2.3.

Historically, changes in the Gila River channel have been due primarily to flooding. Upstream diversion and impoundment of water for irrigation, deforestation of riparian communities for agriculture, and biotically disruptive land-use changes have also been important influences (Huckleberry, 1993). Survey notes from the U.S. General Land Office in the 1860s describe the

Middle Gila River channel as a relatively stable, deep single flow channel with well defined banks, a sandy river-bottom and dense undergrowth (Huckleberry, 1993).

Upstream irrigation development began to impact the streamflow in the Middle Gila River during the late 1800s. Water was diverted to the Florence Canal beginning in 1886 which resulted in diminished flow through the river. By 1892 the river began to widen around Florence due to large flooding events which the banks could not contain. By the turn-of-the-century, the river around Florence began to exhibit characteristics of a braided channel. It was reported that after 1905 the Middle Gila River channel was wide, straight, and braided, without heavy vegetation (Huckleberry, 1993). By 1936, as a result of flood control provided by Coolidge Dam, a single low flow channel had become re-established in the Middle Gila River.

Human activities such as deforestation for agriculture and overgrazing of the riparian community have resulted in the removal of stabilizing vegetation along the river banks and consequently contributed to the widening of the Middle Gila River channel. However, construction of Coolidge Dam and the introduction of tamarisk to the river floodplain have served to counteract some of man's activities by respectively reducing the effects of flooding and stabilizing the river banks.

The Gila River watershed includes the San Pedro River watershed and encompasses an area that extends as far south as Sonora, Mexico and as far east as New Mexico. East of the Florence Project Area, the San Pedro River joins the Gila River at Winkelman (see Figure 3.3-1[II]). The Gila River flows west as a perennial stream through bedrock outcrops near Kelvin and becomes an ephemeral stream west of Price as the Gila River enters the Eloy sub-basin.

The Gila River flows east to west within the Florence Project Area, and is located approximately 1 mile south of the proposed in-situ mine area. The most important influences upon the geomorphic and hydrologic conditions of the Middle Gila River has occurred during or as a result of large flood flows. Their effects far outweigh the influence of human activities on the river. Downstream from the Ashurst-Hayden Dam (see Figure 3.3-1), the river flows over basin alluvium where it shifts laterally and adjusts its channel geometry in response to changing discharge rates and sediment loads. Historically, the Gila River floodplain has been modified several times by significant flooding events. San Pedro river floods in 1886, 1887, and 1890 had significant influences on the Middle Gila River geomorphology. Each major discharge resulted in significant incision and channel widening of the lower San Pedro River, which produced a flux of sediment to the Middle Gila River (Huckleberry, 1993). Such changes in the discharge/sediment ratio to the Gila River due to flooding resulted in changes in the stream pattern.

Surface water canals associated with the Florence Project Area include the following:

- The Central Arizona Project (CAP) Salt-Gila Aqueduct located north of the site which conveys water from the Colorado River.

- The Florence-Casa Grande Canal located south of the Gila River and the site which conveys water from the Gila River.

- The North Side Canal which transects the project area and conveys water from the Gila River. The North Side Canal flows under the Gila River through a siphon and westward along the Gila River floodplain where it traverses through the center of the in-situ mine area.

- The Florence Canal located south of the project area conveys water from the Gila River. The Florence Canal follows the Florence-Casa Grande Canal south of Florence, approximately 3 miles southeast of the proposed in-situ mine area, to the Picacho Reservoir.

- Table 3.3-1 summarizes annual surface water releases from Coolidge Dam to the Gila River from 1968 through 1994. The majority of this water is diverted into the Florence-Casa Grande, Florence, and North Side Canals. Annual releases reported by SCIDD are dependent upon precipitation and customer demands for a given year. All 3 canals and associated lateral distribution systems are unlined. Water deliveries are measured using weirs. Average annual water losses in the irrigation district is estimated to be about 45 percent (ADWR, 1991).

Presently, agricultural and municipal groundwater usage in the region is supplemented by surface water which is diverted from the Ashurst-Hayden Diversion Dam into the Florence-Casa Grande Canal. Four miles below the diversion dam, the Gila River is diverted into the North Side Canal and the Florence Canal. Laterals that connect to the canals transport the water to its place of use (Beer, 1988).

Water flows continually in the canals with the exception of approximately 1 month per year when the canals are shut down for cleaning. Table 3.3-2 presents a summary of Gila River diversions into the 3 canals in the area of the Ashurst-Hayden Dam. This summary is for the years 1968 through 1994 and was compiled from data obtained from SCIDD, 1995 and ADWR (1995). The mean total annual amount of diverted surface water is 300,173 ac-ft/yr, ranging from 55,516 ac-ft in 1990 to 474,669 ac-ft in 1980. Of this amount, the majority is diverted into the Florence-Casa Grande Canal. Of the mean amount (300,173 ac-ft) given in Table 3.3-2, 279,826 ac-ft were diverted into the Florence-Casa Grande Canal, 9,026 ac-ft were diverted into the Florence Canal, and 12,035 ac-ft were diverted into the North Side Canal.

The Town of Florence intermittently discharges wastewater effluent to the Gila River channel. This discharge averages approximately 320 ac-ft/yr between 1987 and 1991 based on ADEQ data. Treated wastewater effluent is also intermittently discharged to the Gila River channel by the Town of Florence, which supplies water and sewer services to Florence Gardens (see Sheet 1.2-1[II]). An average of 170 ac-ft/yr of effluent was discharged between 1987 and 1991, based on ADEQ records. Conversations with the Florence water company during this investigation (Allen, 1995) indicated that the City of Florence was issued a permit to discharge effluent in 1993 which is valid for 5 years. Discharge only occurs when effluent cannot be used for irrigation. Discharge estimates include 77 ac-ft in 1993, no discharge in 1994, and 30 ac-ft in 1995. Long-term discharge of effluent from these sources is not expected, based on mandates from ADWR concerning reuse of effluent (ADWR, 1991).

3.4 STRUCTURAL AND STRATIGRAPHIC SETTING

This section provides a description of the regional geologic setting of the Florence Project Area. Included are descriptions of the depositional history of the bedrock and basin-fill geologic units, and an overview and chronology of structural influences. Figure 3.4-1[II] depicts regional geologic conditions in central Arizona. Refer to Sheet 1.2-1[II] for an illustration of surface geological outcrops in the Florence Project Area. The regional cross sections A-A' (east-west) and B-B' (north-south) shown on Sheet 1.2-1[II] are included in this section as Figures 3.4-2[II] and 3.4-3[II], respectively.

Two billion years ago, a geosynclinal trough extended northeasterly across the present location of the North American continent. This early Precambrian crust was formed through alternating volcanic activity and sedimentation. Three different tectonic assemblages were formed in Arizona during this time; the Northwest Gneiss Belt (Vishnu Schist), the Central Volcanic Belt (Yavapai Schist), and the Southeast Schist Belt (Pinal Schist) (Anderson, 1989). These tectonic assemblages became accreted to the North American craton as a result of the Mazatzal Orogeny; a compressional deformation event that occurred about 1,670 million years ago (Ma) in central to southeast Arizona. This event involved thrust and reverse faulting, and large-scale folding (Anderson, 1989).

The Pinal Schist (1,750-1650 Ma) resulted from metamorphism of oceanic sediments during the Mazatzal Orogeny, and forms the basement rock of the Florence Project Area. It crops out to the west-northwest in the Santan Mountains and to the east in the Tortilla Mountains.

The Mazatzal Orogeny was followed by a tectonically quiet period during which erosion was the dominant geological process. Around 1,400 Ma, thermal instability in the upper mantle resulted in deep crustal melting and widespread emplacement of potassium-rich granites into the upper crust (Anderson, 1989). The Oracle Granite Batholith intruded the Pinal Schist during this time. The Oracle Granite is locally represented by a quartz monzonite porphyry, and is the host for mineralization at the proposed in-situ mine area.

The Grand Canyon Disturbance (900-800 Ma), a deformational event similar to the Mazatzal Orogeny but smaller in magnitude, occurred at the end of the Precambrian Era. This orogeny resulted in uplifting and tilting of the crust, with extensive intrusion of diabase sills and dikes (Wilson, 1962). Dikes of this nature intrude the Oracle Granite and Pinal Schist.

As a result of regional stresses that occurred throughout the late Precambrian and into the early Paleozoic time, east-northeast trending structural lineaments formed in the western continental crust (Anderson, et. al, 1971). One such structure in southern Arizona is the Ray Lineament, trending north 70 degrees east and extending approximately 50 miles from the Sacaton Mountains to the Pinal Mountains. As shown on Figure 3.4-1[II], the Ray Lineament parallels the Pinal Schist-Oracle Granite contact (Conoco, 1976). The Ray Lineament trends west-southwest through the Florence Project Area. At Florence, the lineament intersects a pre-existing Precambrian diabase dike swarm that strikes north 10 to 30 degrees west (Conoco, 1976). Many east-northeast trending Laramide age intrusive bodies were emplaced in central Arizona at the intersections of zones of weakness. After the initial formation of the Ray Lineament and related discontinuities, a long period of erosion occurred in the Paleozoic era, which produced a peneplain landscape.

Significant orogenic activity did not re-occur in Arizona until the latter part of the Cretaceous Period. The Laramide Orogeny occurred during Late Cretaceous through Early Tertiary time (80 to 50 Ma). The event involved regional-scale thrust faulting and folding in southern Arizona (Dickinson, 1989). Reactivation of normal faults produced large northeast-trending vertical block uplifts associated with the emplacement of scattered plutons in western and southern Arizona (Anderson and others, 1971). Intrusions, principally of granodiorite and quartz monzonite, occurred along the Ray Lineament (see Figure 3.4-1[II]) during the Laramide Orogeny. Hydrothermal mineralization associated with these intrusions resulted in the formation of porphyry copper ore deposits (Dickinson, 1989). The Florence orebody was formed in this fashion as the Precambrian Oracle Granite was intruded, and mineralized in association with the emplacement of a Tertiary granodiorite porphyry. The Ray and Sacaton copper orebodies are also associated with intrusions of this type during Tertiary time. Following the formation of the Florence orebody, unmineralized dikes consisting of latite, dacite, andesite, quartz latite, and basalt intruded the Oracle Granite and the granodiorite.

Continued Laramide orogenic activity produced faulting and uplift, resulting in the erosion of Paleozoic and Mesozoic sedimentary sequences. This erosion also exposed the Precambrian and Tertiary intrusive bodies. Oxidation and further erosion occurred on these surfaces, followed by the accumulation of coarse, clastic sediments derived from the surrounding bedrock terrain. This depositional sequence ultimately produced a landscape of low relative relief. Precambrian age outcrops exposed in the surrounding area as a result of the Laramide Orogeny include the Pinal Schist and the Oracle Granite (Nason and others, 1982). Tertiary-age intrusive rocks exposed include the Sacaton Stock and granodiorite porphyry (62 ± 1.0 Ma). Most copper mineralization in the area occurs within the granodiorite porphyry and the Oracle Granite (Conoco, 1976).

An ensuing mid-Tertiary orogeny (32-21 Ma) was a thermal event involving extensive crustal thinning and widespread, varied volcanism (Dickinson, 1989). Thermal upwelling resulted in the formation of localized metamorphic core complexes. Associated crustal extension caused low-angle, gravity-induced faulting. There is little evidence indicating that the mid-Tertiary extensional event affected the Florence Project Area with low-angle normal faulting. A landscape of high relief evolved, eventually modified as deposition of fanglomerates and other coarse-grained clastic sediments occurred in the local basins. These sediments may be correlative to the Whitetail Conglomerate, which is exposed near the Santan Mountains to the west and in the Ray-Superior mining districts approximately 30 miles to the east of the Florence Project Area. Within the proposed in-situ mine area, corehole data indicate that the Whitetail Conglomerate does not occur over the primary portion of the orebody in the graben, but may exist in the down-dropped extension of the orebody to the west (Conoco, 1976). Subsequent erosion probably removed most of the conglomerate, except in grabens (Nason and others, 1982).

As the uplifted topography began to erode, a sedimentary sequence was deposited over the Precambrian surfaces during the Oligocene through Early Miocene (36 to 17 Ma). These deposits are composed of deeply weathered bedrock or grus-type deposits, as well as coarse, angular breccias or gravels. Sediments became finer-grained as the topography matured. The basal breccia/conglomerate was frequently overlain by finer-grained silts and sands, and locally interbedded with lava flows or volcanic ash. Alluvial, fluvial, and lacustrine (lake bed and playa) sediments accumulated during this time in southeast Arizona. Tertiary-age sediments are not believed to exist in the in-situ mine area because of erosion, subsequent uplift, and faulting. It is possible that such sediments are preserved in the deeper portions of the graben to the west of the proposed in-situ mine area, or in the basin center to the south.

The last major orogenic event to affect the Western United States was the Basin and Range Orogeny, an extensional event occurring from the early Miocene to the Pleistocene (17-5 Ma). This tectonic process dissected the crust into a series of blocks bounded by normal faults. Areas of extended crust exposed metamorphic core complexes. Associated igneous activity included batholith, stock and dike emplacement, and volcanism (Nason and others, 1982). The Basin and Range Province, 1 of the 3 physiographic regions of Arizona (refer to Figure 3.2-1[II]), is characterized by elongated fault-block mountain ranges trending northwest-southeast, separated by broad alluvial valleys underlain by grabens or half-grabens. The mountains are often tilted, resulting in the overlying sediments being structurally deformed and eroded. Continuous normal and en echelon faults in the Basin and Range Province produced offsets up to several thousand feet (Nations and Stump, 1981). Figure 3.4-4[II] shows central Arizona with contours of the elevation of crystalline bedrock, and displays the alternating sediment-filled valleys and uplifted mountains typical of the Basin and Range structural style.

Basin and Range faulting may have resulted in partial to complete erosion of Oligocene to Miocene sediments. As much as 4,000 feet of basin-fill sedimentary rocks were deposited in these Tertiary alluvial fan and lake bed environments. Figure 3.4-5[II] illustrates the typical stratigraphic sequence in the Basin and Range province. This sequence includes the probable preservation of late Mesozoic/early Tertiary-age sediments in deeper portions of the grabens. Figure 3.4-6[II] shows a contoured bedrock surface in the regional area surrounding the Florence Project Area, based on well and corehole log information.

The older sediments are overlain by locally-derived clastic deposits, with finer-grained alluvial or lacustrine beds accumulating in the basin interiors, especially where internal drainage existed. Thick evaporite deposits have been identified in some southern Arizona basins (Eberly and Stanley, 1978). Basalt, andesite, and rhyolite erupted as ash and flow through the Miocene, from scattered volcanic centers. The cessation of volcanism and faulting in the Pliocene (5 Ma) prompted the restoration of external drainage, which prevented the further deposition of evaporites. By early Pleistocene (1.6 Ma), erosion had become the pervasive geological process, and has continued to dominate through to the present (Nations and Stump, 1981).

Basin and Range faulting and tilting in the Florence Project Area resulted in north-northwest trending horst and graben structures bounded by normal faults with large displacements to the west (Nason and others, 1982). Figures 3.4-2[II] and 3.4-3[II] depict east-west and north-south subsurface cross sections, respectively, and show no bedrock topography in the Florence Project Area. The Florence orebody occurs on a complex horst block which is bounded on the east and west by grabens. The Party Line Fault, a major normal fault on the east side of the orebody, strikes north 35 degrees west and dips 45 to 55 degrees southwest. This fault is reported to have a vertical displacement of over 1,000 feet (Conoco, 1976, Nason and others, 1982). A series of en echelon normal faults striking north-south to northwest lie west of the Party Line Fault, which form a transition to the graben west of the proposed in-situ mine area.

The Sidewinder Fault occurs near the west side of the in-situ mine area and has a displacement in excess of 1,200 feet (Conoco, 1976). This fault represents a continuation of a complex of north-south trending normal faults to the east. The east-west fault system has downdropped the south end of the horst more than 1,500 feet (Conoco, 1976). Additional en echelon, north to northwest trending normal faults east of the Sidewinder Fault produce a graben east of the in-situ mine area, which strikes north to northwest and extends for about 5 miles or more. The influence of these structural features is addressed on a local scale in Section 4.3.

Post-Basin and Range basin-fill sediments were deposited over the Precambrian bedrock surface at the Town of Florence. The sediments consist of unconsolidated to moderately well-consolidated interbedded clay, silt, sand, and gravel in variable proportions and thicknesses. Basalt flows are interbedded on the west and northwest portions of the in-situ mine area. Total thickness of basin-fill materials in the vicinity of the property ranges from 300 to over 900 feet, and exceeds 2,000 feet at a distance of 1.5 miles southwest of the proposed in-situ mine area. For the purposes of this investigation, the basin-fill deposits in the region are divided into 3 units: (1) the Upper Basin-fill Unit (UBFU); (2) the Middle Fine-Grained Unit (MFGU); and (3) the Lower Basin-fill Unit (LBFU). Although perhaps not contiguous, these units likely correlate with similar units described by Laney and Hahn (1986) in the eastern Salt River Valley to the north. Figure 3-4.5[II] illustrates composite stratigraphic columns in different areas in southern Arizona (Eberly and Stanley, 1978).

The LBFU overlies bedrock and occurs beneath the MFGU or UBFU, with the lower, more consolidated materials forming a conglomerate overlying the bedrock. The conglomerate portion of the LBFU may correlate with the Gila Conglomerate and Whitetail Conglomerate described in the region (Conoco, 1976). The LBFU in the Florence Project Area has been previously described as Gila Conglomerate by Montgomery (1994) and Conoco (1976). The thickness of the LBFU in the Florence Project Area ranges from zero near surface bedrock outcrops to approximately 1,000 feet in the grabens. The average thickness is approximately 300 feet.

In the region surrounding the Florence Project Area, the MFGU is composed of clays, silts, and sands which are consolidated to various degrees. The MFGU is generally discontinuous in the vicinity of the proposed in-situ mine area, and varies in thickness up to approximately 50 feet (Magma, 1995). The composite thickness of the UBFU and MFGU in the surrounding area ranges from zero near surface bedrock outcrops to greater than 300 feet in the graben to the west of the mine property, averaging approximately 100 feet.

As determined during this investigation and reported previously by Montgomery (1994), the UBFU in the vicinity of the proposed in-situ mine area consists of unconsolidated to weakly bedded clays, silts, sands, and gravels. The various material types are interbedded and occur in various proportions and thicknesses.

Recent floodplain alluvium occurs along the Gila River and numerous tributary washes in the Florence Project Area. The alluvium consists chiefly of unconsolidated silt, sand, gravel, and boulders and overlies the basin sediment. Average width of this unit along the Gila River is about 2 miles. Downstream from the Ashurst-Hayden Dam, the river flows over recent alluvium where it shifts laterally and adjusts its channel geometry in response to changing discharge and sediment load. The thickness of the recent alluvium in the Florence Project Area ranges from zero near the bedrock outcrops to approximately 60 feet toward the Gila River, located approximately 1 mile south.

3.5 SUBSIDENCE AND SEISMICITY

This section presents a discussion of land subsidence potential and seismicity conditions in the Florence Project Area. Further discussions about these topics, as they relate to surface facility design, are presented in the geotechnical investigation performed by Terracon Consultants Western, Inc., of Tucson, Arizona (Volume V, Appendix C).

3.5.1 Subsidence Potential

The potential for ground surface subsidence in the Florence Project Area appears to be related to 2 distinct processes, as follows:

1. That which may result from groundwater withdrawal, primarily associated with dewatering of the basin-fill deposits.

2. That which may result from in-situ leaching mineral recovery and the ensuing increase in bedrock void ratio.

3.5.1.1 Subsidence and Fissuring Due to Groundwater Withdrawal

Evidence of subsidence and earth fissuring in the region has been compiled by several sources in the last 20 years, the most recent of which is a study by Harris (1995). Land surface subsidence generally occurs in unconsolidated basin-fill deposits in Central Arizona as the result of groundwater level declines associated with agricultural pumping. As the basin-fill deposits are dewatered, a reduction in pore space ensues, resulting in compaction and densification.

Land subsidence has been documented as affecting approximately 1,100 square miles in western Pinal County (Schuman, 1986). The maximum amount of subsidence generally corresponds to areas of maximum groundwater withdrawals. In the area near the Towns of Maricopa and Stanfield, a water level decline of about 450 feet has resulted in approximately 12 feet of land surface subsidence. Laney and others (1978) report that about 120 square miles in the Eloy and Stanfield areas subsided more than 7 feet from 1952 to 1977.

Investigations performed by Harris (1995), Laney and others (1978) and Laney and Pankratz (1987) indicate that subsidence has been negligible in the Florence Project Area. This is largely due to the predominantly coarse-grained nature of the alluvial deposits in the area which have limited saturated thicknesses.

No documentation of land subsidence in the immediate in-situ mine area was identified during this investigation. If groundwater withdrawal overdraft continues in the region, areas approximately 3 miles south and 5 miles north of the Florence Project Area will be susceptible to land surface subsidence (Laney and Pankratz, 1987). As discussed in Section 3.6, rising water table elevations have been detected in the Florence Project Area during the period from the early 1980s to the present. As a result of the current practices and future goals of the Pinal AMA

(ADWR, 1991), subsidence potential in the Florence Project Area associated with groundwater withdrawal should be further reduced in the future.

As discussed in Section 3.4, the proposed in-situ mine area is located over a bedrock high which transitions to a graben structure to the west. This bedrock configuration beneath the western portion of the orebody in the in-situ mine area could be conducive to basin-fill fissures in the region if groundwater declines and land subsidence continues. As discussed in Section 3.6, groundwater declines in the region reported by ADWR (1991) of approximately 5 feet since the 1950s have not occurred in the Florence Project Area. This is likely because of the relatively shallow depth to bedrock in the proposed in-situ mine area (400 to 1,500 feet bgs), and the lack of large scale pumping comparable to that in the Maricopa/Stanfield area. In addition, the composition of basin-fill deposits in the Florence Project Area, primarily coarse-clastic sediments, are not as conducive to compaction as finer-grained sediments which occur in the Maricopa/Stanfield area. Based on investigations conducted by Laney and others (1978) the proposed in-situ mine area is located between outer boundaries of 2 main basin-fill water bearing units in the region. The lack of subsidence in the Florence Project Area is also reported by Schumann (1974) and others.

As part of this investigation, an evaluation of the potential effect of mine-related groundwater withdrawals upon land surface subsidence potential was performed. The estimated net amount of groundwater expected to be pumped on a yearly basis from the basin-fill deposits within the 10-mile by 10-mile Florence Project Area, and possibly from within the in-situ mine area to support mining activities is approximately 1,293 ac-ft (Magma, 1995). The amount of groundwater currently pumped, primarily from basin-fill deposits, in the 10-mile by 10-mile Florence Project Area, is approximately 13,360 ac-ft (see Section 3.9). Approximately 3,850 ac-ft of this amount is associated with irrigation in the proposed in-situ mine area (Magma, 1995). Anticipated groundwater use within the proposed in-situ mine area over the life of the mine is approximately 60 percent less than current irrigation use. Assuming the 3 agricultural wells currently located within the in-situ mine area will be relocated within the 10-mile by 10-mile area, and will pump similar amounts of groundwater, the resulting groundwater use will increase approximately 1 percent from 13,360 ac-ft to 14,650 ac-ft) in the Florence Project Area.

Similar calculations performed by the U.S. Bureau of Mines (Ahlness and Triplett, 1994) for the Santa Cruz in-situ Copper Mining Research Project estimated a 1.2 percent increase in groundwater withdrawal associated with that proposed operation. Their conclusions indicated that 1.2 percent was statistically moot and would not result in any significant additional surface subsidence at or near the Santa Cruz Site.

Earth fissures are tension cracks that occur in many Arizona alluvial basins as the result of differential settlement of basin-fill deposits resulting from groundwater overdraft. Work performed by Harris (1995) identified several areas with earth fissuring associated with land subsidence in western Pinal County. The closest area of fissuring to the Florence Project Area is south and southeast of the Sacaton Mountains east of Signal Peak, approximately 15 miles east of the proposed in-situ mine area. The area where these fissures are located is part of the Maricopa-Stanfield sub-basin of the Pinal AMA (see Figure 1.1-2). The formation of these and other fissures associated with the sub-basin is dependent on the composition of fill in the basin, which consists of a sequence up to 8,000 feet thick (Oppenheimer, 1980) of unconsolidated alluvial and fluvial clay, silt, sand, and gravel (Harris, 1995). Groundwater extraction near the center of the basin has resulted in groundwater level declines of up to 500 feet since the 1930s.

No evidence of earth fissuring was noted within the proposed in-situ mine area during reconnaissance investigations. Raymond (1981) evaluated the surface subsidence during studies for the Central Arizona Project (CAP) canal alignment in Section 15 (T3S, R9E) approximately 8 miles north of the Florence Project Area. Laney and others (1978) do not report any earth fissuring in the Florence Project Area. The nearest area of documented subsidence is located several miles south of the Town of Florence, Arizona.

3.5.1.2 Potential for Subsidence Due to In-situ Leaching Operations

Relevant studies of subsidence potential associated with in-situ mining include research performed by the U.S. Bureau of Mines (Ahlness and Triplett, 1994). These investigations focused specifically on the "Santa Cruz In-situ Copper Mining Research Project." Results of these studies indicate that the maximum expected surface subsidence resulting from in-situ mineral recovery is approximately 0.00045 inches, based on triaxial compression testing performed on unleached and laboratory leached cores. This amount of surface subsidence is reported to be negligible.

An evaluation of the maximum amount of surface subsidence expected to result from mining activities at the proposed in-situ mine area was performed during this investigation. The analysis utilized methods and results presented by Ahlness and Triplett (1994). The following input parameters were assumed:

Parameter	East Area	West Area
Average depth to orebody	400 feet bgs	800 feet bgs
Average ore zone thickness	200 feet bgs	600 feet
Ore grade	0.34 percent total copper	0.34 percent total copper

The above parameters are within the criteria used by Ahlness and Triplett (1994). Thus, the results performed in association with the Santa Cruz Project can be applied to the Florence Project Area in a conservative sense. Based on triaxial compression tests, Ahlness and Triplet (1994) derived a maximum amount of movement at the top of the ore zone of 0.0005 times the ore zone thickness. Settlement values, based on these assumptions, range from 0.1 to 0.3 inches over the mine life for the ore zone thicknesses cited above. Although this amount of settlement is greater than that reported by Ahlness and Triplett (1994), it will likely have no impact on the project facilities or the surrounding terrain.

3.5.2 Regional Seismicity

Earthquakes in the western United States generally are associated with youthful fault traces and recently active volcanos. The Florence Project Area is relatively remote from Holocene (most recently 10,000 years of earth history) and late Pleistocene (approximately 150,000 to 10,000 years ago) fault traces (Pearthree and others, 1983). The Florence Project Area is also relatively remote from younger volcanic rocks (0-15 MA) (Menges and Pearthree, 1989). The project area is characterized by a low level of seismicity during historic time. As noted by Sumner (1976), seismic sources in Arizona do not correlate directly with the physiographic provinces discussed in Section 3.2.1.

The boundaries of seismic source zones discussed in this subsection are based on historical seismicity, age and recurrence of fault displacements, and Quaternary volcanoes. Based on studies of post-Miocene age landforms, Pearthree and Scarborough (1984) estimated that major block faulting in this area culminated approximately 3 to 10 million years ago during Miocene and Pliocene time. Few faults in the region are considered to be active in the engineering sense. "Active faulting" is defined by Slemmons and McKinney (1977) as a structure that has experienced surface movement once in the past 35,000 years, or recurring movement during the past 500,000 years. Known active faults in the region include the Hurricane/Toroweap, Big Chino, San Andreas and Pitaycachi faults or fault systems. Suspected active faults in the region include the Santa Rita, Sand Tank and Sugar Loaf faults (Sumner, 1976). The closest active and suspected active locations to the Florence Project Area are approximately 130 and 45 miles distant, respectively.

Examination of the Sand Tank fault, located about 45 miles east of the Florence Project Area, was performed by Demsey and Pearthree (1990). Their work indicated that this fault probably generated a surface rupture earthquake of magnitude 6.2 to 6.6 between 8,000 and 20,000 years ago. Their assessment of the Sand Tank fault suggests that the minimum recurrence interval for surface faulting earthquakes is 50,000 to 200,000 years.

Historic seismic activity is generally characterized by broadly scattered events of low magnitude. Earthquake record compilations (Sturgul and Irwin, 1971) indicate that the maximum intensities in the region are on the order of a Modified Mercalli Intensity (MMI) of VI. The 2 historic earthquakes with the greatest intensities consist of the following:

- Baptepito, Sonora, Mexico, 1887; Approximately 190 miles from the Florence Project Area; MMI of VIII-IX near epicenter.

- Calexico, California, 1934, Approximately 250 miles from the Florence Project Area; MMI of V in Tucson and VI in Phoenix, Arizona.

For the purpose of selecting earthquake design parameters, the Florence Project Area falls into various categories. According to Sumner (1976), who divides Arizona and surrounding areas into five zones, the in-situ mine area is located in Zone 5, along with the major metropolitan areas of Phoenix and Tucson. Zone 5 has the lowest risk of the five categories. The Applied Technology Council (ATC, 1981), places Maricopa, Gila, Yavapai and Pinal Counties of Central Arizona into 2 seismic design zones, which are different than the seismic source zones reported by Sumner (1976). Zone 1 for effective peak horizontal ground motion, which incorporates a design seismic coefficient (Aa) of 0.05. Aa is dimensionless, and equivalent to effective peak horizontal ground acceleration (PGA) as a fraction of the force of gravity. The design value is considered a non-amplified, free-field peak horizontal acceleration. A PGA of 0.05 is estimated by Algermissen and others (1982) for recurrence intervals up to 474 years and is the maximum estimated PGA for known or suspected active faults. Zone 2 for effective peak velocity-related ground motion, which is characterized by minimal damage from seismic shaking.

The Florence Project Area borders the Arizona Mountain and Sonoran Zones as defined in a 1992 Arizona Department of Transportation (ADOT) seismic hazard study. The Arizona Mountains zone is considered to have a maximum earthquake of magnitude 6.5, the threshold magnitude above which surface faulting would be expected. The U.S. Bureau of Reclamation (1986) in association with design of the New Waddell Dam, located north of Phoenix, Arizona, considered a magnitude 6.25 earthquake to be the largest that could occur in the Arizona Mountain zone without being generated by a known fault.

For the Sonoran zone, the 1992 ADOT study assigned a maximum earthquake magnitude of 6.0. The seismic activity associated with the Sonoran zone is significantly lower than the Arizona Mountains zone, thus earthquakes in the Sonoran zone do not control seismic design parameters at the Florence Project Area.

3.6 REGIONAL OCCURRENCE OF GROUNDWATER

The Florence Project Area is located along the northern edge of the Eloy sub-basin of the Pinal AMA (Wickham and Corkhill, 1989). It is also approximately 2.5 miles south of the southern edge of the Eastern Salt River Valley (ESRV) sub-basin in the Phoenix AMA (see Figure 1.1-2). The primary source of groundwater in central Arizona is from the basin-fill units. Within the vicinity surrounding the proposed in-situ mine area, the LBFU is the principal source of groundwater withdrawals.

The following discussions summarizing regional groundwater conditions are based on the evaluation of existing information and data compiled during this investigation. These data are included in Appendix B of this volume as Tables B-1, B-2, and B-3 (water level information), and Tables B-4, B-5, and B-6 (well construction information). The most recent measurement of groundwater levels by Brown and Caldwell and Magma personnel was performed in December 1995. A map of the Florence Project Area depicting water table elevation contours associated with the November 1995 data is included as Sheet 3.6-1 of this volume.

3.6.1 Description of the Regional Groundwater System

ADWR (1991) has divided the saturated materials within the Pinal AMA into four main hydrogeologic units. The Upper Alluvial Unit is analogous to the UBFU referenced in this report. The Middle Silt and Clay Unit is analogous to the MFGU, and separates the upper and lower basin-fill units. The Lower Conglomerate Unit is analogous to the LBFU referenced in this report. The Hydrologic Bedrock Unit is similar to the bedrock zones referenced in this report.

The Upper Alluvial Unit consists mainly of unconsolidated to slightly consolidated, interbedded gravels, sands and silt, with some finer-grained materials existing as lenses. The lower half to one-third of this unit is a transition zone containing interbedded coarse and fine alluvial material typical of the underlying Middle Silt and Clay Unit. The Upper Alluvial Unit forms a significant aquifer throughout the area, with well yields that have been reported up to 3,000 gpm (ADWR, 1991).

The Middle Silt and Clay Unit generally separates the upper basin-fill unit from the lower basin-fill unit. This fine-grained unit is reported to be laterally extensive throughout the basin (ADWR, 1991). Near the margins of the basins in basins within the Pinal AMA, this unit may not be distinguishable from the overlying or underlying materials. The Middle Silt and Clay Unit is known for groundwater production in the Eloy sub-basin. The middle alluvial unit has been intercepted during drilling at the in-situ mine area, and has been identified on off-site water well logs for wells within the 100-square mile Florence Project Area as the Middle Fine Grained Unit (MFGU).

The Middle Silt and Clay Unit has been divided into 2 sub-units (Hardt and Chattany, 1965). The uppermost sub-unit consists of about 90 percent clay with intermittent gravel and sand lenses. This sub-unit has been described in core and water well logs throughout the Florence Project Area (Magma, 1995). The lower fine-grained sub-unit is the thickest and is found in deeper areas of the Eloy Basin where it may exceed 3,000 feet in thickness (Hardt and Chattany, 1965). It is predominantly an evaporite unit consisting of anhydrite with minor clay and silt. This sub-unit has been identified to the north and northeast of the proposed mine site, but not within 3 miles of the proposed in-situ mine area.

Beneath the Middle Silt and Clay Unit is the Lower Alluvial Unit. This unit is also known as the Lower Conglomerate Unit, as reported by Montgomery (1994) and Conoco (1976). It is the deepest alluvial unit in the Eloy Basin and was intercepted during current investigation drilling activities. The lithology of the lower alluvial unit is characterized by semi-consolidated to consolidated coarse sediments consisting of granite fragments, cobbles, boulders, sands, and gravels.

The Lower Alluvial Unit locally produces groundwater. In many cases, yields from wells penetrating the lower basin-fill can exceed 1,000 gpm and can be as large as 2,500 gpm (Montgomery, 1994). Where the LBFU occurs directly beneath the MFGU, groundwater may exist under confined or semi-confined conditions. Where the Lower Alluvial Unit is in direct contact with the Upper Alluvial Unit, groundwater exists under generally unconfined conditions.

The Lower Alluvial Unit rests on fractured and faulted bedrock. The bedrock consists of Precambrian granite, gneiss, and schist. The bedrock is considered to be impermeable and non water-bearing compared to the basin-fill units, but is reported to be locally permeable in areas where it is highly fractured. Many wells completed in the region are screened in the basin-fill units as well as the bedrock complex (see Tables B-4 and B-5 in Appendix B).

3.6.2 Depth to Water

Figures 3.6-1[II], 3.6-2[II], and 3.6-3[II] depict regional water table elevations in central Arizona for the years 1900, 1982 through 1985, and 1991 through 1992, respectively. Data used to create these illustrations have been previously compiled by others as discussed below. Groundwater level hydrographs for wells PW-4 and BIA-9, located in the proposed in-situ mine area, are presented in Figures 3.6-4[II] and 3.6-5[II], respectively. Hydrographs from these wells serve to illustrate the general water level trends discussed in this section. A detailed review of ADWR water level information presented in Appendix B for the Florence Project Area was performed as part of this investigation. The results of this review are summarized in Table 3.6-1, and discussed below, with work performed by others.

Groundwater conditions depicted on Figure 3.6-1[II] for circa 1900 represent pre-development conditions. Hardt and Chattany (1965) and Montgomery (1994) report that the groundwater system in western Pinal County was virtually undisturbed prior to 1923. Groundwater elevations in 1900 across the Florence Project Area ranged from 1,380 to 1,420 feet above mean sea level (msl), approximately 40 to 50 feet bgs.

Montgomery (1994) reports that groundwater levels in the Florence Project Area declined during the period from 1923 through 1977 an estimated 150 feet. This is consistent with information reported by Wickman and Corkhill (1989), Laney and Raymond (1978), and Konieczki and English (1979). Based on ADWR data, the area surrounding the Florence Project Area has experienced a long period of decline from the early 1940s to the late 1970s. Measurements from eight wells listed in Table 3.6-1 indicate a groundwater decline of approximately 95 to 180 feet during this period. No wells show a water level rise during this period.

The regional decline in groundwater levels discussed above was caused by substantial groundwater withdrawals and partial elimination of flow in the Gila River. These conditions have occurred in both the Gila River Valley, and the ESRV, which is located approximately four miles north of the in-situ mine area. Ninety percent of the groundwater withdrawals (over 73 million ac-ft in the ESRV alone), were used for irrigation (Laney and others, 1978). The groundwater withdrawals resulted in aquifer overdraft, with significant water level declines (up to hundreds of feet) occurring in areas experiencing heavy agricultural use.

ADWR data indicates that water levels generally rose from the mid 1970s to the mid 1980s. Groundwater measurements from 12 wells shown in Table 3.6-1 around the Florence Project Area indicate a general water table rise of approximately 25 to 115 feet during the period from the late 1970s to the mid 1980s. Water levels declined during this period in 2 wells listed in Table 3.6-1, ranging from 1 to 10 feet. Groundwater conditions for 1982 through 1985 shown in Figure 3.6-2[II] indicate that groundwater elevation ranged from 1,250 to 1,300 feet above msl across the Florence Project Area. These elevations are approximately 200 feet lower than that measured in 1900. The reported water level information indicates that declines in groundwater elevation had stabilized during this period. This behavior is also evident in Figures 3.6-4[II] and 3.6-5[II].

Figures 3.6-4[II] and 3.6-5[II] and Table 3.6-1 show that during the period from the mid 1980s to 1991, water levels again generally show stabilization or slight declines. Groundwater measurements from 12 wells in the Florence Project Area indicate a decline of approximately 2 to 120 feet during this period. Water levels rose from 5 to 30 feet were reported for 3 wells during this period.

Figure 3.6-3[II] shows groundwater conditions for 1991 through 1992 derived from Corkhill and others (1993). Groundwater in proximity to the Florence Project Area occurs at an elevation ranging from 1,250 to 1,350 feet msl, which is approximately 100 to 200 feet below land surface. These data indicate that groundwater elevations have stabilized. Montgomery (1994) reports that the depth to groundwater in the vicinity of the in-situ mine area was about 160 to 170 feet bgs in March 1993, and about 116 to 140 feet bgs in Spring 1994.

Rises in water levels are recorded in Table 3.6-1 for 14 wells during the period from 1991 to 1993 range from 2 to 140 feet. One well exhibited a decline in water level during this period of approximately 45 feet. Groundwater measurements presented in Table 3.6-1 from 1993 to late 1994 generally indicate declining water levels. Groundwater measurements from 10 wells indicate declines ranging from 2 to 60 feet during this period. Four wells indicate water level rise ranging from 10 to 60 feet during this period.

The available water level data suggest that during the period between the early 1980s and early 1990s, groundwater level declines have generally stabilized in the Florence Project Area. This is likely the result of groundwater management practices implemented by the State of Arizona during this time period to conserve groundwater resources. As reported by Montgomery (1994), and supported through findings during this investigation, the majority of groundwater level rises resulted from Gila River floods in the late 1970s, early 1980s and 1993 (see Section 3.3). As discussed in Section 4.2, a rise in groundwater levels in the Florence Project Area following the 1983 flood ranged from no effect to more than 75 feet in 1983 and 1984 (Konieczki and Anderson, 1990). Groundwater level rises following the 1993 flood event ranged from less than 10 feet to more than 100 feet in 1992 and 1993 (Montgomery, 1994). Groundwater level rises attributed to the 1993 flood are likely still occurring. Montgomery (1994) reports that an average rise of approximately 38 feet has occurred across the site between March 1993 and March 1994. The effect of Gila River flow on the groundwater system is discussed further in Section 4.2.

Water levels measured during the 1995 investigation ranged from 100 to 150 feet bgs, significantly higher than those reported in 1993. Water levels measured during this investigation were substantially affected during periods of groundwater pumping. Sheet 3.6-1[II] shows water table elevation contours for November 1995 in the Florence Project Area. Shallower contours shown on Sheet 3.6-1[II] on the area of the Gila River appear to indicate mounding associated with recharge from the Gila River. Montgomery (1994) suggests that this is a transient condition resulting from flooding in February 1993.

3.6.3 Regional Flow Direction and Gradient

As discussed in Section 3.6.1, Hammett (1992) reports that prior to about 1900 the groundwater system in the Florence Project Area was in approximate dynamic equilibrium. Until approximately 1923, the amount of water entering the groundwater system was approximately equal to that extracted, with no appreciable change in storage. During the pre-development time of equilibrium, (see Figure 3.6-1[II]), the general direction of groundwater flow through the Florence Project Area was from the east-southeast to the west-northwest, with a gradient of 8 or 9 feet per mile (Hammett, 1992).

Groundwater withdrawals in excess of recharge over time have differentially lowered groundwater levels in central Arizona. As shown on Figures 3.6-2[II] and 3.6-3[II], the regional flow direction had changed by the 1980s to a southeast to northwest pattern, toward areas of greatest groundwater pumping. As discussed in Section 3.3.1, flows in the Gila River have also been eliminated in all but the wettest years; therefore, infiltration of river water into the upper basin-fill sediments has also been limited to periods of flooding as discussed in Sections 3.6 and 4.2.

Effects of water level declines from pre-development conditions included increased gradient. Sheet 3.6-1[II] shows groundwater elevations for the Florence Project Area derived from data acquired in November 1995 during this investigation. Groundwater flow is generally to the northwest at an approximate gradient of 33 feet per mile (ft/mi) in the northern portion of the Florence Project Area. Montgomery (1994) reports the hydraulic gradient across the proposed in-situ mine area to range from 25 to 65 ft/mi.

Another effect of lowering the water table has been less saturated thickness and less flow in the basin-fill. This results in regional flow patterns which are more affected by geologic structures and rock types in the deeper basin profile. Referring to Sheet 3.6-1[II], groundwater flow direction in the Florence Project Area is to the west and north, and is significantly influenced by mounding in the vicinity of the Gila River to the south and pumping to the north of the proposed in-situ mine area. Groundwater flow in the graben area to the west of the in-situ mine area is to the north. This result is also reported by E.L. Montgomery (1994). Montgomery (1994) also calculated a groundwater velocity of 0.75 feet per day in the graben area west of the mine property. Further discussions of groundwater flow characteristics are presented in Section 4.3.

3.6.4 Aquifer Recharge-Discharge Relationships

As discussed in previous sections, both the basin sediments and the bedrock in the region are water-bearing and appear to be hydraulically interconnected. While it is apparent that percolation from the surface can eventually affect all of the water bearing zones, the primary recharge for each aquifer unit or zone is somewhat unique. With the exception of agricultural runoff, occasional flood flows, and direct precipitation, all of the water entering the Florence Project Area arrives as subsurface flow through and under the Gila River channel from the east. This subflow likely originates as surface flow above the Ashurst/Hayden Diversion Dam (see Figure 3.3-1).

The unconsolidated alluvium and UBFU are recharged primarily through subsurface flow from the Gila River channel, as well as percolation of agricultural water and a small amount of rainfall. Some recharge also occurs as percolation of surface runoff from the mountains at the basin perimeter. The LBFU is recharged primarily by subsurface flow originating from the Gila River. Some recharge occurs through the MFGU that separates the UBFU and LBFU, and through percolation at the basin margins.

The bedrock hydrogeologic unit is initially recharged in the mountains to the east along the Gila River. In areas where the overlying basin-fill units are relatively thin, such as the horst block that contains the Florence orebody, the bedrock complex may also be recharged by groundwater from the overlying LBFU.

Groundwater associated with Gila River underflow comprise the primary recharge to the model domain discussed in Volume IV of this application. Underflow originates from intermittent flow of the middle section of the Gila River and from underflow originating in the area above the Ashurst-Hayden Dam. The model consists of a groundwater flow simulation which is used to verify current hydrogeologic conditions, and to predict groundwater responses associated with proposed in-situ mining operations. The groundwater simulations are based on the conceptual hydrogeologic model derived from the evaluations presented in Section 5.0.

Groundwater contours based on measured water levels show a westward flow gradient along the eastern border that becomes divergent to the north and south in the vicinity of the graben structure west of the proposed in-situ mine area. Flow to the north leaves the Eloy sub-basin and enters the Salt River Valley flow system along the northern boundary of the model domain. A portion of the flow continues south to the center of the Eloy sub-basin. The remainder is diverted around the base of the Santan Mountains. Based on ADWR reports, the regional groundwater flow direction has been generally consistent since the early 1900s (ADWR, 1989).

The other significant source of water in the model domain is vertical recharge from the losing sections of ephemeral reaches of the Gila River. In the model domain, the Gila River is ephemeral and the base of the river is above the regional water table. During flow events in the rivers, water infiltrates downward from the Gila River to the UBFU. Movement of water from the river to the aquifer is influenced by local geologic heterogeneities that aid or restrict the flow of water in the subsurface. Local groundwater flow directions and magnitude in the proposed in-situ mine area are generally to the northwest as regional groundwater flow directions diverge to northern and southern flow. The recharge associated with the Gila River forms a mound in the UBFU that changes local groundwater flow gradients near the river. Mountain front recharge and precipitation are not considered significant sources of recharge to the groundwater system.

Because the primary source of recharge in the model domain is associated with underflow from the Gila River flow system, there are little to no vertical gradients between the UBFU, LBFU, and oxide bedrock zone under steady-state conditions. Transient stresses due to vertical recharge and groundwater withdrawals cause localized vertical gradients. High winter precipitation events can cause flow in the Gila River and increase vertical infiltration and groundwater mounding effects, primarily in the UBFU. In addition, long-term precipitation events recharge the entire Gila River flow system and increase underflows into the model domain. These increases in underflow tend to slowly increase water level elevations across the entire model domain, but do not change general regional groundwater flow patterns. Gila River flows south of the mine site cause localized mounding south of the proposed in-situ mine area, and further increase northerly groundwater flow gradients and direction beneath the property.

3.7 REGIONAL AQUIFER CHARACTERISTICS

Evidence reported by Wickham and Corkhill (1989) suggests that the ESRV sub-basin is in communication with, and may be recharged from, groundwater derived from the Eloy sub-basin in the vicinity of the Florence Project Area. The boundary between the 2 basins is located approximately 2.5 miles north of the in-situ mine area (see Figure 1.1-2). The depositional history of each sub-basin is contemporaneous; therefore, the aquifer characteristics of both sub-basins are discussed. The discussion herein is in terms of 3 basin-fill deposits (UBFU, the MFGU, and the LBFU) and the bedrock zone.

Table 3.7-1 presents a summary of regional aquifer test data acquired from ADWR (1995) and Magma (1995) during this investigation for the region surrounding the Florence Project Area. The well locations presented in Table 3.7-1 can be cross referenced to water level and well construction information presented in Appendix B. The majority of data presented in this table apply to the basin-fill hydrogeologic units and should be used for informational purposes only. These data were acquired from approximately 1941 to the present, likely with a variety of methodology. The data were used to characterize the region in a general sense and for confirmation purposes relevant to the current investigation. Conversions of specific capacity values presented in Table 3.7-1 to hydraulic conductivity values was not performed because of unknown data acquisition details. Project-specific discussions of aquifer characteristics are presented in Section 4.0.

3.7.1 Upper Basin-Fill Unit (UBFU)

The UBFU of the Eloy sub-basin consists primarily of unconsolidated to slightly consolidated sands and gravel, with lenses of finer-grained material (Wickham and Corkhill, 1989). The UBFU of the ESRV sub-basin consists primarily of gravel and sand near the Gila and Salt Rivers and near the margins of the sub-basins, and primarily sands and silts in the remaining areas (Corkhill and others, 1993).

The thickness of the UBFU in the Eloy sub-basin ranges from approximately 50 feet near mountain fronts to approximately 1,200 feet in the basin center (Wickham and Corkhill, 1989). The thickness of the UBFU in the ESRV sub-basin is typically between 100 and 200 feet, being thinner near mountain fronts and thicker in the central sub-basin (Corkhill and others, 1993).

Confined aquifer conditions have been encountered in some areas of the Eloy sub-basin; however, the UBFU is primarily unconfined in this sub-basin (Wickham and Corkhill, 1989). Well yields in the Eloy sub-basin range up to 3,000 gpm (Wickham and Corkhill, 1989). Hydraulic conductivities ranged from 13 to 153 feet per day and specific yields range from 5 to 20 percent (Wickham and Corkhill, 1989). Potential yield to wells in the ESRV sub-basin ranges from 1500 to 5,500 gpm (Corkhill and others, 1993). Hydraulic conductivity ranges from 20 to 250 feet per day and specific yield is estimated to range from about 8 to 22 percent (Corkhill and others, 1993).

3.7.2 Middle Fine-Grained Unit (MFGU)

The reference literature refers to this portion of the sedimentary profile as the MFGU, the Middle Alluvial Unit or the Middle Silt and Clay Unit in the Eloy sub-basin (Wickham and Corkhill, 1989; Corkhill, Corell, Hill, and Carr, 1993). For the purposes of this discussion, this unit will be referred to as the MFGU. The MFGU in the Eloy sub-basin is primarily fine-grained, consisting of silts, clays and sands (Wickham and Corkhill, 1989). The MFGU in the ESRV sub-basin consists of clay, silt, and gypsum-rich mudstone with interbedded sand and gravel. Near the basin margins the MFGU is primarily sand and gravel and is impossible to distinguish from the UBFU or LBFU (Corkhill and others, 1993).

The MFGU in the Eloy sub-basin ranges in thickness from less than 50 feet near the sub-basin margins to greater than 6,500 feet in the sub-basin center (Wickham and Corkhill, 1989). The MFGU in the ESRV sub-basin ranges in thickness from less than 100 feet at the margins to greater than 1,600 feet in the sub-basin center (Corkhill and others, 1993).

The MFGU in the Eloy sub-basin can be locally productive if the well penetrates a sand and gravel stringer; however, productivity in the MFBU is limited (Wickham and Corkhill, 1989). The hydraulic conductivity of the MFGU in the Eloy sub-basin were on average less than 4 feet per day, with specific yields ranging from 3 to 7 percent (Wickham and Corkhill, 1989). The MFGU is the primary source of water in the ESRV sub-basin, with potential yield to wells ranging from 350 to 2,200 gpm (Corkhill and others, 1993). The hydraulic conductivity of the MFGU in the ESRV sub-basin are estimated to range from 5 to 50 feet per day, with specific yields estimated to range from 3 to 14 percent (Corkhill and others, 1993).

3.7.3 Lower Basin-Fill Unit (LBFU)

The LBFU in the Eloy sub-basin consists of consolidated to semi-consolidated, coarse granite fragments, cobbles, boulders, gravel and sands (Wickham and Corkhill, 1989). The LBFU overlies, or is in fault contact with, the hydrologic bedrock in the ESRV sub-basin. The unit is characterized as primarily conglomerate and gravel near the sub-basin margins, and mudstone, gypsum-rich and anhydrite-rich mudstone and anhydrite in the central areas of the sub-basin (Corkhill and others, 1993).

The maximum thickness of the LBFU in both sub-basins is unknown due to a lack of deep drilling data (Wickham and Corkhill, 1989; Corkhill and others, 1993). The LBFU in the Eloy sub-basin ranges from less than 50 feet thick at the margins to greater than 1,500 feet in the central areas of the basin (Wickham and Corkhill, 1989). The LBFU in the ESRV ranges from less than 100 feet thick at the sub-basin margins to greater than 2,000 feet thick in the central portion of the basin (Corkhill and others, 1993).

The LBFU in the Eloy sub-basin is unconfined where the MFGU is not present. However, when the LBFU is in contact with the MFGU the aquifer may be under confined or semi-confined conditions (Wickham and Corkhill, 1989). The well yields from the LBFU are similar to the well yields of the UBFU (Wickham and Corkhill, 1989). Hydraulic conductivity ranges from 0.5 feet per day (ft/day) in the extremely deep and compacted sediments to 133 ft/day in less indurated deposits. The specific yield ranges from about 3 to 18 percent (Wickham and Corkhill, 1989). The LBFU of the ESRV sub-basin has potential well yields of 50 to 3,500 gpm, with the highest yields from wells screened in coarse-grained material (Corkhill and others, 1993). The hydraulic conductivity of the LBFU in the ESRV sub-basin ranges from 5 to 60 feet per day and the specific yield ranges from 3 to 15 percent (Corkhill and others, 1993).

3.7.4 Bedrock Unit

The hydrologic bedrock consists primarily of Precambrian granite, gneiss and schist with Mesozoic granite and related crystalline intrusive rocks, volcanic flows, sedimentary and metamorphic rocks (Wickham and Corkhill, 1989). The hydrologic bedrock is an assumed impermeable boundary which underlies and borders each sub-basin (Wickham and Corkhill, 1989). In the context of defining regional groundwater resources, the bedrock zone does not yield appreciable quantities of water (Wickham and Corkhill, 1989). Local areas do yield significant amounts of groundwater from the bedrock complex. These areas may be associated with areas that are intensely fractured.

3.8 GROUNDWATER QUALITY

Regional groundwater quality data from existing sources is presented in Tables C-1 and C-2 in Appendix C. As part of this investigation, these data were statistically analyzed for a 100-square mile region, centered on the proposed in-situ mine area. The data were evaluated for regional groundwater quality characteristics. An evaluation of concentrations, spatial and temporal distribution, and relationships of chemical parameters within and around the Florence Project Area was also performed. The regional water quality data were used as a basis for analyzing the potential risks associated with operational excursion, which are discussed in detail in Volume IV of this application. The statistical evaluation is documented in a report included with this volume as Appendix C. Methods of analysis and results from the report are summarized in this sub-section.

3.8.1 Chemical Constituents Evaluated

Groundwater quality data in the Florence Project Area have been collected and evaluated since 1941 by various government and private entities. The existing groundwater quality data presented in Tables C-1 and C-2 in Appendix C was originally compiled by Montgomery (1994), and include data previously compiled by Hardt and others (1964), Halpenny and Green (1972 and 1973), Dames and Moore (1974), Water Development Corporation (1975), Halpenny (1976) and files from the USGS, ADEQ, and Magma.

General groundwater quality and Aquifer Water Quality Standard (AWQS) exceedances were evaluated for all water quality variables except for radiological parameters, which were not in a format that could be compared to the standards. Chemical constituents with AWQSs include nitrate, fluoride, arsenic, barium, cadmium, chromium, mercury, lead, and selenium. Where discernible, based on the information presented in Appendix B, water quality signatures for discrete basin-fill and bedrock hydrogeologic units were evaluated separately.

3.8.2 Descriptive Statistics

Descriptive statistics were evaluated for all water quality parameters (variables) except for radiological parameters (plots depicting center values and error bars were constructed for radiological parameters). The following observations can be made based on a review of the descriptive statistics as described in Appendix C.

- The geometric mean and the median are generally lower than the mean indicating right skewed distributions (e.g. distributions where most of the values occur at the lower end and a few high values form a long right tail).

- Thirty-three of the 36 water quality variables have positive skewness values (e.g. right skewness).

- Sodium has the highest mean and median concentration of all the cations.

- Chloride has the highest mean and median concentration of all the anions.

- The median of all trace constituents except boron, iron, and strontium is zero, indicating that more than half of the values for those constituents are equal to zero.

- Only boron and strontium have non-zero values in the lower zones of analysis (quartiles).

- Arsenic, boron, iron, manganese, strontium, and zinc have non-zero upper quartiles.

3.8.3 Statistical Analyses for Sodium, Chloride, Sulfate, Total Dissolved Solids (TDS), and Nitrate

Additional statistical analyses were conducted on five selected water quality variables: sodium, chloride, sulfate, total dissolved solids (TDS), and nitrate. Sodium and chloride are the dominant cation and anion; sulfate and TDS are important from a mining operations standpoint; and nitrate exceeds the AWQS in many cases.

Histograms show the presence of high-end outliers for sulfate and nitrate, and indicate that distributions for all five water quality variables are right skewed. In all five cases, the data display a concave pattern on normal probability plots, which is also indicative of right skewness. Sodium, chloride, and TDS data show a reverse "S" pattern on normal probability plots, suggesting negative kurtosis (e.g. a more peaked distribution that the standard normal curve).

Hypothesis testing was conducted on the five selected water quality variables using both original and natural log-transformed data. In all cases except for log-transformed sodium, the data are nonnormally distributed at the 5 percent significance level. Although values of the test statistic show that log transformations had a normalizing effect on the data, the transformations did not change p-values for chloride, sulfate, nitrate, or TDS.

Concentrations of the five selected water quality variables over different screened formations were compared using boxplots. The boxplots show that, with the exception of sodium, median concentrations are clearly the lowest in the bedrock hydrogeologic unit. (Concentrations of sodium are also lowest in the bedrock zone; however, the difference is insignificant.)

3.8.4 Cations and Anions

Boxplots were used to compare cations and anions. The boxplots show that sodium and chloride have higher median concentrations than the other cations and anions, respectively. Sulfate is prominent due to the presence of 3 high-end outliers.

The dominant cation and the dominant anion were identified for selected samples and then tallied. Results were calculated both in terms of milligrams per liter (mg/l) and milliequivalent per 100 grams (meq/l), and samples collected from wells screened only in bedrock zone were analyzed in a separate group. In general, sodium and chloride are the dominant ions in the majority of samples. Carbonate, however, was the dominant anion in the majority of samples from wells screened only in bedrock, and expressed in terms of mg/l.

Cations and anions from 68 data sets were plotted on a chronological series of Piper diagrams presented in Appendix C. Eighty-one percent of the values in the upper diamond-shaped diagram fall into a cluster defined by 40 to 70 percent sodium and potassium, and 60 to 90 percent sulfate and chloride. No temporal trends are evident.

3.8.5 Spatial Distribution of Sulfate and Nitrate

Spatial distribution of sulfate and nitrate over the 100-square mile Florence Project Area was examined by plotting mean concentrations for each well on regional maps. The results of these efforts are included in Appendix C. The median of the mean well concentrations data for those wells screened only in basin-fill zone within each 1 square mile section were plotted at each center of the section. Those centerpoints were then contoured. Although areas with anomalously high concentrations of both sulfate and nitrate are evident, no clear trends can be identified. Sources of both sulfate and nitrate in the groundwater are likely influenced by agricultural land use in the area.

3.8.6 Summary

Based on these analyses of existing water quality data, the following conclusions can be made:

- Data reviewed during this study indicated approximately 70 nitrate values and 3 cadmium values exceeded AWQS.

- Existing data were obtained using a variety of sampling methods and laboratory methods. Samples were collected over a 100-square mile area, from many types of wells, over a time period of 52 years, and for purposes. All of these factors contribute to variability in the data.

- The existing data are of insufficient quality for determining baseline concentrations for compliance monitoring, but are adequate for general characterization purposes.

- The dominant cation in the bedrock complex is sodium, and the dominant anion in basin-fill is chloride. In the bedrock unit, the dominant cation is carbonate if measured in meq/l and chloride if measured in mg/l.

- Distributions of water quality variables will tend to be right skewed. High end outliers could occur, particularly with sulfate.

- Existing basin-fill groundwater quality data from 1941 to present consists of a total of 100 to 140 samples. The following range in concentrations for selected chemical constituents are reported:

    - Sulfate: less than detection limits to 700 mg/L
    - Nitrate: 0.4 to 138 mg/L
    - Fluoride: 0.3 to 1.5 mg/L
    - TDS: 309 to 3,874 mg/L

- Existing bedrock complex water quality data from the early 1970s to present consists of a total of about 7 samples. The following range in concentrations for selected chemical constituents are reported:

  - Sulfate: 62 to 210 mg/L
  - Nitrate: 0.4 to 1.5 mg/L
  - Fluoride: 0.1 to 1.2 mg/L
  - TDS: 350 to 676 mg/L

3.9 GROUNDWATER USE

As discussed previously, the Florence Project Area is located in the Gila River Basin within the Eloy sub-basin (see Figure 1.1-2[II]) within the Pinal AMA. The Pinal AMA covers approximately 4,000 square miles in central Arizona and includes five groundwater sub-basins (ADWR, 1991). Approximately 80 percent of the population within the Pinal AMA resides in the Eloy sub-basin, and about 50 percent of all agricultural activity also occurs therein (ADWR, 1991). Based on ADWR records through May, 1995 (ADWR, 1995), there are 382 registered wells within the 100 square mile Florence Project Area (covering a 5-mile radius around the in-situ mine area). Sheet 1.2-1[II] shows the locations of these wells. As presented in Table 3.9-1, these wells are used for irrigation, domestic, public water supply, and monitoring purposes. Agricultural and municipal entities are the primary consumers of groundwater in the project area.

3.9.1 Agricultural Withdrawals

The majority of groundwater reported in Table 3.9-1 is used by SCIDD, which is an element of SCIP. SCIP is the primary user of surface water diverted from the Gila River and groundwater pumped from the Florence Project Area. The other primary element of SCIP is GRIC. A delineation of SCIP lands is presented on Figure 3.3-1. Approximately 80 percent of the land in the region is used for agriculture (Beer, 1988). The main crop is cotton which is watered using flood irrigation methods. Approximately 12 percent of the farmers in the Florence Project Area use groundwater from private wells (ADWR, 1991). The remaining farms utilize surface water supplied by SCIDD through 3 canals; the Florence-Casa Grande Canal, the North Side Canal, and the Florence Canal (see Section 3.3).

Table 3.9-2 presents a summary of monthly groundwater pumped by SCIDD in 1994. Use of water for irrigation is seasonal, with peak usage occurring from June through August. A total of 13,332 ac-ft of groundwater was withdrawn in 1994. Groundwater withdrawals in the region are reported to have exceeded recharge since 1952, resulting in an average decline rate of the water table of greater than 5 feet per year (ADWR, 1991). As discussed in Sections 3.5 and 3.6, because the Florence Project Area is located on the edge of 2 primary groundwater basins, groundwater level declines have generally stabilized since the early 1980s in the project area. Infiltration from the excess irrigation is variable and is estimated to be low.

Figures 3.9-1[II] and 3.9-2[II] illustrate monthly water use and groundwater pumped, respectively, by SCIDD for the time period 1982 through 1992. Based on information obtained during this investigation from ADEQ (1995) for the period from 1987 to 1992, the estimated amount of groundwater used by SCIP ranges from 2 to 14 percent, annually, of their total water use.

3.9.2 Community Drinking Water Systems

The Town of Florence owns five public supply wells in the general vicinity of the Florence Project Area. Two wells are located approximately 2.5 miles east of the Florence proposed in-situ mine area at Florence Gardens. Three wells are located in the Town of Florence, approximately 3 miles southeast of the proposed in-situ mine area (see Sheet 1.2-1[II]). The 3 wells located in the Town of Florence provide drinking water to the residents and businesses of Florence. The 2 wells located at Florence Gardens provide drinking water to the residents of Florence Gardens, the Air National Guard (ANG), and the Immigration and Naturalization Service (INS).

The Arizona Department of Corrections owns 2 water supply wells; 1 located approximately 2.5 miles south, and 1 located approximately 3 miles east of, the proposed in-situ mine area (see Sheet 1.2-1[II]). These wells provide drinking water to approximately 4,200 inmates at the Florence Complex of the Arizona State Prison. The majority of privately owned domestic wells are located outside of the Florence Project Area, in rural areas to the south. Tables B-4 and B-5 in Appendix B present additional information concerning these wells.

3.9.2.1 Groundwater Withdrawals

Table 3.9-3 summarizes large municipal water providers in the Pinal AMA (ADWR, 1995). Of the providers listed in Table 3.9-3, the Arizona State Prison at Florence and the Town of Florence are within five miles of the proposed in-situ mine area (see Sheet 1.2-1[II]). Groundwater pumped from wells in 1985 which serve these 2 entities, as presented in Table 3.9-3, consist of 913 ac-ft and 809 ac-ft, respectively.

3.9.2.2 Water Chemistry

Table 3.9-4 presents a summary of analytical results concerning municipal water quality in the Florence Project Area. This testing was performed by others, and is on file at the office of the associated entity discussed. Municipal water suppliers discussed in the section consist of the Town of Florence (formerly the Arizona Sierra Utility Company), which supplies Florence Gardens and the Town of Florence, and the Arizona State Prison. Locations of the wells are shown on Sheet 1.2-1[II].

The groundwater samples were collected by various parties between May 1992 and August 1995. The groundwater samples were obtained from wells 1 and 2 (Arizona Sierra Utility Company) and wells 8 and 9 (Arizona State Prison) and were analyzed at American Analytical Laboratories, located in Tucson, Arizona and Westech Laboratories Inc., of Phoenix, Arizona, respectively.

The concentration of sulfate in these groundwater samples ranges between 50 mg/L and 138 mg/L. The concentrations of nitrate (as N), TDS, and fluoride range between , 0.50 mg/L to 1.25 mg/L, 420 mg/L to 689 mg/L, and 0.26 mg/L to 0.79 mg/L, respectively. Higher concentrations of anions and cations are indicated in groundwater samples from wells 1 and 2 than from wells

8 and 9. The dominant anions and cations in these groundwater samples are chloride and sodium, respectively.

Regulated toxic trace metals analyzed during these sampling events, as presented in Table 3.9-4, are below applicable AWQSs. Organic parameters analyzed in these groundwater samples exhibit values below the reported detection limits.

Table 3.3-1 Summary of Annual Surface Water Releases from Coolidge Dam to the Gila River	
Year	**Release (acre-feet)**
1968	13,965
1969	961
1970	8,155
1971	753
1972	116,521
1973	26,292
1974	9,869
1975	8,999
1976	5,207
1977	33,976
1978	141,421
1979	109,273
1980	136,926
1981	10,695
1982	10,167
1983	540,348
1984	158,348
1985	379,592
1986	27,266
1987	439,258
1988	430,869
1989	394,016
1990	43,892
1991	277,760
1992	549,710
1993	153,366
1994	195,858

Source: San Carlos Irrigation and Drainage District (1995)

Table 3.3-2	Annual Diversions from the Gila River at Ashurst-Hayden Dam to San Carlos Irrigation and Drainage District Canals[a]			
Year	**Total[b]**	**Florence Casa-Grande Canal**	**Florence Canal[c]**	**North Side Canal[d]**
1968	315,634	293,580	9,470	12,627
1969	305,834	284,465	9,176	12,235
1970	224,417	208,736	6,733	8,978
1971	70,321	65,407	2,110	2,813
1972	176,474	164,143	5,295	7,060
1973	324,356	301,693	9,732	12,976
1974	351,347	326,978	10,542	14,056
1975	328,351	305,408	9,852	13,136
1976	180,902	168,262	5,428	7,237
1977	61,269	56,988	1,838	2,451
1978	261,190	242,940	7,837	10,449
1979	421,727	392,260	12,653	16,871
1980	474,669	441,503	14,242	18,989
1981	457,289	442,080	14,261	19,014
1982	291,437	271,074	8,744	11,659
1983	273,187	254,099	8,197	10,929
1984	397,973	370,166	11,941	15,921
1985	458,340	426,315	13,752	18,336
1986	411,975	383,189	12,361	16,481
1987	427,193	397,344	12,818	17,090
1988	420,490	391,109	12,616	16,822
1989	379,428	352,916	11,384	15,179
1990	55,516	51,637	1,666	2,221
1991	297,218	276,451	8,917	11,890
1992	401,020	373,000	12,032	16,043
1993	171,111	159,155	5,134	6,845
1994	166,004	154,405	4,981	6,641
Mean	300,173	279,826	9,026	12,035

[a] Source: San Carlos Irrigation and Drainage District (SCIDD, 1995) and Arizona Department of Water Resources (ADWR, 1995)
[b] Total amount diverted from Ashurst-Hayden Dam
[c] Calculated as 3 percent of the total based on information from SCIDD
[d] Calculated as 4 percent of the total based on information from SCIDD
All amounts are acre-feet per year

Table 3.6-1 Summary of Water Level Declines and Rises, Florence Project Area[a]						
Well ID[b]	**Dates Measured**	**1941 to 1977**	**1977 to 1985**	**1985 to 1991**	**1991 to 1993**	**1993 to 1994**
D(4-8)2ccc	June 1941 to December 1994	-180	-1	-2	+2	-2
D(4-8)35dda	October 1975 to November 1994	NA	+100	-20	+90	-15
D(4-9)03aaa1	February 1954 to December 1969	-110	NA	NA	NA	NA
D(4-9)5aab1	January 1941 to November 1991	-175	-10	+10	+10	+10
D(4-9)5aab2	November 1982 to November 1994	NA	NA	+30	+30	+30
D(4-9)15bca2	April 1978 to November 1994	NA	+5	+5	+35	NA
D(4-9)33aad[c]	November 1984 to November 1994	NA	NA	NA	+80	-15
D(4-10)18dcd1	January 1979 to November 1994	NA	+65	-15	-45	-15
D(4-10)18dcd2	January 1979 to November 1994	NA	+65	-15	+45	-15
D(4-10)30bdd	February 1952 to November 1994	-95	+80	-40	+125	-60
D(5-8)1aac	February 1942 to November 1953	-35	NA	NA	NA	NA
D(5-8)2aaa	January 1977 to November 1994	NA	+110	-60	+95	-25
D(5-8)12aad	February 1952 to November 1994	-115	+115	-120	+140	-30
D(5-9)3dab	February 1953 to November 1994	-140	+80	-25	+65	-10
D(5-9)14cbb	December 1956 to November 1994	-100	+30	-40	+75	NA

Table 3.6-1 Summary of Water Level Declines and Rises, Florence Project Area[a]						
Well ID[b]	**Dates Measured**	**1941 to 1977**	**1977 to 1985**	**1985 to 1991**	**1991 to 1993**	**1993 to 1994**
D(5-9)18bdd1	February 1983 to November 1994	NA	+45	-35	+60	+60
D(5-9)18bdd2	November 1984 to November 1994	NA	+25	-30	+60	-5
D(5-9)22cba	October 1975 to November 1994	NA	+40	-10	+55	+55

[a]Values are estimates based on ADWR (1995) data
[b]See Appendix B for additional well information and Sheet 1.2-1[II] for well locations
[c]Well PW-4
+ = rise (feet)
- = decline (feet)
NA - Not applicable

Table 3.7-1 Summary of Regional Aquifer Test Data				
Well Location	Reported Total Depth (ft)[a]	Reported Pumping Rate (gpm)	Reported Drawdown (ft)[b]	Specific Capacity (gpm/ft)[g]
Township 4 South, Range 10 East				
17 cad	164	1,800	20 (est)	90
29 cdd	795	2,500	46	54
29 adc	410	3,000	14	214
29 daa	622	2,350	30	78
Township 5 South, Range 8 East				
24 d	600	1,700	214	8
13 aaa	396	1,800	23 (in 1947)	78
12 dad	418	1,200	120 (in 1952)	10
13 bca	500	1,500	140 (in 1951)	11
12 aba	430	1,400	75	19
11 dcd	715	1,400	50	28
11 cdd	635	1,800	90	20
11 bcd	150	1,000	25 (in 1930)	40
1 dca	525	2,300	90	26
Township 4 South, Range 9 East				
6 aba	466	1,755	12 (in 1951)	147
6 aaa	463	2,500	15 (in 1951)	166
3	504	2,000	10 (in 1947)	200
18 ada	426	3,500 (est.)	8 (in 1952)	44
4 aaa	433	3,000	9 (in 1947)	333
27 cab	295	300	20 (in 1955)	15
29 dca	1,180	2,461	222	11
32 cb	397	1,500	30	50
6 caa	1,534	2,450	70	35
32 baa	346	1,500	30 (in 1957)	50
32 dda	583	2,600 (est.)	30 (in 1957)	87

Table 3.7-1 Summary of Regional Aquifer Test Data				
Well Location	**Reported Total Depth (ft)[a]**	**Reported Pumping Rate (gpm)**	**Reported Drawdown (ft)[b]**	**Specific Capacity (gpm/ft)[g]**
33 aad(c)	997	1,084	146	7
31 baa	850	800	155	5
29 cbc	334	1,125	20	56
28 dbd(d)	640	1,150	104	11
28 cdb(e)	933	2,015	134	15
22 cab(f)	981	2,240	158	14
27 cad	500	2,000	40	50
26 ccd	410	1,800	27	67
27 ddd	600	2,500	54	46
17 bcc	450	3,500 (est.)	8 (in 1952)	474
7 aaa	426	3,400	6 (in 1951)	4
6 bba	942	1,950	45	41
6 ada	1520	1,650	200	8
Township 4 South, Range 8 East				
2 abb	338	2,200	290 (in 1952)	8
2 aaa	647	1,800	26 (in 1959)	69
35 daa	323	1,000	70	14
Township 5 South, Range 9 East				
22 add	580	2,000	10	200
9 ddd	406	2,700	10 (in 1948)	270
9 aba	500	2,600	30 (in 1957)	87
5 ccd	505	2,980	80	32
4 caa	600	2,700	55	49
11 cdc	845	2,350	5	470
18 bdd	396	2,800	25 (in 1946)	112
19 ddd	300	1,800	125	14
21 add	510	2,000	40 (in 1952)	80
22 abb	600	2,800	100 (in 1958)	28
22 ddd	636	2,000	10	200

Table 3.7-1 Summary of Regional Aquifer Test Data				
Well Location	**Reported Total Depth (ft)[a]**	**Reported Pumping Rate (gpm)**	**Reported Drawdown (ft)[b]**	**Specific Capacity (gpm/ft)[g]**
2 ada	575	2,500	73 (in 1953)	34
4 cda	341	2,900	20 (in 1951)	145
12 cbb	535	2,500	40	63

[a] Feet below ground surface.
[b] Static water level minus pumping water level (value is assumed to reflect reported steady state pumping and static water levels provided by sources).
[c] Well WW-4, currently abandoned, screened in the upper and lower basin-fill units and bedrock.
[d] Well is PW2-1, screened only in bedrock.
[e] Well WW-3, screened in lower basin-fill unit and bedrock.
[f] Well Conoco 2, screened in lower basin-fill unit and bedrock.
[g] Specific capacity calculated from reported pumping rates and drawdown values.

Source: ADWR (1995) and Magma (1995)
gpm - gallons per minute
gpm/ft - gallons per minute per foot of drawdown
est - estimate

All wells screened in basin-fill units unless otherwise noted.
See Appendix B for additional well information and Sheet 1.2-1[II] and Figure 2.1-3[II] for well locations.

Table 3.9-1 Summary of Groundwater Use Within a 5-Mile Radius of the Florence In-Situ Mine Area

Well Type	Number of Registered Wells	Percentage of Total Registered Wells	Annual Withdrawal Reported to ADWR (Acre-feet) 1994
Private Irrigation Within 5-mile radius	70	18.3	NR
Private Irrigation Within 1-mile radius	12	3.1	4,385
Irrigation (San Carlos Irrigation Project)	22	6.0	13,332
Municipal (Public Supply) (Town of Florence)	5	1.0	1,055
Municipal (Institutional) (Arizona State Prison)	2	0.5	1,284
Domestic	99	26.0	NR
Domestic/Irrigation	13	3.4	NR
Domestic/Stock/Irrigation	8	2.0	NR
Domestic/Industrial	1	0.3	NR
Domestic/Stock	12	3.0	NR
Domestic/Stock/Industrial	1	0.3	NR
Industrial	7	2.0	NR
Industrial/Irrigation	5	1.3	NR
Monitor	62	16.2	NR
Irrigation/Stock	3	0.9	NR
Stock	1	0.3	NR
Utility	1	0.3	NR
Utility/Recharge	2	0.5	NR
Unknown Use	55	14.4	NR
Test	1	0.3	NR

Source: ADWR (1995)
NR - Not Reported

Table 3.9-2 San Carlos Irrigation and Drainage District, 1994 Monthly Groundwater Pumped Within a 5-Mile Radius of the Florence In Situ Mine Area

Well No.	January	February	March	April	May	June	July	August	September	October	November	December	Total
2	51.2	35.5	11.0	116.7	64.6	179.4	229.5	198.0	40.7	1.6	49.3	103.7	1,081.2
5	0.5	13.1	33.6	87.5	41.2	45.2	75.1	115.8	124.8	69.7	0.0	19.2	625.7
9	16.4	25.3	42.5	0.0	7.1	65.2	70.5	95.5	16.4	26.4	0.0	0.0	365.3
11	0.1	0.1	0.0	0.0	0.0	0.0	38.2	74.9	2.2	0.0	0.0	0.0	115.5
13	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.6
19	25.6	24.5	125.0	123.1	93.1	175.2	134.2	131.5	67.3	44.3	0.0	125.7	1,069.5
20	0.0	9.4	85.6	44.3	62.0	67.2	39.7	113.4	29.3	22.1	0.0	35.7	508.7
25	25.4	18.0	118.8	92.0	75.5	116.0	102.1	109.7	28.8	52.4	21.2	34.1	794.0
3B	46.9	31.7	92.0	121.1	90.9	161.4	107.6	87.5	8.7	0.3	0.0	0.0	748.1
4B	13.9	49.6	103.0	117.9	127.2	211.0	164.8	200.4	78.2	7.6	0.0	84.0	1157.6
79	67.5	13.1	135.4	93.0	157.6	96.5	104.5	117.3	33.0	0.0	0.0	0.0	817.9
80	0.0	0.7	0.0	0.0	0.0	27.7	38.0	0.0	0.4	0.0	0.0	61.8	128.6
89	0.0	14.4	9.7	45.6	17.7	120.1	24.3	81.9	32.0	21.4	5.2	38.8	411.1
10B	9.5	8.4	0.0	9.1	12.8	100.0	82.2	157.0	14.0	32.3	0.0	0.0	425.3
111	68.7	8.9	138.0	99.6	135.2	52.6	53.8	23.9	3.2	0.0	0.0	0.0	583.9
112	16.3	33.9	82.4	13.1	17.2	39.3	56.7	47.2	5.7	0.2	5.3	20.4	337.7
21B	14.2	0.4	96.2	95.2	33.8	0.0	0.0	121.1	74.0	12.8	0.0	27.4	475.1
23B	0.0	0.0	18.6	2.1	0.0	6.7	12.9	0.0	4.3	7.9	0.0	0.0	52.5
74B	36.2	13.9	130.2	22.2	45.4	113.1	104.7	45.4	39.3	151.7	55.9	86.8	844.8
110A	3.5	15.9	160.3	53.3	46.7	208.2	181.8	58.7	4.5	49.6	21.1	109.5	913.1
110B	3.6	12.7	147.9	31.2	51.4	57.7	168.2	58.6	0.8	40.9	21.9	110.9	705.8
122B	38.9	93.5	237.4	102.7	75.8	131.9	116.4	61.7	34.9	128.6	47.3	100.9	1170.0
Total	438.4	423.3	1,767.6	1,269.7	1,155.2	1,974.4	1,905.2	1,899.5	642.8	669.8	227.2	958.9	13,332.0

Source: San Carlos Irrigation Project (SCIP, 1995)
All amounts are in acre-feet
See Appendix B for additional well information, and Sheet 1.2-1[II] and Figure 2.1-3[II] for well locations

Table 3.9-3 Large Municipal Water Providers, Pinal AMA, 1985				
Provider	**ADWR Well No.**	**Pumpage Population**	**Water Use Rate (ac-ft)[a]**	**gpcd[b]**
Arizona Sierra Utility Company (Town of Florence)	D(4-)25bdc D(4-9)25bdd	1,214	161	118
Arizona State Prison-Florence	D(5-10)6bdc D(5-9)01acd	4,351	913	187
Arizona Training Center	c	485	329	606
Arizona Water Company	c			
Casa Grande System		19,836	6,062	273
Coolidge System		8,174	1,350	147
Stanfield System		580	100	154
Central Arizona College	c	839	155	165
City of Eloy	c	5,867	1,259	192
Maricopa Water Improvement District	c	709	241	303
Pinal County Housing Authority	c	355	147	370
Thunderbird Water Improvement District	c	927	112	108
Town of Florence	D(5-9)02ada D(4-9)36cac1 D(4-9)36cac2	2,684	809	269

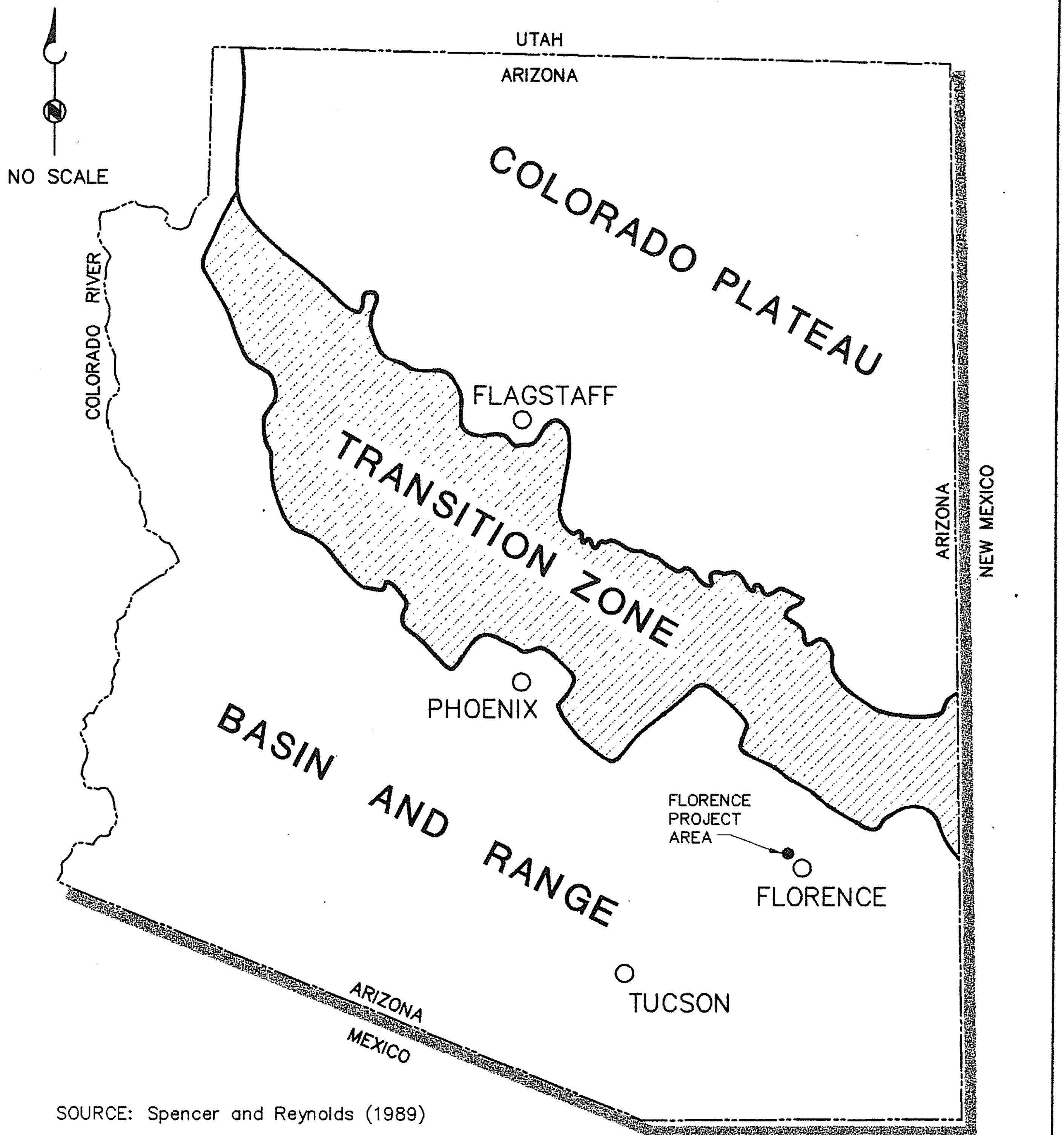
Source: ADWR (1991)
[a]acre-feet
[b]gallons per capita per day
[c]Wells not located within 10 mile by 10 mile Florence Project Area (Sheet 1.2-1[II])

See Sheet 1.2-1[II] for well locations.
Well details presented in Appendix B.

Table 3.9-4	Summary of Analytical Results, Municipal Water Quality in the Florence In-Situ Mine Area				
Chemical Constituent	**Well No. 1 May 4, 1993**	**Well No. 2 May 4, 1992**	**Well No. 8 August 31, 1995**	**Well No. 9 October 29, 1993**	**Well No. 9 August 31, 1994**
Alkalinity	149	170	NA	92	NA
Aluminum	NA	NA	NA	NA	NA
Antimony	NA	NA	<0.005	<0.01	<0.005
Arsenic	<0.005	<0.005	<0.01	<0.01	<0.01
Barium	<0.0006	<0.0006	<0.05	<0.05	<0.05
Cadmium	<0.0007	<0.0007	<0.0005	<0.0005	<0.0005
Calcium	66.3	73.9	NA	49	NA
Chloride	162	166	NA	130	NA
Chromium	<0.003	<0.003	<0.005	<0.005	<0.005
Cobalt	NA	NA	NA	NA	NA
Copper	<0.004	0.008	NA	<0.05	NA
Fluoride	0.79	1.16	0.26	0.36	0.62
Iron	0.034	0.846	NA	<0.05	NA
Lead	<0.02	<0.02	<0.005	0.011	<0.005
Magnesium	18.4	18	NA	14	NA
Manganese	<0.001	0.018	NA	<0.05	NA
Mercury	0.0004	0.0002	<0.001	<0.001	<0.001
Nickel	NA	NA	<0.05	NA	<0.05
Nitrate (N)	1.25	1.25	<0.50	<0.50	<0.50
Potassium	NA	NA	NA	NA	NA
Selenium	<0.005	<0.005	<0.005	<0.005	<0.005
Silver	<0.001	<0.001	<0.002	<0.002	<0.002
Sodium	88.6	108	NA	65	NA
Sulfate	102	138	NA	50	NA
TDS	615	689	NA	420	NA
Thallium	NA	NA	<0.002	NA	<0.002
Zinc	<0.005	0.009	NA	<0.05	NA
pH	7.8	7.6	NA	7.97	NA
Hardness	250	263	NA	180	NA

Source: Open files at the Arizona Sierra Utility Company and Arizona State Prison
NA - Not Available

Well No. 1: Arizona Sierra Utility Company, ADWR Location D(4-9)25bdd
Well No. 2: Arizona Sierra Utility Company, ADWR Location D(4-9)25bdc
Well No. 8: Arizona State Prison, Florence, ADWR Location D(5-10)6bdc
Well No. 9: Arizona State Prison, Florence, ADWR Location D(5-9)1acd
See Appendix B for additional well information, and Sheet 1.2-1[II] for well locations



F3-2-1_2 11-27-95 RobertK

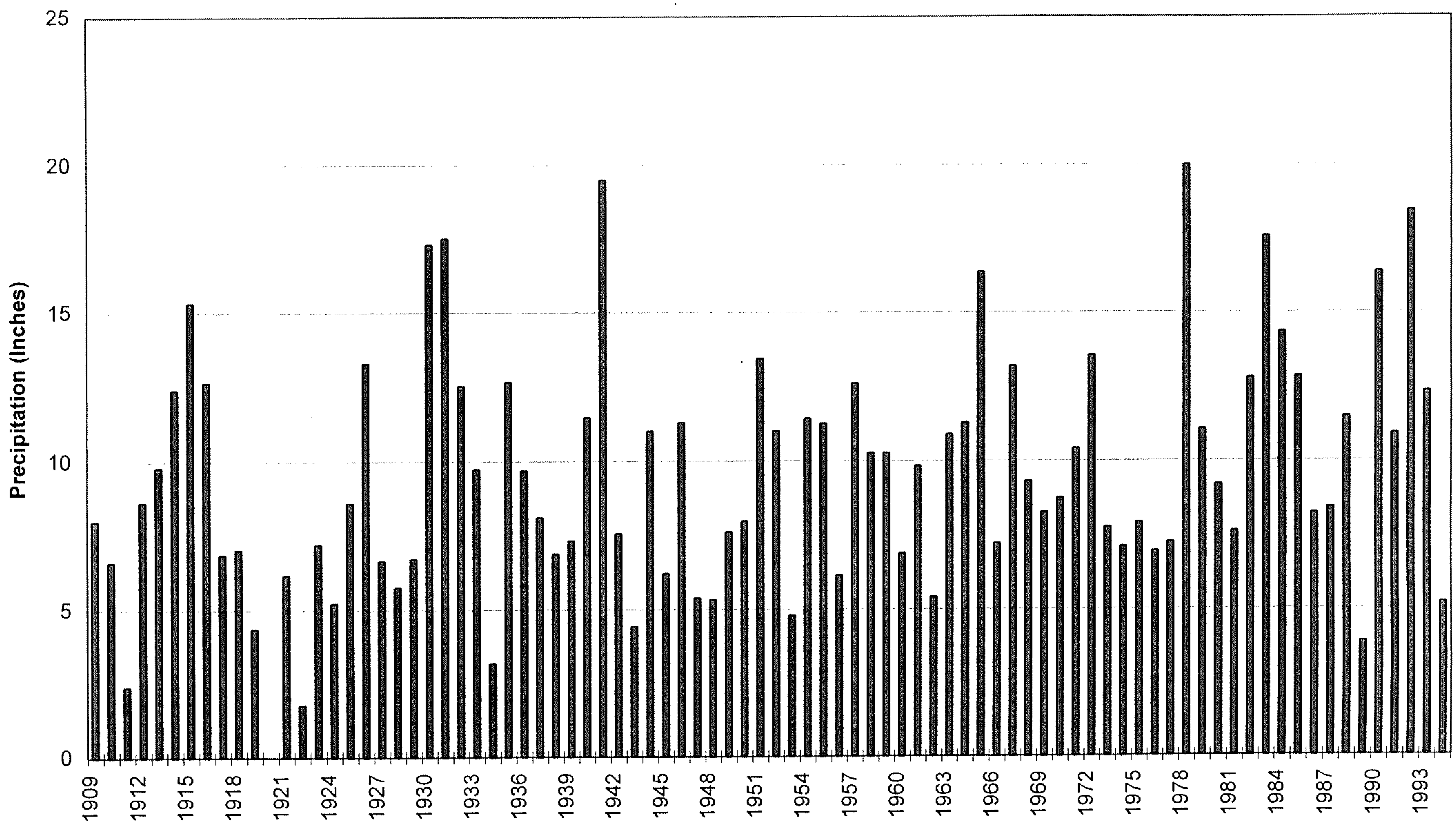
Figure 3.2-1 (II)

MAJOR PHYSIOGRAPHIC PROVINCES OF ARIZONA

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY
Florence Mining Division



Year

Period of Record - 95 years (1909 to 1994)

Source: Atmospheric Sciences Center, Desert Research Center, Western Regional Climate Center, (1995)

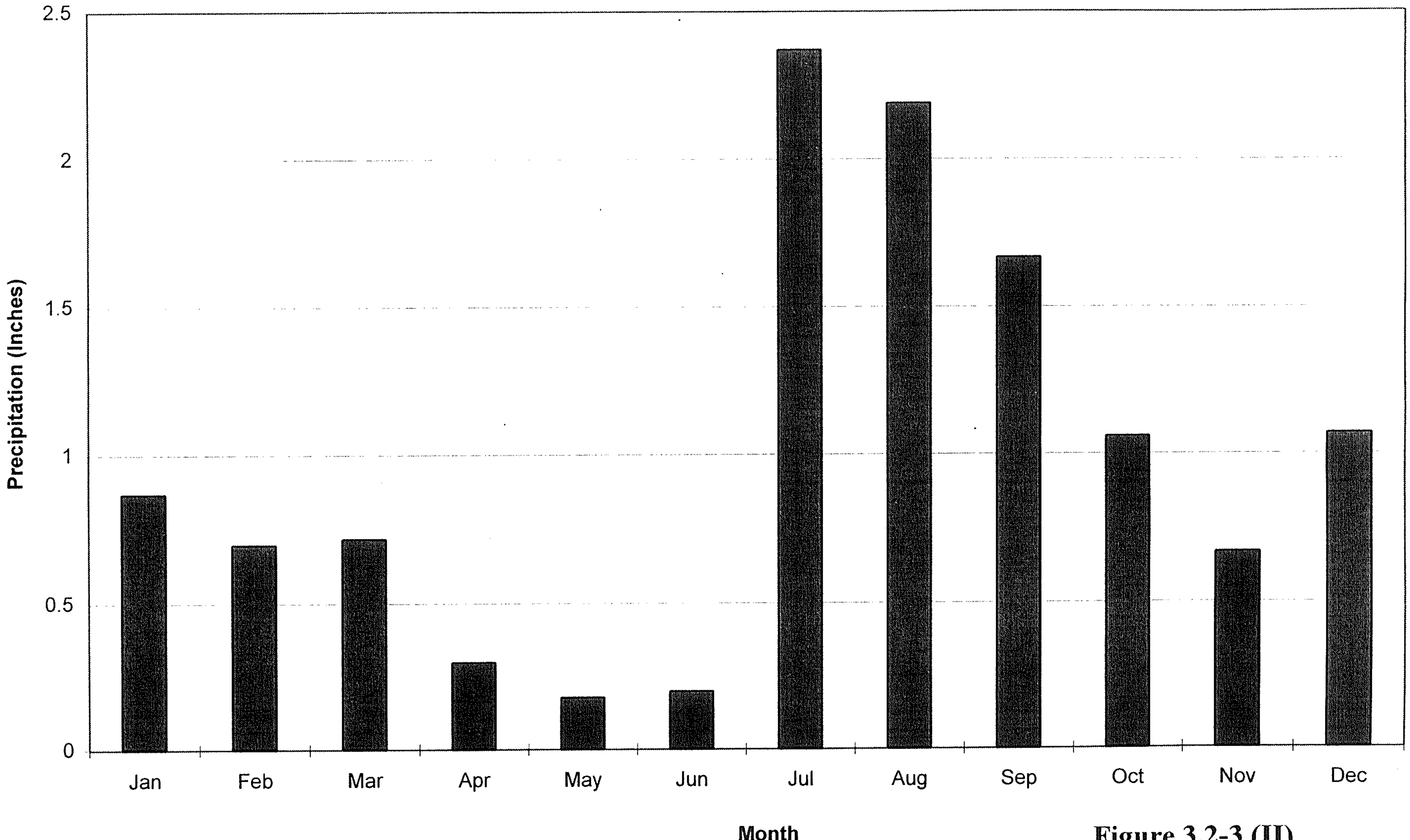
For 1920, data record is missing 26 or more days per month in each month of the year.

BROWN AND CALDWELL

Figure 3.2-2 (II)
ANNUAL PRECIPITATION; FLORENCE, ARIZONA

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

FIG322.XLS 1/6/96



Averages based on 30-year record 1964 through 1994.

Source: National Oceanic and Atmospheric Administration, (1995)

Figure 3.2-3 (II)

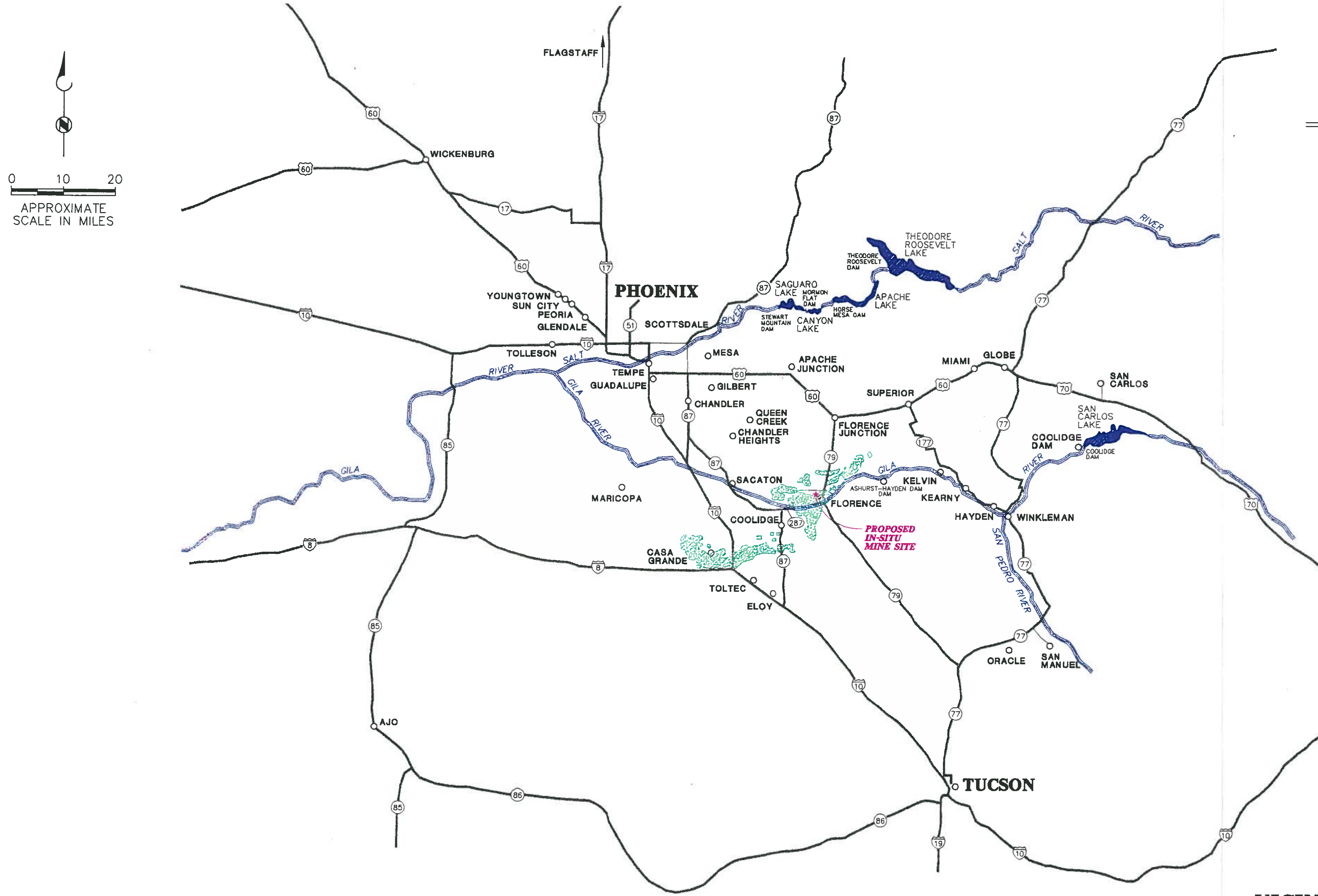
MEAN MONTHLY PRECIPITATION FLORENCE, ARIZONA

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

FIG323.XLS 1/6/96



F3-3-1_2 01-02-96 RobertK

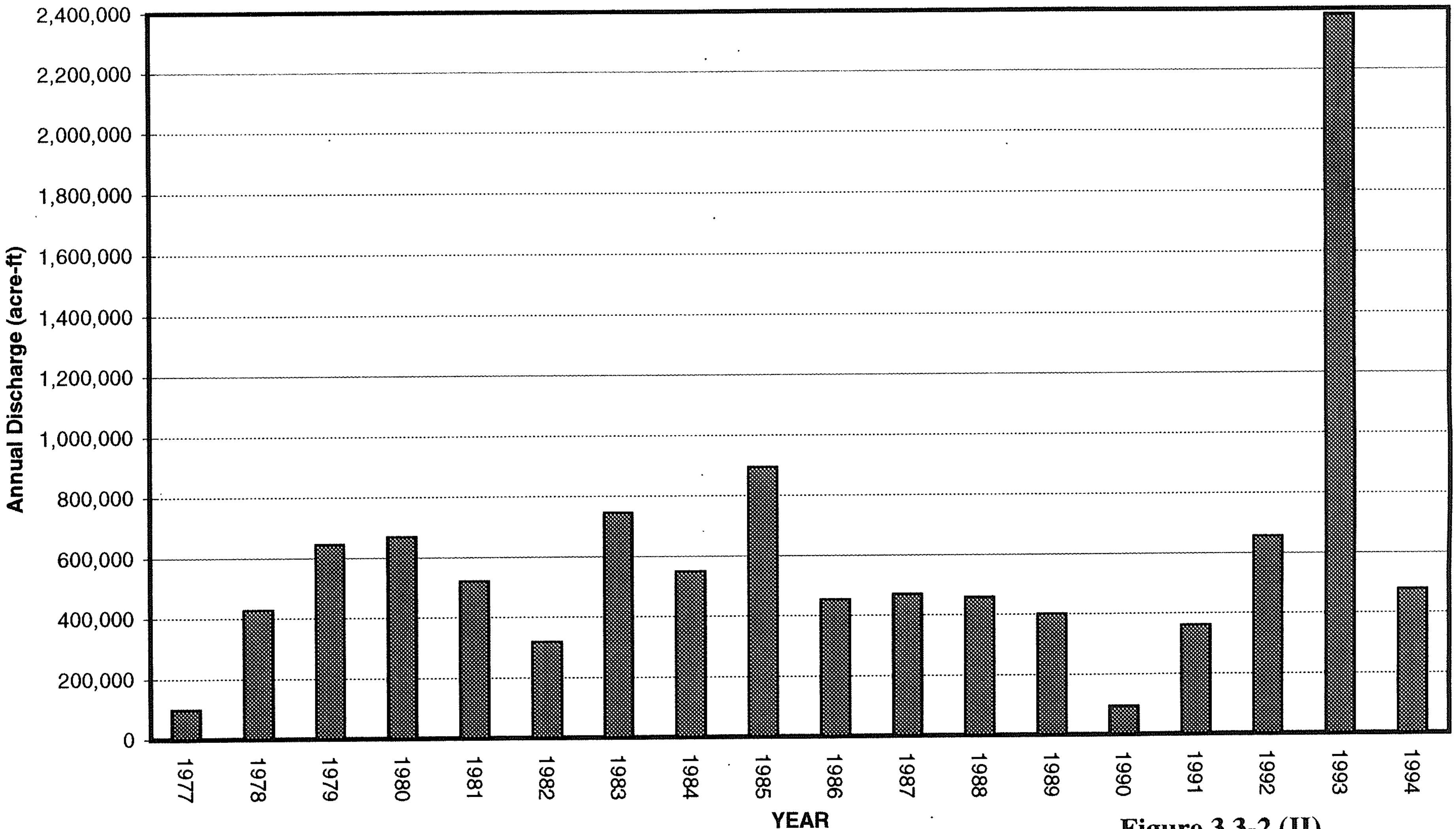
BROWN AND CALDWELL

Figure 3-3-1 (II)

VICINITY MAP SHOWING THE LOCATIONS OF SURFACE WATER FEATURES

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona



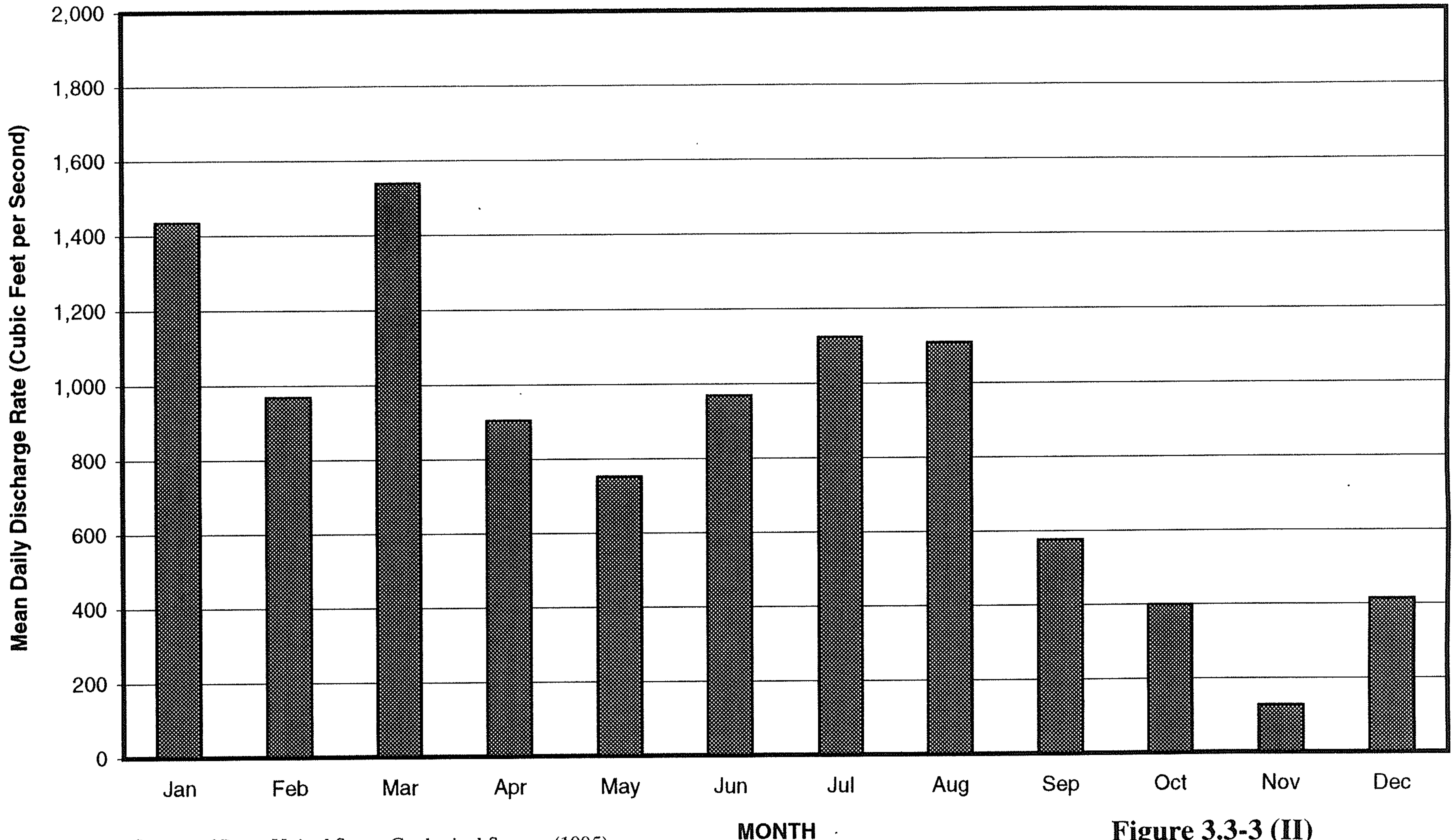
Source of Data: United States Geological Survey, 1995
Values Based on Mean Daily Discharge for the 18 Year Period from 1977 to 1994.

Figure 3.3-2 (II)
ANNUAL DISCHARGE; GILA RIVER AT KELVIN, ARIZONA

BROWN AND CALDWELL

MAGMA COPPER COMPANY
Florence, Arizona

FIGKELVN.XLS 12/20/95



Source of Data: United States Geological Survey (1995)
Values presented according to month.

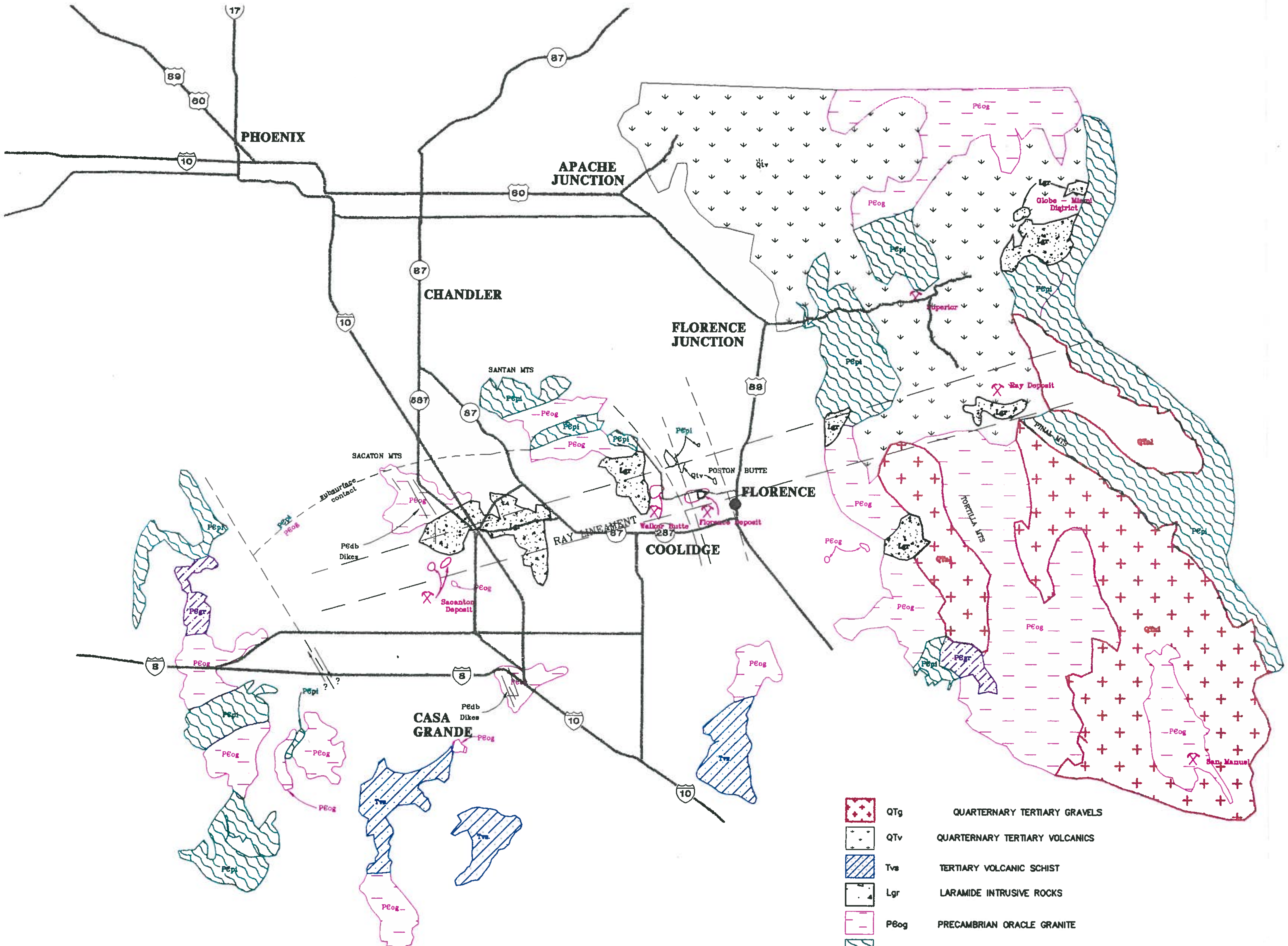
Values Based on Mean Daily Discharge Records for the 18 Year Period from 1977 to 1994.

Figure 3.3-3 (II)
MEAN DAILY DISCHARGE RATE GILA RIVER AT KELVIN, ARIZONA

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

FIGKELVN.XLS 12/20/95



MODIFIED FROM : CONOCO (1976)

BROWN AND CALDWELL

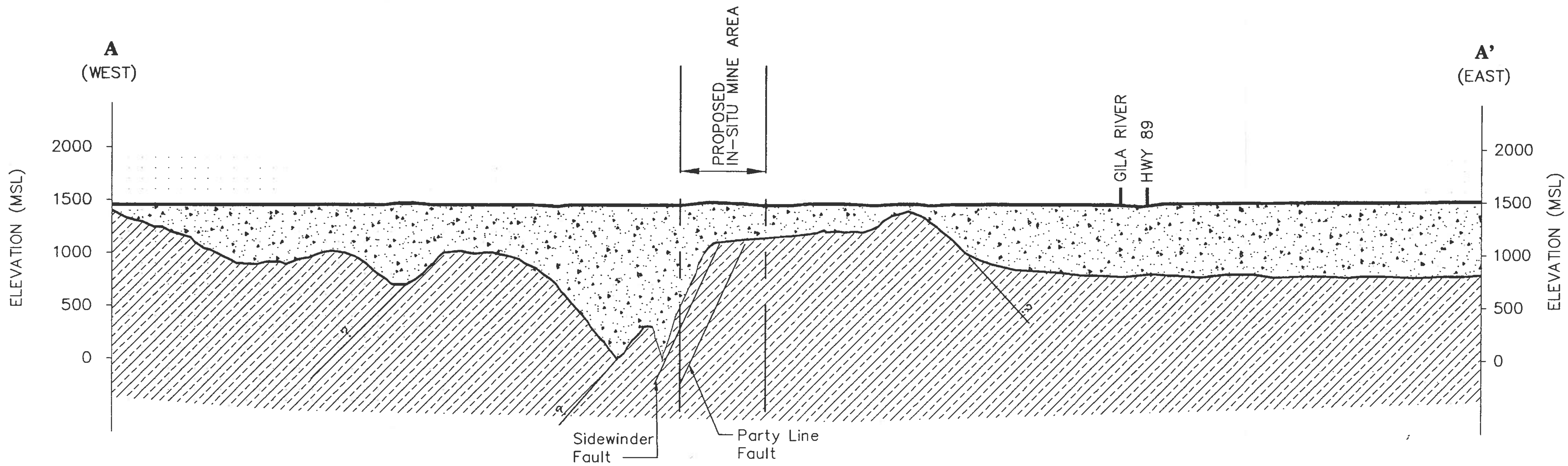
F3-4-1_2 11-14-95 DanH

Figure 3.4-1 (II)

REGIONAL GEOLOGY MAP

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona



VIEW LOOKING FROM THE SOUTH

EXPLANATION:

Basin Fill Deposits Locally Separated into Unconsolidated Alluvium, Upper Basin Fill Unit, Middle Fine Grained Unit, and Lower Basin Fill Unit Based on Lithology, Grain Size and Degree of Cementation

Bedrock, Generally Quartz Monzonite and Granodiorite Porphory

Bedrock Surface Contours Compiled by Brown and Caldwell From Existing Water Well Logs, Exploratory Core Logs and Regional Gravity Surveys

CROSS SECTION LOCATION SHOWN ON SHEET 1.2–1

SCALE: Horizontal 1"= 4,000'
Vertical 1"= 1,000'
Vertical Exaggeration 4 x 1

Figure 3.4-2 (II)

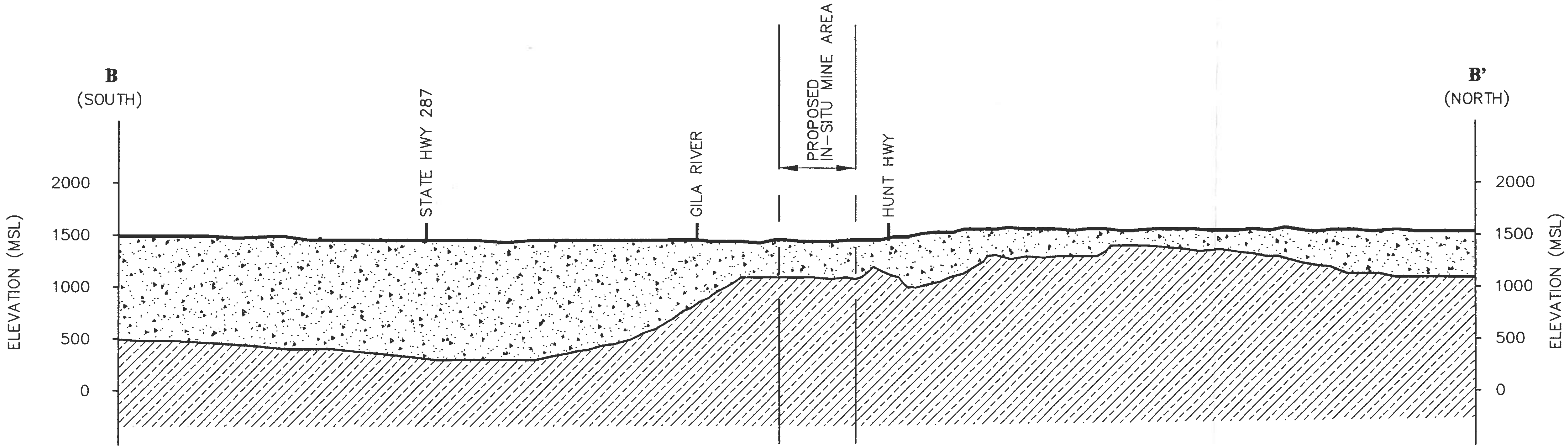
REGIONAL EAST-WEST CROSS SECTION A-A'

F3-4-2_2 12-01-95 RobertK

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona



VIEW LOOKING FROM EAST

EXPLANATION:

Basin Fill Deposits Locally Separated into Unconsolidated Alluvium, Upper Basin Fill Unit, Middle Fine Grained Unit, and Lower Basin Fill Unit Based on Lithology, Grain Size and Degree of Cementation

Bedrock, Generally Quartz Monzonite and Granodiorite Porphory

Bedrock Surface Contours Compiled by Brown and Caldwell From Existing Water Well Logs, Exploratory Core Logs and Regional Gravity Surveys

CROSS SECTION LOCATION SHOWN ON SHEET 1.2-1

SCALE: Horizontal 1"= 4,000'
Vertical 1"= 1,000'
Vertical Exaggeration 4 x 1

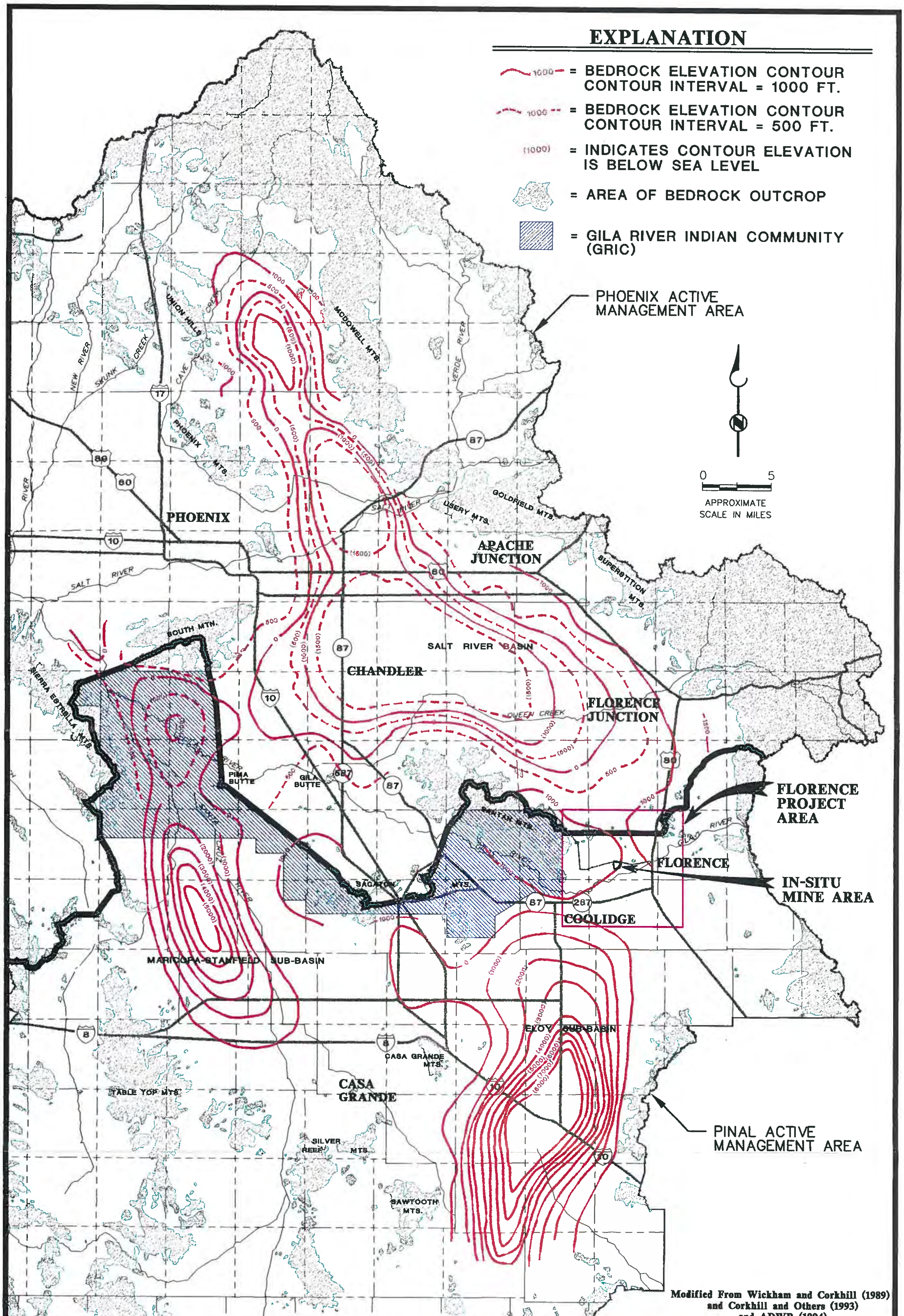
Figure 3.4-3 (II)

REGIONAL NORTH-SOUTH CROSS SECTION B-B'

F3-4-3_2 11-28-95 DanH

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona



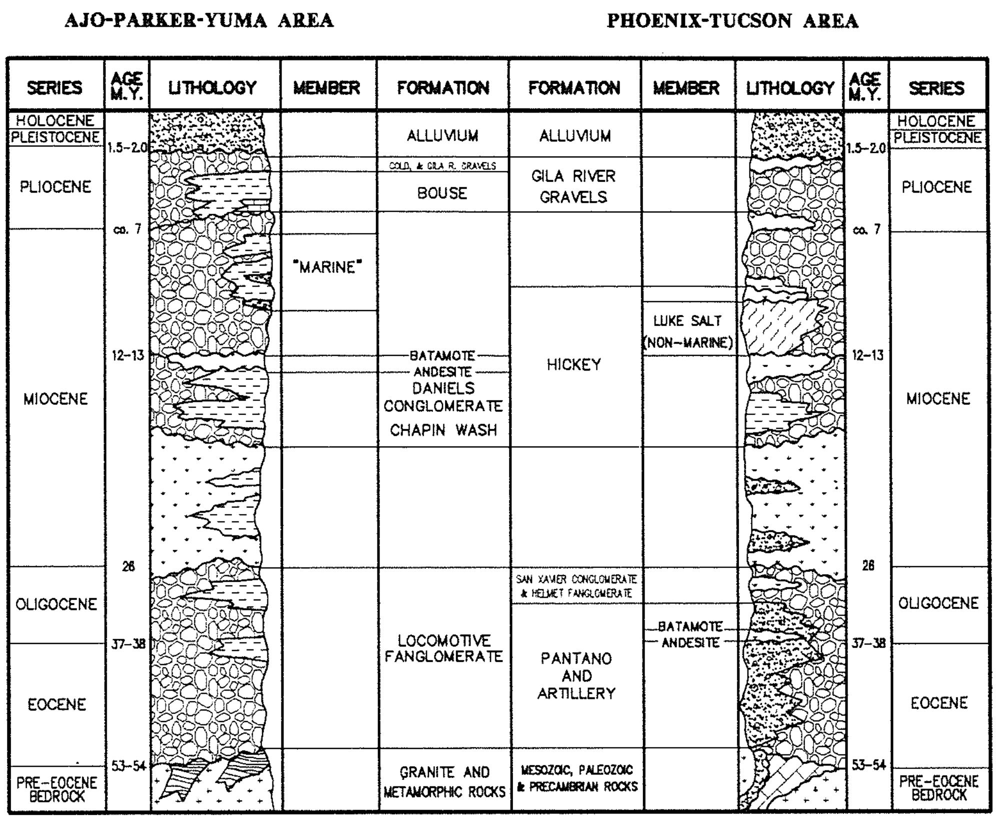
F3-4-4_2 11-30-95 RobertK

Figure 3.4-4 (II)

CENTRAL ARIZONA WITH ELEVATION OF TOP OF BEDROCK

MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL



MODIFIED FROM: Eberly and Stanley, 1978

Figure 3.4-5 (II)

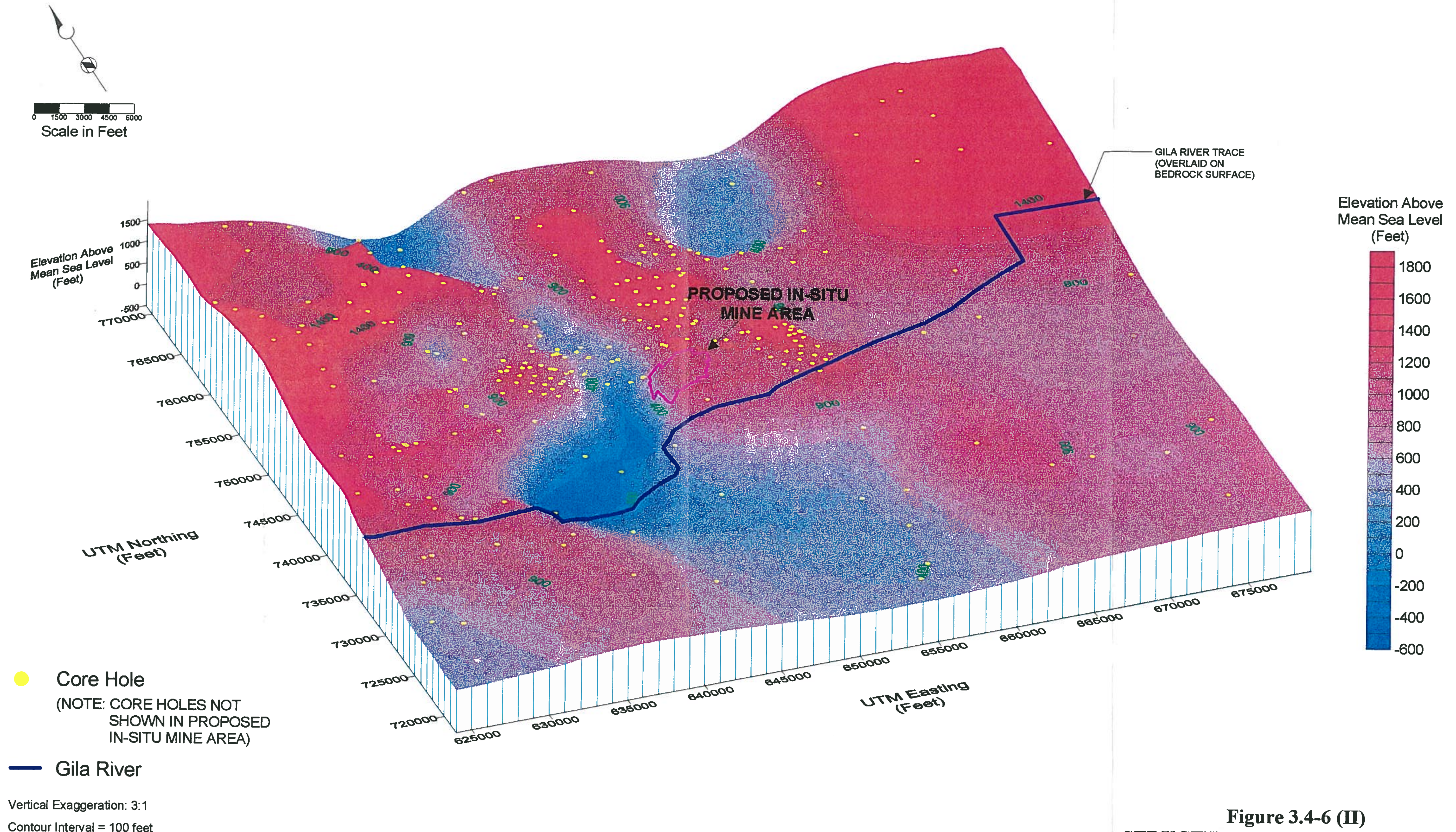
COMPOSITE STRATIGRAPHIC COLUMN SOUTHWEST ARIZONA

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

F3-4-5_2 11-27-95 RobertK



SFIG001 01/02/96 MikeS

BROWN AND CALDWELL

Figure 3.4-6 (II)
STRUCTURAL CONTOUR SURFACE AT TOP OF BEDROCK

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

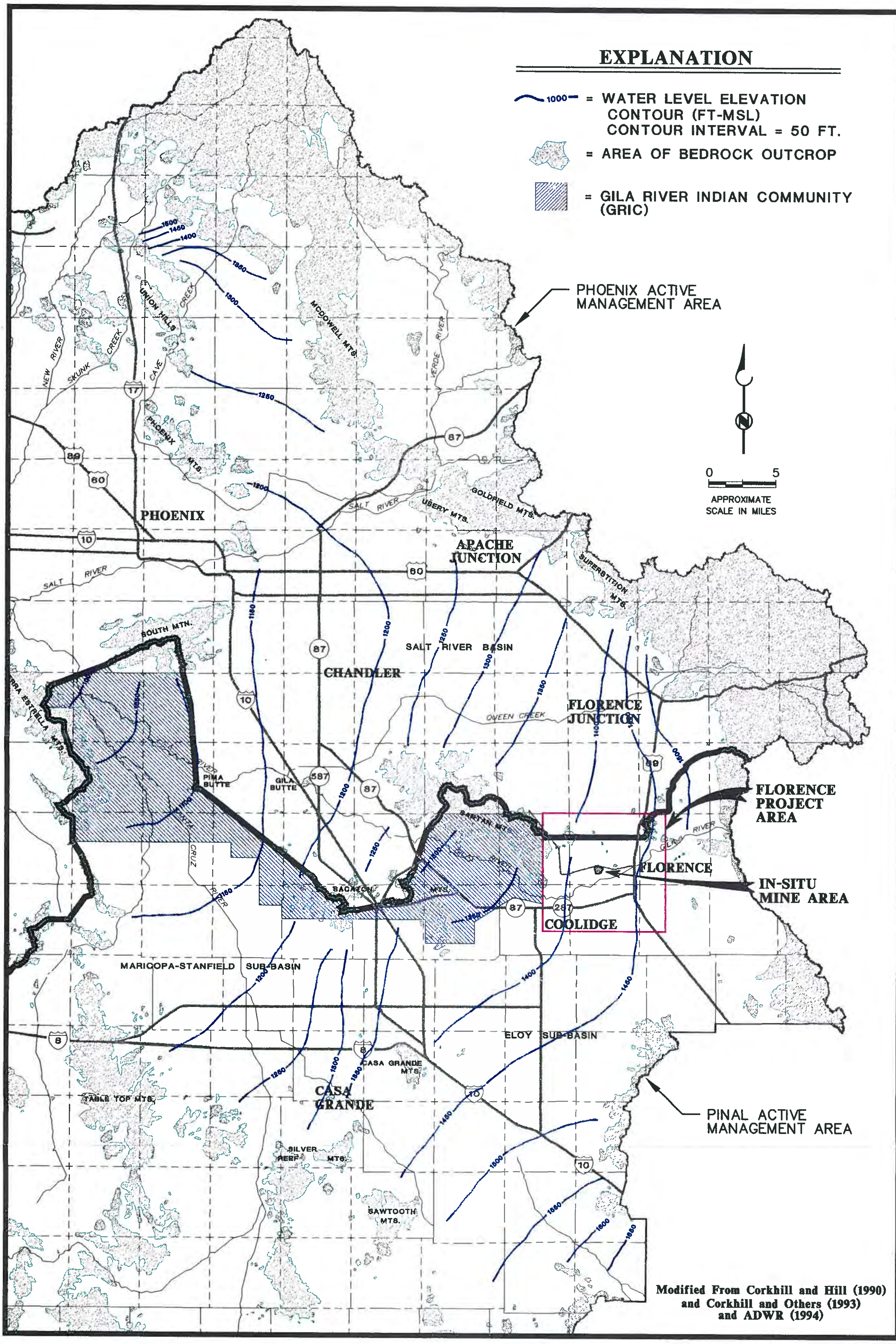


Figure 3.6-1 (II)

PRE-DEVELOPMENT REGIONAL GROUNDWATER HEAD DISTRIBUTION (1900)

MAGMA COPPER COMPANY
Florence, Arizona

F3-6-1_2 11-28-95 DanH

BROWN AND CALDWELL

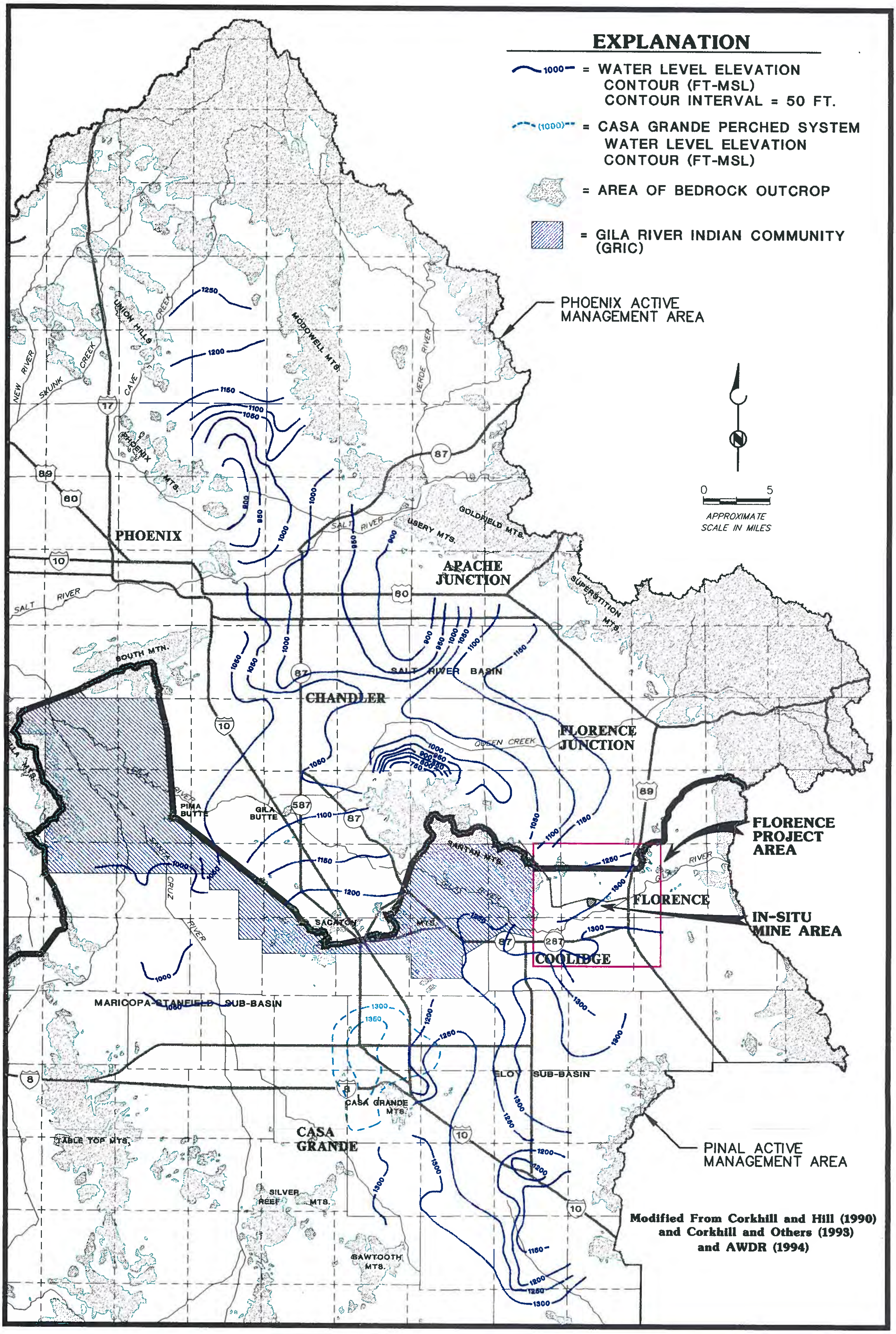


Figure 3.6-2 (II)
REGIONAL GROUNDWATER HEAD DISTRIBUTION (1982-1985)

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

F3-6-2_2 11-28-95 DonH

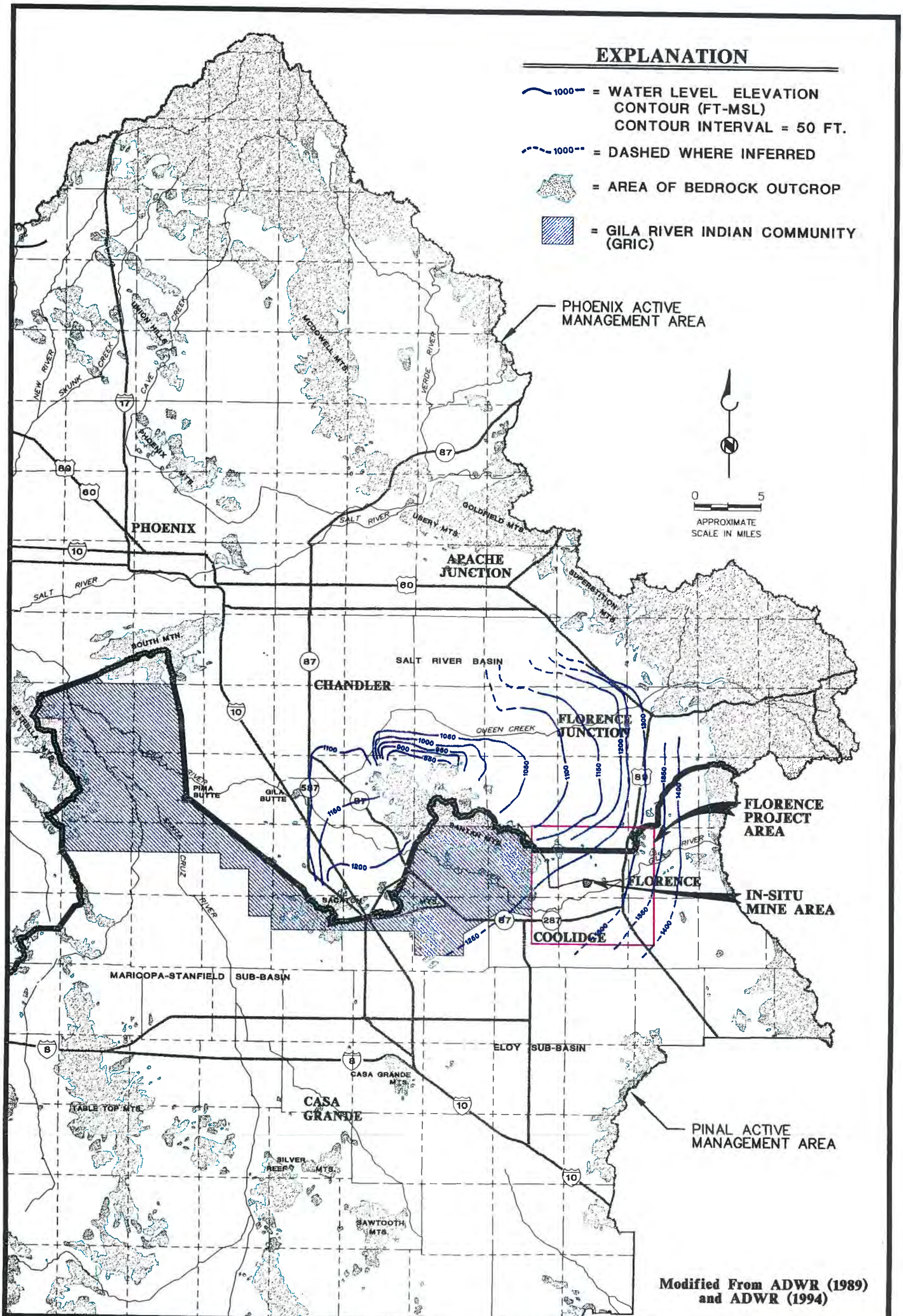


Figure 3.6-3 (II)
REGIONAL GROUNDWATER HEAD DISTRIBUTION (1991-1992)

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

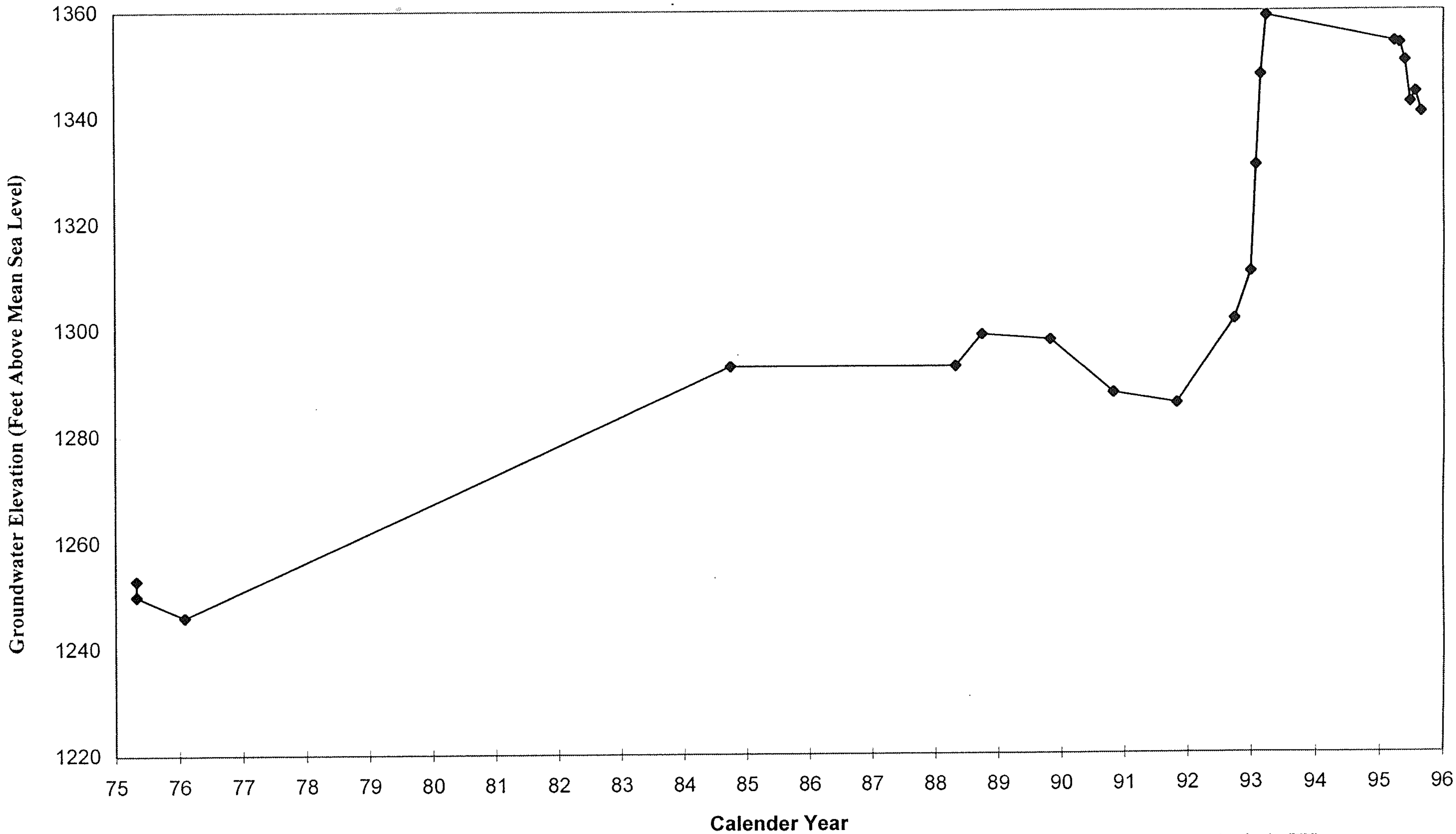


Figure 3.6-4 (II)
WATER LEVEL HYDROGRAPH
FOR WELL PW4

Note: Pre-1995 data from E. Montgomery & Assoc. (1994)

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

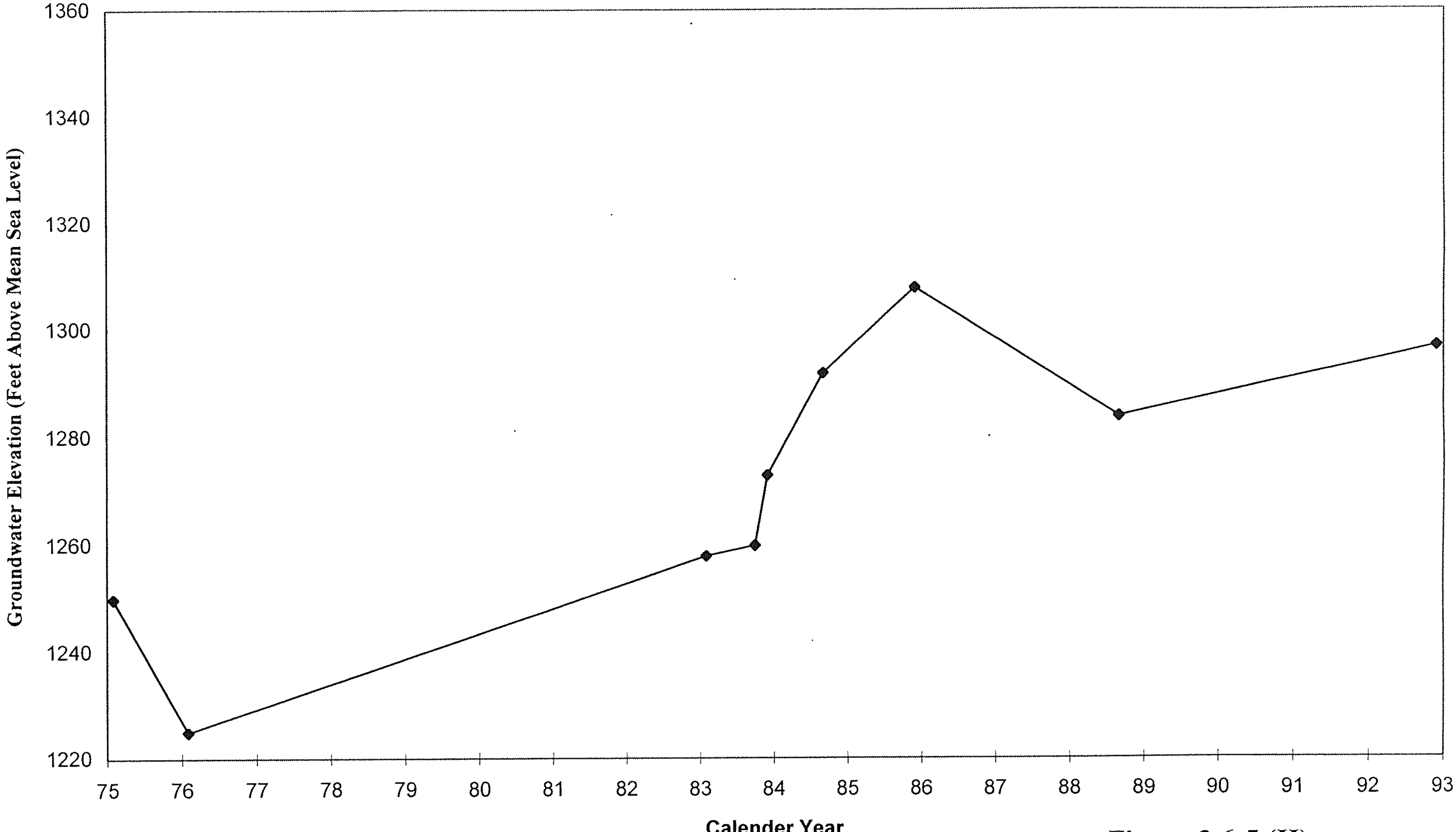
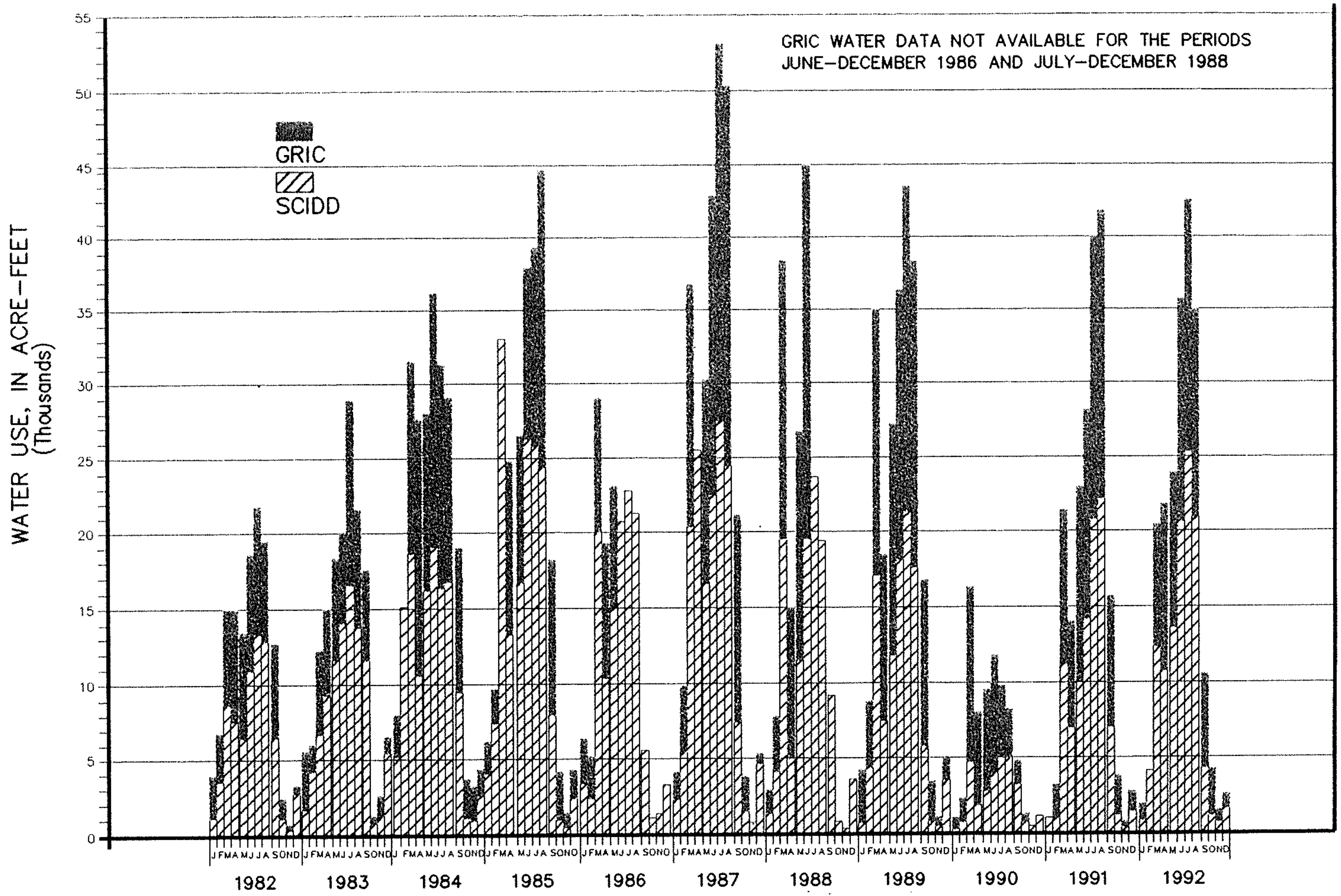


Figure 3.6-5 (II)
WATER LEVEL HYDROGRAPH
FOR WELL BIA-9

Note: Pre-1995 data from E. Montgomery & Assoc. (1994)

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona



SEE FIGURE 3.3–1 FOR DELIMITATION OF SAN CARLOS IRRIGATION PROJECT LANDS.

MODIFIED FROM: Montgomery & Associates, (1994)

EXPLANATION

GRIC = GILA RIVER INDIAN COMMUNITY
SCIDD = SAN CARLOS IRRIGATION AND DRAINAGE DISTRICT

BROWN AND CALDWELL

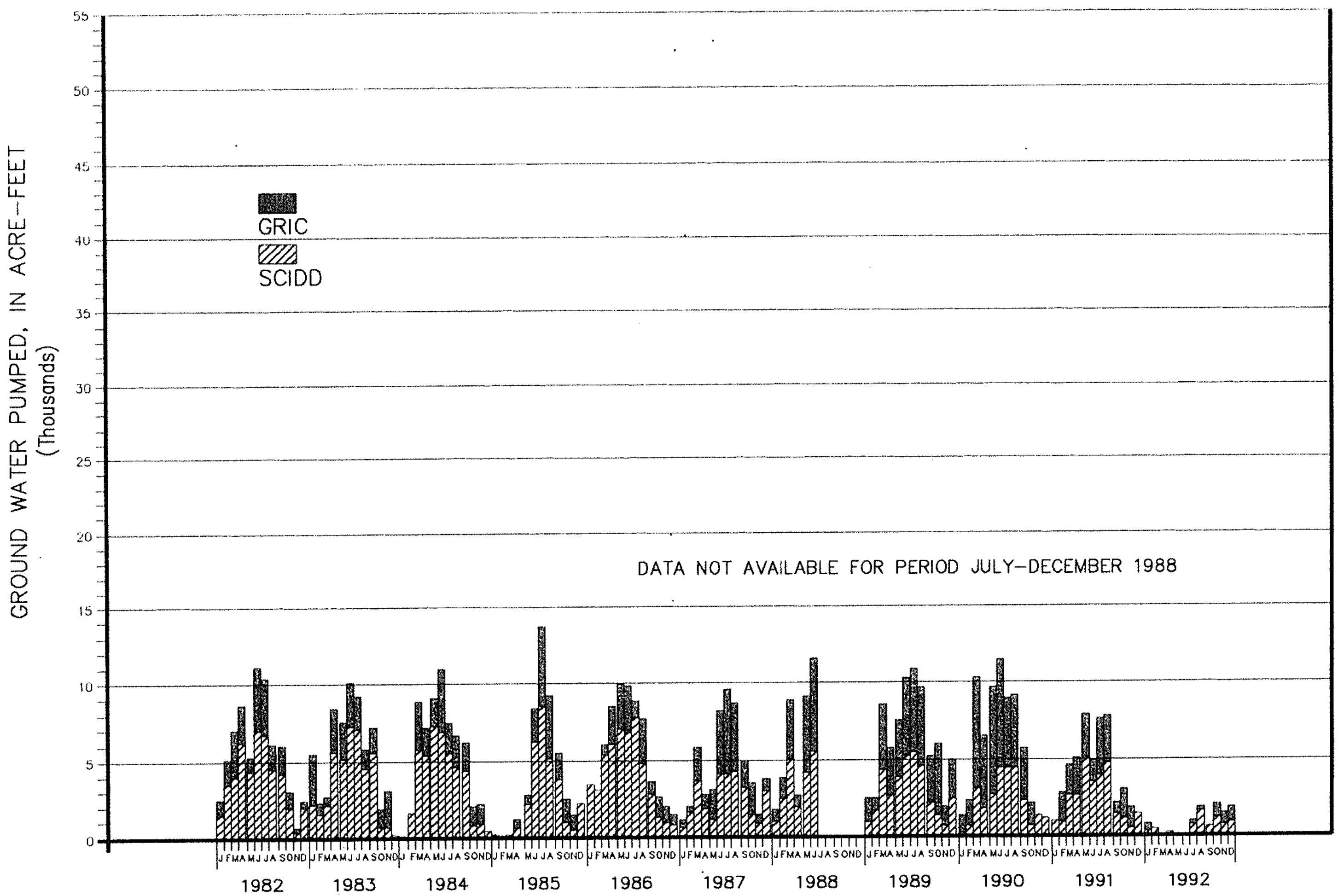
Figure 3.9-1 (II)

WATER USE FOR SAN CARLOS PROJECT (1982-1992, PINAL COUNTY)

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

F3-9-1_2 01-07-96 Dan



SEE FIGURE 3.3-1 FOR DELIMITATION OF SAN CARLOS IRRIGATION PROJECT LANDS.

MODIFIED FROM: Montgomery & Associates, (1994)

EXPLANATION

GRIC = GILA RIVER INDIAN COMMUNITY
SCIDD = SAN CARLOS IRRIGATION AND DRAINAGE DISTRICT

BROWN AND CALDWELL

F3-9-2_2 11-30-95 Roberts

Figure 3.9-2 (II)

GROUNDWATER PUMPED BY SAN CARLOS PROJECT
(1982-1992, PINAL COUNTY)

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

SECTION 4.0

IN-SITU MINE AREA HYDROGEOLOGIC CONDITIONS

This section provides a detailed discussion of the hydrogeologic conditions and related characteristics of the in-situ mine area. The discussions below expand upon the description of the regional setting given in Section 3.0, in addition to presenting the findings of the recent site investigations. A summary of conclusions developed from the results presented in Sections 3.0 and 4.0 are presented in the form of a conceptual hydrogeologic model in Section 5.0.

4.1 EXISTING FEATURES

The 213-acre proposed in-situ mine area is located approximately 1 mile west/southwest of Poston Butte and 2 miles northwest of the Town of Florence, Arizona (see Sheets 1.2-1[II] and 1.2-2[II]). The Gila River trends west-southwest and is located approximately 1/2 mile south of the proposed in-situ mine area. The subject area is located on both agricultural and undisturbed land. It is at a nominal elevation of 1,475 feet above sea level. The elevation of the site declines approximately 25 feet from north to south. At least 3 river terraces are present within the proposed in-situ mine area. These terraces mark past base levels and northern extent of the active channel of the Gila River. The northern-most extent of the active floodplain is currently located approximately 1/4 mile south of the proposed in-situ mine area.

4.1.1 General Surficial Conditions

The surface of the proposed in-situ mine area can be divided into 2 segments based on land usage. As depicted in Figure 4.1-1[II], this division occurs approximately where the San Carlos Irrigation and Drainage District (SCIDD) North Side Canal traverses the property. This canal is discussed further in Section 4.2.2. The southern portion is dominated by agricultural activities, whereas the northern portion has remained relatively undisturbed desert land. Numerous archaeological sites exist in the northern portion, as discussed in Section 4.1.4. Primary disturbances north of the canal consist of dirt roads. These roads provide access from Hunt Highway to adjacent agricultural and mine-related areas. The Southern Pacific Railroad also passes north of the proposed in-situ mine area.

Four irrigation wells are located within the proposed in-situ mine area. Two of these wells are used by SCIDD and discharge to the North Side Canal. The remaining 2 installations are utilized by local farmers and discharge into small irrigation ditches. The wells are generally located near the center of the site along the SCIDD Canal. Section 4.6 contains more information related to these wells.

4.1.2 Conoco Pilot Mine and Underground Workings

Conoco undertook a pilot mining operation at the Florence prospect in 1974 for the purpose of obtaining bulk samples of oxide and sulfide ores, evaluating rock strength to design pit slopes, and assessing the dewatering requirements for open pit mining (Magma, 1995). The location of the underground workings is shown on Sheet 1.2-2 and Figure 4.1-1[II].

Conoco (1976) reports that exploratory coreholes in the vicinity of the underground workings were abandoned by grouting prior to the pilot mining activities. The objective of the abandonment activity was to prevent basin-fill groundwater from migrating through the coreholes into the underground workings. No indication of the number or exact locations of the abandoned coreholes was located in project files.

Conoco (1976) reports that a pilot mine was developed in the proposed in-situ mine area to confirm data obtained from previous exploratory drilling programs, and to provide representative samples of the orebody for on-site metallurgical testing in pilot plant circuits. The pilot mine program also provided an opportunity to study rock properties, fault and fracture patterns, ore continuity, and hydrologic characteristics of the ore deposit. Figure 4.1-2[II] shows a plan view and cross-section of the underground workings. The pilot mines eventually produced approximately 50,200 tons of ore.

A main shaft was advanced to the oxide-sulfide interface. A principal drift was then advanced from the shaft on an east-west heading. Cross cuts were excavated north and south of the main east-west drifts. Generally, rock and ore grade conditions dictated the location of the underground excavations.

Ore from the subsurface was hoisted to the surface and hauled about 1 mile to stockpiles west of a pilot plant. The pilot plant was constructed by Conoco (1976) to provide laboratory and process facilities for testing of copper oxide and sulfide ores. The plant consists of the following pilot-scale components:

- primary crusher;
- fine crusher;
- grinding circuits for oxide and sulfide ores;
- concentrator for sulfide ore;
- vat leaching, agitation leaching and thickening for oxide ore;
- solvent extraction and electrowinning; and
- disposal facilities for tailings.

Further information concerning the operational components of the pilot processing plant are presented in a report on soil quality, which is included with this volume as Appendix G.

Conoco commenced in-shaft drilling operations in June of 1974. Shaft No. 1 was drilled to a depth of 706 feet below ground surface (bgs) and was designated for emergency access and air supply. Shaft No. 2 was drilled to a depth of 730 feet and was designated as the production shaft. The salient features related to the construction of the underground shafts are listed below.

Shaft No. 1: (706 feet total depth)

Borehole diameter - 57½-inches

- Fitted with 42-inch outside diameter 3/8-inch thick, A-36 steel, ring-stiffened casing to full depth.

- Grouted at casing shoe with 15.5 pounds per gallon (ppg) neat cement, followed by cushion plug up to 689 feet, with completion of cementing to surface with 12.85 to 13.3 ppg, 2 percent prehydrated gel cement yielding 1.92 cubic feet per sack.

Shaft No. 2: (730 feet total depth)

- Pilot borehole diameter of 57½-inches, reamed to final diameter of 86 inches.

- Mud used below 620 feet.

- 72-inch inside diameter (ID) 3/8-inch thick, A-36 ring stiffened casing installed to 715 feet.

- Cemented to surface in similar fashion as that procedure described above for Shaft No. 1.

- Some remedial grouting required to halt 6 gallons per minute (gpm) inflow at casing shoe upon initial inspection. Remedial actions resulted in no appreciable flow into cased shaft.

Following shaft construction and excavation necessary to install a dewatering system, a total of 5,480 feet of drift and crosscut was advanced along the 800-foot level (see Figure 4.1-2[II]). The 2 shafts were connected by an 11-foot high by 9-foot wide drift. An underground electrical substation was installed on the east side of the drift. After completion of the substation, a drift was excavated to the west of the shaft. Advancement of this draft was hampered by highly fractured bdrock. The size of this drift was increased from 8 feet square to 9 feet square to provide increased stability.

More stable conditions were encountered east of the shaft. Generally, the rock encountered during drift excavation was more fractured and broken than initially anticipated. Large quantities of timber and steel were used for ground support. Difficult excavting conditions were encountered approximately 500 feet west of the shaft due to a shear zone, advancement to the west was eventually halted.

The 2 shafts are currently open to the underground workings and are sealed at the surface by 1/2-inch thick steel plates. Water levels and groundwater samples are collected from the emergency air shaft at monthly intervals as part of the current investigation. Access is gained through a 3-inch diameter sealable opening in the steelplate covering the emergency shaft. Depth to water in the emergency shaft varies between 135 feet bgs and 140 feet bgs. The 2 shafts are currently enclosed by padlocked chain-link fencing. Telephone poles and electrical wiring indicate the location of the original draw works, as do abandoned ore carts at the surface.

Following mining activity, the pilot mine was kept open for a 2 month instrumentation period for collection of hydrologic and geologic data. All rail, pipe, pumps, and electrical equipment were salvaged from the workings and shaft after completion of testing. Timber in the workings was left intact to allow reentry at a later date.

Golder (1976) and Conoco (1976) conducted hydrologic studies of the underground workings using total flow, weir flow, and in-situ permeability techniques. Total flow from the underground openings was constantly monitored by Conoco during mining activities. Flows measured during the instrumentation period are believed to be the most reliable (Conoco, 1976; Golder, 1976) as only water originating from the rock was recorded. Orifice plate manometer readings taken over a period of 1 3/4 hours indicate that flow into the entire network of underground workings ranged from 425 gpm to 715 gpm, with an average of 530 gpm (Golder, 1976).

4.1.3 Existing Exploratory Coreholes and Test Wells

Three phases of corehole drilling have been implemented in the proposed in-situ mine area. Two phases were conducted prior to 1995, and 1 phase was conducted by Magma in conjunction with the current investigation. Coreholes located in the vicinity of the proposed in-situ mine area are depicted on Figure 4.1-1[II].

Conoco initiated the first phase of drilling which commenced in June of 1970 and continued through late 1975. A total of 686 exploratory drill holes were completed on the property, including 332 coreholes drilled within the primary deposit and another 354 completed in peripheral areas. Of the 332 coreholes drilled over the orebody, only 260 penetrated bedrock. The remaining 72 holes were drilled through basin fill deposits, terminating above the ore deposit. Almost all of the holes were rotary drilled through the base fill and cased with 3-inch diameter pipe. The remainder of each borehole was completed with coring techniques. Almost all core was NX (3.03-inch OD) size unless poor ground conditions necessitated a reduction to BX (2.40-inch OD) size. Depths of total penetration were determined by the occurrence of weak mineralization and/or alteration.

The second phase of corehole drilling occurred during a pre-feasibility study initiated by Magma in January of 1993. As part of a verification drilling program, 23 additional coreholes were drilled from January 1993 through February 1995. The pre-feasibility coreholes were advanced to depths ranging from 770 feet to 1,600 feet bgs. Bedrock ranged in depth from 300 feet to 510 feet bgs. The casing was pulled on selected pre-feasibility coreholes and the top 20 feet cemented upon their completion. Of these coreholes, 17 were drilled near previous Conoco corehole locations, and 6 were drilled in intermediate locations within the copper oxide deposit. Additionally, two 6-inch diameter holes were advanced for obtaining bulk samples for metallurgical testing (CMCC-419 and MCC-426). Drill hole MCC-426 was rotary drilled to a depth of 360 feet bgs and cored to a total depth of 842 feet bgs to the base of the oxide. Drill hole MCC-419 was rotary drilled through the basin-fill deposit to 360 feet and cored in bedrock to 690 feet. Twelve NX (3.03-inch diameter) size holes were advanced to acquire samples for material properties testing.

To further characterize the west edge of the ore deposit, Magma performed a third phase of feasibility stage drilling. Drilling commenced in February 1995 and consisted of advancing approximately 38 diamond drill holes. These coreholes penetrated the oxide and sulfide bedrock zones. A summary of the 1995 corehole program is presented in Table 4.1-1. Two 6-inch diameter coreholes (MCC 533 and MCC 534) were drilled on the west side of the ore deposit to a depth of 1,074 feet and 900 feet bgs, respectively. These coreholes were completed to obtain samples for metallurgical and geochemical testing. Further discussions concerning geochemistry related to corehole samples are presented in Section 4.7.

During this investigation, an assessment was performed to evaluate the current status of the Conoco coreholes. Based on information gathered from the survey coordinates, a field investigation ensued. Approximately 114 of the 337 coreholes were located. The remaining coreholes could not be located due to agricultural activities. The coreholes range in depth from 110 feet to 2,674 feet bgs, and average approximately 1,400 feet bgs. Almost all coreholes were cased to the basin-fill bedrock interface, which ranges in depth from 300 to 1,648 feet bgs, and averages approximately 400 feet bgs. A total of 337 coreholes were investigated. Water levels were measured in approximately 47 coreholes. Small amounts of hydrocarbons were detected in 4 coreholes located in the western area of the site (369MF, 423MF, S1S, and 5). Thicknesses of hydrocarbons of up to 6 inches were measured on top of the water in the coreholes. A corehole abandonment plan was prepared by Brown and Caldwell and submitted to the Arizona Department of Environmental Quality (ADEQ) and the Environmental Protection Agency (EPA) for review. Further discussions of the sequence and methods for corehole abandonment are included in Volume V of this application.

Data from the Conoco and Magma coreholes were used to construct a working conceptual ore reserve model. The structural components of this model were then utilized to select the location of aquifer test wells within the Florence orebody. A summary of the aquifer test wells installed by Magma in 1994 is presented in Table B-4 in Appendix B. These wells ranged in depth from 640 to 900 feet bgs and comprised a total footage of 9,360 feet. Locations of these wells are shown on Sheet 1.2-2[II] and Figure 2.1-2[II]. Data from aquifer tests performed previously in the in-situ mine area by Magma were utilized to characterize hydrogeologic conditions and to scope additional investigations.

4.1.4 Archeological Features

To fulfill requirements set forth by the National Historic Preservation Act (NHPA), an inventory of cultural resources was conducted in late 1994 by Western Cultural Resource Management, Inc. (WCRM) of Colorado. A substantial number of cultural sites associated with an extensive mid to late Hohokam Preclassic period occupation were identified (WCRM, 1995) in the proposed project impact area which includes the area encompassing the proposed in-situ mine area orebody and surface facilities (see Figure 2.1-1[II]) and evaporation pond. Sites located in the proposed impact area could potentially be affected by drilling or facility construction activities.

Testing was conducted by WCRM to determine eligibility for the National Register of Historic Places (NRHP). Such eligibility would mandate protection and preservation of the archaeological properties on the designated land. Inventories conducted by WCRM in late 1994 and July 1995 resulted in the determination that there are at least 27 NRHP eligible sites located in the impact zone. These zones are depicted on Figure 4.1-1[II].

All drilling activities conducted in the proposed in-situ mine area were monitored for cultural resource disturbance as required by NHPA. The locations of wells and boreholes were chosen to avoid archaeological features. The intent of the Cultural Resource Management Plan is to recover data as required, then proceed with facility construction. WCRM reports that the westernmost portion of the proposed in-situ mine area contains a low density of cultural resources. Development in that area would result in a minimal impact to the cultural resources (WCRM, 1995).

4.2 SURFACE WATER HYDROLOGY

The following subsections discuss pertinent surface hydrological features. Many of these features are depicted on Figure 4.1-1[II] and Sheet 1.2-2[II].

4.2.1 Watershed Conditions

The topography across the proposed in-situ mine area is relatively flat, and gently slopes to the south from an elevation of approximately 1,485 to 1,463 feet bgs. The northern half of the proposed in-situ mine area is vegetated with Sonoran Desert scrub, whereas the southern half of the mine area consists of irrigated agricultural fields. There are at least 3 gently sloping river terraces in the proposed in-situ mine area.

Two watersheds are located to the north of the proposed in-situ mine area (see Figure 4.1-1): (1) the East Drainage Watershed (Drainage C), and (2) the West Drainage Watershed (Drainages A and B). In a report prepared by Simons, Li and Associates, Inc. (SLA, 1995), included with this application, drainage areas associated with the West and East Drainages are 1,911.9 acres and 355.4 acres, respectively. One-hundred year, 24-hour design storm peak discharges for the West and East Drainages are 564 cubic feet per second (cfs) and 843 cfs, respectively (SLA, 1995). These arroyos are ephemeral, and both sheet and gully flow migrate from the north to the south towards the Gila River. Natural drainage behavior on the property has been altered by culverts, elevated road beds, and berms (SWCA, 1995).

The drainage that originates in the East Drainage and enters the northeast portion of the mine area through a culvert beneath the Hunt Highway. The drainage maintains a 5-foot channel width before entering a densely vegetated area. Immediately downstream, the runoff from the drainages is controlled by 2 man-made berms approximately 400 feet long, which divert flow off to the east edge of the property. Preliminary investigations of the East Drainage Watershed indicate that no significant reduction in flow rates occurs at the railroad trestle bridge. The corrugated metal pipe at the East Drainage crossing also has a conveyance capacity less than the 100-year flood discharge capacity. The Hunt Highway embankment, however, is not elevated enough to affect the downstream flow rate (SLA, 1995).

The 2 drainages entering the proposed in-situ mine area from the West Drainage through culverts beneath the Hunt Highway flow from north to south. The discernible channels become more shallow and narrow as they progress downstream. Preliminary investigations of the West Drainage Watershed indicates that the existing railroad embankment and the 9.5-foot diameter corrugated metal pipe at the West Drainage crossing will limit the peak surface water discharges onto the mine site. Because the conveyance capacity of the corrugated metal pipe is less than the 100-year discharge, significant backwater would be retained behind the railroad embankment during a 100-year flood event. Therefore, due to upstream storage of runoff, peak flow rates downstream through the mine area would be limited (SLA, 1995).

4.2.2 Canals

The North Side Canal (an unlined canal managed by SCIDD) runs westward along the north edge of the Gila River floodplain and traverses the center of the proposed mine area. There are 4 irrigation wells which border the North Side Canal, 2 SCIDD wells on the proposed in-situ mine area (BIA 9 and BIA 10B) and 2 private irrigation wells owned by Magma just east of the property. These wells provide water for irrigation in the area. The North Side Canal is in service continuously throughout the year, with the exception of a 1 month period each fall, when SCIDD closes the canal for cleaning, and ceases pumping of BIA 9 and BIA 10B.

Tables 4.2-1a and 4.2-1b present a summary of information collected during this investigation associated with the SCIDD North Side Canal. Water samples from the canal were collected in the summer and fall of 1995. The location on the canal where the samples were retrieved is shown on Figure 2.1-3[II]. Average concentrations of nitrate, sulfate, and total dissolved solids (TDS) in this canal water are <0.10 milligrams per liter (mg/L), 85 mg/L, and 480 mg/L, respectively (Table 4.2-1a). Flow estimates of the SCIDD canal were made at the time of each sampling effort using field measurements and methods presented in Chow (1959). As presented in Table 4.2-1b, flow measurements in June through August 1995 ranged from about 4,500 to 6,700 gpm.

4.2.3 Gila River

Previous discussions of the Gila River in the region are presented in Section 3.3. This subsection focuses on geomorphic and flow characteristics, and the potential influence on the groundwater in the in-situ mine area.

U.S. Geological Survey (USGS) quadrangle maps (USGS, 1966, 1981, and 1982) show an average channel width of the Gila River of approximately 142 feet. The measurement location is upstream from the Southern Pacific Railroad crossing near Florence. The Gila River is located approximately 1 mile south of the project site.

Figure 4.2-1 presents a summary of estimated annual stream flow of the Gila River below Ashurst-Hayden Dam, which includes the Florence Project Area and is also known as the Middle Gila River segment (Huckleberry, 1993). The values depicted in Figure 4.2-1[II] were derived by Huckleberry by subtracting annual diversions at Ashurst-Hayden Dam from Annual Gila River discharge amounts recorded at Kelvin, Arizona.

In October of 1983, major flooding occurred due to precipitation brought into Arizona by Tropical Storm Octave. Coolidge Dam retained most of the runoff from Upper Gila River, however the San Pedro River flooded the Middle Gila River. Peak discharge at Kelvin (19 miles upstream from Florence [see Figure 3.3-1[II]]) was 210,624 cfs on October 2, 1983 and it was estimated that peak discharge at Florence was 61,092 cfs (Huckleberry, 1993). Flood flow occurred over a 3-day period. Following the 1983 flood event, average channel widths above the Southern Pacific Railroad crossing had increased to 224 feet.

Flow in the Gila River from the 1983 flood recharged the groundwater system along the Gila River floodplain. Changes in groundwater levels from January 1983 to March 1984 confirmed the occurrence of recharge to the groundwater system. The water-level rise was greatest 15 to 22 miles downstream from the Ashurst-Hayden Dam in the vicinity of Florence, where the average water-level change for 10 wells in that area was +59.4 feet (USGS, 1990). The USGS estimated that 46 to 66 percent of the recharge from October 1983 to March 1984 was the result of streamflow infiltration through the channel and floodplain of the Gila River, and that the estimates of recharge ranged from 449,000 to 640,000 acre-feet (USGS, 1990). Further discussions of regional water table elevation responses to Gila River flow events are presented in Sections 3.6 and 4.3.3.

In January 1993, a split in the mid-latitude jet stream resulted in a series of cold fronts with associated subtropical precipitation in the Gila River watershed. Most of the Middle Gila River streamflow was generated by large volumes of water flowing through the spillways of Coolidge Dam. Peak discharge on January 19, 1993 was 74,749 cfs, and water releases at the dam reached 32,990 cfs on January 20, 1993 (MacNish and others, 1993). Although the peak discharge rates during the 1993 event were less than that of the 1983 event, the total volume of runoff associated with the 1993 flood was much greater; 884,900 acre-feet versus 503,000 acre-feet for the 1983 flood (Huckleberry, 1993). The extent of any modifications to the Gila River floodplain caused by the 1993 event has not yet been determined. It is apparent, however, that segments of relatively narrow low-flow channels have been replaced by wide, braided channels.

4.2.4 100-Year Floodplain Delineation

Hydrologic analyses have been performed by the Federal Emergency Management Agency (FEMA) and compiled in a Flood Insurance Study (FIS) for the unincorporated areas of Pinal County. These analyses evaluated peak discharge-frequency relationships for all possible flooding sources, and a 100-year floodplain delineation was formulated (FEMA, 1990). The primary source of flooding for the Florence area is the Gila River. Reduction in discharge between Florence and Kearny is probably due to overbank storage in the floodplain upstream from Florence.

Delineation of the 100-year floodplain in the proposed in-situ mine area was based on the discharge data provided by FEMA and surveyed cross-sections (Cella Barr Associates, 1995). This information was input into a hydraulic computer model developed by the U.S. Army Corps of Engineers (HEC-2 model) and was used to model the Gila River flow regime in order to estimate the lateral extent of the 100-year floodplain adjacent to the mine area, which is also depicted on Figure 4.1-1[II]. Findings from the investigation of the 100-year flood event indicate that the western limit of the floodplain coincides with the western orebody limits. The eastern extent of the Gila River, however is flowing within a restricted channel area which would result in higher channel velocities and subsequently more erosion of the existing bank.

Table 4.2-2 presents a summary of design discharge criteria for various locations along the Gila River compiled by FEMA (1990). For the Gila River at Florence, peak discharge for a 100-year, 24-hour event is 120,000 cfs.

4.3 LOCAL GEOLOGY AND HYDROGEOLOGY

The following subsections describe the geologic and hydrogeologic characteristics associated in and around the proposed in-situ mine area. Figures 4.3-1[II] through 4.3-4[II] depict subsurface cross-sections at various locations across the site. Pertinent surface features are illustrated on Sheets 1.2-1 and 1.2-2. Surface geology for the area is also shown on Sheet 1.2-2.

4.3.1 Local Stratigraphic Conditions

The hydrogeologic units and the relationships between these units, as identified at the proposed in-situ mine area, generally correlate with hydrogeologic systems identified regionally in the large alluvial basins of southern Arizona (see Figure 3.4-5[II]). The hydrogeologic setting is characterized as consisting of Precambrian bedrock overlain by coarse clastic sediments (Lower), in turn overlain by finer-grained sediments (Middle), and then by variously coarse- and fine-grained deposits (Upper). These classifications are similar to the Lower Basin-Fill Unit (LBFU), Middle Basin-fill Unit (MBFU), and Upper Basin-fill Unit (UBFU) used in the discussions presented herein. Recent alluvium commonly is present above the upper sediments. A typical assemblage of basin-fill sediments does not appear to have accumulated over the proposed in-situ mine area because of its proximity to the margin of the basin.

The lithologic relationships illustrated in Figures 4.3-1[II] through 4.3-4[II] are representative of conditions in the proposed in-situ mine area. It is possible that lateral variations within the units are more prevalent than indicated on these figures. The sediments were derived from both fluvial and subaerial processes; therefore, lateral gradations and facies changes are present. As sediments accumulated over the bedrock, coarse clastics were probably deposited in higher energy environments on the west side of the site, where bedrock sloped steeply off to the west into the regional graben. Such an environment may have produced alluvial fan, talus, rock avalanche or landslide deposits. Contemporaneous sediments deposited on the lower relief topography to the east were likely fluvial in origin, and generally composed of sands and silts. This mantle over the bedrock is now part of the LBFU.

The flat-lying nature of the Middle Fine-Grained Unit (MFGU) suggests a very low relief terrain eventually developed, onto which the fine-grained material was deposited. The UBFU overlies the MFGU, and represents fluvial and alluvial deposits that further developed from the eroding landscape, becoming increasingly fine-grained across the proposed in-situ mine area.

The degree of consolidation of the sediments generally increases with depth. There does not appear to be consistent stratigraphic control on consolidation. Finer-grained sediments are calcareous; however, induration appears most dependent upon depth and is believed to be primarily a result of burial and the effects of the ensuing compaction of the sediments. Well-consolidated basal conglomerate and extremely well-lithified basal breccia occur sporadically, otherwise near-bedrock sediments range from unconsolidated to moderately well-compacted.

4.3.2 Geohydrologic Characteristics of Local Geologic Units

This section describes the geologic units at the in-situ mine site with respect to their areal distribution and thickness, composition, texture, and hydraulic characteristics. Tables 4.3-1, 4.3-2, and 4.3-3 summarize hydraulic conductivity data associated with the proposed in-situ mine area.

4.3.2.1 Alluvium and Vadose Conditions

Soil surveys for Pinal County have been completed by the U.S. Department of Agriculture, Soil Conservation Service (SCS, 1991). Soil information has been compiled on a general, large-scale basis, and on a detailed basis. For this report, general soil descriptions are included. The near-surface soils present at the Florence in-situ mine area consist of the following general categories:

- the northern portion of the area contains soils of the Mohal-Contine association, which is characterized by deep, well-drained, nearly level to gently sloping, loamy and clayey soils generally occurring on alluvial fan terraces; and

- the southern portion of the area consists of 2 general soil groups: the Marana-Sasco-Denure association occurs as stream terraces associated with the Gila River and are characterized by deep, well-drained, nearly level and loamy. The Cipraino-Pinamt-Momoli association is a very shallow to deep, well-drained, nearly level to sloping, very gravelly and cobbly, loamy soils associated with fan terraces.

Recent surficial cover (Recent Alluvium) consists of channel gravels with overlying soils and underlying alluvial and fluvial deposits. The deposits consist of unconsolidated, moist, well-graded sand, silt, and gravel that occur from the land surface to depths of of approximately 70 to 104 feet bgs (see Table 2.3-3). The deposits generally coarsen with depth, with cobble and boulder gravels common in the lower portion. The base of the recent alluvium is typically marked by an abrupt change from boulder-rich gravel to sand, silt, or clay. Although this contact is interpreted to be an unconformity, it is flat-lying beneath the in-situ mine area, as shown on Figures 4.3-1[II] through 4.3-4[II].

The recent alluvium generally lies approximately 10 to 50 feet above the regional water table. Groundwater, however, was locally encountered in 2 exploration boreholes (B2 and B3) at the base of the recent alluvium near the southern perimeter of the in-situ mine site (see section 4.3.2.2). This interval of the subsurface is characterized as well-graded sands and gravels, with data obtained during field testing of the lower cobble and boulder gravels.

The recent alluvium is characterized geophysically as being generally coarse-grained containing little clay, as shown on electric logs of approximately 9 boreholes (see Appendix A). The transition from alluvium to the UBFU is difficult to determine in the vadose zone because the geophysical logs yield best results under saturated conditions. However, a general increase in clay content and a slight decrease in porosity at the contact are indicated on the electric and neutron logs, respectively. The contact between the recent alluvium and the UBFU appears to be gradational in most areas of the proposed in-situ mine area.

A summary of hydraulic conductivity measurements associated within the vadose zone are presented in Table 4.3-1. The field and laboratory testing values are for the UBFU, with the exception of piezometers P3-60 and P4-40, which were obtained from the recent alluvium, and sample M16-GU-300, which was obtained during drilling for monitor well M16 and represents the MFGU, which is saturated. The field test intervals were selected to represent general subsurface soil types. The laboratory test intervals were selected from finer-grained soils which were encountered. The recent alluvium can be described as a porous media with a hydraulic conductivity value estimated to range from 4.82 to 9.35 ft/day (1.7E-03 to 3.3E-03 cm/sec) as presented in Table 4.3-1 for piezometers P3-60 and P4-40.

4.3.2.2 Upper Basin-Fill Unit (UBFU)

The UBFU underlies the recent alluvium and ranges in thickness from 200 to 240 feet at the in-situ mine site. Figure 4.3-5[II] shows elevation contours of the top of the UBFU. The upper portion of the UBFU is not saturated, and forms the lower vadose zone, which extends to depths ranging from 100 to 150 feet bgs. The upper portions of the unit are generally fine-grained and calcareous, consisting of a gradational succession of poorly graded, moist silt and sand with minor gravel. The lower portions are generally coarse-grained, with gravel interbeds common at depth. Although more cohesive than the overlying recent alluvium, the UBFU is generally described as unconsolidated. A distinctive feature of this unit is the reddish-brown clay matrix that is typically present in the sands and gravels. Such iron-oxide coloration is common in both the UBFU and LBFU.

Groundwater was locally encountered in 2 exploration boreholes (B2 and P3-60) near the southern perimeter of the in-situ mine site at a depth of approximately 70 to 80 feet bgs (see Figure 2.1-1[II]). This groundwater is likely associated with percolation of irrigation water from farmland at the surface in this area, and possibly recent Gila River flood events (see Section 4.2). The regional water table occurs within the UBFU. The lower 130 to 150 feet of the UBFU is saturated in the in-situ mine area.

Geophysical investigations show that the UBFU consists of interbedded sedimentary sequences of varying grain sizes. The neutron, sonic, and electric logs generally indicate that these deposits are unconsolidated. The contact between the UBFU and the underlying MFGU is easily recognized in the electric log as a sharp decline in resistivity, which is indicative of decreasing grain size.

A summary of hydraulic conductivity measurements obtained from tests performed in the unsaturated portion of the UBFU are presented in Table 4.3-1. Field hydraulic conductivity tests conducted in the upper 70 to 90 feet of the UBFU indicate hydraulic conductivities ranging from 0.74 to 2.07 ft/day. The results of laboratory permeability tests performed on 5 relatively fine-grained vadose zone samples indicate hydraulic conductivities ranging from 1.49E-03 to 7.82E-02 ft/day. Existing aquifer information concerning the UBFU is presented in Section 3.7 for the regional area. Although the UBFU does yield water, many existing wells are screened in the UBFU, MFGU, and LBFU combined. Existing site-specific information is discussed further with the LBFU in Section 4.3.2.4.

Information acquired during this investigation includes specific aquifer parameter evaluations for the UBFU. As presented in Table 4.3-3, mean hydraulic conductivity values using different investigative methods range from 40.5 to 122.0 ft/day (1.4E-02 to 4.4E-02 cm/sec). As listed in Table 4.3-4, hydraulic conductivity values range from 4.2 ft/day (1.5E-03 cm/sec) to 192.0 ft/day (6.8E-02 cm/sec). Discussions relating to aquifer characteristics of the unsaturated portion of the UBFU are presented in Section 4.2.

4.3.2.3 Middle Fine-Grained Unit (MFGU)

The MFGU underlies the UBFU along a very gently sloping contact that is interpreted to be an unconformity, based on a basin-wide shift in lithofacies. The unit is generally 20 to 30 feet thick at the in-situ mine site but increases to about 55 feet at the southwest corner of the site. The unit appears to be nearly continuous, although it is interpreted to pinch out or grade to coarser-grained beds in the extreme northwest corner of the site. The MFGU could also pinch out against a north-northwest-trending bedrock ridge in the western portion of the in-situ mine site. Structural contours on top of the MFGU are presented on Figure 4.3-6[II].

The MFGU ranges from dark reddish-brown, calcareous clay to silty sand. The unit locally includes desiccation cracks, reworked broken clay clasts, carbonaceous film, and thin interbeds of fine sand or pebbles up to 1 inch-thick. In places, the unit is massive with no detectable internal structure. It is generally calcareous and may be associated with thin zones of caliche. The base of the unit slopes very gently (1 to 2 percent) to the southwest and is generally marked by a change from silty sand to gravel. In light of the numerous faults that are known to affect the bedrock at the in-situ mine site, the relatively flat-lying base of the MFGU is an indication that faulting had essentially ceased prior to the deposition of this unit.

The MFGU is best defined geophysically. It appears as a substantial decrease in resistivity on the electric log as indicated for at least 8 wells (see Appendix A). The relative uniformity of grain sizes can be inferred by the slope of the electric log. Uniform grain sizes are indicated by a relatively flat or slopeless curve, whereas, varying grain sizes are indicated by a sloping line. The contact between the MFGU and underlying LBFU is best recognized by degree of cementation, and increased grain size and as shown on the electric, sonic, and neutron logs.

Existing aquifer characteristic information concerning the MFGU is discussed on a regional basis in Section 3.7. During this investigation, laboratory triaxial permeability testing was conducted on a relatively undisturbed sample retrieved from a depth of 300 feet bgs while advancing the boring for monitor well M16-GU. Results of this testing are included in Table 4.3-1. A hydraulic conductivity value for the MFGU of 5 x 1E-09 cm/sec was measured.

4.3.2.4 Lower Basin-Fill Unit (LBFU)

The LBFU underlies the MFGU at the in-situ mine site with the contact occurring at depths of 260 to 300 feet bgs. These deposits comprise the lower portion of the sedimentary succession that overlies the Precambrian bedrock. Because of the large structural relief on the LBFU/bedrock contact, the thickness of the LBFU is variable, ranging from negligible thicknesses to over 750 feet. These relationships are illustrated on Figure 4.3-7[II], which depicts the proposed in-situ mine area in perspective view.

The thickest deposits of LBFU occur along the western boundary of the proposed in-situ mine area, which coincides with the east flank of a large graben structure that was discussed in Section 4.3.1. The increased thickness is attributable to faulting, subsidence and lithostatic loading in the basin, which presumably provided additional space for deposition. To the east of these thickest deposits is a 400- to 500-foot wide buried bedrock ridge along which the LBFU is generally less than 70 feet thick. Immediately east of the bedrock ridge, the bedrock surface has been eroded and possibly faulted into a north-northwest-trending trough into which LBFU has accumulated to thickness between about 200 and 260 feet. There are borehole indications that the LBFU above the Sidewinder Fault may be displaced, with minor vertical offset.

The top of the east flank of the bedrock trough occurs about halfway across the proposed in-situ mine area. East of this feature, within an area that essentially comprises the eastern half of the site, thickness of the LBFU generally ranges from about 30 to 80 feet.

The LBFU consists of coarse gravel, fanglomerate, conglomerate, and breccia, and is distinguished by its greater degree of consolidation relative to the UBFU. Lithologically, the strata appear generally similar to the overlying UBFU, with the exception of the occurrence of a bedrock gravel or conglomerate, immediately above the bedrock contact, that is locally well-lithified. One such occurrence of a basal gravel or conglomerate coincides with the axis of the bedrock trough feature associated with the Sidewinder Fault Zone, as illustrated on Figure 4.3-7[II]. Within the bedrock trough, the lower 30 feet of LBFU consists of angular cobbles and boulders in a sandy matrix. The clasts are predominantly quartz monzonite in composition. The angular nature and homogeneous composition of these gravels suggests that they were not transported any distance; therefore, these deposits are not likely of fluvial origin, but more likely alluvial.

The geophysical signature of the LBFU is broadly similar to that of the UBFU, but increased cementation and decreased porosity are indicated by the electric, sonic, and neutron logs (see Appendix A). Porosity, as defined by the neutron log, tends to decrease with depth and is lowest in the western portion of the site where the down-faulted graben has caused thickened sequences of LBFU. The LBFU/bedrock interface is easily recognized in the electric, gamma-ray, neutron, and sonic logs. The bedrock units are characterized by higher resistivities, higher gamma-ray counts and an abrupt porosity decrease.

Regional discussions of aquifer characteristics of the LBFU are presented in Section 3.7. Existing information has been reported for the Gila Conglomerate, which may be equivalent to the lower portion of the LBFU. A summary of this information is presented in Table 4.3-2. Transmissivities reported by Halpenny and Green (1976) range from 113,000 to 233,000 gallons per day per foot (gpd/ft). Studies performed by Halpenny and Green (1976), Leggette and others (1976) and Golder (1976) indicate a transmissivity value of 125,000 gpd/ft is considered to be a reasonable mean value.

Hydraulic conductivity for the LBFU conglomerate computed by Montgomery (1994) was approximately 93.0 ft/day (0.033 cm/sec). Montgomery (1994) reports short-term storage coefficient values of 9.4E-04 to 1.4E-02. Anderson (1968), and Halpenny and Green (1976) suggest that a long-term specific yield value of 0.17 for the LBFU conglomerate.

Halpenny (1976) reported a transmissivity value in the LBFU conglomerate located in the graben approximately 2 miles northwest of the in-situ mine area of about 45,000 gpd/ft. Hydraulic conductivity and short-term storage parameters for these materials reported by Montgomery (1994) are 360 gpd/ft^2 and 1.2E-03, respectively.

Aquifer parameter estimates obtained during this investigation relative to the LBFU are summarized in Tables 4.3-3 and 4.3-4. Mean conductivity ranged from 9.2 to 13.7 ft/day (3.2E-03 to 4.8E-03 cm/sec) for different investigative methods. Hydraulic conductivity values for the LBFU ranged from 0.02 ft/day (7.1E-06 cm/sec) to 25.5 ft/day (8.9E-03 cm/sec).

4.3.2.5 Oxide Bedrock Zone

Bedrock underlying the sedimentary succession at the proposed in-situ mine area consists primarily of Precambrian quartz monzonite and Tertiary granodiorite porphyry. Based on the copper mineral assemblage, the bedrock is divided into an upper oxide zone, and lower sulfide zone. The oxide bedrock zone is estimated to range in thickness from approximately 200 feet to over 1,500 feet. A block diagram showing the structural relief on the bedrock upper (oxide) surface is presented on Figure 4.3-8[II].

Based on geophysical logs from at least 12 wells (see Appendix A), the oxide bedrock zone produces a characteristic geophysical signature. The top of bedrock is easily recognized by a sharp increase in gamma-ray counts due to an increase in potassium content of the bedrock. The porosity, shown on neutron log, also tends to decrease compared to the overlying sedimentary deposits. The response of the gamma-ray curve can be useful in distinguishing changes in lithology in the bedrock complex. The primary bedrock component is a quartz monzonite porphyry containing abundant potassium. In contrast, other common lithologies include a granodiorite porphyry and mafic dikes, which contain less potassium and subsequently exhibit lower gamma-ray counts.

A weathered bedrock zone mantles the top of the oxide bedrock zone. This zone consist of a rubbly mixture of fracture filling and angular bedrock fragments, and is expected to be a zone of enhanced hydraulic conductivity. Locally, this zone is often included with the LBFU, as it is difficult to distinguish in-place weathering products from overlying colluvial materials. Below this weathered zone is faulted and extensively fractured quartz monzonite, granodiorite, and associated dikes.

Movement of groundwater through the oxide bedrock zone (and the sulfide bedrock zone) may be influenced in part by secondary permeability resulting from faults, fractures, and associated brecciation. The distribution of these structural features was estimated based on corehole data collected by Conoco and Magma, and from a comprehensive drilling program undertaken by Brown and Caldwell in support of the Magma Florence Aquifer Protection Permit (APP) application.

In general, fault zones were identified during drilling by the appearance of a conspicuous red clay in the oxide bedrock, which likely reflects structural deformation of the bedrock along fault planes. Other criteria used in identifying faults included the recognition of offsets of the oxide zone/sulfide zone contact and offsets of dikes and other lithologic markers within the bedrock.

Faults were also identified in corehole logs by the presence of clay gouge, slickedsides and intense rubblization. Widths of the faults appear to decrease with depth, hence fault-localized zones appear to be funnel-shaped in cross-section.

The occurrence and intensity of fracturing is greatest near the major structural features of the area (the Party Line and Sidewinder Faults) and decrease in abundance away from these discontinuities. The Party Line Fault, which post-dates mineralization and bounds, in part, mineralization in the eastern portion of the orebody, strikes north 34° west and dips 40 to 50 degrees to the southwest. The 2 major faults in the proposed in-situ mine area exhibit a range of displacements. Approximately 1,000 feet of vertical displacement is estimated to have occurred across the Party Line Fault. The Sidewinder Fault occurs in the western portion of the in-situ mine site and typically exhibits about 1,200 feet of vertical displacement. The Sidewinder Fault underlies the bedrock trough discussed in Section 4.2.3.4 and is probably responsible for the position of this bedrock swale.

Hydraulic properties of the oxide bedrock zone were evaluated for permit support investigations and for mine development activities. As discussed in Section 2.0, aquifer test locations were selected based on the distribution of fracture intensity in the oxide bedrock zone and proximity to major faults. A spatial analysis of existing corehole data was performed by Applied Research Associates (ARA) and demonstrated that groups of mine resource blocks could be shown to be similar in terms of hydrogeologic characteristics. The results of this analysis are presented in Appendix D of this volume.

Significant results of ARA's fracture intensity analysis are as follows:

- Hydraulic conductivity field tests, as performed during this investigation, represent the range of hydraulic conductivities in the oxide bedrock zone.

- The intensity of fracturing roughly correlates with position relative to major fault zones, with fracture intensity decreasing away from these zones.

- Fracture density decreases with depth in the oxide and sulfide bedrock zones.

Regional discussions of aquifer characteristics of the oxide bedrock zone are presented in Section 3.7. Existing information concerning this hydrogeologic unit is summarized in Table 4.3-2. Existing information concerning aquifer characteristics of the oxide and sulfide bedrock hydrogeologic units is presented in terms of the bedrock complex, which does not differentiate the 2 zones.

Transmissivity for the bedrock complex in the area is estimated to range from 10,000 to 12,000 gpd/ft (Halpenny and Green, 1976). Montgomery (1994) reports calculated hydraulic conductivity values using this range from 3.35 to 8.93 ft/day (1.7E-03 to 3.21E-03 cm/sec). Montgomery (1994) indicates that these transmissivity and hydraulic conductivity values may be low based on the assumptions and methods used. Dames and Moore (1974) report hydraulic conductivity estimates ranging from 0.23 to 1.27 ft/day (7.8E-05 to 4.4E-04 cm/sec) for the bedrock complex. Estimates of bedrock complex hydraulic conductivity associated with development of the pilot mine include a value of 0.19 ft/day (6.5E-05) reported by Conoco

(1976), and a range from 0.14 to 0.74 ft/day (4.9E-05 to 2.6E-04 cm/sec) reported by Golder (1976). Montgomery (1994) suggests that hydraulic conductivity of the bedrock complex correlates directly with fracture density. Both hydraulic conductivity and fracture density appear to decrease with depth in the bedrock complex.

Aquifer parameter estimates specific to the oxide bedrock zone obtained during this investigation are presented in Tables 4.3-3 and 4.3-4. Mean hydraulic conductivity values for the oxide bedrock zone ranged from 0.1 to 1.0 ft/day (4.6E-05 to 3.5E-04 cm/sec). Values ranged from 7.7E-03 to 3.8 ft/day (2.7E-06 to 1.3E-03 cm/sec).

4.3.2.6 Sulfide Bedrock Zone

The sulfide bedrock zone underlies the oxide bedrock zone and is of unknown lateral extent. The intensity and permeability of the fracture network within the sulfide zone appears to be less than that intercepted in the overlying bedrock. Generally, the sulfide bedrock appears to be more competent than the overlying oxide bedrock zone. The geophysical signature of the sulfide bedrock zone is very similar to the oxide bedrock zone, and the contact is frequently difficult to distinguish.

Regional discussions of aquifer characteristics of the sulfide bedrock zone are presented in Section 3.7 with the oxide bedrock zone discussions. Existing information concerning aquifer characteristics of the oxide and sulfide bedrock hydrogeologic units is presented in terms of the bedrock complex, which does not differentiate the 2 zones. Discussions relative to existing bedrock complex aquifer characteristics is presented in the previous subsection.

Aquifer parameter estimates specific to the lower oxide and sulfide bedrock zones were obtained during this investigation and are presented in Tables 4.3-3 and 4.3-4. The mean hydraulic conductivity values, based on different investigative methods, ranged from 0.03 to 3.0E-04 ft/day (9.5E-06 to 1.1E-7 cm/sec). Hydraulic conductivity values for the sulfide bedrock zone ranged from 0.0055 to 0.05 ft/day (1.96E-06 to 1.7E-05 cm/sec).

4.3.3 Local Groundwater Conditions

The local water table occurs at depths ranging from approximately 110 to 155 feet bgs at the proposed in-situ mine area. The water table occurs within the UBFU approximately 130 to 150 feet above the basal contact of this unit with the MFGU. All of the geologic units below the water table appear to be saturated. The spatial distribution and hydraulic properties of these geologic units were discussed in Section 4.3.2. The hydraulic gradient and flow patterns of the groundwater occurring within these units are discussed below.

4.3.3.1 Flow Within Upper Basin-Fill Unit (UBFU)

Contour maps showing water table elevation of the proposed in-situ mine area wells during 4 consecutive monthly soundings (August through November, 1995) are presented on Figure 4.3-9[II]. Only wells screened within the UBFU were used in generating these maps, and consequently, the contour coverage is limited to the southeastern portion of the mine site. These maps illustrate that water table contour patterns were very similar for the months of September, October and November 1995, all of which show the water table sloping to the northwest at an average gradient of between 0.002 and 0.003 feet per foot (ft/ft). In contrast, the August 1995 contour map shows the water table sloping nearly due west at a steeper (0.007 ft/ft) gradient. The August water table contours appear to be influenced by the pumping of irrigation wells WW-3 and BIA-10B, shown on Figure 4.3-9[II]. The influence of these pumping wells is more pronounced on the LBFU and bedrock oxide zone potentiometric surface maps, as presented in Figures 4.3-10[II] and 4.3-11[II], respectively.

4.3.3.2 Flow Behavior Associated with Middle Fine-Grained Unit (MFGU)

Groundwater within the UBFU is separated from the next underlying groundwater flow zone (LBFU) by the MFGU. The MFGU probably restricts the flow of groundwater between the UBFU and the LBFU. Although generally only 20 to 30 feet thick, the MFGU was recognized across the in-situ mine area except for the far northwest corner.

4.3.3.3 Flow Within Lower Basin-Fill Unit (LBFU)

Contour maps showing the potentiometric surface of LBFU groundwater for the months of August, September, October and November 1995 are shown on Figure 4.3-10[II]. In September, October, and November the contour patterns appear generally similar and show a northwest to west-northwest gradient of between 0.001 and 0.004 ft/ft across most of the site. Along the western perimeter of the mine site, the potentiometric surface depicted for November 1995 abruptly steepens, indicating a higher gradient. The direction of the hydraulic gradient also changes along the western perimeter of the in-situ mine area; it is directed to the west along the central part and to the southwest along the southern part of this perimeter. In August, the effects of pumping from irrigation wells WW-3 and BIA-10B is clearly evident in the contour pattern, which shows a well-developed cone of depression between these wells.

Although no hydraulic barriers separate LBFU groundwater from groundwater flowing within the underlying oxide bedrock zone, it is useful to treat these 2 groundwaters as separate because of the different hydraulic properties and hydrogeochemical conditions of the units.

4.3.3.4 Flow Within Oxide Bedrock Zone

Groundwater flow conditions within the oxide bedrock zone are illustrated in the 4 potentiometric surface contour maps presented on Figure 4.3-11[II]. In general, the contour patterns of the oxide bedrock zone appear very similar to those of the LBFU. The hydraulic gradient is generally directed to the northwest, with the exception of the western perimeter of the in-situ mine site, where the gradient steepens and becomes more westerly. Like the contoured patterns of the LBFU, the change from a relatively shallow, northwest-directed gradient to a more westerly and steeper gradient spatially coincides approximately with the western flank of the bedrock trough.

Like the LBFU contour patterns, the August 1995 contour map shows a well-developed cone of depression caused by irrigation pumping. The center of this cone is somewhat to the west of where it occurs in the LBFU. This shift is interpreted to be a consequence of the data points being in different locations for the LBFU and bedrock oxide zone maps.

4.3.3.5 Flow Within Sulfide Bedrock Zone

Groundwater elevations for wells screened at discrete intervals within the bedrock sulfide zone are shown on Figure 4.3-12[II] for the same 4 timelines as the other hydrogeologic units. Because of the limited number of bedrock sulfide zone wells, and the fact that the wells are distributed along a straight line, potentiometric surface contours cannot be adequately resolved and are not shown on these maps. These data are presented primarily to compare with groundwater elevations from the overlying zones. The subject of vertical hydraulic gradients between the different groundwater zones is addressed in the following section.

4.3.3.6 Vertical Hydraulic Differences

Vertical gradients between the 4 groundwater zones discussed in this report were evaluated by subtracting the hydraulic head data from adjacent zones at cluster wells, or by subtracting the gridded potentiometric surfaces between adjacent zones using surface modelling techniques. Only data from August through November 1995 were used in this evaluation; prior to August, many of the wells used in the overall evaluation were not yet installed. In comparing the vertical gradient found in the UBFU with that of the LBFU, 3 sets of well pairs were used: M2-GU/M3-GL, M10-GU/M11-GL, and M18-GU/M1-GL. In comparing hydraulic gradients in the oxide bedrock zone with those found in the sulfide bedrock zone, 3 sets of well pairs were also used: M4-O/M5-S, M8-O/M9-S, and M12-O/M13-S. Finally, in comparing the gradients in the LBFU with the oxide bedrock zone, both of which have a large number of wells, the potentiometric surface generated using the bedrock oxide zone wells was subtracted from the potentiometric surface generated using the LBFU wells.

Between the UBFU and the LBFU, a slight downward gradient was consistently observed. In September, October, and November 1995, the differences in head ranged from 0.8 feet to 7.9 feet. A significantly larger head difference (11.68 feet) was observed at the M10-GU/M11-GL well pair in August 1995. This well pair is located near irrigation well BIA-10B (screened across UBFU, LBFU, and oxide bedrock zone), and the larger vertical potential appears to have been induced by the pumping of this well. The induced downward gradient adjacent to pumping irrigation well BIA-10B is interpreted to reflect the higher hydraulic conductivity of the UBFU as compared to the LBFU. The higher hydraulic conductivity of the UBFU may result in less depressurization during pumping.

Vertical gradient contours between the LBFU and the bedrock oxide zone are shown on Figure 4.3-13[II]. Except for the August 1995 data, the maximum difference in head between these groundwater zones is plus or minus about 2 feet. These observations are interpreted to mean that the LBFU and bedrock oxide zone are in hydraulic communication.

4.3.3.7 Seasonal Fluctuations

Evaluation of the regional groundwater conditions indicates that seasonal controls on groundwater potentials are significant. These controls include seasonal changes in the stage of the Gila River and seasonal changes in irrigation demand.

Well hydrographs for wells at the proposed in-situ mine area are presented on Figures 4.3-14[II] and 4.3-15[II]. Data are shown only as far back as June 1995, because most of the wells were not installed prior to this time. Available information suggests that seasonal fluctuations associated with irrigation groundwater withdrawal has occurred for at least several years prior to this investigation. Overall, the hydrographs appear similar among wells and between hydrogeologic units. During the interval between June and August 1995, groundwater potentials generally decreased, whereas between August and November 1995, groundwater potentials generally increased. These hydrograph patterns are interpreted to be a reflection of the agricultural evapotranspiration demand and related well withdrawal rates, which are highest in the summer months, tapering off in the fall. It is expected that the groundwater fluid potentials will continue to rise until the onset of the next growing season.

4.3.3.8 Recharge

The Gila River and its underflow are the primary sources of groundwater recharge to the local geologic units. The river underflow is a continuous source of recharge to the regional groundwater system. Infiltration of applied irrigation water is an additional, although relatively minor source of recharge to the local UBFU zone. The slightly higher groundwater potentials in the UBFU, as compared to the LBFU, could be a reflection of these recharge sources.

4.3.3.9 Hydraulic Corehole Testing Results

The hydraulic conductivity values obtained from the slug test analyses ranged from 0.02 to 0.72 ft/day as shown in Table 4.3-3. These values serve only for background information and as an indication of an initial flow rate range to begin step-rate injection testing.

Fracture gradient information relating to injection pressure is presented in Table 4.3-4. The injection pressure required to initiate fracturing is related to the 3 mutually perpendicular principle stresses in a formation. If the 3 are unequal, a fracture is most likely to occur in a plane perpendicular to the least principle stress. For technically relaxed areas that are characterized by normal faulting, as exists at the Florence Project Area, the least principle stress would be horizontal and a fracture produced by injection pressures would extend along a vertical plane. The creation of an induced fracture is also indicated by the fracture gradient of a formation. That is, based on a lithostatic stress of 1.0 pounds per square inch/foot (psi/ft) of depth, a fracture gradient of less than 1.0 psi/ft would indicate the least principle stress is horizontal and an induced fracture would extent vertically.

As described in Warner and Lehr (1981), Hubbert and Villis (1972) calculated that the minimum fracture gradient for a technically relaxed area would be 0.64 psi/ft based on a lithostatic stress of 1.0 psi/ft and a normal formation fluid pressure of 0.46 psi/ft. In Smith (1976) fracture gradients are given for 45 different formations in various areas of the United States. These values ranged from 0.42 to 1.31 psi/ft with an average fracture gradient of 0.72 psi/ft and a median fracture gradient of 0.68 psi/ft. At the Florence Project Area, the fracture gradient values ranted from 0.71 to 1.19 psi/ft with an average of 0.82 psi/ft and a median fracture gradient of 0.81 psi/ft.

According to the requirements of the UIC program for Class III wells, the injection pressure at the wellhead shall be calculated so as to assure that the pressure during injection does not initiate new fractures or propagate existing fractures in the injection zone. Based on tests at the Florence Project Area, it appears a gradient of 0.64 psi/ft can be used to determine maximum allowable wellhead injection pressures to ensure fracturing of the injection will not occur. As previously mentioned, this gradient is the minimum fracture gradient for technically relaxed areas as calculated by Hubbert and Willis (1972) and is well below the fracture gradient values obtained for the injection zone at the Florence Project Area.

4.4 SOIL QUALITY

As a concurrent investigation, Brown and Caldwell was authorized by Magma in October 1995 to conduct a focused facilities investigation at the property. The objective of this investigation was to determine if the brief historic operation of the underground mine and pilot plant had a significant adverse impact on soils at the site.

The preliminary findings of the investigation noted the potential for select operations at the pilot plant and, to a much lesser degree, the underground pilot mine to have impacted soils around these facilities. Based on these findings, a sampling program was subsequently initiated with shallow soil samples (0 to 5 feet bgs) collected from 16 test trenches at the site.

Select soil samples were analyzed for metals; aromatic, volatile, and semivolatile organics; petroleum hydrocarbons and pH using the appropriate ADEQ and EPA methodologies. Results of the sample analyses indicated that shallow copper and hydrocarbon impacts have occurred in the study area, and that the vertical and lateral extent of these impacts are limited. Specifically, elevated concentrations of copper and total recoverable petroleum hydrocarbons were detected above background levels in several locations around the former solution extraction (SX) area. Elevated concentrations of copper were also detected in the oxide and sulfide tailings impoundments and the concentrate storage area.

Field observations and laboratory data indicate that the vertical and horizontal extent of contaminated soils is limited and that all impacts had attenuated to background concentrations at depths of less than 5.0 feet bgs. In addition, no constituent concentrations were observed to exceed their respective ADEQ Health Based Guidance Levels.

The former locations of several fuel storage tanks and a small-scale cyanide agitation leach area at the pilot plant were identified but not investigated. It is the conclusion of Brown and Caldwell that, with the exception of these tank and leach locations, all potentially impacted areas at the facility have been adequately investigated and no additional soil or groundwater investigations are recommended. The Brown and Caldwell report of Focused Facility Investigation has been included in Appendix G.

4.5 GROUNDWATER QUALITY

To supplement existing regional groundwater quality data (see Section 3.8), a baseline monitoring and groundwater characterization program has been designed and implemented as part of the Florence Project. Discussions pertaining to the sampling and analysis program are presented in detail in Volume III of this application and summarized in Section 2.3.4. Laboratory reports are also presented in Volume III. Although baseline sampling activities are scheduled to procede through July, 1996, only results through September 1995 are discussed herein.

The objective of monitoring the groundwater quality is to characterize the background water quality conditions prior to any physical or chemical changes that may result from in-situ production activities. The ambient groundwater chemical data have been compiled for all water-bearing lithologic units. This database is designed to provide a comparative baseline for the identification of future groundwater quality changes.

To meet the need of characterizing the groundwater quality, monitor wells were installed in the UBFU and LBFU, and the oxide and sulfide bedrock zones. To obtain representative samples and maximize the use of the chemical data, the monitor wells were placed in clusters throughout the in-situ mine area (Figure 2.1-3[II]). The groundwater flow direction and the future extent and nature of the mining activity have been considered in selecting the monitor well sites, and the water quality data obtained from each well. In addition to the monitor wells, groundwater samples have and will continue to be collected from irrigation wells (ENG-3, BIA9, WW-3, and BIA10B), the water tank at the existing facility, the air shaft of the Conoco underground workings, and the SCIDD north canal.

4.5.1 Water Quality in Upper Basin-Fill Unit (UBFU)

The monitor wells that are screened in the UBFU are M2-GU, M10-GU and M18-GU (see Sheet 1.2-2[II] and Figure 2.1-3[II]). The depths to the top of the screened intervals of these wells placed in the UBFU range from 178 to 218 feet bgs. Screen bottom depths range from 218 to 258 feet bgs.

Analytical results that have been obtained for the last 5 monthly sampling events (June through October of 1995), are provided in the following tables:

- Table 4.5-1 Inorganics (Common Ions)
- Table 4.5-2 Inorganics (Trace Metals)
- Table 4.5-3 Organics
- Table 4.5-4 Radiochemicals
- Table 4.5-5 Sulfur Isotope Ratios
- Table 4.5-6 Tritium Isotope

Groundwater sampling and testing of wells screened in the UBFU invariably detects higher concentrations of bicarbonate, sulfate, nitrate, chloride, and TDS than groundwater in the LBFU, and the underlying bedrock zones (Table 4.5-1). The concentrations of sulfate in these shallower wells range from 160 mg/L to 270 mg/L (see Figure 4.5-1[II]). Concentrations of sulfate in groundwater samples collected in the last 4 sampling events from the UBFU are below the EPA proposed maximum contaminant level (PMCL) value for drinking water quality standard of 500 mg/L. TDS concentrations in these wells ranges from 790 mg/L to 1,400 mg/L (Figure 4.5-2[II]). Groundwater samples from all wells placed in the UBFU contain concentrations of TDS above the secondary drinking water quality standard of 500 mg/L (Figure 4.5-2[II]). The highest TDS concentration is found in well M10-GU (Figure 4.5-2[II]). Concentrations of fluoride in the UBFU wells range from 0.57 mg/L to 1.2 mg/L.

The concentrations of chloride and nitrate in these UBFU wells range from 150 mg/L to 360 mg/L and 22 mg/L to 140 mg/L, respectively. Chloride concentrations in Well M10-GU, are above the secondary drinking water quality standard of 250 mg/L. Nitrate (NO_3) concentration is above the Arizona Water Quality Stanard (AWQS) value of 45 mg/L in M10-GU (Figure 4.5-3[II]). Groundwater samples collected from Well M10-GU contain the highest concentrations of chloride, sulfate, nitrate, and TDS (Table 4.5-1).

Groundwater samples collected from the monitoring wells were analyzed for the trace metals aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, copper, iron, lead, manganese, molybdenum, mercury, nickel, selenium, silver, thallium, tin, vanadium, and zinc (Table 4.5-2). Except for iron, strontium, and in some instances aluminum and manganese, the majority of the trace metal concentrations in the groundwater samples collected from wells installed in the UBFU are below their respective detection limits and applicable AWQSs. Concentration of iron ranges from <0.04 mg/L to 0.25 mg/L. Figure 4.5-4[II] presents a Piper Diagram illustrating the chemical signature of the UBFU.

Analysis for organic constituents were performed during the August and September 1995 sampling events. Groundwater samples were analyzed for volatile and semi-volatile organic constituents, polychlorinated biphenyls (PCBs), pesticides, and total petroleum hydrocarbons (TPH). No significant concentrations of these chemical constituents were detected in groundwater samples obtained from wells placed in the UBFU. No regulated, hazardous organic components were identified in the groundwater samples collected from these wells (Table 4.5-3).

As part of the baseline groundwater monitoring plan, groundwater samples are analyzed for gross alpha and beta activities, radium-226, radium-228, radon-222, uranium-234, uranium-235, uranium-238, and total uranium. The average concentrations of the radiochemicals in groundwater samples collected from the UBFU wells do not exceed AWQSs values for gross alpha and beta, radium-226 and radium-228 (Table 4.5-4).

Sulfur isotope ratio and tritium concentration were measured during 2 separate sampling events. The first sampling event was designed as a pilot program to characterize the systematic isotopic composition of the groundwater from wells placed in the sedimentary aquifer and the oxide bedrock zone (Tables 4.5-5 and 4.5-6). Together with the groundwater samples, the sulfur isotope ratio value of a 93 percent sulfuric acid sample from Magma's operations at San Manuel, Arizona was also analyzed.

The objective for analyzing the sulfur isotope ratios of the groundwater and the sulfuric acid was to evaluate the systematic isotope differences between the groundwater and the sulfuric acid. Determination of such systematic isotope differences can also be utilized to characterize the vertical homogeneity of the groundwater system. It establishes the isotopic signature of the groundwater and the sulfuric acid which can be used as an indicator parameter during mixing of the groundwater with acid-generated, sulfate-rich solutions used in in-situ leaching operations.

The results of sulfur isotope analysis of groundwater samples collected from the GU-wells (M10-GU, M2-GU, and M6-GU; Table 4.5-5) indicate a substantial distinction between the groundwater and sulfuric acid sulfur isotope ratios. The sulfur isotope disparity between the groundwater samples and the sulfuric acid is at or greater than 6.0 per mil (Table 4.5-5; Figure 4.5-5[II]). This disparity (Figure 4.5-5[II]) can be utilized as an indicator of mixing between the groundwater and sulfate-rich solution generated by sulfuric acid injection. The isotope signature of the sulfuric acid is distinct enough to provide an early warning of acid-generated, sulfate-rich solution mixing with groundwater.

As shown on Figure 4.5-5, the vertical differences of the sulfur isotope results among the 4 groundwater samples are above the analytical error bar (0.12 per mil). This probably indicates a vertical inhomogeneity of the 3 well's groundwater composition that are screened at different depths; hence, limited mixing or vertical communication.

Supplemental to the sulfur isotope analysis, the tritium concentration in groundwater samples from the southeast, central, and northwest monitor well clusters (Figure 2.1-3[II]) were also evaluated. The objective of the tritium analysis was to characterize the relative time of recharge of groundwater in the various geologic units and thereby evaluate the vertical communication of the groundwater system.

The results indicate a substantial variation in tritium concentrations between the 4 wells placed in the various hydrogeologic units of the proposed in-situ mine area (Table 4.5-6 and Figure 4.5-6[II]). The UBFU wells contain a relatively higher concentration of tritium than the LBFU oxide bedrock zone and sulfide bedrock zone wells (Figure 4.5-6[II]).

The vertical stratification of tritium concentration (Figure 4.5-6[II]) within the 4 hydrogeologic units may suggest: (1) absence of vertical groundwater mixing between the UBFU and the LBFU, the oxide and sulfide bedrock zones, or (2) absence of recharge of the groundwater for a long period of time within the oxide and sulfide bedrock zone wells, or (3) fast exchange of tritium with hydrogen ions from minerals that contain water molecules in their structures (e.g., biotite, amphibole).

The low to undetectable concentrations of tritium in the LBFU, and the oxide and sulfide bedrock zones, indicates limited groundwater recharge directly from the UBFU. Vertical communication of the groundwater system could have also induced mixing of deeper zone groundwater with the UBFU groundwater. If such mixing was in existence, then the concentration of tritium and all other inorganic constituents would have been homogenized to similar chemical concentrations.

4.5.2 Water Quality in Lower Basin-Fill Unit (LBFU)

Monitor wells that are completed in the LBFU include M1-GL, M3-GL, M6-GU, M7-GL, M11-GL, M14-GL, M15-GU, M16-GU, and M17-GL (Figure 2.1-3[II]). The depths to the top of the screened intervals of wells installed in the LBFU range between 290 and 938 feet bgs. Screen bottoms occur at depths ranging from 355 to 998 feet bgs, with the deepest wells located at the northwest portion of the proposed in-situ mine area (Figure 2.1-3[II]).

The concentrations of common ions in the groundwater samples collected from wells placed in the LBFU are variable, depending on the well depth. The concentrations of chloride, sulfate, bicarbonate, calcium, magnesium, sodium, and TDS are generally less concentrated in the LBFU than the UBFU (see Figures 4.5-7[II], 4.5-4[II], and 4.5-8[II]).

The sulfate concentrations range from 24 mg/L to 170 mg/L. Chloride and nitrate concentrations range from 63 mg/L to 310 mg/L and <0.10 mg/L to 54 mg/L, respectively. Nitrate (as NO_3) is above the AWQS value of 45 mg/L in results for well M16-GU. TDS concentrations range from 280 mg/L to 1,100 mg/L. With the exception of M6-GU and M7-GL, the groundwater samples collected from wells placed in the LBFU contain TDS concentrations above the secondary drinking water standard of 500 mg/L (Figures 4.5-2[II] and 4.5-8[II]).

Concentrations of sulfate, chloride, nitrate, bicarbonate, and TDS are higher in samples collected from M3-GL, M15-GU, M16-GU and M11-GL than in samples collected from the other wells placed in the LBFU. The minimum concentrations of these parameters are obtained from M7-GL, which is one of the deepest wells placed in the LBFU (Figure 4.5-8[II]).

The September 1995 groundwater composition of M17-GL is very different from the previous months. The analytical results obtained for sodium, calcium, magnesium, chloride, bicarbonate, sulfate, nitrate, phosphate, fluoride, and TDS are much higher than those exhibited by previous results (Table 4.5-1). The composition of the September groundwater data for M17-GL resembles the near surface groundwater composition of the region. This significant change in groundwater composition might have resulted by mixing of near surface groundwater with water from the screened intercept. Observations during well M17-GL sampling activities in September, 1995 indicate that the integrity of the well may be compromised. Further sampling of this well is on hold pending results of investigative efforts currently under way to ascertain the caused of the problem.

All trace metal concentrations, in the samples obtained from the LBFU, except for iron and aluminum, are at or below detection limits and applicable AWQSs. In all cases, the relatively high concentration of iron and aluminum are obtained from the unfiltered samples (Table 4.5-2). Such aluminum and iron concentrations in the unfiltered samples indicate possible entrainment of aluminum and iron-bearing particles in the groundwater system.

The groundwater samples collected from wells placed in the LBFU, oxide and sulfide bedrock zones of the northwest cluster monitor wells variably show anomalous concentrations of acetone compared to other monitor wells. The concentration of acetone and benzoic acid in these wells range between 130 μg/L and 640 μg/L (Table 4.5-3). The presence of acetone in samples from these wells is likely an artifact associated with laboratory procedures. No regulated hazardous organic componets were identified in excedence of AWQSs.

Gross alpha activates for groundwater samples collected from M11-GL ranges from 13+/-10 picocuries per liter (pci/L) to 23+/-14, exceeding the maximum permissible activity of 3 pci/L (Table 4.5-4). Radiochemical analyses results from other LBFU wells are variable from month to month (Table 4.5-4). This variation may have resulted from interference of other parameters. Groundwater samples collected from the LBFU indicate a strong distinction in sulfur isotope ratios when compared to the sulfuric acid (Figure 4.5-5).

The tritium concentration in the wells placed in the LBFU varies with depth. The shallower wells (M3-GL and M11-GL) contain more tritium than the deeper wells (M6-GU and M7-GL). Tritium concentration in M6-GU and M7-GL, is below detection limit, indicating stratification of tritium concentration within the hydrologic system (Figure 4.5-6[II]).

4.5.3 Water Quality in Oxide Bedrock Zone

Groundwater samples from the oxide bedrock zone are collected from 3 monitoring wells (M4-O, M12-O, and M8-O). The depths to the top of the screened intervals in the oxide bedrock zone wells range between 405 to 1,010 feet bgs. Screen bottoms occur at depths ranging from 464 to 1,070 feet bgs. The deepest oxide zone monitoring well (M8-O) is located at the northwest part of the proposed in-situ mine area (Figure 2.1-3[II]). The depths of the screened intervals for M4-O and M12-O are shallower than the western and northwestern monitoring wells installed in the LBFU.

The concentrations of sulfate, nitrate, chloride, and bicarbonate in groundwater samples collected from the oxide zone are 65 mg/L to 160 mg/L, 3 mg/L to 126 mg/L, 38 mg/L to 160 mg/L, and 130 mg/L to 190 mg/L, respectively (Table 4.5-1, Figure 4.5-9[II]). TDS concentrations range from 350 mg/L to 680 mg/L. Concentrations of TDS, sulfate, and nitrate in the deeper oxide zone (M8-O) are lower when compared to the shallower oxide zone wells (Table 4.5-1). TDS concentrations in groundwater samples collected from M4-O and M12-O exceed the secondary drinking water quality standardof 500 mg/L (Figure 4.5-2, 4.5-8). The concentration of fluoride in M4-O is high when compared to the wells placed in the Basin-fill Unit (Table 4.5-1).

Except for aluminum and iron concentrations in well M12-O, all other trace metals are at or below their detection limits and applicable AWQSs. Like groundwater samples from the UBFU and LBFU, aluminum and iron are carried in suspended particles rather than as dissolved constituents (Table 4.5-2).

The radiochemical results of groundwater samples collected from the oxide bedrock zone wells are also variable from month to month (Table 4.5-4). The June and July groundwater samples collected from well M12-O and September samples collected from wells M4-0 and M8-0 show high gross alpha activities ranging from 8 ± 1 pci/L to 51 ± 17 pci/L when compared to the maximum permissible value of 3 pci/L (Table 4.5-4).

The sulfur isotope ratios in the 3 monitoring oxide bedrock zone wells vary from 2.0 per mil to 5.9 per mil (Figure 4.5-5). The lowest ratio is obtained for M8-O, which is the deepest of the 3 oxide zone wells. Tritium concentrations also diminish with depth and is not detected in the deep oxide zone wells (Figure 4.5-6[II]). Tritium values below detection in the oxide bedrock zone may be attributed to the age of the groundwater rather than the ionic substitution with the host rock.

4.5.4 Water Quality in Sulfide Bedrock Zone

Groundwater samples collected from the sulfide bedrock zone are from 3 monitor wells (M5-S, M13-S, and M9-S). The depths to the top of the screened interval in these sulfide bedrock wells range from 516 to 1,510 feet bgs. Screen bottoms occur at depths ranging from 576 to 1,570 feet bgs. The deepest sulfide zone monitoring well (M9-S) is placed in the northwest part of the proposed in-situ mine area (Figure 2.1-3[II]).

The concentrations of sulfate in 2 of the sulfide wells (M9-S and M13-S) are high when compared to the other monitoring wells in the Florence in-situ mine area. The sulfate concentrations in these 2 deep wells range from 1,700 mg/L to 1,800 mg/L (Figures 4.5-1[II], 4.5-10[II]). These significant sulfate concentrations may be related to the dissolution of gypsum ($CaSO_4.2H_2O$) and jarosite ($KFe_3(SO_4)_2(OH)_6$) which may have precipitated within a secondary enrichment zone at the sulfide/oxide interface. These sulfate-bearing minerals could have been deposited during the active leaching of the oxide zone and the percolation of sulfate-enriched groundwater. It is plausible that significant concentrations of calcium, iron, and potassium accompanied the migrating sulfate rich solution, a condition favorable for the formation of jarosite and gypsum. TDS concentrations in these 2 wells placed in the sulfide bedrock zone are also high relative to the other monitoring wells (Figure 4.5-8[II]). The concentrations of TDS in these wells range from 2,800 mg/L to 3,000 mg/L (Figure 4.5-2[II]). The concentrations of bicarbonate, nitrate, and chloride are low when compared to the wells placed in the oxide zone and the Basin-fill Unit (Figure 4.5-8[II]). The pH of the groundwater samples retrieved from the sulfide bedrock zone ranges from 8.3 to 11.

Groundwater samples from the sulfide bedrock zone show higher concentrations of iron than the other monitoring wells placed in the UBFU, LBFU, and oxide bedrock zone (Table 4.5-2). Groundwater samples from M5-S and M9-S indicate that iron is also substantially concentrated in solution.

The relatively high concentration of strontium in M13-S and M9-S (Table 4.5-2), when compared to other monitor wells, may be tied to the concentration of calcium in these wells (Table 4.5-1). Molybdenum is more concentrated (0.06 mg/L to 0.47 mg/L) in the sulfide bedrock zone than in the other hydrogeologic units.

Groundwater samples collected from the 3 sulfide bedrock zone wells show anomalous concentrations of acetone ranging between 21 µg/L and 390 µg/L. The samples obtained from M13-S and M9-S also indicate a concentration of benzoic acid at 530 µg/L and 62 µg/L, respectively (Table 4.5-4). As discussed in Section 4.5.2, the presents of these constituents is likely a laboratory artifact. No other organic constituents have been detected exceeding AWQSs.

The radioisotope analyses for groundwater samples collected from M13-S indicate a gross beta activity above the maximum permissible value of 30 pci/L(Table 4.5-4). The September groundwater sample collected from M9-S show gross alpha activity (35 ± 15 pci/L) exceeding the AWQSs value of 3 pci/L. Tritium concentrations in all of the sulfide zone wells are below the detection limit (Figure 4.5-6). Absence of traces of tritium from the sulfide wells indicate a relatively old groundwater system and an absence of vertical communication with the overlying oxide bedrock zone.

4.5.5 Other Groundwater Samples

Groundwater samples were collected from irrigation well, ENG-3, WW-3, BIA9, and BIA10B during the June and July, 1995 sampling events to supplement the groundwater quality characterization of the proposed Florence in-situ mine area.

The concentration of nitrate in these irrigation wells range between 37 mg/L and 61 mg/L. Three of the irrigation wells (ENG-3, BIA9, and BIA10B) contain concentration of nitrate (NO_3) above the primary drinking water quality standard of 45 mg/L. Sulfate and TDS concentrations in the irrigation wells range between 180 mg/L and 290 mg/L and 1,000 mg/L and 1,300 mg/L, respectively (Table 4.5-1).

Additional groundwater samples were also collected from the water tank (WTANK) that supplies water for all drilling operations at the Magma Florence Project, the SCIDD north side irrigation canal (CANAL), and the air shaft for the Conoco underground mine workings (ASHAFT).

The water from the water tank contains concentrations of nitrate, sulfate, and TDS ranging between 59 mg/L and 110 mg/L, 290 mg/L and 350 mg/L, and 1,300 mg/L and 1,500 mg/L, respectively (Table 4.5-1). The concentration of nitrate (NO_3) in this water exceeds the primary drinking water standard of 45 mg/L. The concentrations of sulfate and TDS are also above the secondary drinking water quality standard.

Groundwater samples collected from the Conoco underground workings air shaft contain the lowest nitrate and sulfate concentrations compared to the irrigation wells and all other monitoring wells (Table 4.5-1). Total dissolved solid concentrations for the air shaft ranges from 740 mg/L and 760 mg/L. The concentrations of iron and manganese in this air shaft range between 21 mg/L and 33 mg/L, and between 1.5 mg/L and 1.6 mg/L, respectively (Table 4.5-2). All trace metal concentrations, except for iron and manganese, in the Conoco underground workings air shaft are below the primary or secondary drinking water quality standards.

4.5.6 Summary

The groundwater chemistry associated with the proposed in-situ mine are shows distinct compositional variation between wells placed in the UBFU, LBFU, oxide bedrock zone, and sulfide bedrock zone hydrogeologic units. The distinction in water chemistry is explicitly indicated by variable concentrations of the common ions and isotope chemistry. Such distinction in water quality suggests limited vertical communication of the hydrologic system.

A summary of all sampling events (June through October) are presented in Figure 4.5-11[II] for sulfate, nitrate, bicarbonate, and TDS. The sulfate concentration in M9-S and M13-S are high when compared to the secondary drinking water quality standard or the EPA proposed sulfate MCL (500 mg/L) value (Figure 4.5-11[II]). Nitrate exceeds the AWQSs value for all sampling events for M10-GU well. It also exceeded the AWQSs value for the August sample collected from M16-GU. TDS concentration exceeds above 500 mg/L in all but M5-S, M8-O, M6-GU, and M7-GL wells (Figure 4.5-11[II]). M9-S and M13-S contain the highest concentration when compared to the other monitoring wells (Figure 4.5-11[II]).

The sulfur isotope and tritium results obtained from the cluster monitor wells may be used as indicators of potential excursions from mining operations. Other chemical constituents that can provide reliable indications of potential changes in groundwater quality associated with mine solution excursions include TDS, sulfate, pH, EC, calcium, magnesium, and fluoride.

4.6 GROUNDWATER USE

Local groundwater withdrawals include irrigation, municipal, and domestic groundwater pumping. A summary of irrigation groundwater use in and around the proposed in-situ mine area is presented in Table 4.6-1. Municipal and domestic pumping occur on a year-round basis, while irrigation pumping is seasonal and dependent on agricultural crop demand. Groundwater withdrawals cause localized depressions in groundwater elevations near the discharging well. These elevation depressions caused by pumping are observed in monthly water-level elevations measurements collected in the local area. Review of the water-levels elevation data from April to November, 1995, indicate that groundwater pumping has localized effects near various wells; however, little change occurs in the primary regional groundwater flow gradient and direction in the Florence Project area. Affects of groundwater pumping are discussed further in Section 4.3.2 and discussions of groundwater use are presented in Section 3.9, Volume II.

One domestic well is located within a 1-mile radius of the In-situ Mine Area. This well is shown on Sheet 1.2-1 as D(4-9)27cac. This well currently serves domestic needs for properties owned by Magma, and will be decommissioned prior to initiation of mining activities (Magma, 1995).

4.7 WHOLE ROCK CHEMISTRY

The bulk composition of the near-surface alluvial material, UBFU, LBFU, oxide bedrock zone and sulfide bedrock zone were analyzed by Skyline Laboratories, Tucson, Arizona. Samples for analysis were collected from drill cores and drill mud pits. Most of the samples analyzed for whole rock chemistry have been used to study the metal attenuation and acid neutralization properties of the materials. Discussions of the geochemical properties of the sample media are presented in Volume IV, Section 3.8. A summary of the geochemistry is presented in Table 4.7-1.

4.7.1 Recent Alluvium and Upper Basin-Fill Units

Six samples were used to characterize the bulk chemistry of the near-surface alluvial materials. Samples were collected from mud pits excavated for drilling purposes. The materials show a homogeneous composition with some variation in SiO_2 and CaO (see Table 4.7-1). The content of CaO ranges from 4.7 to 8.9 weight percent. Samples that contain high calcium values correspond to high concentrations of calcareous concretions. Compared to the other hydrogeologic units, the alluvial material exhibits elevated arsenic concentrations ranging from 2 to 4 parts per million (ppm). Concentrations of barium in the alluvial materials range from 626 to 741 ppm and will act as a sulfate sink during the in-situ mining process (Table 4.7-1). The alluvial material contains low sulfur values compared to the concentrations of calcium, indicating that the material is not acid generating. Based on soil types encountered during this investigation, it is likely that bulk density characteristics encountered in recent alluvium are also indicative of characteristics in the UBFU.

4.7.2 Lower Basin-Fill Unit

Four samples from the lower part of the LBFU were analyzed. Two of the samples were taken at the contact of the LBFU and the oxide bedrock zone. The other 2 samples were collected about 20 feet above the contact. There is significant variation in CaO content between the 2 groups of samples taken from the LBFU (Table 4.7-1). The samples collected from the contact zone contain less calcium and show little to no reaction during dilute hydrochloric acid (HCl) testing. The samples collected above the contact zone contain up to 7.3 weight percent CaO and respond vigorously to acid tests (Table 4.7-1). The LBFU contains lower concentration of sulfur than the other materials analyzed and the average sulfur value is much lower than the concentration of calcium which makes the basin-fill unit a non-acid producing zone.

4.7.3 Bedrock Zones

Twelve drill core samples from the oxide and sulfide bedrock zones that were used for column testing have been analyzed for bulk chemical compositions. The samples were obtained from quartz monzonite (6 samples), granodiorite porphyry (5 samples), and diabase (one sample) lithologic units (Table 4.7-1). The bedrock zone contains a relatively homogeneous chemical composition except for copper and sulfur (Table 4.7-1). The copper content of the oxide bedrock zone is significantly high when compared to the sulfide bedrock zone, whereas, sulfur values are much lower in the oxide zone than the sulfide bedrock zone (Table 4.7-1). The bulk composition of the diabase is significantly different from the quartz monzonite and granodiorite composition. The diabase contains high iron, magnesium, calcium, and titanium and low silica when compared to the quartz monzonite and granodiorite porphyry (Table 4.7-1). Barium concentration in the bedrock zone ranges from 205 ppm in the diabase to 1,416 ppm in the granodiorite porphyry.

Table 4.1-1 Summary of Recent Magma Corehole Data, Florence In-Situ Mine Area						
Corehole ID	Diameter (inches)	Ground Elevation (msl)	Bedrock Depth[a]	Total Depth (ft)[a]	Date Completed	Comments
MCC-533	6	1,474.6	512	1,073	March 3, 1995	Within 150 feet of 419MF and 421MF.
MCC-534	6	1,464.1	361	900	February 5, 1995	NA
MCC-535	3	1,471.8	392	1,279	March 31, 1995	Twins 461-MF.
MCC-536	3	1,472.2	380	1,162	April 10, 1995	100 feet west of 460-MF.
MCC-537	4	1,471.7	383	1,207	April 2, 1995	Twins 466-MF.
MCC-538	3	1,472.1	360	1,169	April 9, 1995	Twins 465-MF.
MCC-539	3	1,468.3	582	1,537	April 12, 1995	Twins 464-MF.
MCC-540	4	1,468.6	355	1,176	April 9, 1995	Twins 473-MF.
MCC-541	4	1,464.3	388	1,031	April 23, 1995	West of 483-MF.
MCC-542	3	1,481.0	597	1,202	April 25, 1995	Twins 539-S.
MCC-543	3	1,479.2	599	1,393	May 4, 1995	Twins 446-S.
MCC-544	4	1,473.7	369	1,321	May 7, 1995	Twins 459-S.
MCC-545	3	1,474.0	415	1,370	May 8, 1995	100 feet east of 455-S.
MCC-546	3	1,477.0	534	1,152	May 31, 1995	Twins 447-S.
MCC-546A	3	1,477.6	534	1,437	June 18, 1995	Twins MCC-546.
MCC-547	3	1,468.7	383	1,500	May 18, 1995	Twins 467-MF.
MCC-548	3	1,467.5	542	1,501	May 22, 1995	Twins 472-MF.
MCC-549	3	1,471.8	346	1,180	May 23, 1995	75 feet south of 437-MF.
MCC-550	3	1,467.8	371	1,175	June 3, 1995	Twins 475-MF.
MCC-551	3	1,467.5	372	1,075	June 5, 1995	Twins 474-MF.
MCC-552	3	1,464.9	450	1,212	June 3, 1995	60 feet west of 485-MF.
MCC-553	3	1,466.5	NA	1,249	June 21, 1995	Twins 480-MF.
MCC-554	3	1,464.0	383	920	June 17, 1995	West of 482-MF.
MCC-555	3	1,464.7	375	1,060	July 11, 1995	Twins 424-MF.
MCC-556	3	1,464.7	384	1,074	June 28, 1995	60 feet west of 484-MF.

Table 4.1-1	Summary of Recent Magma Corehole Data, Florence In-Situ Mine Area					
Corehole ID	Diameter (inches)	Ground Elevation (msl)	Bedrock Depth[a]	Total Depth (ft)[a]	Date Completed	Comments
MCC-557	3	1,463.4	392	1,062	June 24, 1995	Twins 491-MF.
MCC-558	3	1,464.3	386	1,025	July 7, 1995	Twins 490-MF.
MCC-559	3	1,461.8	NA	969	July 12, 1995	Twins 499-MF.
MCC-560	3	1,461.7	400	920	July 12, 1995	Twins 498-MF.
MCC-561	3	1,471.1	495	1,480	July 22, 1995	Twins 426MF.
MCC-562	3	1,467.5	592	1,479	August 4, 1995	Twins 468 MF.
MCC-563	3	1,466.3	NA	1,320	July 23, 1995	25 feet west of 476MF.
MCC-564	3	1,461.8	295	937	August 6, 1995	Twins 497MF.
MCC-565	3	1,464.5	657	1,277	August 5, 1995	Twins 486MF.
MCC-566	3	1,461.5	NA	917	August 15, 1995	Twins 496MF.
MCC-567	3	1,460.6	NA	908	August 24, 1995	Twins 505MF.
MCC-568	3	NA	NA	1,800	September 18, 1995	400 feet west of 426MF.
MCC-569	3	NA	NA	1,665	October 16, 1995	Twins 456S
MCC- 570	3	NA	NA	530	Not completed	15 feet west of 470MF.
MCC-570A	3	NA	NA	1,523	November 9, 1995	NA

Locations shown on Figure 4.1-1
[a] feet below ground surface
MSL: mean sea level
NA: Not applicable or not available

Table 4.2-1a Summary of Canal Water Quality Data, Common Ions and Miscellaneous Parameters[a]

Sample ID	Sampled	Analyzed	Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3	NO2	PO4	F	I	Br	ALK	TDS	pH	IB
Canal	June 27, 1995	June 28, 1995	100	3.4	53	14	100	150	<10.00	95.00	<3.00	<5.00	0.7	1.20	<0.10	<5.00	150	500	8.80	0.23
Canal	July 11, 1995	July 12, 1995	95	4.4	49	14	95	170	<10.00	82.00	<0.10	<0.10	0.9	1.00	0.3	<0.10	170	470	8.70	2.40
Canal	August 14, 1995	August 15, 1995	92	3.2	41	12	97	150	<10.00	75.00	<0.10	<2.50	0.6	0.88	<0.10	0.2	150	460	8.10	1.60
Canal (Filtered)	June 27, 1995	July 3, 1995	100	3.2	46	13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Canal (Filtered)	July 11, 1995	July 13, 1995	97	3.3	41	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Canal (Filtered)	August 14, 1995	August 17, 1995	99	3.1	42	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a]Canal flow calculation derived from field measurements using methods presented in Chow (1959). June: 6,463 gallons per minute (gpm), July: 4,488 gpm, August: 6,733 gpm.

Na - Sodium
K - Potassium
Ca - Calcium
Mg - Magnesium
Cl - Chloride
HCO_3 - Bicarbonate Alkalinity (as CO_3)
SO_4 - Sulfate
NO_3 - Nitrate
NO_2 - Nitrite
PO_4 - Phosphorus
F - Fluoride
CO_3 - Carbonate Alkalinity (as CO_3)
Br - Bromide
ALK - Total Alkalinity
TDS - Total Dissolved Solids
I.B. - Ion Balance
I - Iodide

Location of Canal sample is shown on Figure 2.1-2.
Concentration in milligram/litre, except pH (pH units), I.B. (percent)
Despite the use of trailing zeros in some data, no result has more than two significant figures
< is less than the reported detection limit
NA - Not Analyzed

Table 4.2-1b Summary of Canal Water Quality Data, Trace Metals [(a)]

Sample ID	Sampled	Analyzed	Al	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Hg	Ni	Se	Ag	Sr	Tl	Sn	V	Zn
CANAL	Jun 27 95	Jun 28 95	0.58	<0.005	0.004	0.048	<0.001	<0.05	<0.005	<0.005	<0.04	<0.02	0.31	0.0034	0.130	<0.01	<0.0002	<0.04	<0.004	<0.01	0.41	<0.003	<0.5	<0.04	<0.01
CANAL	Jul 11 95	Jul 12 95	5.1	<0.005	0.006	0.072	<0.001	0.066	<0.005	<0.005	<0.04	<0.02	4.50	0.0080	0.170	<0.01	<0.0002	<0.04	<0.004	<0.01	0.35	<0.003	<0.5	<0.04	<0.01
CANAL	Aug 14 95	Aug 15 95	1.4	<0.005	0.006	0.047	<0.001	0.110	<0.005	<0.005	<0.04	<0.02	1.20	<0.002	0.072	<0.01	<0.0002	<0.04	<0.004	<0.01	0.31	<0.003	<0.5	<0.04	0.012
CANAL (Filtered)	Jun 27 95	Jul 03 95	<0.1	<0.005	0.005	0.033	<0.001	<0.05	<0.005	<0.005	<0.04	<0.02	<0.04	<0.002	<0.01	<0.01	<0.0002	<0.04	<0.004	<0.01	0.38	<0.003	<0.5	<0.04	<0.01
CANAL (Filtered)	Jul 11 95	Jul 13 95	<0.1	<0.005	0.005	0.028	<0.001	0.070	<0.005	<0.005	<0.04	<0.02	<0.04	<0.002	<0.01	<0.01	<0.0002	<0.04	<0.004	<0.01	0.33	<0.003	<0.5	<0.04	<0.01
CANAL (Filtered)	Aug 14 95	Aug 17 95	<0.1	<0.005	0.005	0.038	<0.001	0.110	<0.005	<0.005	<0.04	<0.02	<0.04	<0.002	<0.01	<0.01	<0.0002	<0.04	<0.004	<0.01	0.32	<0.003	<0.5	<0.04	0.013

[a] Canal flow calculation derived from field measurements using methods presented in Chow (1959).
June: 6,463 gallons per minute (gpm), July: 4,488 gpm, August: 6,733 gmp.

Al - Aluminum
Sb - Antimony
As - Arsenic
Ba - Barium
Be - Beryllium
B - Boron
Cd - Cadmium
Cr - Chromium
Co - Cobalt
Cu - Copper
Fe - Iron
Pb - Lead
Mn - Manganese
Mo - Molybdenum
Hg - Murcury
Ni - Nickel
Se - Selenium
Ag - Silver
Sr - Strontium
Tl - Thallium
Sn - Tin
V - Vanadium
Zn - Zinc

Location of Canal sample is shown on Figure 2.1-2
Concentration in milligram/liter.
Despite the use of trailing zeros in some data, no result has more than two significant figures.
< is less than the reported detection limit.
NA - Not Analyzed

Table 4.2-2 Summary of Design Discharge Criteria for the Gila River				
Flooding Source and Location	**Drainage Area (Square Miles)**	**Peak Discharge (cfs)**		
		10-Year (24-hour)	**50-Year (24-hour)**	**100-Year (24-hour)**
Gila River at Florence	18,500	19,000[a]	46,000[a]	120,000[a]
Gila River at Riverside	18,011	26,000[a]	66,000[a]	140,000[a]
Gila River at Kearny	18,000	28,000[a]	68,000[a]	140,000[a]
Gila River at Hayden and Winkleman; Downstream of San Pedro River	17,757	28,000[a]	67,000	140,000
Gila River at Hayden and Winkleman; Upstream of San Pedro River	13,270	22,000[a]	64,000	120,000

Source: Federal Emergency Management Agency (FEMA, 1990)

cfs - cubic feet per second

[a]Discharges increase with decreasing drainage area due to overbank storage (FEMA, 1990).

Table 4.3-1 Summary of Vadose Zone Hydraulic Conductivity Test Results

Boring/Piezometer Name[a]	Interval Tested (ft bgs)	Number of Tests	Average Inflow (gpm)	Hydraulic Conductivity			USCS[d] Classification
				cm/sec	ft/day	md	
Field Tests[b]							
P1-80	70 - 80	2	28	7.3E-04	2.07	NA	CL/ML
P2-90	80 - 90	2	9.7	2.6E-04	0.74	NA	SM
P3-60	50 - 60	2	54	1.7E-03	4.82	NA	SW
P4-40	30 - 40	6	68	3.3E-03	9.35	NA	GW/SW
Laboratory Tests[c]							
P1-80-80	80	NA	NA	2.76E-05	7.82E-02	32.2	ML
P2-90-45	45	NA	NA	1.07E-06	3.03E-03	1.2	ML
B2-55	55	NA	NA	5.30E-07	1.50E-03	0.618	SM
B3-45	45	NA	NA	6.94E-06	1.83E-02	8.1	ML
B4-80	80	NA	NA	5.26E-07	1.49E-03	0.613	ML
M16-GU-300[e]	300	NA	NA	5.00E-09	1.41E-05	0.0058	CL

NA - Not Applicable
bgs- below ground surface
cm/sec - centimeters per second
ft/day - feet per day
gpm - gallons per minute
md - millidarcies
[a] See Appendix A [II] for boring and piezometer well construction details.
[b] See Appendix F [II], for field test report.
[c] Se Section 2.3.1.5 [II] for laboratory analyses description and Appendix F [II], for laboratory results.
[d] Unified Soil Classification System (USCS), ASTM 1990.
[e] M16-GU-300 is located in the Middle Fine-Grained Unit below the unsaturated zone.

Table 4.3-2 Summary of Existing In-Situ Mine Area Aquifer Test Data

Source	Investigative Method/Test Location	Aquifer Characteristics				Lithologic Unit Tested	Interval Tested Measured From Top of Lithologic Unit
		Transmissivity (gpd/ft)	Hydraulic Conductivity[a]		Storage Coefficient (dimensionless)		
			ft/day	cm/sec			
Golder (1976a)	NR/NR	NR	0.08	$3.0X10^{-5}$	$1.0X10^{-6}$	Oxide Bedrock	NR
	NR/NR	NR	0.26	$8.0X10^{-4}$	NR	Diorite dikes	NR
	NR/NR	NR	0.01	$2.0X10^{-6}$	NR	Clayey zones	NR
Golder (1976b)	In-situ corehole permeability/P-1	NR	0.1	$3.5X10^{-5}$	NR	Oxide Bedrock	NR
	In-situ corehole permeability/P-2	NR	0.1	$3.4X10^{-5}$	NR	Sulfide Bedrock	NR
	In-situ corehole permeability/P-3	NR	0.02	$0.8X10^{-5}$	NR	Sulfide Bedrock	NR
Anderson (1968); Halpenny and Greene (1973); Beck and Associates (1975)	Aquifer Test/NR	20,000	2.7	$9.4x10^{-4}$	$7.5x10^{-3}$	Bedrock	0 to 1,000 feet
	Aquifer Test/NR	2,000	0.27	$9.4x10^{-5}$	$7.5x10^{-3}$	Bedrock	1,000 to 2,000 feet
	Aquifer Test/NR	520,000	188	$6.6x10^{-2}$	$1.0x10^{-4}$	Conglomerate	0 to 370 feet
	Aquifer Test/NR	125,000	45	$1.6x10^{-2}$	NR	Conglomerate	0 to 370 feet
	Aquifer Test/NR	50,000	25	$8.7x10^{-3}$	NR	Conglomerate	0 to 270 feet
Dames and Moore (1974)	Air Lifting/DM-A	1,500	0.64	$2.3x10^{-4}$	NR	Bedrock	382 to 700 feet
	Air Lifting/DM-B	200	0.29	1.0x10-4	NR	Bedrock	611 to 700 feet
	Air Lifting/DM-C	1,700	0.91	$3.2x10^{-4}$	NR	Bedrock	358 to 610 feet
	Air Lifting/DM-D	320	0.16	$5.6x10^{-5}$	NR	Bedrock	364 to 635 feet
	Air Lifting/DM-E	2,000	0.87	$3.1x10^{-4}$	NR	Bedrock	392 to 700 feet
Halpenny and Greene (1976)	Measured Specific Capacity/Conoco 1	6,800	1.3	$4.6x10^{-4}$	NR	Conglomerate and Bedrock	NR
	Adjusted Specific Capacity[b]/Conoco 1	15,600	3.0	$1.1x10^{-3}$	NR		
	Measured Specific Capacity/Conoco 2	23,200	4.2	$1.5x10^{-3}$	NR	Conglomerate and Bedrock	NR
	Adjusted Specific Capacity[b]/Conoco 2	29,000	5.2	$1.8x10^{-3}$	NR		
	Aquifer Test/Conoco 3	15,800	3.0	$1.1x10^{-3}$	NR	Conglomerate and Bedrock	NR
	Measured Specific Capacity/Conoco 3	17,400	3.4	$1.2x10^{-3}$	NR		
	Adjusted Specific Capacity[b]/Conoco 3	38,800	7.5	$2.6x10^{-3}$	NR		
	Aquifer Test/Conoco 4	14,100	2.5	$8.8x10^{-4}$	NR	Conglomerate and Bedrock (including sulfide)	NR
	Measured Specific Capacity\Conoco 4	20,200	3.6	$1.3x10^{-3}$	NR		NR
	Adjusted Specific Capacity[b]/Conoco 4	24,600	4.4	$1.6x10^{-3}$	NR		
	Aquifer Test/Conoco 20	19,400	2.7	$9.5x10^{-4}$	NR	Conglomerate and Bedrock	NR
	Measured Specific Capacity/Conoco 20	17,800	2.5	$8.8x10^{-4}$	NR		
	Adjusted Specific Capacity[b]/Conoco 20	20,600	2.9	$1.0x10^{-3}$	NR		

Table 4.3-2 Summary of Existing In-Situ Mine Area Aquifer Test Data

Source	Investigative Method/Test Location	Aquifer Characteristics				Lithologic Unit Tested	Interval Tested Measured From Top of Lithologic Unit
		Transmissivity (gpd/ft)	Hydraulic Conductivity[a]		Storage Coefficient (dimensionless)		
			ft/day	cm/sec			
Halpenny and Greene (1976) - Continued	Aquifer Test Canal Well (Observation)	113,850	NR	NR	$2.7x10^{-4}$	Conglomerate	NR
	Aquifer Test Recorder Well (Observation)	209,700	NR	NR	$2.1x10^{-2}$	Conglomerate	NR
	Aquifer Test BIA-9 (Observation)	161,800	52	$1.8x10^{-2}$	$1.2xX10^{-2}$	Conglomerate and Bedrock	NR
	Aquifer Test OB-1 (Observation)	11,400	2.7	$9.5x10^{-4}$	$1.2x10^{-3}$	Bedrock	NR
	Aquifer Test DM-C (Observation)	12,000	6.4	$3.0x10^{-4}$	NR	Bedrock	NR
Magma Copper (1994)	Aquifer Test PW1-1 (Pumping)	227	0.08	$2.8x10^{-5}$	$6.9x10^{-6}$	Oxide Bedrock	NR
	Aquifer Test OB1-1 (Observation)	1,301	0.46	$1.6x10^{-4}$	$1.7x10^{-4}$	Oxide Bedrock	NR
	Aquifer Test MCC-523 (Observation)	905	NR	NR	$6.7x10^{-5}$	Oxide Bedrock	NR
	Aquifer Test PW2-1 (Pumping)	987	0.6	$2.1x10^{-4}$	$2.1x10^{-3}$	Oxide Bedrock	NR
	Aquifer Test OB2-1 (Observation)	3,441	2.1	$7.4x10^{-4}$	$7.4x10^{-5}$	Oxide Bedrock	NR
	Aquifer Test PW3-1 (Pumping)	5,019	2.4	$8.4x10^{-4}$	$5.5x10^{-2}$	Oxide Bedrock	NR
	Aquifer Test OB3-1 (Observation)	5,655	2.7	$9.5x10^{-4}$	$7.3x10^{-4}$	Oxide Bedrock	NR

[a]Estimated, where appropriate, based on saturated screen interval information from source.
[b]Adjusted specific capacity; values adjusted for decreasing saturated interval thickness during test.
NR - Not reported
gpd/ft - gallons per day per foot
ft/day - feet per day
cm/sec - centimeters per second

Table 4.3-3 Summary of Current Investigation In-Situ Mine Area Aquifer Parameter Measurements

Test Method	Lithologic Unit	Hydraulic Conductivity Range		Mean Hydraulic Conductivity	
		ft/day	cm/sec	ft/day	cm/sec
Aquifer Pump Test	Upper Basin-Fill	19.6 to 61.3	6.8E-03 to 2.1E-02	40.5	1.4E-02
Aquifer Pump Test[a]	Lower Basin-Fill	1.7 to 25.5	6.4E-04 TO 8.9E-03	13.7	4.8E-03
Aquifer Pump Test[a]	Oxide	7.7E-03 to 3.8	2.7E-06 to 1.3E-03	1.0	3.5E-04
Specific Capacity	Upper Basin-Fill	2.9 to 255	1.0E-03 to 9.3E-02	122.0	4.4E-02
Specific Capacity	Lower Basin-Fill	0.02 to 13.1	7.1E-06 to 4.6E-03	9.2	3.2E-03
Specific Capacity	Oxide	0.2 to 2.5	6.1E-05 to 8.8E-04	0.9	3.1E-04
Recovery[b]	Sulfide	3.0E-04 to 3.1E-04	1.1E-07	3.0E-04	1.1E-07
Packer/Slug Test	Oxide	4.3E-03 to 0.7	1.5E-06 to 2.4E-04	0.1	4.6E-05
Packer/Slug Test	Oxide,Sulfide	5.5E-03 to 0.05	1.9E-06 to 1.7E-05	0.03	9.5E-06

[a] Values derived using 3 dimensional interpretation techniques were not used to calculate the mean except for P49-O value.
[b] Values derived using recovery data from M5-S and M13-S obtained during groundwater sampling of the wells.

ft/day: feet per day.
cm/sec: centimeters per second.

Table 4.3-4 Summary of Aquifer Parameter Measurements Related to Fracture Intensity

Corehole/Well Cluster	Lithologic Unit	Interval Tested (ft bgs)	Hydraulic Conductivity		Fracture Gradient (psi/ft)	Fracture Intensity Index[a]
			ft/day	cm/sec		
PW7-1	Oxide	440 to 780	0.2	8.0E-05	NA	B
OB7-1[b]	Oxide	540 to 880	0.1	4.9E-05	NA	B
P12-O	Oxide	440 to 940	0.4	1.3E-04	NA	F
O12-O[b]	Oxide	434 to 929	0.6	2.1E-04	NA	F
P8-GU	Upper Basin Fill	133 to 251	61.3	2.1E-02	NA	C
P19.1-O	Oxide	440 to 660	0.3	1.0E-04	NA	E
O19-0[b]	Oxide	410 to 608	0.2	6.6E-05	NA	E
P19.2-O[b]	Oxide	405 to 602	0.2	5.2E-05	NA	E
P13.1-O	Oxide	772 to 1,449	0.3	1.0E-04	NA	A
P15-O	Oxide	580 to 1,300	0.5	1.7E-04	NA	H
P39-O	Oxide	471 to 826	0.3	1.0E-04	NA	D
O39-O[b]	Oxide	474 to 890	0.3	1.1E-04	NA	D
P28-GL	Lower Basin Fill	279 to 309	8.3	2.8E-03	NA	G
O28-GL[b]	Lower Basin Fill	277 to 387	25.5	8.9E-03	NA	G
P28.1-O[c]	Oxide	399 to 499	3.6	1.2E-03	NA	G
P28.2-O[b]	Oxide	398 to 497	2.7	9.3E-04	NA	G
O28.1-O[b]	Oxide	399 to 499	2.9	1.0E-03	NA	G
P49-O[c]	Oxide	808 to 1,222	7.7E-03	2.7E-06	NA	NA
M1-GL	Lower Basin Fill	315 to 355	17.3	6.0E-03	NA	NA
M1-GL[f]	Lower Basin Fill	315 to 355	3.1	1.1E-03	NA	NA
M2-GU[f]	Upper Basin Fill	198 to 237	192.0	6.8E-02	NA	NA
M3-GL	Lower Basin Fill	298 to 338	15.9	5.5E-03	NA	NA
M3-GL[b]	Lower Basin Fill	298 to 338	14.8	5.1E-03	NA	NA
M3-GL[f]	Lower Basin Fill	298 to 338	11.8	4.2E-03	NA	NA
M4-O	Oxide	405 to 465	0.6	1.9E-04	NA	NA

Table 4.3-4 Summary of Aquifer Parameter Measurements Related to Fracture Intensity

Corehole/Well Cluster	Lithologic Unit	Interval Tested (ft bgs)	Hydraulic Conductivity		Fracture Gradient (psi/ft)	Fracture Intensity Index[a]
			ft/day	cm/sec		
M4-O[f]	Oxide	405 to 465	0.2	7.3E-05	NA	NA
M5-S[g]	Sulfide	516 to 576	3.0E-04	1.1E-07	NA	NA
M6-GU[f]	Lower Basin Fill	524 to 564	0.1	4.8E-05	NA	NA
M8-O[f]	Oxide	1,010 to 1,070	0.2	5.2E-05	NA	NA
M10-GU[f]	Upper Basin Fill	218 to 258	170.0	6.0E-02	NA	D
M11-GL[f]	Lower Basin Fill	290 to 330	6.0	2.1E-03	NA	D
M12-O[f]	Oxide	420 to 480	2.3	8.0E-04	NA	D
M13-S[g]	Sulfide	852 to 911	3.1E-04	1.1E-07	NA	D
M14-GL	Lower Basin Fill	778 to 838	1.7	6.0E-04	NA	NA
M14-GL[c]	Lower Basin Fill	778 to 838	0.1	2.8E-05	NA	NA
M14-GL[f]	Lower Basin Fill	778 to 838	0.5	1.8E-04	NA	NA
M15-GU	Lower Basin Fill	554 to 594	2.6	9.0E-04	NA	NA
M15-GU[f]	Lower Basin Fill	554 to 594	4.2	1.5E-04	NA	NA
M16-GU[f]	Lower Basin Fill	598 to 658	28.0	1.0E-02	NA	NA
M17-GL[f]	Lower Basin Fill	938 to 998	0.2	8.1E-05	NA	NA
M18-GU	Upper Basin Fill	178 to 218	19.6	6.8E-03	NA	NA
M18-GU[f]	Upper Basin Fill	178 to 218	4.2	1.5E-03	NA	NA
PW2-1D	Oxide	400 to 620	1.4	4.7E-04	NA	D
PW4-1	Oxide	440 to 780	3.8	1.3E-03	NA	H
MCC-533	Oxide	860 to 896	NT	NA	0.7	F
MCC-533	Oxide	740 to 776	NT	NA	0.7	F
MCC-533	Oxide	655 to 691	NT	NA	0.8	F
MCC-533	Oxide	605 to 641	NT	NA	0.8	F
MCC-537	Oxide	470 to 521	8.5E-02	3.5E-05	0.7	F
MCC-537	Oxide	395 to 446	NT	NA	0.7	F

Table 4.3-4 Summary of Aquifer Parameter Measurements Related to Fracture Intensity

Corehole/Well Cluster	Lithologic Unit	Interval Tested (ft bgs)	Hydraulic Conductivity		Fracture Gradient (psi/ft)	Fracture Intensity Index[a]
			ft/day	cm/sec		
MCC-540	Oxide	1,061 to 1,097	NT	NA	1.2	F
MCC-540	Oxide	983 to 1,019	2.0E-02	7.0E-06	0.8	F
MCC-540[h]	Oxide	925 to 976	5.7E-02	3.5E-05	0.8	F
MCC-540	Oxide	651 to 702	0.1	3.5E-05	0.8	F
MCC-540	Oxide	504 to 555	0.7	2.4E-04	NA[i]	F
MCC-541	Oxide	507 to 543	3.8E-02	1.4E-05	NA[j]	F
MCC-544	Oxide, Sulfide	913 to 1,305	4.9E-02	1.7E-05	NT	A
MCC-544	Oxide, Sulfide	1,148 to 1,305	5.5E-03	1.7E-06	NT	A
MCC-544	Oxide	1,253 to 1,305	NA[k]	NA	0.7	A
MCC-544	Oxide	1,000 to 1,066	4.3E-03	1.4E-06	0.8	A
MCC-544	Oxide	898 to 964	NA[l]	NA	0.8	A
MCC-544	Oxide	389 to 425	5.7E-02	2.1E-5	0.8	A

NA - Not Applicable
NT - Not Tested
ft bgs - Feet below ground surface
ft/day - Feet per day
psi/ft - Pounds per square inch per foot
[a] A - Fracture Intensity Index 3 and 4 in various proportions.
B - Fracture Intensity Index 1, 2, 3, 4 similar proportions.
C - Fracture Intensity Index 2 near block centers and 3, 4, 5 on block edges.
D - Fracture Intensity Index 3, 4 greater than 70 percent 3.
E - Fracture Intensity Index 3 and 4 on west 3/4 of blocks and 2 on east 1/4.
F - Fracture Intensity Index 4 primarily.
G - Fracture Intensity Index 2, 3, 4 various proportions on east side of in-situ mine area.
H - Fracture Intensity Index 2, 3, 4 various proportions on west side of in-situ mine area.
1 - 0 to 5 fractures per foot.
2 - 6 to 10 fractures per foot.
3 - 11 to 15 fractures per foot.
4 - More than 15 fractures per foot.
5 - Intensely fractured, brecciated, fault zone.

[b] Observation well.
[c] Hydraulic conductivity value derived using 3 dimensional interpretation techniques.
[d] Low pump rate test.
[e] High pump rate test.
[f] Hydraulic conductivity values calculated using specific capacity data; represents the mean value.
[g] Values derived using recovery data obtained during groundwater sampling of the wells.
[h] Influence from irrigation well on slug test.
[i] Unable to induce fracture flow at applied pressure, no fracture gradient value.
[j] Unreliable flow rate data obtained during injection due to pump problems, no fracture gradient value.
[k] Slug test attempted, formation would not take water.
[l] Slug test attempted, formation took water at an extremely slow rate.

Table 4.5-1 Summary of Analytical Results, Common Ions and Miscellaneous Parameters (a)

Sample ID	Sampled	Analyzed	Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3	NO2	PO4	F	I	Br	ALK	TDS	pH	IB	Screened
ASHAFT (Filtered)	Jun 27 1995	Jul 03 1995	140	6.7	94	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
ASHAFT	Jun 27 1995	Jun 28 1995	140	6.9	97	21	210	340	<10.00	<2.50	< 3.0	<5.0	.54	.68	<.10	<5.00	340	740	6.8	1.61	N
ASHAFT	Jul 11 1995	Jul 12 1995	140	6.9	90	20	200	370	<10.00	<.10	< .10	<5.0	.37	.71	<.10	.30	370	760	6.9	4.00	N
ASHAFT (Filtered)	Jul 11 1995	Jul 13 1995	140	6.8	89	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
ASHAFT (Filtered)	Aug 14 1995	Aug 17 1995	140	6.7	91	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
ASHAFT	Aug 14 1995	Aug 15 1995	140	6.8	92	21	220	370	<10.00	1.60	< .10	<2.5	.56	.57	<.10	.36	370	750	6.8	4.00	N
ASHAFT	Sep 12 1995	Sep 13 1995	140	6.8	99	22	210	350	<10.00	1.80	< .10	<2.5	.46	.50	<.10	.35	350	730	6.6	.12	N
ASHAFT (Filtered)	Oct 16 1995	Oct 20 1995	140	6.4	87	20	210	350	<10.00	<2.0	2.3	<5.0	NA	.49	<.10	<.20	350	730	7.0	3.10	N
ASHAFT	Oct 16 1995	Oct 17 1995	150	7.6	100	23	200	350	<10.00	<2.0	< .50	<5.0	.51	.58	<.10	.41	350	720	6.8	3.78	N
BIA10B (Filtered)	Jun 27 1995	Jul 03 1995	170	5	150	35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	200 to 1909
BIA10B	Jun 27 1995	Jun 28 1995	170	5.1	160	36	310	220	<10.00	210.0	53.0	<5.0	<.20	.65	<.10	<5.00	220	1300	7.1	.59	200 to 1909
BIA10B	Jul 11 1995	Jul 12 1995	200	5.6	200	39	350	220	<10.00	260.0	46.0	<5.0	.48	.72	<.10	.40	220	1300	7.3	2.80	200 to 1909
BIA10B (Filtered)	Jul 11 1995	Jul 13 1995	170	5.2	150	33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	200 to 1909
BIA10B	Sep 20 1995	Sep 21 1995	180	5.6	160	37	310	220	<10.00	200.0	47.0	<5.0	<.20	1.50	<.10	.45	220	1300	7.2	2.40	200 to 1909
BIA9 (Filtered)	Jun 23 1995	Jun 28 1995	180	5.4	130	28	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
BIA9	Jun 23 1995	Jun 24 1995	180	5.3	130	28	290	210	<10.00	210.0	44.0	<4.0	<.20	.94	<.10	.40	210	1100	7.2	3.37	N
BIA9 (Filtered)	Jul 11 1995	Jul 13 1995	180	5.4	140	29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
BIA9	Jul 11 1995	Jul 12 1995	210	6	180	34	310	230	<10.00	250.0	44.0	<5.0	<.20	.81	<.10	.41	230	1200	7.3	3.50	N
BIA9	Sep 20 1995	Sep 21 1995	190	5.5	140	31	290	210	<10.00	190.0	43.0	<5.0	<.20	1.50	<.10	.44	210	930	7.1	2.70	N
ENG3	Jun 27 1995	Jun 28 1995	150	5.4	160	31	290	190	<10.00	180.0	38.0	<5.0	<.20	.77	<.10	<5.00	190	920	7.4	1.60	210 to 400
ENG3 (Filtered)	Jun 27 1995	Jul 03 1995	120	5.1	98	22	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	210 to 400
ENG3 (Filtered)	Jul 11 1995	Jul 13 1995	160	5.4	140	32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	210 to 400
ENG3	Jul 11 1995	Jul 12 1995	170	5.5	140	33	250	230	<10.00	270.0	49.0	<5.0	<.20	.83	<.10	.35	230	1200	7.2	3.50	210 to 400
ENG3	Sep 20 1995	Sep 21 1995	150	5	110	27	180	200	<10.00	180.0	27.0	<5.0	<.20	.95	<.10	.32	200	930	7.1	3.90	210 to 400
ENG3	Oct 19 1995	Oct 20 1995	140	5.1	110	27	180	190	<10.00	180.0	25.0	<5.0	<.20	.77	<.10	<.20	190	860	7.3	3.45	210 to 400
M1-GL	Jul 14 1995	Jul 15 1995	100	6.3	80	19	170	160	<10.00	80.0	8.9	<2.5	.80	.96	<.10	.26	160	560	7.5	.39	315 to 355
M1-GL (Filtered)	Jul 14 1995	Jul 18 1995	97	4.1	65	16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	315 to 355
M1-GL	Aug 14 1995	Aug 15 1995	96	4.1	69	16	170	140	<10.00	66.0	11.0	<2.5	.24	.80	<.10	.30	140	600	7.5	.99	315 to 355
M1-GL (Filtered)	Aug 14 1995	Aug 17 1995	88	3.7	64	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	315 to 355
M1-GL	Sep 13 1995	Sep 13 1995	97	4.2	69	17	170	140	<10.00	74.0	12.0	<2.5	.22	.68	<.10	.31	140	620	7.4	.97	315 to 355
M1-GL	Sep 13 1995	Sep 13 1995	100	4.4	70	18	170	140	<10.00	74.0	12.0	<2.5	.23	.66	<.10	.32	140	640	7.3	1.20	315 to 355
M1-GL	Oct 20 1995	Oct 21 1995	100	3.8	76	18	190	150	<10.00	54.0	16.0	<2.0	.26	.76	<.10	<2.00	150	580	7.4	.18	315 to 355
M2-GU	Jun 24 1995	Jun 25 1995	150	4.4	110	26	190	240	<10.00	170.0	26.0	<5.0	<.20	.77	<.10	.30	240	900	7.4	1.07	197.7 to 237.3
M2-GU (Filtered)	Jun 24 1995	Jun 28 1995	150	4.3	110	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	197.7 to 237.3
M2-GU (Filtered)	Jul 13 1995	Jul 17 1995	150	4.1	110	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	197.7 to 237.3

Table 4.5-1 Summary of Analytical Results, Common Ions and Miscellaneous Parameters (a)																				
Sample ID	Sampled	Analyzed	Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3	NO2	PO4	F	I	Br	ALK	TDS	pH	IB	Screened
M2-GU	Jul 13 1995	Jul 14 1995	150	4.1	110	26	200	240	<10.00	200.0	26.0	<2.5	<.20	.89	<.10	.30	240	880	7.3	4.10	197.7 to 237.3
M2-GU	Jul 13 1995	Jul 14 1995	150	4.2	110	27	190	240	<10.00	190.0	26.0	<2.5	<.20	.91	<.10	.33	240	890	7.3	2.40	197.7 to 237.3
M2-GU (Filtered)	Jul 13 1995	Jul 17 1995	140	4.1	110	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	197.7 to 237.3
M2-GU	Aug 15 1995	Aug 16 1995	140	4.2	120	26	200	220	<10.00	180.0	32.0	<1.0	<.20	.70	<.10	.32	220	880	7.3	.31	197.7 to 237.3
M2-GU (Filtered)	Aug 15 1995	Aug 19 1995	140	3.9	120	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	197.7 to 237.3
M2-GU	Sep 11 1995	Sep 12 1995	150	4.1	110	27	190	220	<10.00	180.0	26.0	<2.5	<.20	.59	<.10	.32	220	900	7.1	1.30	197.7 to 237.3
M2-GU	Oct 16 1995	Oct 17 1995	160	4.4	120	28	180	220	<10.00	180.0	25.0	<5.0	<.20	.83	<.10	.25	220	880	7.1	6.20	197.7 to 237.3
M2-GU	Oct 16 1995	Oct 17 1995	150	4.3	120	27	180	220	<10.00	180.0	26.0	<5.0	<.20	.75	<.10	.24	220	880	7.3	4.20	197.7 to 237.3
M3-GL	Jun 25 1995	Jun 25 1995	110	5.5	79	18	170	140	<10.00	110.0	16.0	<5.0	.21	.68	<.10	.29	140	660	7.3	1.05	297.6 to 337.7
M3-GL (Filtered)	Jun 25 1995	Jun 28 1995	110	4.9	78	18	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	297.6 to 337.7
M3-GL	Jul 13 1995	Jul 14 1995	110	5	87	20	190	150	<10.00	130.0	17.0	<2.5	<.20	.78	<.10	.31	150	710	7.4	4.20	297.6 to 337.7
M3-GL (Filtered)	Jul 13 1995	Jul 17 1995	110	4.8	86	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	297.6 to 337.7
M3-GL (Filtered)	Aug 15 1995	Aug 19 1995	100	4.6	89	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	297.6 to 337.7
M3-GL	Aug 15 1995	Aug 16 1995	110	4.9	87	20	180	150	<10.00	100.0	17.0	<2.5	<.20	<.10	<.10	.32	150	700	7.4	1.70	297.6 to 337.7
M3-GL	Sep 11 1995	Sep 12 1995	110	4.8	83	20	190	150	<10.00	100.0	16.0	<1.0	<.20	.48	<.10	.32	150	710	7.4	.65	297.6 to 337.7
M3-GL	Sep 11 1995	Sep 12 1995	100	4.5	78	19	180	140	<10.00	99.0	16.0	<1.0	<.20	.50	<.10	.32	140	690	7.3	1.20	297.6 to 337.7
M3-GL	Oct 16 1995	Oct 17 1995	110	5.1	90	21	170	140	<10.00	110.0	16.0	<5.0	<.20	.67	<.10	.34	140	680	7.3	4.55	297.6 to 337.7
M4-O	Jun 25 1995	Jun 25 1995	160	5.2	35	7.9	130	140	<10.00	130.0	13.0	<5.0	2.00	2.00	<.10	.26	140	670	7.4	1.71	404.8 to 464.2
M4-O (Filtered)	Jun 25 1995	Jun 28 1995	160	4.9	34	7.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	404.8 to 464.2
M4-O (Filtered)	Jul 13 1995	Jul 17 1995	170	5	40	9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	404.8 to 464.2
M4-O	Jul 13 1995	Jul 14 1995	170	5.1	41	9.3	140	160	<10.00	150.0	15.0	<2.5	1.20	2.60	<.10	.28	160	680	7.1	2.60	404.8 to 464.2
M4-O (Filtered)	Aug 15 1995	Aug 19 1995	130	4	33	6.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	404.8 to 464.2
M4-O	Aug 15 1995	Aug 16 1995	150	4.4	34	7.6	120	130	<10.00	98.0	11.0	<2.5	.78	2.10	<.10	.26	130	580	7.5	4.40	404.8 to 464.2
M4-O (Filtered)	Aug 15 1995	Aug 19 1995	140	4.1	34	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	404.8 to 464.2
M4-O	Aug 15 1995	Aug 16 1995	150	4.4	35	7.7	120	130	<10.00	94.0	9.9	<2.5	.69	1.90	<.10	.26	130	560	7.4	4.60	404.8 to 464.2
M4-O	Sep 18 1995	Sep 19 1995	180	5.1	46	11	160	180	<10.00	150.0	21.0	<5.0	.66	1.70	<.10	.29	180	800	7.2	1.80	404.8 to 464.2
M4-O	Oct 16 1995	Oct 17 1995	200	5.9	61	14	160	190	<10.00	160.0	26.0	<5.0	.73	1.70	<.10	.25	190	800	7.2	4.10	404.8 to 464.2
M5-S	Jul 24 1995	Jul 25 1995	180	4.8	20	5.3	90	210	<10.00	140.0	<.1	<2.5	.66	2.80	<.10	<.10	210	560	8.3	3.30	516.4 to 576.1
M5-S (Filtered)	Jul 24 1995	Jul 27 1995	180	4.8	17	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	516.4 to 576.1
M5-S (Filtered)	Aug 18 1995	Aug 24 1995	160	4.3	5.4	2.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	516.4 to 576.1
M5-S	Aug 18 1995	Aug 19 1995	170	4.6	5	2.3	74	60	120	120.0	<.1	<.1	.28	1.90	<.10	.24	180	480	9.6	1.50	516.4 to 576.1
M5-S	Sep 19 1995	Sep 20 1995	160	4.4	3.2	1.1	68	60	100	120.0	<.2	<.2	<.20	3.90	<.10	<.20	160	470	9.9	1.60	516.4 to 576.1
M5-S (Filtered)	Oct 17 1995	Oct 18 1995	150	4	3.9	1.7	53	70	110	95.0	<.5	<.2	NA	4.00	<.10	<.20	180	430	9.8	1.21	516.4 to 576.1
M5-S (Filtered)	Oct 17 1995	Oct 18 1995	160	4.2	4.1	1.7	57	61	120	95.0	<.5	<.2	NA	3.80	<.10	<.20	180	440	9.8	1.70	516.4 to 576.1
M5-S	Oct 17 1995	Oct 18 1995	160	4.2	4	1.9	53	99	81	97.0	<.5	<.2	<.20	3.90	<.10	<.20	180	450	9.7	2.53	516.4 to 576.1

Table 4.5-1 Summary of Analytical Results, Common Ions and Miscellaneous Parameters (a)

Sample ID	Sampled	Analyzed	Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3	NO2	PO4	F	I	Br	ALK	TDS	pH	IB	Screened
M5-S	Oct 17 1995	Oct 18 1995	160	4.1	3.9	1.8	61	90	90	96.0	< .5	<.2	<.20	4.00	<.10	<.20	180	430	9.7	.09	516.4 to 576.1
M6-GU	Jul 19 1995	Jul 20 1995	110	5.4	38	8.1	150	55	<10.00	68.0	2.4	<2.5	2.70	.55	<.10	<.10	55	440	8.5	2.50	524 to 562.5
M6-GU (Filtered)	Jul 19 1995	Jul 25 1995	110	3.3	15	2.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	524 to 562.5
M6-GU	Aug 24 1995	Aug 25 1995	110	3.2	15	2.7	140	51	<10.00	51.0	12.0	<1.0	<.20	.63	<.10	.24	51	380	8.2	2.80	524 to 562.5
M6-GU (Filtered)	Aug 24 1995	Aug 30 1995	110	3.3	15	2.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	524 to 562.5
M6-GU	Sep 19 1995	Sep 21 1995	110	3.5	15	2.9	130	43	<10.00	48.0	1.8	<5.0	<.20	.61	<.10	.31	43	380	8.2	2.50	524 to 562.5
M6-GU	Oct 18 1995	Oct 19 1995	110	3.3	16	2.9	130	57	<10.00	49.0	1.7	<5.0	<.20	.75	<.10	<.20	57	360	8.4	.82	524 to 562.5
M6-GU (Filtered)	Oct 18 1995	Oct 19 1995	120	3.4	16	3	130	51	<10.00	75.0	1.7	<5.0	NA	.69	<.10	<.20	51	470	8.7	.07	524 to 562.5
M7-GL (Filtered)	Aug 22 1995	Aug 25 1995	100	5.5	3	0.18	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	859 to 918
M7-GL	Aug 22 1995	Aug 23 1995	120	6.3	3.2	0.17	70	38	82	43.0	< .1	<2.5	<.20	1.30	<.10	.23	120	300	9.6	2.50	859 to 918
M7-GL	Sep 19 1995	Sep 20 1995	100	2.9	3.6	0.49	62	46	74	33.0	< .2	<.2	<.20	.78	<.10	<.20	120	300	9.8	1.20	859 to 918
M7-GL (Filtered)	Oct 19 1995	Oct 20 1995	100	2.8	3.2	0.25	63	82	28	32.0	< .5	<5.0	NA	.99	<.10	<.20	110	290	9.4	.24	859 to 918
M7-GL	Oct 19 1995	Oct 20 1995	110	2.9	3.5	0.3	63	40	100	24.0	< .5	<5.0	<.20	1.20	<.10	<.20	140	280	9.4	.30	859 to 918
M8-O (Filtered)	Jul 23 1995	Jul 27 1995	130	1.3	2.9	0.29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1010.7 to 1070.3
M8-O	Jul 23 1995	Jul 25 1995	130	1.5	2.9	0.4	38	150	20	78.0	3.0	<2.5	<.20	1.60	<.10	<.10	170	350	9.1	3.60	1010.7 to 1070.3
M8-O	Aug 22 1995	Aug 24 1995	130	1.2	2.7	0.25	40	170	<10.00	71.0	4.3	<1.0	<.20	2.10	<.10	<.10	170	370	8.6	1.60	1010.7 to 1070.3
M8-O (Filtered)	Aug 22 1995	Aug 30 1995	130	1.1	2.7	0.24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1010.7 to 1070.3
M8-O	Sep 15 1995	Sep 16 1995	140	1.1	2.8	0.25	42	160	<10.00	84.0	4.2	<.1	<.20	2.90	<.10	<.10	160	370	8.7	.97	1010.7 to 1070.3
M8-O	Sep 15 1995	Sep 16 1995	140	1.2	3	0.27	41	150	<10.00	83.0	4.3	<.1	<.20	2.80	<.10	<.10	150	370	8.7	2.70	1010.7 to 1070.3
M8-O (Filtered)	Oct 18 1995	Oct 19 1995	130	1.1	2.9	0.23	39	170	<10.00	70.0	3.7	<5.0	NA	2.30	<.10	<.20	170	360	8.7	1.40	1010.7 to 1070.3
M8-O	Oct 18 1995	Oct 19 1995	130	1.4	2.9	0.24	40	150	40	71.0	3.6	<5.0	<.20	2.40	<.10	<.20	190	360	8.7	4.50	1010.7 to 1070.3
M9-S (Filtered)	Aug 23 1995	Aug 30 1995	760	18	210	1.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1510 to 1570
M9-S	Aug 23 1995	Aug 24 1995	730	17	200	1.6	83	<10.0	52	1800.0	< .1	<.1	<.20	1.00	<.10	<.10	66	3000	11.0	2.40	1510 to 1570
M9-S	Sep 22 1995	Sep 23 1995	620	20	210	0.34	75	<10.0	40	1700.0	< .2	<5.0	<.20	1.10	.13	<.40	140	2900	12.0	3.00	1510 to 1570
M9-S (Filtered)	Oct 19 1995	Oct 20 1995	790	14	250	4.9	66	<10.0	28	2000.0	< .5	<5.0	NA	1.10	.11	<.20	45	3100	11.0	2.10	1510 to 1570
M9-S (Filtered)	Oct 19 1995	Oct 20 1995	790	14	240	4.5	68	41	<10.00	2000.0	< .5	<5.0	NA	1.00	.12	<.20	41	3200	11.0	2.20	1510 to 1570
M9-S	Oct 19 1995	Oct 20 1995	670	18	220	-0.2	74	120	<10.00	1700.0	< .5	<5.0	<.20	1.20	.24	<.20	120	2800	11.0	1.20	1510 to 1570
M9-S	Oct 19 1995	Oct 20 1995	680	18	220	-0.2	73	<10	140	1700.0	< .5	<5.0	<.20	1.20	<.10	<.20	140	2800	11.0	1.91	1510 to 1570
M10-GU (Filtered)	Jun 22 1995	Jun 28 1995	190	5.9	170	40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	218 to 258
M10-GU	Jun 22 1995	Jun 23 1995	180	5.6	160	38	340	120	<10.00	240.0	80.0	<10.0	<.20	.98	<.10	.56	120	1300	8.7	.90	218 to 258
M10-GU	Jul 12 1995	Jul 13 1995	180	5.7	170	50	360	240	<10.00	270.0	95.0	<5.0	<.20	.70	<.10	.49	240	1400	6.9	4.10	218 to 258
M10-GU (Filtered)	Jul 12 1995	Jul 14 1995	180	5.6	170	40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	218 to 258
M10-GU	Aug 16 1995	Aug 17 1995	170	5.1	200	40	350	230	<10.00	220.0	140.0	<2.5	<.20	.74	<.10	.49	230	1400	7.1	1.30	218 to 258
M10-GU (Filtered)	Aug 16 1995	Aug 19 1995	160	5.1	210	40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	218 to 258
M10-GU	Sep 12 1995	Sep 13 1995	190	5.6	180	41	350	220	<10.00	230.0	70.0	<2.5	<.20	.57	<.10	.49	220	1400	6.9	1.60	218 to 258

Table 4.5-1 Summary of Analytical Results, Common Ions and Miscellaneous Parameters (a)

Sample ID	Sampled	Analyzed	Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3	NO2	PO4	F	I	Br	ALK	TDS	pH	IB	Screened
M10-GU	Oct 17 1995	Oct 18 1995	190	5.9	190	44	360	230	<10.00	230.0	59.0	<5.0	<.20	.62	<.10	.36	230	1300	7.2	2.86	218 to 258
M11-GL	Jun 23 1995	Jun 24 1995	110	6.4	97	23	200	180	<10.00	93.0	14.0	<2.0	.80	.58	<.10	.30	180	710	7.4	.29	289.9 to 329.6
M11-GL (Filtered)	Jun 23 1995	Jun 28 1995	100	4.7	84	19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	289.9 to 329.6
M11-GL	Jun 23 1995	Jun 24 1995	100	5.6	94	21	200	160	<10.00	92.0	14.0	<2.0	.89	.71	<.10	.28	160	720	7.4	1.75	289.9 to 329.6
M11-GL (Filtered)	Jun 23 1995	Jun 28 1995	100	4.6	84	19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	289.9 to 329.6
M11-GL	Jul 19 1995	Jul 20 1995	110	13	100	22	220	170	<10.00	100.0	16.0	<2.5	<.20	.52	<.10	.31	170	760	7.3	1.80	289.9 to 329.6
M11-GL	Jul 19 1995	Jul 20 1995	100	4.6	99	21	210	170	<10.00	110.0	16.0	<2.5	<.20	.49	<.10	.23	170	760	7.2	4.90	289.9 to 329.6
M11-GL (Filtered)	Jul 19 1995	Jul 25 1995	100	4.3	94	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	289.9 to 329.6
M11-GL (Filtered)	Jul 19 1995	Jul 25 1995	100	6.2	94	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	289.9 to 329.6
M11-GL	Aug 16 1995	Aug 17 1995	97	4.5	100	21	190	160	<10.00	82.0	13.0	<2.5	<.20	.72	<.10	.33	160	700	7.4	2.40	289.9 to 329.6
M11-GL (Filtered)	Aug 16 1995	Aug 19 1995	89	4.2	100	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	289.9 to 329.6
M11-GL	Sep 12 1995	Sep 13 1995	110	4.7	95	22	190	160	<10.00	100.0	14.0	<2.5	<.20	.45	<.10	.34	160	730	7.2	2.20	289.9 to 329.6
M11-GL	Oct 17 1995	Oct 18 1995	110	5	95	22	180	170	<10.00	88.0	13.0	<5.0	<.20	.45	<.10	.28	170	670	7.5	4.19	289.9 to 329.6
M12-O (Filtered)	Jun 24 1995	Jun 28 1995	90	4.6	62	13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	419.5 to 480.1
M12-O	Jun 24 1995	Jun 24 1995	91	5.9	72	16	130	140	<10.00	74.0	6.0	<.4	.86	.51	<.10	<.40	140	540	7.5	3.15	419.5 to 480.1
M12-O	Jul 12 1995	Jul 13 1995	91	6.3	78	17	150	160	<10.00	89.0	5.0	<2.5	1.10	.52	<.10	.20	160	560	7.5	1.70	419.5 to 480.1
M12-O (Filtered)	Jul 12 1995	Jul 14 1995	87	4.5	62	13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	419.5 to 480.1
M12-O	Aug 16 1995	Aug 17 1995	77	4.1	74	14	130	140	<10.00	65.0	4.4	<2.5	<.20	.55	<.10	.26	140	540	7.6	2.00	419.5 to 480.1
M12-O (Filtered)	Aug 16 1995	Aug 19 1995	72	4	77	14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	419.5 to 480.1
M12-O (Filtered)	Aug 16 1995	Aug 19 1995	76	4.1	80	14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	419.5 to 480.1
M12-O	Aug 16 1995	Aug 17 1995	77	4.1	74	14	130	150	<10.00	65.0	4.4	<2.5	<.20	.56	<.10	.25	150	540	7.7	.78	419.5 to 480.1
M12-O	Sep 12 1995	Sep 13 1995	87	4.5	68	14	130	150	<10.00	79.0	4.2	<2.5	<.20	.32	<.10	.26	150	540	7.2	.90	419.5 to 480.1
M12-O	Oct 17 1995	Oct 18 1995	92	4.6	70	15	130	140	<10.00	65.0	3.9	<5.0	<.20	.40	<.10	<.20	140	520	7.7	5.10	419.5 to 480.1
M13-S	Jul 28 1995	Jul 29 1995	490	86	370	47	150	22	<10.00	1800.0	< .1	<2.5	<.20	.65	<.10	<2.50	22	2900	9.7	.47	852 to 911
M13-S (Filtered)	Jul 28 1995	Aug 01 1995	400	17	470	31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	852 to 911
M13-S	Aug 22 1995	Aug 23 1995	400	54	440	2.6	64	<10.00	32	1700.0	< .1	<.1	<.20	.58	<.10	<.10	130	2800	11.0	1.60	852 to 911
M13-S (Filtered)	Aug 22 1995	Aug 25 1995	410	10	480	44	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	852 to 911
M13-S	Sep 19 1995	Sep 20 1995	390	46	440	2.5	59	<10.00	20	1700.0	< .2	<.2	<.20	2.70	<.10	<.20	120	2700	11.0	1.60	852 to 911
M13-S	Oct 18 1995	Oct 19 1995	390	58	460	1.3	54	<10.00	200	1100.0	< .5	<5.0	<.20	.44	.57	<.20	410	1900	12.0	12.00	852 to 911
M13-S	Oct 18 1995	Oct 19 1995	410	90	450	0.68	60	<10.00	40	1100.0	< .5	<5.0	<.20	.48	.42	<.20	390	2300	12.0	13.00	852 to 911
M13-S (Filtered)	Oct 18 1995	Oct 19 1995	400	51	460	1.9	56	<10.00	20	1600.0	< .5	<5.0	NA	.41	.21	<.20	120	2500	11.0	5.70	852 to 911
M13-S (Filtered)	Oct 18 1995	Oct 19 1995	420	91	410	0.28	55	<10.00	40	1500.0	< .5	<5.0	NA	.40	.27	<.20	210	2600	12.0	4.60	852 to 911
M14-GL	Jul 17 1995	Jul 19 1995	150	4.6	32	5.9	190	75	<10.00	98.0	7.9	<2.5	1.70	.38	<.10	.21	75	570	7.9	4.00	777.9 to 837.8
M14-GL (Filtered)	Jul 17 1995	Jul 24 1995	150	4	29	4.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	777.9 to 837.8
M14-GL (Filtered)	Aug 16 1995	Aug 19 1995	140	3.8	26	4.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	777.9 to 837.8

Table 4.5-1 Summary of Analytical Results, Common Ions and Miscellaneous Parameters (a)

Sample ID	Sampled	Analyzed	Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3	NO2	PO4	F	I	Br	ALK	TDS	pH	IB	Screened
M14-GL	Aug 16 1995	Aug 17 1995	110	3.7	33	5.1	160	71	<10.00	63.0	7.1	<2.5	.89	.65	<.10	.28	71	480	8.2	2.80	777.9 to 837.8
M14-GL	Sep 13 1995	Sep 13 1995	130	3.7	25	4.6	170	71	<10.00	79.0	7.3	<2.5	.34	.36	<.10	.30	71	510	8.1	3.60	777.9 to 837.8
M14-GL	Oct 20 1995	Oct 21 1995	150	4.3	31	5.5	190	71	<10.00	63.0	12.0	<2.0	.55	.43	<.10	<2.00	71	530	8.0	1.60	777.9 to 837.8
M15-GU	Jul 24 1995	Jul 25 1995	130	5.6	86	24	300	100	<10.00	80.0	23.0	<2.5	.31	.35	<.10	.46	100	870	7.7	3.30	554.2 to 594.1
M15-GU (Filtered)	Jul 24 1995	Jul 27 1995	130	5.6	87	25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	554.2 to 594.1
M15-GU (Filtered)	Aug 16 1995	Aug 19 1995	130	5.5	93	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	554.2 to 594.1
M15-GU	Aug 16 1995	Aug 17 1995	110	4.7	100	24	270	120	<10.00	68.0	23.0	<2.5	<.20	.64	<.10	.42	120	910	7.5	.63	554.2 to 594.1
M15-GU	Sep 13 1995	Sep 13 1995	130	5.4	88	26	280	120	<10.00	83.0	22.0	<2.5	.31	.56	<.10	.41	120	990	7.4	.04	554.2 to 594.1
M15-GU	Oct 20 1995	Oct 21 1995	130	5.9	99	27	310	120	<10.00	66.0	23.0	<2.0	<.20	.47	<.10	<2.00	120	860	7.4	.30	554.2 to 594.1
M16-GU	Jul 17 1995	Jul 18 1995	140	5.8	120	28	300	130	<10.00	170.0	34.0	<2.5	<.20	.49	<.10	.39	130	1100	7.3	3.30	598 to 658
M16-GU (Filtered)	Jul 17 1995	Jul 24 1995	150	6	120	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	598 to 658
M16-GU (Filtered)	Jul 17 1995	Jul 24 1995	150	5.9	120	29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	598 to 658
M16-GU	Jul 17 1995	Jul 18 1995	140	5.9	120	29	300	140	<10.00	170.0	37.0	<2.5	<.20	.50	<.10	.40	140	1000	6.8	3.80	598 to 658
M16-GU	Aug 17 1995	Aug 18 1995	160	6.3	120	31	310	130	<10.00	160.0	54.0	<2.5	<.20	.63	<.10	.42	130	980	7.4	.92	598 to 658
M16-GU (Filtered)	Aug 17 1995	Aug 24 1995	140	5.5	110	28	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	598 to 658
M16-GU	Sep 14 1995	Sep 15 1995	140	5.6	120	28	280	130	<10.00	150.0	36.0	<2.5	<.20	.48	<.10	.45	130	1100	7.3	1.30	598 to 658
M16-GU	Oct 19 1995	Oct 20 1995	140	5.8	120	30	290	160	<10.00	150.0	35.0	<5.0	<.20	.64	<.10	.31	160	1000	7.5	1.00	598 to 658
M17-GL (Filtered)	Jul 17 1995	Jul 24 1995	130	4.9	31	6.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	938 to 998
M17-GL	Jul 17 1995	Jul 19 1995	130	5.3	41	7.4	120	96	<10.00	150.0	2.4	<2.5	2.30	.67	<.10	<.10	96	540	7.8	2.20	938 to 998
M17-GL	Aug 17 1995	Aug 18 1995	130	5.1	34	6.9	110	100	<10.00	140.0	2.0	<2.5	1.30	.72	<.10	.21	100	510	8.0	.42	938 to 998
M17-GL (Filtered)	Aug 17 1995	Aug 24 1995	120	4.7	30	5.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	938 to 998
M17-GL	Aug 17 1995	Aug 18 1995	130	5.3	35	7	110	100	<10.00	140.0	2.0	<2.5	1.20	.88	<.10	.21	100	520	8.0	.54	938 to 998
M17-GL (Filtered)	Aug 17 1995	Aug 24 1995	130	4.9	31	6.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	938 to 998
M17-GL	Sep 20 1995	Sep 21 1995	210	7	89	25	270	180	<10.00	180.0	29.0	<5.0	3.80	1.00	<.10	.42	180	1000	7.5	1.30	938 to 998
M18-GU	Jul 14 1995	Jul 15 1995	150	4.4	98	22	170	220	<10.00	210.0	23.0	<5.0	<.20	1.20	<.10	.29	220	810	7.4	3.80	177.6 to 217.6
M18-GU (Filtered)	Jul 14 1995	Jul 18 1995	140	4.1	93	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	177.6 to 217.6
M18-GU	Aug 14 1995	Aug 15 1995	140	3.8	87	19	150	220	<10.00	170.0	22.0	<2.5	<.20	.81	<.10	.32	220	790	7.3	1.40	177.6 to 217.6
M18-GU (Filtered)	Aug 14 1995	Aug 17 1995	140	3.9	90	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	177.6 to 217.6
M18-GU	Sep 13 1995	Sep 13 1995	150	4.3	94	22	160	210	<10.00	160.0	22.0	<2.5	<.20	.78	<.10	.33	210	870	7.1	3.00	177.6 to 217.6
M18-GU	Oct 20 1995	Oct 21 1995	130	3.9	95	20	170	210	<10.00	160.0	24.0	<2.0	<.20	.87	<.10	<2.00	210	790	7.3	.76	177.6 to 217.6
M18-GU	Oct 20 1995	Oct 21 1995	130	3.9	100	20	160	220	<10.00	160.0	24.0	<2.0	<.20	.86	<.10	<2.00	220	790	7.3	.76	177.6 to 217.6
P8-1-O	Oct 24 1995	Oct 25 1995	100	4.1	31	7.9	120	110	<10.00	74.0	1.5	<5.0	.49	.77	<.10	<.20	110	480	7.6	3.40	399.5 to 579.6
P8-GU	Sep 20 1995	Sep 21 1995	210	6.8	190	48	420	220	<10.00	230.0	62.0	<5.0	<.20	1.70	<.10	.59	220	1700	7.5	1.00	128.2 to 248.4
P8-GU	Oct 24 1995	Oct 25 1995	190	6.7	200	46	430	220	<10.00	260.0	79.0	<5.0	<.20	.61	<.10	.82	220	1900	7.1	1.80	128.2 to 248.4
P8-GU	Oct 24 1995	Oct 25 1995	190	6.7	190	46	430	220	<10.00	250.0	67.0	<5.0	<.20	.60	<.10	.73	220	1900	7.2	2.10	128.2 to 248.4

Table 4.5-1 Summary of Analytical Results, Common Ions and Miscellaneous Parameters (a)

Sample ID	Sampled	Analyzed	Na	K	Ca	Mg	Cl	HCO3	CO3	SO4	NO3	NO2	PO4	F	I	Br	ALK	TDS	pH	IB	Screened
P28-1-O	Oct 23 1995	Oct 24 1995	84	4.1	51	10	120	120	<10.00	51.0	1.9	<5.0	<.20	.75	<.10	.36	120	500	7.7	1.30	350 to 400
P28-GL	Sep 20 1995	Sep 21 1995	160	5.7	120	29	240	200	<10.00	160.0	29.0	<5.0	<.20	.85	<.10	.40	200	1000	7.5	3.20	279 to 309
P28-GL	Oct 23 1995	Oct 24 1995	150	5	120	27	240	210	<10.00	170.0	30.0	<5.0	<.20	.61	<.10	.60	210	1100	7.2	.50	279 to 309
P28-GL	Oct 23 1995	Oct 24 1995	150	5.1	130	27	240	210	<10.00	170.0	30.0	<5.0	<.20	.58	<.10	.52	210	1100	7.2	1.20	279 to 309
PW7-1	Jun 16 1995	Jun 22 1995	140	5.9	79	11	85	98	<10.00	300.0	2.6	<.4	<.20	.53	<.10	<.40	98	760	7.6	.03	540 to 880
PW7-1	Jun 21 1995	Jun 22 1995	130	5.8	79	11	99	100	<10.00	250.0	2.7	<.4	<.20	.74	<.10	<.40	100	710	7.7	.97	540 to 880
WTANK (Filtered)	Jun 27 1995	Jul 03 1995	180	6.3	160	39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
WTANK (Filtered)	Jun 27 1995	Jul 03 1995	180	6.4	160	39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
WTANK	Jun 27 1995	Jun 28 1995	180	6.6	160	40	270	250	<10.00	290.0	59.0	<5.0	<.20	.68	<.10	<5.00	250	1300	7.4	1.73	N
WTANK	Jun 27 1995	Jun 28 1995	180	6.5	160	39	270	240	<10.00	300.0	61.0	<5.0	<.20	.68	<.10	<5.00	240	1300	7.5	2.06	N
WTANK	Jul 11 1995	Jul 12 1995	200	7.5	192	55	320	270	<10.00	350.0	110.0	<5.0	<.20	.69	<.10	<5.00	270	1500	7.3	2.00	N
WTANK (Filtered)	Jul 11 1995	Jul 13 1995	180	7.1	180	42	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
WTANK (Filtered)	Aug 14 1995	Aug 17 1995	170	6.1	150	37	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	N
WTANK	Aug 14 1995	Aug 15 1995	180	6.5	160	38	270	260	<10.00	290.0	98.0	<2.5	<.20	.56	<.10	<.10	260	1300	7.2	3.40	N
WTANK	Sep 12 1995	Sep 13 1995	170	6.2	160	37	250	250	<10.00	260.0	47.0	<2.5	<.20	.51	<.10	.40	250	1200	7.4	.81	N
WTANK	Oct 16 1995	Oct 17 1995	160	6.2	140	34	220	230	<10.00	230.0	41.0	<5.0	<.20	.60	<.10	.25	230	1100	7.5	2.10	N
WW3	Jun 23 1995	Jun 24 1995	150	5.3	120	26	260	200	<10.00	180.0	38.0	<4.0	<.20	.77	<.10	.38	200	1000	7.2	4.13	240 to 933
WW3 (Filtered)	Jun 23 1995	Jun 28 1995	150	5.3	120	26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	240 to 933
WW3	Jul 11 1995	Jul 12 1995	170	6	170	32	300	210	<10.00	220.0	37.0	<5.0	<.20	.69	<.10	.37	210	1100	7.3	.94	240 to 933
WW3 (Filtered)	Jul 11 1995	Jul 13 1995	150	5.3	130	27	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	240 to 933
Standard Dectection Limit			0.5	0.5	2.0	0.05	0.5	10	10	0.5	0.5	0.07	1.0	0.5	0.2	N	6.0	N	N	N	N
Drinking Water- Primary Standard Limit			N	N	N	N	N	N	N	N	N	N	2-4	N	N	N	N	N	N	N	N

[a]Concentration in milligram/liter, except pH (pH units), I.B. (percent), and S.I. (feet below surface).
Despite the use of trailing zeros in some data, no result has more than two significant figures.
< is less than the reported detection limit.
N - Not Applicable
NA - Not Analyzed

Na - Sodium
K - Potassium
Ca - Calcium
Mg - Magnesium
Cl - Cloride

HCO3 - Bicarbonate Alkalinity (as CO3)
CO3 - Carbonate Alkalinity (as CO3)
SO4 - Sulfate
NO3 - Nitrate
NO2 - Nitrite

PO4 - Phosporus
F - Floride
S.I. Screened Interval
I - Iodide
Br - Bromide

Alk - Total Alkalinity
TDS - Total Dissolved Solids
I.B. - Ion Balance

Table 4.5-2 Summary of Analytical Results, Trace Metals [a]

Sample ID	Sampled	Analyzed	AL	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Hg	Ni	Se	Ag	Sr	Tl	Sn	V	Zn
ASHAFT (Filtered)	Jun 27 1995	Jul 03 1995	<.1	<.005	.002	.057	<.001	.073	<.005	<.005	<.04	<.02	21.	<.002	1.5	.064	<.0002	<.04	<.004	<.01	.85	<.003	<.5	<.04	.012
ASHAFT	Jun 27 1995	Jun 28 1995	<.1	<.005	<.002	.07	<.001	.12	.007	<.005	<.04	<.02	28.	<.002	1.6	.022	<.0002	<.04	<.004	<.01	.88	<.003	<.5	<.04	<.01
ASHAFT	Jul 11 1995	Jul 12 1995	<.1	<.005	<.002	.06	<.001	.11	<.005	<.005	<.04	<.02	33.	<.002	1.5	.05	<.0002	<.04	<.004	<.01	.81	<.003	<.5	<.04	<.01
ASHAFT (Filtered)	Jul 11 1995	Jul 13 1995	<.1	<.005	<.002	.05	<.001	.11	<.005	<.005	<.04	<.02	23.	<.002	1.5	.053	<.0002	<.04	<.004	<.01	.8	<.003	<.5	<.04	.041
ASHAFT (Filtered)	Aug 14 1995	Aug 17 1995	<.1	<.005	<.002	.052	<.001	.14	<.005	<.005	<.04	<.02	9.4	<.002	1.6	.055	<.0002	<.04	<.004	<.01	.8	<.003	<.5	<.04	.019
ASHAFT	Aug 14 1995	Aug 15 1995	<.1	<.005	<.002	.064	<.001	.18	<.005	<.005	<.04	<.02	24.	<.002	1.6	.054	<.0002	<.04	<.004	<.01	.81	<.003	<.5	<.04	.014
ASHAFT	Sep 12 1995	Sep 13 1995	<.1	<.005	<.002	.055	<.001	.21	<.005	.001	<.04	<.02	16.	<.002	1.4	.057	<.0002	<.04	<.004	<.01	.89	<.003	<.5	<.04	.012
ASHAFT (Filtered)	Oct 16 1995	Oct 20 1995	.1	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.25	NA	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	.45
ASHAFT	Oct 16 1995	Oct 17 1995	<.1	<.005	<.002	.058	<.001	.32	<.005	<.005	<.04	<.02	18.	<.002	1.7	.056	<.0002	<.04	<.004	<.01	.91	<.003	<.5	<.04	.02
BIA10B (Filtered)	Jun 27 1995	Jul 03 1995	<.1	<.005	<.002	.069	<.001	.056	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.2	<.003	<.5	<.04	<.01
BIA10B	Jun 27 1995	Jun 28 1995	<.1	<.005	<.002	.072	<.001	.07	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.1	<.003	<.5	<.04	<.01
BIA10B	Jul 11 1995	Jul 12 1995	<.1	<.005	<.002	.068	<.001	.12	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.1	<.003	<.5	<.04	<.01
BIA10B (Filtered)	Jul 11 1995	Jul 13 1995	<.1	<.005	<.002	.064	<.001	.11	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.1	<.003	<.5	<.04	<.01
BIA10B	Sep 20 1995	Sep 21 1995	<.1	<.005	<.002	.079	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.1	<.003	<.5	<.04	<.01
BIA9 (Filtered)	Jun 23 1995	Jun 28 1995	<.1	<.005	<.002	.071	<.001	.16	<.005	<.005	<.04	<.02	<.04	.0049	<.01	<.01	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	<.01
BIA9	Jun 23 1995	Jun 24 1995	<.1	<.005	<.002	.07	<.001	.17	<.005	<.005	<.04	<.02	.06	.0034	<.01	<.01	<.0002	<.04	<.004	<.01	.99	<.003	<.5	<.04	.029
BIA9 (Filtered)	Jul 11 1995	Jul 13 1995	<.1	<.005	<.002	.066	<.001	.15	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	<.01
BIA9	Jul 11 1995	Jul 12 1995	<.1	<.005	<.002	.061	<.001	.14	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.73	<.003	<.5	<.04	<.01
BIA9	Sep 20 1995	Sep 21 1995	<.1	<.005	<.002	.073	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.99	<.003	<.5	<.04	<.01
ENG3	Jun 27 1995	Jun 28 1995	<.1	<.005	.003	.042	<.001	<.05	<.005	<.005	<.04	<.02	.13	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.91	<.003	<.5	<.04	<.01
ENG3 (Filtered)	Jun 27 1995	Jul 03 1995	<.1	<.005	.002	.033	<.001	<.05	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.83	<.003	<.5	<.04	.018
ENG3 (Filtered)	Jul 11 1995	Jul 13 1995	<.1	<.005	<.002	.055	<.001	.15	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.1	<.003	<.5	<.04	<.01
ENG3	Jul 11 1995	Jul 12 1995	<.1	<.005	<.002	.056	<.001	.15	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.1	<.003	<.5	<.04	<.01
ENG3	Sep 20 1995	Sep 21 1995	<.1	<.005	<.002	.046	<.001	<.2	<.005	.0093	<.04	<.02	.05	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.87	<.003	<.5	<.04	<.01
ENG3	Oct 19 1995	Oct 20 1995	.12	<.005	<.002	.045	<.001	<.2	<.005	<.005	<.04	<.02	.1	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.95	<.003	<.5	<.04	.19
M1-GL	Jul 14 1995	Jul 15 1995	6.4	<.005	.003	.082	<.001	<.2	<.005	.02	<.04	.03	4.9	.0059	.18	<.01	<.0002	.045	<.004	<.01	.62	<.003	<.5	<.04	.029
M1-GL (Filtered)	Jul 14 1995	Jul 18 1995	<.1	<.005	<.002	.023	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	.01	<.01	<.0002	<.04	<.004	<.01	.54	<.003	<.5	<.04	.012
M1-GL	Aug 14 1995	Aug 15 1995	<.1	<.005	.003	.024	<.001	.1	<.005	<.005	<.04	<.02	.08	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.55	<.003	<.5	<.04	<.01
M1-GL (Filtered)	Aug 14 1995	Aug 17 1995	<.1	<.005	<.002	.022	<.001	.09	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.51	<.003	<.5	<.04	<.01
M1-GL	Sep 13 1995	Sep 13 1995	<.1	<.005	<.002	.023	<.001	<.2	<.005	.0026	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.58	<.003	<.5	<.04	<.01
M1-GL	Sep 13 1995	Sep 13 1995	<.1	<.005	.003	.024	<.001	<.2	<.005	.0031	<.04	<.02	.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.58	<.003	<.5	<.04	.013
M1-GL	Oct 20 1995	Oct 21 1995	<.1	<.005	<.002	.019	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.011	.0003	<.04	<.004	.011	.6	<.003	<.5	<.04	<.01

Table 4.5-2 Summary of Analytical Results, Trace Metals [a]

Sample ID	Sampled	Analyzed	AL	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Hg	Ni	Se	Ag	Sr	Tl	Sn	V	Zn
M2-GU	Jun 24 1995	Jun 25 1995	.15	<.005	<.002	.048	<.001	.15	<.005	<.005	<.04	<.02	.25	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.77	<.003	<.5	<.04	.01
M2-GU (Filtered)	Jun 24 1995	Jun 28 1995	<.1	<.005	.002	.046	<.001	.15	<.005	<.005	<.04	<.02	<.04	.0052	<.01	<.01	<.0002	<.04	<.004	<.01	.76	<.003	<.5	<.04	<.01
M2-GU (Filtered)	Jul 13 1995	Jul 17 1995	<.1	<.005	<.002	.044	.002	.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.012	<.0002	<.04	<.004	<.01	.68	<.003	<.5	<.04	.017
M2-GU	Jul 13 1995	Jul 14 1995	<.1	<.005	<.002	.043	.002	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.71	<.003	<.5	<.04	.017
M2-GU	Jul 13 1995	Jul 14 1995	<.1	<.005	.002	.045	.002	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.73	<.003	<.5	<.04	.015
M2-GU (Filtered)	Jul 13 1995	Jul 17 1995	<.1	<.005	<.002	.043	.001	.21	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	.049	<.004	<.01	.69	<.003	<.5	<.04	.019
M2-GU	Aug 15 1995	Aug 16 1995	<.1	<.005	.004	.043	<.001	<.2	.008	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	.006	<.01	.79	<.003	<.5	<.04	<.01
M2-GU (Filtered)	Aug 15 1995	Aug 19 1995	<.1	<.005	.004	.041	<.001	<.2	.008	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	.006	<.01	.87	<.003	<.5	<.04	<.01
M2-GU	Sep 11 1995	Sep 12 1995	<.1	<.005	.003	.047	<.001	.26	<.005	<.005	<.04	<.02	.11	<.002	<.01	<.01	<.0002	.075	<.004	<.01	.81	<.003	<.5	<.04	.017
M2-GU	Oct 16 1995	Oct 17 1995	<.1	<.005	.003	.048	<.001	.36	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.8	<.003	<.5	<.04	.022
M2-GU	Oct 16 1995	Oct 17 1995	<.1	<.005	.002	.048	<.001	.29	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.8	<.003	<.5	<.04	.018
M3-GL	Jun 25 1995	Jun 25 1995	.21	<.005	<.002	.028	<.001	.091	<.005	<.005	<.04	.023	.23	.0057	<.01	<.01	<.0002	<.04	<.004	<.01	.72	<.003	<.5	<.04	<.01
M3-GL (Filtered)	Jun 25 1995	Jun 28 1995	<.1	<.005	<.002	.027	<.001	.082	<.005	<.005	<.04	<.02	.06	.0044	<.01	<.01	<.0002	<.04	<.004	<.01	.7	<.003	<.5	<.04	.043
M3-GL	Jul 13 1995	Jul 14 1995	<.1	<.005	<.002	.027	.002	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.024	<.0002	<.04	<.004	<.01	.71	<.003	<.5	<.04	.016
M3-GL (Filtered)	Jul 13 1995	Jul 17 1995	<.1	<.005	<.002	.027	.002	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	.043	<.004	<.01	.69	<.003	<.5	<.04	.018
M3-GL (Filtered)	Aug 15 1995	Aug 19 1995	<.1	<.005	.002	.024	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	.005	<.01	.79	<.003	<.5	<.04	<.01
M3-GL	Aug 15 1995	Aug 16 1995	<.1	<.005	.007	.026	<.001	<.2	.008	<.005	<.04	<.02	.14	<.002	<.01	<.01	<.0002	<.04	.042	<.01	.78	<.003	<.5	<.04	<.01
M3-GL	Sep 11 1995	Sep 12 1995	<.1	<.005	.004	.026	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.74	<.003	<.5	<.04	<.01
M3-GL	Sep 11 1995	Sep 12 1995	<.1	<.005	<.002	.025	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.73	<.003	<.5	<.04	<.01
M3-GL	Oct 16 1995	Oct 17 1995	<.1	<.005	<.002	.028	<.001	.22	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.8	<.003	<.5	<.04	.019
M4-O	Jun 25 1995	Jun 25 1995	1.1	<.005	<.002	.027	<.001	.21	<.005	<.005	<.04	<.02	.96	.0032	<.01	.072	<.0002	<.04	<.004	<.01	.43	<.003	<.5	<.04	.013
M4-O (Filtered)	Jun 25 1995	Jun 28 1995	<.1	<.005	<.002	.015	<.001	.22	<.005	<.005	<.04	<.02	.06	.0038	<.01	.068	<.0002	<.04	<.004	<.01	.4	<.003	<.5	<.04	.045
M4-O (Filtered)	Jul 13 1995	Jul 17 1995	<.1	<.005	<.002	.016	.002	.31	<.005	<.005	<.04	<.02	<.04	<.002	.022	.093	<.0002	<.04	<.004	<.01	.43	<.003	<.5	<.04	.024
M4-O	Jul 13 1995	Jul 14 1995	.39	<.005	<.002	.019	.002	.27	<.005	<.005	<.04	<.02	.31	<.002	.022	.077	<.0002	<.04	<.004	<.01	.45	<.003	<.5	<.04	.016
M4-O (Filtered)	Aug 15 1995	Aug 19 1995	<.1	<.005	<.002	.011	<.001	.28	.008	<.005	<.04	<.02	<.04	<.002	<.01	.085	<.0002	<.04	.005	<.01	.4	<.003	<.5	<.04	<.01
M4-O	Aug 15 1995	Aug 16 1995	.31	<.005	.002	.015	<.001	.25	.007	<.005	<.04	<.02	.36	<.002	.015	.067	<.0002	<.04	.009	<.01	.4	<.003	<.5	<.04	<.01
M4-O (Filtered)	Aug 15 1995	Aug 19 1995	<.1	<.005	.003	.011	<.001	.26	.008	<.005	<.04	<.02	<.04	<.002	<.01	.077	<.0002	<.04	.008	<.01	.41	<.003	<.5	<.04	<.01
M4-O	Aug 15 1995	Aug 16 1995	.25	.094	<.002	.014	<.001	.23	.014	<.005	<.04	<.02	.26	<.002	.014	.067	<.0002	<.04	.007	<.01	.41	<.003	<.5	<.04	<.01
M4-O	Sep 18 1995	Sep 19 1995	<.1	<.005	<.002	.019	<.001	.27	<.005	<.005	<.04	<.02	.06	<.002	.011	.044	<.0002	<.04	<.004	<.01	.57	<.003	<.5	<.04	<.01
M4-O	Oct 16 1995	Oct 17 1995	<.1	<.005	<.002	.021	<.001	.37	<.005	<.005	<.04	<.02	<.04	<.002	.015	.058	<.0002	<.04	<.004	.012	.67	<.003	<.5	<.04	.017
M5-S	Jul 24 1995	Jul 25 1995	.63	<.005	.006	.029	<.001	.74	<.005	.0083	<.04	<.02	6.7	<.002	.23	.15	<.0002	<.04	<.004	<.01	3.1	<.003	3.1	<.04	.021
M5-S (Filtered)	Jul 24 1995	Jul 27 1995	<.1	<.005	.003	.023	<.001	.74	<.005	<.005	<.04	<.02	.72	<.002	.14	.14	<.0002	<.04	<.004	<.01	.93	<.003	<.5	<.04	<.01

Table 4.5-2 Summary of Analytical Results, Trace Metals [a]

Sample ID	Sampled	Analyzed	AL	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Hg	Ni	Se	Ag	Sr	Tl	Sn	V	Zn
M5-S (Filtered)	Aug 18 1995	Aug 24 1995	<.1	<.005	<.002	.008	<.001	.62	<.005	<.005	<.04	<.02	11.	<.002	.24	.055	<.0002	<.04	<.004	<.01	.089	<.003	<.5	<.04	.028
M5-S	Aug 18 1995	Aug 19 1995	.18	<.005	<.002	.008	<.001	.68	<.005	<.005	<.04	<.02	14.	<.002	.28	.09	<.0002	<.04	<.004	<.01	.086	<.003	<.5	<.04	.015
M5-S	Sep 19 1995	Sep 20 1995	.11	<.005	<.002	.006	<.001	.57	<.005	<.005	<.04	<.02	4.9	<.002	.11	.072	<.0002	<.04	<.004	<.01	.047	<.003	<.5	<.04	<.01
M5-S (Filtered)	Oct 17 1995	Oct 18 1995	<.1	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.08	NA	.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	.027
M5-S (Filtered)	Oct 17 1995	Oct 18 1995	<.1	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.07	NA	.011	NA	NA	NA	NA	NA	NA	NA	NA	NA	.028
M5-S	Oct 17 1995	Oct 18 1995	<.1	<.005	<.002	.006	<.001	.86	<.005	<.005	<.04	<.02	.08	<.002	<.01	.082	<.0002	<.04	<.004	<.01	.082	<.003	<.5	<.04	.015
M5-S	Oct 17 1995	Oct 18 1995	<.1	<.005	<.002	.007	<.001	.76	<.005	<.005	<.04	<.02	.06	<.002	.012	.079	<.0002	<.04	<.004	<.01	.079	<.003	<.5	<.04	.015
M6-GU	Jul 19 1995	Jul 20 1995	12.	<.005	.003	.1	<.001	<.2	<.005	.028	<.04	.083	11.	.0059	.29	.011	<.0002	<.04	<.004	<.01	.39	<.003	<.5	<.04	.05
M6-GU (Filtered)	Jul 19 1995	Jul 25 1995	<.1	<.005	<.002	.007	<.001	<.2	<.005	.012	<.04	<.02	.04	<.002	.04	.016	<.0002	<.04	<.004	<.01	.13	<.003	<.5	<.04	<.01
M6-GU	Aug 24 1995	Aug 25 1995	.16	<.005	<.002	.008	<.001	.076	<.005	.0079	<.04	<.02	.13	<.002	.024	<.01	.0005	<.04	<.004	<.01	.13	<.003	<.5	<.04	.012
M6-GU (Filtered)	Aug 24 1995	Aug 30 1995	<.1	<.005	<.002	.007	<.001	.071	<.005	.0069	<.04	<.02	<.04	<.002	.022	<.01	.0002	<.04	<.004	<.01	.13	<.003	<.5	<.04	<.01
M6-GU	Sep 19 1995	Sep 21 1995	<.1	<.005	<.002	.008	<.001	<.2	<.005	.0086	<.04	<.02	<.04	<.002	.021	<.01	<.0002	<.04	<.004	<.01	.13	<.003	<.5	<.04	<.01
M6-GU	Oct 18 1995	Oct 19 1995	<.1	<.005	<.002	.008	<.001	<.2	<.005	.0089	<.04	<.02	.07	<.002	.02	<.01	<.0002	<.04	<.004	<.01	.14	<.003	<.5	<.04	.13
M6-GU (Filtered)	Oct 18 1995	Oct 19 1995	.17	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.22	NA	.02	NA	NA	NA	NA	NA	NA	NA	NA	NA	.45
M7-GL (Filtered)	Aug 22 1995	Aug 25 1995	<.1	<.005	<.002	.013	<.001	.14	<.005	<.005	<.04	<.02	.04	<.002	.01	.042	<.0002	<.04	<.004	<.01	.061	<.003	<.5	<.04	.014
M7-GL	Aug 22 1995	Aug 23 1995	.15	<.005	<.002	.015	<.001	.16	<.005	.014	<.04	<.02	7.2	.0024	.094	.032	<.0002	<.04	<.004	<.01	.072	<.003	<.5	<.04	.27
M7-GL	Sep 19 1995	Sep 20 1995	.18	<.005	<.002	.008	<.001	<.2	<.005	<.005	<.04	<.02	6.2	.0041	.17	.035	<.0002	<.04	<.004	<.01	.048	<.003	<.5	<.04	.018
M7-GL (Filtered)	Oct 19 1995	Oct 20 1995	.14	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.12	NA	<.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	.28
M7-GL	Oct 19 1995	Oct 20 1995	.17	<.005	.003	.018	<.001	<.2	<.005	<.005	<.04	<.02	.15	<.002	<.01	.033	<.0002	<.04	<.004	<.01	.059	<.003	<.5	<.04	.17
M8-O (Filtered)	Jul 23 1995	Jul 27 1995	<.1	<.005	<.002	.007	<.001	.32	<.005	<.005	<.04	<.02	.2	<.002	.019	.12	<.0002	<.04	<.004	<.01	<.007	<.003	<.5	<.04	<.01
M8-O	Jul 23 1995	Jul 25 1995	.11	<.005	<.002	.009	<.001	.32	<.005	<.005	<.04	<.02	1.9	<.002	.04	.12	<.0002	<.04	<.004	<.01	.22	<.003	<.5	<.04	<.01
M8-O	Aug 22 1995	Aug 24 1995	<.1	<.005	<.002	<.005	<.001	.34	<.005	.0055	<.04	<.02	.12	<.002	.01	.13	<.0002	<.04	<.004	<.01	.022	<.003	<.5	<.04	<.01
M8-O (Filtered)	Aug 22 1995	Aug 30 1995	<.1	<.005	<.002	.005	<.001	.34	<.005	.014	<.04	<.02	.08	<.002	.011	.13	<.0002	<.04	.005	<.01	.022	<.003	<.5	<.04	NA
M8-O	Sep 15 1995	Sep 16 1995	<.1	<.005	<.002	<.005	<.001	.34	<.005	.015	<.04	<.02	.11	<.002	.01	.13	<.0002	<.04	.006	<.01	.023	<.003	<.5	<.04	<.01
M8-O	Sep 15 1995	Sep 16 1995	<.1	<.005	<.002	<.005	<.001	.37	<.005	.012	<.04	<.02	<.04	<.002	<.01	.15	<.0002	<.04	.005	<.01	.025	<.003	<.5	<.04	<.01
M8-O (Filtered)	Oct 18 1995	Oct 19 1995	.23	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.19	NA	<.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	.58
M8-O	Oct 18 1995	Oct 19 1995	<.1	<.005	<.002	<.005	<.001	.37	<.005	.0076	<.04	<.02	.07	<.002	<.01	.13	<.0002	<.04	.005	<.01	.025	<.003	<.5	<.04	.14
M9-S (Filtered)	Aug 23 1995	Aug 30 1995	.26	<.005	<.002	.074	<.001	1.1	<.005	.0082	<.04	.058	24.	.005	.16	.33	<.0002	<.04	<.004	<.01	2.	<.003	<.5	<.04	NA
M9-S	Aug 23 1995	Aug 24 1995	.39	<.005	<.002	.073	<.001	1.1	<.005	.0098	<.04	.076	38.	.0062	.26	.36	<.0002	<.04	<.004	<.01	2.	<.003	<.5	<.04	.58
M9-S	Sep 22 1995	Sep 23 1995	<.1	<.005	<.002	.047	<.001	.98	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.36	<.0002	<.04	<.004	<.01	2.1	<.003	<.5	<.04	<.01
M9-S (Filtered)	Oct 19 1995	Oct 20 1995	.21	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.31	NA	<.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	.3
M9-S (Filtered)	Oct 19 1995	Oct 20 1995	.21	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.13	NA	<.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	.36

Table 4.5-2 Summary of Analytical Results, Trace Metals [a]																									
Sample ID	**Sampled**	**Analyzed**	**AL**	**Sb**	**As**	**Ba**	**Be**	**B**	**Cd**	**Cr**	**Co**	**Cu**	**Fe**	**Pb**	**Mn**	**Mo**	**Hg**	**Ni**	**Se**	**Ag**	**Sr**	**Tl**	**Sn**	**V**	**Zn**
M9-S	Oct 19 1995	Oct 20 1995	<.1	<.005	<.002	.079	<.001	1.1	<.005	<.005	<.04	<.02	.08	<.002	<.01	.5	<.0002	<.04	<.004	<.01	2.4	<.003	<.5	<.04	.12
M9-S	Oct 19 1995	Oct 20 1995	.25	<.005	<.002	.082	<.001	1.1	<.005	<.005	<.04	<.02	.11	<.002	<.01	.51	<.0002	<.04	<.004	<.01	2.5	<.003	<.5	<.04	.28
M10-GU (Filtered)	Jun 22 1995	Jun 28 1995	<.1	<.005	<.002	.082	<.001	.16	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.3	<.003	<.5	<.04	<.01
M10-GU	Jun 22 1995	Jun 23 1995	<.1	<.005	<.002	.078	<.001	.16	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.2	<.003	<.5	<.04	<.01
M10-GU	Jul 12 1995	Jul 13 1995	<.1	<.005	<.002	.076	<.001	.15	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.3	<.003	<.5	<.04	<.01
M10-GU (Filtered)	Jul 12 1995	Jul 14 1995	<.1	<.005	<.002	.075	<.001	.15	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.3	<.003	<.5	<.04	<.01
M10-GU	Aug 16 1995	Aug 17 1995	<.1	<.005	.003	.072	<.001	.23	.013	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	.007	<.01	1.3	<.003	<.5	<.04	<.01
M10-GU (Filtered)	Aug 16 1995	Aug 19 1995	<.1	<.005	.003	.07	<.001	<.2	.008	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.3	<.003	<.5	<.04	<.01
M10-GU	Sep 12 1995	Sep 13 1995	<.1	<.005	<.002	.08	<.001	<.2	<.005	.0019	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.4	<.003	<.5	<.04	.013
M10-GU	Oct 17 1995	Oct 18 1995	<.1	<.005	.002	.083	<.001	.29	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.4	<.003	<.5	<.04	.014
M11-GL	Jun 23 1995	Jun 24 1995	4.8	<.005	<.002	.076	<.001	.11	<.005	.015	<.04	.11	5.9	.016	.1	<.01	<.0002	<.04	<.004	<.01	.77	<.003	<.5	<.04	.046
M11-GL (Filtered)	Jun 23 1995	Jun 28 1995	<.1	<.005	<.002	.037	<.001	.098	<.005	<.005	<.04	<.02	<.04	.003	<.01	<.01	<.0002	<.04	<.004	<.01	.7	<.003	<.5	<.04	.021
M11-GL	Jun 23 1995	Jun 24 1995	3.	<.005	.002	.062	<.001	.098	<.005	.015	<.04	.078	3.7	.0051	.07	<.01	<.0002	<.04	<.004	<.01	.75	<.003	<.5	<.04	.097
M11-GL (Filtered)	Jun 23 1995	Jun 28 1995	<.1	<.005	.005	.037	<.001	.096	<.005	<.005	<.04	<.02	<.04	.0021	<.01	<.01	<.0002	<.04	<.004	<.01	.7	<.003	<.5	<.04	<.01
M11-GL	Jul 19 1995	Jul 20 1995	.24	<.005	<.002	.038	<.001	<.2	<.005	.0073	<.04	<.02	.31	<.002	.014	<.01	<.0002	<.04	<.004	<.01	.74	<.003	<.5	<.04	.013
M11-GL	Jul 19 1995	Jul 20 1995	.34	<.005	<.002	.039	<.001	<.2	<.005	.0056	<.04	<.02	.46	<.002	.016	<.01	<.0002	<.04	<.004	<.01	.72	<.003	<.5	<.04	.011
M11-GL (Filtered)	Jul 19 1995	Jul 25 1995	<.1	<.005	<.002	.033	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.7	<.003	<.5	<.04	.015
M11-GL (Filtered)	Jul 19 1995	Jul 25 1995	<.1	<.005	<.002	.033	<.001	<.2	<.005	<.005	<.04	<.02	.05	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.7	<.003	<.5	<.04	.018
M11-GL	Aug 16 1995	Aug 17 1995	<.1	<.005	<.002	.034	<.001	<.2	.01	<.005	<.04	<.02	.05	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.74	<.003	<.5	<.04	<.01
M11-GL (Filtered)	Aug 16 1995	Aug 19 1995	<.1	<.005	.004	.032	<.001	<.2	.01	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	.007	<.01	.75	<.003	<.5	<.04	<.01
M11-GL	Sep 12 1995	Sep 13 1995	<.1	<.005	<.002	.036	<.001	<.2	<.005	.0026	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.77	<.003	<.5	<.04	<.01
M11-GL	Oct 17 1995	Oct 18 1995	<.1	<.005	<.002	.037	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.76	<.003	<.5	<.04	.022
M12-O (Filtered)	Jun 24 1995	Jun 28 1995	<.1	<.005	<.002	.031	<.001	.077	<.005	<.005	<.04	<.02	<.04	.0045	.049	<.01	<.0002	<.04	<.004	<.01	.56	<.003	<.5	<.04	<.01
M12-O	Jun 24 1995	Jun 24 1995	4.4	<.005	.003	.06	<.001	.084	<.005	.0063	<.04	.5	5.3	.015	.23	<.01	<.0002	<.04	<.004	<.01	.6	<.003	<.5	<.04	<.01
M12-O	Jul 12 1995	Jul 13 1995	6.3	<.005	.003	.072	<.001	.066	<.005	.0088	<.04	.77	7.3	.007	.3	<.01	<.0002	<.04	<.004	<.01	.62	<.003	<.5	<.04	<.01
M12-O (Filtered)	Jul 12 1995	Jul 14 1995	<.1	<.005	.002	.029	<.001	.06	<.005	.011	<.04	<.02	<.04	<.002	.032	<.01	<.0002	<.04	<.004	<.01	.55	<.003	<.5	<.04	<.01
M12-O	Aug 16 1995	Aug 17 1995	<.1	<.005	.004	.027	<.001	<.2	.007	<.005	<.04	<.02	.09	<.002	.011	<.01	<.0002	<.04	<.004	<.01	.58	<.003	<.5	<.04	<.01
M12-O (Filtered)	Aug 16 1995	Aug 19 1995	<.1	<.005	.003	.025	<.001	<.2	.011	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.59	<.003	<.5	<.04	<.01
M12-O (Filtered)	Aug 16 1995	Aug 19 1995	<.1	<.005	.003	.026	<.001	<.2	.017	<.005	<.04	<.02	<.04	<.002	.011	<.01	<.0002	<.04	<.004	<.01	.61	<.003	<.5	<.04	<.01
M12-O	Aug 16 1995	Aug 17 1995	<.1	<.005	.003	.026	<.001	<.2	.008	<.005	<.04	<.02	.09	<.002	.013	<.01	<.0002	<.04	<.004	<.01	.59	<.003	<.5	<.04	<.01
M12-O	Sep 12 1995	Sep 13 1995	<.1	<.005	.002	.03	<.001	<.2	<.005	.0026	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.61	<.003	<.5	<.04	.011
M12-O	Oct 17 1995	Oct 18 1995	<.1	<.005	<.002	.031	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.58	<.003	<.5	<.04	.034

Table 4.5-2 Summary of Analytical Results, Trace Metals [a]

Sample ID	Sampled	Analyzed	AL	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Hg	Ni	Se	Ag	Sr	Tl	Sn	V	Zn
M13-S	Jul 28 1995	Jul 29 1995	.13	<.005	<.002	.067	<.001	1.1	.012	.0056	<.04	.045	9.4	<.002	.076	.2	<.0002	<.04	<.004	<.01	3.6	<.003	<.5	<.04	.099
M13-S (Filtered)	Jul 28 1995	Aug 01 1995	<.1	<.005	<.002	.059	<.001	.68	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.45	<.0002	<.04	<.004	<.01	3.8	<.003	<.5	<.04	.018
M13-S	Aug 22 1995	Aug 23 1995	<.1	<.005	<.002	.083	<.001	.56	<.005	<.005	<.04	<.02	2.6	<.002	.026	.31	<.0002	<.04	<.004	<.01	4.4	<.003	<.5	<.04	<.01
M13-S (Filtered)	Aug 22 1995	Aug 25 1995	<.1	<.005	<.002	.027	<.001	.78	<.005	<.005	<.04	<.02	.19	<.002	.055	.47	<.0002	<.04	<.004	<.01	3.9	<.003	<.5	<.04	<.01
M13-S	Sep 19 1995	Sep 20 1995	<.1	<.005	<.002	.042	<.001	.56	<.005	<.005	<.04	<.02	2.	.0029	.025	.34	<.0002	<.04	<.004	<.01	4.5	<.003	<.5	<.04	<.01
M13-S	Oct 18 1995	Oct 19 1995	<.1	<.005	<.002	.037	<.001	.68	<.005	<.005	<.04	<.02	.08	<.002	<.01	.36	<.0002	<.04	<.004	<.01	4.9	<.003	<.5	<.04	.1
M13-S	Oct 18 1995	Oct 19 1995	<.1	<.005	<.002	.034	<.001	.68	<.005	<.005	<.04	<.02	.09	<.002	<.01	.35	<.0002	<.04	<.004	<.01	4.7	<.003	<.5	<.04	.097
M13-S (Filtered)	Oct 18 1995	Oct 19 1995	.15	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.09	NA	<.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	.22
M13-S (Filtered)	Oct 18 1995	Oct 19 1995	.13	NA	NA	NA	NA	NA	NA	NA	NA	<.02	.11	NA	<.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	.26
M14-GL	Jul 17 1995	Jul 19 1995	2.7	<.005	<.002	.046	<.001	<.2	<.005	.0055	<.04	.066	3.2	<.002	.081	<.01	<.0002	<.04	<.004	<.01	.4	<.003	<.5	<.04	.15
M14-GL (Filtered)	Jul 17 1995	Jul 24 1995	<.1	<.005	<.002	.021	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	.025	.019	<.0002	<.04	<.004	<.01	.33	<.003	<.5	<.04	.024
M14-GL (Filtered)	Aug 16 1995	Aug 19 1995	<.1	<.005	.003	.019	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.016	<.0002	<.04	.011	.013	.33	<.003	<.5	<.04	<.01
M14-GL	Aug 16 1995	Aug 17 1995	2.	<.005	.002	.033	<.001	<.2	.01	<.005	<.04	.048	2.4	<.002	.057	<.01	<.0002	<.04	<.004	<.01	.38	<.003	<.5	<.04	.045
M14-GL	Sep 13 1995	Sep 13 1995	<.1	<.005	<.002	.019	<.001	<.2	<.005	.0038	<.04	<.02	.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.31	<.003	<.5	<.04	<.01
M14-GL	Oct 20 1995	Oct 21 1995	<.1	<.005	<.002	.017	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.34	<.003	<.5	<.04	.021
M15-GU	Jul 24 1995	Jul 25 1995	.56	<.005	<.002	.017	<.001	<.2	<.005	.012	<.04	<.02	.83	<.002	.024	<.01	<.0002	<.04	<.004	<.01	.042	<.003	<.5	<.04	.012
M15-GU (Filtered)	Jul 24 1995	Jul 27 1995	<.1	<.005	<.002	.011	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.032	<.003	<.5	<.04	<.01
M15-GU (Filtered)	Aug 16 1995	Aug 19 1995	<.1	<.005	.003	.007	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.012	<.0002	<.04	.023	<.01	.99	<.003	<.5	<.04	.013
M15-GU	Aug 16 1995	Aug 17 1995	<.1	<.005	.002	.006	<.001	<.2	.011	<.005	<.04	<.02	.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.98	<.003	<.5	<.04	<.01
M15-GU	Sep 13 1995	Sep 13 1995	<.1	<.005	<.002	.008	<.001	<.2	<.005	.0026	<.04	<.02	.05	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.91	<.003	<.5	<.04	.014
M15-GU	Oct 20 1995	Oct 21 1995	<.1	<.005	<.002	.007	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.95	<.003	<.5	<.04	.025
M16-GU	Jul 17 1995	Jul 18 1995	<.1	<.005	<.002	.014	<.001	<.2	<.005	<.005	<.04	<.02	.1	<.002	.06	.017	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	.046
M16-GU (Filtered)	Jul 17 1995	Jul 24 1995	.15	<.005	<.002	.016	<.001	<.2	<.005	<.005	<.04	<.02	2.3	<.002	.071	.026	<.0002	<.04	<.004	<.01	1.1	<.003	<.5	<.04	.18
M16-GU (Filtered)	Jul 17 1995	Jul 24 1995	<.1	<.005	<.002	.014	<.001	<.2	<.005	<.005	<.04	<.02	.1	<.002	.06	.014	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	.041
M16-GU	Jul 17 1995	Jul 18 1995	.13	<.005	<.002	.015	<.001	<.2	<.005	<.005	<.04	<.02	2.6	<.002	.069	.03	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	.21
M16-GU	Aug 17 1995	Aug 18 1995	<.1	<.005	<.002	.009	<.001	.11	<.005	<.005	<.04	<.02	.57	<.002	.028	<.01	<.0002	<.04	<.004	<.01	.94	<.003	<.5	<.04	<.01
M16-GU (Filtered)	Aug 17 1995	Aug 24 1995	<.1	<.005	<.002	.009	<.001	.11	<.005	<.005	<.04	<.02	.17	<.002	.026	<.01	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	<.01
M16-GU	Sep 14 1995	Sep 15 1995	<.1	<.005	<.002	.011	<.001	<.2	<.005	.0012	<.04	<.02	.17	<.002	.024	<.01	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	<.01
M16-GU	Oct 19 1995	Oct 20 1995	.27	<.005	<.002	.012	<.001	<.2	<.005	<.005	<.04	<.02	.33	<.002	.031	<.01	<.0002	<.04	<.004	<.01	1.1	<.003	<.5	<.04	.3
M17-GL (Filtered)	Jul 17 1995	Jul 24 1995	<.1	<.005	<.002	.007	<.001	.26	<.005	<.005	<.04	<.02	.05	<.002	.1	.076	<.0002	<.04	.005	<.01	.19	<.003	<.5	<.04	.022
M17-GL	Jul 17 1995	Jul 19 1995	2.3	<.005	<.002	.043	<.001	.22	<.005	.0062	<.04	.12	3.9	.0042	.2	.062	<.0002	<.04	<.004	<.01	.25	<.003	<.5	<.04	.17
M17-GL	Aug 17 1995	Aug 18 1995	1.6	<.005	.002	.033	<.001	.21	<.005	.0084	<.04	.06	1.8	<.002	.11	.045	<.0002	<.04	<.004	<.01	.21	<.003	<.5	<.04	.021

Table 4.5-2 Summary of Analytical Results, Trace Metals [a]

Sample ID	Sampled	Analyzed	AL	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Hg	Ni	Se	Ag	Sr	Tl	Sn	V	Zn
M17-GL (Filtered)	Aug 17 1995	Aug 24 1995	<.1	<.005	<.002	.006	<.001	.21	<.005	<.005	<.04	<.02	<.04	<.002	.079	.049	<.0002	<.04	<.004	<.01	.18	<.003	<.5	<.04	<.01
M17-GL	Aug 17 1995	Aug 18 1995	2.	<.005	<.002	.06	<.001	.21	<.005	.0094	<.04	.064	2.	.0023	.12	.05	<.0002	<.04	<.004	<.01	.22	<.003	<.5	<.04	.022
M17-GL (Filtered)	Aug 17 1995	Aug 24 1995	<.1	<.005	<.002	.007	<.001	.21	<.005	<.005	<.04	<.02	<.04	.0041	.082	.054	<.0002	<.04	<.004	<.01	.18	<.003	<.5	<.04	<.01
M17-GL	Sep 20 1995	Sep 21 1995	<.1	<.005	.007	.016	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	.061	<.01	<.0002	<.04	<.004	<.01	.86	<.003	<.5	<.04	<.01
M18-GU	Jul 14 1995	Jul 15 1995	.12	<.005	<.002	.046	<.001	.25	<.005	<.005	<.04	<.02	.21	<.002	.023	<.01	<.0002	<.04	<.004	<.01	.66	<.003	<.5	<.04	.035
M18-GU (Filtered)	Jul 14 1995	Jul 18 1995	<.1	<.005	<.002	.043	<.001	.23	<.005	<.005	<.04	<.02	<.04	<.002	.02	.015	<.0002	<.04	<.004	<.01	.63	<.003	<.5	<.04	.033
M18-GU	Aug 14 1995	Aug 15 1995	<.1	<.005	.003	.042	<.001	.15	<.005	<.005	<.04	<.02	.12	<.002	<.01	<.01	<.0002	<.04	.01	<.01	.59	<.003	<.5	<.04	.015
M18-GU (Filtered)	Aug 14 1995	Aug 17 1995	<.1	<.005	<.002	.043	<.001	.15	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.6	<.003	<.5	<.04	.012
M18-GU	Sep 13 1995	Sep 13 1995	<.1	<.005	<.002	.046	<.001	<.2	<.005	.0028	<.04	<.02	<.04	<.002	.011	<.01	<.0002	<.04	<.004	<.01	.66	<.003	<.5	<.04	<.01
M18-GU	Oct 20 1995	Oct 21 1995	<.1	<.005	<.002	.039	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.011	<.0002	<.04	<.004	<.01	.66	<.003	<.5	<.04	.011
M18-GU	Oct 20 1995	Oct 21 1995	<.1	<.005	<.002	.04	<.001	<.2	<.005	<.005	<.04	<.02	.08	<.002	<.01	<.01	<.0002	<.04	<.004	.019	.66	<.003	<.5	<.04	.01
P8-1-O	Oct 24 1995	Oct 25 1995	<.1	<.005	<.002	.01	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.036	<.0002	<.04	<.004	<.01	.32	<.003	<.5	<.04	.036
P8-GU	Sep 20 1995	Sep 21 1995	<.1	<.005	.002	.12	<.001	.22	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.3	<.003	<.5	<.04	<.01
P8-GU	Oct 24 1995	Oct 25 1995	<.1	<.005	<.002	.12	<.001	.25	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.4	<.003	<.5	<.04	.025
P8-GU	Oct 24 1995	Oct 25 1995	<.1	<.005	.002	.12	<.001	.25	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.4	<.003	<.5	<.04	.017
P28-1-O	Oct 23 1995	Oct 24 1995	<.1	<.005	.003	.029	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.012	<.0002	<.04	<.004	<.01	.47	<.003	<.5	<.04	.03
P28-GL	Sep 20 1995	Sep 21 1995	<.1	<.005	<.002	.051	<.001	<.2	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.93	<.003	<.5	<.04	<.01
P28-GL	Oct 23 1995	Oct 24 1995	<.1	<.005	<.002	.053	<.001	.23	<.005	<.005	<.04	<.02	.2	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.92	<.003	<.5	<.04	.019
P28-GL	Oct 23 1995	Oct 24 1995	<.1	<.005	<.002	.053	<.001	.05	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	.94	<.003	<.5	<.04	.018
PW7-1	Jun 16 1995	Jun 22 1995	<.1	<.005	<.002	.026	<.001	.26	.01	<.005	<.04	<.02	<.04	<.002	<.01	.096	<.0002	<.04	<.004	<.01	.62	<.003	<.5	<.04	<.01
PW7-1	Jun 21 1995	Jun 22 1995	<.1	<.005	<.002	.025	<.001	.22	<.005	<.005	<.04	<.02	<.04	<.002	<.01	.097	<.0002	<.04	<.004	<.01	.61	<.003	<.5	<.04	.011
WTANK (Filtered)	Jun 27 1995	Jul 03 1995	<.1	<.005	<.002	.073	<.001	.13	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.4	<.003	<.5	<.04	.036
WTANK (Filtered)	Jun 27 1995	Jul 03 1995	<.1	<.005	.002	.074	<.001	.14	.007	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.4	<.003	<.5	<.04	.033
WTANK	Jun 27 1995	Jun 28 1995	<.1	<.005	<.002	.076	<.001	.17	<.005	<.005	<.04	<.02	.09	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.4	<.003	<.5	<.04	.047
WTANK	Jun 27 1995	Jun 28 1995	<.1	<.005	.003	.075	<.001	.16	<.005	<.005	<.04	<.02	.05	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.4	<.003	<.5	<.04	.044
WTANK	Jul 11 1995	Jul 12 1995	<.1	<.005	<.002	.083	<.001	.28	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.6	<.003	<.5	<.04	<.01
WTANK (Filtered)	Jul 11 1995	Jul 13 1995	<.1	<.005	<.002	.078	<.001	.25	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.5	<.003	<.5	<.04	<.01
WTANK (Filtered)	Aug 14 1995	Aug 17 1995	<.1	<.005	.003	.071	<.001	.25	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.2	<.003	<.5	<.04	<.01
WTANK	Aug 14 1995	Aug 15 1995	<.1	<.005	.003	.072	<.001	.26	<.005	<.005	<.04	<.02	.08	<.002	<.01	<.01	<.0002	<.04	.005	<.01	1.3	<.003	<.5	<.04	.011
WTANK	Sep 12 1995	Sep 13 1995	<.1	<.005	<.002	.065	<.001	.26	<.005	.0017	<.04	<.02	.05	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.3	<.003	<.5	<.04	.022
WTANK	Oct 16 1995	Oct 17 1995	<.1	<.005	<.002	.058	<.001	.33	<.005	<.005	<.04	<.02	.06	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.2	<.003	<.5	<.04	.021
WW3	Jun 23 1995	Jun 24 1995	<.1	<.005	<.002	.066	<.001	.14	<.005	<.005	<.04	<.02	<.04	.0032	<.01	<.01	<.0002	<.04	<.004	<.01	.98	<.003	<.5	<.04	<.01

Table 4.5-2 Summary of Analytical Results, Trace Metals [a]

Sample ID	Sampled	Analyzed	AL	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Hg	Ni	Se	Ag	Sr	Tl	Sn	V	Zn
WW3 (Filtered)	Jun 23 1995	Jun 28 1995	<.1	<.005	<.002	.065	<.001	.15	<.005	<.005	<.04	<.02	<.04	.011	<.01	<.01	<.0002	<.04	<.004	<.01	.97	<.003	<.5	<.04	<.01
WW3	Jul 11 1995	Jul 12 1995	<.1	<.005	<.002	.062	<.001	.13	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	<.01
WW3 (Filtered)	Jul 11 1995	Jul 13 1995	<.1	<.005	<.002	.06	<.001	.12	<.005	<.005	<.04	<.02	<.04	<.002	<.01	<.01	<.0002	<.04	<.004	<.01	1.	<.003	<.5	<.04	<.01
Standard Detection Limit			0.5	0.006	0.005	0.05	0.004	0.05	0.005	0.005	0.05	0.05	0.05	0.005	0.05	0.05	0.002	0.05	0.01	0.05	0.05	0.002	0.05	0.05	0.05
Drinking Water - Primary Standard Limit			N	0.01	0.05	1.0	N	N	0.01	0.05	N	N	N	0.05	N	N	0.002	N	0.01	0.05	N	N	N	N	N

Concentration in milligram/liter.

Despite the use of trailing zeros in some data, no result has more than two significant figures.

< is less than the reported detection limit.

NA - Not Analyzed

N - Not Applicable

Al - Aluminum
Sb - Antimony
As - Arsenic
Ba - Barium
Be - Beryllium
B - Boron
Cd - Cadmium
Cr - Chromium
Co - Cobalt
Cu - Copper
Fe - Iron
Pb - Lead
Mn - Manganese
Mo - Molybdenum
Hg - Mercury
Ni - Nickel
Se - Selenium
Ag - Silver
Sr - Strontium
Tl - Thallium
Sn - Tin
V - Vanadium
Zn - Zinc

Table 4.5-3 Summary of Analytical Results - Organics

Sample ID	Sampled	Analyzed	1,2,3-TClBnz	1,2,4-TClBnz	1,2-DiBr-3-ClPro	Ace	b2-Et-Hxl Phth	Bnz Acid	Bnz	Iso Prop Bnz	BuBnxl Phth	ClMeth	DiMeth Phth	HexClBu	Naph	Phen	Tol	TPH	TRPH	CDiS	MethKey	m,p-Xyl	MethBu Key
M1-GL	Aug 14 1995	Aug 17 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	1.3	< 2.	< 10.	< .5	< 4.
M1-GL	Sep 13 1995	Sep 17 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.35	< 2.	< 10.	< .5	< 4.
M1-GL	Sep 13 1995	Sep 17 1995	< .5	< .5	< 2.	< 10	< 7.	< 50	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.22	< 2.	< 10.	< .5	< 4.
M2-GU	Jun 24 1995	Jun 29 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.4	NA	NA	NA	NA
M2-GU	Jul 13 1995	Jul 18 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.6	NA	NA	NA	NA
M2-GU	Jul 13 1995	Jul 18 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	.06	.5	NA	NA	NA	NA
M2-GU	Aug 15 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	3.4	< 2.	< 10.	< .5	< 4.
M2-GU	Sep 11 1995	Sep 14 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.3	< 2.	< 10.	< .5	< 4.
M3-GL	Jun 25 1995	Jun 29 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.36	NA	NA	NA	NA
M3-GL	Jul 13 1995	Jul 18 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.28	NA	NA	NA	NA
M3-GL	Aug 15 1995	Aug 18 1995	< .5	< .5	< 2.	< 10	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.44	< 2	< 10	< .5	< 4.
M3-GL	Sep 11 1995	Sep 14 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.22	< 2.	< 10.	< .5	< 4.
M3-GL	Sep 11 1995	Sep 14 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	1.1	< 2.	< 10.	< .5	< 4.
M4-O	Aug 15 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.28	< 2.	< 10.	< .5	< 4.
M4-O	Aug 15 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	3.1	< 2.	< 10.	< .5	< 4.
M4-O	Sep 18 1995	Sep 20 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	.16	< .5	< .05	.64	< 2.	< 10.	< .5	< 4.
M5-S	Aug 18 1995	Aug 23 1995	< 3.	< 3.	< 10.	390.	< 7.	< 50.	< 3.	< 3.	< 5.	< 3.	7.9	< 3.	< 3.	< .05	< 3.	.71	1.3	< 10.	< 50.	< 3.	< 20
M5-S	Sep 19 1995	Sep 25 1995	< .5	< .5	< 2.	160.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	.85	.54	< 2.	80.	< .5	< 4.
M6-GU	Jul 19 1995	Jul 22 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	< .2	NA	NA	NA	NA
M6-GU	Aug 24 1995	Aug 30 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.23	< 2.	< 10.	< .5	< 4.
M6-GU	Sep 19 1995	Sep 26 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	.11	.2	< 2.	< 10.	< .5	< 4.
M7-GL	Aug 22 1995	Aug 29 1995	< 1.	< 1.	< 4.	640.	< 7.	< 50.	< 1.	< 1.	< 5.	< 1.	< 5.	< 1.	< 1.	< .05	< 1.	.97	.46	< 4.	< 20.	< 1.	< 8
M7-GL	Sep 19 1995	Sep 25 1995	< .5	< .5	< 2.	190.	< 7.	< 50	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	.18	1.6	< 2.	16.	< .5	< 4.
M8-O	Jul 23 1995	Jul 29 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.31	NA	NA	NA	NA
M8-O	Aug 22 1995	Aug 29 1995	< .5	< .5	< 2.	140.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.38	< 2.	< 10.	< .5	< 4.
M8-O	Sep 15 1995	Sep 17 1995	< .5	< .5	< 2.	110.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	< .2	< 2.	10.	< .5	< 4.

Table 4.5-3 Summary of Analytical Results - Organics

Sample ID	Sampled	Analyzed	1,2,3-TClBnz	1,2,4-TClBnz	1,2-DiBr-3-ClPro	Ace	b2-Et-Hxl Phth	Bnz Acid	Bnz	Iso Prop Bnz	BuBnxl Phth	ClMeth	DiMeth Phth	HexClBu	Naph	Phen	Tol	TPH	TRPH	CDiS	MethKey	m,p-Xyl	MethBu Key
M8-O	Sep 15 1995	Sep 17 1995	< .5	< .5	< 2.	94.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5	< .5	< .5	< .05	< .5	.16	.21	< 2.	8.5	< .5	< 4.
M9-S	Aug 23 1995	Aug 29 1995	< .5	< .5	< 2.	130	< 7.	62.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	12	.78	.58	< 2.	< 10.	< .5	< 4
M9-S	Sep 22 1995	Sep 26 1995	.59	< .5	< 2.	140.	20.	< 50.	1.1	.63	5.6	< .5	< 5.	< .5	.73	.06	150.	.69	1.2	2.2	11.	.52	3.8
M10-GU	Jun 22 1995	Jun 29 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.8	NA	NA	NA	NA
M10-GU	Jul 12 1995	Jul 19 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.6	NA	NA	NA	NA
M10-GU	Aug 16 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	.06	< .5	< .05	< .2	< 2.	< 10.	< .5	< 4.
M10-GU	Sep 12 1995	Sep 17 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.21	< 2.	< 10.	< .5	< 4.
M11-GL	Jun 23 1995	Jun 29 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.85	NA	NA	NA	NA
M11-GL	Jun 23 1995	Jun 29 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.42	NA	NA	NA	NA
M11-GL	Aug 16 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.33	< 2.	< 10.	< .5	< 4
M11-GL	Sep 12 1995	Sep 17 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.35	< 2.	< 10.	< .5	< 4.
M12-O	Jun 24 1995	Jun 29 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	.77	NA	NA	NA	NA
M12-O	Aug 16 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.2	< 2.	< 10.	< .5	< 4.
M12-O	Aug 16 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	.08	< .5	< .05	< .2	< 2.	< 10.	< .5	< 4.
M12-O	Sep 12 1995	Sep 17 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.55	< 2.	< 10.	< .5	< 4.
M13-S	Aug 22 1995	Aug 29 1995	< .5	< .5	< 2.	21.	< 40.	530.	< .5	< .5	< 30.	.92	< 30.	< .5	< .5	< .05	< .5	.84	.56	< 2.	< .5	< .5	< 4.
M13-S	Sep 19 1995	Sep 25 1995	< .5	< .5	< 2.	60.	< 7.	150.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	.08	.59	1.1	.61	< 2.	110.	< .5	< 4.
M14-GL	Aug 16 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.3	< 2.	< 10.	< .5	< 4
M14-GL	Sep 13 1995	Sep 17 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.38	< 2.	< 10.	< .5	< 4.
M15-GU	Aug 16 1995	Aug 18 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.21	< 2.	< 10.	< .5	< 4.
M15-GU	Sep 13 1995	Sep 17 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.22	< 2.	< 10.	< .5	< 4.
M16-GU	Aug 17 1995	Aug 23 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	.07	< .5	< .05	.61	< 2.	< 10.	< .5	< 4.
M16-GU	Sep 14 1995	Sep 17 1995	< .5	< .5	< 2.	71.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.28	< 2.	< 10.	< .5	< 4.
M17-GL	Aug 17 1995	Aug 23 1995	1.8	1.2	2.4	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	1.	3.4	< .05	< .5	< .05	1.2	< 2.	< 10.	< .5	< 4.
M17-GL	Aug 17 1995	Aug 23 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	.57	< .05	< .5	< .05	.9	< 2.	< 10.	< .5	< 4.
M17-GL	Sep 20 1995	Sep 26 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	.13	.5	2.1	< 10.	< .5	< 4.

Table 4.5-3 Summary of Analytical Results - Organics

Sample ID	Sampled	Analyzed	1,2,3-TClBnz	1,2,4-TClBnz	1,2-DiBr-3-ClPro	Ace	b2-Et-Hxl Phth	Bnz Acid	Bnz	Iso Prop Bnz	BuBnxl Phth	ClMeth	DiMeth Phth	HexClBu	Naph	Phen	Tol	TPH	TRPH	CDiS	MethKey	m,p-Xyl	MethBu Key
M18-GU	Aug 14 1995	Aug 17 1995	.81	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	2.4	< .05	< .5	< .05	.26	< 2.	< 10.	< .5	< 4.
M18-GU	Sep 13 1995	Sep 17 1995	< .5	< .5	< 2.	< 10.	< 7.	< 50.	< .5	< .5	< 5.	< .5	< 5.	< .5	< .5	< .05	< .5	< .05	.21	< 2.	< 10.	< .5	< 4.
PW7-1	Jun 16 1995	Jun 24 1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< .05	< .5	NA	NA	NA	NA

Concentration in milligram/liter, except: Phenolics (milligram/liter; mg/L), TPH Deisel (mg/L), TRPH (mg/L).

Despite the use of trailing zeros in some data, no result has more than two significant figures.

< is less than the reported detection limit.

NA - Not Analyzed

For details of other organic analytes refer to Appendices.

1,2,3-TClBnz - 1,2,3-Trichlorobenzene
1,2,4-TClBnz - 1,2,4-Trichlorobenzene
1,2-DiBr-3-ClPro - 1,2-Dibromo-3-chloropropane
Ace - Acetone
b2-Et-Hxl Phth - Bis (2-ethylhexyl) phtalate
Bnz Acid - Benzoic Acid
Bnz - Benzene
Iso Prop Bnz - Isopropylbenzene
BuBnxl Phth - Butylbenzylphthalate
ClMeth - Chloromethane
DiMeth Phth - Dimethylphthalate
HexClBu - Hexachlorobutadiene
Naph - Naphthalene
Phen - Phenolics
Tol - Toluene
TPH Total Petroleum Hydrocarbons Diesel
TRPH
CDiS - Carbon Disulfide
MethKey Methylethyl Ketone
m,p-Xyl - m and p Xylene Isomers
MethBuKey - Methyl Isobutyl Ketone

Table 4.5-4 Summary of Analytical Results - Radiochemicals [a]

Sample ID	Sampled	Analyzed	ALPHA	BETA	Ra-226	Ra-228	Rn-222	U-234	U-235	U-238	U-Total	S.I.
M1-GL	14 Jul 1995	21 Jul 1995	20 +/- 13	16 +/- 7.4	< 0.6	< 2	112.2 +/- 11.8	2.19 +/- 0.62	< 0.6	1.48 +/- 0.5	0.006	315 to 355
M1-GL	14 Aug 1995	25 Aug 1995	0.63 +/- 3.5	10 +/- 5.6	< 0.6	< 3	261.2 +/- 39.6	3.31 +/- 1.05	< 0.6	1.94 +/- 0.88	0.011	315 to 355
M1-GL	13 Sep 1995	21 Sep 1995	7.0+/-3.0	3.0+/-1.0	< 0.6	< 2	159.4 +/- 16.9	3.71 +/- 1.52	< 0.6	2.29 +/- 1.22	0.011	315 to 355
M1-GL	13 Sep 1995	20 Sep 1995	< 3	< 3	< 0.6	< 2	245.6 +/- 26	5.59 +/- 1.08	< 0.6	3.98 +/- 0.9	0.006	315 to 355
M1-GL	20 Oct 1995	25 Oct 1995	1.7 +/- 40	5.7 +/- 47	-0.009 +/- 0.014	0.8 +/- 5.7	208 +/- 24	2.8 +/- 0.41	0.17 +/- 0.099	1.43 +/- 0.29	4.32 +/- 0.88	315 to 355
M2-GU	24 Jun 1995	01 Jul 1995	7.9 +/- 6.3	7.4 +/- 3.4	1.3 +/- 0.3	<1	146.2 +/- 11.9	4.56 +/- 1.43	<0.6	1.73 +/- 0.83	7.8 +/- 2	197.7 to 237.3
M2-GU	13 Jul 1995	20 Jul 1995	24 +/- 14	3.0 +/- 6.6	< 0.6	< 3	195.8 +/- 23.4	2.55 +/- 0.86	< 0.6	1.05 +/- 0.52	0.005	197.7 to 237.3
M2-GU	13 Jul 1995	20 Jul 1995	7.5 +/- 10	7.9 +/- 6.9	< 0.6	< 2	130.8 +/- 13.3	4.81 +/- 0.88	< 0.6	3.2 +/- 0.69	0.005	197.7 to 237.3
M2-GU	15 Aug 1995	23 Aug 1995	4.3 +/- 5.2	8.0 +/- 8.9	< 0.6	< 2	97.3 +/- 14	0.43 +/- 0.11	< 0.6	0.15 +/- 0.08	0.017	197.7 to 237.3
M2-GU	11 Sep 1995	14 Sep 1995	< 5	< 3	< 0.6	< 3	138.3 +/- 9.3	6.08 +/- 0.9	< 0.6	5.48 +/- 0.85	0.014	197.7 to 237.3
M2-GU	16 Oct 1995	20 Oct 1995	<4.5 +/- 24	<17 +/- 33	0.04 +/- 0.15	0.36 +/- 0.38	197 +/- 22	3.95 +/- 0.45	0.28 +/- 0.11	2.21 +/- 0.32	6.71 +/- 0.98	197.7 to 237.3
M2-GU	16 Oct 1995	20 Oct 1995	11 +/- 29	4.6 +/- 34	0.09 +/- 0.12	0.59 +/- 0.37	180 +/- 21	4.24 +/- 0.48	0.106 +/- 0.07	1.97 +/- 0.31	5.96 +/- 0.94	197.7 to 237.3
M3-GL	25 Jun 1995	01 Jul 1995	9.6 +/- 6.3	6.0 +/- 3.3	<0.6	12 +/- 2	177.4 +/- 11.8	4.34 +/- 1.47	<0.6	1.27 +/- 0.76	3.9 +/- 2.1	297.6 to 337.7
M3-GL	13 Jul 1995	27 Jul 1992	12 +/- 11	11 +/- 7.1	< 0.6	< 3	153 +/- 14.9	4.27 +/- 1.26	< 0.6	2.9 +/- 0.98	0.005	297.6 to 337.7
M3-GL	15 Aug 1995	24 Aug 1995	1.1 +/- 5.9	4.8 +/- 5.2	< 0.6	< 2	146.5 +/- 17.5	4.53 +/- 1.08	< 0.6	1.89 +/- 0.65	0.013	297.6 to 337.7
M3-GL	11 Sep 1995	15 Sep 1995	< 2	4.0+/-1	< 0.6	< 2	161 +/- 15	7.3 +/- 1.03	< 0.6	4.83 +/- 0.8	0.014	297.6 to 337.7
M3-GL	11 Sep 1995	15 Sep 1995	< 3	< 3	< 0.6	< 2	160.6 +/- 10.9	4.25 +/- 0.78	< 0.6	1.85 +/- 0.5	0.009	297.6 to 337.7
M3-GL	16 Oct 1995	20 Oct 1995	<12 +/- 20	33 +/- 36	0.12 +/- 0.17	0.38 +/- 0.39	196 +/- 22	4.31 +/- 0.49	0.087 +/- 0.068	1.31 +/- 0.25	3.96 +/- 0.76	297.6 to 337.7
M4-O	25 Jun 1995	01 Jul 1995	10 +/- 6.2	8.8 +/- 3.4	<0.6	<2	1351 +/- 30	2.79 +/- 1.14	<0.6	2.12 +/- 1	5.9 +/- 1.1	404.8 to 464.2
M4-O	13 Jul 1995	19 Jul 1995	9.8 +/- 9.9	15 +/- 7.3	< 0.6	< 3	1253.3 +/- 38.4	2.01 +/- 0.78	< 0.6	1.11 +/- 0.55	0.003	404.8 to 464.2
M4-O	15 Aug 1995	23 Aug 1995	2.2 +/- 4.9	8.1 +/- 8.9	< 0.6	< 2	1089.1 +/- 39.8	2.52 +/- 0.61	< 0.6	1.48 +/- 0.46	0.011	404.8 to 464.2
M4-O	15 Aug 1995	24 Aug 1995	0.92 +/- 5.1	3.5 +/- 5.0	< 0.6	< 2	2442.1 +/- 88.5	2.16 +/- 0.5	< 0.6	1.45 +/- 0.46	0.013	404.8 to 464.2
M4-O	18 Sep 1995	23 Sep 1995	12+/-3.0	< 3	< 0.6	< 2	1149.7 +/- 30.9	6.6 +/- 1.66	< 0.6	< 0.6	0.019	404.8 to 464.2
M4-O	16 Oct 1995	20 Oct 1995	7.4 +/- 27	<10 +/- 33	0.09 +/- 0.17	0.84 +/- 0.44	1032 +/- 49	5.56 +/- 0.57	0.37 +/- 0.13	4.31 +/- 0.49	13.1 +/- 1.5	404.8 to 464.2
M5-S	24 Jul 1995	30 Jul 1995	3.9 +/- 3.4	6.5 +/- 2.1	< 0.6	< 2	1607.3 +/- 47.9	1.12 +/- 0.42	< 0.6	0.9 +/- 0.37	0.003	516.4 to 576.1
M5-S	18 Aug 1995	31 Aug 1995	< 1.9 +/- 11	7.5 +/- 13	<0.6	<2	360.7 +/- 60.9	0.65 +/- 0.3	< 0.6	0.47 +/- 0.24	0.003	516.4 to 576.1
M5-S	19 Sep 1995	25 Sep 1995	< 2	4.0+/-1.0	< 0.6	< 2	13.8 +/- 8.2	0.92 +/- 0.64	< 0.6	0.51 +/- 0.49	0.012	516.4 to 576.1
M5-S	17 Oct 1995	20 Oct 1995	6.5 +/- 32	<31 +/- 44	0.15 +/- 0.11	0.04 +/- 0.35	24.5 +/- 7.8	0.233 + - 0.1	-0.013 +/- 0.015	0.117 +/- 0.075	0.35 +/- 0.23	516.4 to 576.1
M5-S	17 Oct 1995	20 Oct 1995	1.3 +/- 31	<42 +/- 42	1.54 +/- 0.42	0.5 +/- 0.42	57 +/- 11	0.6 +/- 0.17	0.082 +/- 0.064	0.23 +/- 0.11	0.7 +/- 0.33	516.4 to 576.1
M6-GU	19 Jul 1995	27 Jul 1995	10 +/- 7.3	19 +/- 4.4	< 0.6	3 +/- 2	734.8 +/- 32.9	0.29 +/- 0.09	< 0.6	0.17 +/- 0.06	0.002	524 to 562.5
M6-GU	24 Aug 1995	01 Sep 1995	2.1 +/- 15	10 +/- 13	1.1 +/- 0.6	< 3	949.4 +/- 7.9	2.33 +/- 0.46	< 0.6	1.38 +/- 0.35	< 0.007	524 to 562.5
M6-GU	19 Sep 1995	25 Sep 1995	< 2	4+/-1.0	< 0.6	< 1	933.4 +/- 30.9	0.86 +/- 0.77	< 0.6	0.67 +/- 0.6	0.006	524 to 562.5
M6-GU	18 Oct 1995	24 Oct 1995	<9.2 +/- 27	<24 +/- 44	0.21 +/- 0.2	0.14 +/- 0.4	988 +/- 58	0.41 +/- 0.14	0.044 +/- 0.047	0.24 +/- 0.11	0.72 +/- 0.33	524 to 562.5
M7-GL	22 Aug 1995	31 Aug 1995	14 +/- 20	14 +/- 14	< 0.6	< 1	442.3 +/- 69.2	1.13 +/- 0.43	< 0.6	1.04 +/- 0.48	< 0.002	859 to 918
M7-GL	19 Sep 1995	25 Sep 1995	< 2	< 3	< 0.6	< 2	751.4 +/- 46.8	6.43 +/- 1.04	< 0.6	7.44 +/- 1.13	0.006	859 to 918
M7-GL	19 Oct 1995	25 Oct 1995	41 +/- 41	32 +/- 50	0.005 +/- 0.013	0.12 +/- 0.38	1367 +/- 69	0.196 +/- 0.1	0.049 +/- 0.048	0.103 +/- 0.078	0.31 +/- 0.23	859 to 918
M8-O	23 Jul 1995	28 Jul 1995	1.4 +/- 2.8	9.5 +/- 2.2	< 0.6	< 2	4528.5 +/- 82.7	0.65 +/- 0.56	< 0.6	0.59 +/- 0.5	0.007	1010.7 to 1070.3
M8-O	22 Aug 1995	01 Sep 1995	19 +/- 23	2.4 +/- 12	< 0.6	< 1	2747.5 +/- 109	4.12 +/- 0.63	< 0.6	3.62 +/- 0.61	0.004	1010.7 to 1070.3

Table 4.5-4 Summary of Analytical Results - Radiochemicals [a]

Sample ID	Sampled	Analyzed	ALPHA	BETA	Ra-226	Ra-228	Rn-222	U-234	U-235	U-238	U-Total	S.I.
M8-O	15 Sep 1995	22 Sep 1995	9.0+/-1.0	4.0+/-1.0	< 0.6	< 2	3311.7 +/- 69	5.49 +/- 1.63	< 0.6	7.56 +/- 1.92	0.018	1010.7 to 1070.3
M8-O	15 Sep 1995	22 Sep 1995	8.0+/-1.0	< 3	< 0.6	< 3	3270.1 +/- 67.7	5.37 +/- 1.03	< 0.6	6.5 +/- 1.14	0.016	1010.7 to 1070.3
M8-O	18 Oct 1995	24 Oct 1995	<3.9 +/- 29	<40 +/- 43	0.12 +/- 0.12	0.25 +/- 0.4	3790 +/- 110	6.12 +/- 0.61	0.37 +/- 0.13	6.65 +/- 0.64	20.1 +/- 1.9	1010.7 to 1070.3
M9-S	23 Aug 1995	01 Sep 1995	26 +/- 31	23 +/- 15	< 0.6	< 1	44.5 +/- 22.2	3 +/- 0.64	< 0.6	1.55 +/- 0.43	< 0.002	1510 to 1570
M9-S	22 Sep 1995	29 Sep 1995	35 +/- 15	29 +/- 4	< 0.6	< 2	15.7 +/- 6.1	< 0.7	< 0.6	< 0.7	0.081	1510 to 1570
M9-S	19 Oct 1995	25 Oct 1995	2.1 +/- 50	12 +/- 47	0.039 +/- 0.021	0.19 +/- 0.41	13.9 +/- 9.1	0.086 +/- 0.083	0.037 +/- 0.046	0.049 +/- 0.051	0.15 +/- 0.16	1510 to 1570
M9-S	19 Oct 1995	25 Oct 1995	<16 +/- 46	1.4 +/- 46	0.61 +/- 0.3	0.36 +/- 0.44	21.1 +/- 9.8	0.065 +/- 0.072	0.022 +/- 0.042	0.029 +/- 0.048	0.09 +/- 0.15	1510 to 1570
M10-GU	22 Jun 1995	27 Jun 1995	36 +/- 22	14 +/- 12	0.9 +/- 0.5	<2	171.3 +/- 12.1	4.9 +/- 1.9	<0.6	2.4 +/- 1.2	0.007	218 to 258
M10-GU	12 Jul 1995	18 Jul 1995	1.4 +/- 10	14 +/- 7.4	< 0.6	< 4	43.4 +/- 8.8	3.42 +/- 0.75	< 0.6	1.27 +/- 0.45	0.005	218 to 258
M10-GU	16 Aug 1995	25 Aug 1995	9.7 +/- 11	6.0 +/- 5.4	< 0.6	< 2	78.1 +/- 19.9	4.19 +/- 1.36	< 0.6	1.64 +/- 0.92	0.029	218 to 258
M10-GU	12 Sep 1995	18 Sep 1995	< 4	14+/-2.0	0.7 +/- 0.6	< 3	228.5 +/- 22.3	14.89 +/- 2.22	0.58 +/- 0.41	13.42 +/- 2.05	0.014	218 to 258
M10-GU	17 Oct 1995	20 Oct 1995	45 +/- 55	<22 +/- 44	0.05 +/- 0.11	0.08 +/- 0.38	180 +/- 19	5.91 +/- 0.59	0.247 +/- 0.1	2.96 +/- 0.39	9 +/- 1.2	218 to 258
M11-GL	23 Jun 1995	02 Jul 1995	17 +/- 7.8	16 +/- 3.8	1.1 +/- 0.9	<2	630.4 +/- 20.8	5.51 +/- 2.69	<0.6	3.89 +/- 2.13	9.4 +/- 2.4	289.9 to 329.6
M11-GL	23 Jun 1995	01 Jul 1995	23 +/- 14	16 +/- 10	<0.6	<2	1409 +/- 43	5.29 +/- 1.97	<0.6	2.43 +/- 1.35	7.7 +/- 1.7	289.9 to 329.6
M11-GL	19 Jul 1995	27 Jul 1995	13 +/- 7.9	8.7 +/- 3.8	1.5 +/- 0.6	< 3	377.3 +/- 23.4	3 +/- 0.89	< 0.6	2.3 +/- 0.72	0.011	289.9 to 329.6
M11-GL	19 Jul 1995	27 Jul 1995	20 +/- 9.0	14 +/- 4.1	< 0.6	7 +/- 3	808.7 +/- 51.8	4.43 +/- 0.75	< 0.6	2.14 +/- 0.5	0.014	289.9 to 329.6
M11-GL	16 Aug 1995	25 Aug 1995	13 +/- 10	9.5 +/- 5.7	< 0.6	< 2	538.3 +/- 38.6	4.39 +/- 1.17	< 0.6	1.28 +/- 1	0.01	289.9 to 329.6
M11-GL	12 Sep 1995	19 Sep 1995	< 3	< 3	< 0.6	< 2	660.6 +/- 28.4	8.23 +/- 1.22	< 0.6	3.39 +/- 0.72	0.011	289.9 to 329.6
M11-GL	17 Oct 1995	20 Oct 1995	7.4 +/- 37	<11 +/- 45	0.59 +/- 0.25	0.24 +/- 0.43	1370 +/- 51	5.57 +/- 0.62	0.25 +/- 0.12	3.43 +/- 0.46	10.4 +/- 1.4	289.9 to 329.6
M12-O	24 Jun 1995	01 Jul 1995	23 +/- 8.5	19 +/- 4.0	2.9 +/- 0.6	<1	8756 +/- 85	2.99 +/- 0.97	<0.6	2.58 +/- 0.91	5.6 +/- 1	419.5 to 480.1
M12-O	12 Jul 1995	19 Jul 1995	51 +/- 17	30 +/- 8.2	1.8 +/- 0.6	< 4	8023.7 +/- 106.3	5.33 +/- 0.9	< 0.6	5.28 +/- 0.89	0.006	419.5 to 480.1
M12-O	16 Aug 1995	25 Aug 1995	3.3 +/- 6.4	9.0 +/- 5.6	< 0.6	3 +/- 2	3804.4 +/- 115.7	3.18 +/- 1.02	< 0.6	2.99 +/- 1	0.015	419.5 to 480.1
M12-O	16 Aug 1995	25 Aug 1995	6.9 +/- 7.6	8.7 +/- 5.6	0.8 +/- 0.5	4 +/- 2	14038.8 +/- 302.7	2.56 +/- 0.71	< 0.6	2.77 +/- 0.74	0.016	419.5 to 480.1
M12-O	12 Sep 1995	20 Sep 1995	2.0+/-1	< 3	2.4 +/- 0.6	< 3	7349.8 +/- 101.8	5.79 +/- 0.91	< 0.6	6.3 +/- 0.96	0.012	419.5 to 480.1
M12-O	17 Oct 1995	20 Oct 1995	7.1 +/- 35	<11 +/- 45	2.7 +/- 0.53	1.53 +/- 0.46	9900 +/- 140	3.24 +/- 0.41	0.243 +/- 0.1	3.46 +/- 0.42	10.5 +/- 1.3	419.5 to 480.1
M13-S	28 Jul 1995	08 Aug 1995	21 +/- 26	85 +/- 21	1.1 +/- 0.5	< 2	157.7 +/- 21	0.93 +/- 0.34	< 0.6	2.46 +/- 0.57	0.003	852 to 911
M13-S	22 Aug 1995	31 Aug 1995	8.5 +/- 23	46 +/- 18	< 0.6	< 2	410.3 +/- 46.9	< 0.6	< 0.6	< 0.6	< 0.001	852 to 911
M13-S	19 Sep 1995	25 Sep 1995	7.0+/-5.0	73+/-5.0	< 0.6	< 2	8 +/- 6.1	3.86 +/- 0.96	< 0.6	3 +/- 0.82	< 0.003	852 to 911
M13-S	18 Oct 1995	24 Oct 1995	<6.2 +/- 46	46 +/- 50	0.04 +/- 0.15	0.29 +/- 0.39	2.8 +/- 4.1	0.2 +/- 0.12	0.045 +/- 0.056	0.23 +/- 0.11	0.68 +/- 0.33	852 to 911
M13-S	18 Oct 1995	24 Oct 1995	<6.5 +/- 48	42 +/- 50	0.12 +/- 0.18	0.77 +/- 0.45	3.7 +/- 3.7	0.21 +/- 0.12	0.06 +/- 0.07	0.181 +/- 0.098	0.55 +/- 0.3	852 to 911
M14-GL	17 Jul 1995	22 Jul 1995	17 +/- 11	16 +/- 7.4	< 0.9	36 +/- 13	13.8 +/- 3.8	3.93 +/- 1.81	< 0.6	< 0.6	0.002	777.9 to 837.8
M14-GL	16 Aug 1995	25 Aug 1995	6.5 +/- 7.2	7.4 +/- 5.4	< 0.6	4 +/- 2	699.3 +/- 52.6	1.42 +/- 0.46	< 0.6	0.99 +/- 0.38	0.009	777.9 to 837.8
M14-GL	13 Sep 1995	22 Sep 1995	3.0+/-1.0	3.0+/-1.0	< 0.6	< 2	850.5 +/- 35.8	3.09 +/- 1.05	< 0.6	3.68 +/- 1.14	0.006	777.9 to 837.8
M14-GL	20 Oct 1995	25 Oct 1995	29 +/- 60	5.7 +/- 47	0.014 +/- 0.018	0.82 +/- 0.49	1041 +/- 52	1.06 +/- 0.23	0.151 +/- 0.088	0.61 +/- 0.17	1.85 +/- 0.52	777.9 to 837.8
M15-GU	24 Jul 1995	31 Jul 1995	12 +/- 6.4	9.2 +/- 3.2	< 0.6	< 2	545.3 +/- 29	2.1 +/- 0.62	< 0.6	0.73 +/- 0.55	0.008	554.2 to 594.1
M15-GU	16 Aug 1995	25 Aug 1995	1.1 +/- 6.1	4.6 +/- 5.2	< 0.6	< 2	423.5 +/- 42.9	3.75 +/- 0.8	< 0.6	1.73 +/- 0.55	0.012	554.2 to 594.1
M15-GU	13 Sep 1995	22 Sep 1995	5.0+/-2.0	7.0+/-2.0	< 0.6 +/- 0.3	< 2	455.6 +/- 26.9	17.2 +/- 2.9	1.04 +/- 0.62	17.9 +/- 2.98	0.011	554.2 to 594.1
M15-GU	20 Oct 1995	25 Oct 1995	1.6 +/- 37	12 +/- 47		-0.02 +/- 0.36	704 +/- 45	2.62 +/- 0.36	0.037 +/- 0.046	1.07 +/- 0.23	3.22 +/- 0.69	554.2 to 594.1

Table 4.5-4 Summary of Analytical Results - Radiochemicals [a]

Sample ID	Sampled	Analyzed	ALPHA	BETA	Ra-226	Ra-228	Rn-222	U-234	U-235	U-238	U-Total	S.I.
M16-GU	17 Jul 1995	22 Jul 1995	18 +/- 14	14 +/- 7.4	< 0.6	< 1	153.5 +/- 11.6	3.55 +/- 0.89	< 0.6	1.24 +/- 0.51	0.003	598 to 658
M16-GU	17 Jul 1995	22 Jul 1995	7.7 +/- 11	12 +/- 7.2	< 0.6	< 1	658.1 +/- 28.2	3.46 +/- 0.78	< 0.6	1.21 +/- 0.45	0.003	598 to 658
M16-GU	17 Aug 1995	25 Aug 1995	8.8 +/- 9.8	7.2 +/- 5.5	< 0.8	< 4	517.8 +/- 46.2	2.49 +/- 0.72	< 0.6	1.84 +/- 0.57	0.003	598 to 658
M16-GU	14 Sep 1995	22 Sep 1995	< 2	4.0+/-2.0	< 0.6	< 3	480.1 +/- 27.3	2.8 +/- 0.91	< 0.6	1.95 +/- 0.7	0.004	598 to 658
M16-GU	19 Oct 1995	25 Oct 1995	<12 +/- 36	<9.3 +/- 45	0.013 +/- 0.014	0.22 +/- 0.37	535 +/- 42	3.48 +/- 0.43	0.191 +/- 0.096	1.33 +/- 0.26	4.02 +/- 0.78	598 to 658
M17-GL	17 Jul 1995	22 Jul 1995	21 +/- 12	25 +/- 7.9	< 0.6	4 +/- 3	502.9 +/- 33.2	1.51 +/- 0.49	< 0.6	0.87 +/- 0.37	0.007	938 to 998
M17-GL	17 Aug 1995	26 Aug 1995	2.0 +/- 5.4	5.0 +/- 5.2	< 0.6	< 3	466.2 +/- 44.8	1.48 +/- 0.52	< 0.6	0.64 +/- 0.36	0.002	938 to 998
M17-GL	17 Aug 1995	26 Aug 1995	< 0.17 +/- 4.4	3.5 +/- 5.0	< 0.6	< 4	706.5 +/- 53.3	2.55 +/-0.9	< 0.6	2.19 +/- 0.86	0.003	938 to 998
M17-GL	20 Sep 1995	25 Sep 1995	24+/-5.0	26+/-2.0	< 0.6	2 +/- 1	507.7 +/- 20.7	5.67 +/- 1.1	< 0.6	2.78 +/- 0.73	0.017	938 to 998
M18-GU	14 Jul 1995	21 Jul 1995	6.9 +/- 9.7	15 +/- 7.3	< 0.6	< 2	40.8 +/- 5.3	5.06 +/- 0.86	< 0.6	1.91 +/- 0.5	0.006	177.6 to 217.6
M18-GU	14 Aug 1995	25 Aug 1995	10 +/- 9.4	< 0.12 +/- 4.7	< 0.6	< 3	44.6 +/- 15.9	4.44 +/- 0.74	< 0.6	2.09 +/- 0.48	0.016	177.6 to 217.6
M18-GU	13 Sep 1995	20 Sep 1995	< 2	< 3	1.2 +/- 0.7	< 2	122 +/- 15.5	4.71 +/- 0.77	< 0.6	2.91 +/- 0.58	0.014	177.6 to 217.6
M18-GU	20 Oct 1995	25 Oct 1995	49 +/- 48	<26 +/- 44	0.011 +/- 0.019	0.39 +/- 0.4	116 +/- 18	4.01 +/- 0.51	0.22 +/- 0.11	1.66 +/- 0.31	5.01 +/- 0.94	177.6 to 217.6
M18-GU	20 Oct 1995	25 Oct 1995	19 +/- 41	38 +/- 50	0.00 +/- 0.02	0.44 +/- 0.4	102 +/- 18	3.91 +/- 0.46	0.206 +/- 0.096	1.7 +/- 0.29	5.15 +/- 0.88	177.6 to 217.6
P8-1-O	24 Oct 1995	27 Oct 1995	1.3 +/- 31	5.8 +/- 47	0.032 +/- 0.015	0.95 +/- 0.5	4044 +/- 88	0.82 +/- 0.21	0.061 +/- 0.064	0.4 +/- 0.15	1.22 +/- 0.44	399.5 to 579.6
P8-GU	20 Sep 1995	25 Sep 1995	7+/-3.0	15+/-2.0	< 0.6	< 1	69.7 +/- 12.3	6.44 +/- 1.08	< 0.6	3.75 +/- 0.8	0.016	128.2 to 248.4
P8-GU	24 Oct 1995	27 Oct 1995	1.8 +/- 43	35 +/- 43	0.0063 +/- 0.0096	0.79 +/- 0.57	130 +/- 16	5.42 +/- 0.62	0.28 +/- 0.13	2.53 +/- 0.4	7.6 +/- 1.2	128.2 to 248.4
P8-GU	24 Oct 1995	27 Oct 1995	<5.3 +/- 39	<5.0 +/- 46	0.02 +/- 0.013	0.72 +/- 0.4	160 +/- 19	4.99 +/- 0.54	0.25 +/- 0.11	2.49 +/- 0.36	7.5 +/- 1.1	128.2 to 248.4
P28-1-O	23 Oct 1995	27 Oct 1995	1.3 +/- 31	<2.9 +/- 46	0.67 +/- 0.34	0.27 +/- 0.36	4940 +/- 110	2.41 +/- 0.35	0.102 +/- 0.07	1.85 +/- 0.3	5.59 +/- 0.9	350 to 400
P28-GL	20 Sep 1995	25 Sep 1995	9+/-3.0	11+/-1.0	< 0.6	< 1	140.4 +/- 11.5	4.83 +/- 1.01	< 0.6	2.36 +/- 0.68	0.016	279 to 309
P28-GL	23 Oct 1995	27 Oct 1995	<17 +/- 30	5.7 +/- 47	0.049 +/- 0.02	0.15 +/- 0.44	144 +/- 18	4.36 +/- 0.49	0.072 +/- 0.061	1.85 +/- 0.3	5.58 +/- 0.91	279 to 309
P28-GL	23 Oct 1995	27 Oct 1995	<18 +/- 31	<20 +/- 44	0.026 +/- 0.013	0.44 +/- 0.42	160 +/- 20	4.64 +/- 0.52	0.185 +/- 0.097	2.2 +/- 0.34	6.6 +/- 1	279 to 309
Standard Detection Limit			1.0	1.0	5.0	5.0	N	0.05	0.05	0.05	N	N
Drinking Water - Primary Standard Limit			3.0	30.0	5.0	5.0	N	N	N	N	N	N

[a] Results are in pico Currie/liter, except S.I (feet below surface).

Despite the use of trailing zeros in some data, no result has more than two significant figures.

+/- - plus or minus

N - Not Applicable

Ra-228 - Radium 228

Rn-222 - Radon 222

U-234 - Uranium 234

U-235 - Uranium 235

U-Total - Total Uranium

S.I. - Screened Interval

Table 4.5-5 Summary of Analytical Results - Sulfur Isotope Ratios				
Laboratory Number	**Well ID**	**$\delta^{34}S$, ‰ (CDT)[a]**		**Screen Interval[b]**
		June, 1995 Groundwater Sample	**July, 1995 Groundwater Sample**	
S-2270, 2320	M10-GU	4.8	4.3	218 to 258
S-2271, 2321	M11-GL	6.0	5.7	290 to 330
S-2273, 2319	M12-O	5.5	5.9	420 to 480
S-2317	M13-S	NA	2.3	852 to 911
S-2322	M2-GU	NA	4.6	198 to 237
S-2323	M3-GL	NA	5.3	298 to 338
S-2318	M4-O	NA	4.3	405 to 416
S-2314	M5-S	NA	4.0	516 to 576
S-2313	M6-GU	NA	8.0	524 to 563
S-2325	M7-GL	NA	5.8	859 to 918
S-2316	M8-O	NA	2.0	1,011 to 1,070
S-2326	M9-S	NA	-1.5	1,510 to 1,570
S-2272	93 percent sulfuric acid[c]	-2.4	-2.4	NA

[a]CDT - Canyon Diablo Troilite
[b]Feet below groundwater surface
[c]Acid from San Manuel Magma Copper Metallurgical Department
NA - Not available
The analytical precision, based on repeated analyses of a laboratory standard, is 0.12 ‰ (1σ, n = 19).
‰ (1σ, n = 19 - 1 standard deviation based on 19 samples

Table 4.5-6 Summary of Analytical Results - Tritium Isotope				
Laboratory Number	**Well ID**	**Tritium (Tu)**		**Screen Interval[a]**
		June, 1995 Groundwater Sample	**July, 1995 Groundwater Sample**	
AT-514, 545	M10-GU	7.6 ± 0.5	7.1 ± 0.5	218 to 258
AT-515, 563	M11-GL	1.8 ± 0.4	1.6 ± 0.4	290 to 330
AT-516, 567	M12-O	<0.7	<0.7	420 to 480
547	M13-S	NA	<0.7	852 to 911
566	M2-GU	NA	5.6 ± 0.4	198 to 237
562	M3-GL	NA	3.0 ± 0.4	298 to 338
564	M4-O	NA	2.3 ± 0.4	405 to 416
548	M5-S	NA	<0.7	516 to 576
545	M6-GU	NA	<0.7	524 to 563
569	M7-GL	NA	<0.7	859 to 918
546	M8-O	NA	<0.7	1,011 to 1,070
568	M9-S	NA	<0.7	1,510 to 1,570

[a]feet below ground surface
Tu - Concentrations of Tritium Units
NA - Not available
The analytical precision, based on repeated analyses of a laboratory standard, is 0.12 ‰ (1σ, n = 19).
Detection limit - 0.7 Tritium Units (TU)
Background, this run - 0.594 ± 0.020 capacity per minute (cpm)
Background, long term - 0.597 ± 0.004 cpm (n = 22)
Efficiency, this run - 0.1114 ± 0.0017
Efficiency, long term - 0.1094 ± 0.0009 (n = 23)
Counter efficiency determined using National Institute for Science and Technology (NIST) Standard Reference Material 4361B.

Table 4.6-1 Summary of Private Irrigation Groundwater Use Within 1 Mile of the Proposed In-Situ Mine Area

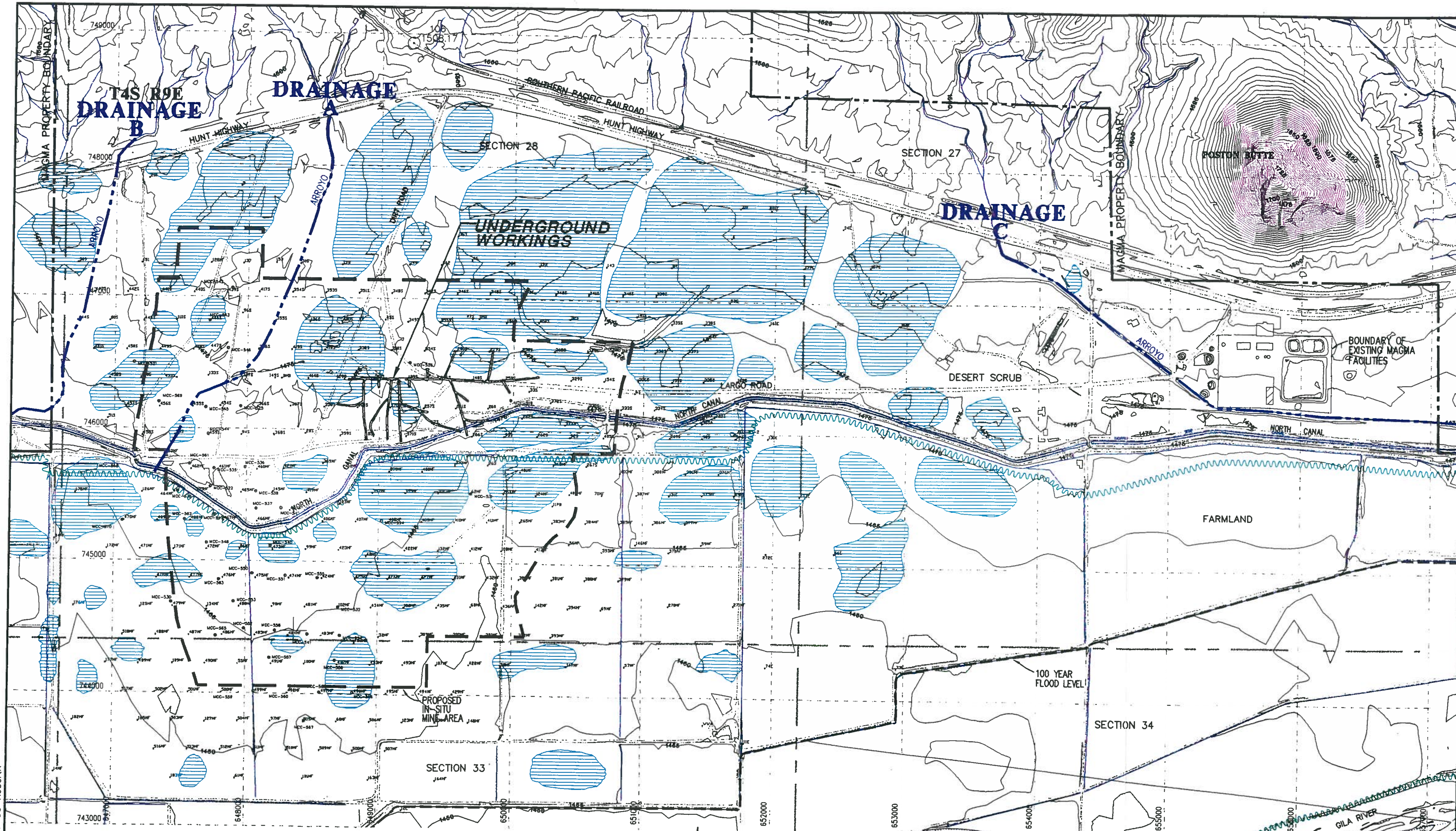
ADWR Registration Number	Well ID	Owner	1993 Water Use (Acre-Feet)	1994 Water Use (Acre-Feet)
55-627614	D(4-9)27cad Supply Well 1	Magma Copper Company	0.00	0.00
55-627612	D(4-9)27cbd1 England No. 3	Magma Copper Company	210.67	519.90
55-627611	D(4-9)27ddd England No. 2	Magma Copper Company	66.03	416.07
55-627608	D(4-9)28cdb WW3, PW-3	Magma Copper Company	395.40	754.66
55-609666	D(4-9)29dab	Riggins Pinal	0.00	0.00
55-609667	D(4-9)29dac	Riggins Pinal	0.00	0.00
55-627610	D(4-9)29dca PW-20	Magma Copper Company	217.66	511.20
55-609672	D(4-9)32baa2	Riggins Pinal	471.50	859.34
55-609671	D(4-9)32bda	Riggins Pinal	0.00	0.00
55-609668	D(4-9)32cbd1	Riggins Pinal	517.96	730.60
55-609670	D(4-9)32cbd2	Riggins Pinal	379.36	593.13
55-609669	D(4-9)32dda	Riggins Pinal	0.00	0.00
55-627609	D(4-9)33aad PW-4	Magma Copper Company	0.00	0.00
Total Water Use	NA	NA	2,258.58	4,384.90

NA - Not applicable
Source: ADWR, 1995
See Appendix B for additional well information
See Sheet 1.2-2 for locations

Table 4.7-1 Summary of Geochemical Analysis Results																
Rock Type	Sample Identification	Weight Percent														
		Cu	Fe	S	SiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	L.O.I.	Total Oxide
Calcareous	Basin-Fill-Unit: MCC 537: 342 to 344	0.027	2.80	0.018	63.86	12.14	4.42	0.06	1.23	5.92	2.27	3.97	0.64	0.19	5.81	100.51
Non Calcareous	Basin-Fill-Unit: MCC 537: 351 to 358	0.026	2.85	0.027	69.55	13.03	4.54	0.07	1.43	1.43	2.25	4.67	0.66	0.15	2.88	100.66
Calcareous	Basin-Fill-Unit: MCC 534: 339 to 340	0.016	2.85	0.014	62.80	10.99	4.40	0.09	1.20	7.25	1.91	3.69	0.65	0.14	7.32	100.44
Non Calcareous	Basin-Fill-Unit: MCC 534: 356 to 357	0.088	4.25	0.016	68.53	12.48	6.62	0.10	1.28	1.45	2.18	4.00	0.85	0.18	3.02	100.69
Oxide	Quartz Monzonite: MCC 522: 480 to 493	0.190	1.95	0.017	71.75	12.81	2.79	0.02	0.94	0.88	2.66	5.52	0.47	0.11	0.89	98.84
Oxide	Qtz Monz: 95-S: 677 to 689 and 697 to 706	0.330	1.15	0.033	73.27	12.81	1.67	<.01	0.32	0.83	2.43	5.75	0.53	0.14	1.10	98.85
Oxide	Quartz Monzonite: 256-S: 502 to 518	0.500	1.65	0.014	70.90	13.90	2.50	<.01	0.50	0.43	1.32	7.51	0.52	0.17	2.25	100.00
Oxide	Granodiorite Porphyry: MCC 521: 1,369 to 1,378	0.200	1.85	0.590	69.86	13.40	2.75	0.02	1.32	2.69	2.92	4.18	0.35	0.10	2.56	100.15
Oxide	Granodiorite Porphyry: MCC 531: 786 to 800	0.280	1.80	0.110	62.11	14.47	2.78	0.02	2.23	4.14	1.08	4.57	0.52	0.13	8.52	100.57
Oxide	Granodiorite Porphyry: 99 MF: 783 to 810	0.770	2.10	0.014	68.09	15.42	3.17	0.03	1.67	2.52	3.60	3.57	0.49	0.17	2.21	100.95
Oxide	Diabase: 258-S: 414 to 424	0.860	5.95	0.021	52.15	15.11	11.25	0.13	5.58	4.55	1.16	1.90	1.14	0.13	6.78	99.88
Sulfide	Quartz Monzonite: 99 MF: 1,509 to 1,538	0.440	2.35	0.704	68.86	13.66	3.68	0.02	1.28	1.87	2.57	5.42	0.80	0.24	2.17	100.57
Sulfide	Quartz Monzonite: 126 MF: 1,770 to 1,805	0.150	1.70	0.210	70.09	14.22	2.70	0.03	1.34	2.30	3.09	4.53	0.32	0.08	2.11	100.81
Sulfide	Quartz Monzonite: 48 MF: 1,090 to 1,124	0.420	1.35	0.856	69.99	13.11	2.03	0.01	1.30	1.24	2.01	6.57	0.64	0.21	2.23	99.01
Sulfide	Granodiorite Porphyry: 99 MF: 931 to 968	0.110	2.25	0.247	65.86	15.40	3.57	0.02	1.94	3.05	3.42	3.47	0.57	0.18	3.00	100.48
Sulfide	Granodiorite Porphyry: 126 MF: 1,671 to 1,725	0.060	2.45	0.223	66.36	15.93	3.58	0.05	1.26	2.62	4.16	3.54	0.53	0.26	2.18	100.47
Alluvium	ALUO 36 L at 5 feet 9 inches	0.003	2.65	0.027	64.38	11.80	4.25	0.07	1.68	5.10	1.92	3.19	0.65	0.15	7.16	100.35
Alluvium	ALUF 26 at 5 feet 4 inches	0.001	3.00	0.019	64.46	11.23	4.85	0.08	1.46	4.74	1.96	2.99	0.81	0.14	6.26	98.98
Alluvium	ALUF 18 at 5 feet 9 inches	0.002	2.65	0.023	64.72	11.54	4.25	0.07	1.52	4.75	1.90	3.27	0.66	0.15	6.52	99.35
Alluvium	ALUM 14 at 5 feet 8 inches	0.002	2.60	0.021	60.08	10.21	4.28	0.06	1.58	8.91	1.76	2.74	0.74	0.14	9.85	100.35
Alluvium	FLU PS 1 at 6 feet	0.002	2.75	0.027	58.86	10.20	4.53	0.06	1.61	8.65	2.04	2.65	0.78	0.12	8.82	98.32
Alluvium	FLU PS 2 at 6 feet	0.002	2.70	0.025	64.32	11.57	4.62	0.08	1.40	6.03	2.20	3.10	0.80	0.15	6.52	100.79

Table 4.7-1 (continued). Summary of Geochemical Analysis Results

Rock Type	Sample Identification	Parts per Million (ppm)															
		Ba	Sr	Y	Sc	Zr	Ag	As	Sb	Pb	Zn	Cd	Co	Ni	Se	Hg	Cl
Calcareous	Basin-Fill-Unit: MCC 537: 342 to 344	680	242	36	9	273	0.4	3	<0.1	16	60	0	8	12	<0.1	0.03	230
Non Calcareous	Basin-Fill-Unit: MCC 537: 351 to 358	710	218	42	9	233	0.1	2	<0.1	16	46	<0.1	8	10	<0.1	0.02	325
Calcareous	Basin-Fill-Unit: MCC 534: 339 to 340	593	180	42	9	312	0.1	2	<0.1	16	65	0	8	12	<0.1	0.02	335
Non Calcareous	Basin-Fill-Unit: MCC 534: 356 to 357	593	201	42	11	260	0.4	3	<0.1	18	65	<0.1	10	12	<0.1	0.04	330
Oxide	Quartz Monzonite: MCC 522: 480 to 493	672	177	32	11	121	1.0	1	<0.1	8	26	1	2	10	0.6	0.03	350
Oxide	Qtz Monz: 95-S: 677 to 689 and 697 to 706	636	316	146	12	194	0.8	0	<0.1	12	26	2	2	8	1.5	0.02	205
Oxide	Quartz Monzonite: 256-S: 502 to 518	856	129	46	12	223	1.0	0	<0.1	6	22	0	4	6	1.1	0.02	225
Oxide	Granodiorite Porphyry: MCC 521: 1,369 to 1,378	798	473	12	6	94	0.6	0	<0.1	2	32	0	8	12	0.6	0.01	365
Oxide	Granodiorite Porphyry: MCC 531: 786 to 800	738	218	10	5	112	0.3	0	<0.1	6	48	3	12	12	3.5	0.03	310
Oxide	Granodiorite Porphyry: 99 MF: 783 to 810	949	554	9	6	123	0.6	<0.2	<0.1	2	32	0	8	10	<0.1	0.02	380
Oxide	Diabase: 258-S: 414 to 424	205	141	28	42	127	0.6	1	<0.1	8	156	0	32	65	<0.1	0.02	385
Sulfide	Quartz Monzonite: 99 MF: 1,509 to 1,538	845	204	70	15	302	1.1	<0.2	<0.1	6	30	<0.1	10	10	2.5	0.05	390
Sulfide	Quartz Monzonite: 126 MF: 1,770 to 1,805	688	414	10	6	92	0.1	<0.2	<0.1	2	26	<0.1	10	10	14.0	0.05	445
Sulfide	Quartz Monzonite: 48 MF: 1,090 to 1,124	815	263	32	13	262	1.0	<0.2	<0.1	6	20	0	8	8	4.2	0.06	360
Sulfide	Granodiorite Porphyry: 99 MF: 931 to 968	984	552	9	7	107	0.3	0	<0.1	<2	26	<0.1	8	12	0.5	0.03	390
Sulfide	Granodiorite Porphyry: 126 MF: 1,671 to 1,725	1416	798	11	4	150	0.1	<0.2	<0.1	6	70	<0.1	8	6	1.0	0.03	360
Alluvium	ALUO 36 L at 5 feet 9 inches	748	289	29	9	268	<0.1	3	0.1	10	50	<0.1	8	18	<0.1	0.02	215
Alluvium	ALUF 26 at 5 feet 4 inches	693	276	30	9	325	<0.1	2	0.1	8	48	<0.1	8	14	<0.1	0.02	205
Alluvium	ALUF 18 at 5 feet 9 inches	715	369	30	9	287	<0.1	3	0.2	10	50	<0.1	8	18	<0.1	0.02	240
Alluvium	ALUM 14 at 5 feet 8 inches	655	331	29	8	287	<0.1	4	<0.1	8	44	<0.1	8	14	<0.1	0.03	285
Alluvium	FLU PS 1 at 6 feet	626	387	29	8	318	<0.1	3	0.2	8	42	0	8	14	<0.1	0.01	510
Alluvium	FLU PS 2 at 6 feet	741	334	32	8	307	<0.1	2	0.3	8	50	0	10	14	<0.1	0.01	470



0 350 700
SCALE IN FEET

BROWN AND CALDWELL

EXPLANATION

- ARCHAEOLOGICAL SITES
- 490HF EXISTING 1995 CORE HOLES
- MCC-548 1995 COREHOLES
- FARMLAND BOUNDARY

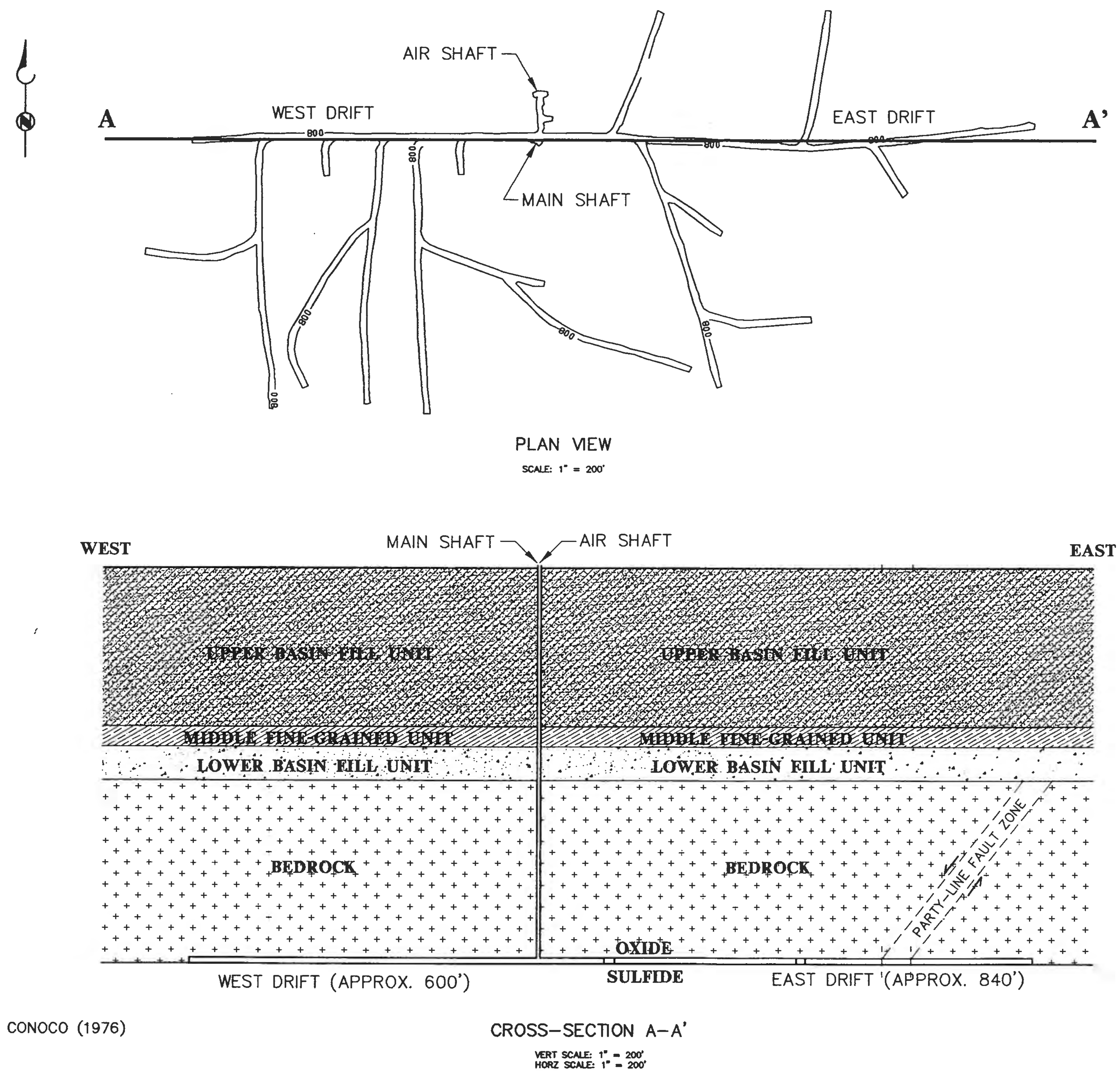
N

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

Figure 4.1-1 (II)

EXISTING FEATURES OF THE IN-SITU MINE AREA

F4-1-1_2 12-01-95 RobertK



MODIFIED FROM: CONOCO (1976)

F4-1-2_2 01-02-96 RobertK

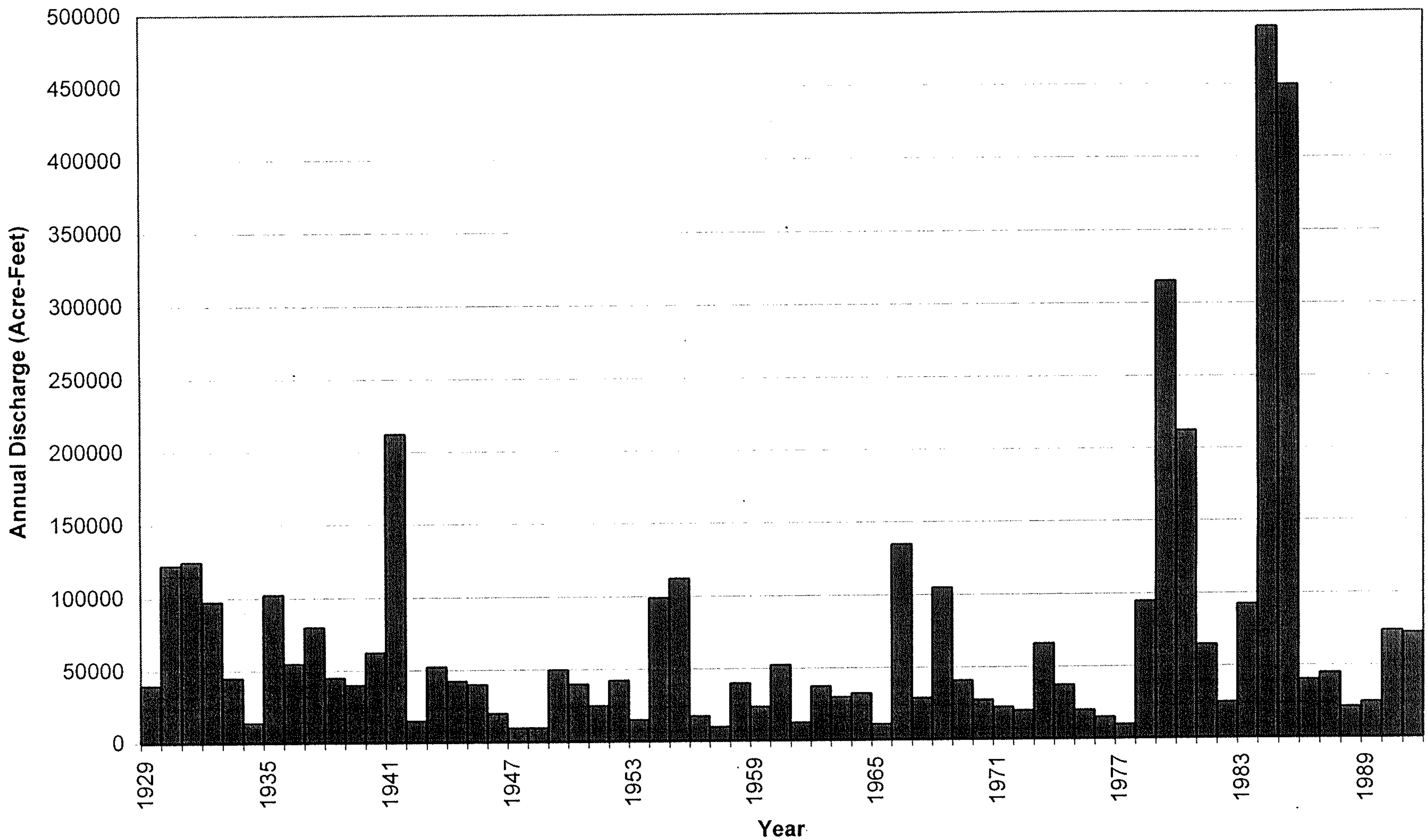
BROWN AND CALDWELL

Figure 4.1-2 (II)

PLAN VIEW AND CROSS-SECTION OF UNDERGROUND WORKINGS

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona



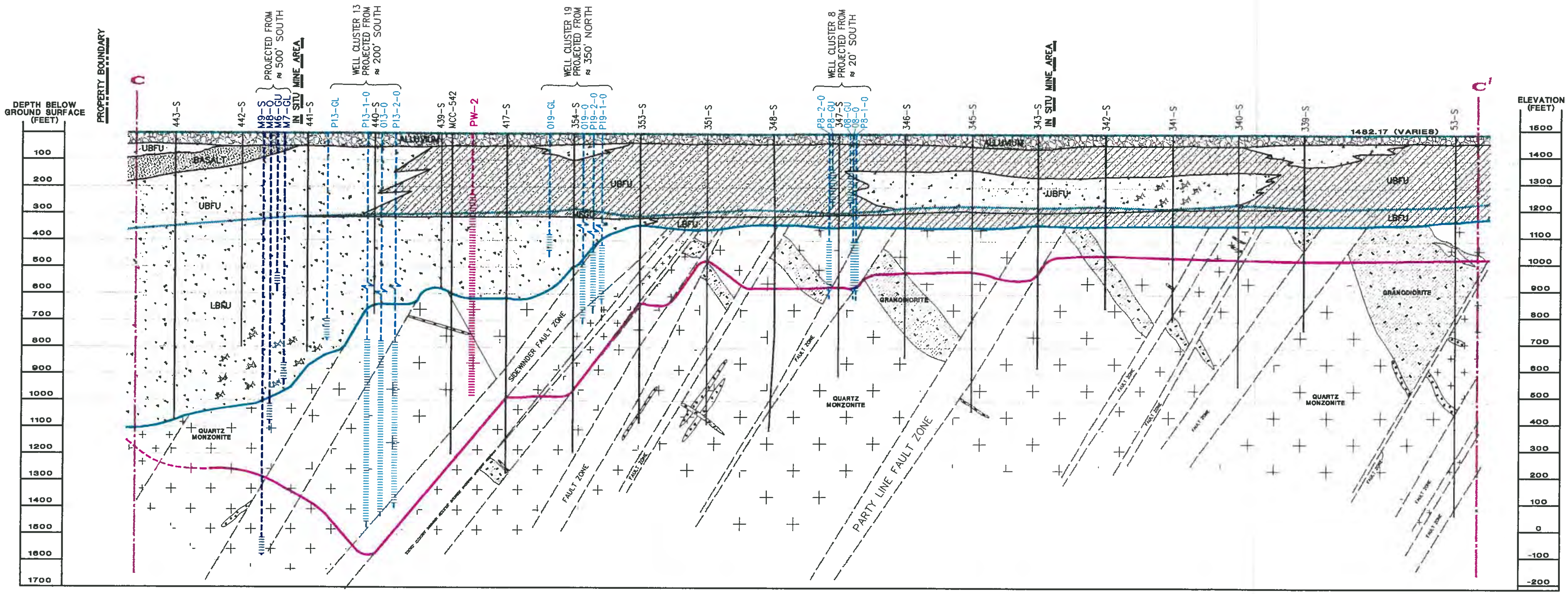
Source: Huckleberry, 1993

Figure 4.2-1 (II)
ESTIMATED ANNUAL STREAMFLOW OF THE GILA RIVER BELOW THE ASHURST-HAYDEN DAM (1929-1991)

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

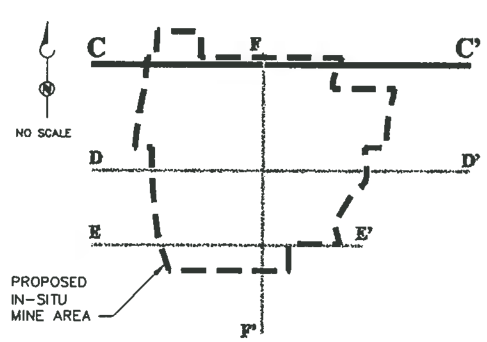
FIG421.XLS 1/6/96



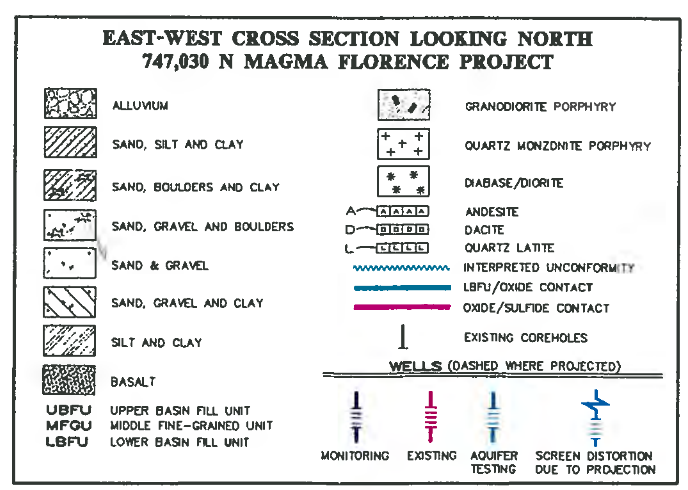
0 200 400
VERT SCALE IN FEET

0 200 400
HORIZ SCALE IN FEET

GENERALIZED GEOLOGIC CROSS-SECTION C-C′
VIEW LOOKING TO THE NORTH



KEY MAP

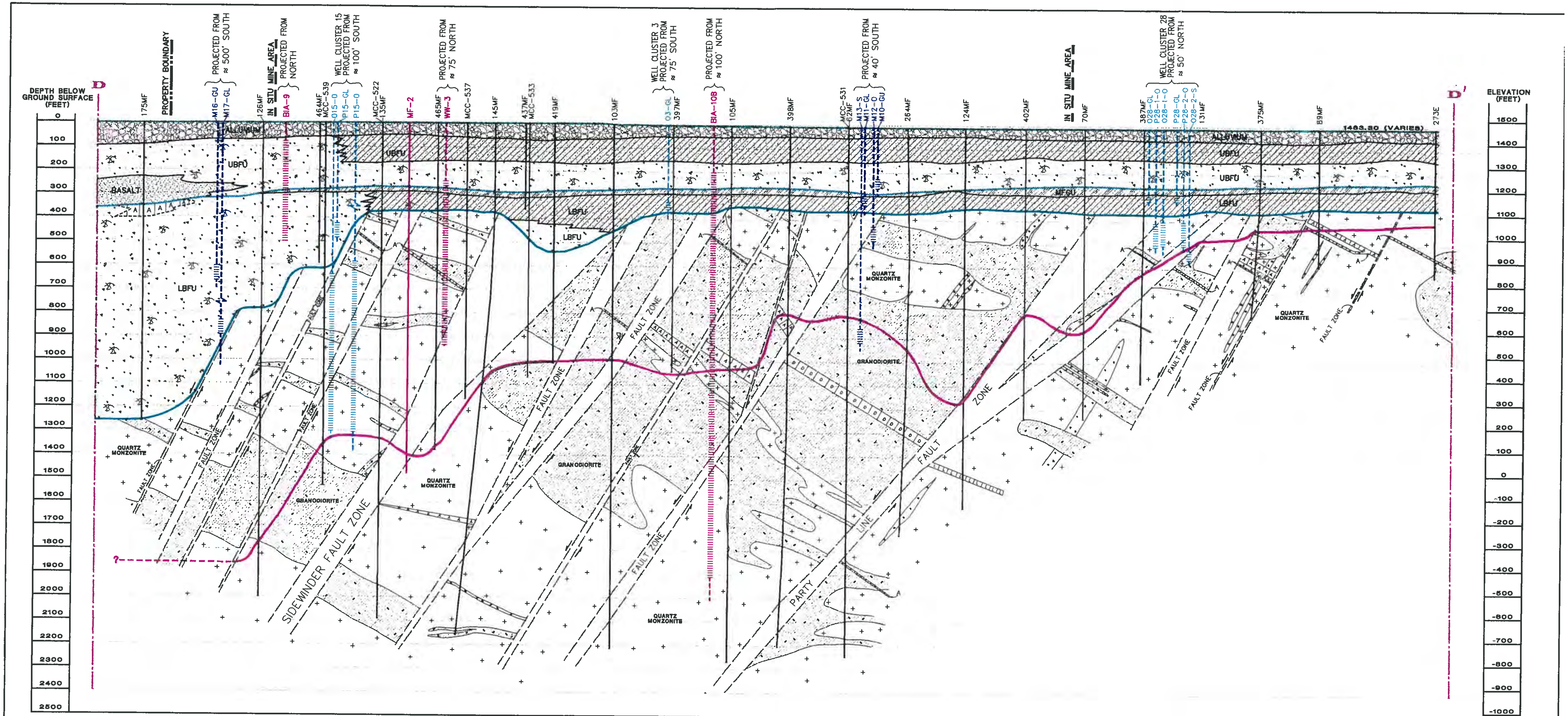


NOTE:
DEPICTIONS OF WELL PROJECTED ONTO SECTION ARE ADJUSTED TO PLACE SCREENS IN PROPER GEOLOGIC VIEW

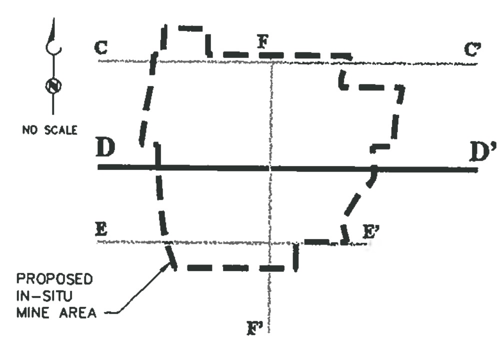
Figure 4.3-1 (II)
HYDROGEOLOGIC CROSS-SECTION C-C′

MAGMA
MAGMA COPPER COMPANY
Florence Mining Division

BROWN AND CALDWELL



GENERALIZED GEOLOGIC CROSS-SECTION D-D'
VIEW LOOKING TO THE NORTH



KEY MAP

EAST-WEST CROSS SECTION LOOKING NORTH
745,520 N MAGMA FLORENCE PROJECT

- ALLUVIUM
- SAND, SILT AND CLAY
- SAND, BOULDERS AND CLAY
- SAND, GRAVEL AND BOULDERS
- SAND & GRAVEL
- SAND, GRAVEL AND CLAY
- SILT AND CLAY
- BASALT
- UBFU UPPER BASIN FILL UNIT
- MFGU MIDDLE FINE-GRAINED UNIT
- LBFU LOWER BASIN FILL UNIT
- GRANODIORITE PORPHYRY
- QUARTZ MONZONITE PORPHYRY
- DIABASE/DIORITE
- A — ANDESITE
- D — DACITE
- L — QUARTZ LATITE
- BASIN FILL UNCONFORMITY
- LBFU/OXIDE CONTACT
- OXIDE/SULFIDE CONTACT
- EXISTING COREHOLES

WELLS (DASHED WHERE PROJECTED)

MONITORING | EXISTING | AQUIFER TESTING | SCREEN DISTORTION DUE TO PROJECTION

NOTE:
DEPICTIONS OF WELL PROJECTED ONTO SECTION ARE ADJUSTED TO PLACE SCREENS IN PROPER GEOLOGIC VIEW

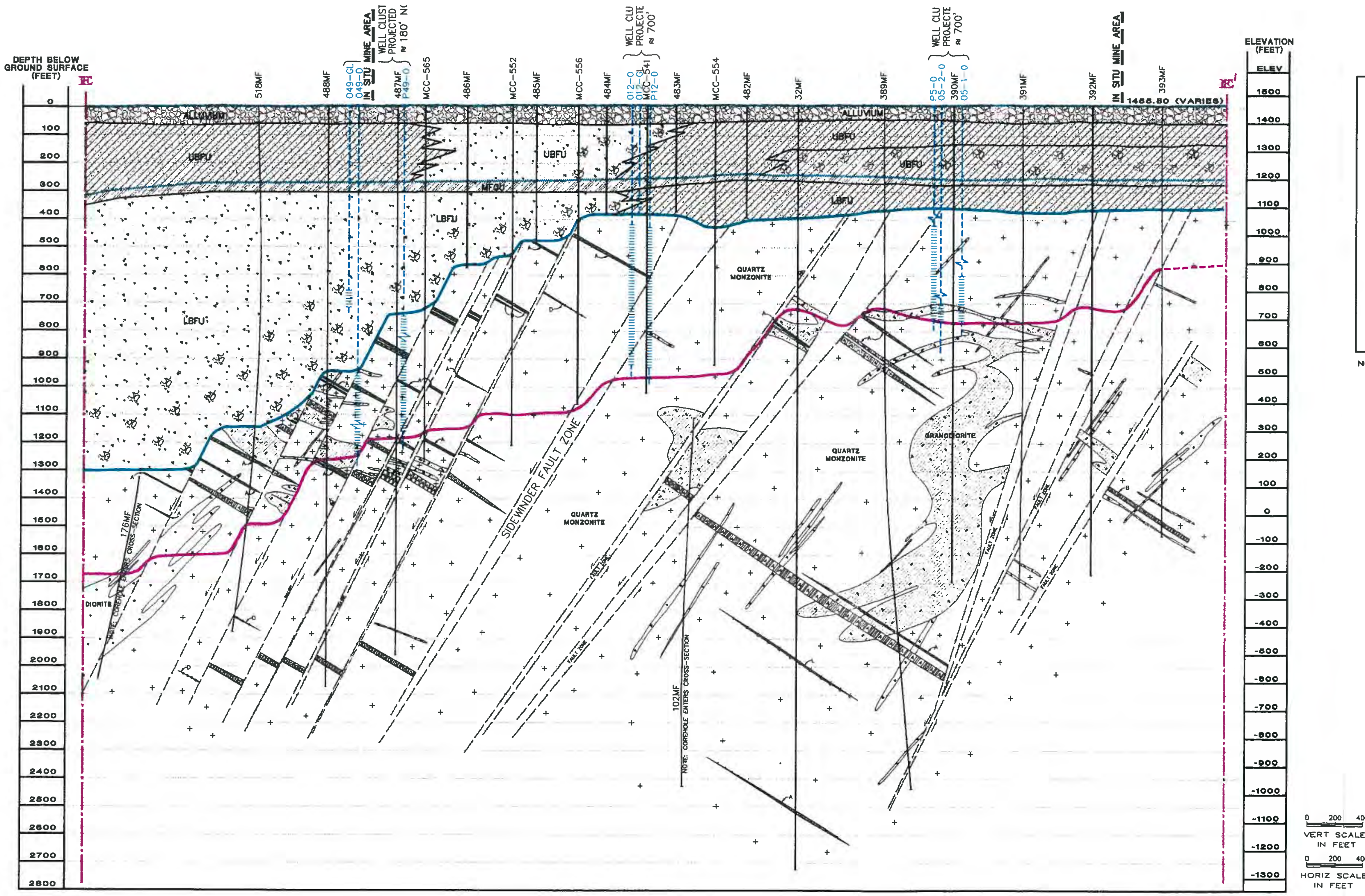
0 200 400
VERT SCALE IN FEET

0 200 400
HORIZ SCALE IN FEET

Figure 4.3-2 (II)
HYDROGEOLOGIC CROSS-SECTION D-D'

MAGMA
MAGMA COPPER COMPANY
Florence Mining Division

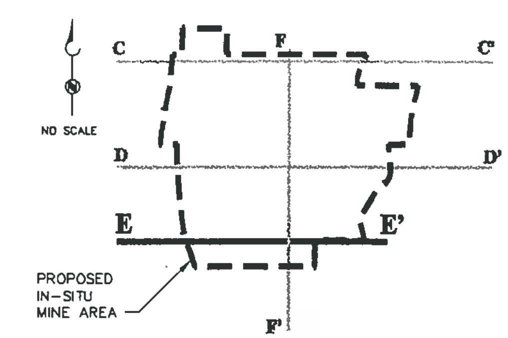
BROWN AND CALDWELL



EAST-WEST CROSS SECTION LOOKING NORTH
744,440 N MAGMA FLORENCE PROJECT

	ALLUVIUM		GRANODIORITE PORPHYRY
	SAND, SILT AND CLAY		QUARTZ MONZONITE PORPHYRY
	SAND, BOULDERS AND CLAY		DIABASE/DIORITE
	SAND, GRAVEL AND BOULDERS	A	ANDESITE
		D	DACITE
		L	QUARTZ LATITE
	SAND & GRAVEL		INTERPRETED UNCONFORMITY
	SAND, GRAVEL AND CLAY		LBFU/OXIDE CONTACT
			OXIDE/SULFIDE CONTACT
	SILT AND CLAY		EXISTING COREHOLES
	BASALT		WELLS (DASHED WHERE PROJECTED)
UBFU	UPPER BASIN FILL UNIT		MONITORING
MFGU	MIDDLE FINE-GRAINED UNIT		EXISTING
LBFU	LOWER BASIN FILL UNIT		AQUIFER TESTING
			SCREEN DISTORTION DUE TO PROJECTION

NOTE:
DEPICTIONS OF WELL PROJECTED ONTO SECTION ARE ADJUSTED TO PLACE SCREENS IN PROPER GEOLOGIC VIEW



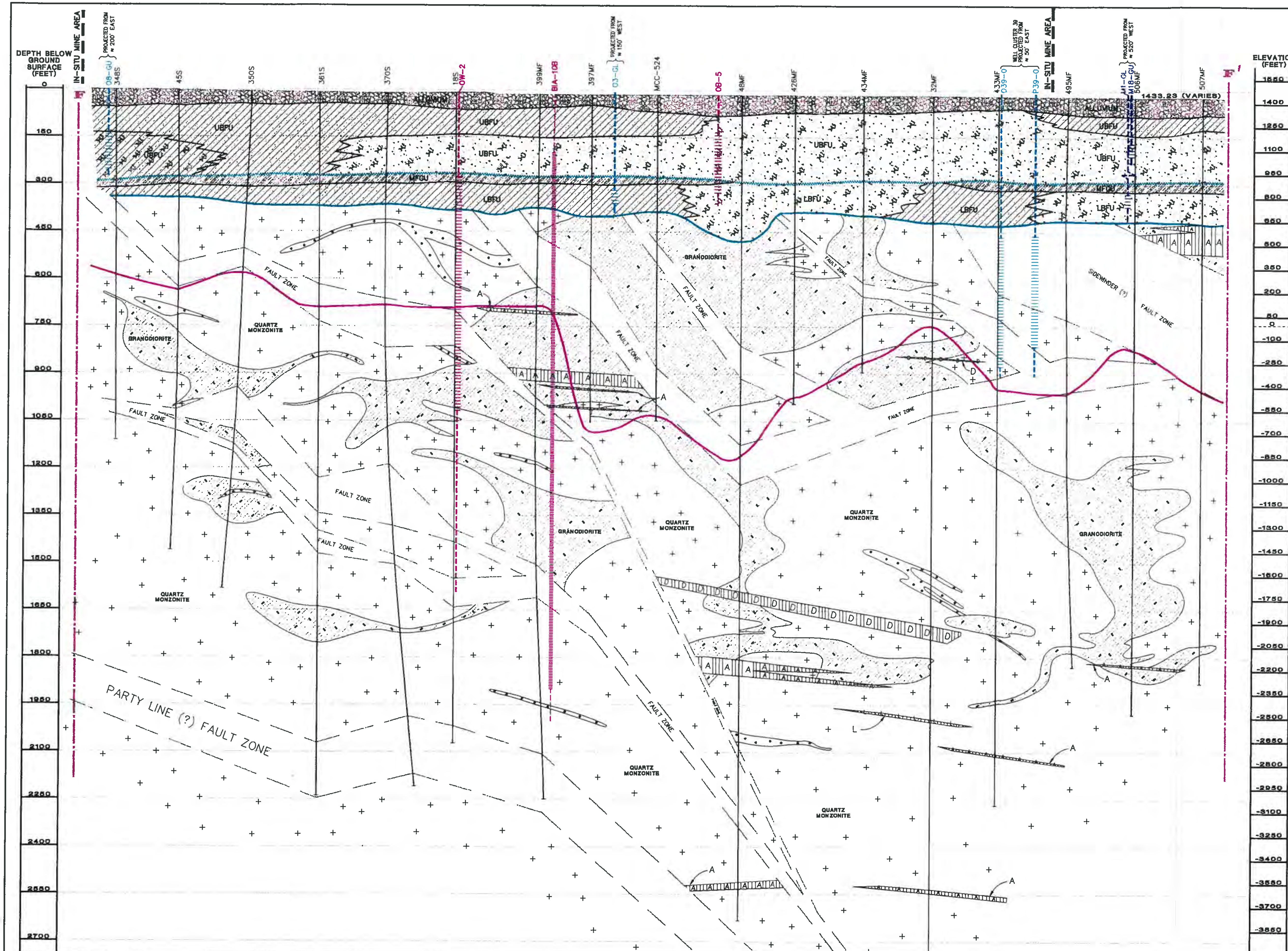
KEY MAP

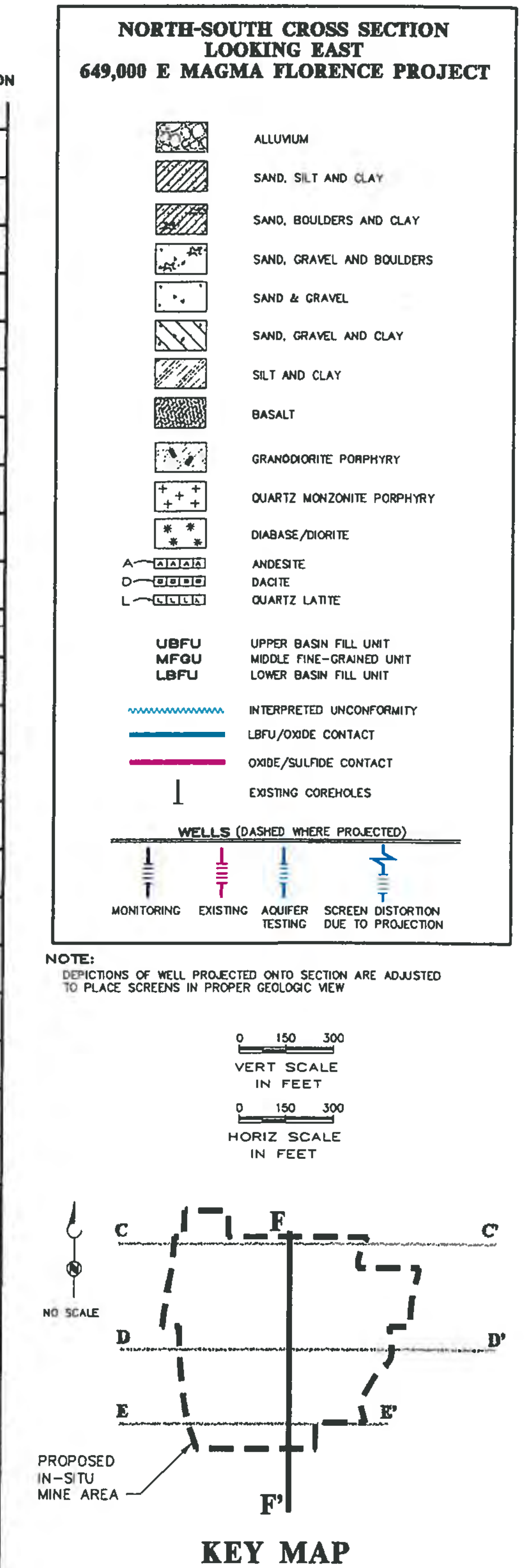
GENERALIZED GEOLOGIC CROSS-SECTION E-E'
VIEW LOOKING TO THE NORTH

Figure 4.3-3 (II)
HYDROGEOLOGIC CROSS-SECTION E-E'

MAGMA
MAGMA COPPER COMPANY
Florence Mining Division

BROWN AND CALDWELL





NOTE: DEPICTIONS OF WELL PROJECTED ONTO SECTION ARE ADJUSTED TO PLACE SCREENS IN PROPER GEOLOGIC VIEW

Figure 4.3-4 (II)

HYDROGEOLOGIC CROSS-SECTION F-F'

BROWN AND CALDWELL

GENERALIZED GEOLOGIC CROSS-SECTION F-F'
VIEW LOOKING TO THE EAST

MAGMA COPPER COMPANY
Florence Mining Division

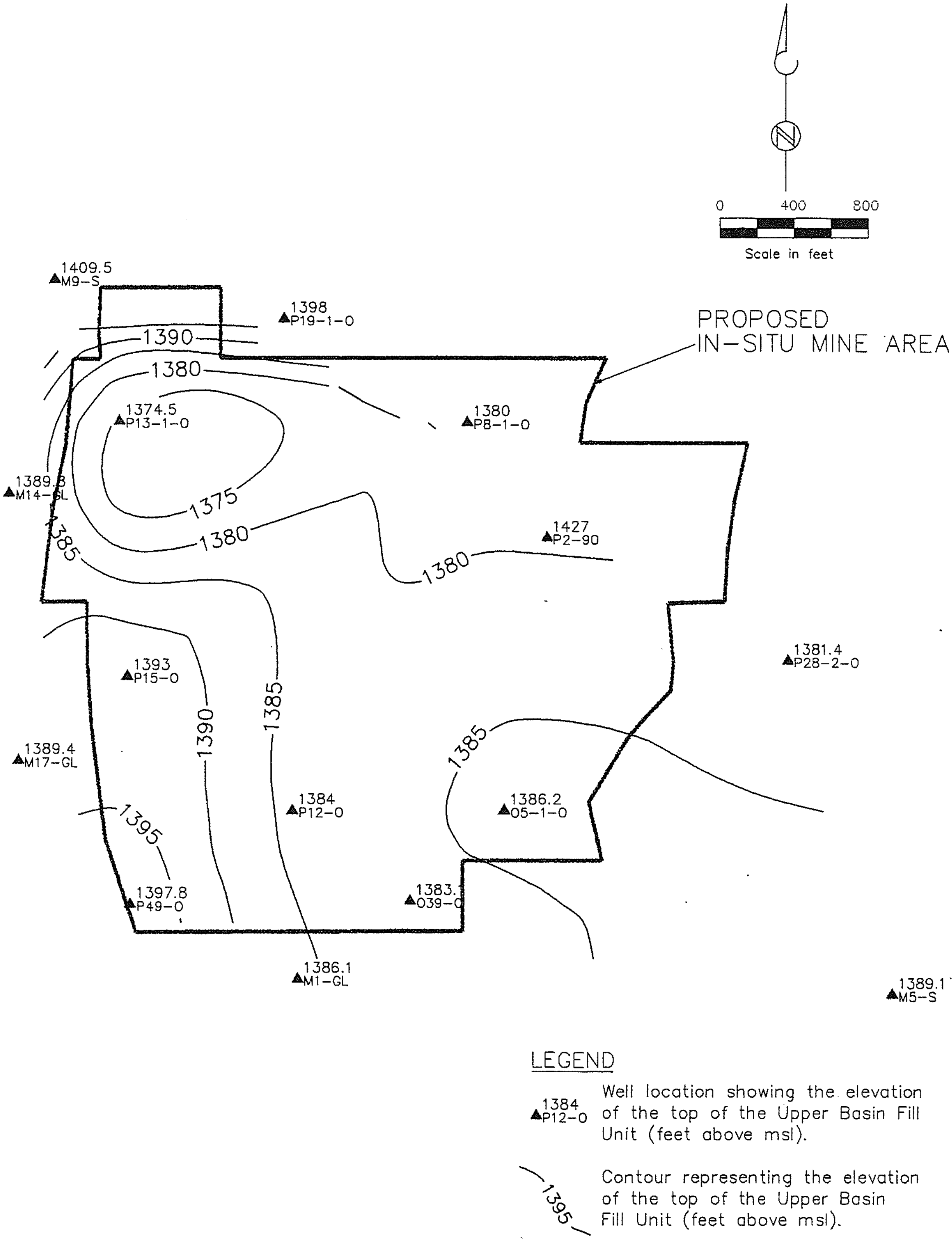


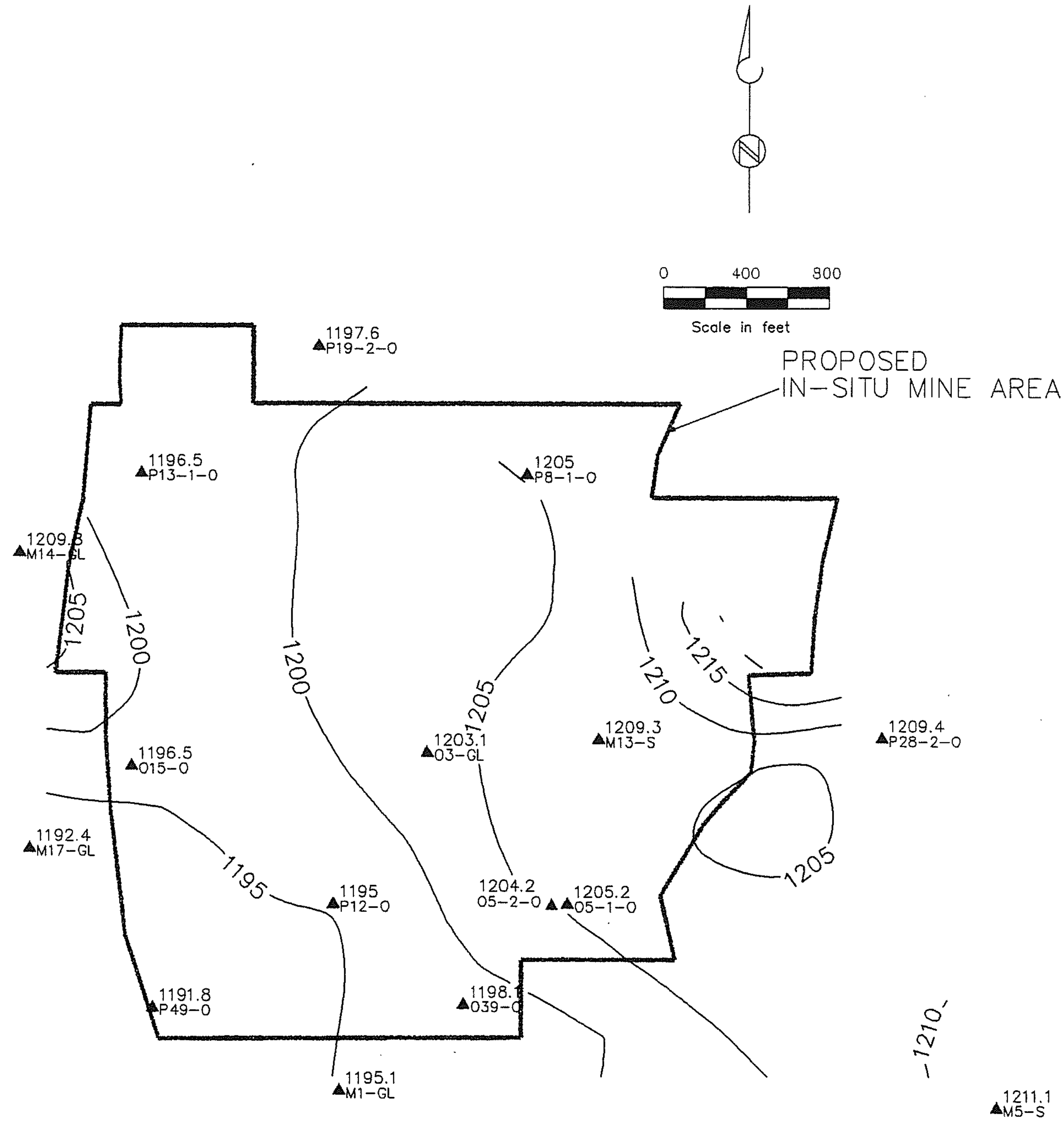
Figure 4.3-5 (II)
STRUCTURAL CONTOURS ON TOP OF THE UPPER BASIN FILL UNIT

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

GJC/VADOSE.dwg



LEGEND

1191.8 P49-0 Exploration borehole location showing elevation of the top of the Upper Basin Fill Unit (feet above msl).

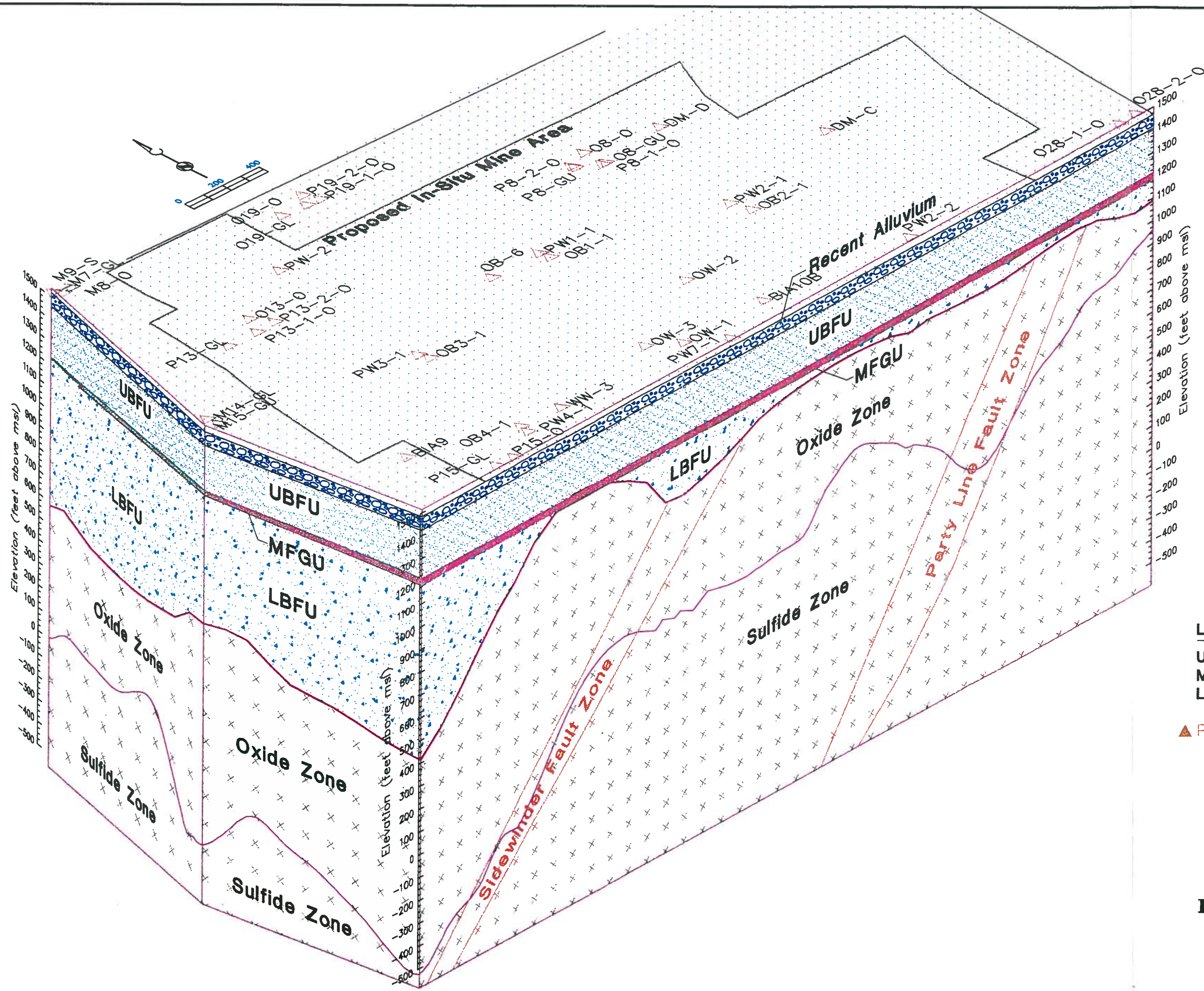
1195 Contour representing the elevation of the top of the Middle Fine-Grained Unit (feet above msl).

Figure 4.3-6 (II)
STRUCTURAL CONTOURS ON TOP OF THE MIDDLE FINE-GRAINED UNIT

GJC/top_mid.dwg

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona



LEGEND

UBFU	Upper Basin Fill Unit
MFGU	Middle Fine-Grained Unit
LBFU	Lower Basin Fill Unit
▲ PW3-1	Locations of Selected Wells

Figure 4.3-7 (II)
BLOCK DIAGRAM OF PROPOSED IN-SITU MINE AREA

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GEOL.DWG 11-05-95 GJC

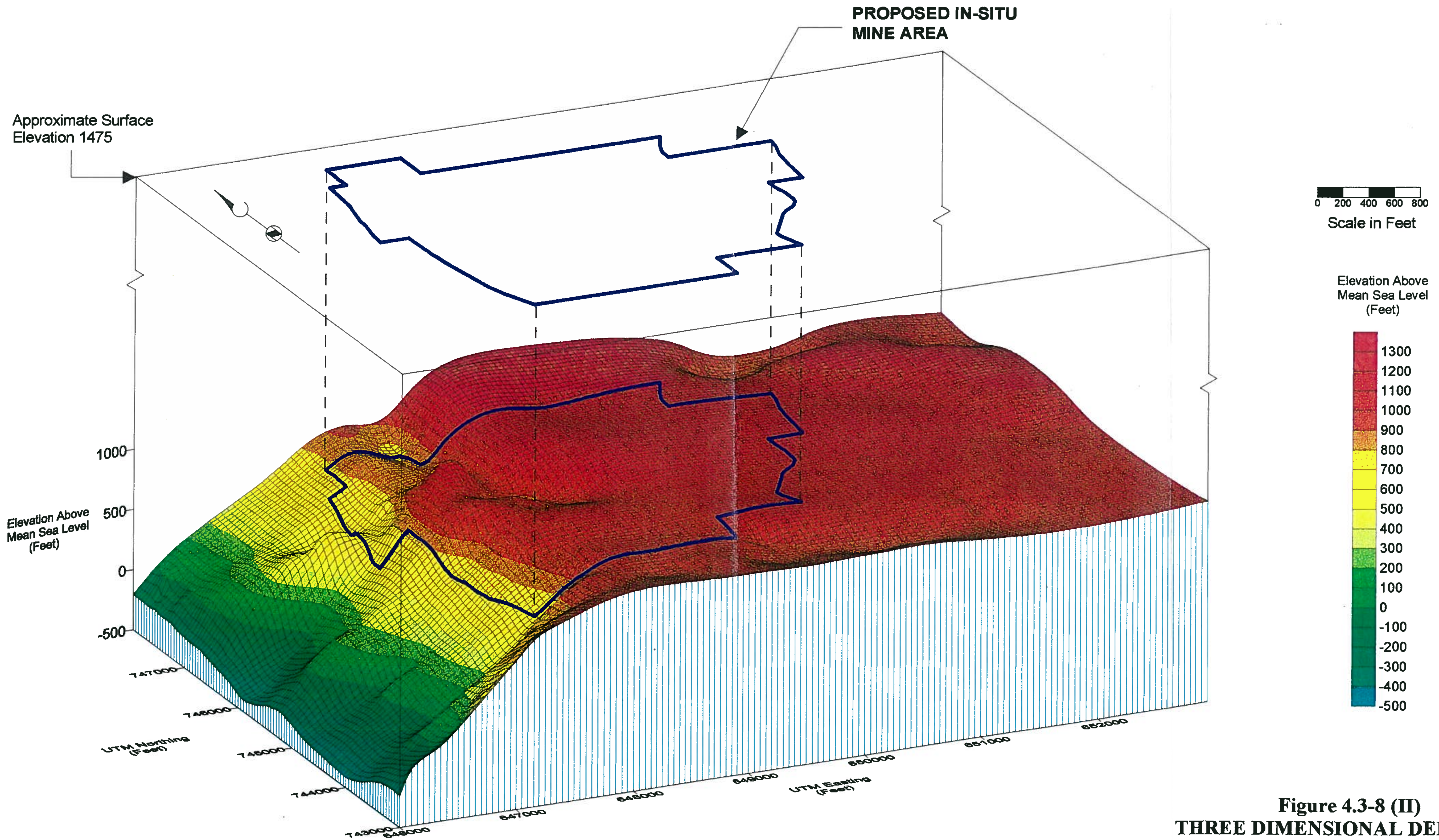

Figure 4.3-8 (II)
THREE DIMENSIONAL DEPICTION OF TOP OF OXIDE BEDROCK ZONE

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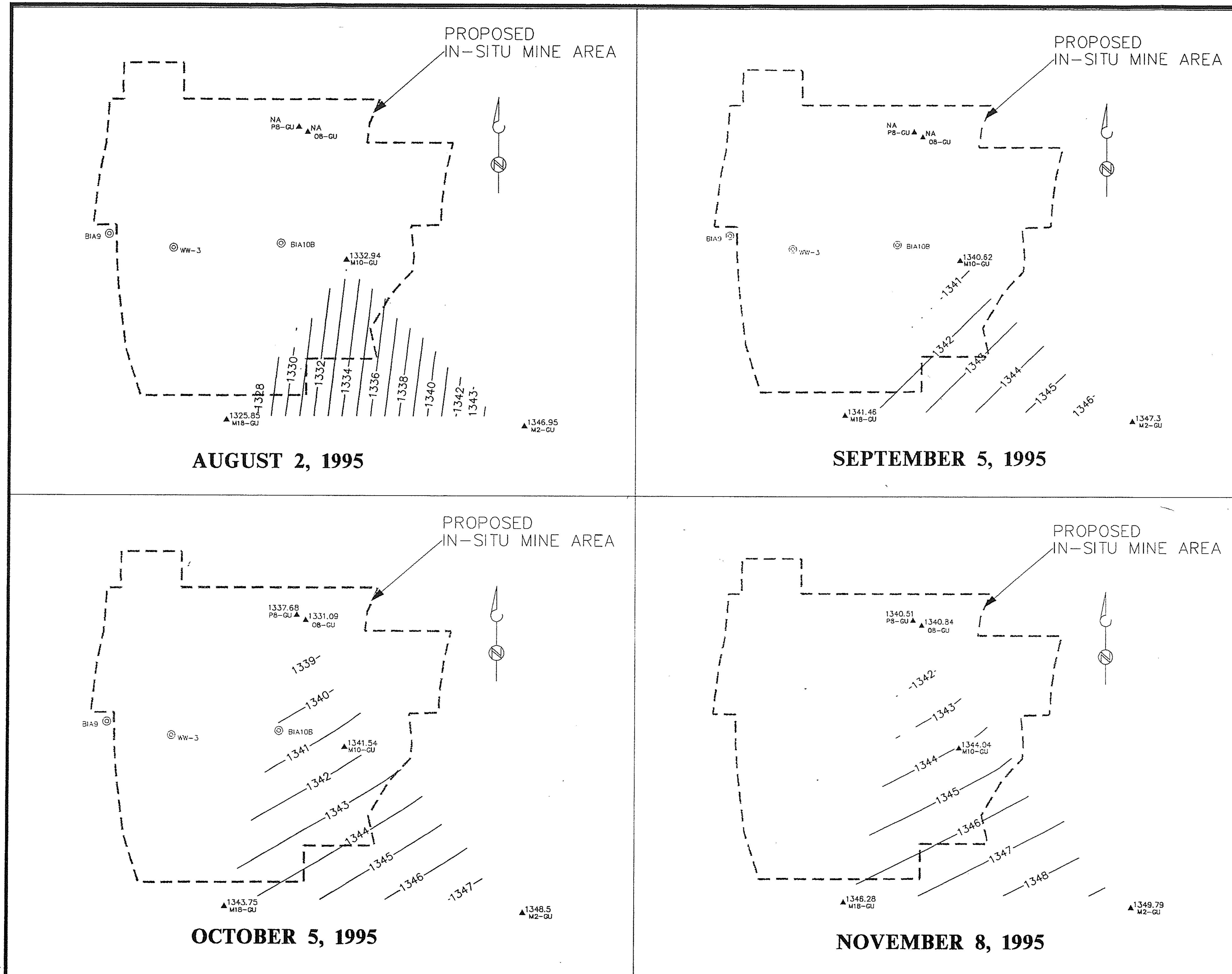
BROWN AND CALDWELL

SFIG006 01/02/96 MikeS



0 500 1000

Scale in feet

▲ 1340.62 M10-GU	Upper Basin Fill Unit well with measured groundwater potential (feet above msl)
▲ NA P8-GU	Upper Basin Fill Unit well (water level measurement not available)
◎ WW-3	Pumping irrigation well
1344	Contours of approximately equal groundwater potential (feet above msl)

Figure 4.3-9 (II)

GROUNDWATER POTENTIALS AND WATER TABLE CONTOURS UPPER BASIN FILL UNIT

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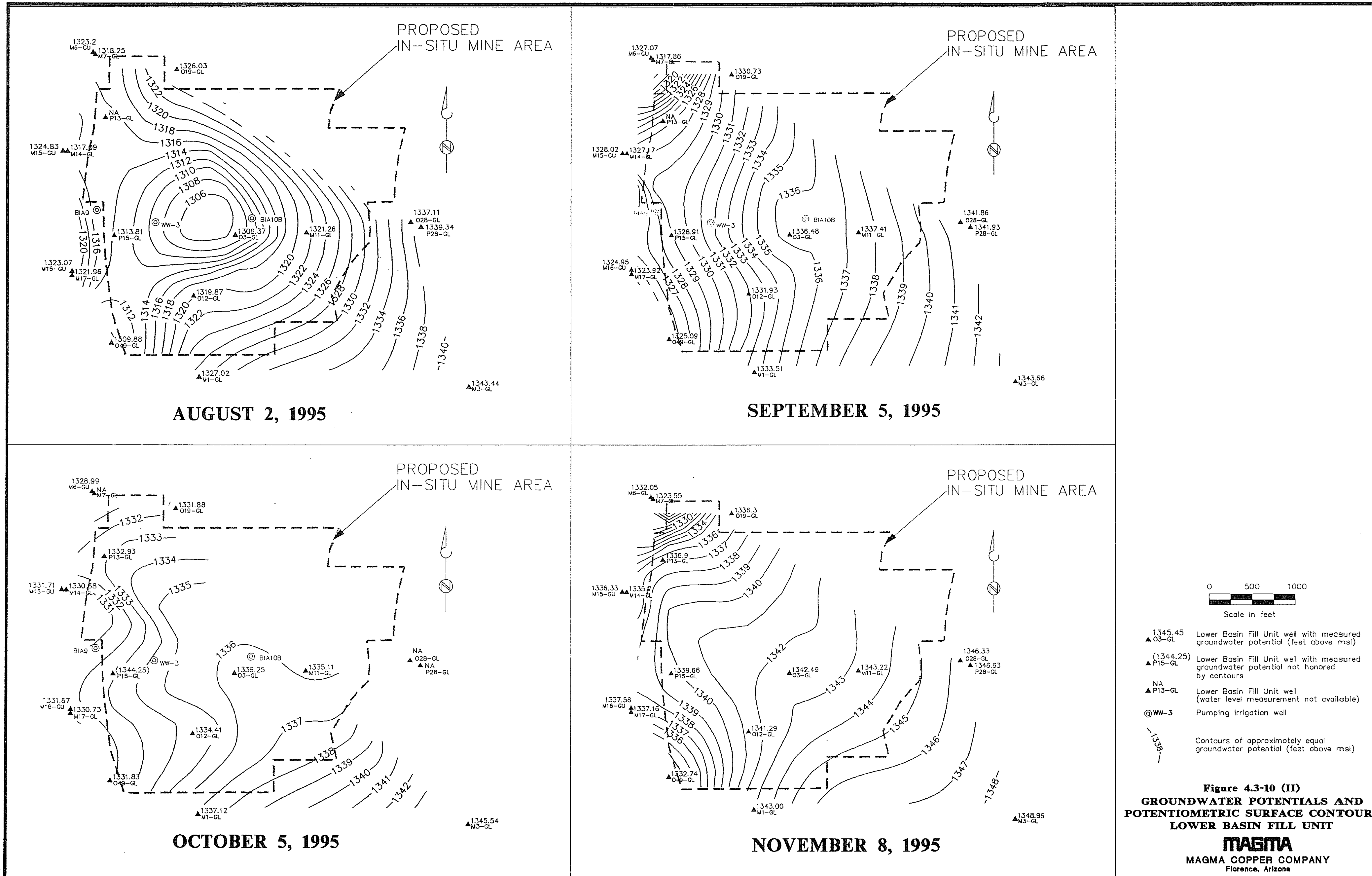

Figure 4.3-10 (II)
GROUNDWATER POTENTIALS AND POTENTIOMETRIC SURFACE CONTOURS LOWER BASIN FILL UNIT

MAGMA

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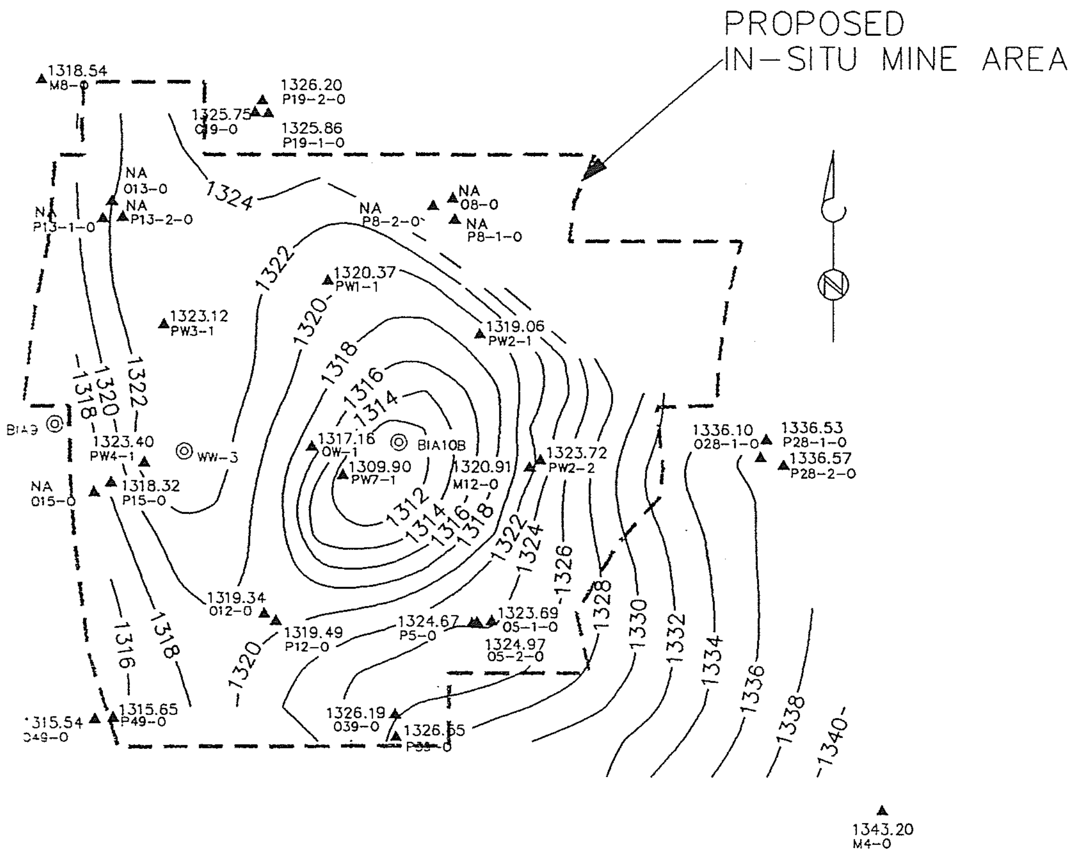
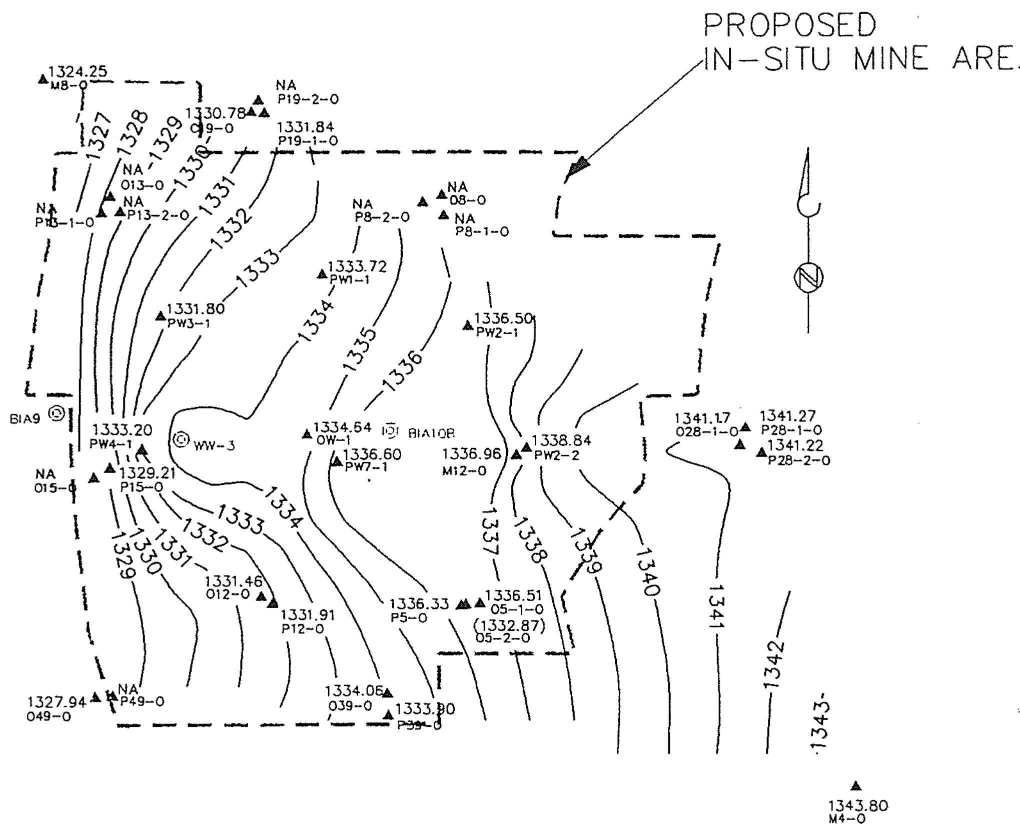


AUGUST 2, 1995



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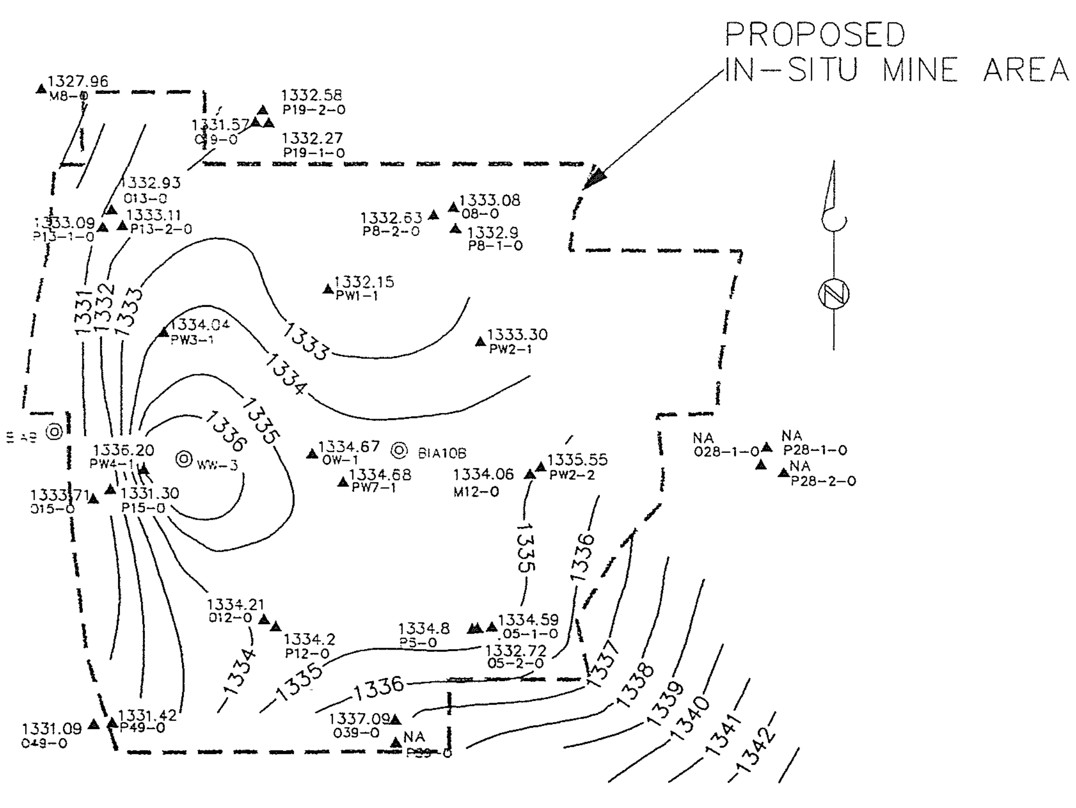

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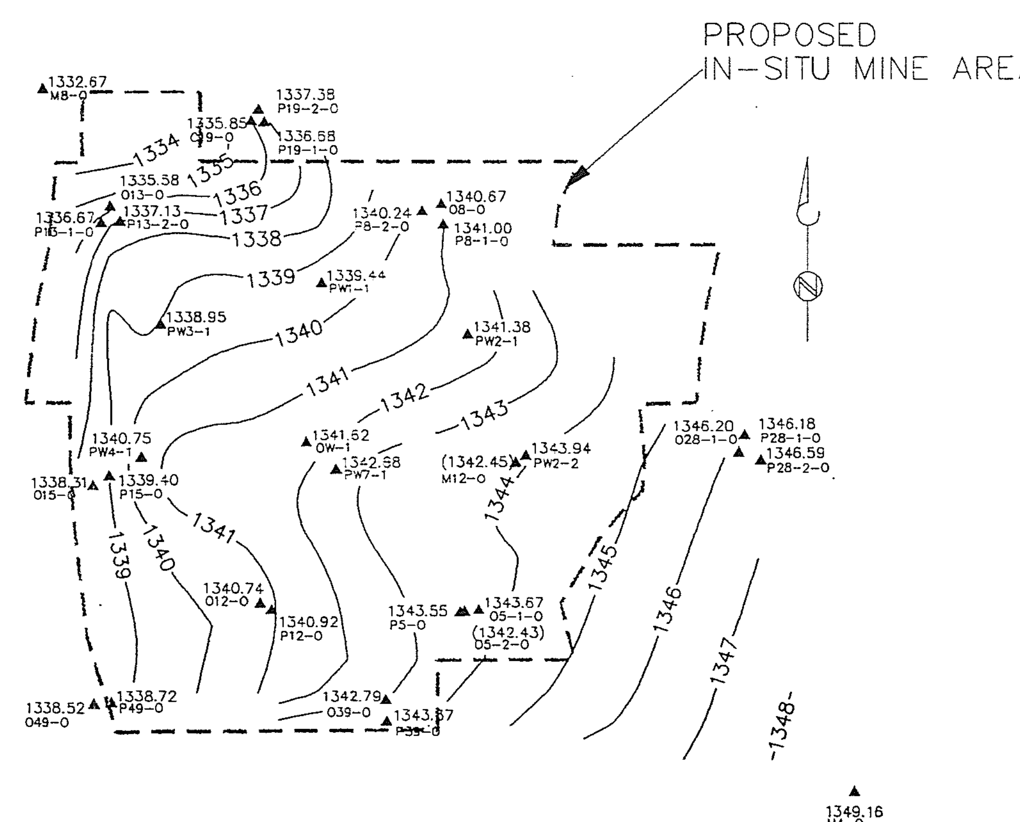

NOVEMBER 8, 1995

0 500 1000

Scale in feet

- ▲ 1345.45 P12-0 — Oxide Bedrock Zone well with measured groundwater potential (feet above msl)
- ▲ (1342.43) 05-2-0 — Oxide Bedrock Zone well with measured groundwater potential not honored by contours
- ▲ NA 08-0 — Oxide Bedrock Zone well (water level measurement not available)
- ◎ WW-3 — Pumping irrigation well
- 1338 — Contours of approximately equal groundwater potential (feet above msl)

Figure 4.3-11 (II)
GROUNDWATER POTENTIALS AND POTENTIOMETRIC SURFACE CONTOURS OXIDE BEDROCK ZONE

MAGMA

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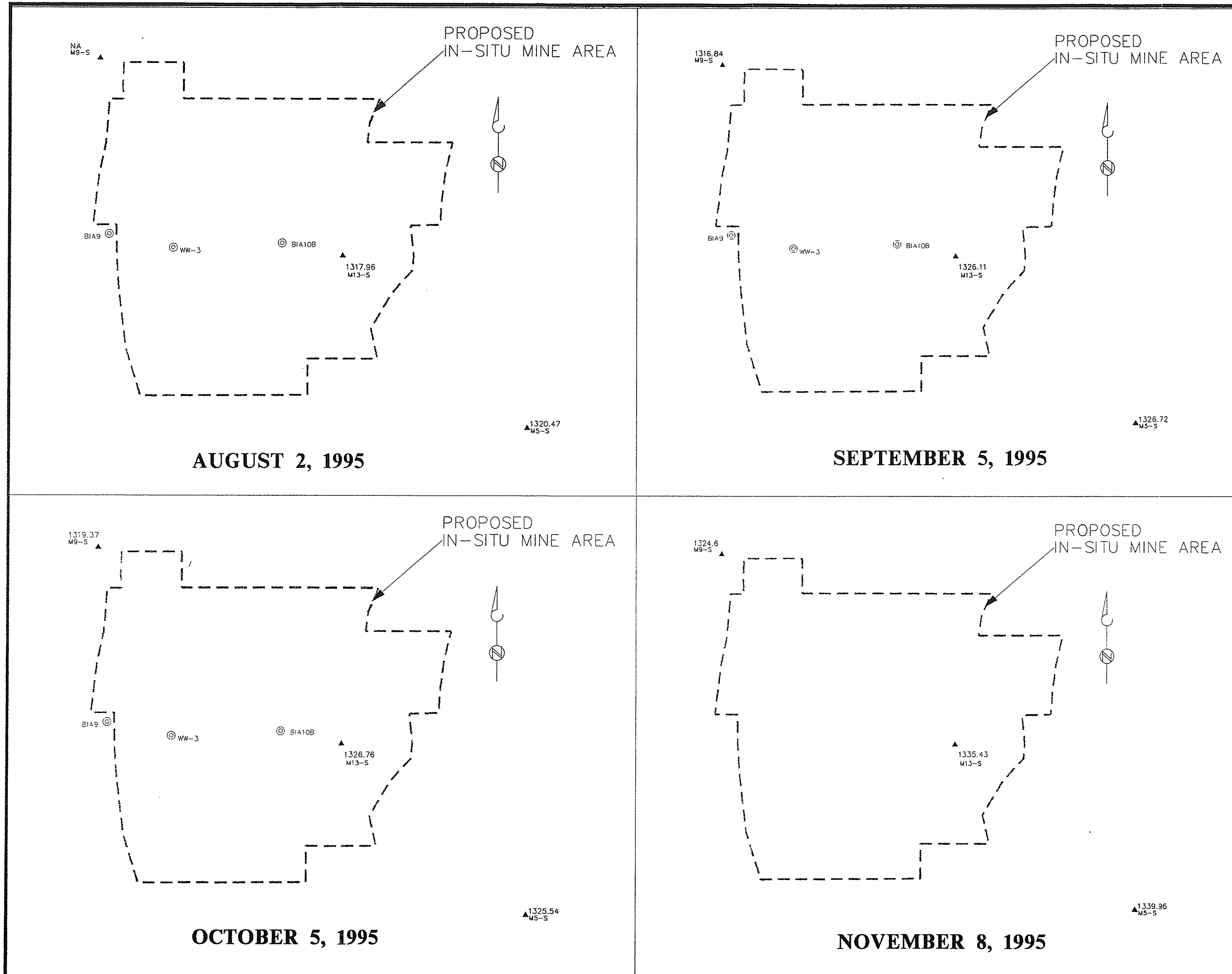

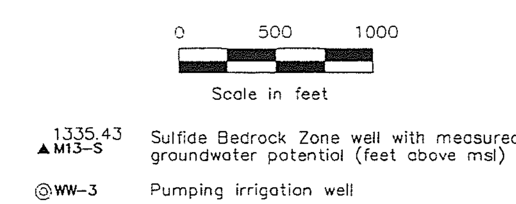

Figure 4.3-12 (II)
GROUNDWATER POTENTIALS
SULFIDE BEDROCK ZONE

MAGMA

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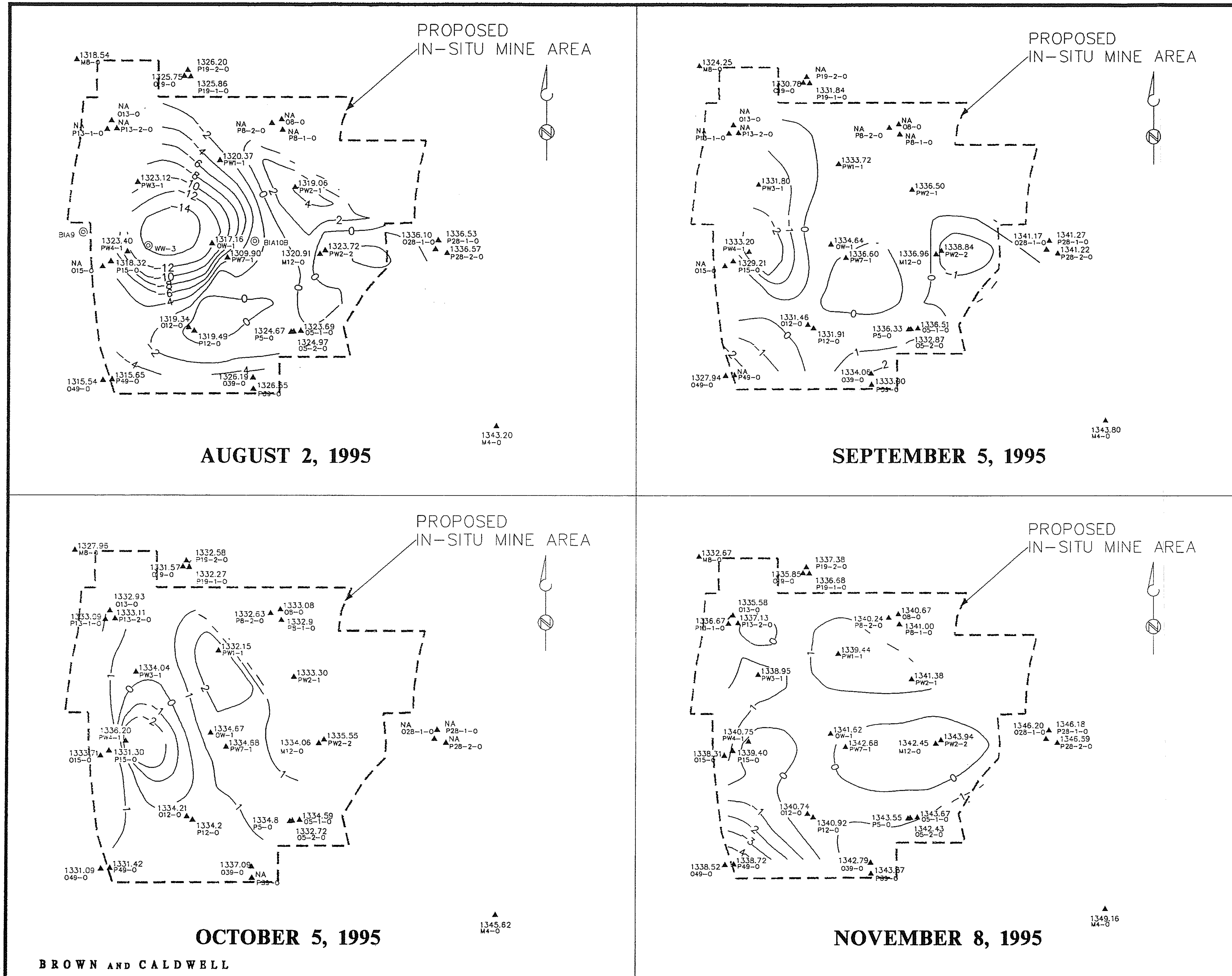
GJC/GW.DWG



0 500 1000
Scale in feet

1334.06 M4-0 Oxide Bedrock Zone well with measured groundwater potential (feet above msl)

NA M4-0 Oxide Bedrock Zone well (water level measurement not available)

WW-3 Pumping irrigation well

Contours of approximately equal difference in groundwater potential between Lower Basin Fill Unit and Oxide Bedrock Zone

Figure 4.3-13 (II)
VERTICAL HEAD GRADIENT BETWEEN THE LOWER BASIN FILL UNIT AND THE OXIDE BEDROCK ZONE

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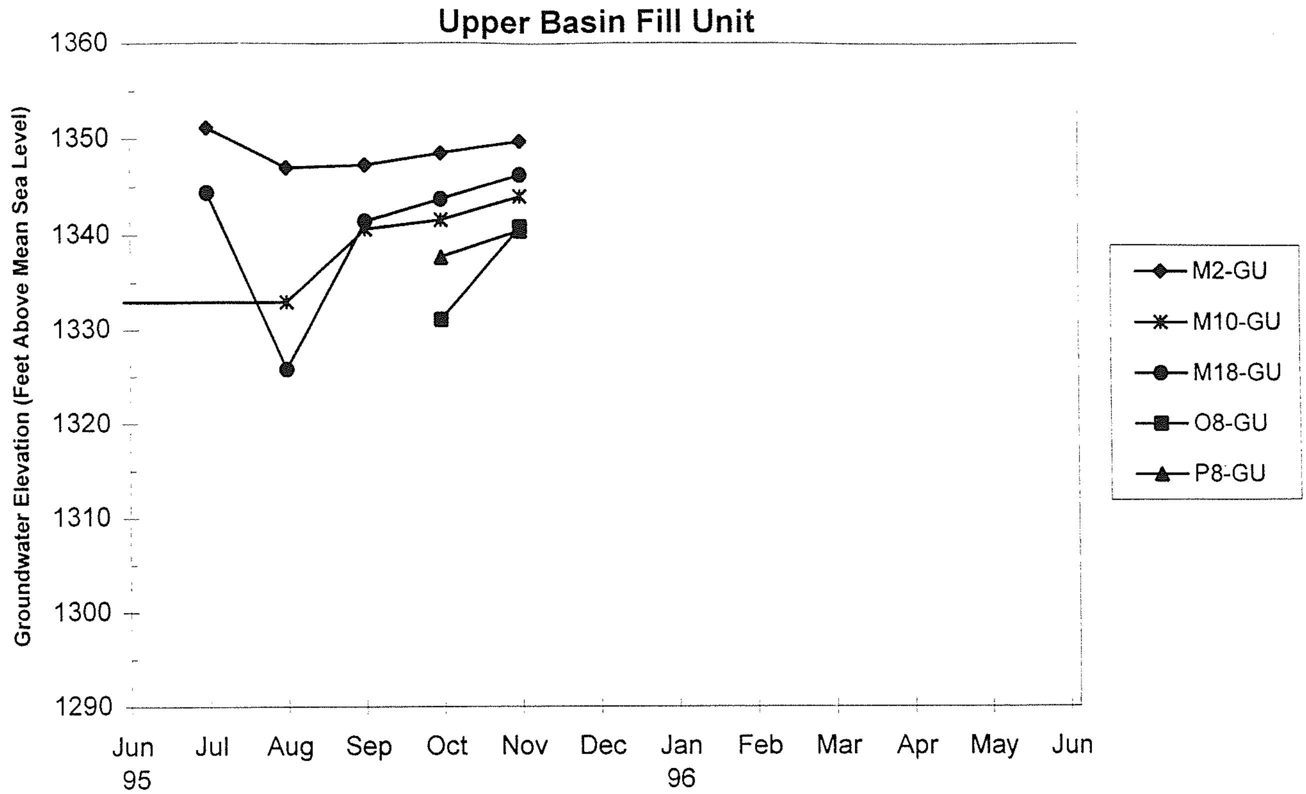
Florence, Arizona



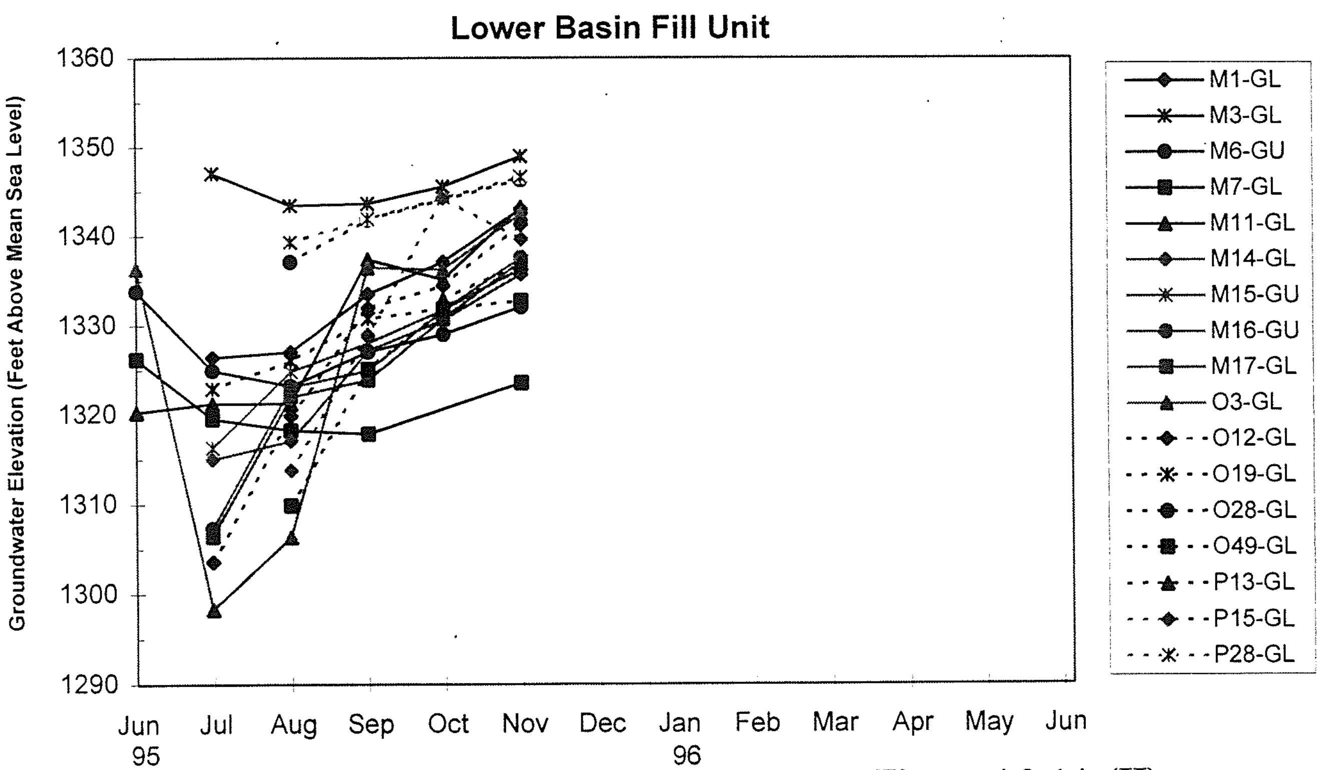


Figure 4.3-14 (II)

WELL HYDROGRAPHS: UPPER AND LOWER BASIN FILL UNITS

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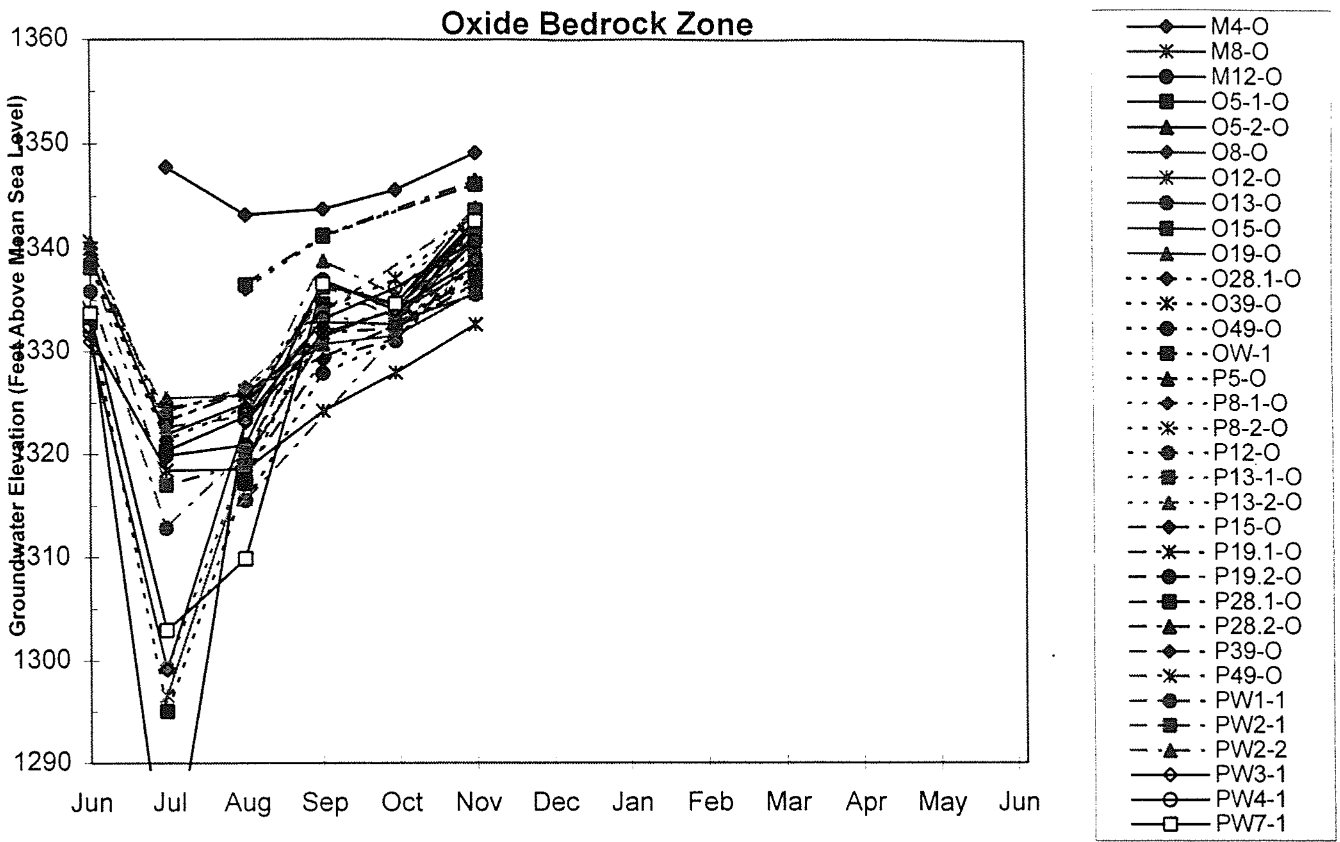
HYDROS.XLS 1/2/96



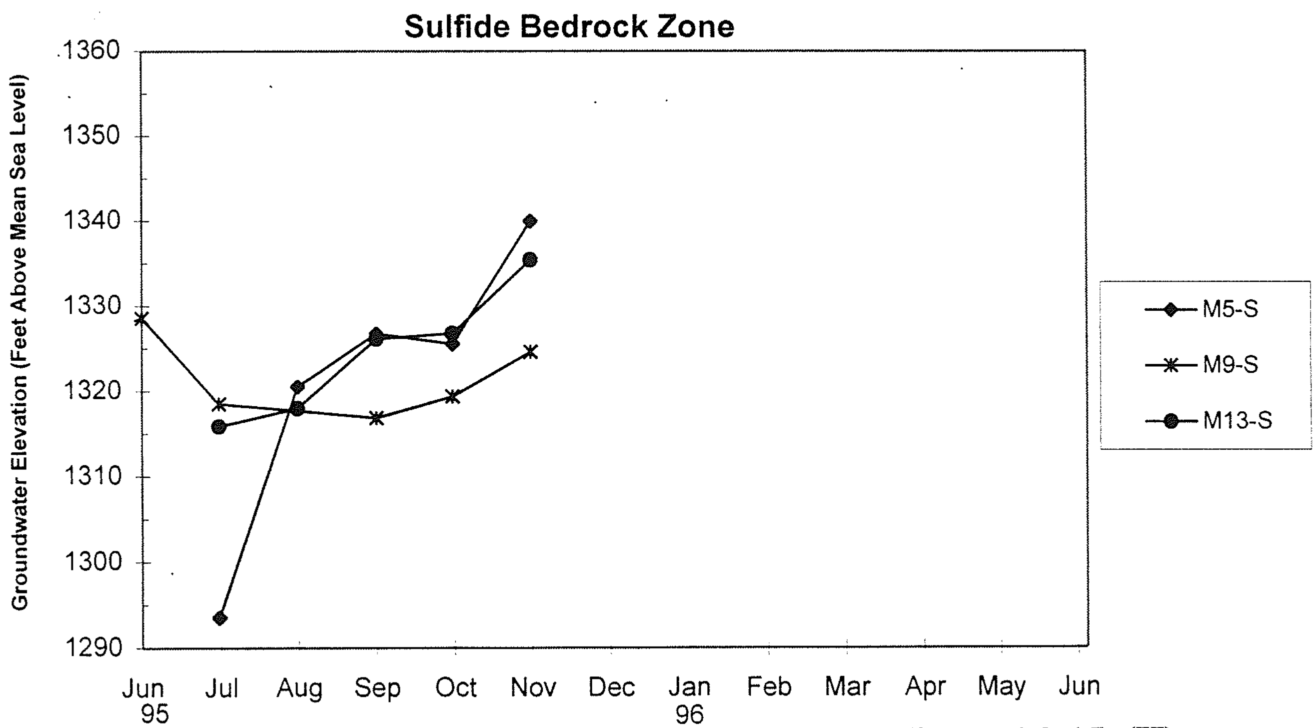


Figure 4.3-15 (II)

WELL HYDROGRAPHS: OXIDE AND SULFIDE BEDROCK ZONES

BROWN AND CALDWELL

MAGMA COPPER COMPANY
Florence, Arizona

HYDROS.XLS 1/2/96

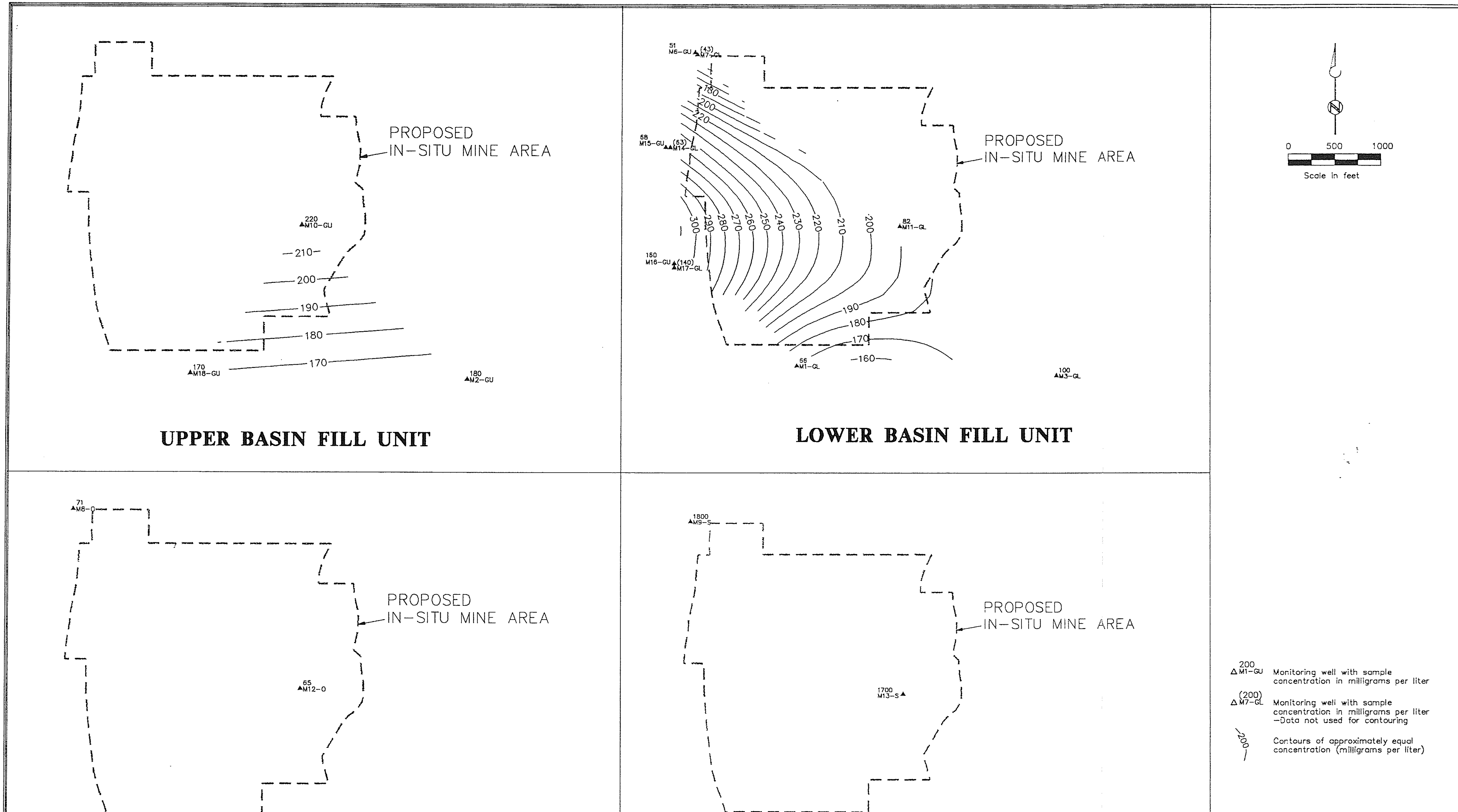


Figure 4.5-1 (II)
SULFATE DISTRIBUTION IN THE PROPOSED IN-SITU MINE AREA; AUGUST, 1995

MAGMA

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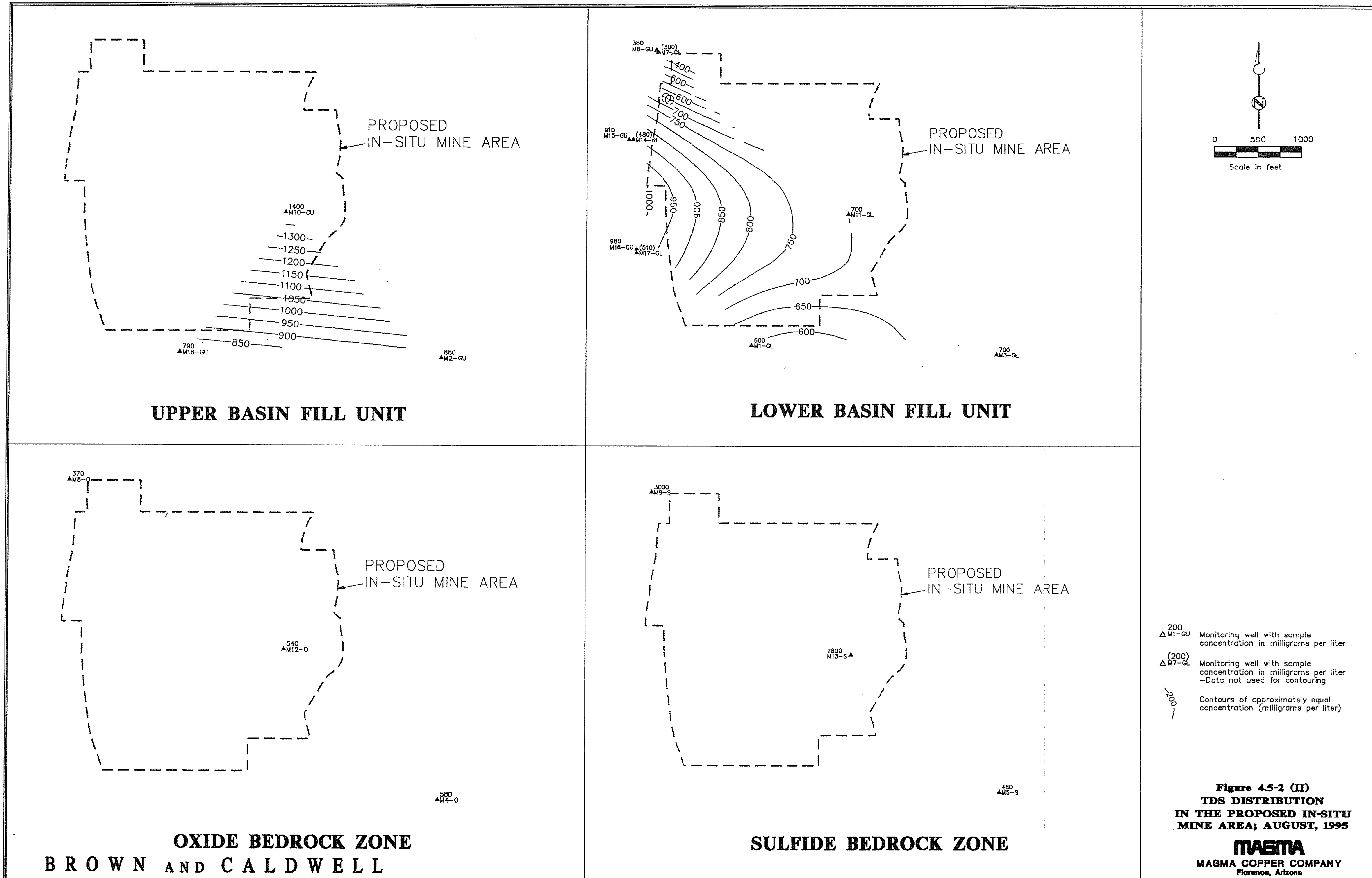

Figure 4.5-2 (II)
TDS DISTRIBUTION IN THE PROPOSED IN-SITU MINE AREA; AUGUST, 1995

MAGMA

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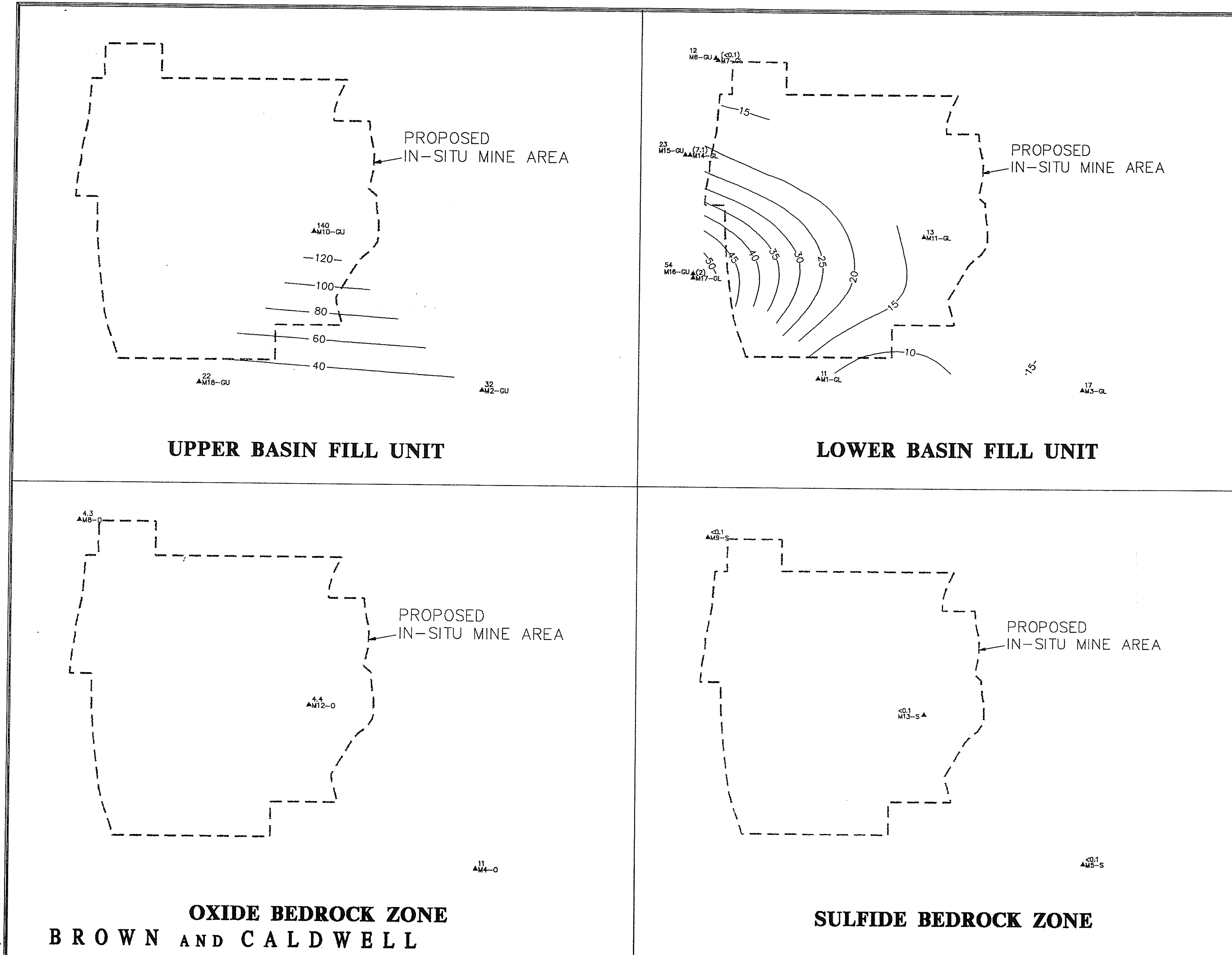

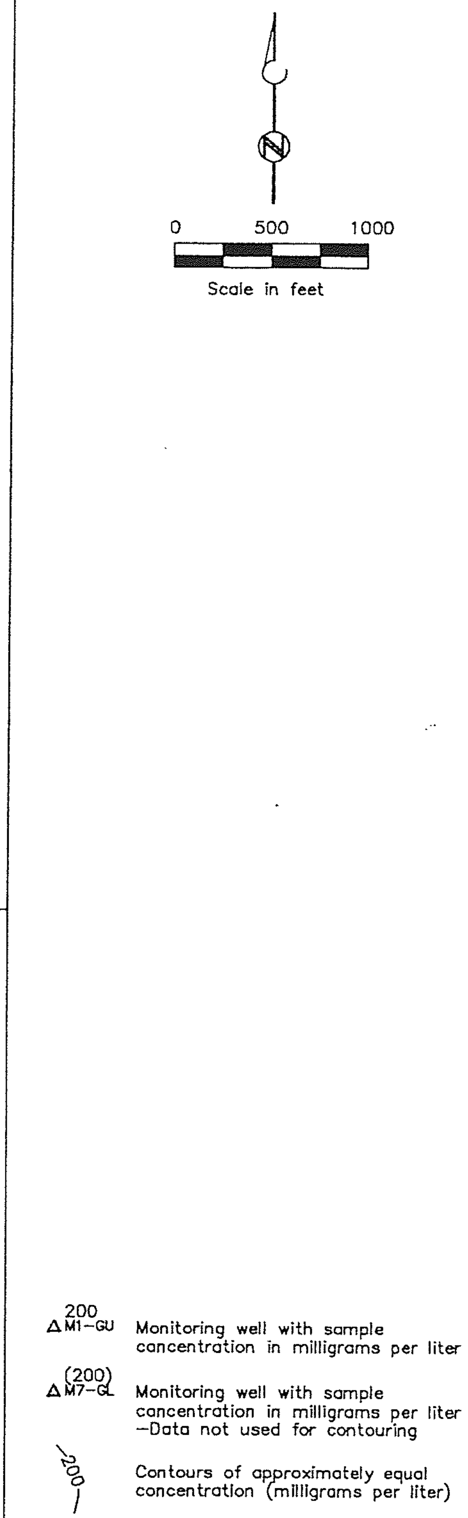

Figure 4.5-3 (II)
NITRATE DISTRIBUTION IN THE PROPOSED IN-SITU MINE AREA; AUGUST, 1995

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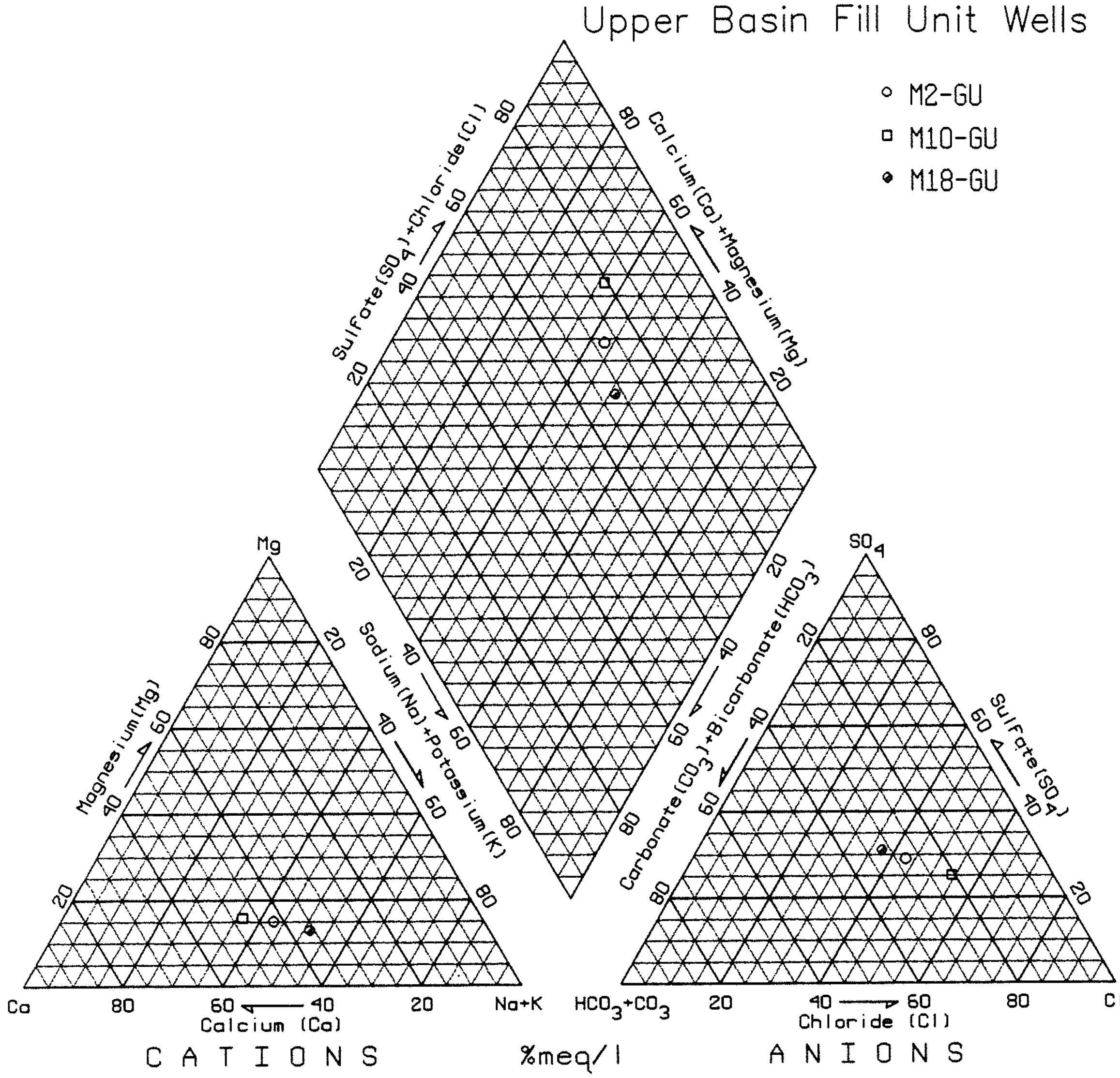

Piper diagram showing chemical analyses of groundwater from monitoring wells completed in the Upper Basin Fill Unit as percentages of total equivalents

Figure 4.5-4 (II)
PIPER DIAGRAM:
UPPER BASIN FILL UNIT

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GJC/PIPER_GU.DWG

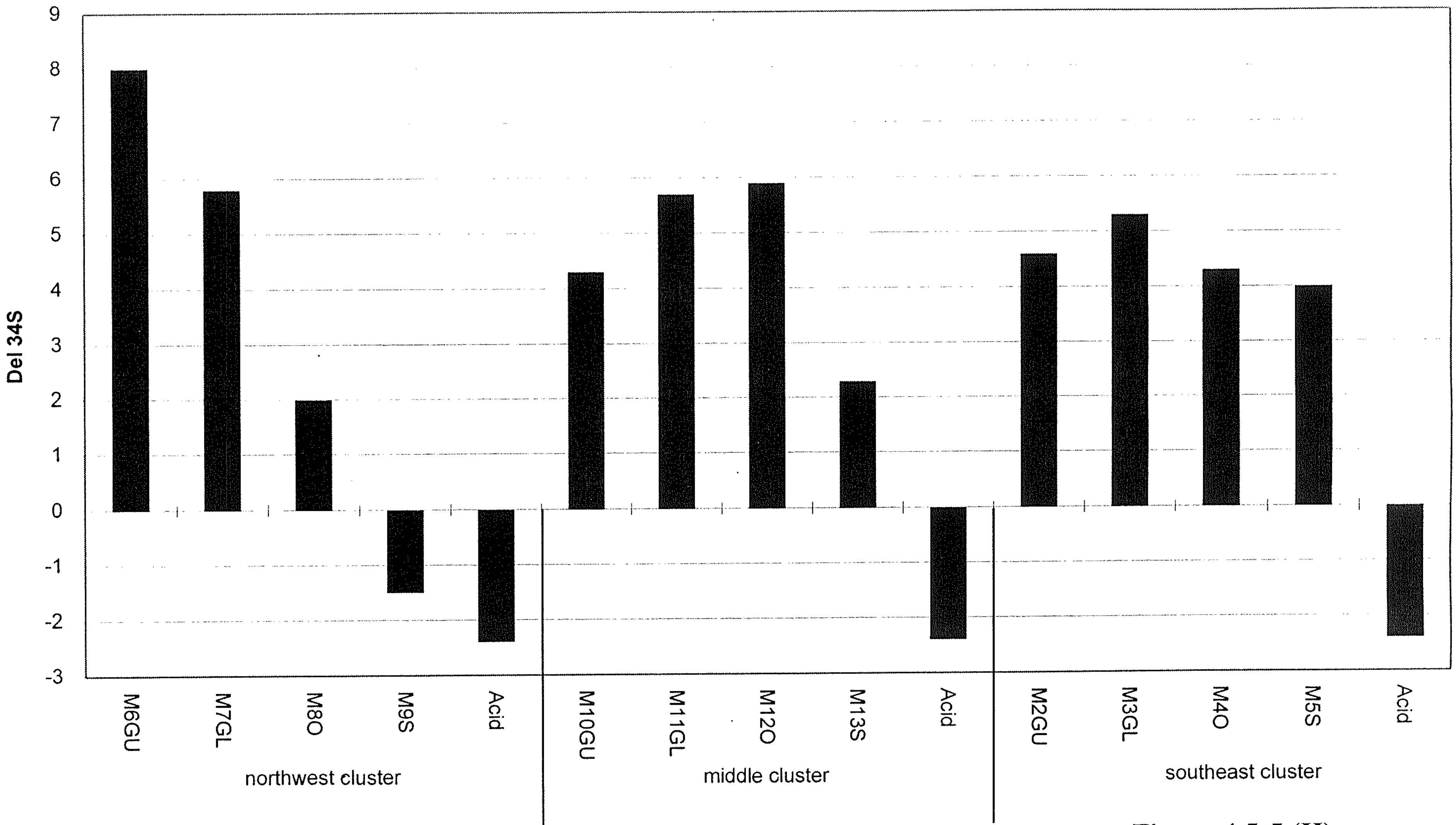

Figure 4.5-5 (II)
SULFUR ISOTOPE RATIO OF MONITOR WELL CLUSTERS

Del 34S represents the change in sulfur isotope ratio.

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FIG455_6.XLS 1/2/96

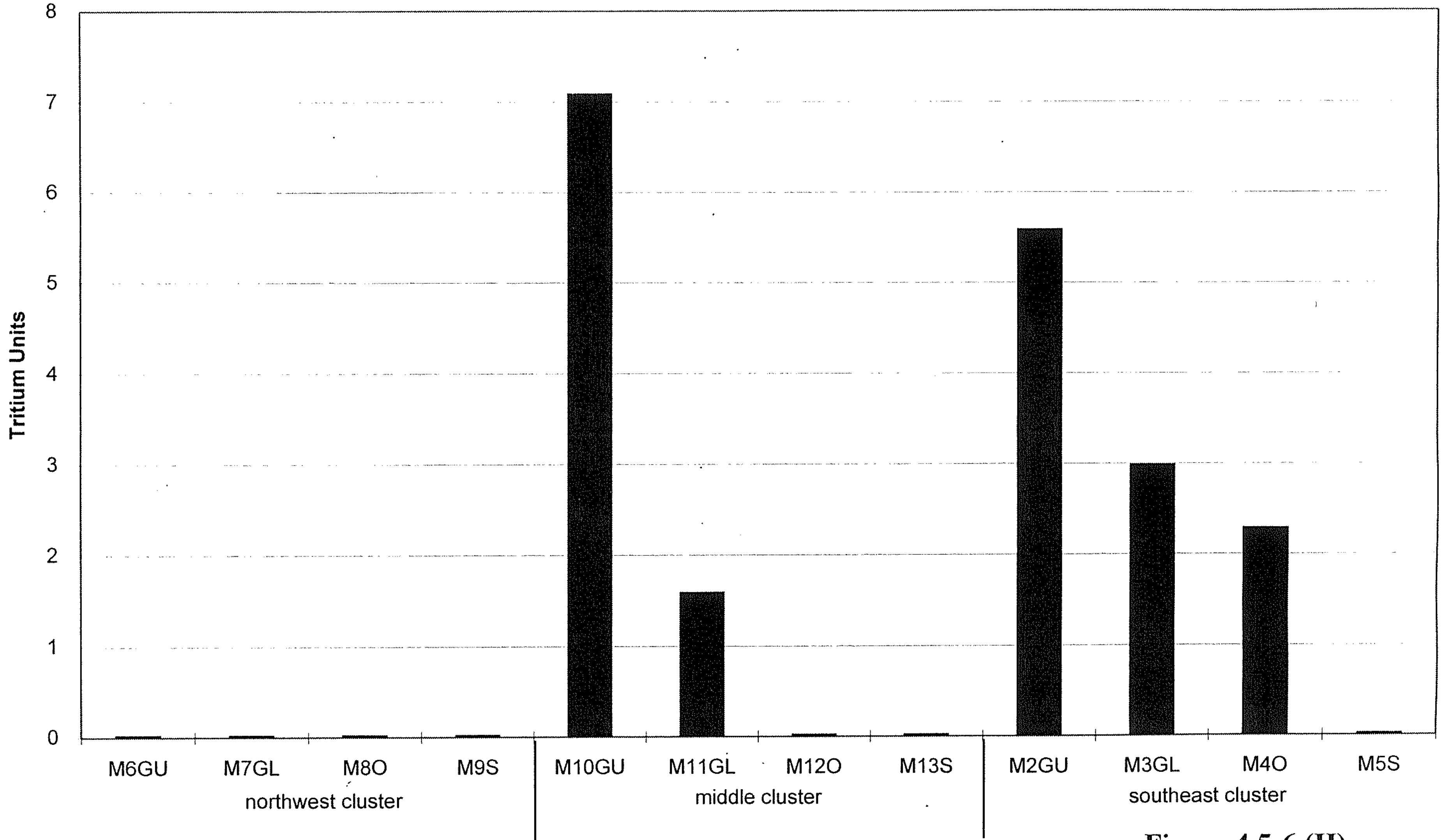

Figure 4.5-6 (II)
TRITIUM CONCENTRATION OF MONITOR WELL CLUSTERS

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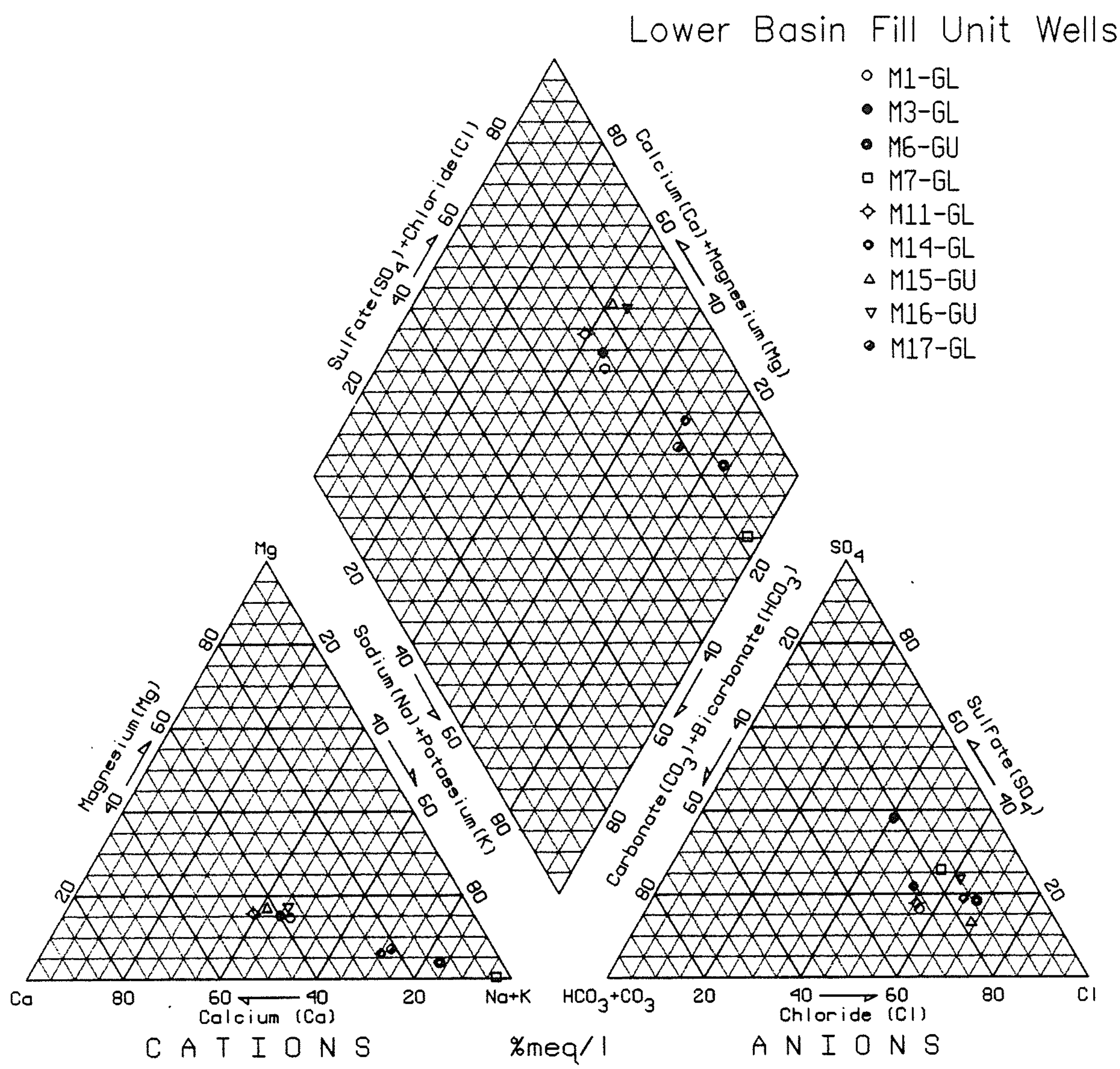
FIG455_6.XLS 1/2/96



Piper diagram showing chemical analyses of groundwater from monitoring wells completed in the Lower Basin Fill Unit as percentages of total equivalents

Figure 4.5-7 (II)
PIPER DIAGRAM:
LOWER BASIN FILL UNIT

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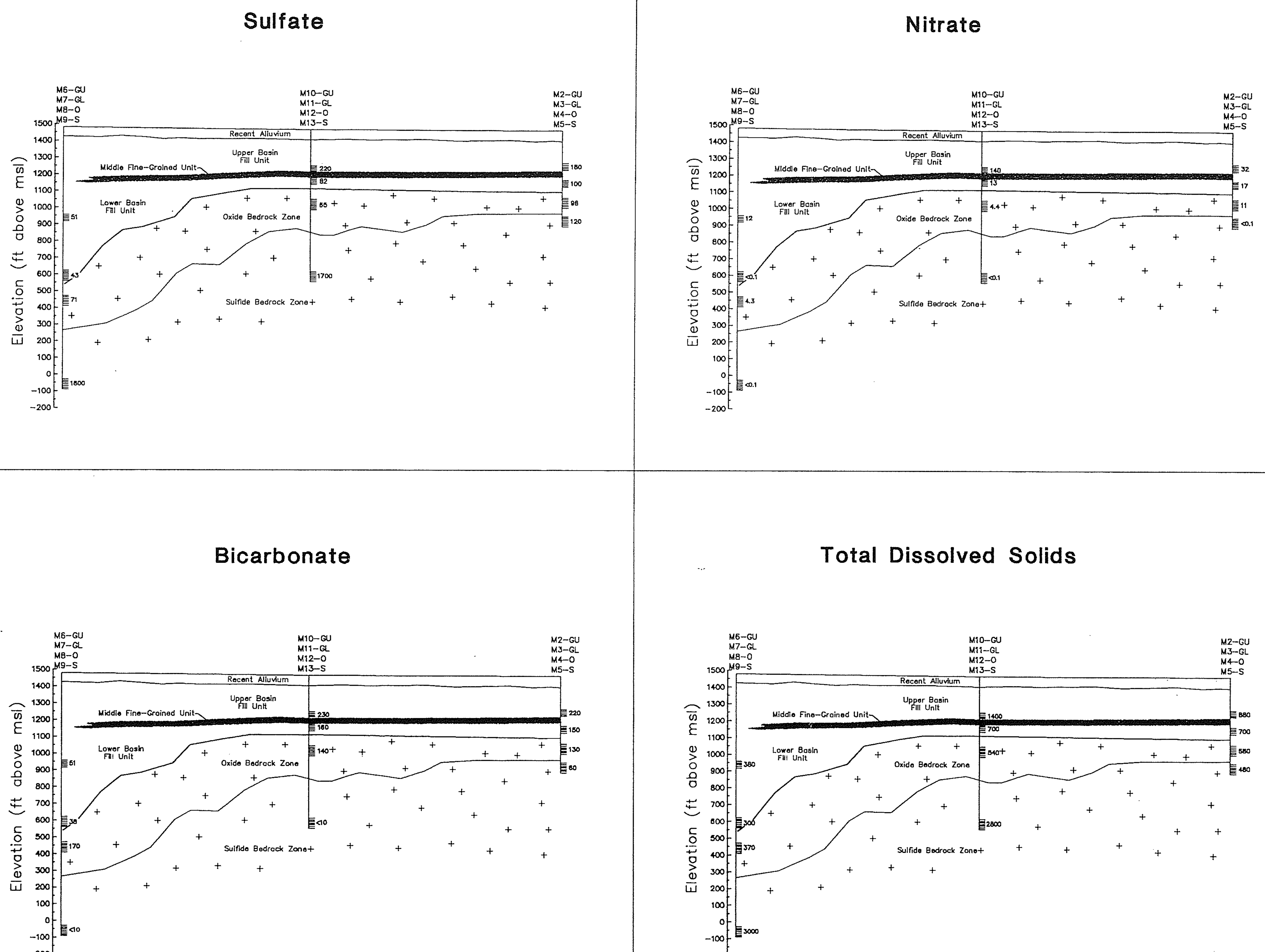
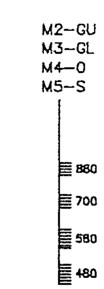
GJC/PIPER_GL.DWG



BROWN AND CALDWELL



Cluster wells with screened interval and concentration value in milligrams per liter

Figure 4.5-8 (II)

CROSS SECTION VIEW SHOWING DISTRIBUTION OF SULFATE, NITRATE, BICARBONATE, AND TOTAL DISSOLVED SOLIDS (TDS) IN CLUSTER MONITORING WELLS

MAGMA

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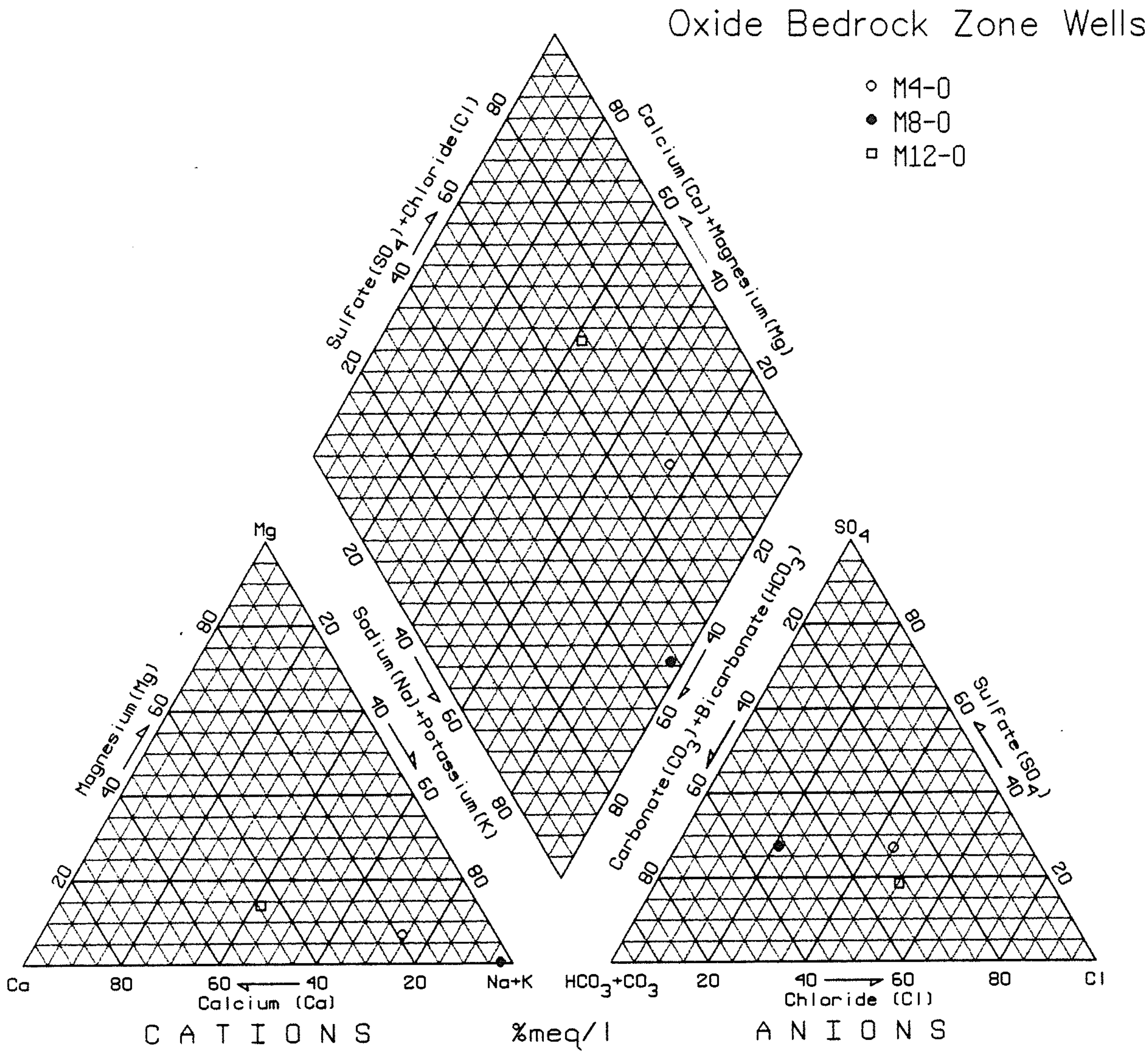

Piper diagram showing chemical analyses of groundwater from monitoring wells completed in the Oxide Bedrock Zone as percentages of total equivalents

FIGURE 4.5-9 (II)
PIPER DIAGRAM:
OXIDE BEDROCK ZONE

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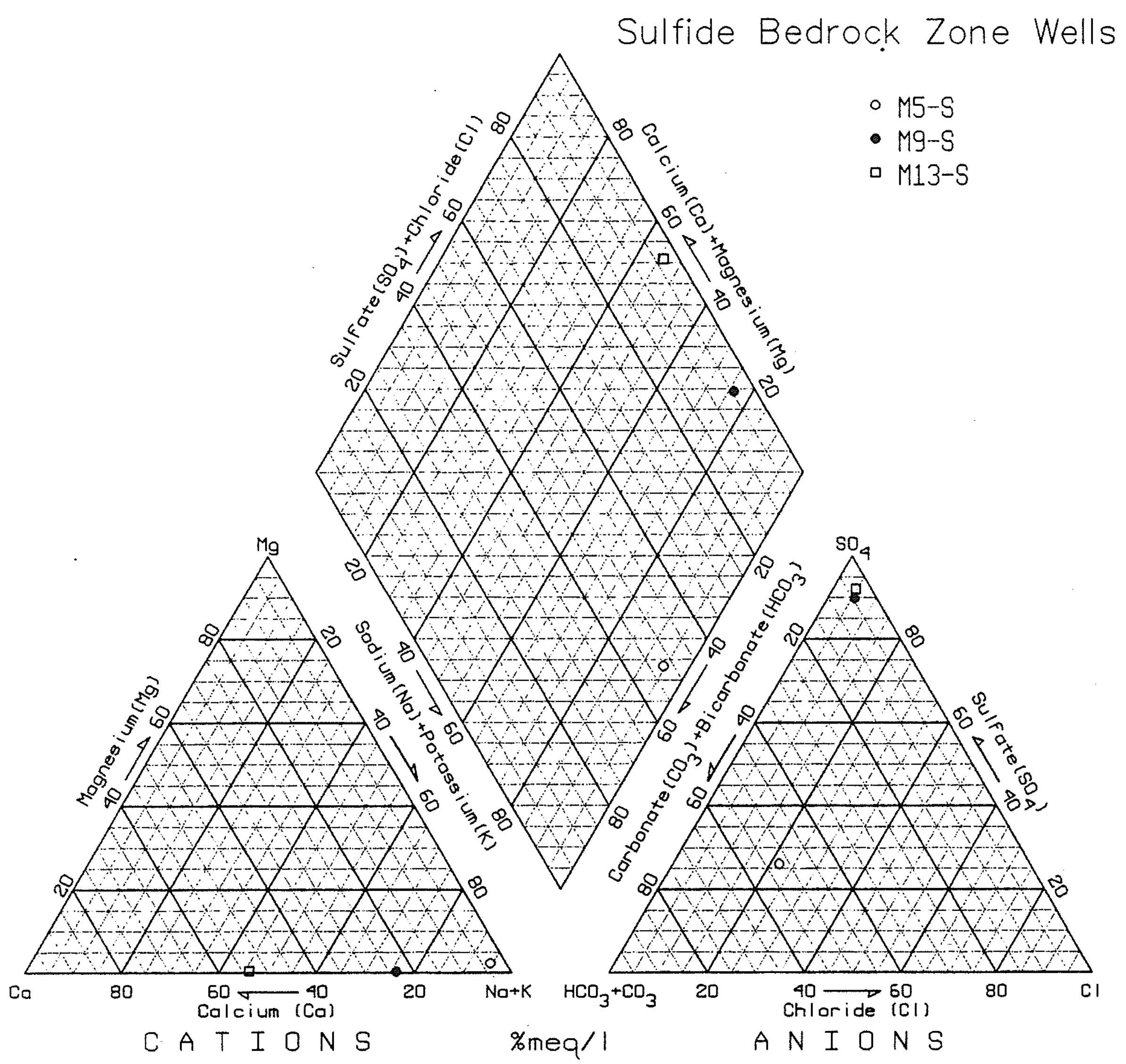
GJC/PIPER_O.DWG



Piper diagram showing chemical analyses of groundwater from monitoring wells completed in the Sulfide Bedrock Zone as percentages of total equivalents

Figure 4.5-10 (II)
PIPER DIAGRAM:
SULFIDE BEDROCK ZONE

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Florence, Arizona

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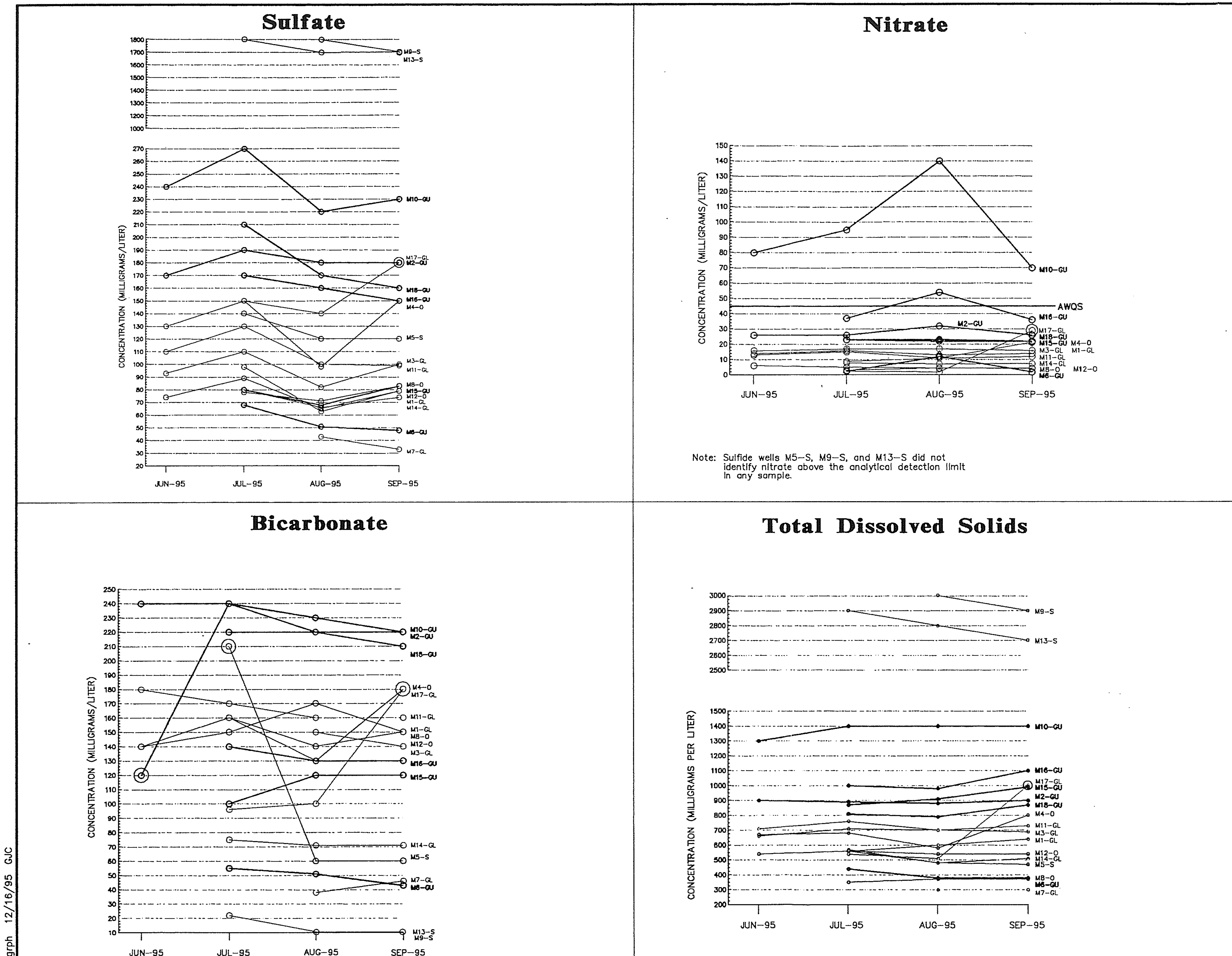
GJC/PIPER_S.DWG



chemgrph 12/16/95 GJC

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LEGEND

AWQS Arizona Water Quality Standard

◎ Value is not representative (see section 4.0)

Figure 4.5-11 (II)

CONCENTRATION VS TIME GRAPHS FOR PROJECT MONITOR WELLS

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SECTION 5.0

CONCEPTUAL HYDROGEOLOGIC SITE MODEL

The previous two chapters of this document have presented both a regional and local overview of the geological and hydrological characteristics of the Magma Copper Company (Magma) Florence study area. These characteristics are interrelated to form a conceptual hydrogeologic model. This model becomes the basis for more detailed simulations of groundwater flow and solute transport behavior presented in Volume IV of this application. Calibration to known conditions during the numerical simulations serves as further validation of the initial hydrogeologic interpretations. The on-going analysis of groundwater flow will provide an effective means of refining the original model.

5.1 MODEL COMPONENTS

As depicted in Figure 5.1-2(II), site-specific components of the geologic profile can be characterized by dividing the system into sedimentary and igneous bedrock components. The following is a description of the properties of each component, and what role each plays in controlling groundwater flux.

5.1.1 Basin-Fill Deposits

As compared to the underlying crystalline rock, the hydrologic properties of the basin-fill deposits appear to be more uniform laterally and vertically. Intergranular permeability appears to dominate, with limited influence of any structural discontinuities upon the permeability profile. The system is layered, with high overlying permeability of the Upper Basin-Fill Unit (UBFU) somewhat isolated from the underlying sedimentary sequence of moderate conductivity. This impedance to downward flow is probably caused by intercalated finer-grained units throughout the sequence and by the Middle Fine-Grained Unit (MFGU). Bulk permeability appears to decrease with depth due to increases in compaction and induration. Although there are significant variations in transmissivity in the vertical dimension, only limited downward head gradients are evident (see Figure 4.3-13[II]). The groundwater potentials detected in the vertical profile are principally associated with the stress of regional irrigation withdrawals from the high-yield deposits in the basin-fill. It is likely that the whole of the basin-fill aquifer receives recharge from a common source, the regional underflow and infiltrated contribution of the Gila River.

Considering the depositional history of the sediments, refinements to a simply layered model merit consideration. A generalized reconstruction of the relationship between sedimentation and structural adjustments in the basement rocks reveals the presence of several localized conditions that may influence groundwater behavior. Possibly the most significant of these conditions is the potential presence of fractures and fault zones within the older and stratigraphically lower sediments directly over and adjacent to the oxide orebody. These discontinuities are likely present because the accumulation of basin sediments was contemporaneous with Basin and Range fault activity. Older, more indurated and disrupted conglomerates may also occupy a north-trending swale along the west-facing flank of the Poston Butte horst. This crystalline bedrock surface was once exposed to the atmosphere, as evident from the presence of a deep and well developed oxidized zone in the porphyry complex. Prior to regional subsidence of the west graben, this surface appears to have been part of a peneplain, a portion of which is now preserved as the sediment/crystalline bedrock contact underlying the eastern half of the study area. As assumed by the apparent lack of local fault displacements in the MFGU, any significant disruption of the sedimentary basin-fill is likely restricted to the Lower Basin-Fill Unit (LBFU).

In addition to the effects of structural discontinuities, the mechanics of clastic sedimentary deposition have likely contributed to the occurrence of elevated hydraulic conductivity in those deposits in close proximity to the buried west flank of the Poston Butte horst. These sediments were deposited in a mountain-front setting, with alluvial fan and colluvial deposition as the dominant processes. Therefore, particle size decreases basinward, and clay/silt content increases. In addition, these water-lain deposits usually express preferential permeability, with the vertical conductivity considerably lower than the horizontal. However, all of these probable variations in the groundwater flow regime should be viewed in the context of the age and depth of burial of the older sedimentary sequence. Simply, the degree of compaction is likely the controlling factor on hydraulic conductivity, with all of the indurated material relatively low in permeability.

An important distinction is evident when comparing the LBFU with the overlying coarse grained sediments of the UBFU. The genesis of the younger, more permeable sediments above the MFGU appears to be related to a depositional environment similar to that present today. The sediments appear to be laterally uniform, based on the occurrence of high-yield wells throughout the area. The predominantly coarse-grained nature of the unit is indicative of a high-energy, externally-drained geomorphic regime.

The preference for lateral flow in the basin-fill deposits is expressed in the dissolved groundwater chemistry. Nitrate values originating from agricultural land use are elevated in the UBFU, with a marked decrease in concentration in the LBFU. The distribution and ratios of dissolved constituents in groundwater deep in the west graben is markedly different than that of groundwater migrating over the top of the oxide ore body. Tritium values significantly decrease with depth, implying that the source of recharge to the deeper sedimentary horizons is primarily from lateral, not vertical flux.

The inducement for the vertical migration of groundwater may be essentially artificial, caused by large-scale irrigation pumping of the sedimentary aquifer, therein stressing the less permeable sedimentary profile at depth. These effects, and distortions in the ambient lateral distribution of hydraulic heads, are probably seasonal and could cause significant transient influences upon local groundwater flow direction and gradient.

5.1.2 Crystalline Bedrock Complex

The saturated sedimentary sequence described above is deposited over a complex of mineralized igneous rock types. For the purpose of simulating groundwater flow, it is realistic to infer that none of these rock types possess appreciable matrix permeability. Groundwater flow in the crystalline mass is controlled by the direction, aperture and interconnection of rock discontinuities. In the case of the Florence orebody, the principal discontinuities are an array of dominant north to northwest-trending normal fault zones, with intervening segments of moderately to highly fractured bedrock. There appears to be no correlation between actual rock type and measured hydraulic conductivities at the levels of precision and resolution employed.

Although the general structural fabric is dominated by normal faulting, the effect of these features and other intersecting structures upon groundwater flux has created more complex condition. This complexity can be resolved from a comparison and assessment of the conditions depicted on Figure 5.1-1(II). When collectively evaluated, these data sets reveal structural elements that control the rate and direction of groundwater movement through the fractured crystalline mass.

The two principal fault zones that have been identified through exhaustive drilling programs are the Sidewinder and the Party Line Faults (see Figure 5.1-2[II]). Some segments of the Sidewinder in the center of the proposed in-situ leach field that are in excess of 200 feet in width, consisting of highly fractured and brecciated bedrock. Vertical displacements along these primary structures are in excess of 1,000 feet. Both of these faults appear to be affected by an east to west-trending structural lineament that deflects the normal faults in a left-lateral sense. The inferred structure also appears to have controlled the development of the oxide zone. Based on corehole data, the deepest penetration of the oxidation process in the orebody, and the greatest preserved thickness of oxide materials are at the convergence of the east-west structure with the two normal fault zones.

As interpreted from geophysical studies, fracture intensity data, the distribution of estimated permeabilities, and variations in hydraulic head gradients, the central core of the site west of the Sidewinder fault zone may be higher in conductivity than that portion of the site east of the fault (see Figure 5.1-2[II]). Hydraulic gradients flatten across this locale, drawdowns in observation wells during aquifer testing were more pronounced and widespread west of the Sidewinder Fault, and the intensity of conjugate faults and rock fracturing are greater in this area. The lateral and vertical extent of this zone of higher conductivity appears to correlate with the occurrence of the thickest part of the oxide body. This region also correlates with the buried ridge in the top of crystalline bedrock surface that trends northward along the western flank of the Poston Butte horst.

Due to the potential existence of higher conductivity in that portion of the hanging wall of the Sidewinder fault that is heavily oxidized, a similar zone of enhanced conductivity is inferred in the same relative position immediately west of the Party Line structure. In addition, a northwest-trending feature of structurally high bedrock and thicker oxide deposition diverges from the intercept of the inferred east-west lineament with the Sidewinder fault zone. This feature is interpreted to be a region of elevated fracture permeability.

In addition to being supported by the site-specific data sets, the concepts expressed above are in keeping with the broader knowledge base related to ore genesis and structural history. As discussed by Nason and others (1982), enhanced zones of rock permeability caused by fracturing and brecciation were present upon initial mineralization. These permeability variations influenced primary mineralization. The subsequent lateral and vertical distribution of oxidized ore was also controlled by this network of more permeable regions in the bedrock. As stated by Nason and others (1982), these permeable features were the conduits for the percolation of meteoric water from the surface that oxidized the upper portion of the orebody and subsequently formed zones of supergene enrichment.

Oxidation of the ore deposit is believed to have continued throughout a late stage cyclic period of erosion and normal faulting. It is plausible to assume that the Basin and Range faults and any east-west structural elements existed as planes of structural weakness and brecciation prior to major displacement. The continued tectonic adjustments along these structures in the late Tertiary and early Quaternary time has likely maintained the permeability contrasts prevalent throughout the history of emplacement and hydrogeochemical adjustment of the Florence orebody.

A further correlation between the structural fabric of the site and the distribution of hydraulic conductivity is demonstrated by the nature and magnitude of the Sidewinder fault zone. Based upon corehole and other data, the extent of the fault zone is depicted as a rather narrow region of disrupted and sheared bedrock. From a regional perspective, the entire face of the horst, including the rock mass up to and encompassing the designated fault zone, can be defined as the bounding tectonic structure. When viewed from this perspective, the hanging wall of the structure is actually within a large complex of conjugate faults, containing highly fractured rock.

Hydraulic communication between the top of the oxide ore and the overlying or flanking sediments appears to be intimate. This high degree of communication is expressed in at least two ways. First, head distributions in the two units mimic each other, with similar response in groundwater potential when large scale stresses due to pumping are imprinted over the ambient conditions. The second line of evidence is the lack of appreciable vertical head gradients between the Oxide Bedrock Zone and the LBFU. A downward head is present when the region is experiencing the effects of irrigation withdrawals. This condition appears to rapidly dissipate once the transient effects of this pumping subsides.

On the basis of the available data, a pattern of consistently lower hydraulic conductivity with depth is not evident in the oxide bedrock zone. Independent of the influence of significant structures, some decrease in overall permeability in the oxide zone should be anticipated due to effect of overburden pressure on fracture aperture and interconnection. What is measured is the relatively low permeability and apparent degree of isolation of groundwater that resides in the underlying sulfide bedrock. Wells that are discretely screened in the sulfide bedrock are slow to recover from low-yield purging in preparation for water quality sampling. The dissolved chemistry of these samples is, in two cases, laden with high sulfate, iron and calcium concentrations in a high pH environment. This condition is indicative of a zone of enrichment associated with the initial development of the overlying oxide. Fracture infilling in the sulfide bedrock near the interface may be dominated by the presence of jarosite and gypsum. The existence of these sulfate minerals induces the capacity for some subsequent dissolved migration of sulfate. However, elevated sulfate concentrations have not been measured in the oxide zone. When considering these factors and the lack of tritium concentrations in the sulfide bedrock, low hydraulic conductivity in the deep, unoxidized bedrock appears to restrict appreciable groundwater flux within the sulfide bedrock.

5.2 THE ASSUMPTION OF EQUIVALENT POROUS MEDIUM

The assumption that the fractured oxide orebody of the Florence deposit behaves as an equivalent porous medium (EPM) is a prerequisite for performing subsequent analyses of groundwater flow and solute transport. This assumption is validated by observing the behavior of the fractured rock under pumping stress and confirming that these responses are similar to those experienced in a typical intergranular medium. In the case of the Florence site, the intensity and persistence of the rock discontinuities are sufficient to cause the aquifer to behave as an EPM at the scale required for this assessment. The clearest demonstration of this EPM behavior is the laterally persistent head responses in the fractured rock resulting from high-capacity pumping of the saturated medium. As with the test pumping of WW-3 (see Figure 5.1-1[II]), drawdowns were experienced across the site, with only a slight elongation of the cone of depression along the trend of the Sidewinder fault zone. In addition, the August 1995 water levels depict the dominant effects of irrigation pumping over and in the oxide bedrock zone. Again, the depressurization within the crystalline rock is wide-spread and general symmetrical.

The various elements of the conceptual hydrogeologic model discussed above have been integrated into the numerical model presented in Volume IV, establishing its geometry and enable predictions of control and/or excursion within and out of the in-situ mine area.

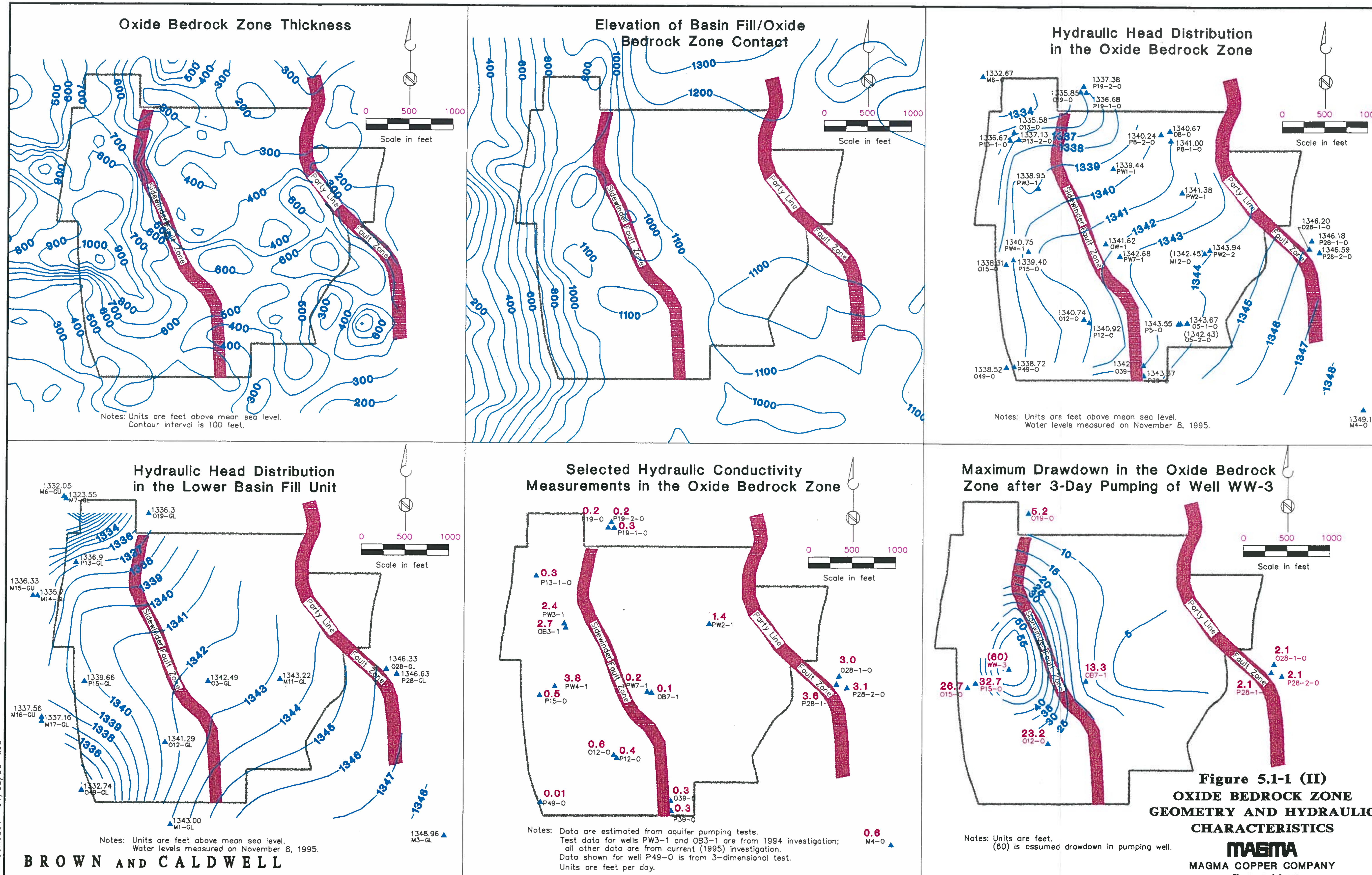
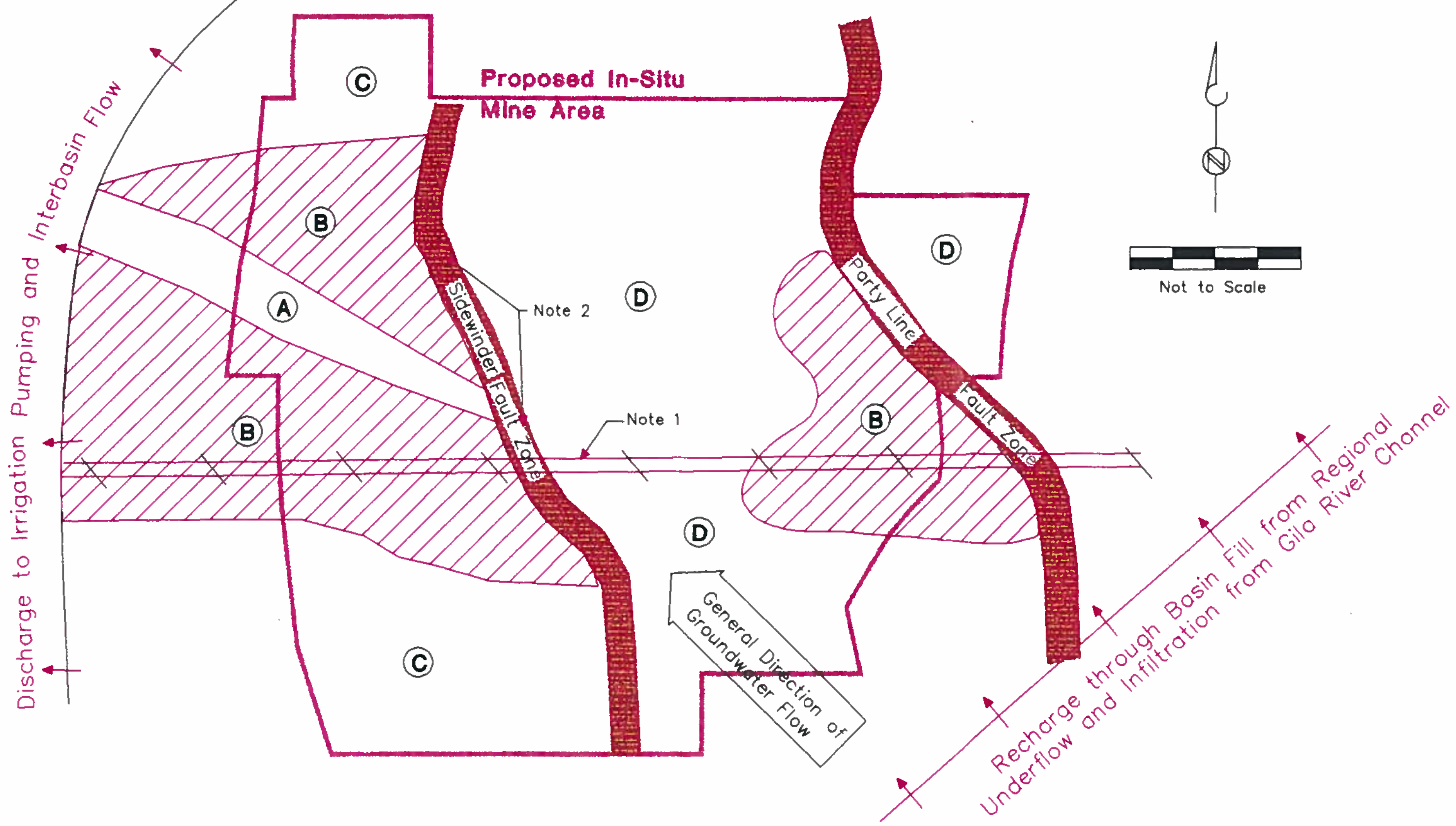


Figure 5.1-1 (II)
OXIDE BEDROCK ZONE GEOMETRY AND HYDRAULIC CHARACTERISTICS



PLAN VIEW SHOWING BEDROCK FEATURES

LEGEND

A. Possible structural feature expressed as alignment of zones of thicker oxide deposition.

B. Apparent region of relatively higher hydraulic conductivity that correlates with occurrence of thicker oxide zone.

C. Potential zones of relatively lower hydraulic conductivity based on head distribution and in–place permeability measurements.

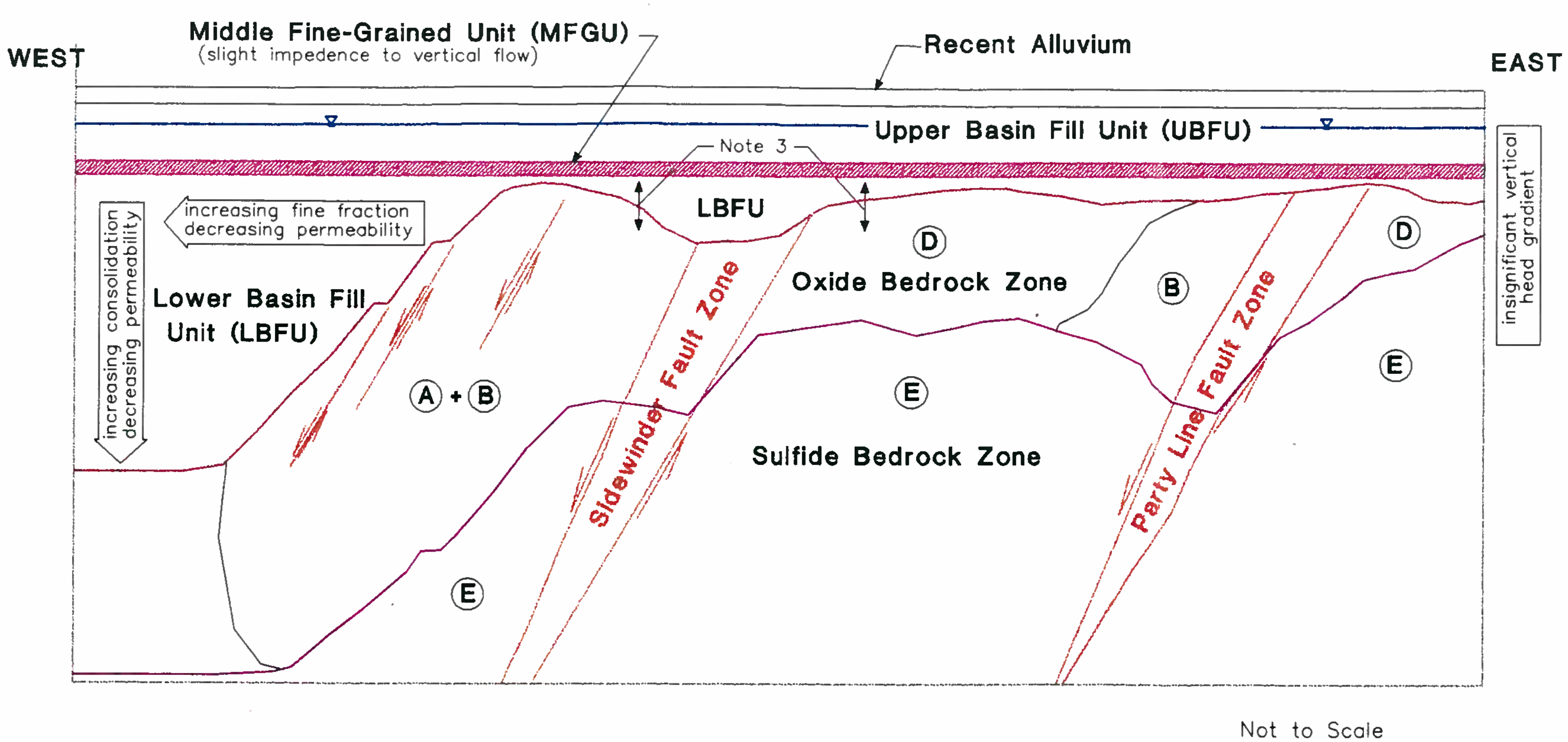
D. Probable regions of nominal hydraulic conductivity.

E. Sulfide component possessing relatively lower permeability due to depth of burial, with fewer interconnected conductive fractures.

Note 1. Distinct lineament expressed in top of bedrock surface and as an alignment of elongated regions of thicker oxide deposition.

Note 2. Potential preferential flow along fault structures; does not appear to be laterally persistent condition.

Note 3. High degree of hydraulic communication between LBFU and Oxide Bedrock Zone.



Not to Scale

GENERALIZED CROSS SECTION LOOKING NORTH

Figure 5.1-2 (II)
CONCEPTUAL HYDROGEOLOGIC COMPONENTS OF LOCAL SETTING

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

conclu2.dwg/GJC

SECTION 6.0

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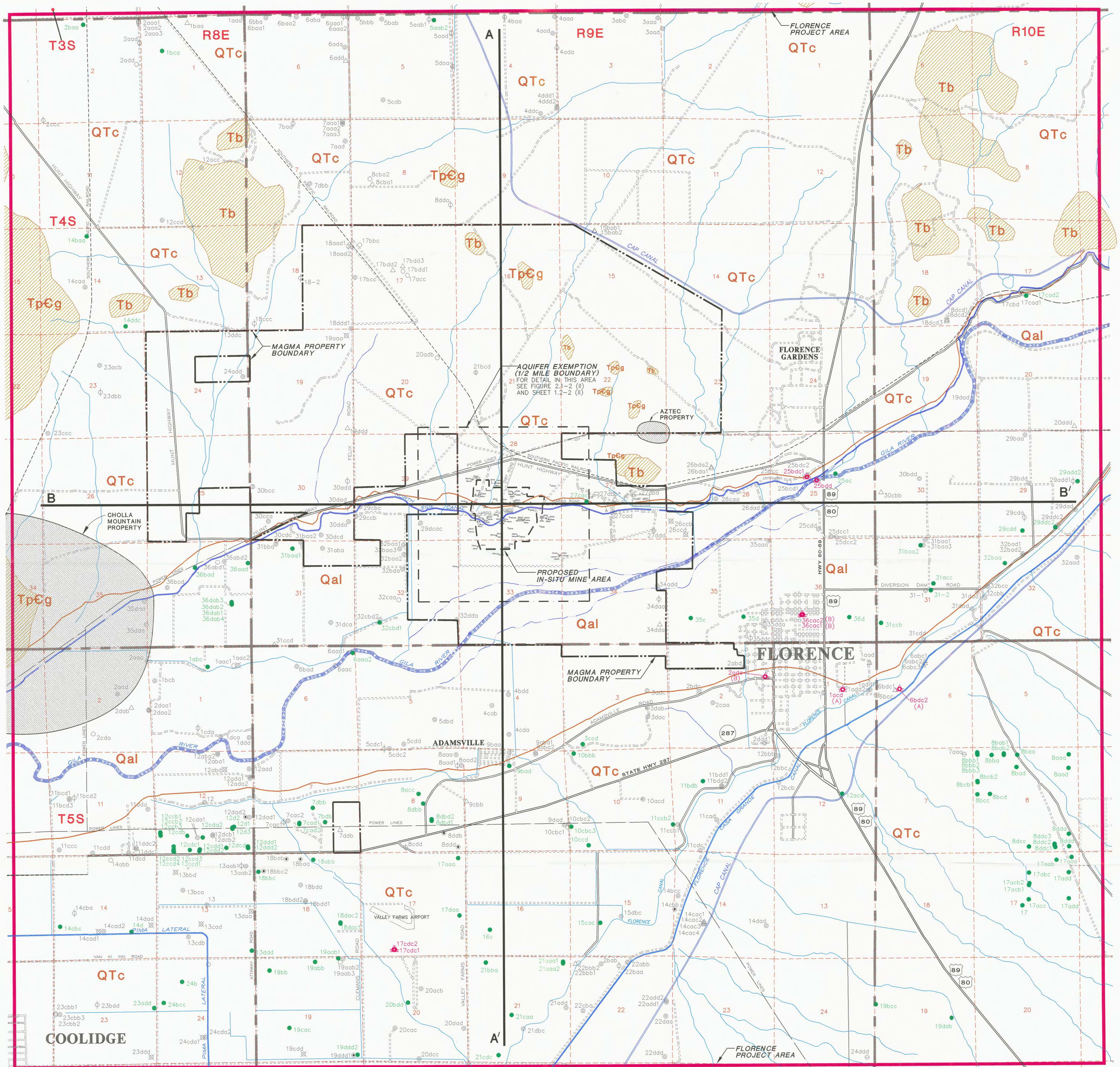


0 1000 2000
SCALE IN FEET

EXPLANATION

Tp€g	BEDROCK COMPLEX
Tb	BASALT
Qal	RECENT ALLUVIUM
QTc	BASIN FILL
	GEOLOGIC CONTACT
A — A'	LINE OF GEOLOGIC CROSS-SECTION

WELL AND BOREHOLE SYMBOLS

- IRRIGATION WELL
- INDUSTRIAL WELL
- STOCK WELL
- MONITOR WELL
- PIEZOMETER WELL
- TEST WELL
- MINERAL EXPLORATION WELL
- UNCLASSIFIED WELL
- DOMESTIC WELL
- PUBLIC SUPPLY WELL
  (A) = ARIZONA STATE PRISON
  (B) = TOWN OF FLORENCE

WELL STATUS INDICATORS

- UNUSED WELL
- ABANDONED WELL
- DESTROYED WELL

	CENTRAL ARIZONA PROJECT SALT–GILA AQUEDUCT
	MAGMA COPPER COMPANY PROPERTY BOUNDARY
	MINING EXPLORATION AREA
	FLORENCE PROJECT AREA BOUNDARY

Modified from Wickham and Corkhill (1989) and Corkhill and Others (1993)

REGISTERED GEOLOGIST 12069 RALPH E. WEEKS ARIZONA, U.S.A.

REGISTERED GEOLOGIST 24511 Clayton Mark Wallis ARIZONA, U.S.A.

Sheet 1.2-1 (II)

FLORENCE PROJECT AREA MAP SHOWING SURFACE GEOLOGY, AND LOCATIONS OF EXISTING WELLS AND OTHER REGIONAL HYDROLOGICAL FEATURES

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

S1-2-1.2 11-28-95 DanH

BROWN AND CALDWELL

EXPLANATION

PW-4 ● = EXISTING WELL LOCATION

015-O ▲ = AQUIFER TEST AND OBSERVATION WELLS

MCC-540 ⊙ = COREHOLES IN WHICH PACKER TESTING WAS PERFORMED

M1-GL ■ = MONITOR WELL LOCATION

26 = RESOURCE BLOCKS AND STRUCTURE LEVEL ELEVATION: 700 FEET

C—C' = LOCATION OF GEOLOGIC CROSS SECTION

0 350 700

SCALE IN FEET

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY

Florence, Arizona

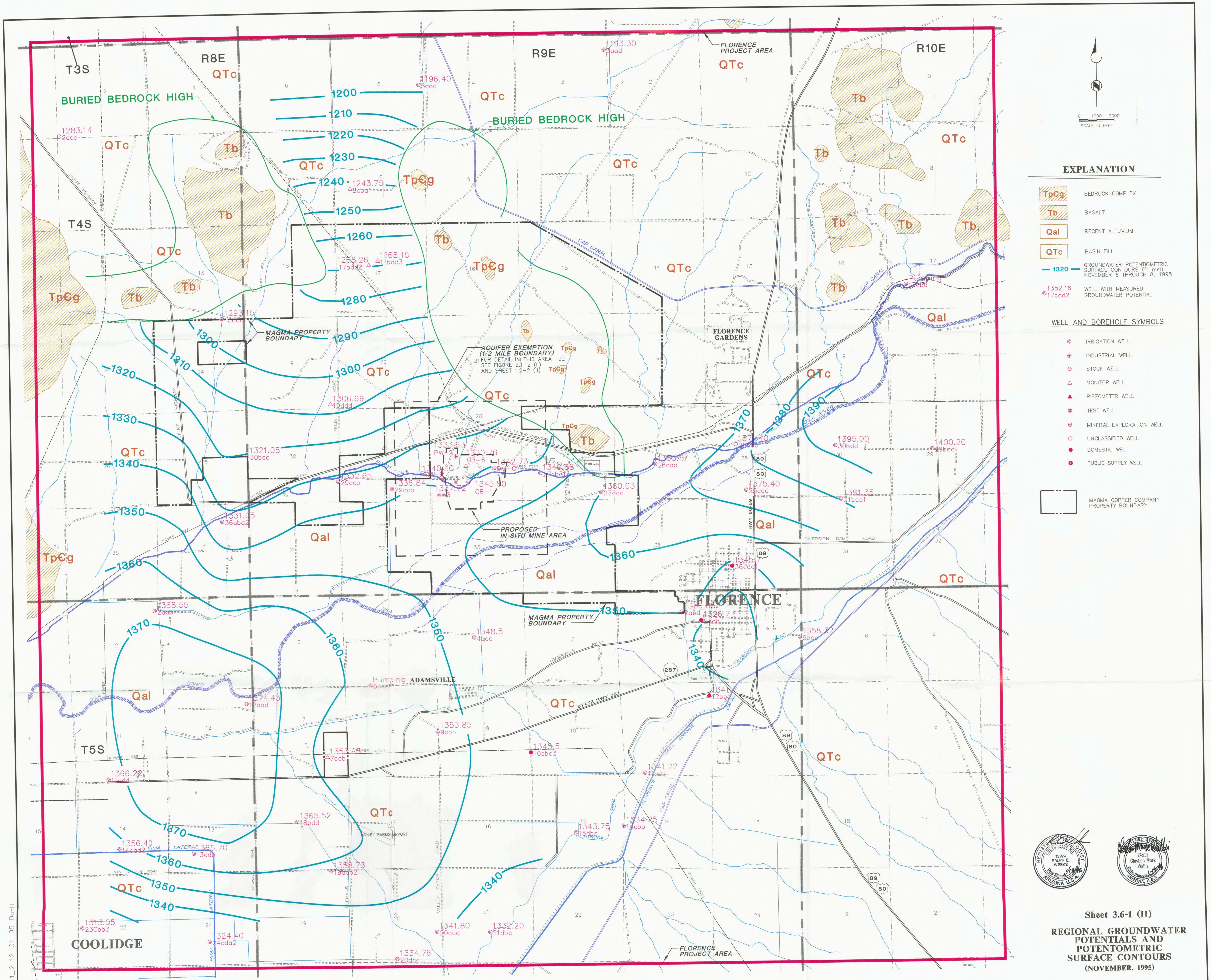
REGISTERED GEOLOGIST CERTIFICATE NO. 12009 RALPH E. WEEKS ARIZONA, U.S.A.

REGISTERED GEOLOGIST 24511 Claybon Mark Wallis ARIZONA, U.S.A.

Sheet 1.2-2 (II)

FLORENCE IN-SITU MINE AREA MAP

S1-2-2.2 11-28-95 DanH



Sheet 3.6-1 (II)

REGIONAL GROUNDWATER POTENTIALS AND POTENTOMETRIC SURFACE CONTOURS (NOVEMBER, 1995)

MAGMA

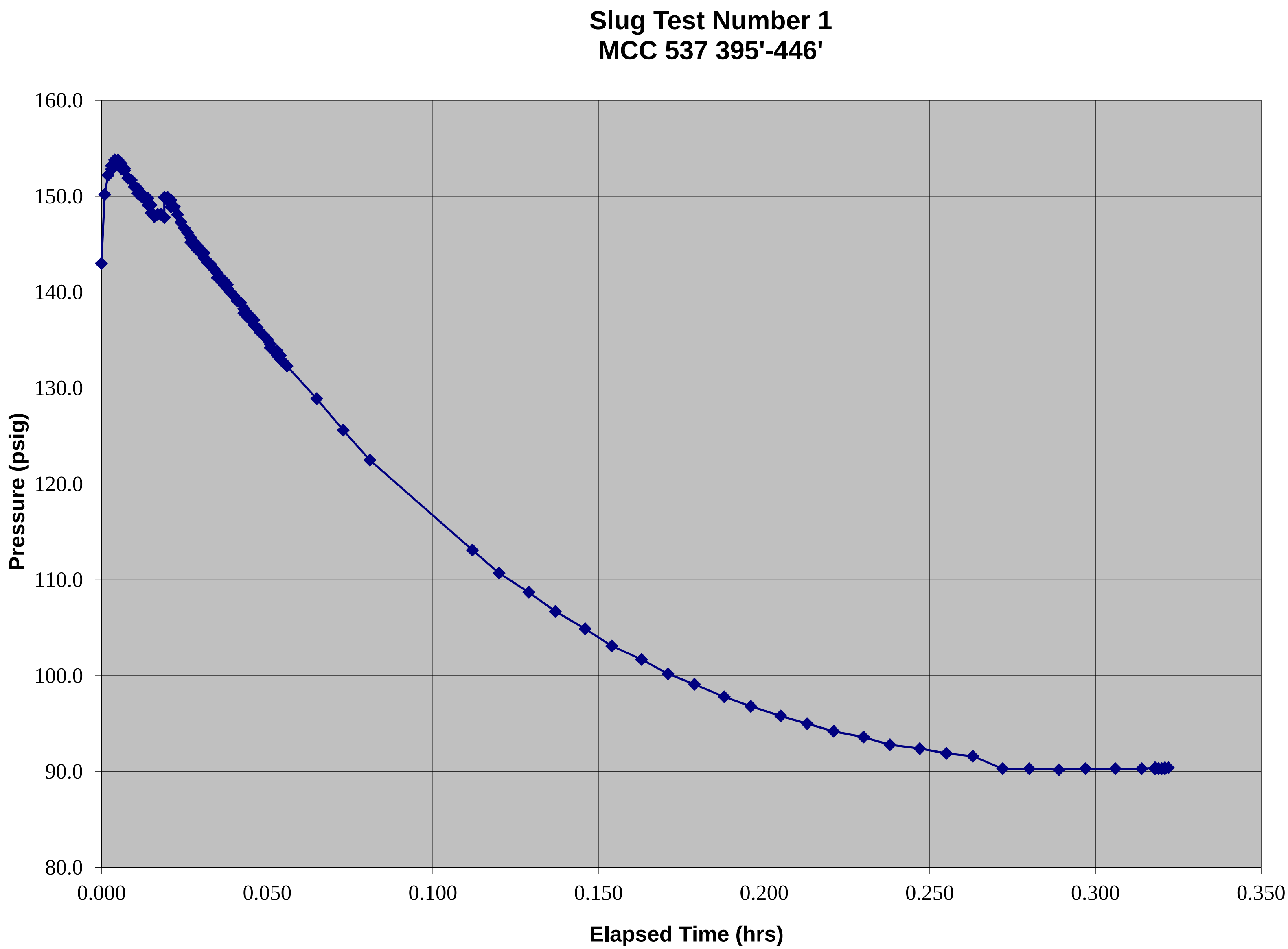
MAGMA COPPER COMPANY

Florence, Arizona

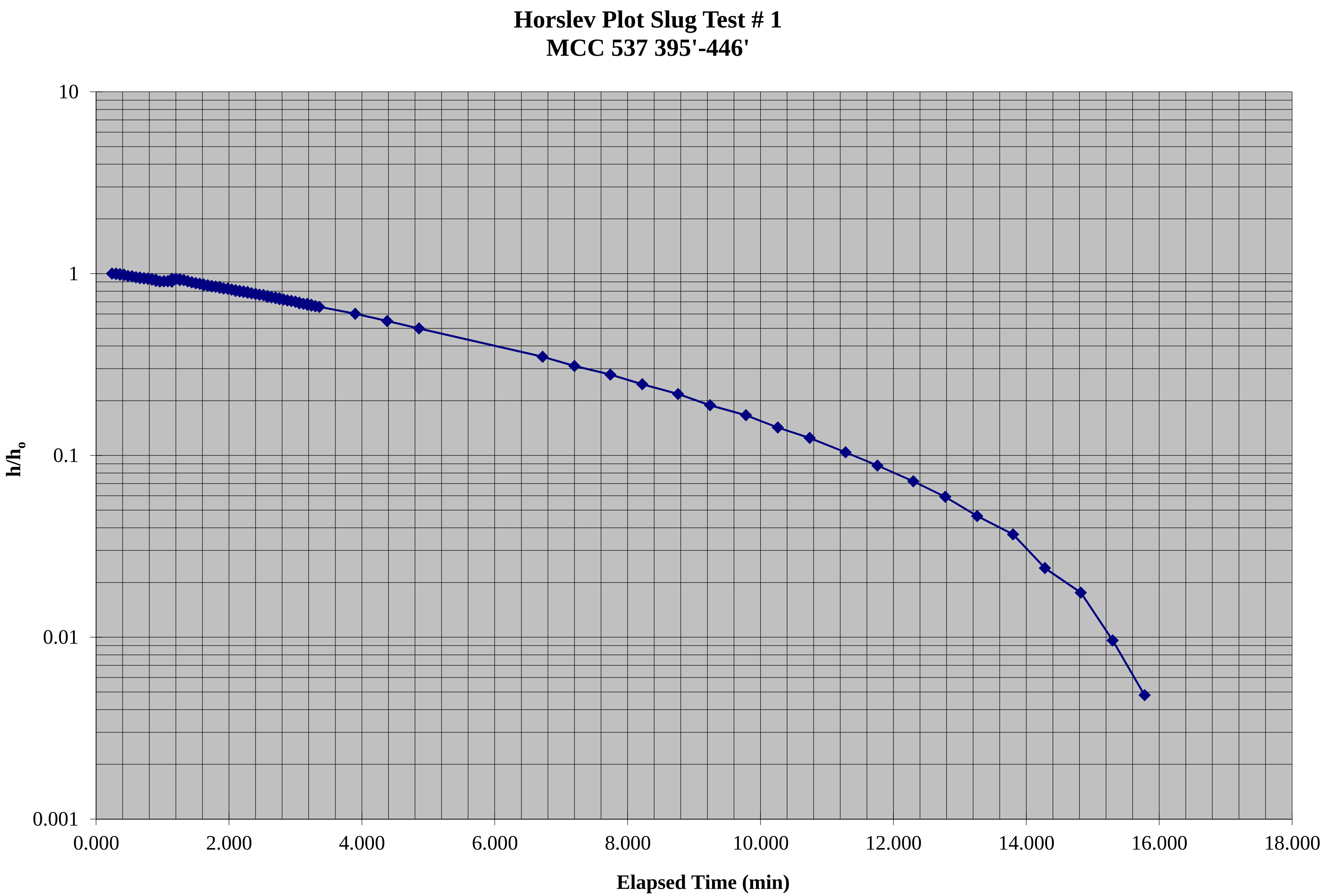
BROWN AND CALDWELL

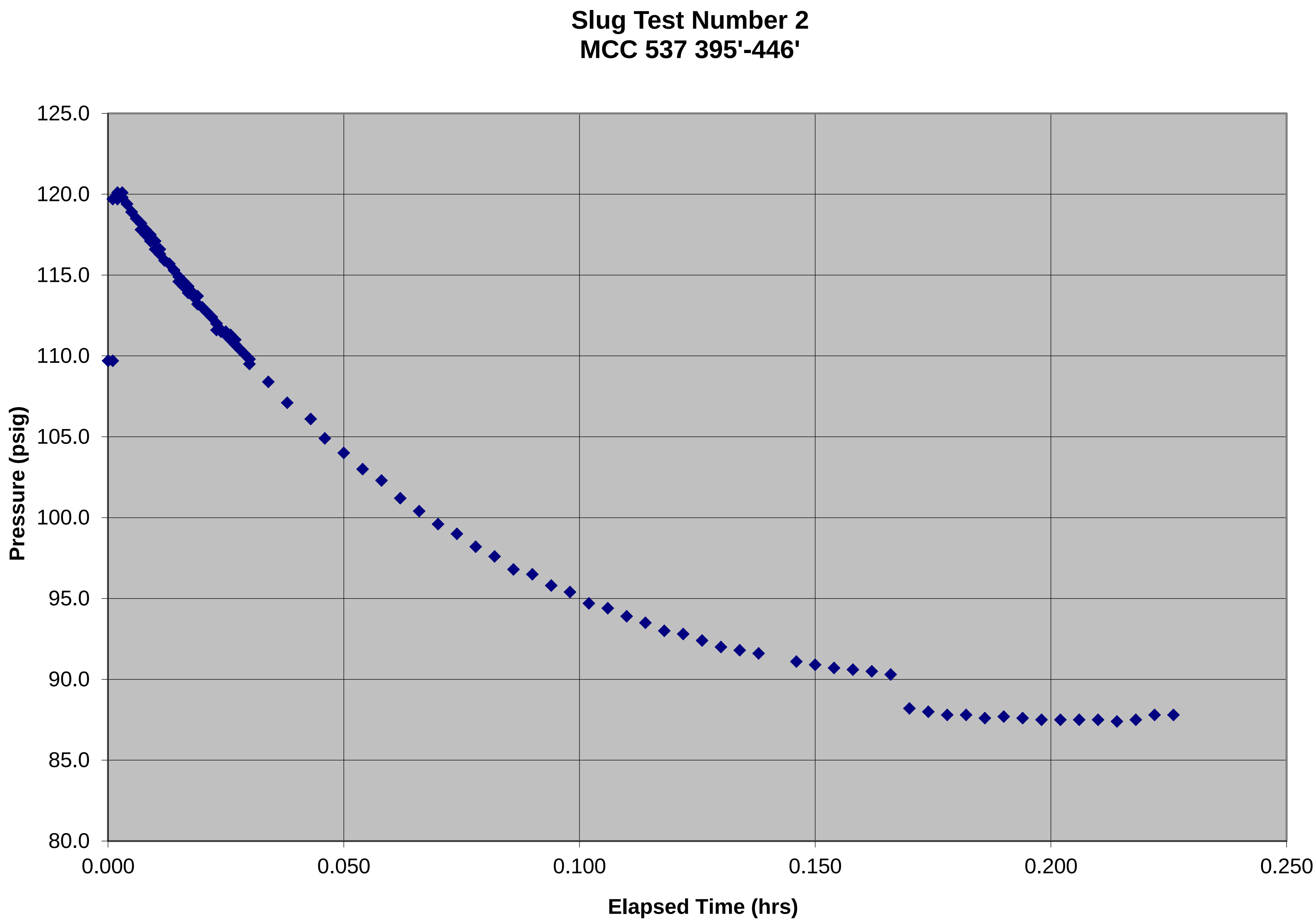
EXHIBIT I-2

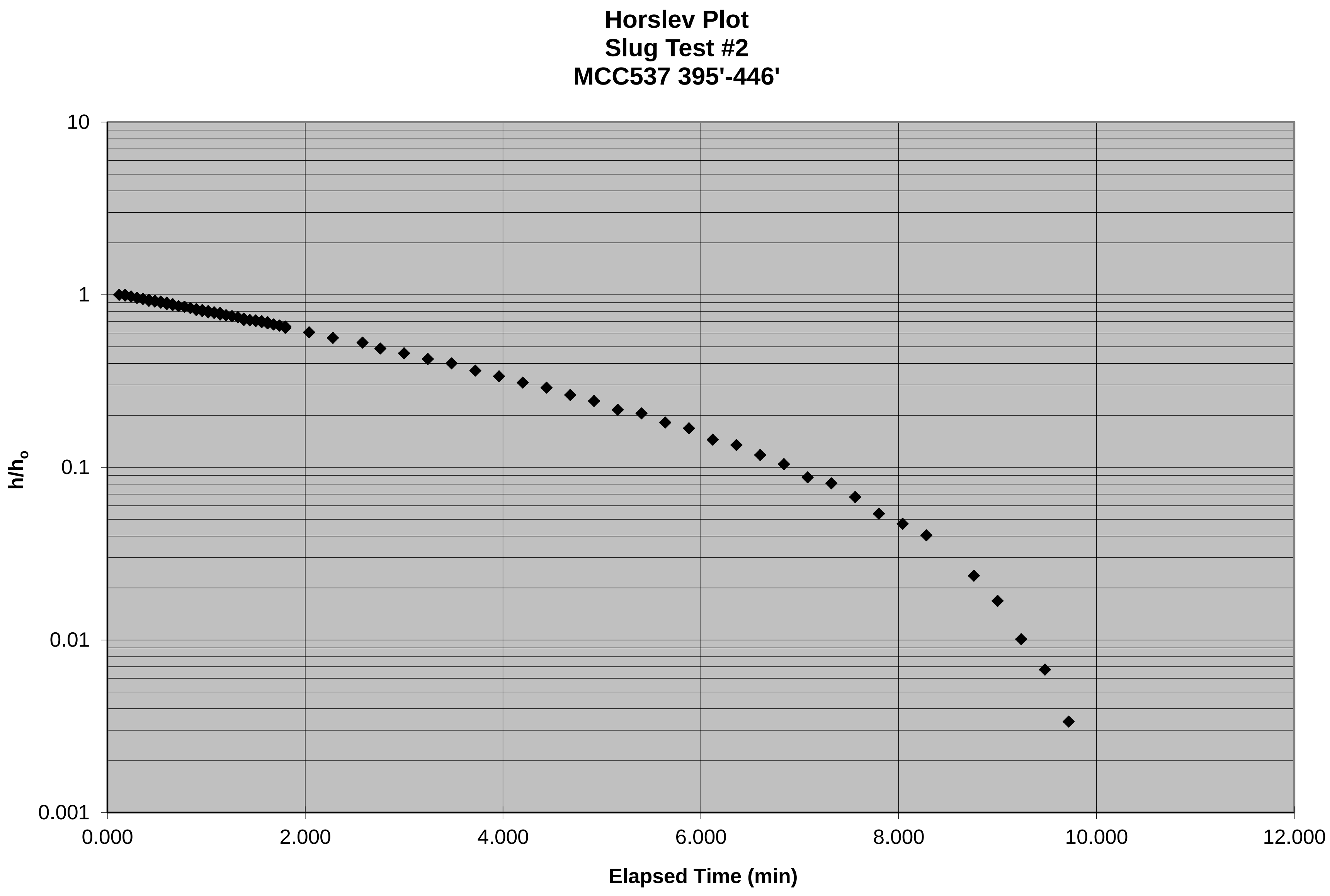
Fracture Gradient Packer Testing Data



Slug Test Number 1
MCC 537 395'-446'
Pressure (psig)
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
Elapsed Time (hrs)


Horslev Plot Slug Test # 1
MCC 537 395'-446'
10
1
0.1
0.01
0.001
h/h_o
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
Elapsed Time (min)


Slug Test Number 2
MCC 537 395'-446'
Pressure (psig)
125.0
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
0.000
0.050
0.100
0.150
0.200
0.250
Elapsed Time (hrs)


Horslev Plot
Slug Test #2
MCC537 395'-446'
10
1
0.1
0.01
0.001
h/h$_o$
0.000
2.000
4.000
6.000
8.000
10.000
12.000
Elapsed Time (min)

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
Static Pressure					
18.882	-	-	-	90.4	-
18.882	0.000	0.000	0.00E+00	109.7	0.649832
18.883	0.001	0.060	4.17E-05	109.7	0.649832
18.883	0.001	0.060	4.17E-05	119.7	0.986532
18.884	0.002	0.120	8.33E-05	119.7	0.986532
18.884	0.002	0.120	8.33E-05	120.1	1
18.885	0.003	0.180	1.25E-04	120.1	1
18.885	0.003	0.180	1.25E-04	119.8	0.989899
18.885	0.003	0.180	1.25E-04	119.8	0.989899
18.886	0.004	0.240	1.67E-04	119.4	0.976431
18.886	0.004	0.240	1.67E-04	119.4	0.976431
18.887	0.005	0.300	2.08E-04	118.9	0.959596
18.887	0.005	0.300	2.08E-04	118.9	0.959596
18.888	0.006	0.360	2.50E-04	118.5	0.946128
18.888	0.006	0.360	2.50E-04	118.5	0.946128
18.889	0.007	0.420	2.92E-04	118.2	0.936027
18.889	0.007	0.420	2.92E-04	118.2	0.936027
18.889	0.007	0.420	2.92E-04	117.8	0.922559
18.890	0.008	0.480	3.33E-04	117.8	0.922559
18.890	0.008	0.480	3.33E-04	117.5	0.912458
18.891	0.009	0.540	3.75E-04	117.5	0.912458
18.891	0.009	0.540	3.75E-04	117.1	0.89899
18.892	0.010	0.600	4.17E-04	117.1	0.89899
18.892	0.010	0.600	4.17E-04	116.6	0.882155
18.893	0.011	0.660	4.58E-04	116.6	0.882155
18.893	0.011	0.660	4.58E-04	116.3	0.872054
18.893	0.011	0.660	4.58E-04	116.3	0.872054
18.894	0.012	0.720	5.00E-04	115.9	0.858586
18.894	0.012	0.720	5.00E-04	115.9	0.858586
18.895	0.013	0.780	5.42E-04	115.7	0.851852
18.895	0.013	0.780	5.42E-04	115.7	0.851852
18.896	0.014	0.840	5.83E-04	115.3	0.838384
18.896	0.014	0.840	5.83E-04	115.3	0.838384
18.897	0.015	0.900	6.25E-04	114.9	0.824916
18.897	0.015	0.900	6.25E-04	114.9	0.824916
18.897	0.015	0.900	6.25E-04	114.6	0.814815
18.898	0.016	0.960	6.67E-04	114.6	0.814815
18.898	0.016	0.960	6.67E-04	114.3	0.804714
18.899	0.017	1.020	7.08E-04	114.3	0.804714
18.899	0.017	1.020	7.08E-04	113.9	0.791246
18.900	0.018	1.080	7.50E-04	113.9	0.791246
18.900	0.018	1.080	7.50E-04	113.7	0.784512
18.901	0.019	1.140	7.92E-04	113.7	0.784512
18.901	0.019	1.140	7.92E-04	113.2	0.767677
18.901	0.019	1.140	7.92E-04	113.2	0.767677
18.902	0.020	1.200	8.33E-04	113.0	0.760943

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
18.902	0.020	1.200	8.33E-04	113.0	0.760943
18.903	0.021	1.260	8.75E-04	112.7	0.750842
18.903	0.021	1.260	8.75E-04	112.7	0.750842
18.904	0.022	1.320	9.17E-04	112.4	0.740741
18.904	0.022	1.320	9.17E-04	112.4	0.740741
18.905	0.023	1.380	9.58E-04	112.0	0.727273
18.905	0.023	1.380	9.58E-04	112.0	0.727273
18.905	0.023	1.380	9.58E-04	111.6	0.713805
18.906	0.024	1.440	1.00E-03	111.6	0.713805
18.906	0.024	1.440	1.00E-03	111.5	0.710438
18.907	0.025	1.500	1.04E-03	111.5	0.710438
18.907	0.025	1.500	1.04E-03	111.3	0.703704
18.908	0.026	1.560	1.08E-03	111.3	0.703704
18.908	0.026	1.560	1.08E-03	111.0	0.693603
18.909	0.027	1.620	1.12E-03	111.0	0.693603
18.909	0.027	1.620	1.12E-03	110.7	0.683502
18.909	0.027	1.620	1.12E-03	110.7	0.683502
18.910	0.028	1.680	1.17E-03	110.4	0.673401
18.910	0.028	1.680	1.17E-03	110.4	0.673401
18.911	0.029	1.740	1.21E-03	110.1	0.6633
18.911	0.029	1.740	1.21E-03	110.1	0.6633
18.912	0.030	1.800	1.25E-03	109.8	0.653199
18.912	0.030	1.800	1.25E-03	109.8	0.653199
18.912	0.030	1.800	1.25E-03	109.5	0.643098
18.916	0.034	2.040	1.42E-03	108.4	0.606061
18.920	0.038	2.280	1.58E-03	107.1	0.56229
18.925	0.043	2.580	1.79E-03	106.1	0.52862
18.928	0.046	2.760	1.92E-03	104.9	0.488215
18.932	0.050	3.000	2.08E-03	104.0	0.457912
18.936	0.054	3.240	2.25E-03	103.0	0.424242
18.940	0.058	3.480	2.42E-03	102.3	0.400673
18.944	0.062	3.720	2.58E-03	101.2	0.363636
18.948	0.066	3.960	2.75E-03	100.4	0.3367
18.952	0.070	4.200	2.92E-03	99.6	0.309764
18.956	0.074	4.440	3.08E-03	99.0	0.289562
18.960	0.078	4.680	3.25E-03	98.2	0.262626
18.964	0.082	4.920	3.42E-03	97.6	0.242424
18.968	0.086	5.160	3.58E-03	96.8	0.215488
18.972	0.090	5.400	3.75E-03	96.5	0.205387
18.976	0.094	5.640	3.92E-03	95.8	0.181818
18.980	0.098	5.880	4.08E-03	95.4	0.16835
18.984	0.102	6.120	4.25E-03	94.7	0.144781
18.988	0.106	6.360	4.42E-03	94.4	0.13468
18.992	0.110	6.600	4.58E-03	93.9	0.117845
18.996	0.114	6.840	4.75E-03	93.5	0.104377
19.000	0.118	7.080	4.92E-03	93.0	0.087542
19.004	0.122	7.320	5.08E-03	92.8	0.080808
19.008	0.126	7.560	5.25E-03	92.4	0.06734

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
19.012	0.130	7.800	5.42E-03	92.0	0.053872
19.016	0.134	8.040	5.58E-03	91.8	0.047138
19.020	0.138	8.280	5.75E-03	91.6	0.040404
19.028	0.146	8.760	6.08E-03	91.1	0.023569
19.032	0.150	9.000	6.25E-03	90.9	0.016835
19.036	0.154	9.240	6.42E-03	90.7	0.010101
19.040	0.158	9.480	6.58E-03	90.6	0.006734
19.044	0.162	9.720	6.75E-03	90.5	0.003367
19.048	0.166	9.960	6.92E-03	90.3	-0.003367
19.052	0.170	10.200	7.08E-03	88.2	-0.074074
19.056	0.174	10.440	7.25E-03	88.0	-0.080808
19.060	0.178	10.680	7.42E-03	87.8	-0.087542
19.064	0.182	10.920	7.58E-03	87.8	-0.087542
19.068	0.186	11.160	7.75E-03	87.6	-0.094276
19.072	0.190	11.400	7.92E-03	87.7	-0.090909
19.076	0.194	11.640	8.08E-03	87.6	-0.094276
19.080	0.198	11.880	8.25E-03	87.5	-0.097643
19.084	0.202	12.120	8.42E-03	87.5	-0.097643
19.088	0.206	12.360	8.58E-03	87.5	-0.097643
19.092	0.210	12.600	8.75E-03	87.5	-0.097643
19.096	0.214	12.840	8.92E-03	87.4	-0.10101
19.100	0.218	13.080	9.08E-03	87.5	-0.097643
19.104	0.222	13.320	9.25E-03	87.8	-0.087542
19.108	0.226	13.560	9.42E-03	87.8	-0.087542

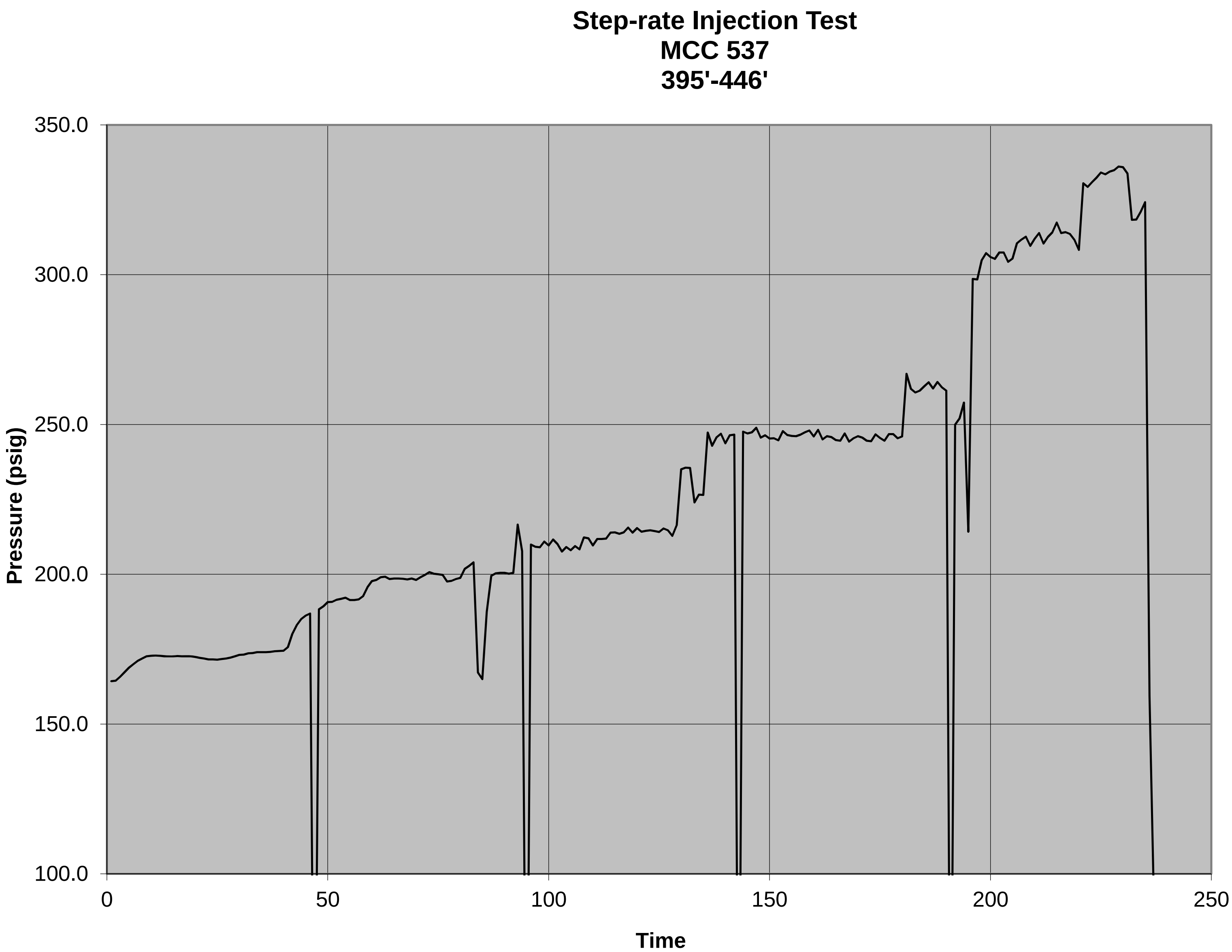
Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
Static Pressure					
18.560				91.3	
18.560	0.000	0.000	0.00E+00	143.0	0.8272
18.560	0.000	0.000	0.00E+00	143.0	0.8272
18.561	0.001	0.060	4.17E-05	150.2	0.9424
18.561	0.001	0.060	4.17E-05	150.2	0.9424
18.562	0.002	0.120	8.33E-05	152.2	0.9744
18.562	0.002	0.120	8.33E-05	152.2	0.9744
18.563	0.003	0.180	1.25E-04	152.8	0.984
18.563	0.003	0.180	1.25E-04	152.8	0.984
18.563	0.003	0.180	1.25E-04	153.2	0.9904
18.564	0.004	0.240	1.67E-04	153.2	0.9904
18.564	0.004	0.240	1.67E-04	153.8	1
18.565	0.005	0.300	2.08E-04	153.8	1
18.565	0.005	0.300	2.08E-04	153.4	0.9936
18.566	0.006	0.360	2.50E-04	153.4	0.9936
18.566	0.006	0.360	2.50E-04	152.9	0.9856
18.567	0.007	0.420	2.92E-04	152.9	0.9856
18.567	0.007	0.420	2.92E-04	152.7	0.9824
18.567	0.007	0.420	2.92E-04	152.7	0.9824
18.568	0.008	0.480	3.33E-04	151.9	0.9696
18.568	0.008	0.480	3.33E-04	151.9	0.9696
18.569	0.009	0.540	3.75E-04	151.7	0.9664
18.569	0.009	0.540	3.75E-04	151.7	0.9664
18.570	0.010	0.600	4.17E-04	151.0	0.9552
18.570	0.010	0.600	4.17E-04	151.0	0.9552
18.571	0.011	0.660	4.58E-04	150.8	0.952
18.571	0.011	0.660	4.58E-04	150.8	0.952
18.571	0.011	0.660	4.58E-04	150.3	0.944
18.572	0.012	0.720	5.00E-04	150.3	0.944
18.572	0.012	0.720	5.00E-04	150.0	0.9392
18.573	0.013	0.780	5.42E-04	150.0	0.9392
18.573	0.013	0.780	5.42E-04	149.8	0.936
18.574	0.014	0.840	5.83E-04	149.8	0.936
18.574	0.014	0.840	5.83E-04	149.1	0.9248
18.575	0.015	0.900	6.25E-04	149.1	0.9248
18.575	0.015	0.900	6.25E-04	148.3	0.912
18.575	0.015	0.900	6.25E-04	148.3	0.912
18.576	0.016	0.960	6.67E-04	147.9	0.9056
18.576	0.016	0.960	6.67E-04	147.9	0.9056
18.577	0.017	1.020	7.08E-04	148.1	0.9088
18.577	0.017	1.020	7.08E-04	148.1	0.9088
18.578	0.018	1.080	7.50E-04	148.1	0.9088
18.578	0.018	1.080	7.50E-04	148.1	0.9088
18.579	0.019	1.140	7.92E-04	147.8	0.904
18.579	0.019	1.140	7.92E-04	147.8	0.904

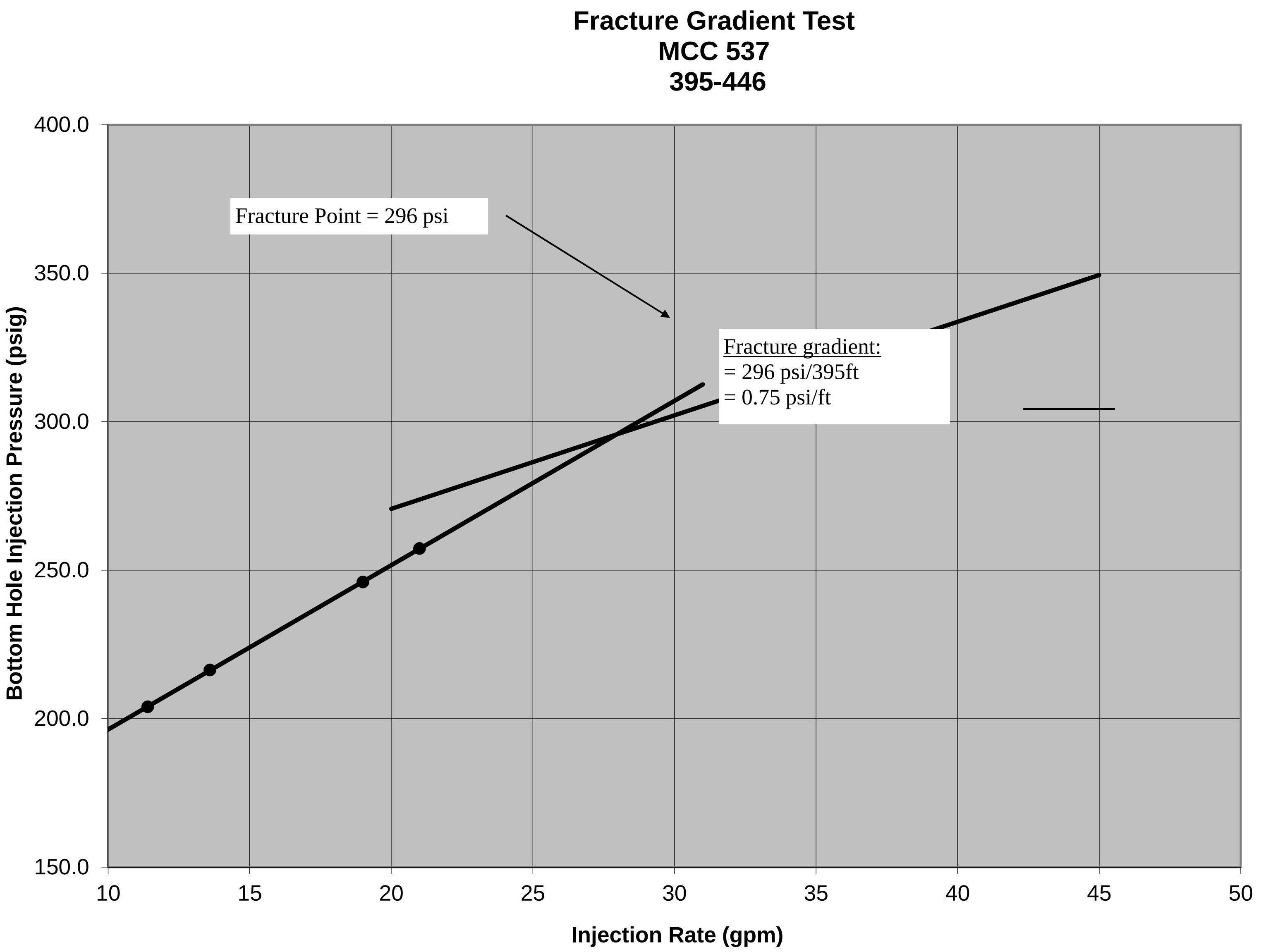
Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
18.579	0.019	1.140	7.92E-04	149.9	0.9376
18.580	0.020	1.200	8.33E-04	149.9	0.9376
18.580	0.020	1.200	8.33E-04	149.6	0.9328
18.581	0.021	1.260	8.75E-04	149.6	0.9328
18.581	0.021	1.260	8.75E-04	148.9	0.9216
18.582	0.022	1.320	9.17E-04	148.9	0.9216
18.582	0.022	1.320	9.17E-04	148.9	0.9216
18.583	0.023	1.380	9.58E-04	148.1	0.9088
18.583	0.023	1.380	9.58E-04	148.1	0.9088
18.584	0.024	1.440	1.00E-03	147.3	0.896
18.584	0.024	1.440	1.00E-03	147.3	0.896
18.585	0.025	1.500	1.04E-03	146.7	0.8864
18.585	0.025	1.500	1.04E-03	146.7	0.8864
18.586	0.026	1.560	1.08E-03	146.2	0.8784
18.586	0.026	1.560	1.08E-03	146.2	0.8784
18.587	0.027	1.620	1.13E-03	145.7	0.8704
18.587	0.027	1.620	1.13E-03	145.7	0.8704
18.587	0.027	1.620	1.13E-03	145.2	0.8624
18.588	0.028	1.680	1.17E-03	145.2	0.8624
18.588	0.028	1.680	1.17E-03	144.8	0.856
18.589	0.029	1.740	1.21E-03	144.8	0.856
18.589	0.029	1.740	1.21E-03	144.4	0.8496
18.590	0.030	1.800	1.25E-03	144.4	0.8496
18.590	0.030	1.800	1.25E-03	144.1	0.8448
18.591	0.031	1.860	1.29E-03	144.1	0.8448
18.591	0.031	1.860	1.29E-03	143.6	0.8368
18.591	0.031	1.860	1.29E-03	143.6	0.8368
18.592	0.032	1.920	1.33E-03	143.1	0.8288
18.592	0.032	1.920	1.33E-03	143.1	0.8288
18.593	0.033	1.980	1.38E-03	142.9	0.8256
18.593	0.033	1.980	1.38E-03	142.9	0.8256
18.594	0.034	2.040	1.42E-03	142.4	0.8176
18.594	0.034	2.040	1.42E-03	142.4	0.8176
18.595	0.035	2.100	1.46E-03	142.0	0.8112
18.595	0.035	2.100	1.46E-03	142.0	0.8112
18.595	0.035	2.100	1.46E-03	141.5	0.8032
18.596	0.036	2.160	1.50E-03	141.5	0.8032
18.596	0.036	2.160	1.50E-03	141.2	0.7984
18.597	0.037	2.220	1.54E-03	141.2	0.7984
18.597	0.037	2.220	1.54E-03	140.8	0.792
18.598	0.038	2.280	1.58E-03	140.8	0.792
18.598	0.038	2.280	1.58E-03	140.4	0.7856
18.598	0.038	2.280	1.58E-03	140.4	0.7856
18.599	0.039	2.340	1.63E-03	140.0	0.7792
18.599	0.039	2.340	1.63E-03	140.0	0.7792
18.600	0.040	2.400	1.67E-03	139.6	0.7728
18.600	0.040	2.400	1.67E-03	139.6	0.7728
18.601	0.041	2.460	1.71E-03	139.1	0.7648

Slug Test 1 Data

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
18.601	0.041	2.460	1.71E-03	139.1	0.7648
18.602	0.042	2.520	1.75E-03	138.9	0.7616
18.602	0.042	2.520	1.75E-03	138.9	0.7616
18.603	0.043	2.580	1.79E-03	138.3	0.752
18.603	0.043	2.580	1.79E-03	138.3	0.752
18.603	0.043	2.580	1.79E-03	137.8	0.744
18.604	0.044	2.640	1.83E-03	137.8	0.744
18.604	0.044	2.640	1.83E-03	137.5	0.7392
18.605	0.045	2.700	1.88E-03	137.5	0.7392
18.605	0.045	2.700	1.88E-03	137.1	0.7328
18.606	0.046	2.760	1.92E-03	137.1	0.7328
18.606	0.046	2.760	1.92E-03	136.6	0.7248
18.606	0.046	2.760	1.92E-03	136.6	0.7248
18.607	0.047	2.820	1.96E-03	136.3	0.72
18.607	0.047	2.820	1.96E-03	136.3	0.72
18.608	0.048	2.880	2.00E-03	135.8	0.712
18.608	0.048	2.880	2.00E-03	135.8	0.712
18.609	0.049	2.940	2.04E-03	135.5	0.7072
18.609	0.049	2.940	2.04E-03	135.5	0.7072
18.610	0.050	3.000	2.08E-03	135.1	0.7008
18.610	0.050	3.000	2.08E-03	135.1	0.7008
18.610	0.050	3.000	2.08E-03	135.1	0.7008
18.611	0.051	3.060	2.13E-03	134.6	0.6928
18.611	0.051	3.060	2.13E-03	134.2	0.6864
18.612	0.052	3.120	2.17E-03	133.9	0.6816
18.613	0.053	3.180	2.21E-03	133.9	0.6816
18.613	0.053	3.180	2.21E-03	133.4	0.6736
18.614	0.054	3.240	2.25E-03	133.4	0.6736
18.614	0.054	3.240	2.25E-03	133.0	0.6672
18.614	0.054	3.240	2.25E-03	133.0	0.6672
18.615	0.055	3.300	2.29E-03	132.7	0.6624
18.615	0.055	3.300	2.29E-03	132.7	0.6624
18.616	0.056	3.360	2.33E-03	132.3	0.656
18.625	0.065	3.900	2.71E-03	128.9	0.6016
18.633	0.073	4.380	3.04E-03	125.6	0.5488
18.641	0.081	4.860	3.37E-03	122.5	0.4992
18.672	0.112	6.720	4.67E-03	113.1	0.3488
18.680	0.120	7.200	5.00E-03	110.7	0.3104
18.689	0.129	7.740	5.38E-03	108.7	0.2784
18.697	0.137	8.220	5.71E-03	106.7	0.2464
18.706	0.146	8.760	6.08E-03	104.9	0.2176
18.714	0.154	9.240	6.42E-03	103.1	0.1888
18.723	0.163	9.780	6.79E-03	101.7	0.1664
18.731	0.171	10.260	7.13E-03	100.2	0.1424
18.739	0.179	10.740	7.46E-03	99.1	0.1248
18.748	0.188	11.280	7.83E-03	97.8	0.104
18.756	0.196	11.760	8.17E-03	96.8	0.088
18.765	0.205	12.300	8.54E-03	95.8	0.072

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
18.773	0.213	12.780	8.88E-03	95.0	0.0592
18.781	0.221	13.260	9.21E-03	94.2	0.0464
18.790	0.230	13.800	9.58E-03	93.6	0.0368
18.798	0.238	14.280	9.92E-03	92.8	0.024
18.807	0.247	14.820	1.03E-02	92.4	0.0176
18.815	0.255	15.300	1.06E-02	91.9	0.0096
18.823	0.263	15.780	1.10E-02	91.6	0.0048
18.832	0.272	16.320	1.13E-02	90.3	-0.016
18.840	0.280	16.800	1.17E-02	90.3	-0.016
18.849	0.289	17.340	1.20E-02	90.2	-0.0176
18.857	0.297	17.820	1.24E-02	90.3	-0.016
18.866	0.306	18.360	1.28E-02	90.3	-0.016
18.874	0.314	18.840	1.31E-02	90.3	-0.016
18.878	0.318	19.080	1.33E-02	90.4	-0.0144
18.878	0.318	19.080	1.33E-02	90.3	-0.016
18.878	0.318	19.080	1.33E-02	90.3	-0.016
18.879	0.319	19.140	1.33E-02	90.3	-0.016
18.879	0.319	19.140	1.33E-02	90.3	-0.016
18.880	0.320	19.200	1.33E-02	90.3	-0.016
18.880	0.320	19.200	1.33E-02	90.3	-0.016
18.881	0.321	19.260	1.34E-02	90.3	-0.016
18.881	0.321	19.260	1.34E-02	90.3	-0.016
18.881	0.321	19.260	1.34E-02	90.4	-0.0144
18.882	0.322	19.320	1.34E-02	90.4	-0.0144


Step-rate Injection Test
MCC 537
395'-446'
Pressure (psig)
350.0
300.0
250.0
200.0
150.0
100.0
0
50
100
150
200
250
Time


Fracture Gradient Test
MCC 537
395-446
Fracture Point = 296 psi
Fracture gradient:
= 296 psi/395ft
= 0.75 psi/ft
400.0
350.0
300.0
250.0
200.0
150.0
10
15
20
25
30
35
40
45
50
Bottom Hole Injection Pressure (psig)
Injection Rate (gpm)

Step-rate Injection Test			
Time	Injection Rate (gpm)	Pressure (psig)	
19.502	11.4	164.3	
19.506	11.4	164.5	
19.510	11.4	165.8	
19.514	11.4	167.3	
19.518	11.4	168.8	
19.522	11.4	170.0	
19.526	11.4	171.1	
19.530	11.4	171.9	
19.534	11.4	172.6	
19.538	11.4	172.8	
19.542	11.4	172.9	
19.546	11.4	172.8	
19.554	11.4	172.6	
19.558	11.4	172.6	
19.563	11.4	172.6	
19.567	11.4	172.7	
19.571	11.4	172.6	
19.576	11.4	172.6	
19.580	11.4	172.6	
19.585	11.4	172.4	
19.589	11.4	172.1	
19.594	11.4	171.9	
19.598	11.4	171.6	
19.602	11.4	171.6	
19.607	11.4	171.5	
19.611	11.4	171.7	
19.616	11.4	171.9	
19.620	11.4	172.2	
19.625	11.4	172.6	
19.629	11.4	173.1	
19.633	11.4	173.2	
19.638	11.4	173.6	
19.642	11.4	173.7	
19.647	11.4	174.0	
19.651	11.4	174.0	
19.656	11.4	174.0	
19.660	11.4	174.1	
19.664	11.4	174.3	
19.669	11.4	174.4	
19.673	11.4	174.5	
19.678	11.4	175.7	
19.682	11.4	180.1	
19.687	11.4	183.1	
19.691	11.4	185.1	
19.695	11.4	186.2	
19.700	11.4	186.9	

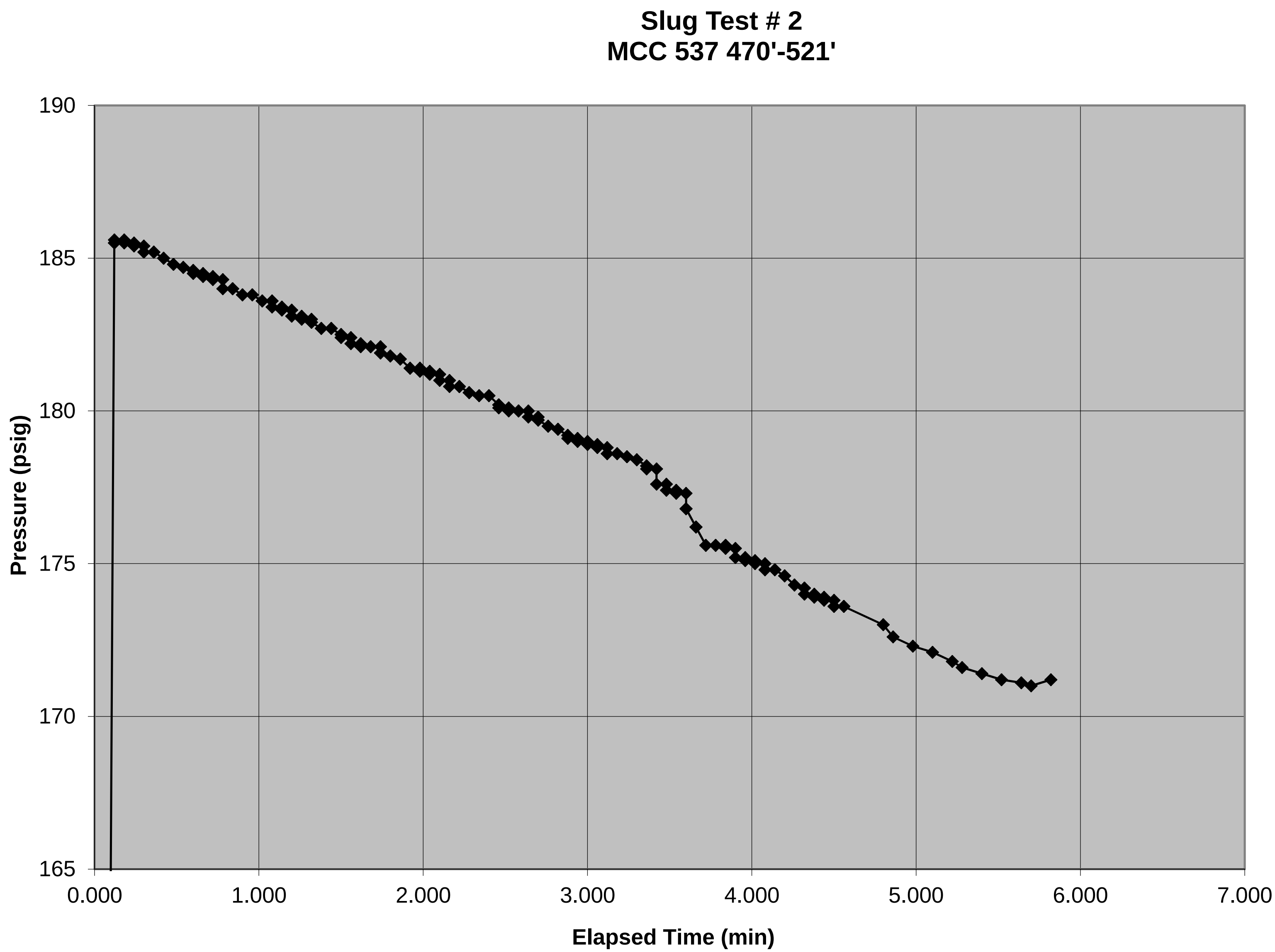
Time	Injection Rate (gpm)	Pressure (psig)	
19.704	11.4	188.3	
19.709	11.4	189.3	
19.713	11.4	190.7	
19.718	11.4	190.8	
19.722	11.4	191.5	
19.726	11.4	191.8	
19.731	11.4	192.2	
19.735	11.4	191.4	
19.740	11.4	191.4	
19.744	11.4	191.6	
19.749	11.4	192.7	
19.753	11.4	195.7	
19.757	11.4	197.7	
19.762	11.4	198.1	
19.766	11.4	199.0	
19.771	11.4	199.2	
19.775	11.4	198.4	
19.780	11.4	198.6	
19.784	11.4	198.6	
19.788	11.4	198.5	
19.793	11.4	198.3	
19.797	11.4	198.6	
19.802	11.4	198.1	
19.806	11.4	199.0	
19.811	11.4	199.8	
19.815	11.4	200.7	
19.819	11.4	200.2	
19.824	11.4	200.0	
19.828	11.4	199.8	
19.833	11.4	197.6	
19.837	11.4	197.8	
19.842	11.4	198.4	
19.846	11.4	198.8	
19.850	11.4	201.8	
19.855	11.4	202.8	
19.859	11.4	204.0	
19.864	13.6	167.2	
19.868	13.6	165.0	
19.873	13.6	187.4	
19.877	13.6	199.5	
19.881	13.6	200.3	
19.886	13.6	200.5	
19.890	13.6	200.5	
19.895	13.6	200.2	
19.899	13.6	200.5	
19.904	13.6	216.6	
19.908	13.6	207.7	

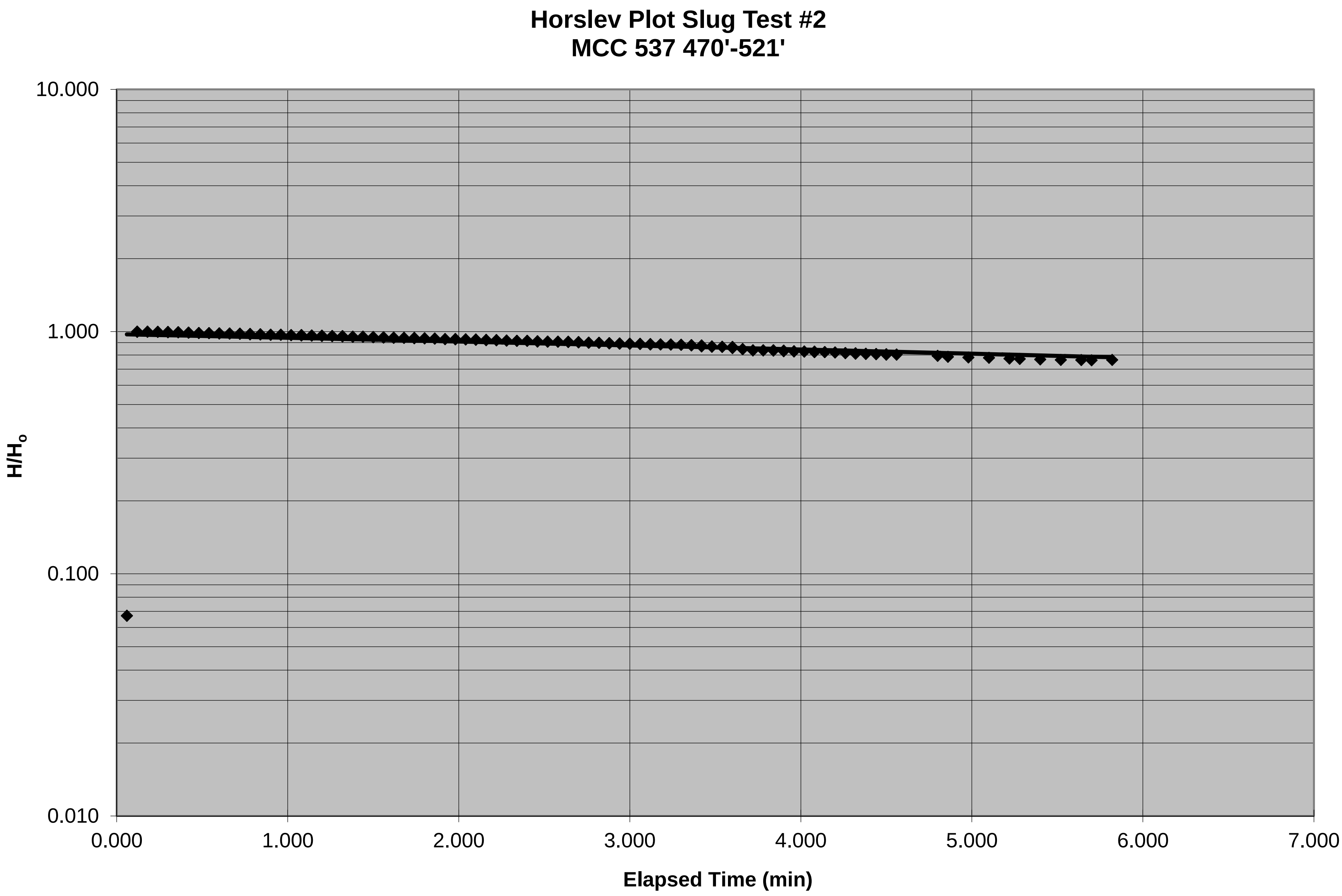
Time	Injection Rate (gpm)	Pressure (psig)	
19.912	13.6	209.9	
19.917	13.6	209.2	
19.921	13.6	209.0	
19.926	13.6	210.9	
19.930	13.6	209.6	
19.935	13.6	211.6	
19.939	13.6	210.1	
19.943	13.6	207.6	
19.948	13.6	209.1	
19.952	13.6	208.0	
19.957	13.6	209.4	
19.961	13.6	208.3	
19.966	13.6	212.3	
19.970	13.6	212.0	
19.974	13.6	209.6	
19.979	13.6	211.8	
19.983	13.6	211.8	
19.988	13.6	211.9	
19.992	13.6	213.9	
19.997	13.6	214.0	
20.001	13.6	213.5	
20.005	13.6	214.0	
20.010	13.6	215.6	
20.014	13.6	213.9	
20.019	13.6	215.4	
20.023	13.6	214.2	
20.028	13.6	214.5	
20.032	13.6	214.7	
20.036	13.6	214.4	
20.041	13.6	214.1	
20.045	13.6	215.3	
20.050	13.6	214.7	
20.054	13.6	212.8	
20.059	13.6	216.4	
20.063	19	235.0	
20.067	19	235.6	
20.072	19	235.5	
20.076	19	224.0	
20.081	19	226.6	
20.085	19	226.5	
20.090	19	247.3	
20.094	19	242.9	
20.098	19	245.7	
20.103	19	246.9	
20.107	19	243.7	
20.112	19	246.4	
20.116	19	246.6	

Time	Injection Rate (gpm)	Pressure (psig)	
20.121	19	247.6	
20.125	19	247.0	
20.129	19	247.4	
20.134	19	248.9	
20.138	19	245.6	
20.143	19	246.4	
20.147	19	245.3	
20.152	19	245.4	
20.156	19	244.7	
20.160	19	247.8	
20.165	19	246.5	
20.169	19	246.2	
20.174	19	246.1	
20.178	19	246.6	
20.183	19	247.4	
20.187	19	248.0	
20.191	19	246.0	
20.196	19	248.2	
20.200	19	245.0	
20.205	19	246.1	
20.209	19	245.8	
20.214	19	244.8	
20.218	19	244.6	
20.222	19	247.0	
20.227	19	244.3	
20.231	19	245.4	
20.236	19	246.1	
20.240	19	245.6	
20.245	19	244.6	
20.249	19	244.4	
20.253	19	246.7	
20.258	19	245.5	
20.262	19	244.6	
20.267	19	246.8	
20.271	19	246.8	
20.276	19	245.4	
20.280	19	246.0	
20.284	21	266.9	
20.289	21	261.9	
20.293	21	260.7	
20.298	21	261.3	
20.302	21	262.7	
20.307	21	264.1	
20.311	21	262.0	
20.315	21	264.2	
20.320	21	262.4	
20.324	21	261.3	

Time	Injection Rate (gpm)	Pressure (psig)	
20.329	21	249.9	
20.333	21	252.0	
20.338	21	257.3	
20.342	33	214.2	
20.346	33	298.6	
20.351	33	298.4	
20.355	33	304.8	
20.360	33	307.2	
20.364	33	305.9	
20.369	33	305.3	
20.373	33	307.4	
20.377	33	307.4	
20.382	33	304.3	
20.386	33	305.4	
20.391	33	310.5	
20.395	33	311.7	
20.400	33	312.7	
20.404	33	309.6	
20.408	33	312.0	
20.413	33	313.9	
20.417	33	310.4	
20.422	33	312.6	
20.426	33	314.1	
20.431	33	317.4	
20.435	33	313.9	
20.439	33	314.2	
20.444	33	313.6	
20.448	33	311.6	
20.453	37	308.3	
20.457	37	330.5	
20.462	37	329.3	
20.466	37	330.9	
20.470	37	332.4	
20.475	37	334.1	
20.479	37	333.5	
20.484	37	334.4	
20.488	37	334.9	
20.493	37	336.1	
20.497	37	335.9	
20.501	37	333.8	
20.506	37	318.3	
20.510	37	318.4	
20.515	37	321.0	
20.519	37	324.2	End Test
20.524	-	159.4	
20.528	-	90.3	
20.532	-	90.3	

Slug Test #2 Plot



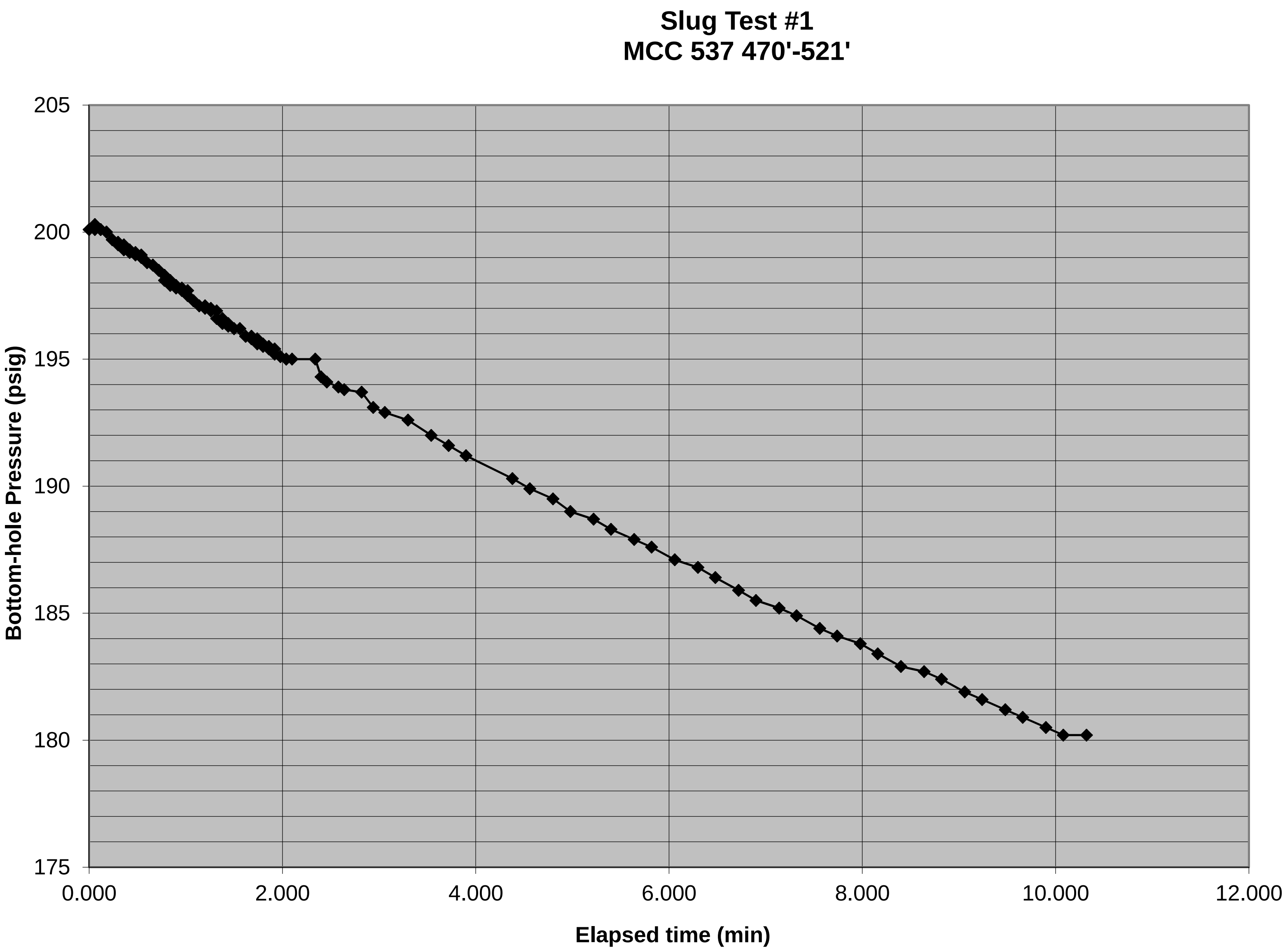

Horslev Plot Slug Test #2
MCC 537 470'-521'
10.000
1.000
0.100
0.010
H/Ho
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
Elapsed Time (min)

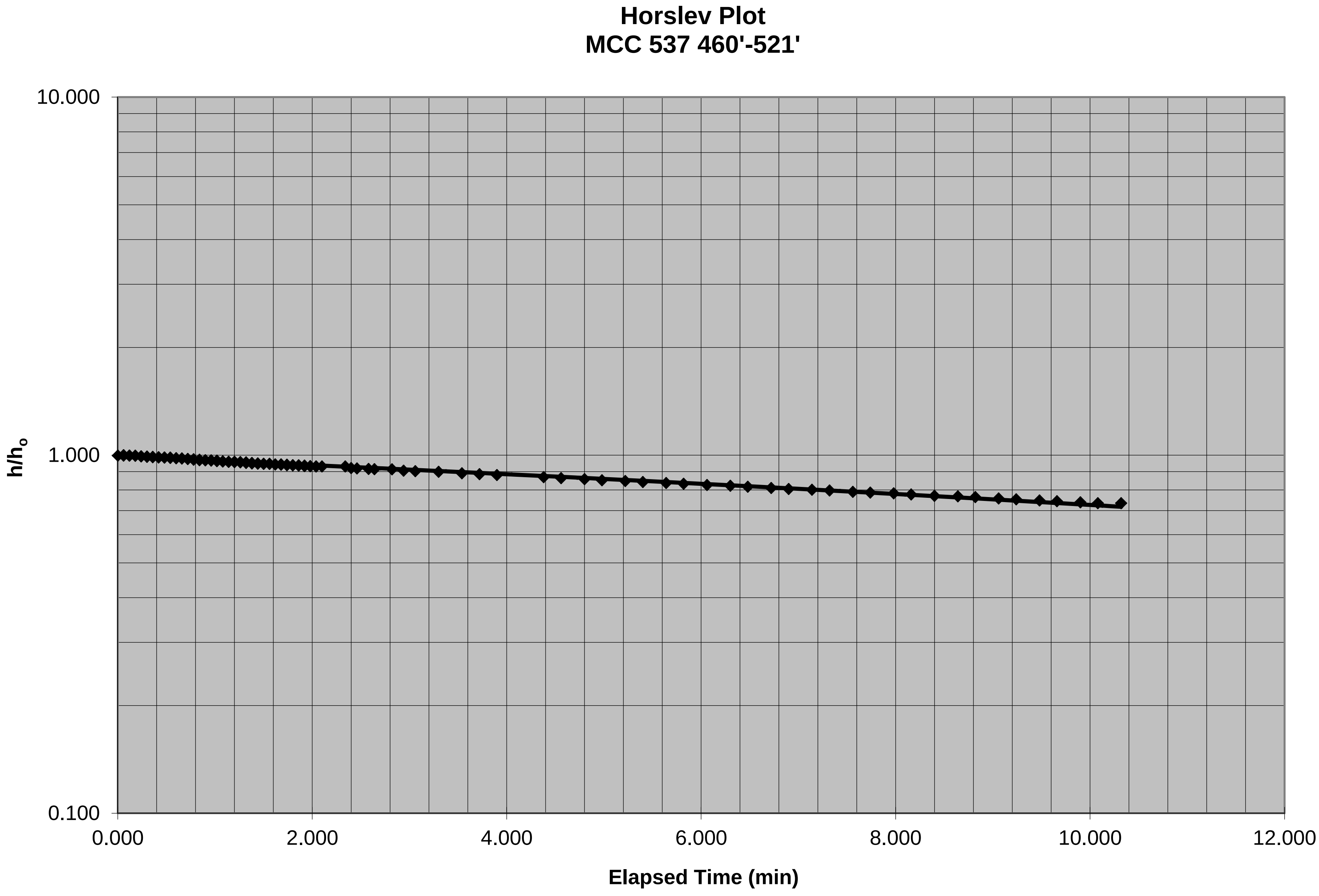
Slug Test #2 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
Static Pressure						
16:17:36	16.293				124.5	
16:17:37	16.294	4.17E-05	0.060	0.001	128.6	0.067
16:17:39	16.294	4.17E-05	0.060	0.001	128.6	0.067
16:17:40	16.295	8.33E-05	0.120	0.002	185.5	0.998
16:17:42	16.295	8.33E-05	0.120	0.002	185.5	0.998
16:17:44	16.295	8.33E-05	0.120	0.002	185.6	1.000
16:17:45	16.296	0.000125	0.180	0.003	185.6	1.000
16:17:47	16.296	0.000125	0.180	0.003	185.5	0.998
16:17:48	16.297	0.000167	0.240	0.004	185.5	0.998
16:17:50	16.297	0.000167	0.240	0.004	185.4	0.997
16:17:52	16.298	0.000208	0.300	0.005	185.4	0.997
16:17:53	16.298	0.000208	0.300	0.005	185.2	0.993
16:17:55	16.299	0.00025	0.360	0.006	185.2	0.993
16:17:56	16.299	0.00025	0.360	0.006	185.2	0.993
16:17:58	16.299	0.00025	0.360	0.006	185.2	0.993
16:18:00	16.3	0.000292	0.420	0.007	185	0.990
16:18:01	16.3	0.000292	0.420	0.007	185	0.990
16:18:03	16.301	0.000333	0.480	0.008	184.8	0.987
16:18:05	16.301	0.000333	0.480	0.008	184.8	0.987
16:18:06	16.302	0.000375	0.540	0.009	184.7	0.985
16:18:08	16.302	0.000375	0.540	0.009	184.7	0.985
16:18:09	16.303	0.000417	0.600	0.01	184.6	0.984
16:18:11	16.303	0.000417	0.600	0.01	184.6	0.984
16:18:12	16.303	0.000417	0.600	0.01	184.5	0.982
16:18:14	16.304	0.000458	0.660	0.011	184.5	0.982
16:18:16	16.304	0.000458	0.660	0.011	184.4	0.980
16:18:17	16.305	0.0005	0.720	0.012	184.4	0.980
16:18:19	16.305	0.0005	0.720	0.012	184.3	0.979
16:18:20	16.306	0.000542	0.780	0.013	184.3	0.979
16:18:22	16.306	0.000542	0.780	0.013	184	0.974
16:18:24	16.307	0.000583	0.840	0.014	184	0.974
16:18:25	16.307	0.000583	0.840	0.014	184	0.974
16:18:27	16.307	0.000583	0.840	0.014	184	0.974
16:18:28	16.308	0.000625	0.900	0.015	183.8	0.971
16:18:30	16.308	0.000625	0.900	0.015	183.8	0.971
16:18:31	16.309	0.000667	0.960	0.016	183.8	0.971
16:18:33	16.309	0.000667	0.960	0.016	183.8	0.971
16:18:35	16.31	0.000708	1.020	0.017	183.6	0.967
16:18:36	16.31	0.000708	1.020	0.017	183.6	0.967
16:18:38	16.311	0.00075	1.080	0.018	183.6	0.967
16:18:40	16.311	0.00075	1.080	0.018	183.6	0.967
16:18:41	16.311	0.00075	1.080	0.018	183.4	0.964
16:18:43	16.312	0.000792	1.140	0.019	183.4	0.964
16:18:44	16.312	0.000792	1.140	0.019	183.3	0.962

Slug Test #2 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
16:18:46	16.313	0.000833	1.200	0.02	183.3	0.962
16:18:48	16.313	0.000833	1.200	0.02	183.1	0.959
16:18:49	16.314	0.000875	1.260	0.021	183.1	0.959
16:18:51	16.314	0.000875	1.260	0.021	183	0.957
16:18:52	16.315	0.000917	1.320	0.022	183	0.957
16:18:54	16.315	0.000917	1.320	0.022	182.9	0.956
16:18:55	16.315	0.000917	1.320	0.022	182.9	0.956
16:18:57	16.316	0.000958	1.380	0.023	182.7	0.953
16:18:59	16.316	0.000958	1.380	0.023	182.7	0.953
16:19:00	16.317	0.001	1.440	0.024	182.7	0.953
16:19:02	16.317	0.001	1.440	0.024	182.7	0.953
16:19:04	16.318	0.001042	1.500	0.025	182.5	0.949
16:19:05	16.318	0.001042	1.500	0.025	182.5	0.949
16:19:06	16.318	0.001042	1.500	0.025	182.4	0.948
16:19:08	16.319	0.001083	1.560	0.026	182.4	0.948
16:19:10	16.319	0.001083	1.560	0.026	182.2	0.944
16:19:11	16.32	0.001125	1.620	0.027	182.2	0.944
16:19:13	16.32	0.001125	1.620	0.027	182.1	0.943
16:19:15	16.321	0.001167	1.680	0.028	182.1	0.943
16:19:16	16.321	0.001167	1.680	0.028	182.1	0.943
16:19:18	16.322	0.001208	1.740	0.029	182.1	0.943
16:19:19	16.322	0.001208	1.740	0.029	181.9	0.939
16:19:21	16.322	0.001208	1.740	0.029	181.9	0.939
16:19:23	16.323	0.00125	1.800	0.03	181.8	0.938
16:19:24	16.323	0.00125	1.800	0.03	181.8	0.938
16:19:26	16.324	0.001292	1.860	0.031	181.7	0.936
16:19:27	16.324	0.001292	1.860	0.031	181.7	0.936
16:19:29	16.325	0.001333	1.920	0.032	181.4	0.931
16:19:30	16.325	0.001333	1.920	0.032	181.4	0.931
16:19:32	16.326	0.001375	1.980	0.033	181.4	0.931
16:19:34	16.326	0.001375	1.980	0.033	181.4	0.931
16:19:35	16.326	0.001375	1.980	0.033	181.3	0.930
16:19:37	16.327	0.001417	2.040	0.034	181.3	0.930
16:19:39	16.327	0.001417	2.040	0.034	181.2	0.928
16:19:40	16.328	0.001458	2.100	0.035	181.2	0.928
16:19:42	16.328	0.001458	2.100	0.035	181	0.925
16:19:43	16.329	0.0015	2.160	0.036	181	0.925
16:19:45	16.329	0.0015	2.160	0.036	180.8	0.921
16:19:46	16.33	0.001542	2.220	0.037	180.8	0.921
16:19:48	16.33	0.001542	2.220	0.037	180.8	0.921
16:19:50	16.33	0.001542	2.220	0.037	180.8	0.921
16:19:51	16.331	0.001583	2.280	0.038	180.6	0.918
16:19:53	16.331	0.001583	2.280	0.038	180.6	0.918
16:19:54	16.332	0.001625	2.340	0.039	180.5	0.917
16:19:56	16.332	0.001625	2.340	0.039	180.5	0.917
16:19:58	16.333	0.001667	2.400	0.04	180.5	0.917
16:19:59	16.333	0.001667	2.400	0.04	180.5	0.917

Slug Test #2 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
16:20:01	16.334	0.001708	2.460	0.041	180.2	0.912
16:20:02	16.334	0.001708	2.460	0.041	180.2	0.912
16:20:04	16.334	0.001708	2.460	0.041	180.1	0.910
16:20:06	16.335	0.00175	2.520	0.042	180.1	0.910
16:20:07	16.335	0.00175	2.520	0.042	180	0.908
16:20:09	16.336	0.001792	2.580	0.043	180	0.908
16:20:10	16.336	0.001792	2.580	0.043	180	0.908
16:20:12	16.337	0.001833	2.640	0.044	180	0.908
16:20:14	16.337	0.001833	2.640	0.044	179.8	0.905
16:20:15	16.338	0.001875	2.700	0.045	179.8	0.905
16:20:17	16.338	0.001875	2.700	0.045	179.7	0.903
16:20:18	16.338	0.001875	2.700	0.045	179.7	0.903
16:20:20	16.339	0.001917	2.760	0.046	179.5	0.900
16:20:22	16.339	0.001917	2.760	0.046	179.5	0.900
16:20:23	16.34	0.001958	2.820	0.047	179.4	0.899
16:20:25	16.34	0.001958	2.820	0.047	179.4	0.899
16:20:26	16.341	0.002	2.880	0.048	179.2	0.895
16:20:28	16.341	0.002	2.880	0.048	179.2	0.895
16:20:29	16.341	0.002	2.880	0.048	179.1	0.894
16:20:31	16.342	0.002042	2.940	0.049	179.1	0.894
16:20:33	16.342	0.002042	2.940	0.049	179	0.892
16:20:34	16.343	0.002083	3.000	0.05	179	0.892
16:20:36	16.343	0.002083	3.000	0.05	178.9	0.890
16:20:37	16.344	0.002125	3.060	0.051	178.9	0.890
16:20:39	16.344	0.002125	3.060	0.051	178.8	0.889
16:20:41	16.345	0.002167	3.120	0.052	178.8	0.889
16:20:42	16.345	0.002167	3.120	0.052	178.6	0.885
16:20:44	16.345	0.002167	3.120	0.052	178.6	0.885
16:20:45	16.346	0.002208	3.180	0.053	178.6	0.885
16:20:47	16.346	0.002208	3.180	0.053	178.6	0.885
16:20:49	16.347	0.00225	3.240	0.054	178.5	0.884
16:20:50	16.347	0.00225	3.240	0.054	178.5	0.884
16:20:52	16.348	0.002292	3.300	0.055	178.4	0.882
16:20:53	16.348	0.002292	3.300	0.055	178.4	0.882
16:20:55	16.349	0.002333	3.360	0.056	178.2	0.879
16:20:57	16.349	0.002333	3.360	0.056	178.2	0.879
16:20:58	16.349	0.002333	3.360	0.056	178.1	0.877
16:21:00	16.35	0.002375	3.420	0.057	178.1	0.877
16:21:01	16.35	0.002375	3.420	0.057	177.6	0.869
16:21:03	16.351	0.002417	3.480	0.058	177.6	0.869
16:21:04	16.351	0.002417	3.480	0.058	177.4	0.866
16:21:06	16.352	0.002458	3.540	0.059	177.4	0.866
16:21:08	16.352	0.002458	3.540	0.059	177.3	0.864
16:21:09	16.353	0.0025	3.600	0.06	177.3	0.864
16:21:11	16.353	0.0025	3.600	0.06	176.8	0.856
16:21:13	16.353	0.0025	3.600	0.06	176.8	0.856
16:21:14	16.354	0.002542	3.660	0.061	176.2	0.846

Slug Test #2 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
16:21:16	16.354	0.002542	3.660	0.061	176.2	0.846
16:21:17	16.355	0.002583	3.720	0.062	175.6	0.836
16:21:19	16.355	0.002583	3.720	0.062	175.6	0.836
16:21:20	16.356	0.002625	3.780	0.063	175.6	0.836
16:21:22	16.356	0.002625	3.780	0.063	175.6	0.836
16:21:24	16.357	0.002667	3.840	0.064	175.6	0.836
16:21:25	16.357	0.002667	3.840	0.064	175.6	0.836
16:21:27	16.357	0.002667	3.840	0.064	175.5	0.835
16:21:28	16.358	0.002708	3.900	0.065	175.5	0.835
16:21:30	16.358	0.002708	3.900	0.065	175.2	0.830
16:21:31	16.359	0.00275	3.960	0.066	175.2	0.830
16:21:33	16.359	0.00275	3.960	0.066	175.1	0.828
16:21:35	16.36	0.002792	4.020	0.067	175.1	0.828
16:21:36	16.36	0.002792	4.020	0.067	175	0.827
16:21:38	16.361	0.002833	4.080	0.068	175	0.827
16:21:40	16.361	0.002833	4.080	0.068	174.8	0.823
16:21:41	16.361	0.002833	4.080	0.068	174.8	0.823
16:21:43	16.362	0.002875	4.140	0.069	174.8	0.823
16:21:44	16.362	0.002875	4.140	0.069	174.8	0.823
16:21:46	16.363	0.002917	4.200	0.07	174.6	0.820
16:21:47	16.363	0.002917	4.200	0.07	174.6	0.820
16:21:49	16.364	0.002958	4.260	0.071	174.3	0.815
16:21:51	16.364	0.002958	4.260	0.071	174.3	0.815
16:21:52	16.365	0.003	4.320	0.072	174.2	0.813
16:21:54	16.365	0.003	4.320	0.072	174.2	0.813
16:21:55	16.365	0.003	4.320	0.072	174	0.810
16:21:57	16.366	0.003042	4.380	0.073	174	0.810
16:21:59	16.366	0.003042	4.380	0.073	173.9	0.809
16:22:00	16.367	0.003083	4.440	0.074	173.9	0.809
16:22:02	16.367	0.003083	4.440	0.074	173.8	0.807
16:22:03	16.368	0.003125	4.500	0.075	173.8	0.807
16:22:05	16.368	0.003125	4.500	0.075	173.6	0.804
16:22:07	16.368	0.003125	4.500	0.075	173.6	0.804
16:22:08	16.369	0.003167	4.560	0.076	173.6	0.804
16:22:10	16.369	0.003167	4.560	0.076	173.6	0.804
16:22:22	16.373	0.003333	4.800	0.08	173	0.794
16:22:27	16.374	0.003375	4.860	0.081	172.6	0.787
16:22:34	16.376	0.003458	4.980	0.083	172.3	0.782
16:22:40	16.378	0.003542	5.100	0.085	172.1	0.779
16:22:46	16.38	0.003625	5.220	0.087	171.8	0.774
16:22:53	16.381	0.003667	5.280	0.088	171.6	0.771
16:22:59	16.383	0.00375	5.400	0.09	171.4	0.768
16:23:05	16.385	0.003833	5.520	0.092	171.2	0.764
16:23:12	16.387	0.003917	5.640	0.094	171.1	0.763
16:23:18	16.388	0.003958	5.700	0.095	171	0.761
16:23:25	16.39	0.004042	5.820	0.097	171.2	0.764

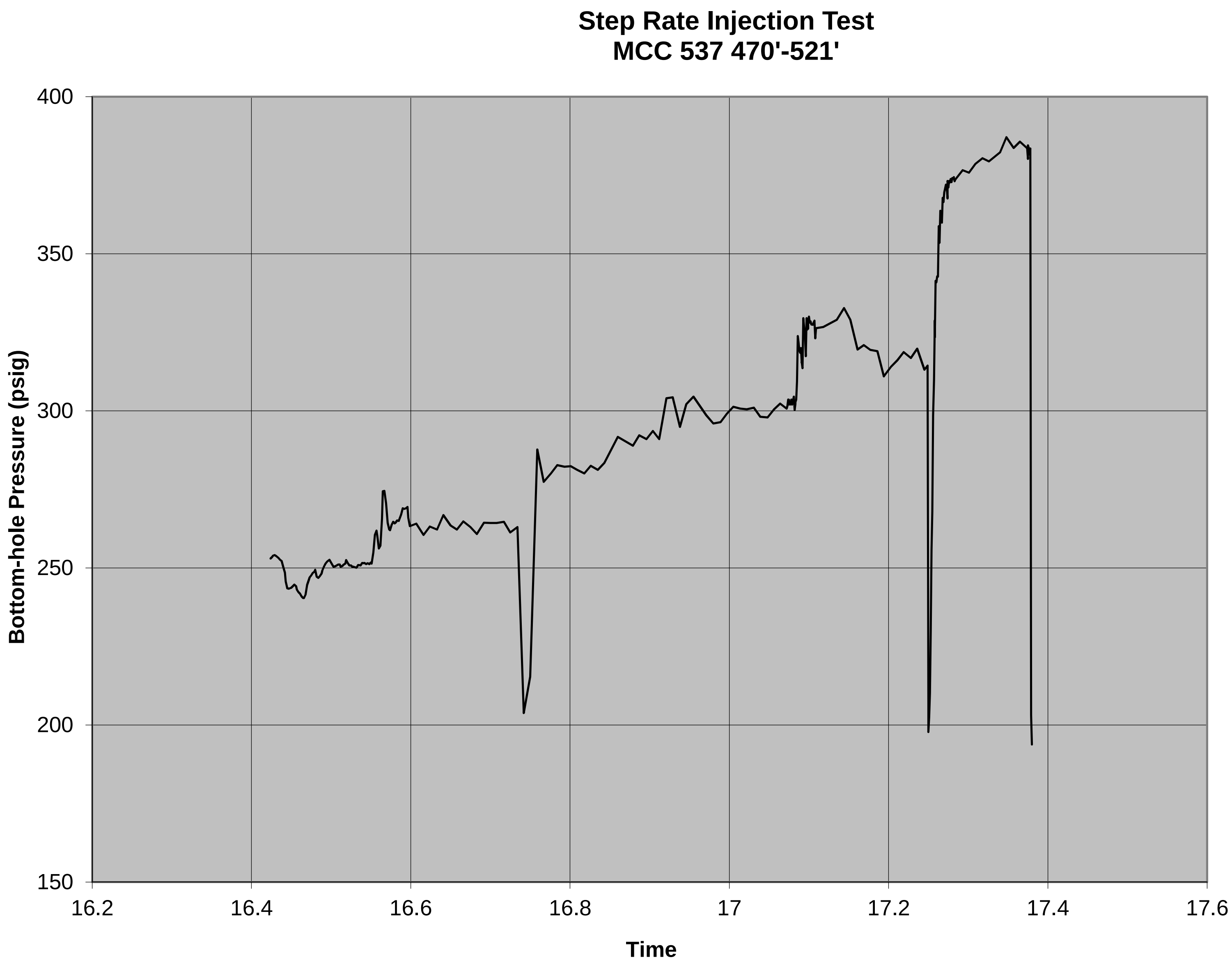

Slug Test #1
MCC 537 470'-521'
205
200
195
190
185
180
175
0.000
2.000
4.000
6.000
8.000
10.000
12.000
Bottom-hole Pressure (psig)
Elapsed time (min)


Horslev Plot
MCC 537 460'-521'
10.000
1.000
0.100
h/h$_o$
0.000
2.000
4.000
6.000
8.000
10.000
12.000
Elapsed Time (min)

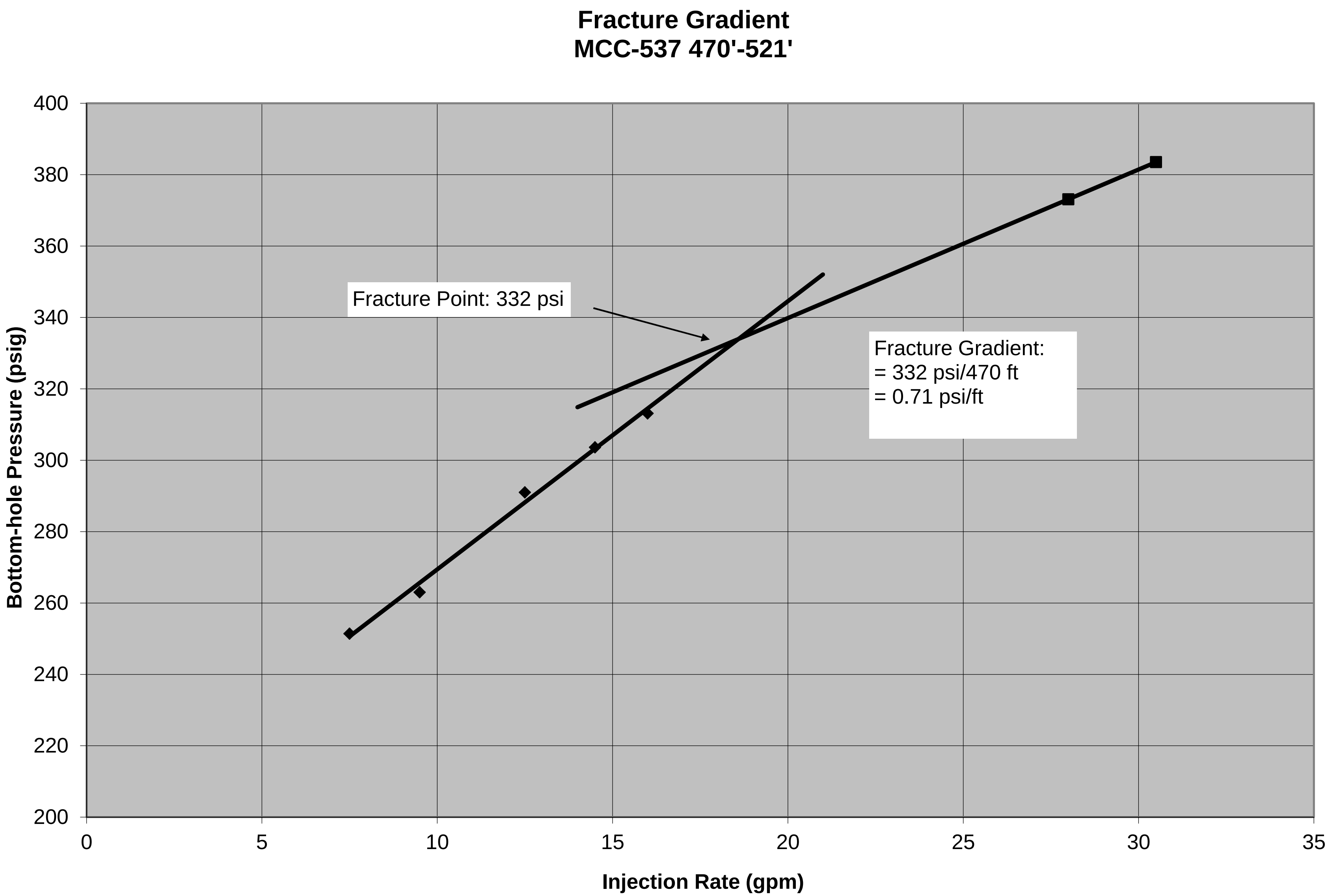
Slug Test #1 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
Static Pressure						
16:03:31	16.059				124.6	
16:03:33	16.059	0.00E+00	0.000	0.000	200.1	0.997
16:03:34	16.060	4.17E-05	0.060	0.001	200.1	0.997
16:03:36	16.060	4.17E-05	0.060	0.001	200.3	1.000
16:03:38	16.060	4.17E-05	0.060	0.001	200.3	1.000
16:03:39	16.061	8.33E-05	0.120	0.002	200.1	0.997
16:03:41	16.061	8.33E-05	0.120	0.002	200.1	0.997
16:03:42	16.062	1.25E-04	0.180	0.003	200	0.996
16:03:44	16.062	1.25E-04	0.180	0.003	200	0.996
16:03:46	16.063	1.67E-04	0.240	0.004	199.7	0.992
16:03:47	16.063	1.67E-04	0.240	0.004	199.7	0.992
16:03:49	16.064	2.08E-04	0.300	0.005	199.6	0.991
16:03:50	16.064	2.08E-04	0.300	0.005	199.6	0.991
16:03:52	16.064	2.08E-04	0.300	0.005	199.5	0.989
16:03:54	16.065	2.50E-04	0.360	0.006	199.5	0.989
16:03:55	16.065	2.50E-04	0.360	0.006	199.3	0.987
16:03:57	16.066	2.92E-04	0.420	0.007	199.3	0.987
16:03:58	16.066	2.92E-04	0.420	0.007	199.2	0.985
16:04:00	16.067	3.33E-04	0.480	0.008	199.2	0.985
16:04:01	16.067	3.33E-04	0.480	0.008	199.1	0.984
16:04:03	16.068	3.75E-04	0.540	0.009	199.1	0.984
16:04:05	16.068	3.75E-04	0.540	0.009	199	0.983
16:04:06	16.068	3.75E-04	0.540	0.009	199	0.983
16:04:08	16.069	4.17E-04	0.600	0.010	198.8	0.980
16:04:10	16.069	4.17E-04	0.600	0.010	198.8	0.980
16:04:11	16.070	4.58E-04	0.660	0.011	198.7	0.979
16:04:13	16.070	4.58E-04	0.660	0.011	198.7	0.979
16:04:14	16.071	5.00E-04	0.720	0.012	198.5	0.976
16:04:16	16.071	5.00E-04	0.720	0.012	198.5	0.976
16:04:18	16.072	5.42E-04	0.780	0.013	198.3	0.974
16:04:19	16.072	5.42E-04	0.780	0.013	198.3	0.974
16:04:21	16.072	5.42E-04	0.780	0.013	198.1	0.971
16:04:22	16.073	5.83E-04	0.840	0.014	198.1	0.971
16:04:24	16.073	5.83E-04	0.840	0.014	197.9	0.968
16:04:26	16.074	6.25E-04	0.900	0.015	197.9	0.968
16:04:27	16.074	6.25E-04	0.900	0.015	197.8	0.967
16:04:29	16.075	6.67E-04	0.960	0.016	197.8	0.967
16:04:30	16.075	6.67E-04	0.960	0.016	197.7	0.966
16:04:32	16.076	7.08E-04	1.020	0.017	197.7	0.966
16:04:33	16.076	7.08E-04	1.020	0.017	197.5	0.963
16:04:35	16.076	7.08E-04	1.020	0.017	197.5	0.963
16:04:37	16.077	7.50E-04	1.080	0.018	197.3	0.960
16:04:38	16.077	7.50E-04	1.080	0.018	197.3	0.960
16:04:40	16.078	7.92E-04	1.140	0.019	197.1	0.958

16:04:41	16.078	7.92E-04	1.140	0.019	197.1	0.958
16:04:43	16.079	8.33E-04	1.200	0.020	197.1	0.958
16:04:45	16.079	8.33E-04	1.200	0.020	197.1	0.958
16:04:46	16.079	8.33E-04	1.200	0.020	197	0.956
16:04:48	16.080	8.75E-04	1.260	0.021	197	0.956
16:04:49	16.080	8.75E-04	1.260	0.021	196.9	0.955
16:04:51	16.081	9.17E-04	1.320	0.022	196.9	0.955
16:04:52	16.081	9.17E-04	1.320	0.022	196.6	0.951
16:04:54	16.082	9.58E-04	1.380	0.023	196.6	0.951
16:04:56	16.082	9.58E-04	1.380	0.023	196.4	0.948
16:04:57	16.083	1.00E-03	1.440	0.024	196.4	0.948
16:04:59	16.083	1.00E-03	1.440	0.024	196.3	0.947
16:05:00	16.083	1.00E-03	1.440	0.024	196.3	0.947
16:05:02	16.084	1.04E-03	1.500	0.025	196.2	0.946
16:05:04	16.084	1.04E-03	1.500	0.025	196.2	0.946
16:05:05	16.085	1.08E-03	1.560	0.026	196.2	0.946
16:05:07	16.085	1.08E-03	1.560	0.026	196.2	0.946
16:05:08	16.086	1.12E-03	1.620	0.027	195.9	0.942
16:05:10	16.086	1.12E-03	1.620	0.027	195.9	0.942
16:05:12	16.087	1.17E-03	1.680	0.028	195.9	0.942
16:05:13	16.087	1.17E-03	1.680	0.028	195.9	0.942
16:05:15	16.087	1.17E-03	1.680	0.028	195.8	0.941
16:05:16	16.088	1.21E-03	1.740	0.029	195.8	0.941
16:05:18	16.088	1.21E-03	1.740	0.029	195.6	0.938
16:05:20	16.089	1.25E-03	1.800	0.030	195.6	0.938
16:05:21	16.089	1.25E-03	1.800	0.030	195.5	0.937
16:05:23	16.090	1.29E-03	1.860	0.031	195.5	0.937
16:05:24	16.090	1.29E-03	1.860	0.031	195.4	0.935
16:05:26	16.091	1.33E-03	1.920	0.032	195.4	0.935
16:05:28	16.091	1.33E-03	1.920	0.032	195.2	0.933
16:05:29	16.091	1.33E-03	1.920	0.032	195.2	0.933
16:05:31	16.092	1.37E-03	1.980	0.033	195.1	0.931
16:05:32	16.092	1.37E-03	1.980	0.033	195.1	0.931
16:05:34	16.093	1.42E-03	2.040	0.034	195	0.930
16:05:36	16.093	1.42E-03	2.040	0.034	195	0.930
16:05:37	16.094	1.46E-03	2.100	0.035	195	0.930
16:05:52	16.098	1.62E-03	2.340	0.039	195	0.930
16:05:56	16.099	1.67E-03	2.400	0.040	194.3	0.921
16:06:01	16.100	1.71E-03	2.460	0.041	194.1	0.918
16:06:06	16.102	1.79E-03	2.580	0.043	193.9	0.915
16:06:11	16.103	1.83E-03	2.640	0.044	193.8	0.914
16:06:22	16.106	1.96E-03	2.820	0.047	193.7	0.913
16:06:28	16.108	2.04E-03	2.940	0.049	193.1	0.905
16:06:35	16.110	2.12E-03	3.060	0.051	192.9	0.902
16:06:52	16.114	2.29E-03	3.300	0.055	192.6	0.898
16:07:03	16.118	2.46E-03	3.540	0.059	192	0.890
16:07:16	16.121	2.58E-03	3.720	0.062	191.6	0.885
16:07:27	16.124	2.71E-03	3.900	0.065	191.2	0.880
16:07:54	16.132	3.04E-03	4.380	0.073	190.3	0.868
16:08:07	16.135	3.17E-03	4.560	0.076	189.9	0.863
16:08:20	16.139	3.33E-03	4.800	0.080	189.5	0.857

16:08:33	16.142	3.46E-03	4.980	0.083	189	0.851
16:08:45	16.146	3.62E-03	5.220	0.087	188.7	0.847
16:08:58	16.149	3.75E-03	5.400	0.090	188.3	0.841
16:09:11	16.153	3.92E-03	5.640	0.094	187.9	0.836
16:09:23	16.156	4.04E-03	5.820	0.097	187.6	0.832
16:09:36	16.160	4.21E-03	6.060	0.101	187.1	0.826
16:09:49	16.164	4.38E-03	6.300	0.105	186.8	0.822
16:10:02	16.167	4.50E-03	6.480	0.108	186.4	0.816
16:10:14	16.171	4.67E-03	6.720	0.112	185.9	0.810
16:10:27	16.174	4.79E-03	6.900	0.115	185.5	0.804
16:10:40	16.178	4.96E-03	7.140	0.119	185.2	0.801
16:10:53	16.181	5.08E-03	7.320	0.122	184.9	0.797
16:11:05	16.185	5.25E-03	7.560	0.126	184.4	0.790
16:11:18	16.188	5.37E-03	7.740	0.129	184.1	0.786
16:11:31	16.192	5.54E-03	7.980	0.133	183.8	0.782
16:11:44	16.195	5.67E-03	8.160	0.136	183.4	0.777
16:11:56	16.199	5.83E-03	8.400	0.140	182.9	0.770
16:12:09	16.203	6.00E-03	8.640	0.144	182.7	0.768
16:12:22	16.206	6.12E-03	8.820	0.147	182.4	0.764
16:12:35	16.210	6.29E-03	9.060	0.151	181.9	0.757
16:12:47	16.213	6.42E-03	9.240	0.154	181.6	0.753
16:13:00	16.217	6.58E-03	9.480	0.158	181.2	0.748
16:13:13	16.220	6.71E-03	9.660	0.161	180.9	0.744
16:13:26	16.224	6.87E-03	9.900	0.165	180.5	0.738
16:13:38	16.227	7.00E-03	10.080	0.168	180.2	0.734
16:13:51	16.231	7.17E-03	10.320	0.172	180.2	0.734



Step Rate Injection Test
MCC 537 470'-521'
Bottom-hole Pressure (psig)
400
350
300
250
200
150
16.2
16.4
16.6
16.8
17
17.2
17.4
17.6
Time


Fracture Gradient
MCC-537 470'-521'
Bottom-hole Pressure (psig)
400
380
360
340
320
300
280
260
240
220
200
0
5
10
15
20
25
30
35
Injection Rate (gpm)
Fracture Point: 332 psi
Fracture Gradient:
= 332 psi/470 ft
= 0.71 psi/ft

Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
16:25:26	16.424	7.5	253	
16:25:32	16.426	7.5	253.5	
16:25:38	16.427	7.5	253.9	
16:25:45	16.429	7.5	254.1	
16:25:51	16.431	7.5	253.8	
16:25:58	16.433	7.5	253.4	
16:26:04	16.434	7.5	253.2	
16:26:10	16.436	7.5	252.6	
16:26:17	16.438	7.5	252.2	
16:26:23	16.44	7.5	250.2	
16:26:30	16.442	7.5	248.5	
16:26:36	16.443	7.5	245.7	
16:26:42	16.445	7.5	243.5	
16:26:49	16.447	7.5	243.4	
16:26:55	16.449	7.5	243.6	
16:27:01	16.45	7.5	243.7	
16:27:08	16.452	7.5	244.2	
16:27:14	16.454	7.5	244.7	
16:27:21	16.456	7.5	244.2	
16:27:27	16.457	7.5	243.1	
16:27:33	16.459	7.5	242.3	
16:27:40	16.461	7.5	241.8	
16:27:46	16.463	7.5	240.9	
16:27:52	16.465	7.5	240.4	
16:27:59	16.466	7.5	240.4	
16:28:05	16.468	7.5	241.5	
16:28:11	16.47	7.5	244.6	
16:28:18	16.472	7.5	246.2	
16:28:24	16.473	7.5	247	
16:28:31	16.475	7.5	247.6	
16:28:37	16.477	7.5	248.4	
16:28:43	16.479	7.5	248.8	
16:28:50	16.48	7.5	249.4	
16:28:56	16.482	7.5	247.2	
16:29:02	16.484	7.5	246.8	
16:29:09	16.486	7.5	247.4	
16:29:15	16.488	7.5	248.2	
16:29:21	16.489	7.5	249.2	
16:29:28	16.491	7.5	250.4	
16:29:34	16.493	7.5	251.4	
16:29:41	16.495	7.5	252	
16:29:47	16.496	7.5	252.2	
16:29:53	16.498	7.5	252.6	
16:30:00	16.5	7.5	251.7	
16:30:13	16.503	7.5	250.4	

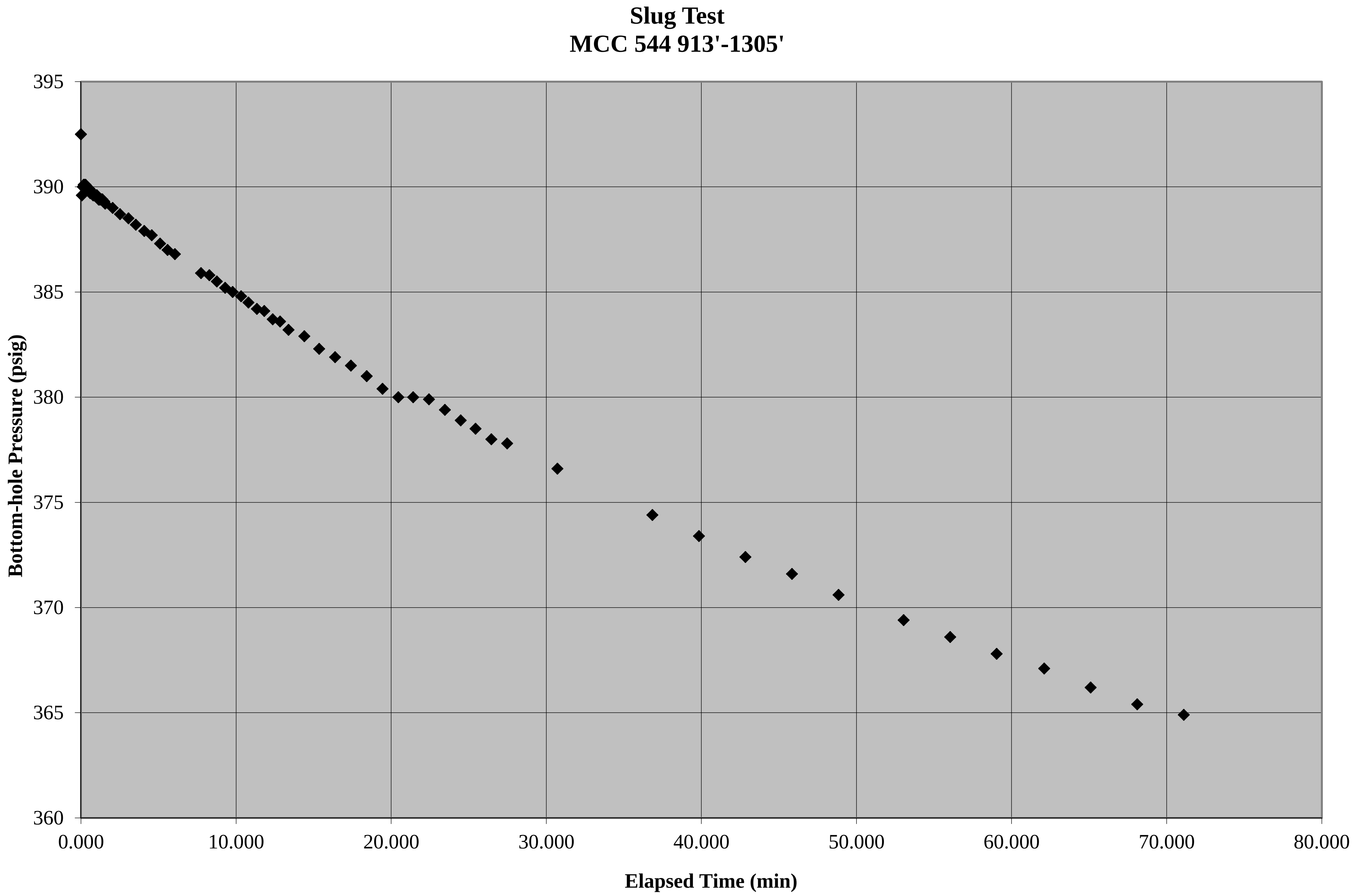
Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
16:30:19	16.505	7.5	250.5	
16:30:25	16.507	7.5	250.8	
16:30:32	16.509	7.5	251.1	
16:30:38	16.511	7.5	251.1	
16:30:44	16.512	7.5	250.4	
16:30:51	16.514	7.5	250.6	
16:30:57	16.516	7.5	251.1	
16:31:04	16.518	7.5	251.4	
16:31:10	16.519	7.5	252.5	
16:31:16	16.521	7.5	251.5	
16:31:23	16.523	7.5	250.8	
16:31:29	16.525	7.5	250.8	
16:31:36	16.527	7.5	250.3	
16:31:42	16.528	7.5	250.4	
16:31:48	16.53	7.5	250.2	
16:31:54	16.532	7.5	250.1	
16:32:01	16.534	7.5	250.9	
16:32:07	16.535	7.5	250.9	
16:32:14	16.537	7.5	250.8	
16:32:20	16.539	7.5	251.6	
16:32:26	16.541	7.5	251.5	
16:32:33	16.542	7.5	251.6	
16:32:39	16.544	7.5	251.2	
16:32:46	16.546	7.5	251.5	
16:32:52	16.548	7.5	251.2	
16:32:58	16.55	7.5	251.7	
16:33:05	16.551	7.5	251.4	
16:33:11	16.553	9.5	254.9	
16:33:17	16.555	9.5	260.6	
16:33:24	16.557	9.5	261.9	
16:33:30	16.558	9.5	260.3	
16:33:37	16.56	9.5	256.2	
16:33:43	16.562	9.5	257.1	
16:33:49	16.564	9.5	265.7	
16:33:56	16.565	9.5	274.4	
16:34:02	16.567	9.5	274.5	
16:34:08	16.569	9.5	270.6	
16:34:15	16.571	9.5	264.4	
16:34:21	16.573	9.5	262.2	
16:34:27	16.574	9.5	262	
16:34:34	16.576	9.5	263.7	
16:34:40	16.578	9.5	264.7	
16:34:47	16.58	9.5	264.2	
16:34:53	16.581	9.5	264.4	
16:34:59	16.583	9.5	265.1	
16:35:06	16.585	9.5	265	
16:35:19	16.588	9.5	267	

Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
16:35:25	16.59	9.5	269	
16:35:31	16.592	9.5	268.8	
16:35:38	16.594	9.5	269	
16:35:44	16.596	9.5	269.4	
16:35:50	16.597	9.5	266	
16:35:57	16.599	9.5	263.3	
16:36:27	16.607	9.5	264.1	
16:36:57	16.616	9.5	260.5	
16:37:28	16.624	9.5	263.2	
16:37:58	16.633	9.5	262.2	
16:38:28	16.641	9.5	266.8	
16:38:58	16.65	9.5	263.5	
16:39:29	16.658	9.5	262.2	
16:39:59	16.666	9.5	264.8	
16:40:29	16.675	9.5	263	
16:40:59	16.683	9.5	260.8	
16:41:30	16.692	9.5	264.4	
16:42:00	16.7	9.5	264.3	
16:42:30	16.708	9.5	264.3	
16:43:00	16.717	9.5	264.7	
16:43:31	16.725	9.5	261.3	
16:44:01	16.734	9.5	263	
16:44:31	16.742	12.5	203.8	
16:45:02	16.75	12.5	215.4	
16:45:32	16.759	12.5	287.7	
16:46:02	16.767	12.5	277.4	
16:46:32	16.776	12.5	280.1	
16:47:03	16.784	12.5	282.7	
16:47:33	16.793	12.5	282.2	
16:48:03	16.801	12.5	282.4	
16:48:34	16.809	12.5	281.2	
16:49:04	16.818	12.5	280.1	
16:49:34	16.826	12.5	282.5	
16:50:04	16.835	12.5	281.2	
16:50:35	16.843	12.5	283.4	
16:51:35	16.86	12.5	291.7	
16:52:44	16.879	12.5	288.9	
16:53:14	16.887	12.5	292.2	
16:53:44	16.896	12.5	291	
16:54:15	16.904	12.5	293.6	
16:54:45	16.912	12.5	291	
16:55:15	16.921	14.5	304	
16:55:46	16.929	14.5	304.3	
16:56:16	16.938	14.5	294.9	
16:56:46	16.946	14.5	302.1	
16:57:17	16.955	14.5	304.5	
16:58:17	16.971	14.5	298.6	

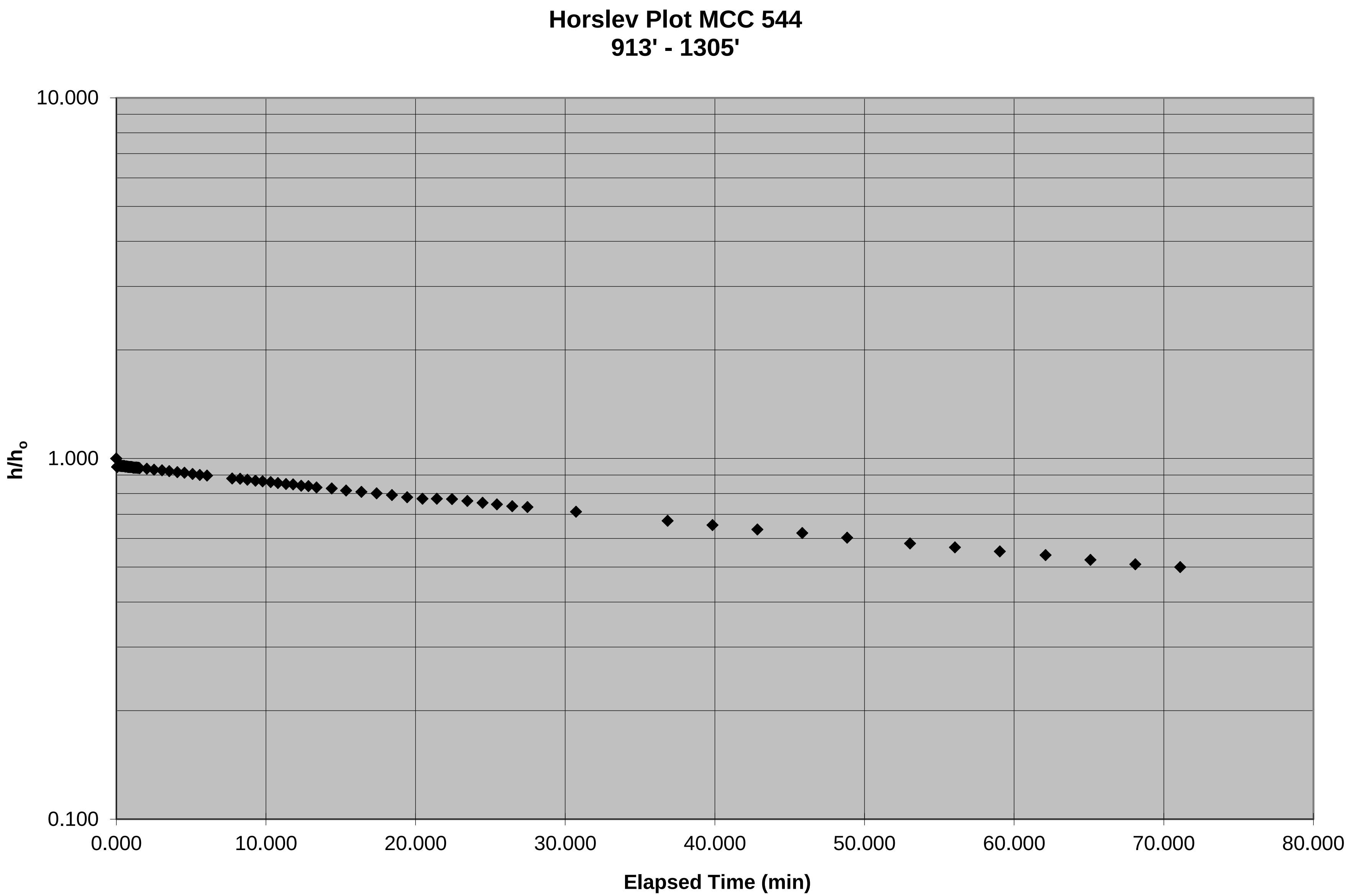
Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
16:58:47	16.98	14.5	296	
16:59:19	16.989	14.5	296.4	
16:59:49	16.997	14.5	299.1	
17:00:20	17.005	14.5	301.3	
17:00:50	17.014	14.5	300.7	
17:01:20	17.022	14.5	300.5	
17:01:51	17.031	14.5	301	
17:02:21	17.039	14.5	298.1	
17:02:51	17.048	14.5	297.9	
17:03:22	17.056	14.5	300.4	
17:03:52	17.064	14.5	302.3	
17:04:20	17.072	14.5	300.7	
17:04:22	17.073	14.5	301.6	
17:04:25	17.074	14.5	303.6	
17:04:29	17.075	14.5	303.5	
17:04:32	17.075	14.5	302	
17:04:35	17.076	14.5	302.2	
17:04:38	17.077	14.5	302	
17:04:41	17.078	14.5	303.6	
17:04:45	17.079	14.5	302	
17:04:51	17.081	14.5	304.5	
17:04:54	17.082	14.5	300.3	
17:04:57	17.083	14.5	302.2	
17:05:01	17.083	14.5	302.8	
17:05:04	17.084	14.5	303.6	
17:05:07	17.085	16	309.3	
17:05:10	17.086	16	323.8	
17:05:13	17.087	16	321.7	
17:05:16	17.088	16	319.3	
17:05:20	17.089	16	318.5	
17:05:23	17.09	16	320	
17:05:26	17.091	16	315.4	
17:05:29	17.091	16	315.5	
17:05:32	17.092	16	313.6	
17:05:36	17.093	16	329.5	
17:05:39	17.094	16	326.8	
17:05:42	17.095	16	324.5	
17:05:45	17.096	16	317.4	
17:05:48	17.097	16	329.5	
17:05:51	17.098	16	325.9	
17:05:55	17.099	16	326.2	
17:05:58	17.099	16	328.6	
17:06:01	17.1	16	330	
17:06:04	17.101	16	328.1	
17:06:07	17.102	16	328.5	
17:06:11	17.103	16	327.5	
17:06:17	17.105	16	327.4	

Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
17:06:20	17.106	16	328.1	
17:06:24	17.107	16	328.7	
17:06:27	17.107	16	328.4	
17:06:30	17.108	16	323.1	
17:06:33	17.109	16	326.3	
17:07:06	17.118	16	326.7	
17:07:37	17.127	16	327.9	
17:08:07	17.135	16	329	
17:08:37	17.144	16	332.7	
17:09:08	17.152	16	329	
17:09:38	17.161	16	319.5	
17:10:08	17.169	16	320.9	
17:10:39	17.177	16	319.4	
17:11:09	17.186	16	319	
17:11:39	17.194	16	311	
17:12:10	17.203	16	314	
17:12:40	17.211	16	316.1	
17:13:10	17.219	16	318.7	
17:13:40	17.228	16	316.8	
17:14:11	17.236	16	319.8	
17:14:41	17.245	16	313.1	
17:14:56	17.249	28	314.4	
17:14:59	17.25	28	207.2	
17:15:02	17.25	28	197.8	
17:15:05	17.251	28	202.5	
17:15:08	17.252	28	210.2	
17:15:11	17.253	28	229.8	
17:15:14	17.254	28	255.8	
17:15:18	17.255	28	267.9	
17:15:21	17.256	28	298.5	
17:15:24	17.257	28	309.8	
17:15:27	17.258	28	328.8	
17:15:31	17.258	28	323.4	
17:15:34	17.259	28	341.4	
17:15:37	17.26	28	340.9	
17:15:40	17.261	28	342.8	
17:15:43	17.262	28	342.7	
17:15:46	17.263	28	358.8	
17:15:50	17.264	28	353.5	
17:15:53	17.265	28	363.7	
17:15:56	17.266	28	360.5	
17:15:59	17.266	28	361.5	
17:16:02	17.267	28	359.9	
17:16:05	17.268	28	367.8	
17:16:09	17.269	28	366.5	
17:16:12	17.27	28	369.6	
17:16:18	17.272	28	372	

Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
17:16:22	17.273	28	371	
17:16:25	17.274	28	367.6	
17:16:28	17.274	28	373.2	
17:16:31	17.275	28	371.1	
17:16:34	17.276	28	373.2	
17:16:38	17.277	28	372.7	
17:16:41	17.278	28	373.8	
17:16:44	17.279	28	372.8	
17:16:47	17.28	28	374.1	
17:16:50	17.281	28	374	
17:16:54	17.282	28	374.4	
17:16:57	17.282	28	374.1	
17:17:00	17.283	28	373.1	
17:17:03	17.284	30.5	373.7	
17:17:33	17.293	30.5	376.6	
17:18:04	17.301	30.5	375.8	
17:18:34	17.309	30.5	378.6	
17:19:04	17.318	30.5	380.4	
17:19:35	17.326	30.5	379.4	
17:20:24	17.34	30.5	382.3	
17:20:54	17.348	30.5	387.1	
17:21:25	17.357	30.5	383.7	
17:21:55	17.365	30.5	385.7	
17:22:25	17.374	30.5	383.6	
17:22:28	17.375	30.5	380.2	
17:22:32	17.375	30.5	384.5	
17:22:35	17.376	30.5	383.7	
17:22:38	17.377	30.5	381.6	
17:22:41	17.378	30.5	383.5	End Test
17:22:44	17.379		203.1	
17:22:48	17.38		193.8	
Summary of Injection Data				
		7.5	251.4	
		9.5	263	
		12.5	291	
		14.5	303.6	
		16	313.1	
		28	373.1	
		30.5	383.5	



Slug Test
MCC 544 913'-1305'
Bottom-hole Pressure (psig)
395
390
385
380
375
370
365
360
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
Elapsed Time (min)

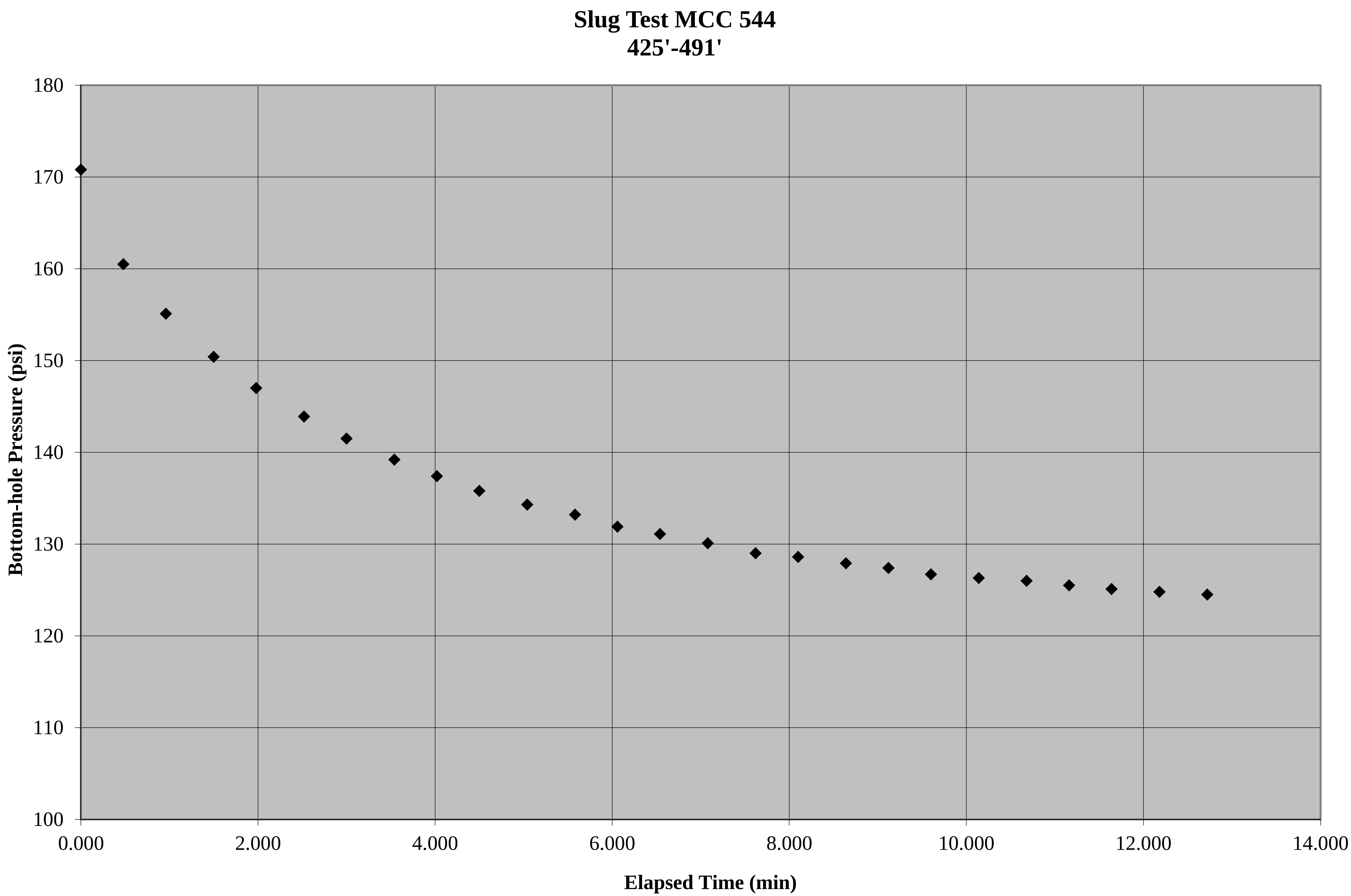


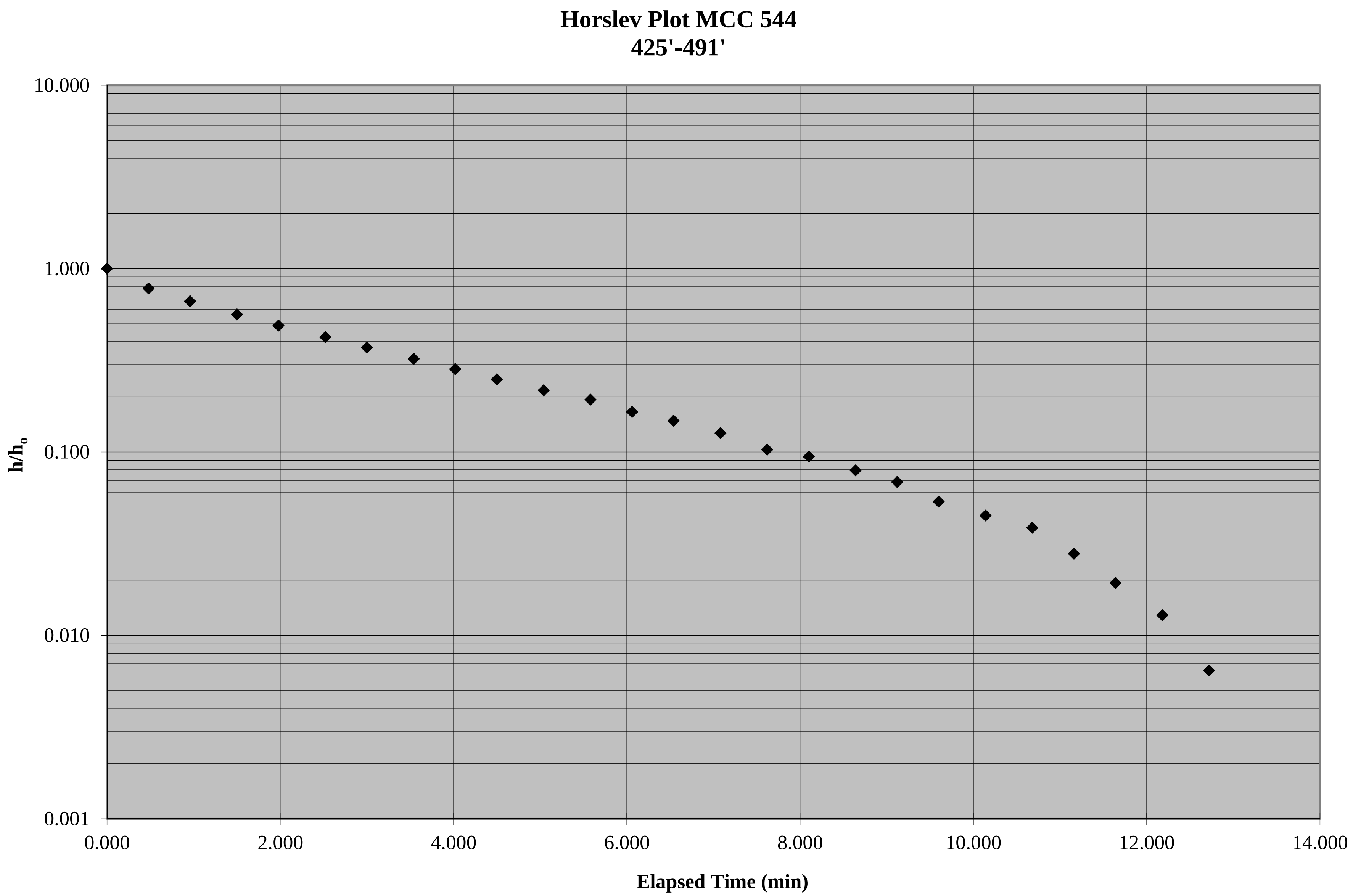
Horslev Plot MCC 544
913' - 1305'
10.000
1.000
0.100
h/h_o
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
Elapsed Time (min)

Slug Test Data MCC 544 913'-1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
13:56:33	13.943	0.000	0.000	0.000	337.3	-
13:56:35	13.943	0.000	0.000	0.000	392.5	1.000
13:56:36	13.943	0.000	0.000	0.000	392.5	1.000
13:56:38	13.944	0.001	0.060	0.000	389.6	0.947
13:56:40	13.944	0.001	0.060	0.000	389.6	0.947
13:56:41	13.945	0.002	0.120	0.000	390	0.955
13:56:43	13.945	0.002	0.120	0.000	390	0.955
13:56:44	13.946	0.003	0.180	0.000	390.1	0.957
13:56:46	13.946	0.003	0.180	0.000	390.1	0.957
13:56:48	13.947	0.004	0.240	0.000	390	0.955
13:56:49	13.947	0.004	0.240	0.000	390	0.955
13:56:51	13.947	0.004	0.240	0.000	390.1	0.957
13:56:52	13.948	0.005	0.300	0.000	390.1	0.957
13:56:54	13.948	0.005	0.300	0.000	389.9	0.953
13:56:56	13.949	0.006	0.360	0.000	389.9	0.953
13:56:57	13.949	0.006	0.360	0.000	389.9	0.953
13:56:59	13.95	0.007	0.420	0.000	389.9	0.953
13:57:00	13.95	0.007	0.420	0.000	389.9	0.953
13:57:02	13.951	0.008	0.480	0.000	389.9	0.953
13:57:04	13.951	0.008	0.480	0.000	389.9	0.953
13:57:05	13.951	0.008	0.480	0.000	389.9	0.953
13:57:07	13.952	0.009	0.540	0.000	389.9	0.953
13:57:08	13.952	0.009	0.540	0.000	389.9	0.953
13:57:10	13.953	0.010	0.600	0.000	389.7	0.949
13:57:11	13.953	0.010	0.600	0.000	389.7	0.949
13:57:13	13.954	0.011	0.660	0.000	389.8	0.951
13:57:15	13.954	0.011	0.660	0.000	389.8	0.951
13:57:16	13.955	0.012	0.720	0.001	389.7	0.949
13:57:18	13.955	0.012	0.720	0.001	389.7	0.949
13:57:20	13.955	0.012	0.720	0.001	389.7	0.949
13:57:21	13.956	0.013	0.780	0.001	389.7	0.949
13:57:23	13.956	0.013	0.780	0.001	389.6	0.947
13:57:24	13.957	0.014	0.840	0.001	389.6	0.947
13:57:26	13.957	0.014	0.840	0.001	389.6	0.947
13:57:28	13.958	0.015	0.900	0.001	389.6	0.947
13:57:29	13.958	0.015	0.900	0.001	389.6	0.947
13:57:31	13.958	0.015	0.900	0.001	389.6	0.947
13:57:32	13.959	0.016	0.960	0.001	389.6	0.947
13:57:34	13.959	0.016	0.960	0.001	389.6	0.947
13:57:35	13.96	0.017	1.020	0.001	389.6	0.947
13:57:37	13.96	0.017	1.020	0.001	389.6	0.947
13:57:39	13.961	0.018	1.080	0.001	389.5	0.946
13:57:40	13.961	0.018	1.080	0.001	389.5	0.946
13:57:42	13.962	0.019	1.140	0.001	389.4	0.944

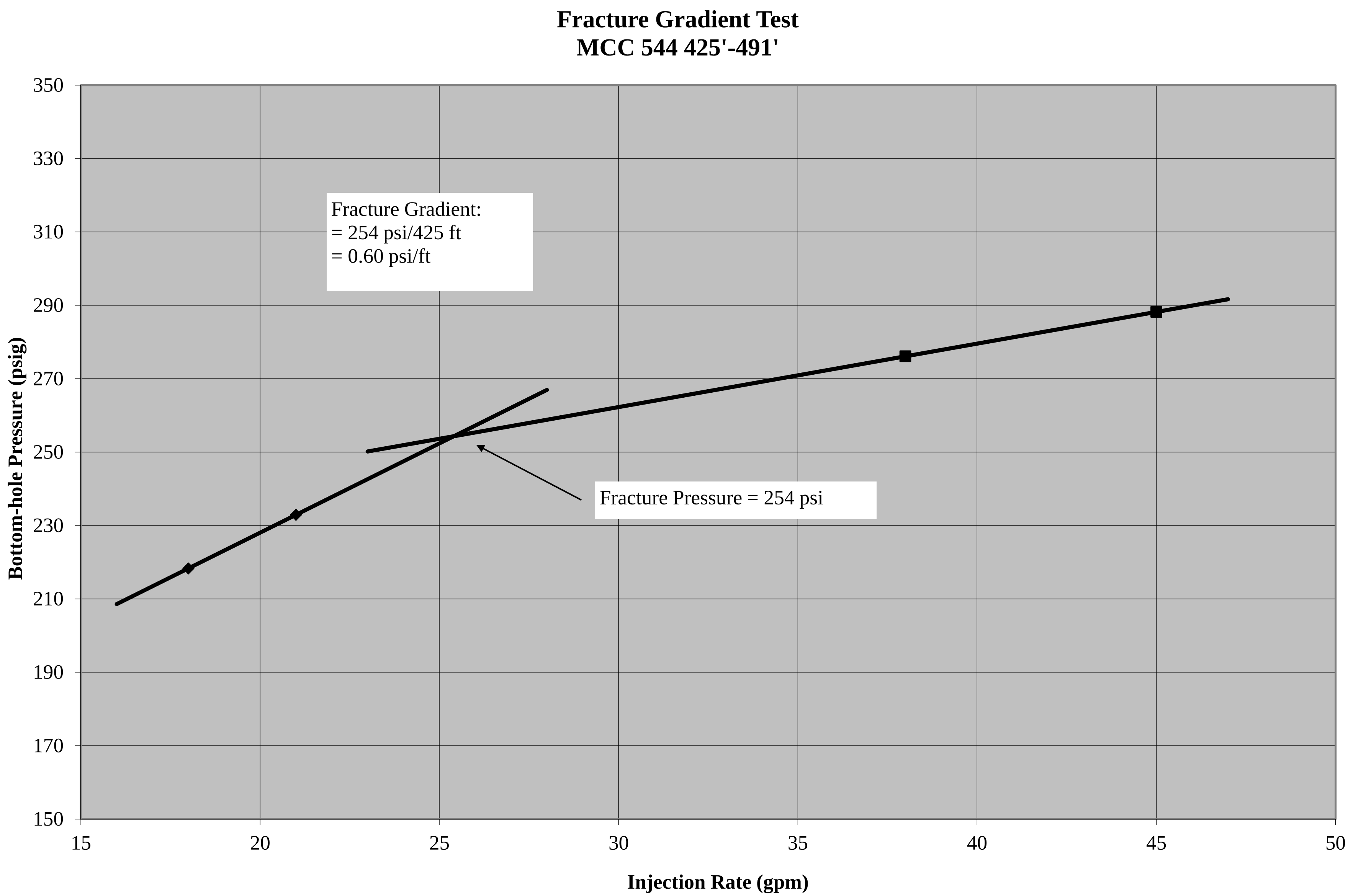
Slug Test Data MCC 544 913'-1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
13:57:43	13.962	0.019	1.140	0.001	389.4	0.944
13:57:45	13.962	0.019	1.140	0.001	389.4	0.944
13:57:47	13.963	0.020	1.200	0.001	389.4	0.944
13:57:48	13.963	0.020	1.200	0.001	389.4	0.944
13:57:50	13.964	0.021	1.260	0.001	389.4	0.944
13:57:51	13.964	0.021	1.260	0.001	389.4	0.944
13:57:53	13.965	0.022	1.320	0.001	389.4	0.944
13:57:55	13.965	0.022	1.320	0.001	389.4	0.944
13:57:56	13.966	0.023	1.380	0.001	389.4	0.944
13:57:58	13.966	0.023	1.380	0.001	389.4	0.944
13:57:59	13.966	0.023	1.380	0.001	389.4	0.944
13:58:01	13.967	0.024	1.440	0.001	389.3	0.942
13:58:02	13.967	0.024	1.440	0.001	389.3	0.942
13:58:04	13.968	0.025	1.500	0.001	389.3	0.942
13:58:06	13.968	0.025	1.500	0.001	389.3	0.942
13:58:07	13.969	0.026	1.560	0.001	389.2	0.940
13:58:38	13.977	0.034	2.040	0.001	389	0.937
13:59:08	13.985	0.042	2.520	0.002	388.7	0.931
13:59:38	13.994	0.051	3.060	0.002	388.5	0.928
14:00:08	14.002	0.059	3.540	0.002	388.2	0.922
14:00:39	14.011	0.068	4.080	0.003	387.9	0.917
14:01:09	14.019	0.076	4.560	0.003	387.7	0.913
14:01:39	14.028	0.085	5.100	0.004	387.3	0.906
14:02:10	14.036	0.093	5.580	0.004	387	0.900
14:02:40	14.044	0.101	6.060	0.004	386.8	0.897
14:04:21	14.072	0.129	7.740	0.005	385.9	0.880
14:04:51	14.081	0.138	8.280	0.006	385.8	0.879
14:05:21	14.089	0.146	8.760	0.006	385.5	0.873
14:05:51	14.098	0.155	9.300	0.006	385.2	0.868
14:06:23	14.106	0.163	9.780	0.007	385	0.864
14:06:54	14.115	0.172	10.320	0.007	384.8	0.861
14:07:24	14.123	0.180	10.800	0.007	384.5	0.855
14:07:54	14.132	0.189	11.340	0.008	384.2	0.850
14:08:25	14.14	0.197	11.820	0.008	384.1	0.848
14:08:55	14.149	0.206	12.360	0.009	383.7	0.841
14:09:27	14.157	0.214	12.840	0.009	383.6	0.839
14:09:57	14.166	0.223	13.380	0.009	383.2	0.832
14:10:58	14.183	0.240	14.400	0.010	382.9	0.826
14:11:58	14.199	0.256	15.360	0.011	382.3	0.815
14:12:59	14.216	0.273	16.380	0.011	381.9	0.808
14:13:59	14.233	0.290	17.400	0.012	381.5	0.801
14:15:00	14.25	0.307	18.420	0.013	381	0.792
14:16:01	14.267	0.324	19.440	0.014	380.4	0.781
14:17:01	14.284	0.341	20.460	0.014	380	0.774
14:18:00	14.3	0.357	21.420	0.015	380	0.774
14:19:01	14.317	0.374	22.440	0.016	379.9	0.772
14:20:01	14.334	0.391	23.460	0.016	379.4	0.763

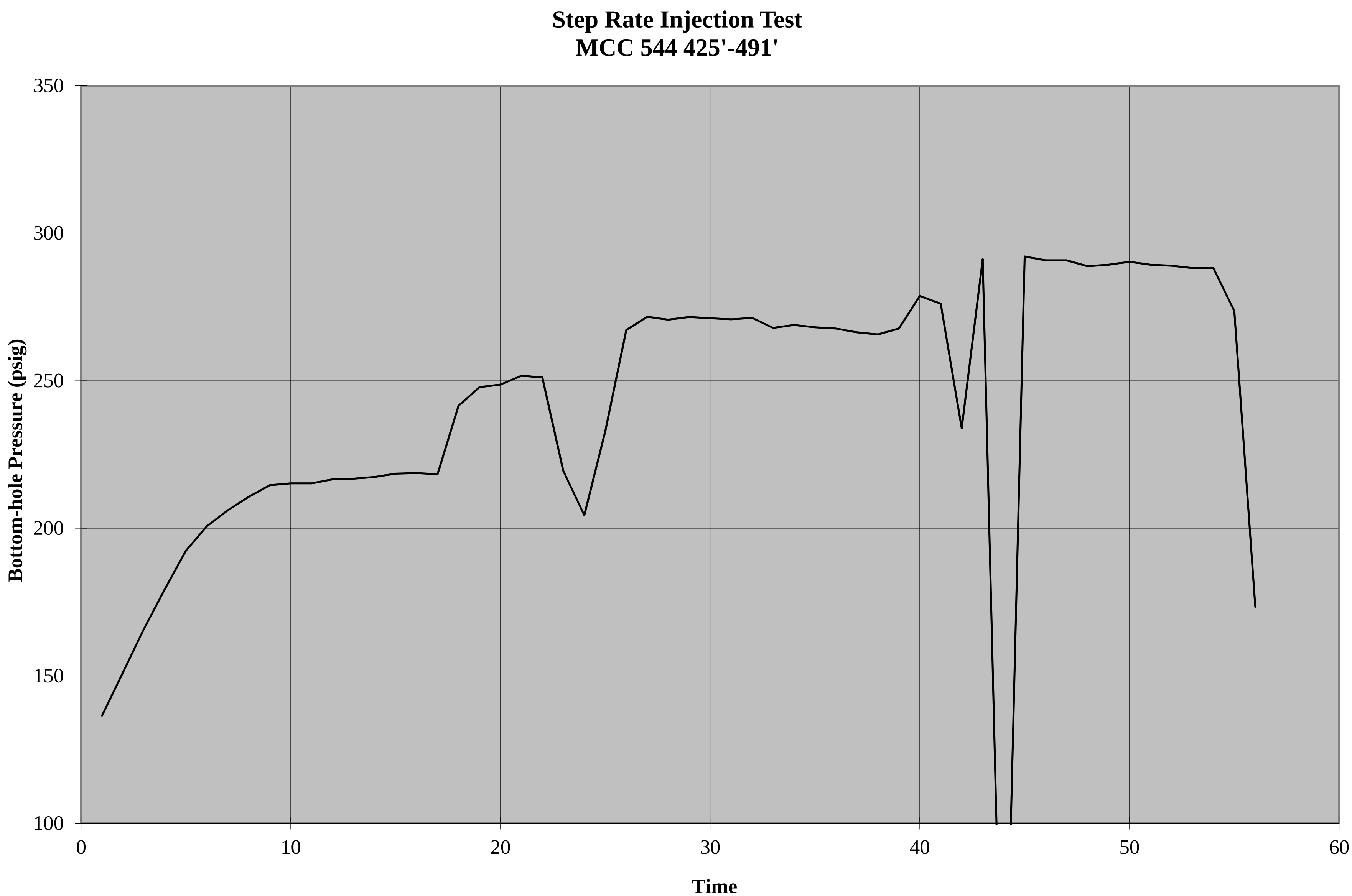
Slug Test Data MCC 544 913'-1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
14:21:02	14.351	0.408	24.480	0.017	378.9	0.754
14:22:03	14.367	0.424	25.440	0.018	378.5	0.746
14:23:03	14.384	0.441	26.460	0.018	378	0.737
14:24:04	14.401	0.458	27.480	0.019	377.8	0.734
14:27:18	14.455	0.512	30.720	0.021	376.6	0.712
14:33:24	14.557	0.614	36.840	0.026	374.4	0.672
14:36:24	14.607	0.664	39.840	0.028	373.4	0.654
14:39:24	14.657	0.714	42.840	0.030	372.4	0.636
14:42:26	14.707	0.764	45.840	0.032	371.6	0.621
14:45:26	14.757	0.814	48.840	0.034	370.6	0.603
14:49:37	14.827	0.884	53.040	0.037	369.4	0.582
14:52:38	14.877	0.934	56.040	0.039	368.6	0.567
14:55:39	14.927	0.984	59.040	0.041	367.8	0.553
14:58:39	14.978	1.035	62.100	0.043	367.1	0.540
15:01:41	15.028	1.085	65.100	0.045	366.2	0.524
15:04:41	15.078	1.135	68.100	0.047	365.4	0.509
15:07:41	15.128	1.185	71.100	0.049	364.9	0.500


Slug Test MCC 544
425'-491'
180
170
160
150
140
130
120
110
100
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Bottom-hole Pressure (psi)
Elapsed Time (min)


Horslev Plot MCC 544
425'-491'
10.000
1.000
0.100
0.010
0.001
h/h$_o$
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Elapsed Time (min)

Slug Test Data MCC 544 425'-491'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
13:23:41	13.395	-	-	-	124.2	-
13:24:13	13.404	0.000	0.000	0.000	170.8	1.000
13:24:44	13.412	0.008	0.480	0.000	160.5	0.779
13:25:14	13.42	0.016	0.960	0.001	155.1	0.663
13:25:44	13.429	0.025	1.500	0.001	150.4	0.562
13:26:14	13.437	0.033	1.980	0.001	147	0.489
13:26:45	13.446	0.042	2.520	0.002	143.9	0.423
13:27:15	13.454	0.050	3.000	0.002	141.5	0.371
13:27:45	13.463	0.059	3.540	0.002	139.2	0.322
13:28:16	13.471	0.067	4.020	0.003	137.4	0.283
13:28:46	13.479	0.075	4.500	0.003	135.8	0.249
13:29:18	13.488	0.084	5.040	0.003	134.3	0.217
13:29:48	13.497	0.093	5.580	0.004	133.2	0.193
13:30:18	13.505	0.101	6.060	0.004	131.9	0.165
13:30:49	13.513	0.109	6.540	0.005	131.1	0.148
13:31:19	13.522	0.118	7.080	0.005	130.1	0.127
13:31:51	13.531	0.127	7.620	0.005	129	0.103
13:32:21	13.539	0.135	8.100	0.006	128.6	0.094
13:32:51	13.548	0.144	8.640	0.006	127.9	0.079
13:33:22	13.556	0.152	9.120	0.006	127.4	0.069
13:33:52	13.564	0.160	9.600	0.007	126.7	0.054
13:34:24	13.573	0.169	10.140	0.007	126.3	0.045
13:34:54	13.582	0.178	10.680	0.007	126	0.039
13:35:24	13.59	0.186	11.160	0.008	125.5	0.028
13:35:55	13.598	0.194	11.640	0.008	125.1	0.019
13:36:26	13.607	0.203	12.180	0.008	124.8	0.013
13:36:57	13.616	0.212	12.720	0.009	124.5	0.006


Fracture Gradient Test
MCC 544 425'-491'
Fracture Gradient:
= 254 psi/425 ft
= 0.60 psi/ft
Fracture Pressure = 254 psi
Bottom-hole Pressure (psig)
350
330
310
290
270
250
230
210
190
170
150
15
20
25
30
35
40
45
50
Injection Rate (gpm)

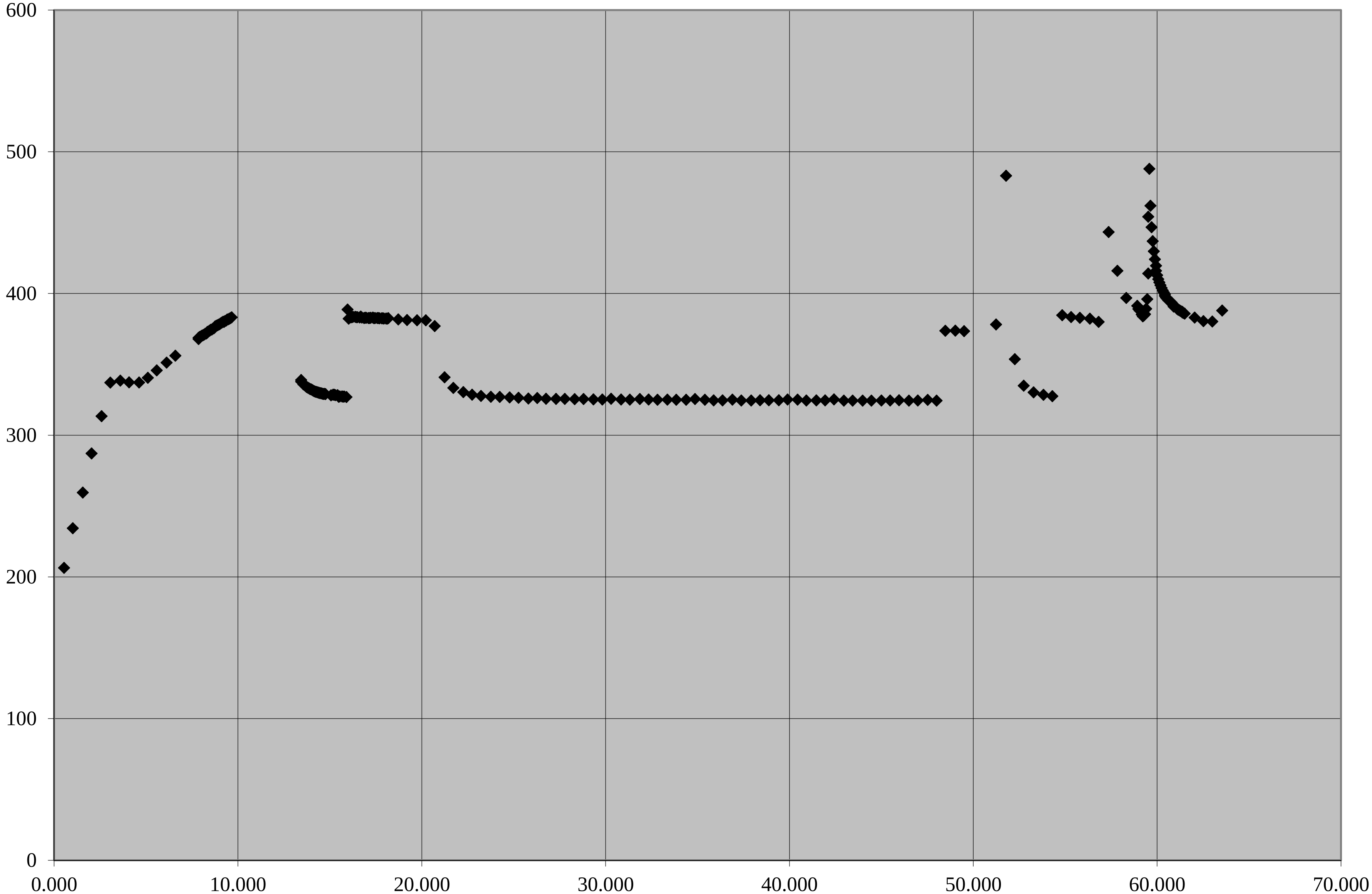


Step Rate Injection Test
MCC 544 425'-491'
Bottom-hole Pressure (psig)
350
300
250
200
150
100
0
10
20
30
40
50
60
Time

Step Rate Injection Test MCC 544 425'-491'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
14:42:31	14.709	0.000	0.000	18	136.5	
14:43:02	14.717	0.008	0.480	18	151.2	
14:43:32	14.726	0.017	1.020	18	166	
14:44:02	14.734	0.025	1.500	18	179.4	
14:44:34	14.743	0.034	2.040	18	192.4	
14:45:04	14.751	0.042	2.520	18	200.7	
14:45:35	14.76	0.051	3.060	18	206.1	
14:46:06	14.768	0.059	3.540	18	210.7	
14:47:21	14.789	0.080	4.800	18	214.6	
14:47:53	14.798	0.089	5.340	18	215.2	
14:48:23	14.807	0.098	5.880	18	215.2	
14:48:54	14.815	0.106	6.360	18	216.6	
14:49:24	14.823	0.114	6.840	18	216.8	
14:49:54	14.832	0.123	7.380	18	217.4	
14:50:26	14.841	0.132	7.920	18	218.5	
14:50:56	14.849	0.140	8.400	18	218.7	
14:51:27	14.857	0.148	8.880	18	218.3	
14:51:57	14.866	0.157	9.420	21	241.5	
14:52:27	14.874	0.165	9.900	21	247.8	
14:52:59	14.883	0.174	10.440	21	248.7	
14:53:29	14.892	0.183	10.980	21	251.7	
14:54:00	14.9	0.191	11.460	21	251.1	
14:54:30	14.908	0.199	11.940	21	219.4	
14:55:00	14.917	0.208	12.480	21	204.4	
14:55:31	14.925	0.216	12.960	21	232.9	
14:56:01	14.934	0.225	13.500	38	267.2	
14:56:17	14.938	0.229	13.740	38	271.7	
14:56:22	14.939	0.230	13.800	38	270.7	
14:56:27	14.941	0.232	13.920	38	271.6	
14:56:31	14.942	0.233	13.980	38	271.2	
14:57:01	14.95	0.241	14.460	38	270.8	
14:57:32	14.959	0.250	15.000	38	271.3	
14:58:02	14.967	0.258	15.480	38	267.9	
14:58:32	14.976	0.267	16.020	38	268.9	
14:59:03	14.984	0.275	16.500	38	268.1	
14:59:33	14.993	0.284	17.040	38	267.7	
15:00:03	15.001	0.292	17.520	38	266.4	
15:00:34	15.009	0.300	18.000	38	265.7	
15:01:04	15.018	0.309	18.540	38	267.7	
15:01:34	15.026	0.317	19.020	38	278.7	
15:02:05	15.035	0.326	19.560	38	276.1	
15:02:35	15.043	0.334	20.040	45	233.9	
15:03:05	15.051	0.342	20.520	45	291.2	

Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
15:03:36	15.06	0.351	21.060	45	292.1	
15:04:06	15.068	0.359	21.540	45	290.8	
15:04:36	15.077	0.368	22.080	45	290.8	
15:05:06	15.085	0.376	22.560	45	288.8	
15:05:37	15.094	0.385	23.100	45	289.3	
15:06:07	15.102	0.393	23.580	45	290.3	
15:06:37	15.11	0.401	24.060	45	289.3	
15:07:08	15.119	0.410	24.600	45	289	
15:07:38	15.127	0.418	25.080	45	288.2	
15:08:08	15.136	0.427	25.620	45	288.2	End Test
15:08:39	15.144	0.435	26.100		273.6	
15:09:09	15.153	0.444	26.640		173.4	

Slug Test Plot



Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
Static Pressure					
8:35:08	8.585	0.000	0.000	0.000	180.2
8:35:38	8.594	0.009	0.540	0.000	206.4
8:36:08	8.602	0.017	1.020	0.001	234.3
8:36:38	8.611	0.026	1.560	0.001	259.5
8:37:09	8.619	0.034	2.040	0.001	287.1
8:37:41	8.628	0.043	2.580	0.002	313.4
8:38:11	8.636	0.051	3.060	0.002	337.1
8:38:41	8.645	0.060	3.600	0.002	338.5
8:39:11	8.653	0.068	4.080	0.003	337.3
8:39:42	8.662	0.077	4.620	0.003	337.2
8:40:12	8.67	0.085	5.100	0.004	340.5
8:40:42	8.678	0.093	5.580	0.004	345.7
8:41:12	8.687	0.102	6.120	0.004	351.2
8:41:43	8.695	0.110	6.600	0.005	356.1
8:42:56	8.716	0.131	7.860	0.005	367.9
8:42:59	8.716	0.131	7.860	0.005	368.7
8:43:02	8.717	0.132	7.920	0.005	369.3
8:43:06	8.718	0.133	7.980	0.006	369.7
8:43:09	8.719	0.134	8.040	0.006	370.2
8:43:12	8.72	0.135	8.100	0.006	370.6
8:43:15	8.721	0.136	8.160	0.006	371
8:43:18	8.722	0.137	8.220	0.006	371.6
8:43:22	8.723	0.138	8.280	0.006	371.8
8:43:25	8.724	0.139	8.340	0.006	372.5
8:43:28	8.724	0.139	8.340	0.006	372.9
8:43:31	8.725	0.140	8.400	0.006	373.3
8:43:34	8.726	0.141	8.460	0.006	373.8
8:43:37	8.727	0.142	8.520	0.006	374.4
8:43:41	8.728	0.143	8.580	0.006	374.6
8:43:44	8.729	0.144	8.640	0.006	375.2
8:43:47	8.73	0.145	8.700	0.006	375.5
8:43:50	8.731	0.146	8.760	0.006	376.3
8:43:53	8.731	0.146	8.760	0.006	376.7
8:43:57	8.732	0.147	8.820	0.006	377.2
8:44:00	8.733	0.148	8.880	0.006	377.5
8:44:03	8.734	0.149	8.940	0.006	378
8:44:06	8.735	0.150	9.000	0.006	378.3
8:44:09	8.736	0.151	9.060	0.006	378.9
8:44:12	8.737	0.152	9.120	0.006	379.4
8:44:16	8.738	0.153	9.180	0.006	380
8:44:19	8.739	0.154	9.240	0.006	380
8:44:22	8.739	0.154	9.240	0.006	380.1
8:44:25	8.74	0.155	9.300	0.006	380.6
8:44:29	8.741	0.156	9.360	0.006	380.9

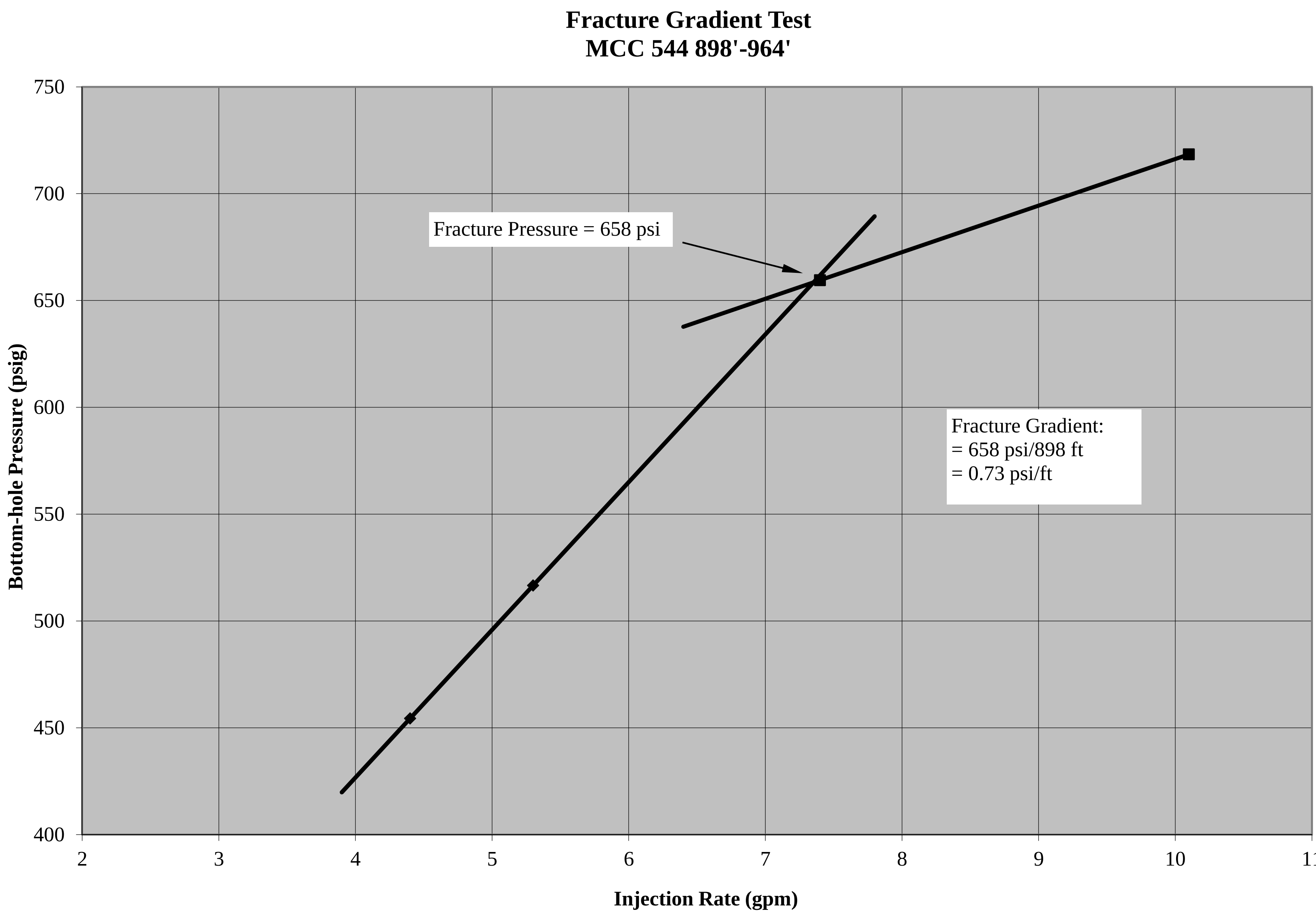
Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
8:44:32	8.742	0.157	9.420	0.007	381.6
8:44:35	8.743	0.158	9.480	0.007	381.8
8:44:38	8.744	0.159	9.540	0.007	382.2
8:44:41	8.745	0.160	9.600	0.007	382.7
8:44:44	8.746	0.161	9.660	0.007	383.2
8:48:31	8.809	0.224	13.440	0.009	338.9
8:48:34	8.809	0.224	13.440	0.009	337.8
8:48:37	8.81	0.225	13.500	0.009	337.2
8:48:40	8.811	0.226	13.560	0.009	335.9
8:48:44	8.812	0.227	13.620	0.009	335.4
8:48:47	8.813	0.228	13.680	0.009	334.7
8:48:52	8.814	0.229	13.740	0.010	334
8:48:55	8.815	0.230	13.800	0.010	333.5
8:48:58	8.816	0.231	13.860	0.010	333.1
8:49:01	8.817	0.232	13.920	0.010	332.6
8:49:04	8.818	0.233	13.980	0.010	332.3
8:49:08	8.819	0.234	14.040	0.010	331.9
8:49:12	8.82	0.235	14.100	0.010	331.4
8:49:16	8.821	0.236	14.160	0.010	331
8:49:19	8.822	0.237	14.220	0.010	330.7
8:49:22	8.823	0.238	14.280	0.010	330.5
8:49:25	8.824	0.239	14.340	0.010	330.2
8:49:28	8.825	0.240	14.400	0.010	330
8:49:31	8.825	0.240	14.400	0.010	330
8:49:35	8.826	0.241	14.460	0.010	329.7
8:49:38	8.827	0.242	14.520	0.010	329.6
8:49:41	8.828	0.243	14.580	0.010	329.4
8:49:44	8.829	0.244	14.640	0.010	329.1
8:49:47	8.83	0.245	14.700	0.010	329.2
8:49:51	8.831	0.246	14.760	0.010	329
8:50:08	8.836	0.251	15.060	0.010	328.1
8:50:16	8.838	0.253	15.180	0.011	328.6
8:50:21	8.839	0.254	15.240	0.011	328.6
8:50:26	8.84	0.255	15.300	0.011	328.2
8:50:30	8.842	0.257	15.420	0.011	328.2
8:50:35	8.843	0.258	15.480	0.011	327.1
8:50:40	8.844	0.259	15.540	0.011	327.4
8:50:45	8.846	0.261	15.660	0.011	327.4
8:50:50	8.847	0.262	15.720	0.011	327.2
8:50:54	8.848	0.263	15.780	0.011	327.3
8:50:59	8.85	0.265	15.900	0.011	326.9
8:51:04	8.851	0.266	15.960	0.011	388.7
8:51:09	8.852	0.267	16.020	0.011	382.2
8:51:13	8.854	0.269	16.140	0.011	383.2
8:51:18	8.855	0.270	16.200	0.011	383.3
8:51:23	8.856	0.271	16.260	0.011	383.5
8:51:28	8.858	0.273	16.380	0.011	383.5

Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
8:51:33	8.859	0.274	16.440	0.011	383.3
8:51:37	8.86	0.275	16.500	0.011	383.3
8:51:42	8.862	0.277	16.620	0.012	383.1
8:51:47	8.863	0.278	16.680	0.012	383.7
8:51:52	8.864	0.279	16.740	0.012	383
8:51:57	8.866	0.281	16.860	0.012	382.7
8:52:01	8.867	0.282	16.920	0.012	382.9
8:52:06	8.868	0.283	16.980	0.012	382.8
8:52:11	8.87	0.285	17.100	0.012	382.7
8:52:16	8.871	0.286	17.160	0.012	382.7
8:52:21	8.872	0.287	17.220	0.012	382.8
8:52:25	8.874	0.289	17.340	0.012	383
8:52:30	8.875	0.290	17.400	0.012	382.6
8:52:35	8.876	0.291	17.460	0.012	382.7
8:52:39	8.878	0.293	17.580	0.012	382.7
8:52:44	8.879	0.294	17.640	0.012	382.7
8:52:49	8.88	0.295	17.700	0.012	382.5
8:52:54	8.882	0.297	17.820	0.012	382.5
8:52:59	8.883	0.298	17.880	0.012	382.5
8:53:03	8.884	0.299	17.940	0.012	382.3
8:53:08	8.886	0.301	18.060	0.013	382.3
8:53:13	8.887	0.302	18.120	0.013	382.2
8:53:18	8.888	0.303	18.180	0.013	382.6
8:53:48	8.897	0.312	18.720	0.013	381.7
8:54:18	8.905	0.320	19.200	0.013	381.3
8:54:49	8.914	0.329	19.740	0.014	381.1
8:55:19	8.922	0.337	20.220	0.014	381.1
8:55:49	8.93	0.345	20.700	0.014	377
8:56:20	8.939	0.354	21.240	0.015	340.9
8:56:50	8.947	0.362	21.720	0.015	333.4
8:57:20	8.956	0.371	22.260	0.015	330.4
8:57:51	8.964	0.379	22.740	0.016	328.6
8:58:21	8.972	0.387	23.220	0.016	327.7
8:58:51	8.981	0.396	23.760	0.017	327.1
8:59:22	8.989	0.404	24.240	0.017	327
8:59:52	8.998	0.413	24.780	0.017	326.7
9:00:22	9.006	0.421	25.260	0.018	326.4
9:00:52	9.015	0.430	25.800	0.018	325.9
9:01:23	9.023	0.438	26.280	0.018	326.2
9:01:53	9.031	0.446	26.760	0.019	325.7
9:02:23	9.04	0.455	27.300	0.019	325.6
9:02:54	9.048	0.463	27.780	0.019	325.6
9:03:24	9.057	0.472	28.320	0.020	325.4
9:03:54	9.065	0.480	28.800	0.020	325.5
9:04:25	9.074	0.489	29.340	0.020	325.3
9:04:55	9.082	0.497	29.820	0.021	325.2
9:05:25	9.09	0.505	30.300	0.021	325.7

Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
9:05:56	9.099	0.514	30.840	0.021	325.2
9:06:26	9.107	0.522	31.320	0.022	325.1
9:06:56	9.116	0.531	31.860	0.022	325.5
9:07:26	9.124	0.539	32.340	0.022	325.2
9:07:57	9.132	0.547	32.820	0.023	325
9:08:27	9.141	0.556	33.360	0.023	325.1
9:08:58	9.149	0.564	33.840	0.023	325
9:09:28	9.158	0.573	34.380	0.024	325
9:09:58	9.166	0.581	34.860	0.024	325.5
9:10:28	9.175	0.590	35.400	0.025	325
9:10:59	9.183	0.598	35.880	0.025	324.6
9:11:29	9.191	0.606	36.360	0.025	324.6
9:11:59	9.2	0.615	36.900	0.026	325.1
9:12:30	9.208	0.623	37.380	0.026	324.5
9:13:00	9.217	0.632	37.920	0.026	324.5
9:13:30	9.225	0.640	38.400	0.027	324.7
9:14:00	9.233	0.648	38.880	0.027	324.7
9:14:31	9.242	0.657	39.420	0.027	324.7
9:15:01	9.25	0.665	39.900	0.028	325.2
9:15:31	9.259	0.674	40.440	0.028	325.1
9:16:02	9.267	0.682	40.920	0.028	324.5
9:16:32	9.276	0.691	41.460	0.029	324.6
9:17:02	9.284	0.699	41.940	0.029	324.6
9:17:33	9.292	0.707	42.420	0.029	325.3
9:18:03	9.301	0.716	42.960	0.030	324.4
9:18:33	9.309	0.724	43.440	0.030	324.4
9:19:04	9.318	0.733	43.980	0.031	324.4
9:19:34	9.326	0.741	44.460	0.031	324.4
9:20:04	9.335	0.750	45.000	0.031	324.5
9:20:35	9.343	0.758	45.480	0.032	324.5
9:21:05	9.351	0.766	45.960	0.032	324.7
9:21:35	9.36	0.775	46.500	0.032	324.4
9:22:06	9.368	0.783	46.980	0.033	324.5
9:22:36	9.377	0.792	47.520	0.033	324.9
9:23:06	9.385	0.800	48.000	0.033	324.4
9:23:36	9.393	0.808	48.480	0.034	373.7
9:24:07	9.402	0.817	49.020	0.034	373.8
9:24:37	9.41	0.825	49.500	0.034	373.4
9:26:21	9.439	0.854	51.240	0.036	378.1
9:26:51	9.448	0.863	51.780	0.036	483.1
9:27:21	9.456	0.871	52.260	0.036	353.7
9:27:52	9.464	0.879	52.740	0.037	334.9
9:28:24	9.473	0.888	53.280	0.037	330.2
9:28:54	9.482	0.897	53.820	0.037	328.5
9:29:24	9.49	0.905	54.300	0.038	327.5
9:29:55	9.499	0.914	54.840	0.038	384.7
9:30:25	9.507	0.922	55.320	0.038	383.4

Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
9:30:55	9.515	0.930	55.800	0.039	382.8
9:31:26	9.524	0.939	56.340	0.039	382.2
9:31:56	9.532	0.947	56.820	0.039	380
9:32:26	9.541	0.956	57.360	0.040	443.4
9:32:57	9.549	0.964	57.840	0.040	416
9:33:27	9.557	0.972	58.320	0.041	396.9
9:34:00	9.567	0.982	58.920	0.041	391.3
9:34:04	9.568	0.983	58.980	0.041	389.1
9:34:07	9.569	0.984	59.040	0.041	388.6
9:34:10	9.569	0.984	59.040	0.041	388.1
9:34:13	9.57	0.985	59.100	0.041	387.6
9:34:16	9.571	0.986	59.160	0.041	385.2
9:34:20	9.572	0.987	59.220	0.041	383.9
9:34:23	9.573	0.988	59.280	0.041	384.5
9:34:26	9.574	0.989	59.340	0.041	385.4
9:34:29	9.575	0.990	59.400	0.041	389.2
9:34:32	9.576	0.991	59.460	0.041	396
9:34:35	9.577	0.992	59.520	0.041	414.1
9:34:39	9.577	0.992	59.520	0.041	454.2
9:34:42	9.578	0.993	59.580	0.041	488
9:34:45	9.579	0.994	59.640	0.041	461.9
9:34:48	9.58	0.995	59.700	0.041	446.8
9:34:51	9.581	0.996	59.760	0.041	436.9
9:34:55	9.582	0.997	59.820	0.042	429.8
9:34:58	9.583	0.998	59.880	0.042	424.1
9:35:01	9.584	0.999	59.940	0.042	419.6
9:35:04	9.584	0.999	59.940	0.042	416
9:35:07	9.585	1.000	60.000	0.042	412.9
9:35:11	9.586	1.001	60.060	0.042	410.1
9:35:14	9.587	1.002	60.120	0.042	407.8
9:35:17	9.588	1.003	60.180	0.042	405.8
9:35:20	9.589	1.004	60.240	0.042	403.9
9:35:23	9.59	1.005	60.300	0.042	402.2
9:35:26	9.591	1.006	60.360	0.042	400.8
9:35:30	9.592	1.007	60.420	0.042	399.5
9:35:33	9.592	1.007	60.420	0.042	398.3
9:35:36	9.593	1.008	60.480	0.042	397.2
9:35:39	9.594	1.009	60.540	0.042	396.3
9:35:42	9.595	1.010	60.600	0.042	395.3
9:35:46	9.596	1.011	60.660	0.042	395.1
9:35:49	9.597	1.012	60.720	0.042	394.3
9:35:52	9.598	1.013	60.780	0.042	393.7
9:35:55	9.599	1.014	60.840	0.042	392.7
9:35:58	9.6	1.015	60.900	0.042	391.5
9:36:02	9.6	1.015	60.900	0.042	390.8
9:36:05	9.601	1.016	60.960	0.042	391.1
9:36:08	9.602	1.017	61.020	0.042	390.3

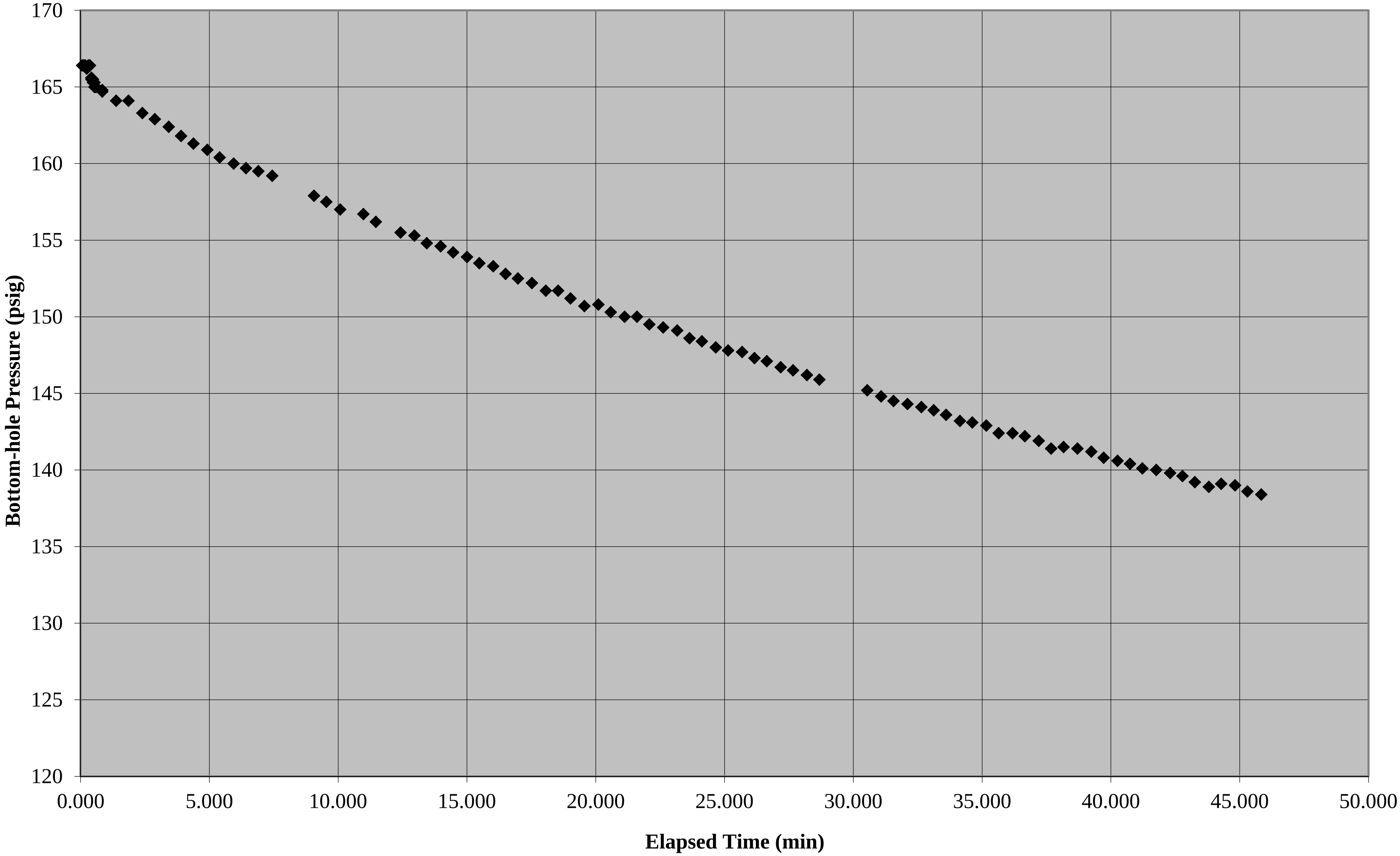
Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
9:36:11	9.603	1.018	61.080	0.042	389.2
9:36:14	9.604	1.019	61.140	0.042	388.6
9:36:18	9.605	1.020	61.200	0.043	388.2
9:36:21	9.606	1.021	61.260	0.043	387.7
9:36:24	9.607	1.022	61.320	0.043	387.3
9:36:27	9.608	1.023	61.380	0.043	387
9:36:30	9.608	1.023	61.380	0.043	386.6
9:36:34	9.609	1.024	61.440	0.043	386.2
9:36:37	9.61	1.025	61.500	0.043	385.8
9:37:07	9.619	1.034	62.040	0.043	383
9:37:37	9.627	1.042	62.520	0.043	380.5
9:38:08	9.635	1.050	63.000	0.044	380.2
9:38:38	9.644	1.059	63.540	0.044	388

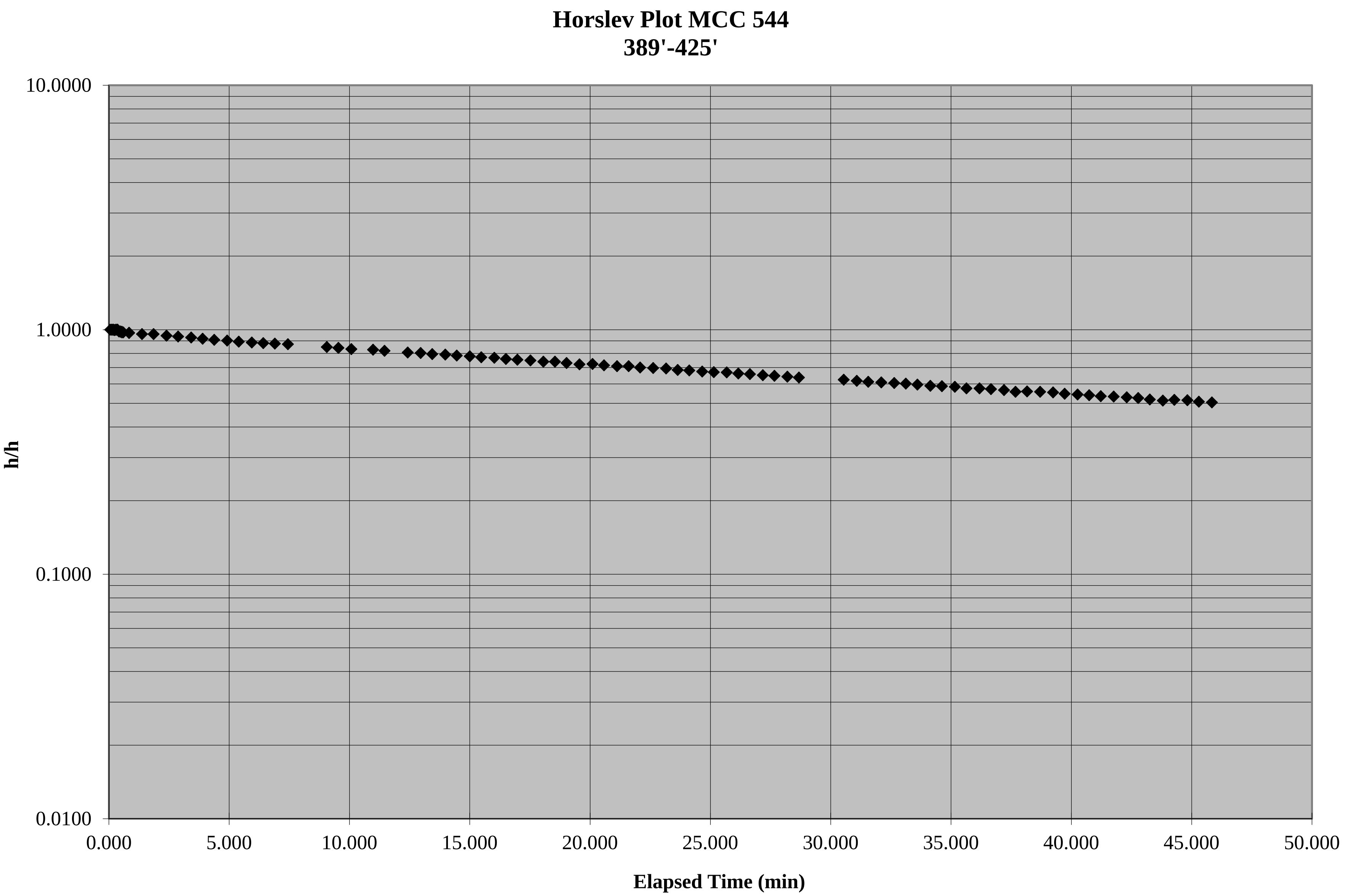

Fracture Gradient Test
MCC 544 898'-964'
Bottom-hole Pressure (psig)
750
700
650
600
550
500
450
400
2
3
4
5
6
7
8
9
10
11
Injection Rate (gpm)
Fracture Pressure = 658 psi
Fracture Gradient:
= 658 psi/898 ft
= 0.73 psi/ft

Step Rate Injection Test Data MCC 544 898'-964'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
9:39:08	9.652	0.000	0.000	4.4	413	
9:39:39	9.661	0.009	0.540	4.4	433.9	
9:40:09	9.669	0.017	1.020	4.4	455.8	
9:40:39	9.678	0.026	1.560	4.4	452.1	
9:41:10	9.686	0.034	2.040	4.4	451.9	
9:41:40	9.694	0.042	2.520	4.4	452.6	
9:42:10	9.703	0.051	3.060	4.4	452.2	
9:42:41	9.711	0.059	3.540	4.4	452.5	
9:43:11	9.72	0.068	4.080	4.4	452.4	
9:43:41	9.728	0.076	4.560	4.4	452.6	
9:44:11	9.737	0.085	5.100	4.4	452.6	
9:44:42	9.745	0.093	5.580	4.4	453.1	
9:45:12	9.753	0.101	6.060	4.4	454.1	
9:45:42	9.762	0.110	6.600	4.4	453.1	
9:46:13	9.77	0.118	7.080	4.4	453.7	
9:46:43	9.779	0.127	7.620	4.4	453.8	
9:47:13	9.787	0.135	8.100	4.4	452.6	
9:47:44	9.795	0.143	8.580	4.4	452.2	
9:48:14	9.804	0.152	9.120	4.4	470.9	
9:48:44	9.812	0.160	9.600	4.4	457.1	
9:49:15	9.821	0.169	10.140	4.4	454.5	
9:49:45	9.829	0.177	10.620	4.4	454.5	
9:50:15	9.838	0.186	11.160	4.4	453.5	
9:50:45	9.846	0.194	11.640	4.4	452.8	
9:51:16	9.854	0.202	12.120	4.4	452.2	
9:51:46	9.863	0.211	12.660	4.4	452.6	
9:52:17	9.871	0.219	13.140	4.4	452.8	
9:52:47	9.88	0.228	13.680	4.4	452.8	
9:53:17	9.888	0.236	14.160	4.4	452.5	
9:53:47	9.896	0.244	14.640	4.4	453.1	
9:54:18	9.905	0.253	15.180	4.4	453.2	
9:54:48	9.913	0.261	15.660	4.4	452.6	
9:55:18	9.922	0.270	16.200	4.4	452.9	
9:55:49	9.93	0.278	16.680	4.4	453	
9:56:19	9.939	0.287	17.220	4.4	453.6	
9:56:49	9.947	0.295	17.700	4.4	454.2	
9:57:20	9.955	0.303	18.180	4.4	454.4	
9:57:50	9.964	0.312	18.720	5.3	467.6	
9:58:20	9.972	0.320	19.200	5.3	515.1	
9:58:51	9.981	0.329	19.740	5.3	513.1	
9:59:21	9.989	0.337	20.220	5.3	516.3	
9:59:51	9.998	0.346	20.760	5.3	515.7	
10:00:21	10.006	0.354	21.240	5.3	517.4	
10:00:52	10.014	0.362	21.720	5.3	516.9	
10:01:22	10.023	0.371	22.260	5.3	517	

10:01:52	10.031	0.379	22.740	5.3	516.1	
10:02:23	10.04	0.388	23.280	5.3	517.1	
10:02:53	10.048	0.396	23.760	5.3	518.7	
10:03:23	10.056	0.404	24.240	5.3	519.4	
10:03:54	10.065	0.413	24.780	5.3	519	
10:04:24	10.073	0.421	25.260	5.3	519.5	
10:04:54	10.082	0.430	25.800	5.3	518.2	
10:05:25	10.09	0.438	26.280	5.3	517.3	
10:05:55	10.099	0.447	26.820	5.3	515.6	
10:06:25	10.107	0.455	27.300	5.3	516	
10:06:56	10.115	0.463	27.780	5.3	516.2	
10:07:26	10.124	0.472	28.320	5.3	516.6	
10:07:56	10.132	0.480	28.800	7.4	616.2	
10:08:27	10.141	0.489	29.340	7.4	668.8	
10:08:57	10.149	0.497	29.820	7.4	666.3	
10:09:27	10.158	0.506	30.360	7.4	655.6	
10:09:57	10.166	0.514	30.840	7.4	654.1	
10:10:28	10.174	0.522	31.320	7.4	653	
10:10:58	10.183	0.531	31.860	7.4	652.6	
10:11:28	10.191	0.539	32.340	7.4	659.9	
10:11:59	10.2	0.548	32.880	7.4	651.1	
10:12:29	10.208	0.556	33.360	7.4	653.1	
10:12:59	10.216	0.564	33.840	7.4	652.2	
10:13:30	10.225	0.573	34.380	7.4	654.8	
10:14:00	10.233	0.581	34.860	7.4	655.6	
10:14:30	10.242	0.590	35.400	7.4	655.5	
10:15:00	10.25	0.598	35.880	7.4	660.6	
10:16:58	10.283	0.631	37.860	7.4	665.1	
10:17:29	10.291	0.639	38.340	7.4	659.5	
10:20:00	10.333	0.681	40.860	10.1	718.3	
10:20:31	10.342	0.690	41.400	10.1	709.8	
10:21:01	10.35	0.698	41.880	10.1	712.7	
10:21:31	10.359	0.707	42.420	10.1	708.9	
10:22:38	10.377	0.725	43.500	10.1	714.1	
10:23:08	10.386	0.734	44.040	10.1	707	
10:23:39	10.394	0.742	44.520	10.1	712.7	
10:24:09	10.403	0.751	45.060	10.1	709.5	
10:24:39	10.411	0.759	45.540	10.1	715.9	
10:25:10	10.419	0.767	46.020	10.1	714.2	
10:25:40	10.428	0.776	46.560	10.1	717.9	
10:26:10	10.436	0.784	47.040	10.1	718.4	End Test
10:26:41	10.445	0.793	47.580	-	394.4	
10:27:12	10.453	0.801	48.060	-	383.7	

Slug Test
MCC 544 389'-425'

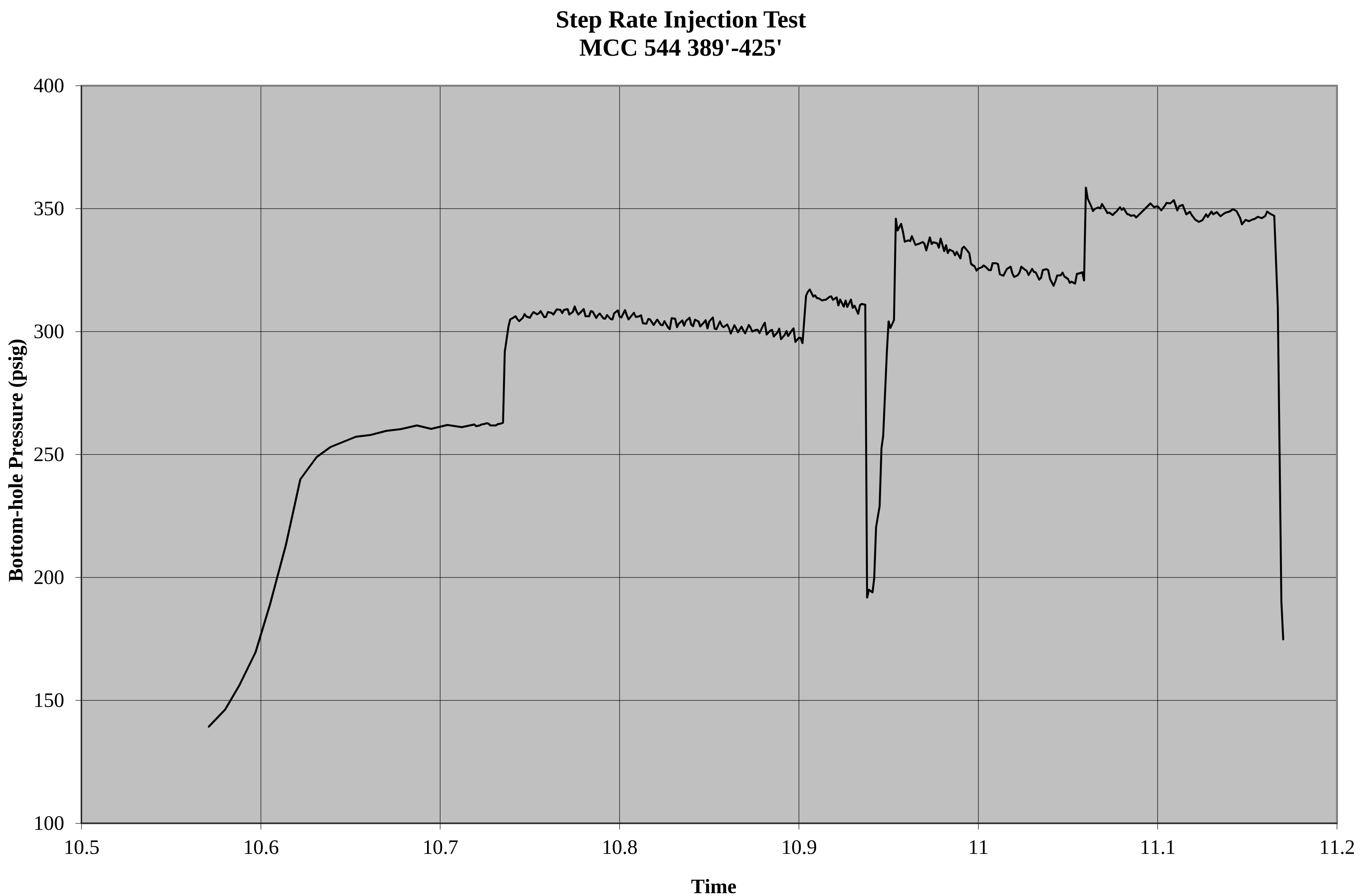



Horslev Plot MCC 544
389'-425'
10.0000
1.0000
0.1000
0.0100
h/h
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
50.000
Elapsed Time (min)

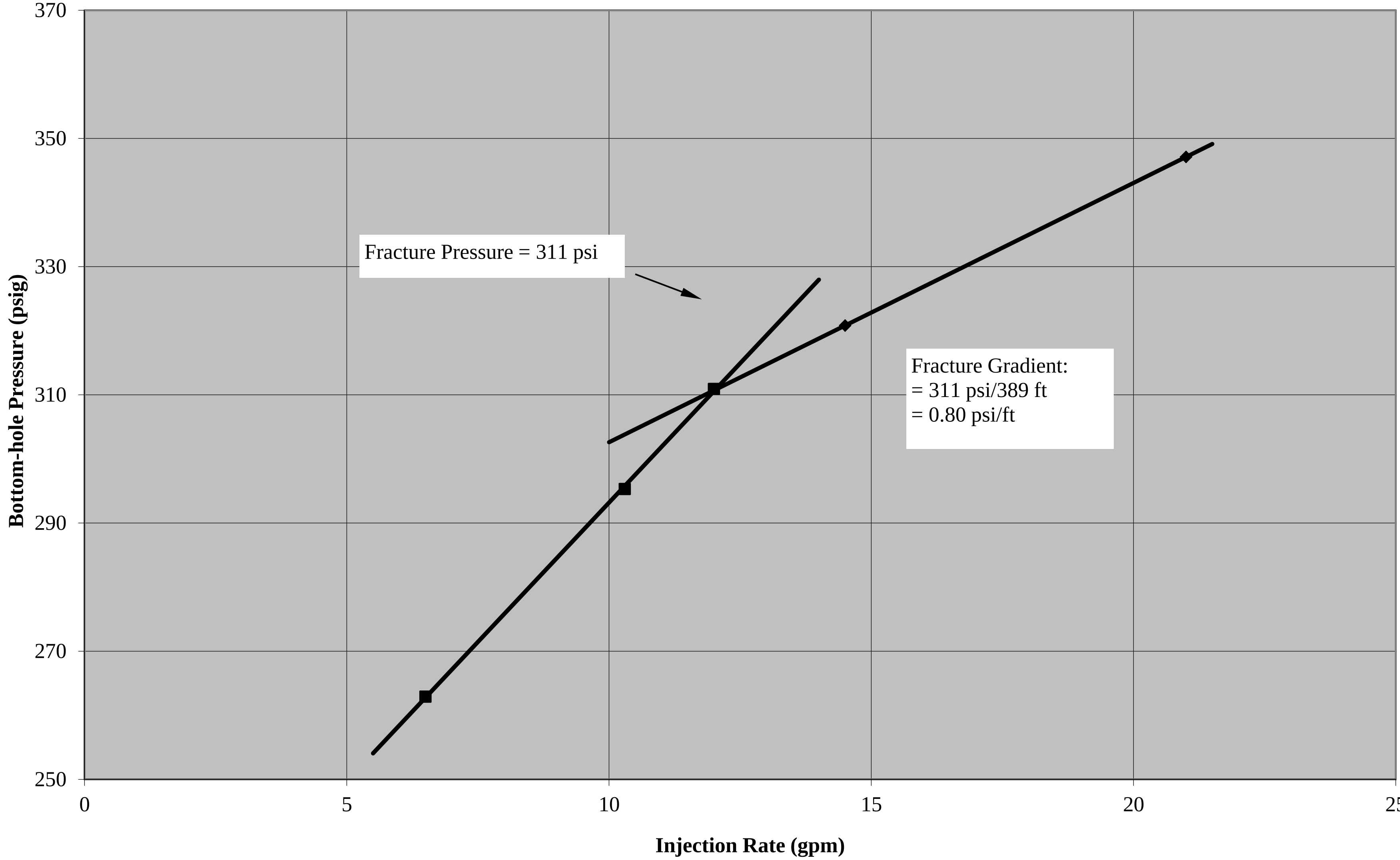
Slug Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
9:47:56	9.799	-	-	-	109.9	-
9:48:01	9.8	0.001	0.060	0.000	166.4	1.0000
9:48:02	9.801	0.002	0.120	0.000	166.4	1.0000
9:48:04	9.801	0.002	0.120	0.000	166.4	1.0000
9:48:06	9.802	0.003	0.180	0.000	166.4	1.0000
9:48:07	9.802	0.003	0.180	0.000	166.4	1.0000
9:48:09	9.802	0.003	0.180	0.000	166.4	1.0000
9:48:10	9.803	0.004	0.240	0.000	166.2	0.9965
9:48:12	9.803	0.004	0.240	0.000	166.2	0.9965
9:48:14	9.804	0.005	0.300	0.000	166.4	1.0000
9:48:15	9.804	0.005	0.300	0.000	166.4	1.0000
9:48:17	9.805	0.006	0.360	0.000	166.4	1.0000
9:48:18	9.805	0.006	0.360	0.000	166.4	1.0000
9:48:20	9.806	0.007	0.420	0.000	165.6	0.9858
9:48:22	9.806	0.007	0.420	0.000	165.6	0.9858
9:48:23	9.806	0.007	0.420	0.000	165.5	0.9841
9:48:25	9.807	0.008	0.480	0.000	165.5	0.9841
9:48:26	9.807	0.008	0.480	0.000	165.3	0.9805
9:48:28	9.808	0.009	0.540	0.000	165.3	0.9805
9:48:30	9.808	0.009	0.540	0.000	165	0.9752
9:48:31	9.809	0.010	0.600	0.000	165	0.9752
9:48:47	9.813	0.014	0.840	0.001	164.7	0.9699
9:48:49	9.813	0.014	0.840	0.001	164.8	0.9717
9:49:19	9.822	0.023	1.380	0.001	164.1	0.9593
9:49:49	9.83	0.031	1.860	0.001	164.1	0.9593
9:50:19	9.839	0.040	2.400	0.002	163.3	0.9451
9:50:50	9.847	0.048	2.880	0.002	162.9	0.9381
9:51:20	9.856	0.057	3.420	0.002	162.4	0.9292
9:51:50	9.864	0.065	3.900	0.003	161.8	0.9186
9:52:20	9.872	0.073	4.380	0.003	161.3	0.9097
9:52:50	9.881	0.082	4.920	0.003	160.9	0.9027
9:53:21	9.889	0.090	5.400	0.004	160.4	0.8938
9:53:51	9.898	0.099	5.940	0.004	160	0.8867
9:54:21	9.906	0.107	6.420	0.004	159.7	0.8814
9:54:52	9.914	0.115	6.900	0.005	159.5	0.8779
9:55:22	9.923	0.124	7.440	0.005	159.2	0.8726
9:56:59	9.95	0.151	9.060	0.006	157.9	0.8496
9:57:29	9.958	0.159	9.540	0.007	157.5	0.8425
9:58:00	9.967	0.168	10.080	0.007	157	0.8336
9:58:55	9.982	0.183	10.980	0.008	156.7	0.8283
9:59:25	9.99	0.191	11.460	0.008	156.2	0.8195
10:00:21	10.006	0.207	12.420	0.009	155.5	0.8071
10:00:53	10.015	0.216	12.960	0.009	155.3	0.8035
10:01:23	10.023	0.224	13.440	0.009	154.8	0.7947
10:01:54	10.032	0.233	13.980	0.010	154.6	0.7912

Slug Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
10:02:24	10.04	0.241	14.460	0.010	154.2	0.7841
10:02:56	10.049	0.250	15.000	0.010	153.9	0.7788
10:03:26	10.057	0.258	15.480	0.011	153.5	0.7717
10:03:56	10.066	0.267	16.020	0.011	153.3	0.7681
10:04:26	10.074	0.275	16.500	0.011	152.8	0.7593
10:04:57	10.082	0.283	16.980	0.012	152.5	0.7540
10:05:27	10.091	0.292	17.520	0.012	152.2	0.7487
10:05:59	10.1	0.301	18.060	0.013	151.7	0.7398
10:06:29	10.108	0.309	18.540	0.013	151.7	0.7398
10:06:59	10.116	0.317	19.020	0.013	151.2	0.7310
10:07:31	10.125	0.326	19.560	0.014	150.7	0.7221
10:08:01	10.134	0.335	20.100	0.014	150.8	0.7239
10:08:32	10.142	0.343	20.580	0.014	150.3	0.7150
10:09:02	10.151	0.352	21.120	0.015	150	0.7097
10:09:32	10.159	0.360	21.600	0.015	150	0.7097
10:10:03	10.167	0.368	22.080	0.015	149.5	0.7009
10:10:34	10.176	0.377	22.620	0.016	149.3	0.6973
10:11:04	10.185	0.386	23.160	0.016	149.1	0.6938
10:11:35	10.193	0.394	23.640	0.016	148.6	0.6850
10:12:05	10.201	0.402	24.120	0.017	148.4	0.6814
10:12:35	10.21	0.411	24.660	0.017	148	0.6743
10:13:06	10.218	0.419	25.140	0.017	147.8	0.6708
10:13:36	10.227	0.428	25.680	0.018	147.7	0.6690
10:14:06	10.235	0.436	26.160	0.018	147.3	0.6619
10:14:36	10.243	0.444	26.640	0.019	147.1	0.6584
10:15:07	10.252	0.453	27.180	0.019	146.7	0.6513
10:15:37	10.26	0.461	27.660	0.019	146.5	0.6478
10:16:09	10.269	0.470	28.200	0.020	146.2	0.6425
10:16:39	10.277	0.478	28.680	0.020	145.9	0.6372
10:18:31	10.308	0.509	30.540	0.021	145.2	0.6248
10:19:01	10.317	0.518	31.080	0.022	144.8	0.6177
10:19:31	10.325	0.526	31.560	0.022	144.5	0.6124
10:20:01	10.334	0.535	32.100	0.022	144.3	0.6088
10:20:33	10.343	0.544	32.640	0.023	144.1	0.6053
10:21:03	10.351	0.552	33.120	0.023	143.9	0.6018
10:21:34	10.359	0.560	33.600	0.023	143.6	0.5965
10:22:04	10.368	0.569	34.140	0.024	143.2	0.5894
10:22:34	10.376	0.577	34.620	0.024	143.1	0.5876
10:23:05	10.385	0.586	35.160	0.024	142.9	0.5841
10:23:35	10.393	0.594	35.640	0.025	142.4	0.5752
10:24:06	10.402	0.603	36.180	0.025	142.4	0.5752
10:24:37	10.41	0.611	36.660	0.025	142.2	0.5717
10:25:07	10.419	0.620	37.200	0.026	141.9	0.5664
10:25:37	10.427	0.628	37.680	0.026	141.4	0.5575
10:26:08	10.435	0.636	38.160	0.027	141.5	0.5593
10:26:38	10.444	0.645	38.700	0.027	141.4	0.5575
10:27:10	10.453	0.654	39.240	0.027	141.2	0.5540

Slug Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
10:27:40	10.461	0.662	39.720	0.028	140.8	0.5469
10:28:10	10.47	0.671	40.260	0.028	140.6	0.5434
10:28:41	10.478	0.679	40.740	0.028	140.4	0.5398
10:29:11	10.486	0.687	41.220	0.029	140.1	0.5345
10:29:43	10.495	0.696	41.760	0.029	140	0.5327
10:30:13	10.504	0.705	42.300	0.029	139.8	0.5292
10:30:43	10.512	0.713	42.780	0.030	139.6	0.5257
10:31:13	10.52	0.721	43.260	0.030	139.2	0.5186
10:31:44	10.529	0.730	43.800	0.030	138.9	0.5133
10:32:14	10.537	0.738	44.280	0.031	139.1	0.5168
10:32:44	10.546	0.747	44.820	0.031	139	0.5150
10:33:16	10.554	0.755	45.300	0.031	138.6	0.5080
10:33:46	10.563	0.764	45.840	0.032	138.4	0.5044


Step Rate Injection Test
MCC 544 389'-425'
Bottom-hole Pressure (psig)
400
350
300
250
200
150
100
10.5
10.6
10.7
10.8
10.9
11
11.1
11.2
Time

Fracture Gradient Test
MCC 544 389'-425'



Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:34:17	10.571	0.000	0.000	6.5	139.3	
10:34:47	10.58	0.009	0.540	6.5	146.2	
10:35:17	10.588	0.017	1.020	6.5	156.1	
10:35:49	10.597	0.026	1.560	6.5	169.5	
10:36:19	10.605	0.034	2.040	6.5	188.8	
10:36:50	10.614	0.043	2.580	6.5	213.3	
10:37:20	10.622	0.051	3.060	6.5	239.9	
10:37:50	10.631	0.060	3.600	6.5	248.9	
10:38:20	10.639	0.068	4.080	6.5	253.1	
10:39:10	10.653	0.082	4.920	6.5	257.2	
10:39:40	10.661	0.090	5.400	6.5	257.9	
10:40:10	10.67	0.099	5.940	6.5	259.6	
10:40:41	10.678	0.107	6.420	6.5	260.3	
10:41:12	10.687	0.116	6.960	6.5	261.8	
10:41:43	10.695	0.124	7.440	6.5	260.4	
10:42:13	10.704	0.133	7.980	6.5	262	
10:42:45	10.712	0.141	8.460	6.5	261.1	
10:43:08	10.719	0.148	8.880	6.5	262.2	
10:43:13	10.72	0.149	8.940	6.5	261.5	
10:43:18	10.722	0.151	9.060	6.5	261.8	
10:43:23	10.723	0.152	9.120	6.5	262.2	
10:43:28	10.724	0.153	9.180	6.5	262.3	
10:43:32	10.726	0.155	9.300	6.5	262.7	
10:43:37	10.727	0.156	9.360	6.5	262.5	
10:43:42	10.728	0.157	9.420	6.5	261.8	
10:43:47	10.73	0.159	9.540	6.5	261.8	
10:43:52	10.731	0.160	9.600	6.5	261.8	
10:43:56	10.732	0.161	9.660	6.5	262.3	
10:44:01	10.734	0.163	9.780	6.5	262.6	
10:44:06	10.735	0.164	9.840	6.5	262.9	
10:44:11	10.736	0.165	9.900	10.3	291.7	
10:44:15	10.738	0.167	10.020	10.3	302	
10:44:20	10.739	0.168	10.080	10.3	304.9	
10:44:25	10.74	0.169	10.140	10.3	305.3	
10:44:30	10.742	0.171	10.260	10.3	306.2	
10:44:35	10.743	0.172	10.320	10.3	305	
10:44:39	10.744	0.173	10.380	10.3	304.2	
10:44:44	10.746	0.175	10.500	10.3	305.5	
10:44:49	10.747	0.176	10.560	10.3	307.1	
10:44:54	10.748	0.177	10.620	10.3	306.1	
10:44:59	10.75	0.179	10.740	10.3	305.6	
10:45:03	10.751	0.180	10.800	10.3	306.9	
10:45:08	10.752	0.181	10.860	10.3	307.9	
10:45:13	10.754	0.183	10.980	10.3	307	
10:45:18	10.755	0.184	11.040	10.3	307.4	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:45:22	10.756	0.185	11.100	10.3	308.3	
10:45:27	10.758	0.187	11.220	10.3	305.8	
10:45:32	10.759	0.188	11.280	10.3	306	
10:45:37	10.76	0.189	11.340	10.3	307.9	
10:45:42	10.762	0.191	11.460	10.3	307.6	
10:45:46	10.763	0.192	11.520	10.3	306.9	
10:45:51	10.764	0.193	11.580	10.3	307.9	
10:45:56	10.765	0.194	11.640	10.3	309	
10:46:01	10.767	0.196	11.760	10.3	308.8	
10:46:05	10.768	0.197	11.820	10.3	307.5	
10:46:10	10.769	0.198	11.880	10.3	308.8	
10:46:15	10.771	0.200	12.000	10.3	309.1	
10:46:20	10.772	0.201	12.060	10.3	306.9	
10:46:25	10.774	0.203	12.180	10.3	308	
10:46:29	10.775	0.204	12.240	10.3	310.2	
10:46:34	10.776	0.205	12.300	10.3	308.2	
10:46:39	10.777	0.206	12.360	10.3	306.9	
10:46:44	10.779	0.208	12.480	10.3	308.3	
10:46:48	10.78	0.209	12.540	10.3	309.1	
10:46:53	10.781	0.210	12.600	10.3	306.2	
10:46:58	10.783	0.212	12.720	10.3	306.2	
10:47:03	10.784	0.213	12.780	10.3	308.3	
10:47:07	10.785	0.214	12.840	10.3	308.1	
10:47:12	10.787	0.216	12.960	10.3	305.5	
10:47:17	10.788	0.217	13.020	10.3	306.7	
10:47:22	10.789	0.218	13.080	10.3	307.3	
10:47:26	10.791	0.220	13.200	10.3	305.3	
10:47:31	10.792	0.221	13.260	10.3	305.2	
10:47:36	10.793	0.222	13.320	10.3	306.7	
10:47:41	10.795	0.224	13.440	10.3	305.1	
10:47:46	10.796	0.225	13.500	10.3	304.9	
10:47:50	10.797	0.226	13.560	10.3	307.4	
10:47:55	10.799	0.228	13.680	10.3	308.6	
10:48:00	10.8	0.229	13.740	10.3	306.1	
10:48:05	10.801	0.230	13.800	10.3	305.7	
10:48:10	10.803	0.232	13.920	10.3	308.7	
10:48:14	10.804	0.233	13.980	10.3	306.6	
10:48:19	10.805	0.234	14.040	10.3	304.9	
10:48:24	10.807	0.236	14.160	10.3	306.7	
10:48:29	10.808	0.237	14.220	10.3	307.6	
10:48:34	10.809	0.238	14.280	10.3	305.9	
10:48:38	10.811	0.240	14.400	10.3	306.2	
10:48:43	10.812	0.241	14.460	10.3	306.6	
10:48:48	10.813	0.242	14.520	10.3	303.4	
10:48:53	10.815	0.244	14.640	10.3	303.2	
10:48:57	10.816	0.245	14.700	10.3	305.1	
10:49:02	10.817	0.246	14.760	10.3	304.9	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:49:07	10.819	0.248	14.880	10.3	302.7	
10:49:12	10.82	0.249	14.940	10.3	303.8	
10:49:16	10.821	0.250	15.000	10.3	304.8	
10:49:21	10.823	0.252	15.120	10.3	302.7	
10:49:26	10.824	0.253	15.180	10.3	302.6	
10:49:31	10.825	0.254	15.240	10.3	304.2	
10:49:36	10.827	0.256	15.360	10.3	301.7	
10:49:40	10.828	0.257	15.420	10.3	301	
10:49:45	10.829	0.258	15.480	10.3	305.4	
10:49:50	10.831	0.260	15.600	10.3	305.2	
10:49:55	10.832	0.261	15.660	10.3	301.8	
10:49:59	10.833	0.262	15.720	10.3	303.2	
10:50:04	10.835	0.264	15.840	10.3	304.5	
10:50:09	10.836	0.265	15.900	10.3	302.4	
10:50:14	10.837	0.266	15.960	10.3	304.3	
10:50:19	10.839	0.268	16.080	10.3	305.6	
10:50:23	10.84	0.269	16.140	10.3	302.8	
10:50:28	10.841	0.270	16.200	10.3	302.2	
10:50:33	10.842	0.271	16.260	10.3	304.8	
10:50:38	10.844	0.273	16.380	10.3	304.1	
10:50:42	10.845	0.274	16.440	10.3	302.1	
10:50:47	10.847	0.276	16.560	10.3	303.7	
10:50:52	10.848	0.277	16.620	10.3	304.6	
10:50:57	10.849	0.278	16.680	10.3	301.3	
10:51:02	10.85	0.279	16.740	10.3	304.1	
10:51:06	10.852	0.281	16.860	10.3	305.7	
10:51:11	10.853	0.282	16.920	10.3	301.2	
10:51:16	10.854	0.283	16.980	10.3	301	
10:51:21	10.856	0.285	17.100	10.3	304.1	
10:51:25	10.857	0.286	17.160	10.3	302.4	
10:51:30	10.858	0.287	17.220	10.3	301.8	
10:51:35	10.86	0.289	17.340	10.3	302.9	
10:51:40	10.861	0.290	17.400	10.3	301.4	
10:51:45	10.862	0.291	17.460	10.3	299.2	
10:51:49	10.864	0.293	17.580	10.3	302.6	
10:51:54	10.865	0.294	17.640	10.3	301.3	
10:51:59	10.866	0.295	17.700	10.3	299.7	
10:52:04	10.868	0.297	17.820	10.3	302	
10:52:08	10.869	0.298	17.880	10.3	300.5	
10:52:13	10.87	0.299	17.940	10.3	299.3	
10:52:18	10.872	0.301	18.060	10.3	302.7	
10:52:23	10.873	0.302	18.120	10.3	301.7	
10:52:27	10.874	0.303	18.180	10.3	300	
10:52:33	10.876	0.305	18.300	10.3	300.7	
10:52:37	10.877	0.306	18.360	10.3	300.7	
10:52:42	10.878	0.307	18.420	10.3	299.4	
10:52:47	10.88	0.309	18.540	10.3	302.5	

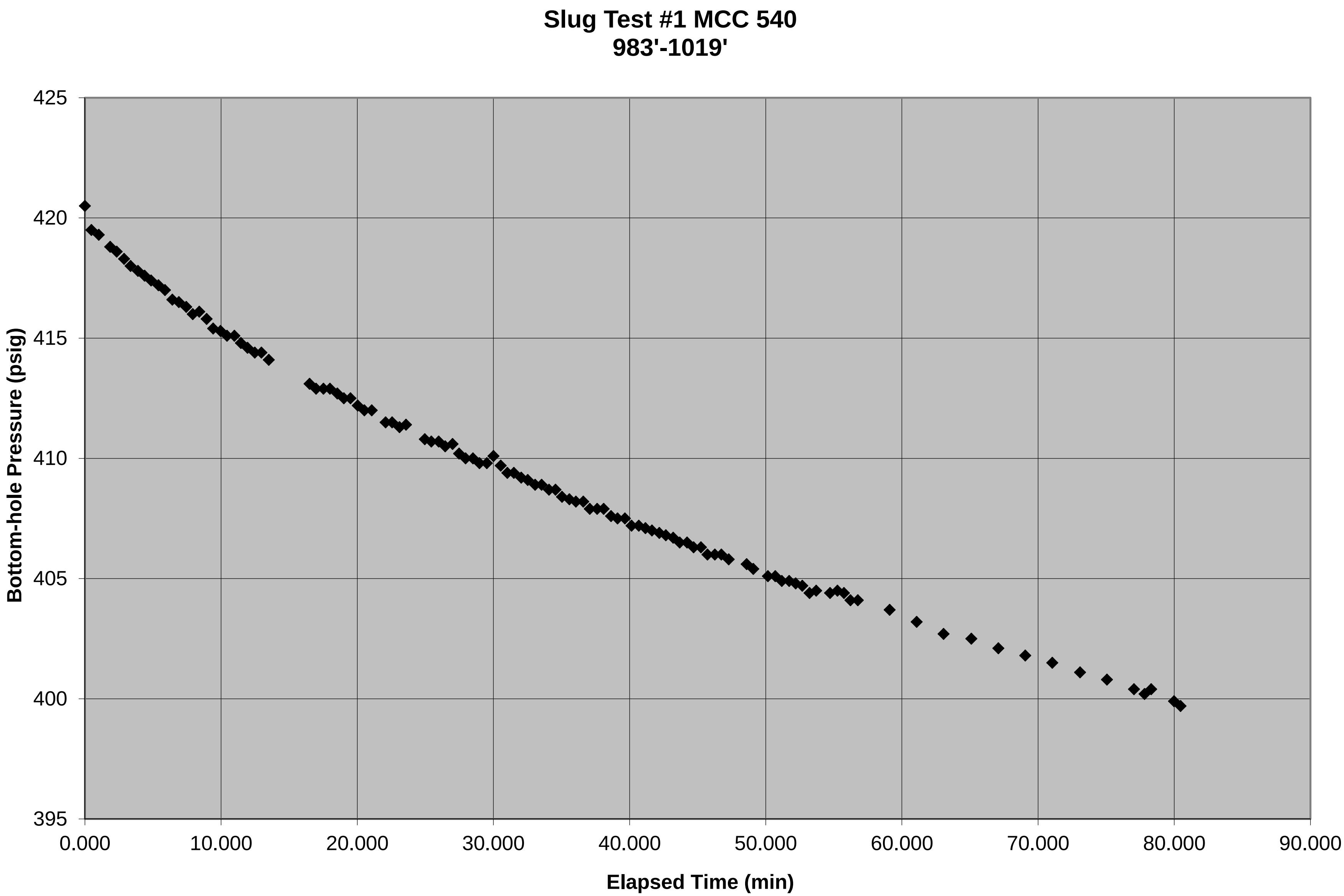
Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:52:51	10.881	0.310	18.600	10.3	303.6	
10:52:56	10.882	0.311	18.660	10.3	298.8	
10:53:01	10.884	0.313	18.780	10.3	300.4	
10:53:06	10.885	0.314	18.840	10.3	300.7	
10:53:10	10.886	0.315	18.900	10.3	298	
10:53:15	10.888	0.317	19.020	10.3	299.6	
10:53:20	10.889	0.318	19.080	10.3	301.2	
10:53:25	10.89	0.319	19.140	10.3	296.9	
10:53:30	10.892	0.321	19.260	10.3	298.6	
10:53:34	10.893	0.322	19.320	10.3	300.2	
10:53:39	10.894	0.323	19.380	10.3	298.2	
10:53:44	10.896	0.325	19.500	10.3	300.4	
10:53:49	10.897	0.326	19.560	10.3	301.3	
10:53:53	10.898	0.327	19.620	10.3	295.8	
10:53:58	10.9	0.329	19.740	10.3	297.5	
10:54:03	10.901	0.330	19.800	10.3	297.4	
10:54:08	10.902	0.331	19.860	10.3	295.3	
10:54:13	10.904	0.333	19.980	12	314.6	
10:54:17	10.905	0.334	20.040	12	316.2	
10:54:22	10.906	0.335	20.100	12	317.1	
10:54:27	10.908	0.337	20.220	12	314.2	
10:54:32	10.909	0.338	20.280	12	314.7	
10:54:37	10.91	0.339	20.340	12	313.6	
10:54:41	10.911	0.340	20.400	12	313.5	
10:54:46	10.913	0.342	20.520	12	312.6	
10:54:51	10.914	0.343	20.580	12	312.9	
10:54:56	10.915	0.344	20.640	12	312.9	
10:55:00	10.917	0.346	20.760	12	314.1	
10:55:05	10.918	0.347	20.820	12	314.3	
10:55:10	10.919	0.348	20.880	12	312.9	
10:55:15	10.921	0.350	21.000	12	313.9	
10:55:20	10.922	0.351	21.060	12	310.6	
10:55:24	10.923	0.352	21.120	12	313	
10:55:29	10.925	0.354	21.240	12	310.1	
10:55:34	10.926	0.355	21.300	12	312.6	
10:55:39	10.927	0.356	21.360	12	310	
10:55:43	10.929	0.358	21.480	12	313	
10:55:48	10.93	0.359	21.540	12	309.6	
10:55:53	10.931	0.360	21.600	12	310.5	
10:55:58	10.933	0.362	21.720	12	307.2	
10:56:02	10.934	0.363	21.780	12	310.7	
10:56:07	10.935	0.364	21.840	12	311.2	
10:56:12	10.937	0.366	21.960	12	310.9	
10:56:17	10.938	0.367	22.020	14.5	191.8	
10:56:22	10.939	0.368	22.080	14.5	195	
10:56:26	10.941	0.370	22.200	14.5	193.9	
10:56:31	10.942	0.371	22.260	14.5	199.7	

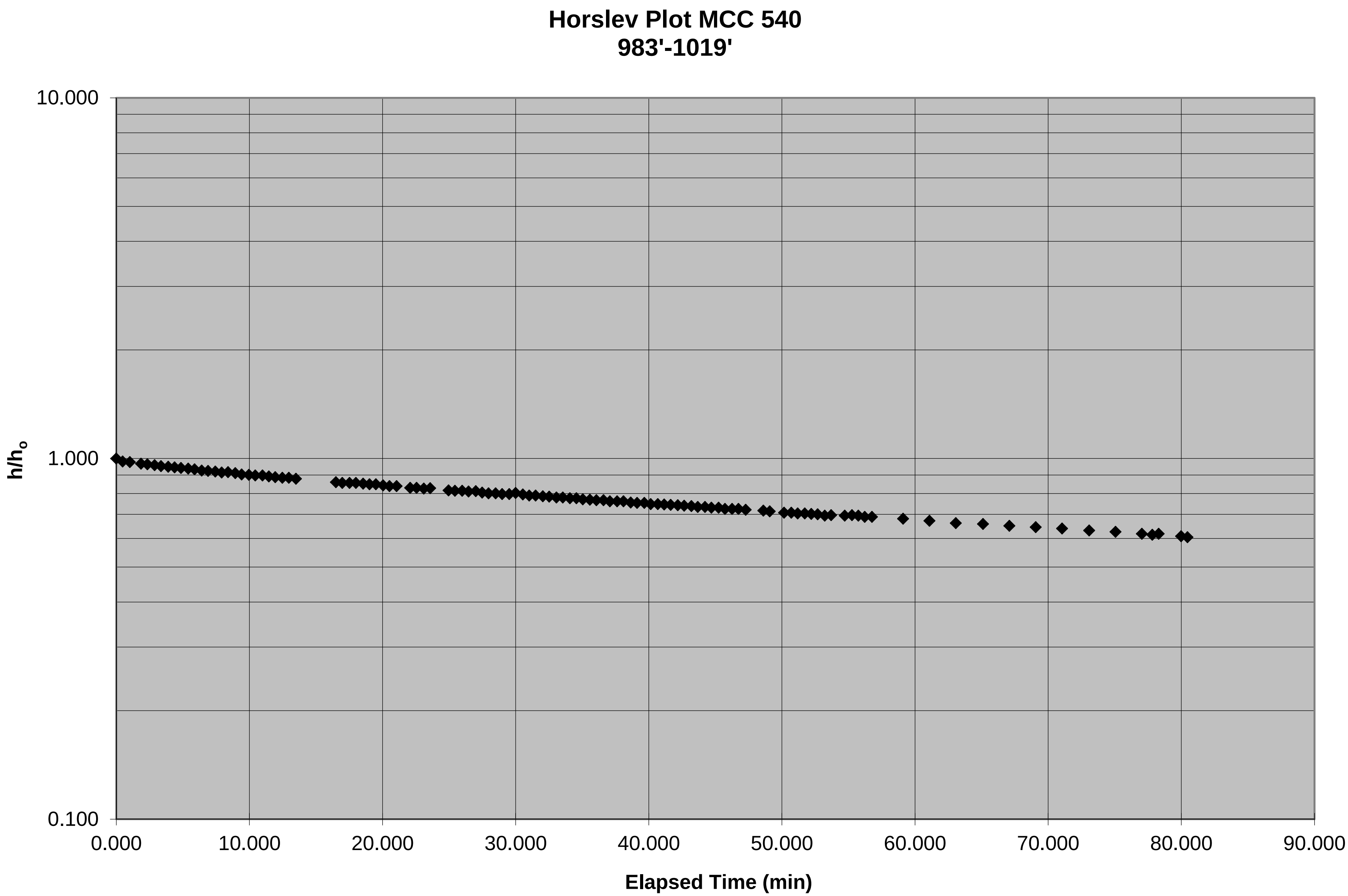
Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:56:36	10.943	0.372	22.320	14.5	220.4	
10:56:41	10.945	0.374	22.440	14.5	229	
10:56:46	10.946	0.375	22.500	14.5	252.5	
10:56:50	10.947	0.376	22.560	14.5	257.5	
10:56:55	10.949	0.378	22.680	14.5	291.7	
10:57:00	10.95	0.379	22.740	14.5	304.1	
10:57:05	10.951	0.380	22.800	14.5	301.5	
10:57:09	10.953	0.382	22.920	14.5	304.6	
10:57:14	10.954	0.383	22.980	14.5	345.9	
10:57:19	10.955	0.384	23.040	14.5	341.1	
10:57:24	10.957	0.386	23.160	14.5	343.8	
10:57:29	10.958	0.387	23.220	14.5	340.6	
10:57:33	10.959	0.388	23.280	14.5	336.5	
10:57:38	10.961	0.390	23.400	14.5	337.1	
10:57:43	10.962	0.391	23.460	14.5	336.8	
10:57:48	10.963	0.392	23.520	14.5	338.8	
10:57:53	10.965	0.394	23.640	14.5	335.2	
10:57:57	10.966	0.395	23.700	14.5	335.5	
10:58:02	10.967	0.396	23.760	14.5	335.7	
10:58:07	10.969	0.398	23.880	14.5	336.4	
10:58:12	10.97	0.399	23.940	14.5	335.7	
10:58:16	10.971	0.400	24.000	14.5	333	
10:58:21	10.973	0.402	24.120	14.5	338.3	
10:58:26	10.974	0.403	24.180	14.5	335.6	
10:58:31	10.975	0.404	24.240	14.5	336.3	
10:58:35	10.977	0.406	24.360	14.5	335.9	
10:58:40	10.978	0.407	24.420	14.5	334.1	
10:58:45	10.979	0.408	24.480	14.5	337.8	
10:58:50	10.981	0.410	24.600	14.5	332.7	
10:58:55	10.982	0.411	24.660	14.5	335.1	
10:58:59	10.983	0.412	24.720	14.5	331.9	
10:59:04	10.984	0.413	24.780	14.5	333.3	
10:59:09	10.986	0.415	24.900	14.5	332.6	
10:59:14	10.987	0.416	24.960	14.5	331	
10:59:18	10.988	0.417	25.020	14.5	332.4	
10:59:23	10.99	0.419	25.140	14.5	329.7	
10:59:28	10.991	0.420	25.200	14.5	333.8	
10:59:33	10.992	0.421	25.260	14.5	334.5	
10:59:38	10.994	0.423	25.380	14.5	332.8	
10:59:42	10.995	0.424	25.440	14.5	331.7	
10:59:47	10.996	0.425	25.500	14.5	327.5	
10:59:52	10.998	0.427	25.620	14.5	326.5	
10:59:57	10.999	0.428	25.680	14.5	324.8	
11:00:02	11	0.429	25.740	14.5	325.6	
11:00:06	11.002	0.431	25.860	14.5	326.2	
11:00:11	11.003	0.432	25.920	14.5	326.9	
11:00:16	11.004	0.433	25.980	14.5	326.4	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
11:00:21	11.006	0.435	26.100	14.5	325	
11:00:26	11.007	0.436	26.160	14.5	325	
11:00:30	11.008	0.437	26.220	14.5	327.8	
11:00:35	11.01	0.439	26.340	14.5	327.8	
11:00:40	11.011	0.440	26.400	14.5	327.5	
11:00:45	11.012	0.441	26.460	14.5	323.3	
11:00:49	11.014	0.443	26.580	14.5	322.7	
11:00:54	11.015	0.444	26.640	14.5	324.2	
11:00:59	11.016	0.445	26.700	14.5	325.5	
11:01:04	11.018	0.447	26.820	14.5	326.4	
11:01:08	11.019	0.448	26.880	14.5	323.7	
11:01:13	11.02	0.449	26.940	14.5	322.2	
11:01:18	11.022	0.451	27.060	14.5	322.9	
11:01:23	11.023	0.452	27.120	14.5	324.1	
11:01:27	11.024	0.453	27.180	14.5	326.4	
11:01:32	11.026	0.455	27.300	14.5	325.2	
11:01:37	11.027	0.456	27.360	14.5	324.7	
11:01:42	11.028	0.457	27.420	14.5	323	
11:01:47	11.03	0.459	27.540	14.5	325.5	
11:01:51	11.031	0.460	27.600	14.5	324.3	
11:01:56	11.032	0.461	27.660	14.5	324.1	
11:02:01	11.034	0.463	27.780	14.5	321.1	
11:02:06	11.035	0.464	27.840	14.5	321.9	
11:02:10	11.036	0.465	27.900	14.5	325	
11:02:15	11.038	0.467	28.020	14.5	325.4	
11:02:20	11.039	0.468	28.080	14.5	325	
11:02:25	11.04	0.469	28.140	14.5	321.4	
11:02:30	11.042	0.471	28.260	14.5	318.6	
11:02:34	11.043	0.472	28.320	14.5	320.5	
11:02:39	11.044	0.473	28.380	14.5	322.8	
11:02:44	11.046	0.475	28.500	14.5	322.9	
11:02:49	11.047	0.476	28.560	14.5	324	
11:02:54	11.048	0.477	28.620	14.5	322.4	
11:02:58	11.05	0.479	28.740	14.5	321.4	
11:03:03	11.051	0.480	28.800	14.5	319.8	
11:03:08	11.052	0.481	28.860	14.5	320.3	
11:03:13	11.054	0.483	28.980	14.5	319.5	
11:03:17	11.055	0.484	29.040	14.5	323.5	
11:03:22	11.056	0.485	29.100	14.5	323.6	
11:03:27	11.058	0.487	29.220	14.5	324.1	
11:03:32	11.059	0.488	29.280	14.5	320.8	
11:03:37	11.06	0.489	29.340	21	358.5	
11:03:41	11.061	0.490	29.400	21	354	
11:03:46	11.063	0.492	29.520	21	350.9	
11:03:51	11.064	0.493	29.580	21	349	
11:03:56	11.065	0.494	29.640	21	349.9	
11:04:00	11.067	0.496	29.760	21	350.5	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
11:04:05	11.068	0.497	29.820	21	350.1	
11:04:10	11.069	0.498	29.880	21	351.9	
11:04:15	11.071	0.500	30.000	21	349.5	
11:04:20	11.072	0.501	30.060	21	348.2	
11:04:24	11.073	0.502	30.120	21	348.4	
11:04:29	11.075	0.504	30.240	21	347.4	
11:04:34	11.076	0.505	30.300	21	348.2	
11:04:39	11.077	0.506	30.360	21	348.8	
11:04:44	11.079	0.508	30.480	21	350.6	
11:04:48	11.08	0.509	30.540	21	349.5	
11:04:53	11.081	0.510	30.600	21	350.2	
11:04:58	11.083	0.512	30.720	21	347.8	
11:05:02	11.084	0.513	30.780	21	347.6	
11:05:08	11.085	0.514	30.840	21	347.1	
11:05:12	11.087	0.516	30.960	21	347.3	
11:05:17	11.088	0.517	31.020	21	346.4	
11:05:22	11.089	0.518	31.080	21	347.1	
11:05:47	11.096	0.525	31.500	21	352.1	
11:05:54	11.098	0.527	31.620	21	350.6	
11:06:00	11.1	0.529	31.740	21	351	
11:06:06	11.102	0.531	31.860	21	349.3	
11:06:13	11.104	0.533	31.980	21	351.2	
11:06:19	11.105	0.534	32.040	21	352.3	
11:06:25	11.107	0.536	32.160	21	352.1	
11:06:32	11.109	0.538	32.280	21	353.4	
11:06:38	11.111	0.540	32.400	21	349.3	
11:06:45	11.112	0.541	32.460	21	351	
11:06:51	11.114	0.543	32.580	21	351.5	
11:06:57	11.116	0.545	32.700	21	347.7	
11:07:04	11.118	0.547	32.820	21	348.7	
11:07:10	11.119	0.548	32.880	21	347.4	
11:07:16	11.121	0.550	33.000	21	345.5	
11:07:23	11.123	0.552	33.120	21	344.6	
11:07:29	11.125	0.554	33.240	21	345.3	
11:07:36	11.127	0.556	33.360	21	347.7	
11:07:42	11.128	0.557	33.420	21	346.6	
11:07:47	11.13	0.559	33.540	21	348.8	
11:07:53	11.131	0.560	33.600	21	347.7	
11:07:59	11.133	0.562	33.720	21	348.6	
11:08:06	11.135	0.564	33.840	21	346.9	
11:08:12	11.137	0.566	33.960	21	348	
11:08:18	11.138	0.567	34.020	21	348.4	
11:08:25	11.14	0.569	34.140	21	348.8	
11:08:31	11.142	0.571	34.260	21	349.8	
11:08:38	11.144	0.573	34.380	21	349	
11:08:44	11.146	0.575	34.500	21	346.2	
11:08:50	11.147	0.576	34.560	21	343.6	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
11:08:57	11.149	0.578	34.680	21	345.4	
11:09:03	11.151	0.580	34.800	21	344.9	
11:09:09	11.153	0.582	34.920	21	345.6	
11:09:16	11.154	0.583	34.980	21	345.8	
11:09:22	11.156	0.585	35.100	21	346.7	
11:09:29	11.158	0.587	35.220	21	346.1	
11:09:35	11.16	0.589	35.340	21	347	
11:09:41	11.161	0.590	35.400	21	348.8	
11:09:48	11.163	0.592	35.520	21	347.8	
11:09:54	11.165	0.594	35.640	21	347.1	
11:10:00	11.167	0.596	35.760		309.8	
11:10:07	11.169	0.598	35.880		190.2	
11:10:13	11.17	0.599	35.940		174.8	


Slug Test #1 MCC 540
983'-1019'
Bottom-hole Pressure (psig)
425
420
415
410
405
400
395
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
90.000
Elapsed Time (min)

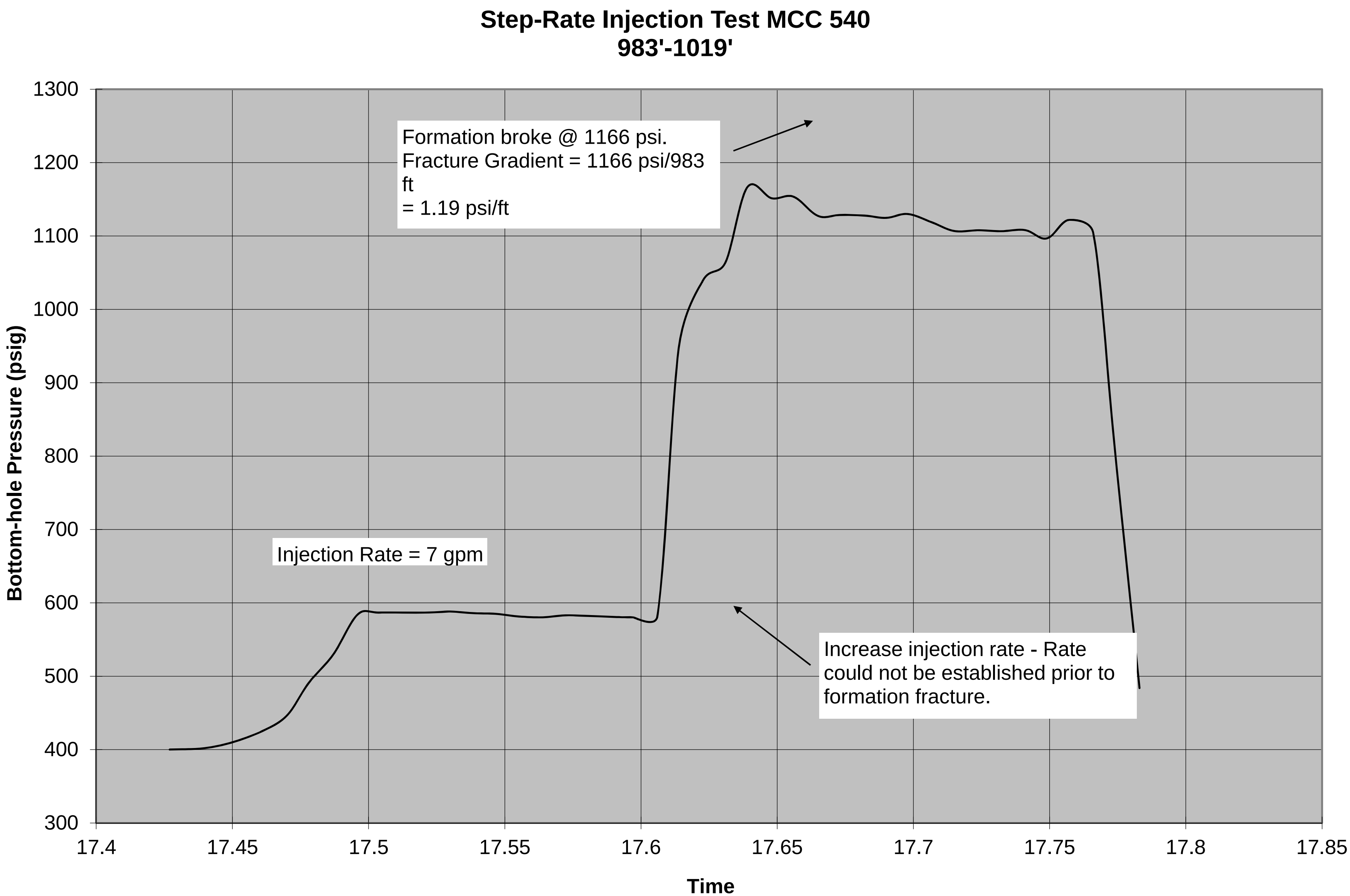


Horslev Plot MCC 540
983'-1019'
10.000
1.000
0.100
h/h$_o$
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
90.000
Elapsed Time (min)

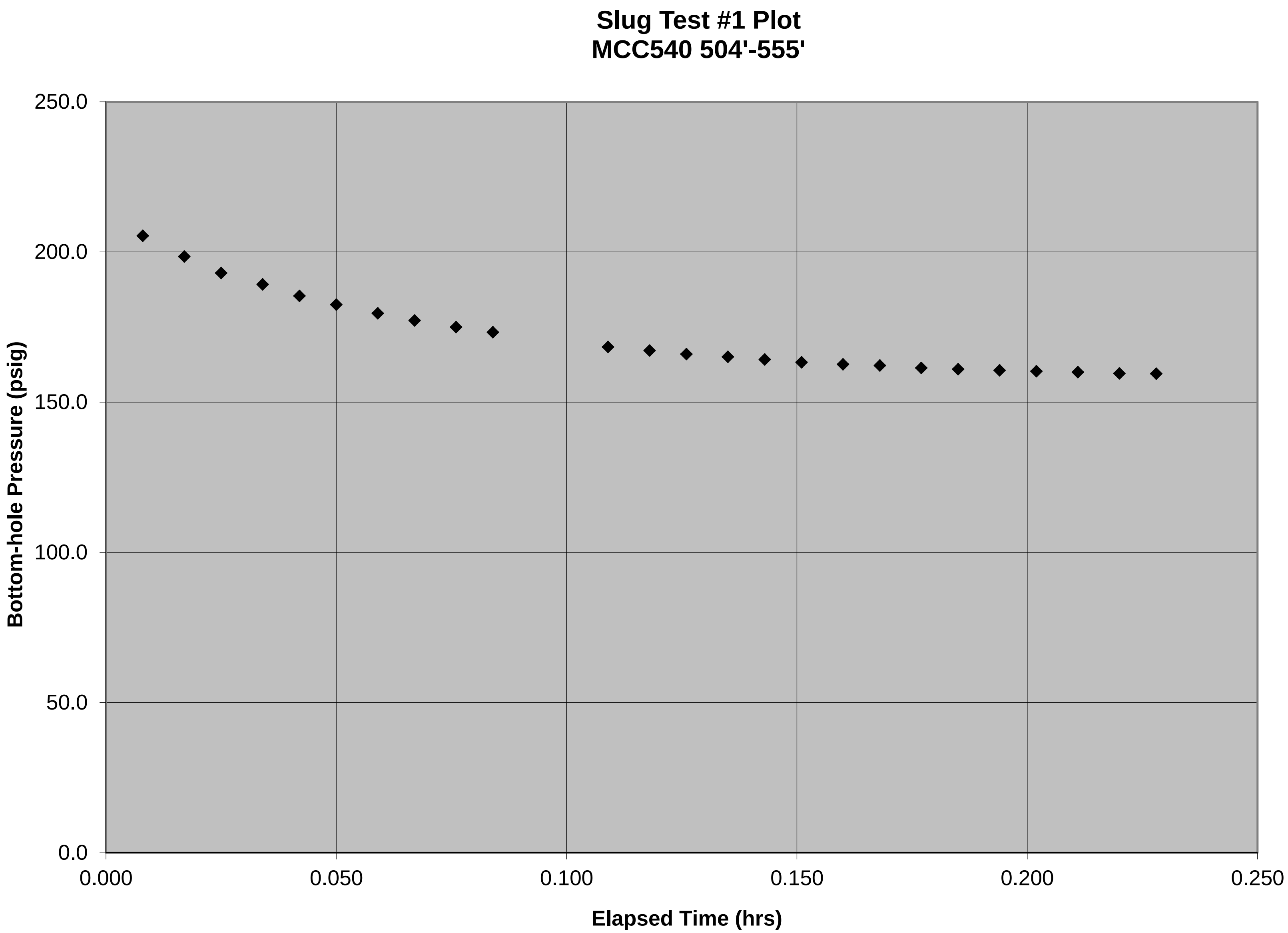
Slug Test Data MCC 540 983'-1019'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
16:00:37	16.01	-	-	-	367.8	-
16:04:40	16.078	0.000	0.000	0.000	420.5	1.000
16:05:11	16.086	0.008	0.480	0.000	419.5	0.981
16:05:41	16.095	0.017	1.020	0.001	419.3	0.977
16:06:32	16.109	0.031	1.860	0.001	418.8	0.968
16:07:02	16.117	0.039	2.340	0.002	418.6	0.964
16:07:33	16.126	0.048	2.880	0.002	418.3	0.958
16:08:03	16.134	0.056	3.360	0.002	418	0.953
16:08:33	16.143	0.065	3.900	0.003	417.8	0.949
16:09:04	16.151	0.073	4.380	0.003	417.6	0.945
16:09:34	16.159	0.081	4.860	0.003	417.4	0.941
16:10:04	16.168	0.090	5.400	0.004	417.2	0.937
16:10:35	16.176	0.098	5.880	0.004	417	0.934
16:11:05	16.185	0.107	6.420	0.004	416.6	0.926
16:11:35	16.193	0.115	6.900	0.005	416.5	0.924
16:12:06	16.202	0.124	7.440	0.005	416.3	0.920
16:12:36	16.21	0.132	7.920	0.006	416	0.915
16:13:06	16.218	0.140	8.400	0.006	416.1	0.917
16:13:37	16.227	0.149	8.940	0.006	415.8	0.911
16:14:07	16.235	0.157	9.420	0.007	415.4	0.903
16:14:37	16.244	0.166	9.960	0.007	415.3	0.901
16:15:08	16.252	0.174	10.440	0.007	415.1	0.898
16:15:38	16.261	0.183	10.980	0.008	415.1	0.898
16:16:08	16.269	0.191	11.460	0.008	414.8	0.892
16:16:39	16.277	0.199	11.940	0.008	414.6	0.888
16:17:09	16.286	0.208	12.480	0.009	414.4	0.884
16:17:39	16.294	0.216	12.960	0.009	414.4	0.884
16:18:10	16.303	0.225	13.500	0.009	414.1	0.879
16:21:10	16.353	0.275	16.500	0.011	413.1	0.860
16:21:41	16.361	0.283	16.980	0.012	412.9	0.856
16:22:11	16.37	0.292	17.520	0.012	412.9	0.856
16:22:41	16.378	0.300	18.000	0.013	412.9	0.856
16:23:12	16.387	0.309	18.540	0.013	412.7	0.852
16:23:42	16.395	0.317	19.020	0.013	412.5	0.848
16:24:12	16.403	0.325	19.500	0.014	412.5	0.848
16:24:43	16.412	0.334	20.040	0.014	412.2	0.843
16:25:13	16.42	0.342	20.520	0.014	412	0.839
16:25:43	16.429	0.351	21.060	0.015	412	0.839
16:26:46	16.446	0.368	22.080	0.015	411.5	0.829
16:27:16	16.454	0.376	22.560	0.016	411.5	0.829
16:27:46	16.463	0.385	23.100	0.016	411.3	0.825
16:28:17	16.471	0.393	23.580	0.016	411.4	0.827
16:29:38	16.494	0.416	24.960	0.017	410.8	0.816
16:30:08	16.502	0.424	25.440	0.018	410.7	0.814
16:30:39	16.511	0.433	25.980	0.018	410.7	0.814

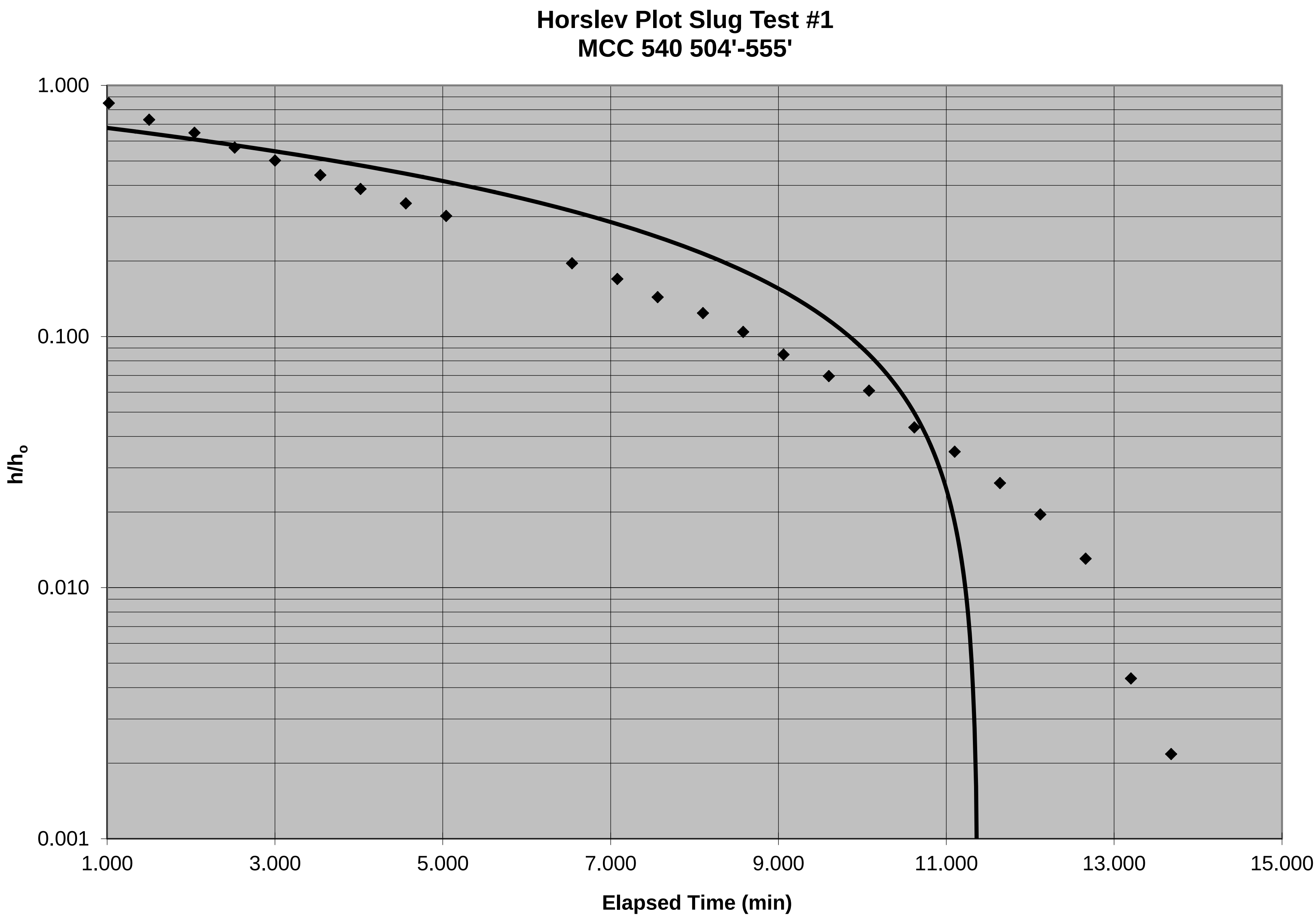
Slug Test Data MCC 540 983'-1019'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
16:31:09	16.519	0.441	26.460	0.018	410.5	0.810
16:31:39	16.528	0.450	27.000	0.019	410.6	0.812
16:32:10	16.536	0.458	27.480	0.019	410.2	0.805
16:32:40	16.544	0.466	27.960	0.019	410	0.801
16:33:10	16.553	0.475	28.500	0.020	410	0.801
16:33:41	16.561	0.483	28.980	0.020	409.8	0.797
16:34:11	16.57	0.492	29.520	0.021	409.8	0.797
16:34:41	16.578	0.500	30.000	0.021	410.1	0.803
16:35:12	16.587	0.509	30.540	0.021	409.7	0.795
16:35:42	16.595	0.517	31.020	0.022	409.4	0.789
16:36:13	16.603	0.525	31.500	0.022	409.4	0.789
16:36:43	16.612	0.534	32.040	0.022	409.2	0.786
16:37:13	16.62	0.542	32.520	0.023	409.1	0.784
16:37:44	16.629	0.551	33.060	0.023	408.9	0.780
16:38:14	16.637	0.559	33.540	0.023	408.9	0.780
16:38:44	16.646	0.568	34.080	0.024	408.7	0.776
16:39:14	16.654	0.576	34.560	0.024	408.7	0.776
16:39:45	16.662	0.584	35.040	0.024	408.4	0.770
16:40:15	16.671	0.593	35.580	0.025	408.3	0.769
16:40:45	16.679	0.601	36.060	0.025	408.2	0.767
16:41:16	16.688	0.610	36.600	0.025	408.2	0.767
16:41:46	16.696	0.618	37.080	0.026	407.9	0.761
16:42:16	16.705	0.627	37.620	0.026	407.9	0.761
16:42:47	16.713	0.635	38.100	0.026	407.9	0.761
16:43:19	16.722	0.644	38.640	0.027	407.6	0.755
16:43:49	16.73	0.652	39.120	0.027	407.5	0.753
16:44:19	16.739	0.661	39.660	0.028	407.5	0.753
16:44:50	16.747	0.669	40.140	0.028	407.2	0.748
16:45:20	16.756	0.678	40.680	0.028	407.2	0.748
16:45:50	16.764	0.686	41.160	0.029	407.1	0.746
16:46:21	16.772	0.694	41.640	0.029	407	0.744
16:46:51	16.781	0.703	42.180	0.029	406.9	0.742
16:47:21	16.789	0.711	42.660	0.030	406.8	0.740
16:47:52	16.798	0.720	43.200	0.030	406.7	0.738
16:48:22	16.806	0.728	43.680	0.030	406.5	0.734
16:48:53	16.815	0.737	44.220	0.031	406.5	0.734
16:49:24	16.823	0.745	44.700	0.031	406.3	0.731
16:49:55	16.832	0.754	45.240	0.031	406.3	0.731
16:50:25	16.84	0.762	45.720	0.032	406	0.725
16:50:55	16.849	0.771	46.260	0.032	406	0.725
16:51:26	16.857	0.779	46.740	0.032	406	0.725
16:51:56	16.866	0.788	47.280	0.033	405.8	0.721
16:53:16	16.888	0.810	48.600	0.034	405.6	0.717
16:53:46	16.896	0.818	49.080	0.034	405.4	0.713
16:54:52	16.914	0.836	50.160	0.035	405.1	0.708
16:55:22	16.923	0.845	50.700	0.035	405.1	0.708
16:55:52	16.931	0.853	51.180	0.036	404.9	0.704

Slug Test Data MCC 540 983'-1019'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
16:56:23	16.94	0.862	51.720	0.036	404.9	0.704
16:56:53	16.948	0.870	52.200	0.036	404.8	0.702
16:57:23	16.956	0.878	52.680	0.037	404.7	0.700
16:57:54	16.965	0.887	53.220	0.037	404.4	0.694
16:58:24	16.973	0.895	53.700	0.037	404.5	0.696
16:59:25	16.99	0.912	54.720	0.038	404.4	0.694
16:59:55	16.999	0.921	55.260	0.038	404.5	0.696
17:00:25	17.007	0.929	55.740	0.039	404.4	0.694
17:00:56	17.015	0.937	56.220	0.039	404.1	0.689
17:01:26	17.024	0.946	56.760	0.039	404.1	0.689
17:03:46	17.063	0.985	59.100	0.041	403.7	0.681
17:05:46	17.096	1.018	61.080	0.042	403.2	0.672
17:07:46	17.129	1.051	63.060	0.044	402.7	0.662
17:09:45	17.163	1.085	65.100	0.045	402.5	0.658
17:11:45	17.196	1.118	67.080	0.047	402.1	0.651
17:13:45	17.229	1.151	69.060	0.048	401.8	0.645
17:15:45	17.262	1.184	71.040	0.049	401.5	0.639
17:17:45	17.296	1.218	73.080	0.051	401.1	0.632
17:19:44	17.329	1.251	75.060	0.052	400.8	0.626
17:21:44	17.362	1.284	77.040	0.054	400.4	0.619
17:22:29	17.375	1.297	77.820	0.054	400.2	0.615
17:22:59	17.383	1.305	78.300	0.054	400.4	0.619
17:24:38	17.411	1.333	79.980	0.056	399.9	0.609
17:25:08	17.419	1.341	80.460	0.056	399.7	0.605


Step-Rate Injection Test MCC 540
983'-1019'
Formation broke @ 1166 psi.
Fracture Gradient = 1166 psi/983 ft
= 1.19 psi/ft
Injection Rate = 7 gpm
Increase injection rate - Rate could not be established prior to formation fracture.
Bottom-hole Pressure (psig)
1300
1200
1100
1000
900
800
700
600
500
400
300
17.4
17.45
17.5
17.55
17.6
17.65
17.7
17.75
17.8
17.85
Time

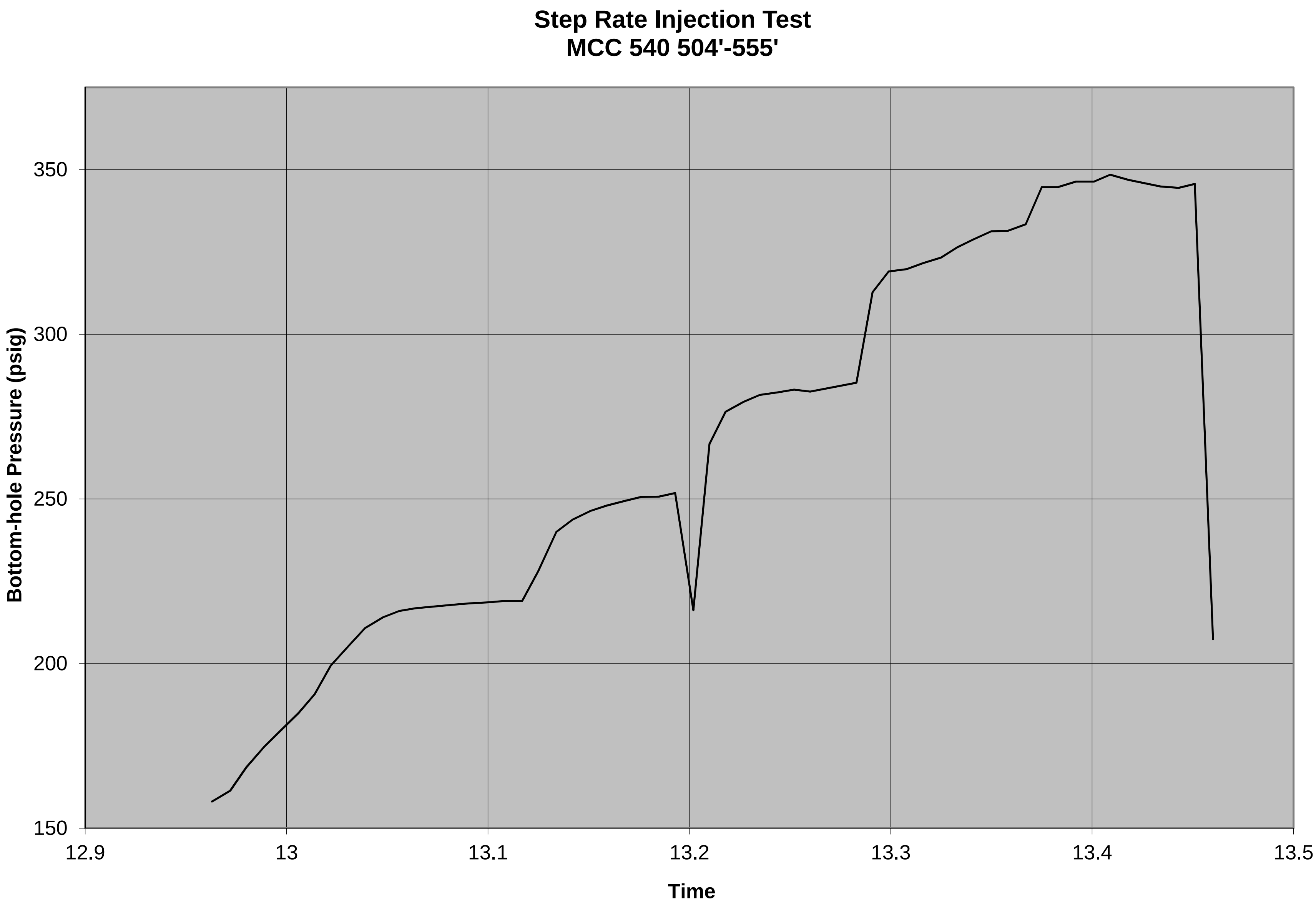
Step Rate Injection Test MCC 540 983'-1019'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
17:25:39	17.427	0.000	0.000	7	400	
17:26:09	17.436	0.009	0.540	7	401	
17:26:39	17.444	0.017	1.020	7	404.2	
17:27:10	17.453	0.026	1.560	7	413.6	
17:27:40	17.461	0.034	2.040	7	425.2	
17:28:10	17.47	0.043	2.580	7	446.2	
17:28:41	17.478	0.051	3.060	7	490.7	
17:29:14	17.487	0.060	3.600	7	529.3	
17:29:45	17.496	0.069	4.140	7	584.1	
17:30:15	17.504	0.077	4.620	7	586.7	
17:31:17	17.521	0.094	5.640	7	586.6	
17:31:47	17.53	0.103	6.180	7	588.1	
17:32:18	17.538	0.111	6.660	7	586	
17:32:48	17.547	0.120	7.200	7	584.9	
17:33:19	17.555	0.128	7.680	7	581.4	
17:33:49	17.564	0.137	8.220	7	580.3	
17:34:19	17.572	0.145	8.700	7	582.9	
17:34:50	17.58	0.153	9.180	7	582.2	
17:35:20	17.589	0.162	9.720	7	580.9	
17:35:50	17.597	0.170	10.200	7	580.3	
17:36:21	17.606	0.179	10.740	7	581.4	Increase Rate
17:36:51	17.614	0.187	11.220		950.9	
17:37:21	17.623	0.196	11.760		1040.8	
17:37:52	17.631	0.204	12.240		1063.8	
17:38:22	17.639	0.212	12.720		1166.2	Fm. Fractured
17:38:52	17.648	0.221	13.260		1151.3	
17:39:23	17.656	0.229	13.740		1153.5	
17:39:53	17.665	0.238	14.280		1127.2	
17:40:23	17.673	0.246	14.760		1128.6	
17:40:54	17.682	0.255	15.300		1127.8	
17:41:24	17.69	0.263	15.780		1124.6	
17:41:54	17.698	0.271	16.260		1129.9	
17:42:25	17.707	0.280	16.800		1118.2	
17:42:55	17.715	0.288	17.280		1106.7	
17:43:25	17.724	0.297	17.820		1107.8	
17:43:56	17.732	0.305	18.300		1106.4	
17:44:26	17.741	0.314	18.840		1108	
17:44:57	17.749	0.322	19.320		1096.6	
17:45:27	17.757	0.330	19.800		1121.8	
17:45:57	17.766	0.339	20.340		1104.2	
17:46:27	17.774	0.347	20.820		807.1	
17:46:58	17.783	0.356	21.360		483.8	
Note: Could not establish rate before formation fractured at 1166 psi.						
Fracture gradient = 1166 psi/983 ft = 1.19 psi/ft.						


Slug Test #1 Plot
MCC540 504'-555'
250.0
200.0
150.0
100.0
50.0
0.0
0.000
0.050
0.100
0.150
0.200
0.250
Bottom-hole Pressure (psig)
Elapsed Time (hrs)

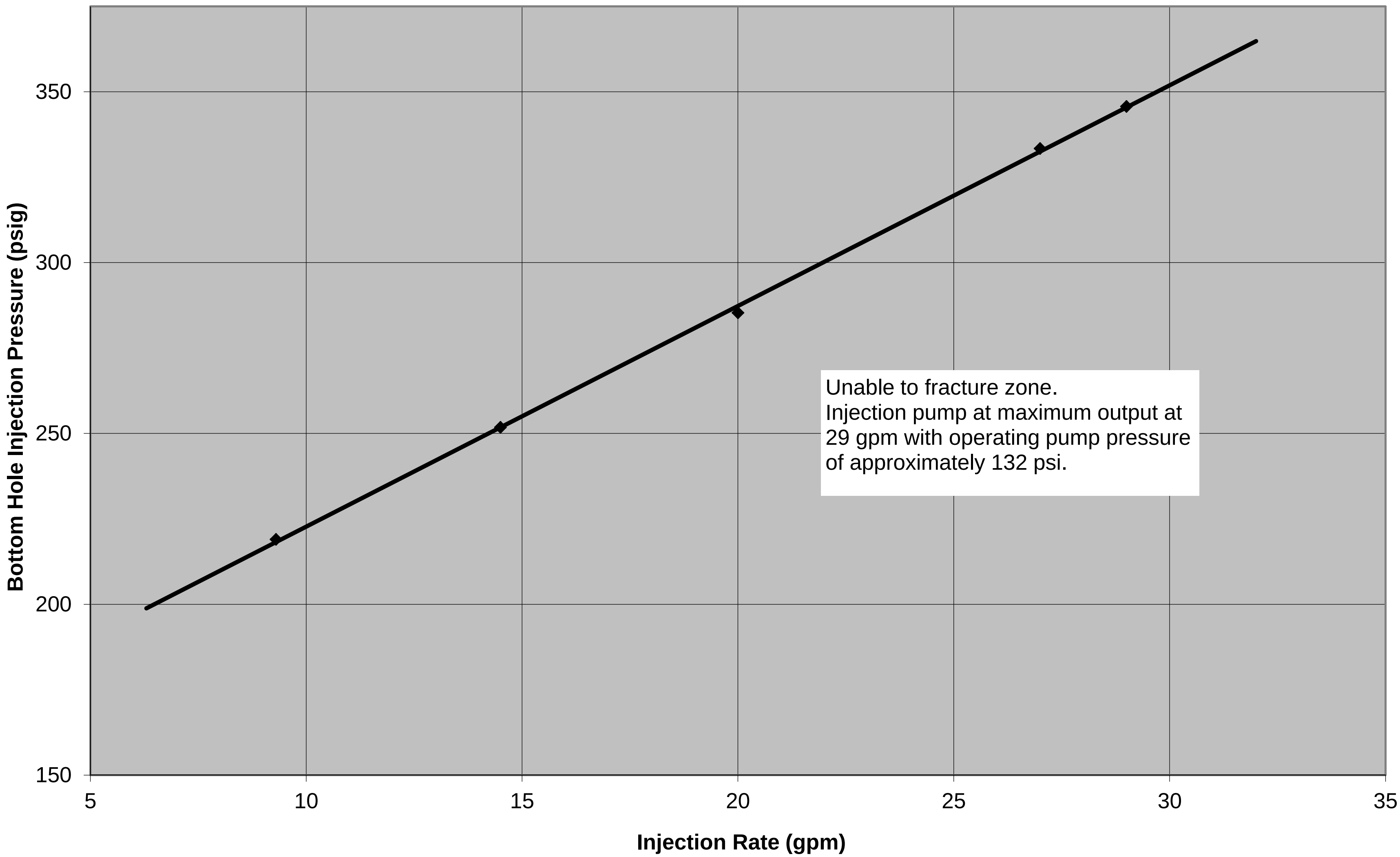


Horslev Plot Slug Test #1
MCC 540 504'-555'
1.000
0.100
0.010
0.001
h/ho
1.000
3.000
5.000
7.000
9.000
11.000
13.000
15.000
Elapsed Time (min)

Slug Test Data MCC 540 504'-555'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
12:32:33	12.543	0.000	0.000	0.000	159.4	-
12:33:05	12.551	0.008	0.480	3.33E-04	205.4	1.000
12:33:35	12.560	0.017	1.020	7.08E-04	198.5	0.850
12:34:06	12.568	0.025	1.500	1.04E-03	193.0	0.730
12:34:36	12.577	0.034	2.040	1.42E-03	189.2	0.648
12:35:06	12.585	0.042	2.520	1.75E-03	185.4	0.565
12:35:36	12.593	0.050	3.000	2.08E-03	182.5	0.502
12:36:07	12.602	0.059	3.540	2.46E-03	179.6	0.439
12:36:37	12.610	0.067	4.020	2.79E-03	177.2	0.387
12:37:07	12.619	0.076	4.560	3.17E-03	175.0	0.339
12:37:38	12.627	0.084	5.040	3.50E-03	173.3	0.302
12:39:08	12.652	0.109	6.540	4.54E-03	168.4	0.196
12:39:39	12.661	0.118	7.080	4.92E-03	167.2	0.170
12:40:09	12.669	0.126	7.560	5.25E-03	166.0	0.143
12:40:39	12.678	0.135	8.100	5.63E-03	165.1	0.124
12:41:10	12.686	0.143	8.580	5.96E-03	164.2	0.104
12:41:40	12.694	0.151	9.060	6.29E-03	163.3	0.085
12:42:10	12.703	0.160	9.600	6.67E-03	162.6	0.070
12:42:40	12.711	0.168	10.080	7.00E-03	162.2	0.061
12:43:11	12.720	0.177	10.620	7.38E-03	161.4	0.043
12:43:42	12.728	0.185	11.100	7.71E-03	161.0	0.035
12:44:13	12.737	0.194	11.640	8.08E-03	160.6	0.026
12:44:43	12.745	0.202	12.120	8.42E-03	160.3	0.020
12:45:13	12.754	0.211	12.660	8.79E-03	160.0	0.013
12:45:45	12.763	0.220	13.200	9.17E-03	159.6	0.004
12:46:15	12.771	0.228	13.680	9.50E-03	159.5	0.002

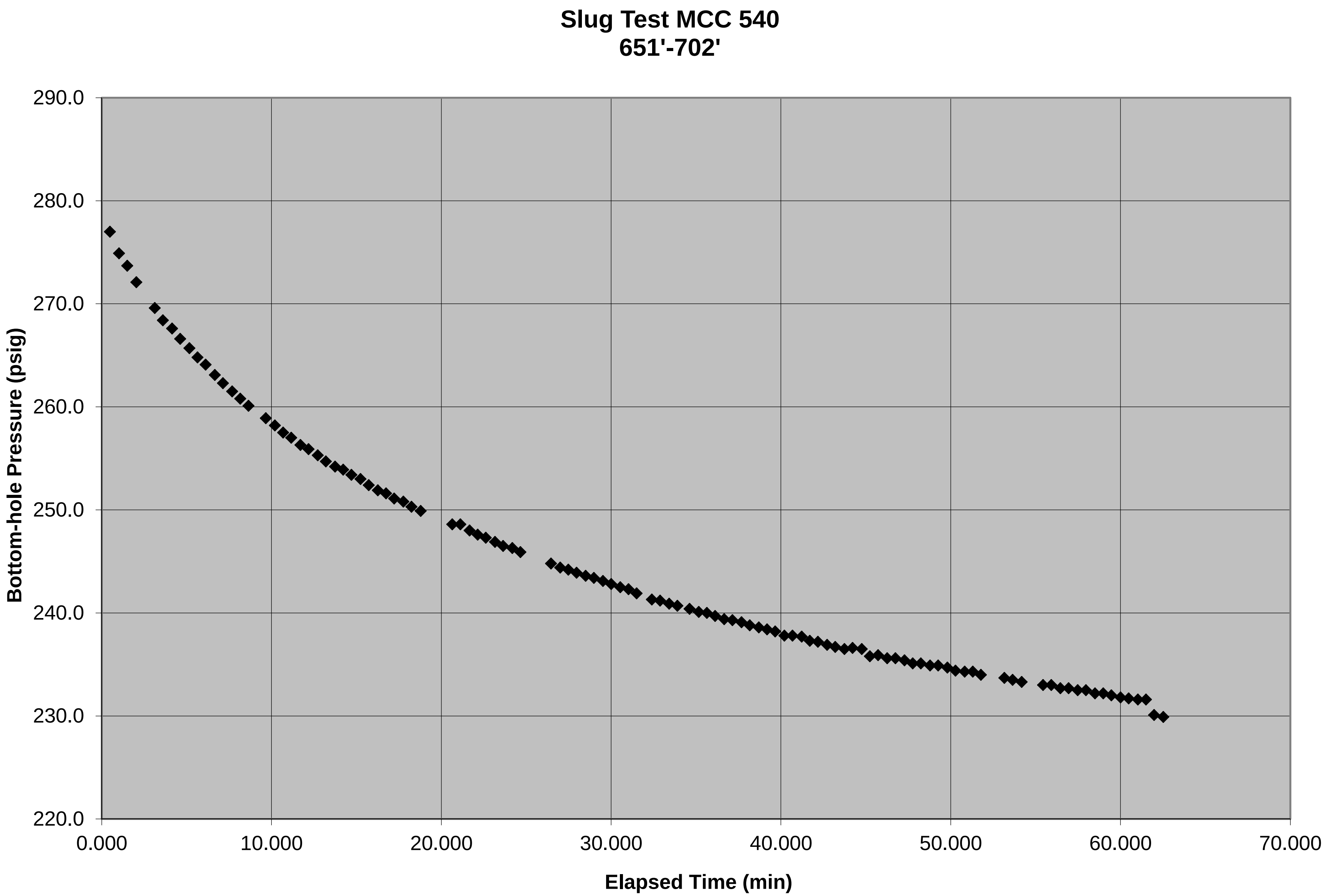

Step Rate Injection Test
MCC 540 504'-555'
Bottom-hole Pressure (psig)
350
300
250
200
150
12.9
13
13.1
13.2
13.3
13.4
13.5
Time

Fracture Gradient Injection Test
MCC 540 504'-555'

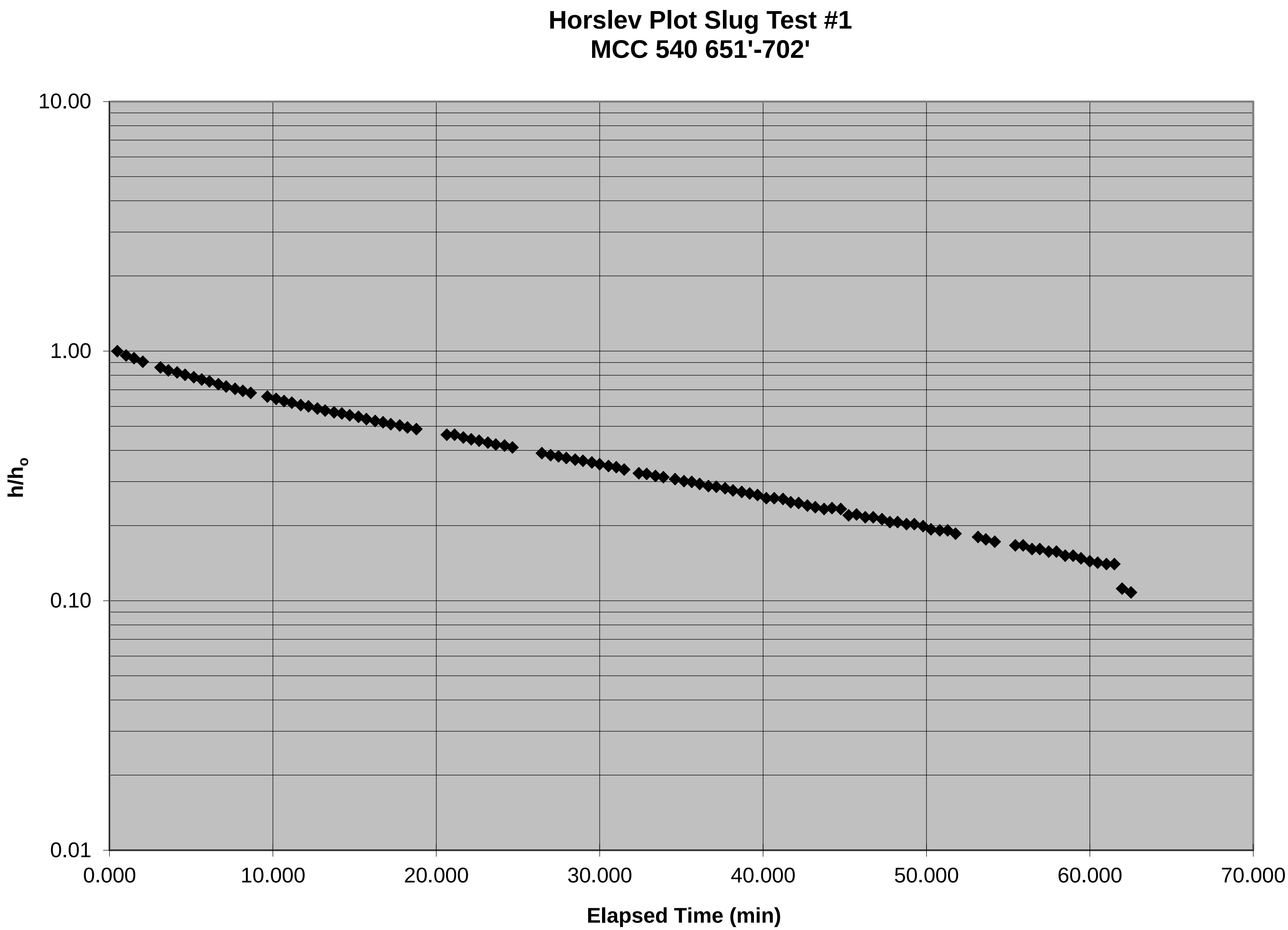


Step Rate Injection Test Data MCC 540 504'-555'						
Time	Time	Injection Rate (gpm)	Elapsed Time (hrs)	Elapsed Time (min)	Pressure (psig)	
Static Pressure						
12:57:18	12.955				157.3	
12:57:49	12.963	9.3	0.008	0.48	158.1	
12:58:19	12.972	9.3	0.017	1.02	161.4	
12:58:49	12.98	9.3	0.025	1.5	168.5	
12:59:19	12.989	9.3	0.034	2.04	174.8	
12:59:50	12.997	9.3	0.042	2.52	179.6	
13:00:20	13.006	9.3	0.051	3.06	185	
13:00:50	13.014	9.3	0.059	3.54	190.7	
13:01:21	13.022	9.3	0.067	4.02	199.4	
13:01:51	13.031	9.3	0.076	4.56	205.5	
13:02:21	13.039	9.3	0.084	5.04	210.8	
13:02:51	13.048	9.3	0.093	5.58	214.1	
13:03:22	13.056	9.3	0.101	6.06	216	
13:03:52	13.064	9.3	0.109	6.54	216.8	
13:04:59	13.083	9.3	0.128	7.68	217.9	
13:05:29	13.091	9.3	0.136	8.16	218.3	
13:05:59	13.1	9.3	0.145	8.7	218.6	
13:06:30	13.108	9.3	0.153	9.18	219	
13:07:00	13.117	9.3	0.162	9.72	219	
13:07:32	13.125	14.5	0.17	10.2	228.1	
13:08:02	13.134	14.5	0.179	10.74	240	
13:08:32	13.142	14.5	0.187	11.22	243.7	
13:09:03	13.151	14.5	0.196	11.76	246.4	
13:09:33	13.159	14.5	0.204	12.24	248	
13:10:03	13.168	14.5	0.213	12.78	249.4	
13:10:33	13.176	14.5	0.221	13.26	250.6	
13:11:05	13.185	14.5	0.23	13.8	250.7	
13:11:35	13.193	14.5	0.238	14.28	251.8	
13:12:06	13.202	20	0.247	14.82	216.2	
13:12:36	13.21	20	0.255	15.3	266.7	
13:13:06	13.218	20	0.263	15.78	276.5	
13:13:37	13.227	20	0.272	16.32	279.5	
13:14:07	13.235	20	0.28	16.8	281.6	
13:14:37	13.244	20	0.289	17.34	282.4	
13:15:07	13.252	20	0.297	17.82	283.2	
13:15:38	13.26	20	0.305	18.3	282.6	
13:16:57	13.283	20	0.328	19.68	285.3	
13:17:28	13.291	27	0.336	20.16	312.8	
13:17:58	13.299	27	0.344	20.64	319.1	
13:18:28	13.308	27	0.353	21.18	319.8	
13:18:58	13.316	27	0.361	21.66	321.6	
13:19:29	13.325	27	0.37	22.2	323.3	
13:19:59	13.333	27	0.378	22.68	326.4	
13:20:29	13.341	27	0.386	23.16	328.8	

Step Rate Injection Test Data MCC 540 504'-555'						
Time	Time	Injection Rate (gpm)	Elapsed Time (hrs)	Elapsed Time (min)	Pressure (psig)	
13:20:59	13.35	27	0.395	23.7	331.3	
13:21:30	13.358	27	0.403	24.18	331.4	
13:22:00	13.367	27	0.412	24.72	333.4	
13:22:30	13.375	29	0.42	25.2	344.7	
13:23:01	13.383	29	0.428	25.68	344.7	
13:23:31	13.392	29	0.437	26.22	346.4	
13:24:03	13.401	29	0.446	26.76	346.4	
13:24:33	13.409	29	0.454	27.24	348.5	
13:25:03	13.418	29	0.463	27.78	346.9	
13:25:34	13.426	29	0.471	28.26	345.9	
13:26:04	13.434	29	0.479	28.74	344.9	
13:26:34	13.443	29	0.488	29.28	344.5	
13:27:04	13.451	29	0.496	29.76	345.7	End Test
13:27:35	13.46		0.505	30.3	207.4	



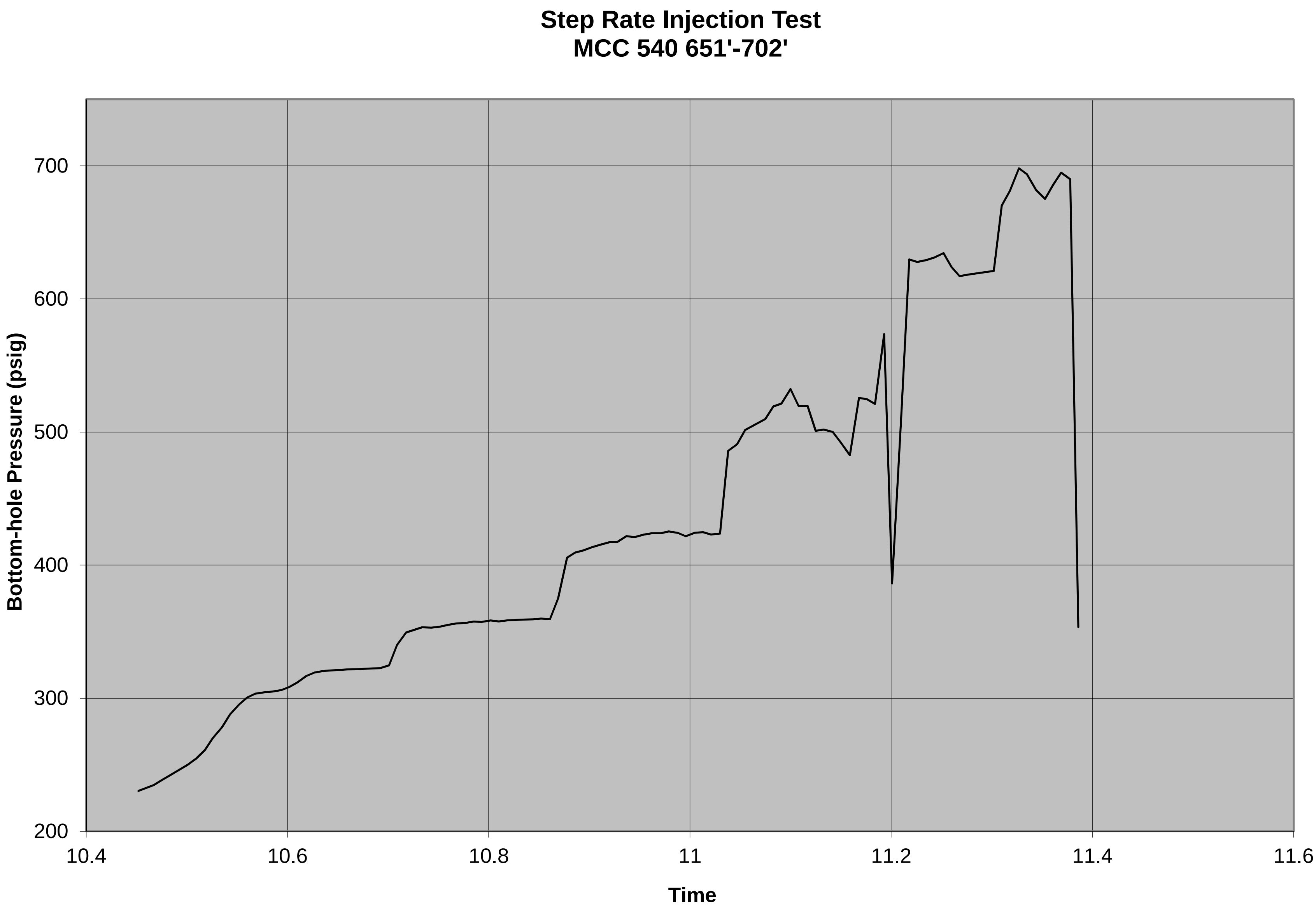
Slug Test MCC 540
651'-702'
Bottom-hole Pressure (psig)
290.0
280.0
270.0
260.0
250.0
240.0
230.0
220.0
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
Elapsed Time (min)

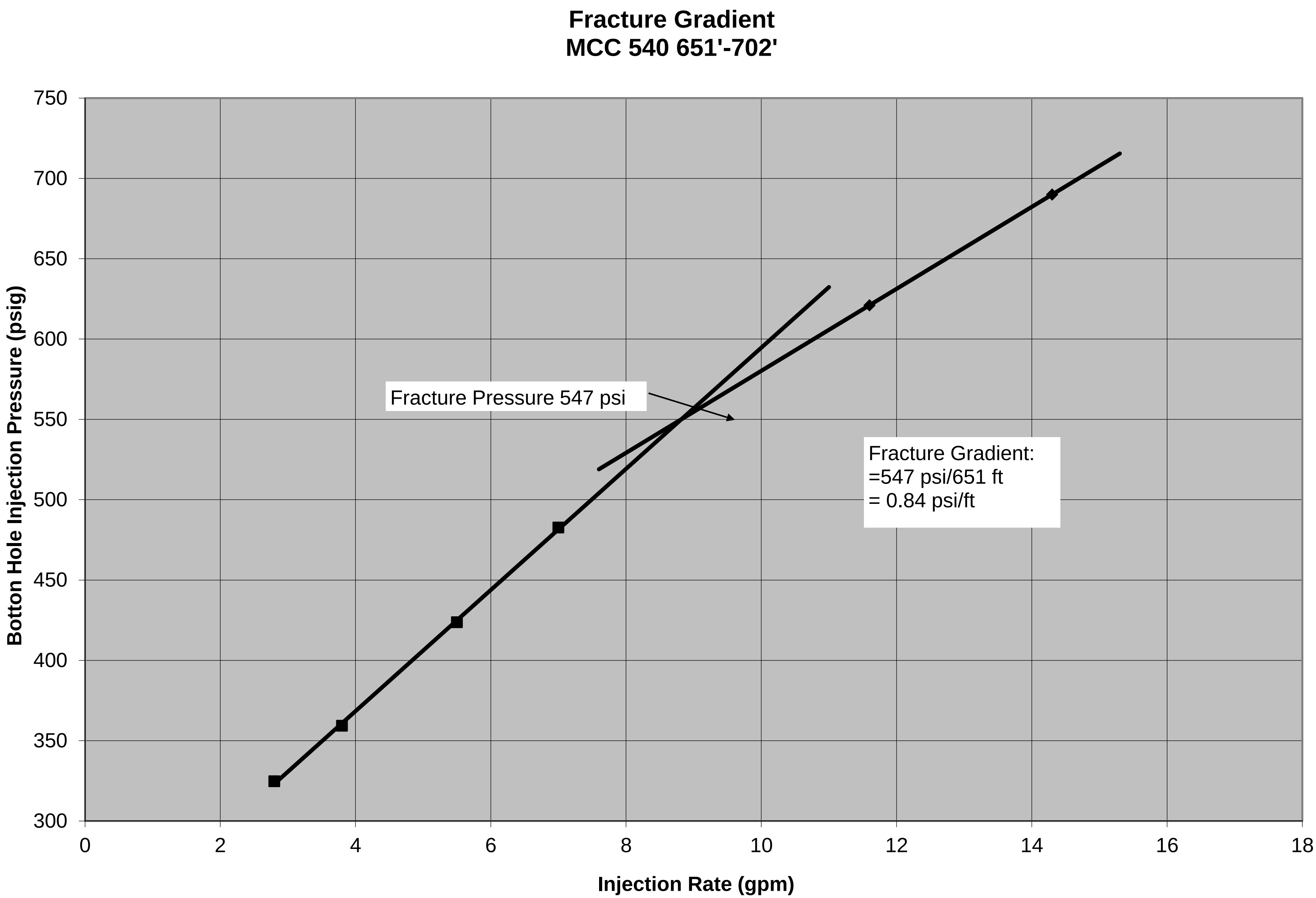

Horslev Plot Slug Test #1
MCC 540 651'-702'
10.00
1.00
0.10
0.01
h/h_o
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
Elapsed Time (min)

Slug Test Data MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
9:24:07	9.402	-	-	-	224.2	-
9:24:38	9.410	0.008	0.480	3.33E-04	277.0	1.00
9:25:08	9.419	0.017	1.020	7.08E-04	274.9	0.96
9:25:38	9.427	0.025	1.500	1.04E-03	273.7	0.94
9:26:09	9.436	0.034	2.040	1.42E-03	272.1	0.91
9:27:14	9.454	0.052	3.120	2.17E-03	269.6	0.86
9:27:44	9.462	0.060	3.600	2.50E-03	268.4	0.84
9:28:15	9.471	0.069	4.140	2.88E-03	267.6	0.82
9:28:45	9.479	0.077	4.620	3.21E-03	266.6	0.80
9:29:15	9.488	0.086	5.160	3.58E-03	265.7	0.79
9:29:45	9.496	0.094	5.640	3.92E-03	264.8	0.77
9:30:16	9.504	0.102	6.120	4.25E-03	264.1	0.76
9:30:46	9.513	0.111	6.660	4.63E-03	263.1	0.74
9:31:16	9.521	0.119	7.140	4.96E-03	262.3	0.72
9:31:47	9.530	0.128	7.680	5.33E-03	261.5	0.71
9:32:17	9.538	0.136	8.160	5.67E-03	260.8	0.69
9:32:47	9.546	0.144	8.640	6.00E-03	260.1	0.68
9:33:48	9.563	0.161	9.660	6.71E-03	258.9	0.66
9:34:18	9.572	0.170	10.200	7.08E-03	258.2	0.64
9:34:48	9.580	0.178	10.680	7.42E-03	257.5	0.63
9:35:18	9.588	0.186	11.160	7.75E-03	257.0	0.62
9:35:49	9.597	0.195	11.700	8.13E-03	256.3	0.61
9:36:19	9.605	0.203	12.180	8.46E-03	255.9	0.60
9:36:49	9.614	0.212	12.720	8.83E-03	255.3	0.59
9:37:20	9.622	0.220	13.200	9.17E-03	254.7	0.58
9:37:50	9.631	0.229	13.740	9.54E-03	254.2	0.57
9:38:20	9.639	0.237	14.220	9.88E-03	253.9	0.56
9:38:51	9.647	0.245	14.700	1.02E-02	253.4	0.55
9:39:21	9.656	0.254	15.240	1.06E-02	253.0	0.55
9:39:51	9.664	0.262	15.720	1.09E-02	252.4	0.53
9:40:22	9.673	0.271	16.260	1.13E-02	251.9	0.52
9:40:52	9.681	0.279	16.740	1.16E-02	251.6	0.52
9:41:22	9.689	0.287	17.220	1.20E-02	251.1	0.51
9:41:52	9.698	0.296	17.760	1.23E-02	250.8	0.50
9:42:23	9.706	0.304	18.240	1.27E-02	250.3	0.49
9:42:53	9.715	0.313	18.780	1.30E-02	249.9	0.49
9:44:45	9.746	0.344	20.640	1.43E-02	248.6	0.46
9:45:15	9.754	0.352	21.120	1.47E-02	248.6	0.46
9:45:45	9.763	0.361	21.660	1.50E-02	248.0	0.45
9:46:16	9.771	0.369	22.140	1.54E-02	247.6	0.44
9:46:46	9.779	0.377	22.620	1.57E-02	247.3	0.44
9:47:16	9.788	0.386	23.160	1.61E-02	246.9	0.43
9:47:46	9.796	0.394	23.640	1.64E-02	246.5	0.42
9:48:17	9.805	0.403	24.180	1.68E-02	246.3	0.42

Slug Test Data MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
9:48:47	9.813	0.411	24.660	1.71E-02	245.9	0.41
9:50:36	9.843	0.441	26.460	1.84E-02	244.8	0.39
9:51:06	9.852	0.450	27.000	1.88E-02	244.4	0.38
9:51:36	9.860	0.458	27.480	1.91E-02	244.2	0.38
9:52:06	9.868	0.466	27.960	1.94E-02	243.9	0.37
9:52:37	9.877	0.475	28.500	1.98E-02	243.6	0.37
9:53:07	9.885	0.483	28.980	2.01E-02	243.4	0.36
9:53:37	9.894	0.492	29.520	2.05E-02	243.1	0.36
9:54:08	9.902	0.500	30.000	2.08E-02	242.8	0.35
9:54:38	9.911	0.509	30.540	2.12E-02	242.5	0.35
9:55:08	9.919	0.517	31.020	2.15E-02	242.3	0.34
9:55:38	9.927	0.525	31.500	2.19E-02	241.9	0.34
9:56:31	9.942	0.540	32.400	2.25E-02	241.3	0.32
9:57:01	9.950	0.548	32.880	2.28E-02	241.2	0.32
9:57:32	9.959	0.557	33.420	2.32E-02	240.9	0.32
9:58:02	9.967	0.565	33.900	2.35E-02	240.7	0.31
9:58:45	9.979	0.577	34.620	2.40E-02	240.4	0.31
9:59:15	9.988	0.586	35.160	2.44E-02	240.1	0.30
9:59:46	9.996	0.594	35.640	2.48E-02	240.0	0.30
10:00:16	10.004	0.602	36.120	2.51E-02	239.7	0.29
10:00:46	10.013	0.611	36.660	2.55E-02	239.4	0.29
10:01:17	10.021	0.619	37.140	2.58E-02	239.3	0.29
10:01:47	10.030	0.628	37.680	2.62E-02	239.1	0.28
10:02:17	10.038	0.636	38.160	2.65E-02	238.8	0.28
10:02:47	10.047	0.645	38.700	2.69E-02	238.6	0.27
10:03:18	10.055	0.653	39.180	2.72E-02	238.4	0.27
10:03:48	10.063	0.661	39.660	2.75E-02	238.2	0.27
10:04:18	10.072	0.670	40.200	2.79E-02	237.8	0.26
10:04:49	10.080	0.678	40.680	2.83E-02	237.8	0.26
10:05:19	10.089	0.687	41.220	2.86E-02	237.7	0.26
10:05:49	10.097	0.695	41.700	2.90E-02	237.3	0.25
10:06:20	10.105	0.703	42.180	2.93E-02	237.2	0.25
10:06:50	10.114	0.712	42.720	2.97E-02	236.9	0.24
10:07:20	10.122	0.720	43.200	3.00E-02	236.7	0.24
10:07:50	10.131	0.729	43.740	3.04E-02	236.5	0.23
10:08:21	10.139	0.737	44.220	3.07E-02	236.6	0.23
10:08:51	10.148	0.746	44.760	3.11E-02	236.5	0.23
10:09:21	10.156	0.754	45.240	3.14E-02	235.8	0.22
10:09:52	10.164	0.762	45.720	3.18E-02	235.9	0.22
10:10:22	10.173	0.771	46.260	3.21E-02	235.6	0.22
10:10:52	10.181	0.779	46.740	3.25E-02	235.6	0.22
10:11:23	10.190	0.788	47.280	3.28E-02	235.4	0.21
10:11:53	10.198	0.796	47.760	3.32E-02	235.1	0.21
10:12:23	10.206	0.804	48.240	3.35E-02	235.1	0.21
10:12:53	10.215	0.813	48.780	3.39E-02	234.9	0.20
10:13:24	10.223	0.821	49.260	3.42E-02	234.9	0.20
10:13:54	10.232	0.830	49.800	3.46E-02	234.7	0.20

Slug Test Data MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
10:14:24	10.240	0.838	50.280	3.49E-02	234.4	0.19
10:14:55	10.249	0.847	50.820	3.53E-02	234.3	0.19
10:15:25	10.257	0.855	51.300	3.56E-02	234.3	0.19
10:15:55	10.265	0.863	51.780	3.60E-02	234.0	0.19
10:17:17	10.288	0.886	53.160	3.69E-02	233.7	0.18
10:17:47	10.296	0.894	53.640	3.73E-02	233.5	0.18
10:18:17	10.305	0.903	54.180	3.76E-02	233.3	0.17
10:19:34	10.326	0.924	55.440	3.85E-02	233.0	0.17
10:20:04	10.334	0.932	55.920	3.88E-02	233.0	0.17
10:20:34	10.343	0.941	56.460	3.92E-02	232.7	0.16
10:21:04	10.351	0.949	56.940	3.95E-02	232.7	0.16
10:21:35	10.360	0.958	57.480	3.99E-02	232.5	0.16
10:22:05	10.368	0.966	57.960	4.03E-02	232.5	0.16
10:22:35	10.377	0.975	58.500	4.06E-02	232.2	0.15
10:23:06	10.385	0.983	58.980	4.10E-02	232.2	0.15
10:23:36	10.393	0.991	59.460	4.13E-02	232.0	0.15
10:24:07	10.402	1.000	60.000	4.17E-02	231.8	0.14
10:24:37	10.410	1.008	60.480	4.20E-02	231.7	0.14
10:25:07	10.419	1.017	61.020	4.24E-02	231.6	0.14
10:25:37	10.427	1.025	61.500	4.27E-02	231.6	0.14
10:26:08	10.435	1.033	61.980	4.30E-02	230.1	0.11
10:26:38	10.444	1.042	62.520	4.34E-02	229.9	0.11

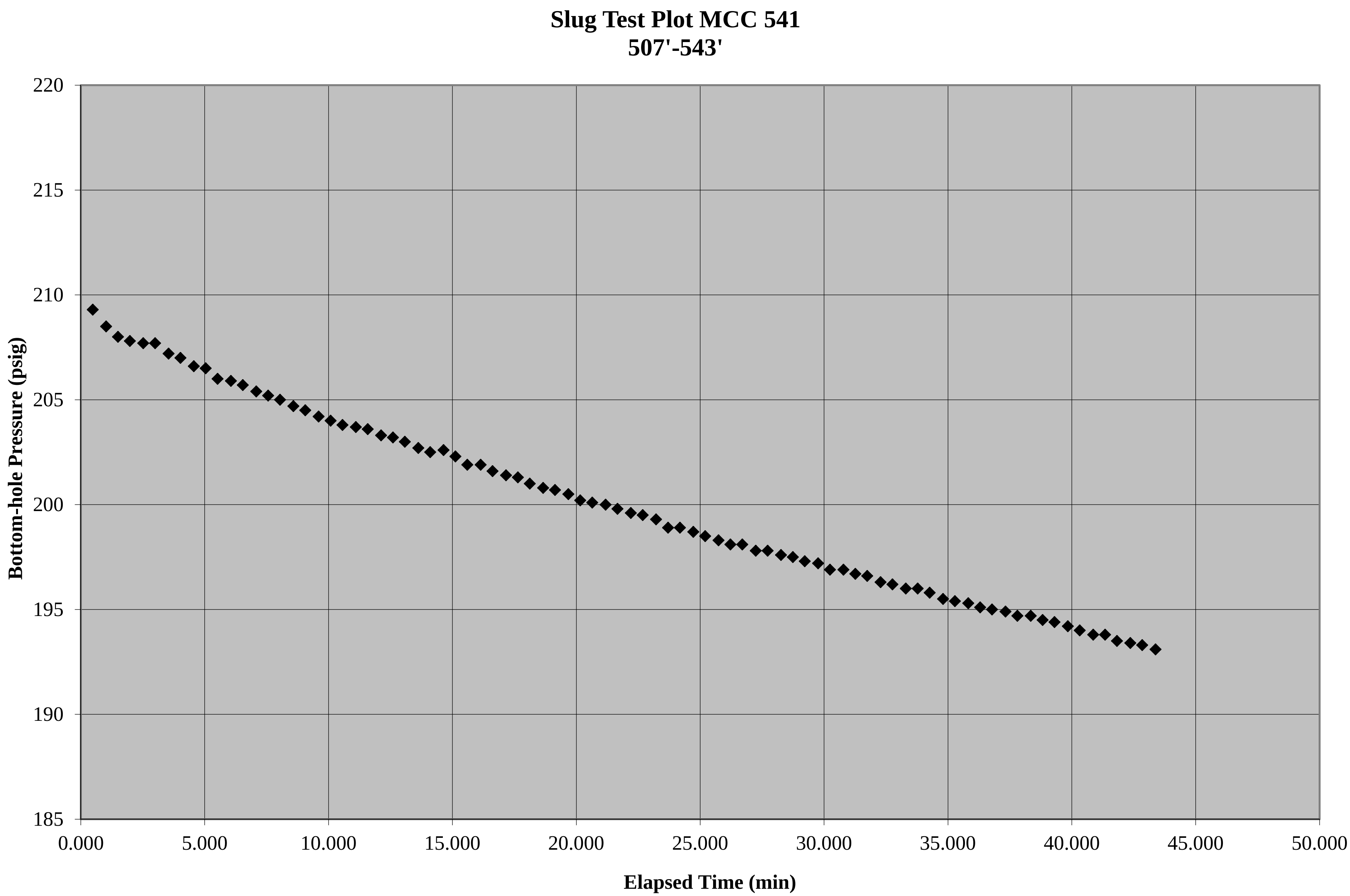

Step Rate Injection Test
MCC 540 651'-702'
Bottom-hole Pressure (psig)
700
600
500
400
300
200
10.4
10.6
10.8
11
11.2
11.4
11.6
Time

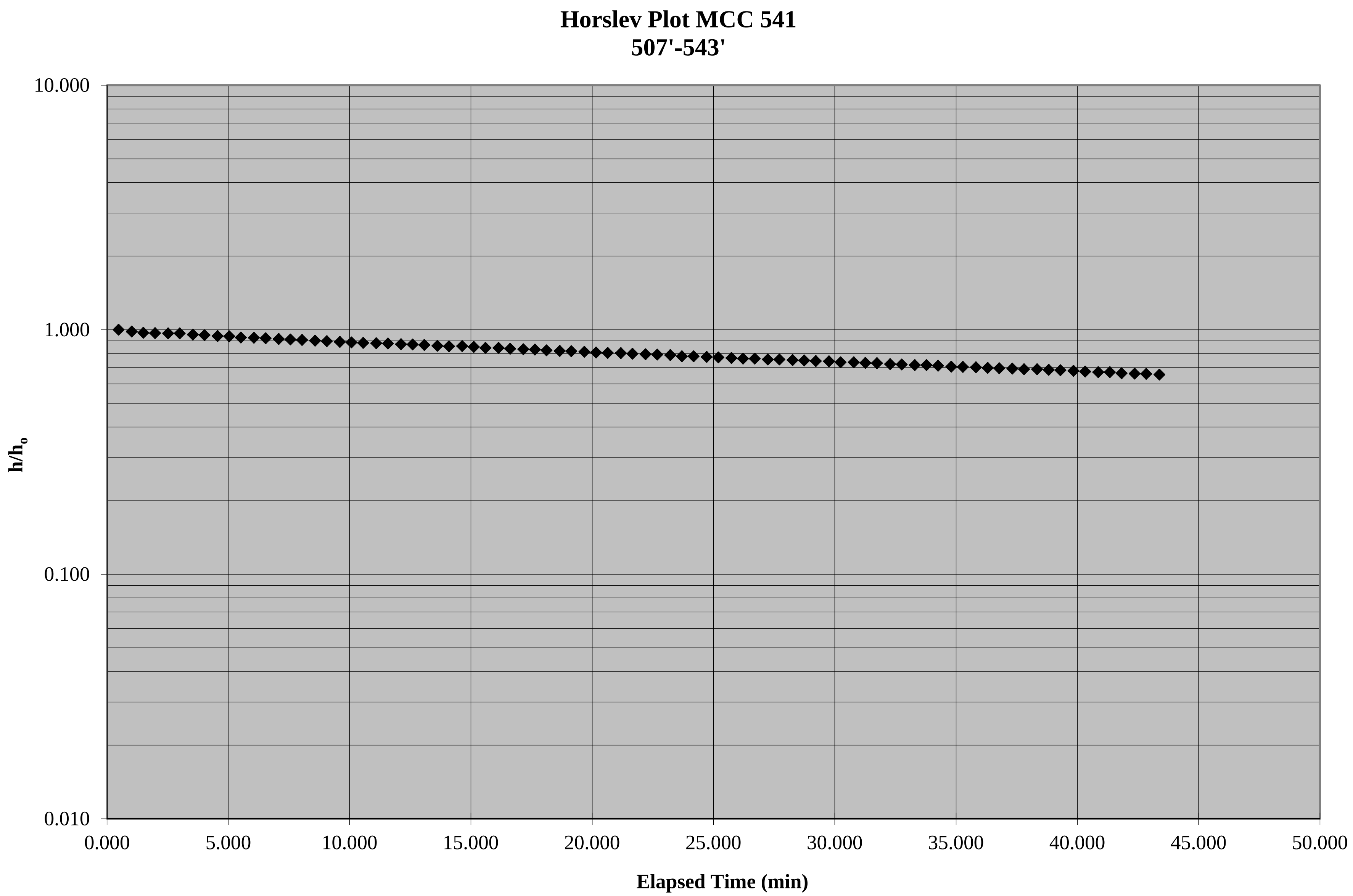

Fracture Gradient
MCC 540 651'-702'
Botton Hole Injection Pressure (psig)
750
700
650
600
550
500
450
400
350
300
0
2
4
6
8
10
12
14
16
18
Injection Rate (gpm)
Fracture Pressure 547 psi
Fracture Gradient:
=547 psi/651 ft
= 0.84 psi/ft

Step Rate Injection Test MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
10:26:38	10.444	-	-	-	229.9	
10:27:08	10.452	0.008	0.48	2.8	230.4	Start Test
10:28:03	10.467	0.023	1.38	2.8	234.7	
10:28:33	10.476	0.032	1.92	2.8	238.9	
10:29:03	10.484	0.04	2.4	2.8	242.4	
10:29:33	10.493	0.049	2.94	2.8	246.4	
10:30:04	10.501	0.057	3.42	2.8	250.1	
10:30:34	10.509	0.065	3.9	2.8	254.5	
10:31:04	10.518	0.074	4.44	2.8	261	
10:31:35	10.526	0.082	4.92	2.8	270.2	
10:32:05	10.535	0.091	5.46	2.8	278.2	
10:32:35	10.543	0.099	5.94	2.8	287.8	
10:33:05	10.552	0.108	6.48	2.8	295.3	
10:33:36	10.56	0.116	6.96	2.8	300.5	
10:34:06	10.568	0.124	7.44	2.8	303.4	
10:34:36	10.577	0.133	7.98	2.8	304.4	
10:35:07	10.585	0.141	8.46	2.8	305	
10:35:37	10.594	0.15	9	2.8	306.1	
10:36:07	10.602	0.158	9.48	2.8	308.5	
10:36:38	10.61	0.166	9.96	2.8	311.9	
10:37:08	10.619	0.175	10.5	2.8	316.8	
10:37:38	10.627	0.183	10.98	2.8	319.3	
10:38:09	10.636	0.192	11.52	2.8	320.5	
10:39:32	10.659	0.215	12.9	2.8	321.6	
10:40:02	10.667	0.223	13.38	2.8	321.7	
10:41:02	10.684	0.24	14.4	2.8	322.4	
10:41:33	10.692	0.248	14.88	2.8	322.6	
10:42:03	10.701	0.257	15.42	2.8	324.7	
10:42:33	10.709	0.265	15.9	3.8	340	
10:43:03	10.718	0.274	16.44	3.8	349.4	
10:44:04	10.734	0.29	17.4	3.8	353.3	
10:44:34	10.743	0.299	17.94	3.8	353	
10:45:05	10.751	0.307	18.42	3.8	353.7	
10:45:35	10.76	0.316	18.96	3.8	355.2	
10:46:05	10.768	0.324	19.44	3.8	356.2	
10:46:36	10.777	0.333	19.98	3.8	356.6	
10:47:06	10.785	0.341	20.46	3.8	357.6	
10:47:36	10.793	0.349	20.94	3.8	357.3	
10:48:07	10.802	0.358	21.48	3.8	358.4	
10:48:37	10.81	0.366	21.96	3.8	357.7	
10:49:07	10.819	0.375	22.5	3.8	358.5	
10:49:37	10.827	0.383	22.98	3.8	358.8	
10:50:08	10.835	0.391	23.46	3.8	359.1	
10:50:38	10.844	0.4	24	3.8	359.3	
10:51:08	10.852	0.408	24.48	5.5	359.8	
10:51:39	10.861	0.417	25.02	5.5	359.5	

Step Rate Injection Test MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
10:52:09	10.869	0.425	25.5	5.5	375	
10:52:39	10.878	0.434	26.04	5.5	405.6	
10:53:09	10.886	0.442	26.52	5.5	409.4	
10:53:40	10.894	0.45	27	5.5	411	
10:54:10	10.903	0.459	27.54	5.5	413.5	
10:54:40	10.911	0.467	28.02	5.5	415.3	
10:55:12	10.92	0.476	28.56	5.5	417.2	
10:55:42	10.928	0.484	29.04	5.5	417.5	
10:56:13	10.937	0.493	29.58	5.5	421.8	
10:56:43	10.945	0.501	30.06	5.5	421	
10:57:13	10.954	0.51	30.6	5.5	422.9	
10:57:44	10.962	0.518	31.08	5.5	423.9	
10:58:15	10.971	0.527	31.62	5.5	423.9	
10:58:46	10.979	0.535	32.1	5.5	425.3	
10:59:16	10.988	0.544	32.64	5.5	424.2	
10:59:46	10.996	0.552	33.12	5.5	421.7	
11:00:17	11.005	0.561	33.66	5.5	424.3	
11:00:47	11.013	0.569	34.14	5.5	424.8	
11:01:17	11.021	0.577	34.62	5.5	423	
11:01:47	11.03	0.586	35.16	5.5	423.7	
11:02:18	11.038	0.594	35.64	7	485.9	
11:02:48	11.047	0.603	36.18	7	490.8	
11:03:18	11.055	0.611	36.66	7	501.6	
11:04:29	11.075	0.631	37.86	7	509.8	
11:04:59	11.083	0.639	38.34	7	519.2	
11:05:29	11.091	0.647	38.82	7	521.4	
11:05:59	11.1	0.656	39.36	7	532.3	
11:06:30	11.108	0.664	39.84	7	519.5	
11:07:00	11.117	0.673	40.38	7	519.6	
11:07:30	11.125	0.681	40.86	7	500.9	
11:08:01	11.133	0.689	41.34	7	501.8	
11:08:31	11.142	0.698	41.88	7	500.1	
11:09:01	11.15	0.706	42.36	7	492.1	
11:09:31	11.159	0.715	42.9	7	482.6	
11:10:03	11.168	0.724	43.44	11.6	525.7	
11:10:33	11.176	0.732	43.92	11.6	524.6	
11:11:04	11.184	0.74	44.4	11.6	521.1	
11:11:34	11.193	0.749	44.94	11.6	573.6	
11:12:04	11.201	0.757	45.42	11.6	386.3	
11:12:35	11.21	0.766	45.96	11.6	510.8	
11:13:05	11.218	0.774	46.44	11.6	629.6	
11:13:35	11.226	0.782	46.92	11.6	627.8	
11:14:05	11.235	0.791	47.46	11.6	629.2	
11:14:36	11.243	0.799	47.94	11.6	631.1	
11:15:06	11.252	0.808	48.48	11.6	634.4	
11:15:36	11.26	0.816	48.96	11.6	624	
11:16:07	11.268	0.824	49.44	11.6	617.1	

Step Rate Injection Test MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
11:16:37	11.277	0.833	49.98	11.6	618.3	
11:18:06	11.302	0.858	51.48	11.6	621	
11:18:36	11.31	0.866	51.96	14.3	670.2	
11:19:07	11.318	0.874	52.44	14.3	681.1	
11:19:37	11.327	0.883	52.98	14.3	698.1	
11:20:07	11.335	0.891	53.46	14.3	693.7	
11:20:39	11.344	0.9	54	14.3	681.9	
11:21:09	11.353	0.909	54.54	14.3	675.1	
11:21:39	11.361	0.917	55.02	14.3	685.8	
11:22:10	11.369	0.925	55.5	14.3	694.8	
11:22:40	11.378	0.934	56.04	14.3	689.9	End Test
11:23:10	11.386	0.942	56.52	-	353.5	


Slug Test Plot MCC 541
507'-543'
220
215
210
205
200
195
190
185
Bottom-hole Pressure (psig)
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
50.000
Elapsed Time (min)

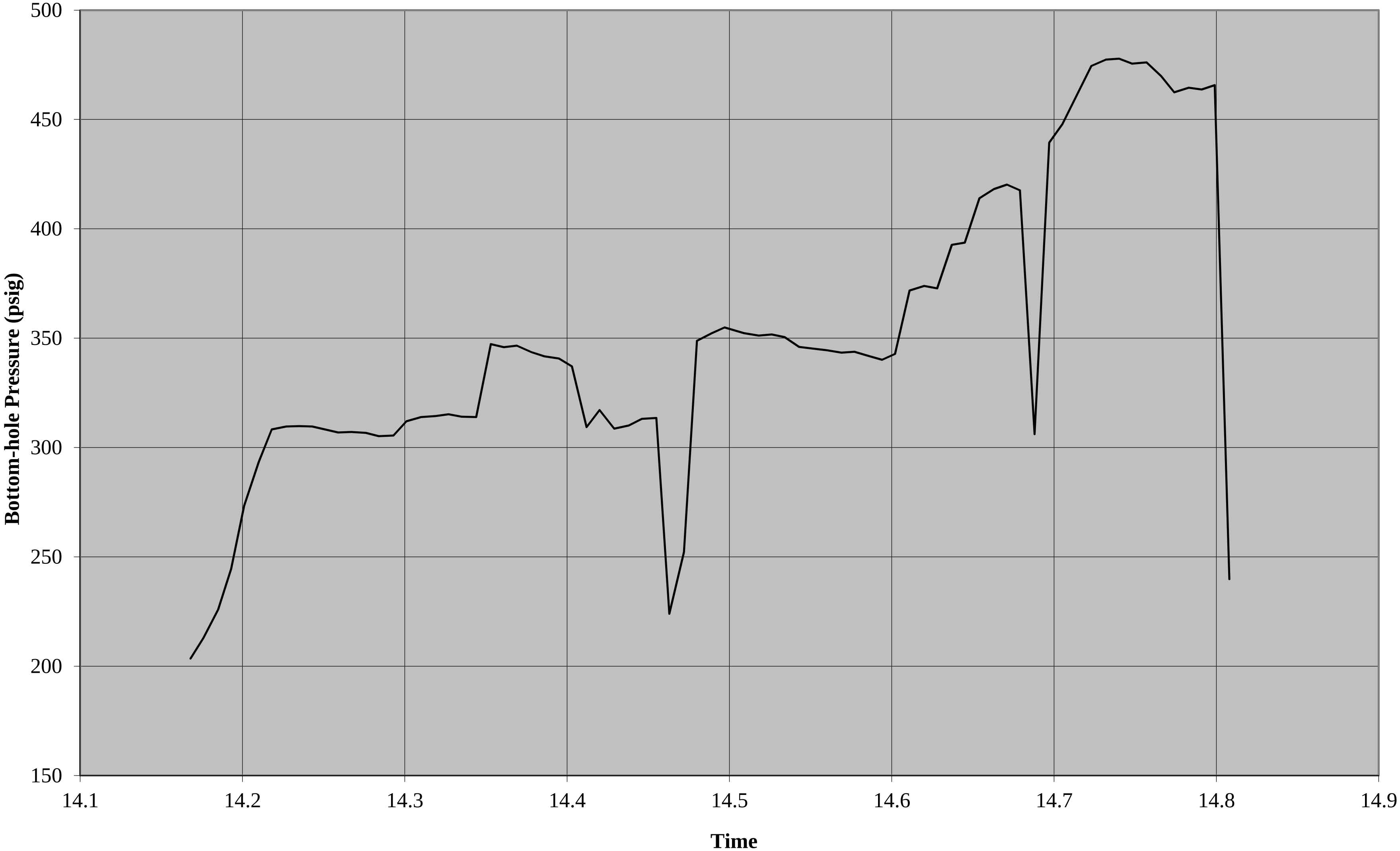


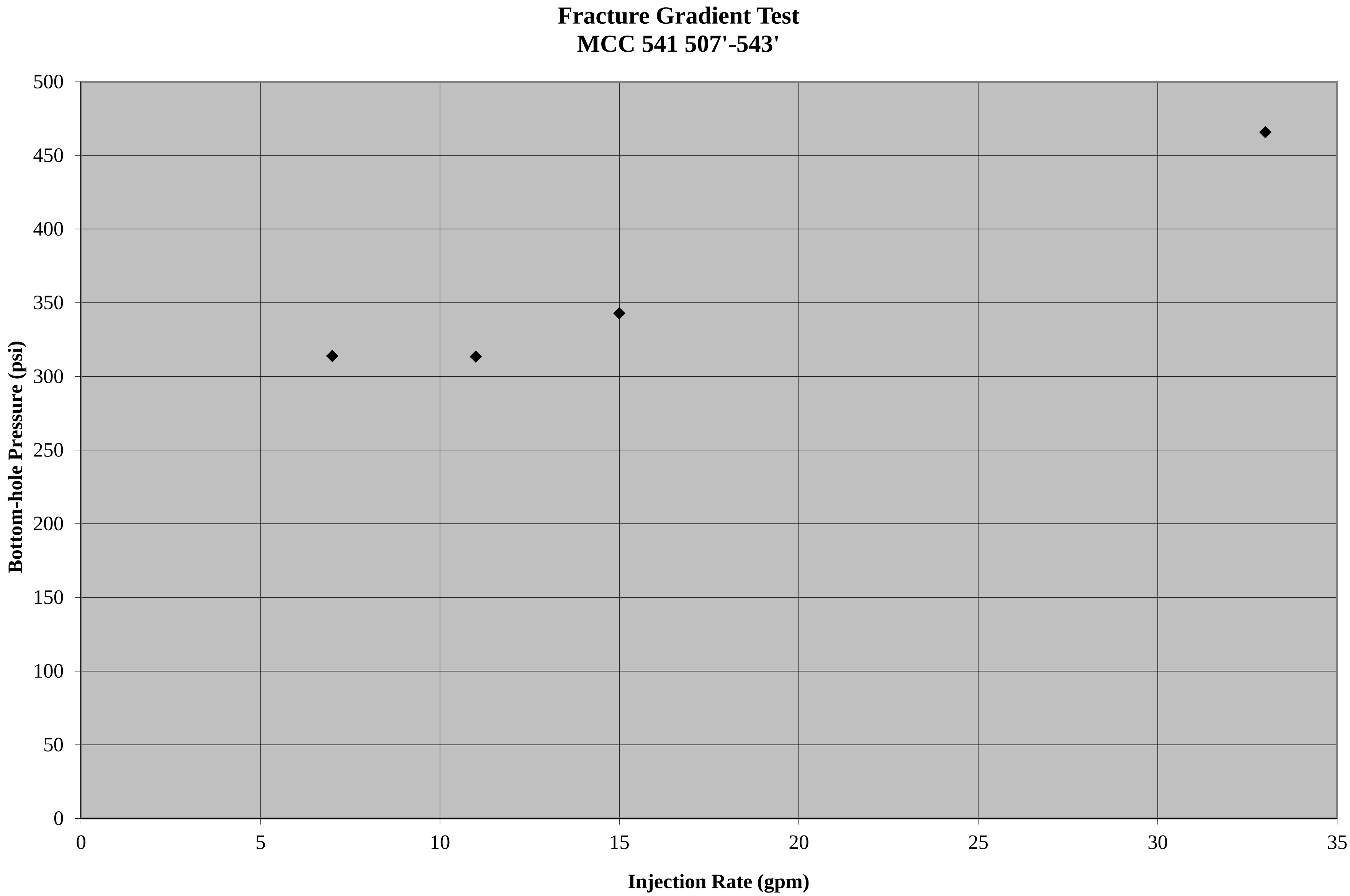
Horslev Plot MCC 541
507'-543'
10.000
1.000
0.100
0.010
h/h_o
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
50.000
Elapsed Time (min)

Slug Test Data MCC 541 507'-543'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
13:24:11	13.403	0.000	0.000	0.000	162.3	-
13:24:41	13.411	0.008	0.480	0.000	209.3	1.000
13:25:11	13.42	0.017	1.020	0.001	208.5	0.983
13:25:41	13.428	0.025	1.500	0.001	208	0.972
13:26:11	13.436	0.033	1.980	0.001	207.8	0.968
13:26:42	13.445	0.042	2.520	0.002	207.7	0.966
13:27:12	13.453	0.050	3.000	0.002	207.7	0.966
13:27:42	13.462	0.059	3.540	0.002	207.2	0.955
13:28:13	13.47	0.067	4.020	0.003	207	0.951
13:28:43	13.479	0.076	4.560	0.003	206.6	0.943
13:29:13	13.487	0.084	5.040	0.003	206.5	0.940
13:29:43	13.495	0.092	5.520	0.004	206	0.930
13:30:14	13.504	0.101	6.060	0.004	205.9	0.928
13:30:44	13.512	0.109	6.540	0.005	205.7	0.923
13:31:14	13.521	0.118	7.080	0.005	205.4	0.917
13:31:44	13.529	0.126	7.560	0.005	205.2	0.913
13:32:15	13.537	0.134	8.040	0.006	205	0.909
13:32:45	13.546	0.143	8.580	0.006	204.7	0.902
13:33:15	13.554	0.151	9.060	0.006	204.5	0.898
13:33:45	13.563	0.160	9.600	0.007	204.2	0.891
13:34:16	13.571	0.168	10.080	0.007	204	0.887
13:34:46	13.579	0.176	10.560	0.007	203.8	0.883
13:35:16	13.588	0.185	11.100	0.008	203.7	0.881
13:35:46	13.596	0.193	11.580	0.008	203.6	0.879
13:36:17	13.605	0.202	12.120	0.008	203.3	0.872
13:36:47	13.613	0.210	12.600	0.009	203.2	0.870
13:37:17	13.621	0.218	13.080	0.009	203	0.866
13:37:47	13.63	0.227	13.620	0.009	202.7	0.860
13:38:18	13.638	0.235	14.100	0.010	202.5	0.855
13:38:48	13.647	0.244	14.640	0.010	202.6	0.857
13:39:18	13.655	0.252	15.120	0.011	202.3	0.851
13:39:49	13.663	0.260	15.600	0.011	201.9	0.843
13:40:19	13.672	0.269	16.140	0.011	201.9	0.843
13:40:49	13.68	0.277	16.620	0.012	201.6	0.836
13:41:19	13.689	0.286	17.160	0.012	201.4	0.832
13:41:49	13.697	0.294	17.640	0.012	201.3	0.830
13:42:20	13.705	0.302	18.120	0.013	201	0.823
13:42:50	13.714	0.311	18.660	0.013	200.8	0.819
13:43:20	13.722	0.319	19.140	0.013	200.7	0.817
13:43:51	13.731	0.328	19.680	0.014	200.5	0.813
13:44:21	13.739	0.336	20.160	0.014	200.2	0.806
13:44:51	13.747	0.344	20.640	0.014	200.1	0.804
13:45:21	13.756	0.353	21.180	0.015	200	0.802
13:45:51	13.764	0.361	21.660	0.015	199.8	0.798
13:46:22	13.773	0.370	22.200	0.015	199.6	0.794

Slug Test Data MCC 541 507'-543'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
13:46:52	13.781	0.378	22.680	0.016	199.5	0.791
13:47:22	13.79	0.387	23.220	0.016	199.3	0.787
13:47:53	13.798	0.395	23.700	0.016	198.9	0.779
13:48:23	13.806	0.403	24.180	0.017	198.9	0.779
13:48:53	13.815	0.412	24.720	0.017	198.7	0.774
13:49:23	13.823	0.420	25.200	0.018	198.5	0.770
13:49:54	13.832	0.429	25.740	0.018	198.3	0.766
13:50:24	13.84	0.437	26.220	0.018	198.1	0.762
13:50:54	13.848	0.445	26.700	0.019	198.1	0.762
13:51:24	13.857	0.454	27.240	0.019	197.8	0.755
13:51:54	13.865	0.462	27.720	0.019	197.8	0.755
13:52:25	13.874	0.471	28.260	0.020	197.6	0.751
13:52:55	13.882	0.479	28.740	0.020	197.5	0.749
13:53:25	13.89	0.487	29.220	0.020	197.3	0.745
13:53:56	13.899	0.496	29.760	0.021	197.2	0.743
13:54:26	13.907	0.504	30.240	0.021	196.9	0.736
13:54:56	13.916	0.513	30.780	0.021	196.9	0.736
13:55:26	13.924	0.521	31.260	0.022	196.7	0.732
13:55:57	13.932	0.529	31.740	0.022	196.6	0.730
13:56:27	13.941	0.538	32.280	0.022	196.3	0.723
13:56:57	13.949	0.546	32.760	0.023	196.2	0.721
13:57:27	13.958	0.555	33.300	0.023	196	0.717
13:57:58	13.966	0.563	33.780	0.023	196	0.717
13:58:28	13.974	0.571	34.260	0.024	195.8	0.713
13:58:58	13.983	0.580	34.800	0.024	195.5	0.706
13:59:28	13.991	0.588	35.280	0.025	195.4	0.704
13:59:59	14	0.597	35.820	0.025	195.3	0.702
14:00:29	14.008	0.605	36.300	0.025	195.1	0.698
14:00:59	14.016	0.613	36.780	0.026	195	0.696
14:01:29	14.025	0.622	37.320	0.026	194.9	0.694
14:02:00	14.033	0.630	37.800	0.026	194.7	0.689
14:02:30	14.042	0.639	38.340	0.027	194.7	0.689
14:03:00	14.05	0.647	38.820	0.027	194.5	0.685
14:03:31	14.058	0.655	39.300	0.027	194.4	0.683
14:04:01	14.067	0.664	39.840	0.028	194.2	0.679
14:04:31	14.075	0.672	40.320	0.028	194	0.674
14:05:01	14.084	0.681	40.860	0.028	193.8	0.670
14:05:31	14.092	0.689	41.340	0.029	193.8	0.670
14:06:02	14.1	0.697	41.820	0.029	193.5	0.664
14:06:32	14.109	0.706	42.360	0.029	193.4	0.662
14:07:02	14.117	0.714	42.840	0.030	193.3	0.660
14:07:33	14.126	0.723	43.380	0.030	193.1	0.655

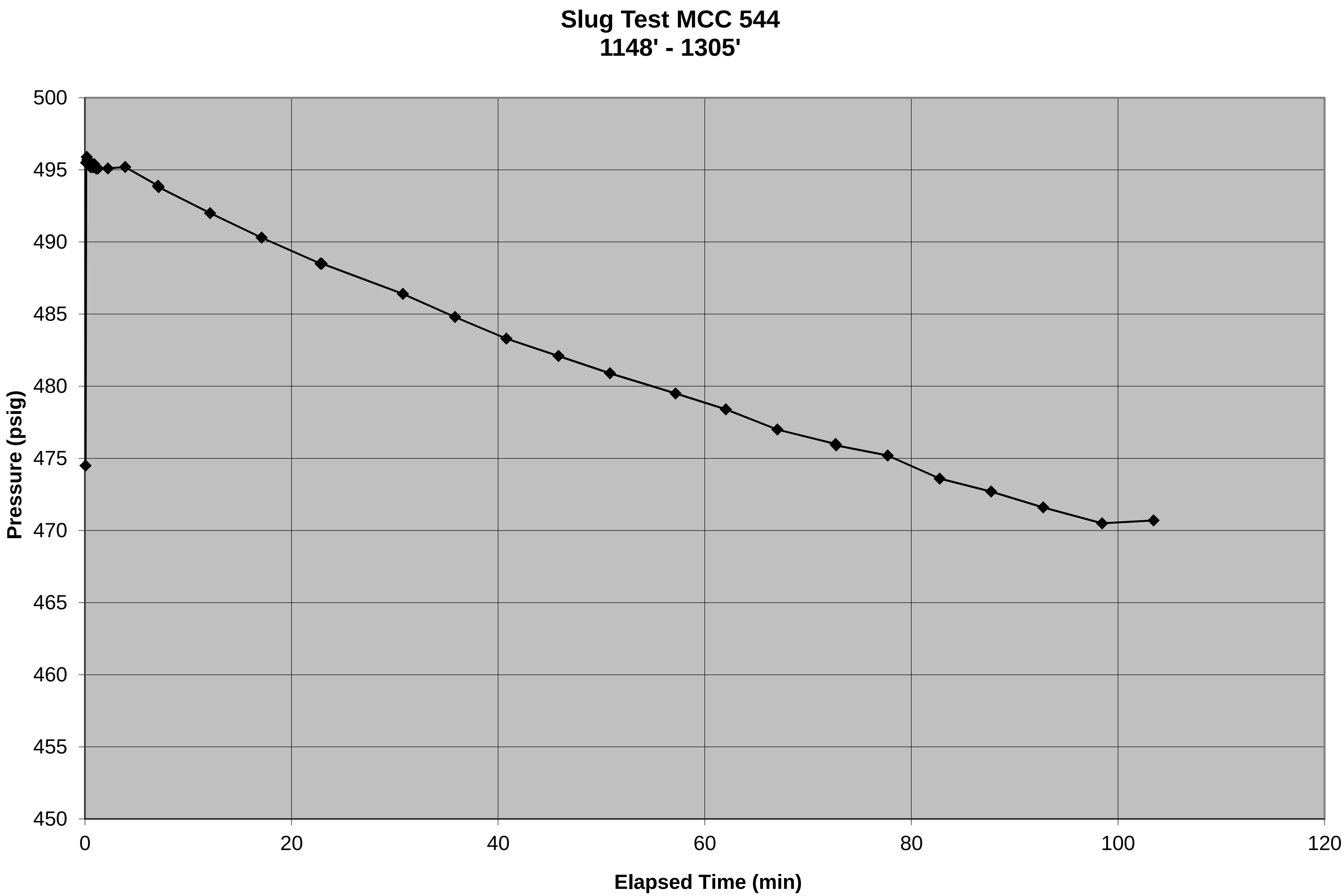
Step Rate Injection Test
MCC 541 507'-543'

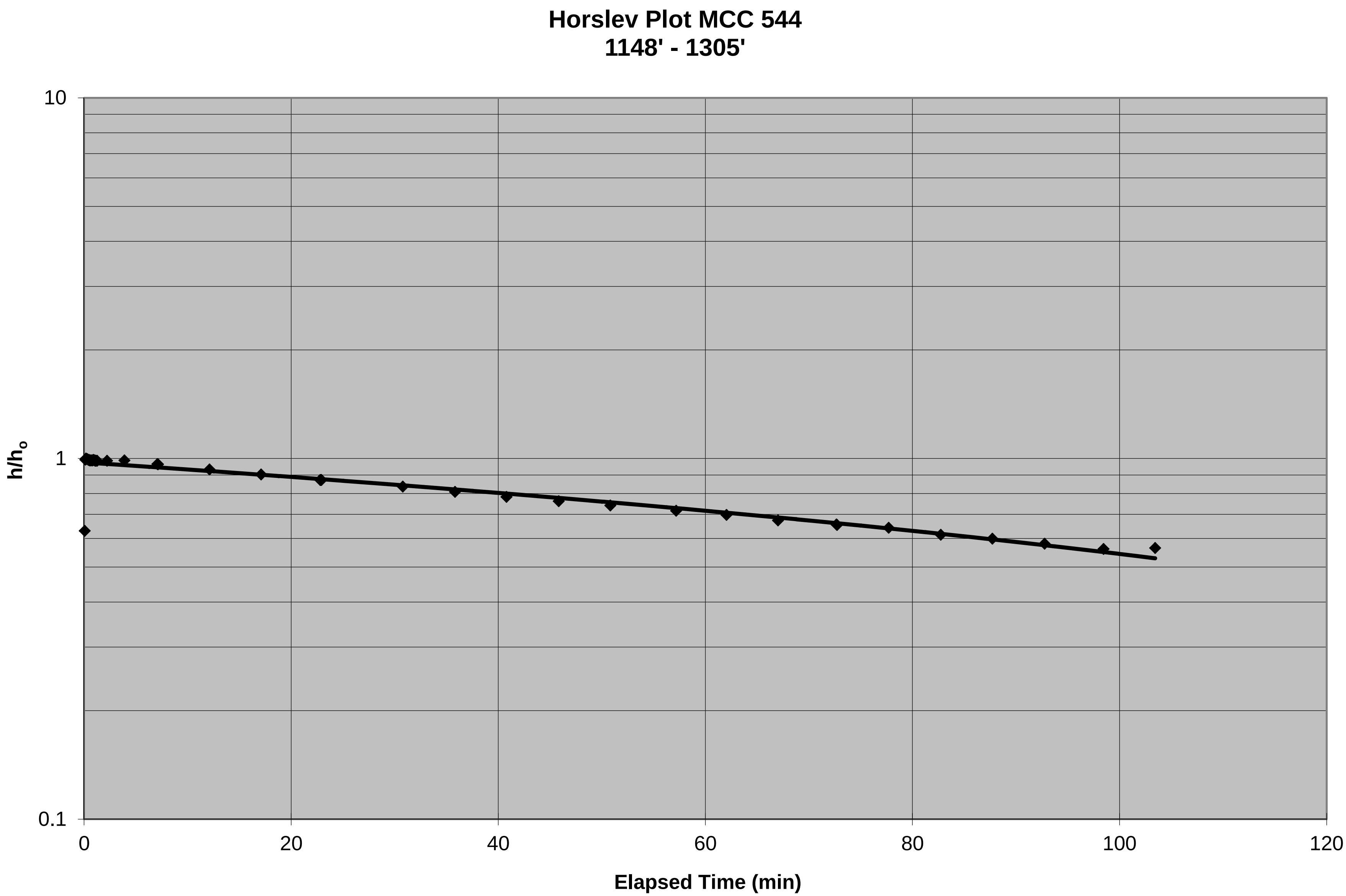



Fracture Gradient Test
MCC 541 507'-543'
Bottom-hole Pressure (psi)
0
50
100
150
200
250
300
350
400
450
500
0
5
10
15
20
25
30
35
Injection Rate (gpm)

Step Rate Injection Test Data MCC 541 507'-543'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
14:10:04	14.168	0.000	0.000	7	203.5	
14:10:34	14.176	0.008	0.480	7	213	
14:11:04	14.185	0.017	1.020	7	225.9	
14:11:34	14.193	0.025	1.500	7	244.5	
14:12:05	14.201	0.033	1.980	7	273.3	
14:12:35	14.21	0.042	2.520	7	293.4	
14:13:05	14.218	0.050	3.000	7	308.3	
14:13:36	14.227	0.059	3.540	7	309.6	
14:14:06	14.235	0.067	4.020	7	309.8	
14:14:36	14.243	0.075	4.500	7	309.6	
14:15:32	14.259	0.091	5.460	7	306.9	
14:16:02	14.267	0.099	5.940	7	307.1	
14:16:32	14.276	0.108	6.480	7	306.7	
14:17:03	14.284	0.116	6.960	7	305.2	
14:17:34	14.293	0.125	7.500	7	305.5	
14:18:05	14.301	0.133	7.980	7	312	
14:18:35	14.31	0.142	8.520	7	313.9	
14:19:07	14.319	0.151	9.060	7	314.4	
14:19:37	14.327	0.159	9.540	7	315.2	
14:20:07	14.335	0.167	10.020	7	314.1	
14:20:38	14.344	0.176	10.560	7	313.9	
14:21:09	14.353	0.185	11.100	11	347.3	
14:21:40	14.361	0.193	11.580	11	345.9	
14:22:10	14.369	0.201	12.060	11	346.6	
14:22:40	14.378	0.210	12.600	11	343.6	
14:23:10	14.386	0.218	13.080	11	341.7	
14:23:41	14.395	0.227	13.620	11	340.7	
14:24:13	14.403	0.235	14.100	11	337.1	
14:24:43	14.412	0.244	14.640	11	309.3	
14:25:13	14.42	0.252	15.120	11	317.1	
14:25:45	14.429	0.261	15.660	11	308.6	
14:26:15	14.438	0.270	16.200	11	310.1	
14:26:47	14.446	0.278	16.680	11	313.1	
14:27:17	14.455	0.287	17.220	11	313.5	
14:27:48	14.463	0.295	17.700	15	224	
14:28:18	14.472	0.304	18.240	15	252.2	
14:28:49	14.48	0.312	18.720	15	348.8	
14:29:20	14.489	0.321	19.260	15	352.2	
14:29:50	14.497	0.329	19.740	15	354.9	
14:30:33	14.509	0.341	20.460	15	352.3	
14:31:03	14.518	0.350	21.000	15	351.2	
14:31:34	14.526	0.358	21.480	15	351.7	
14:32:04	14.534	0.366	21.960	15	350.5	
14:32:35	14.543	0.375	22.500	15	346	
14:33:06	14.552	0.384	23.040	15	345.2	

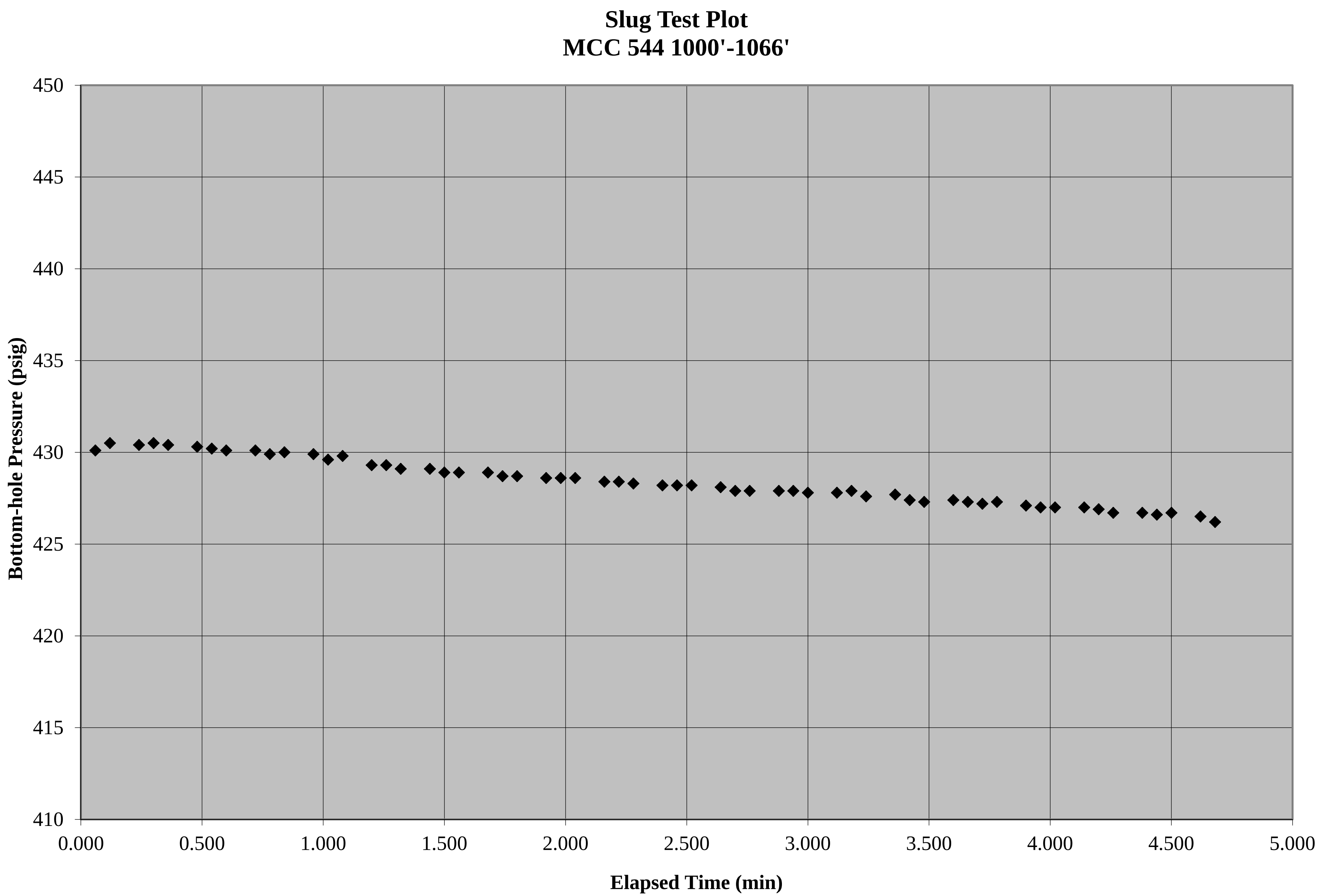
Step Rate Injection Test Data MCC 541 507'-543'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
14:33:38	14.56	0.392	23.520	15	344.5	
14:34:08	14.569	0.401	24.060	15	343.4	
14:34:38	14.577	0.409	24.540	15	343.8	
14:35:08	14.586	0.418	25.080	15	341.8	
14:35:39	14.594	0.426	25.560	15	340.1	
14:36:09	14.602	0.434	26.040	15	342.8	
14:36:39	14.611	0.443	26.580	RNE	371.8	Increase rate
14:37:11	14.62	0.452	27.120	RNE	373.9	Flow rate erratic
14:37:41	14.628	0.460	27.600	RNE	372.8	
14:38:12	14.637	0.469	28.140	RNE	392.7	Valve sticking
14:38:43	14.645	0.477	28.620	RNE	393.7	Pumping erratically
14:39:14	14.654	0.486	29.160	RNE	414	
14:39:45	14.663	0.495	29.700	RNE	418.2	
14:40:16	14.671	0.503	30.180	RNE	420.2	
14:40:46	14.679	0.511	30.660	RNE	417.6	
14:41:18	14.688	0.520	31.200	33	306.1	
14:41:48	14.697	0.529	31.740	33	439.4	Pumping erratically
14:42:18	14.705	0.537	32.220	33	447.7	
14:43:23	14.723	0.555	33.300	33	474.5	Flow rate erratic
14:43:54	14.732	0.564	33.840	33	477.4	
14:44:24	14.74	0.572	34.320	33	477.8	
14:44:54	14.748	0.580	34.800	33	475.5	
14:45:26	14.757	0.589	35.340	33	476.1	
14:45:56	14.766	0.598	35.880	33	469.8	
14:46:27	14.774	0.606	36.360	33	462.4	
14:46:57	14.783	0.615	36.900	33	464.5	
14:47:27	14.791	0.623	37.380	33	463.7	
14:47:58	14.799	0.631	37.860	33	465.7	End Test
14:48:28	14.808	0.640	38.400		239.8	
RNE - Rate Not Established.						

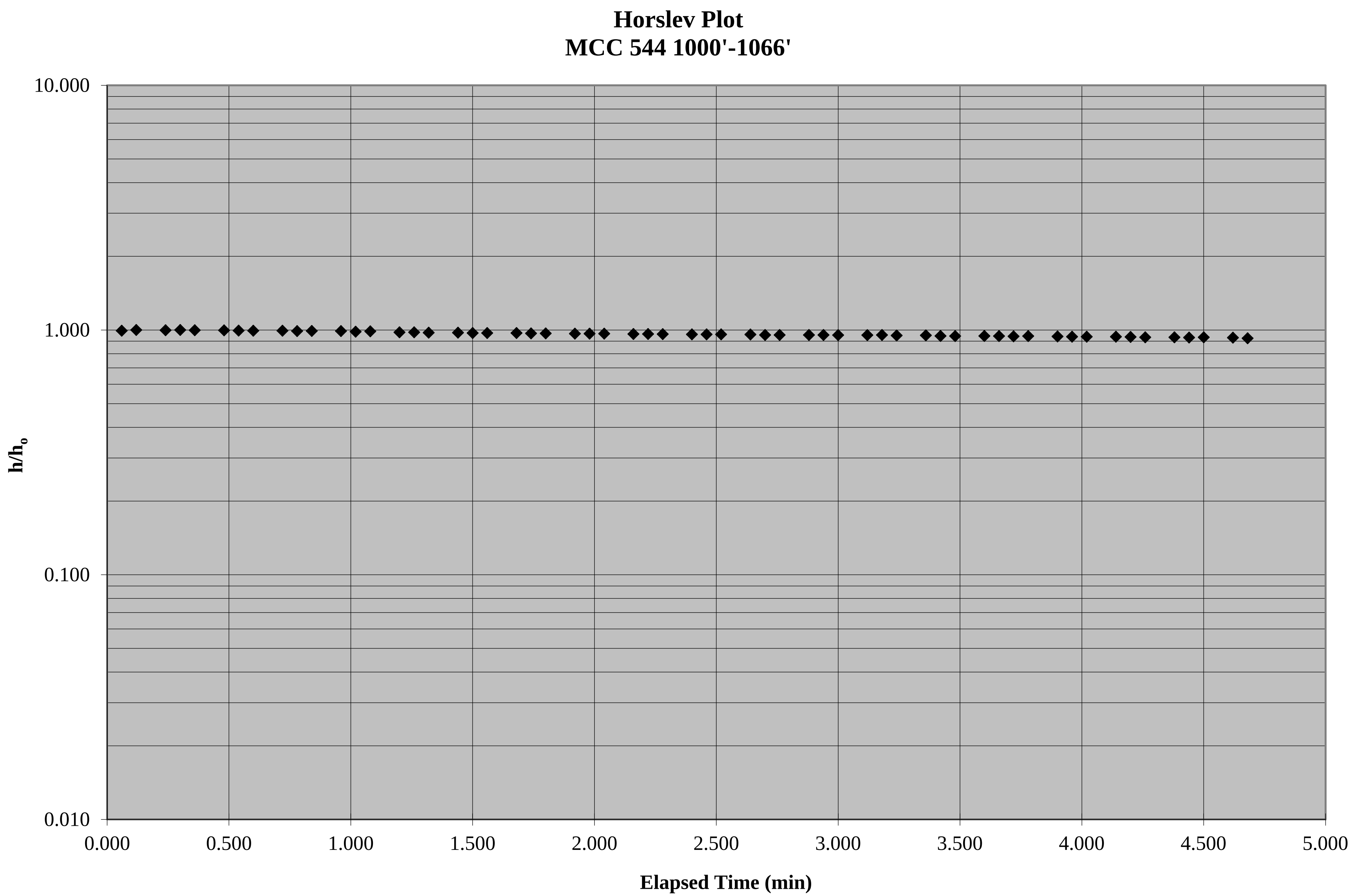

Slug Test MCC 544
1148' - 1305'
Pressure (psig)
500
495
490
485
480
475
470
465
460
455
450
0
20
40
60
80
100
120
Elapsed Time (min)


Horslev Plot MCC 544
1148' - 1305'
10
1
0.1
h/ho
0
20
40
60
80
100
120
Elapsed Time (min)

Slug Test Data MCC 544 1148' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
16:16:07	16.269	-	-		438	-
16:16:11	16.27	0.001	0.06	4.17E-05	474.5	0.630397
16:16:14	16.271	0.002	0.12	8.33E-05	495.5	0.993092
16:16:19	16.272	0.003	0.18	1.25E-04	495.9	1
16:16:23	16.273	0.004	0.24	1.67E-04	495.7	0.996546
16:16:28	16.274	0.005	0.3	2.08E-04	495.7	0.996546
16:16:33	16.276	0.007	0.42	2.92E-04	495.4	0.991364
16:16:38	16.277	0.008	0.48	3.33E-04	495.4	0.991364
16:16:42	16.278	0.009	0.54	3.75E-04	495.2	0.98791
16:16:46	16.279	0.01	0.6	4.17E-04	495.2	0.98791
16:16:49	16.28	0.011	0.66	4.58E-04	495.2	0.98791
16:16:54	16.282	0.013	0.78	5.42E-04	495.2	0.98791
16:16:57	16.282	0.013	0.78	5.42E-04	495.2	0.98791
16:17:00	16.283	0.014	0.84	5.83E-04	495.2	0.98791
16:17:03	16.284	0.015	0.9	6.25E-04	495.4	0.991364
16:17:08	16.286	0.017	1.02	7.08E-04	495.2	0.98791
16:17:11	16.286	0.017	1.02	7.08E-04	495.2	0.98791
16:17:14	16.287	0.018	1.08	7.50E-04	495.1	0.986183
16:17:18	16.288	0.019	1.14	7.92E-04	495.1	0.986183
16:17:22	16.29	0.021	1.26	8.75E-04	495.1	0.986183
16:18:23	16.306	0.037	2.22	1.54E-03	495.1	0.986183
16:20:01	16.334	0.065	3.9	2.71E-03	495.2	0.98791
16:23:12	16.387	0.118	7.08	4.92E-03	493.9	0.965458
16:23:15	16.388	0.119	7.14	4.96E-03	493.8	0.963731
16:28:15	16.471	0.202	12.12	8.42E-03	492	0.932642
16:33:16	16.554	0.285	17.1	1.19E-02	490.3	0.903282
16:38:57	16.649	0.38	22.8	1.58E-02	488.5	0.872193
16:39:01	16.65	0.381	22.86	1.59E-02	488.5	0.872193
16:39:04	16.651	0.382	22.92	1.59E-02	488.5	0.872193
16:46:56	16.782	0.513	30.78	2.14E-02	486.4	0.835924
16:51:57	16.866	0.597	35.82	2.49E-02	484.8	0.80829
16:56:57	16.949	0.68	40.8	2.83E-02	483.3	0.782383
17:01:57	17.033	0.764	45.84	3.18E-02	482.1	0.761658
17:06:57	17.116	0.847	50.82	3.53E-02	480.9	0.740933
17:13:18	17.222	0.953	57.18	3.97E-02	479.5	0.716753
17:18:10	17.303	1.034	62.04	4.31E-02	478.4	0.697755
17:23:10	17.386	1.117	67.02	4.65E-02	477	0.673575
17:28:48	17.48	1.211	72.66	5.05E-02	476	0.656304
17:28:52	17.481	1.212	72.72	5.05E-02	475.9	0.654577
17:33:52	17.564	1.295	77.7	5.40E-02	475.2	0.642487
17:38:52	17.648	1.379	82.74	5.75E-02	473.6	0.614853
17:43:52	17.731	1.462	87.72	6.09E-02	472.7	0.599309
17:48:52	17.815	1.546	92.76	6.44E-02	471.6	0.580311
17:54:36	17.91	1.641	98.46	6.84E-02	470.5	0.561313

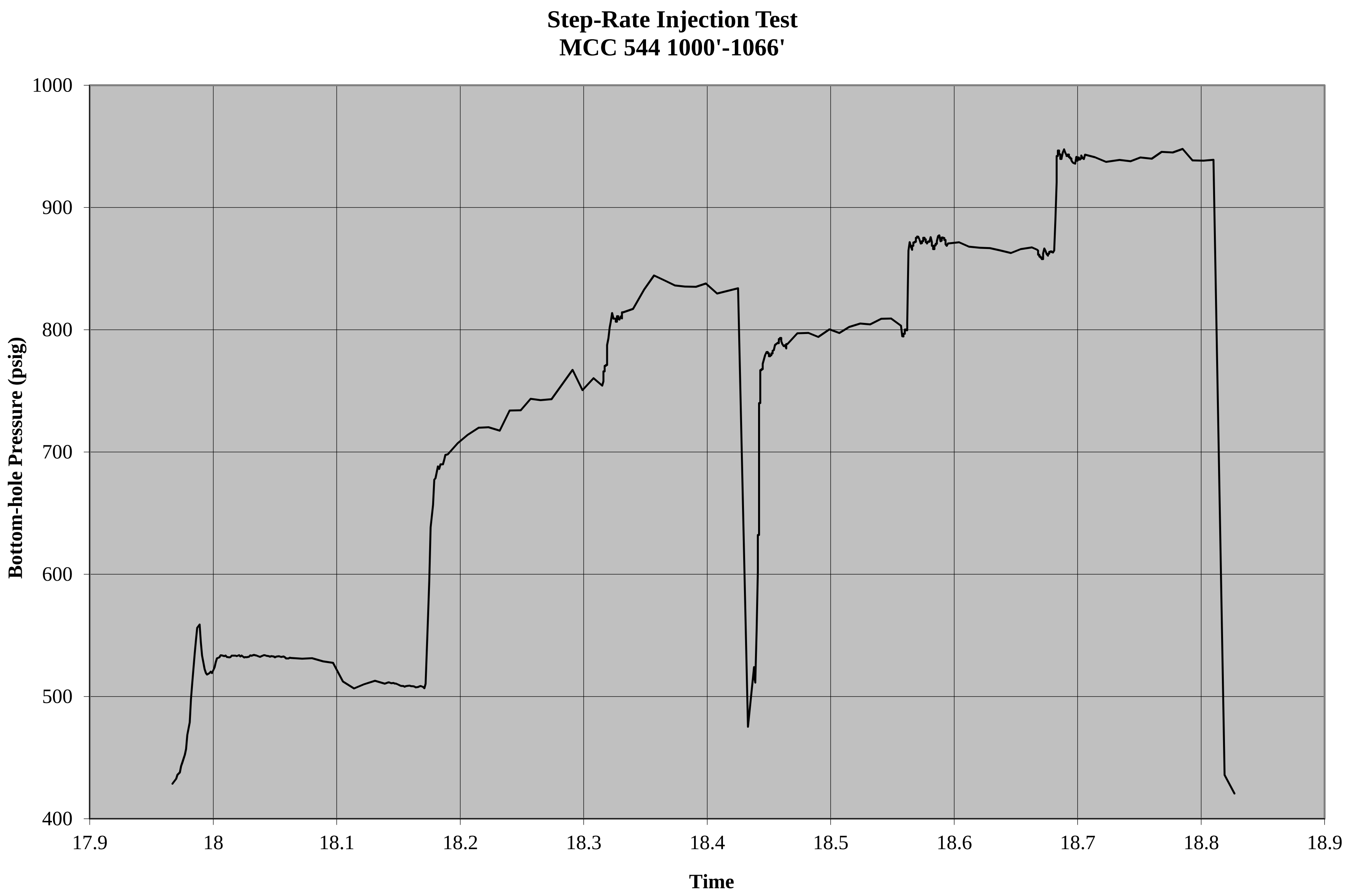
Slug Test Data MCC 544 1148' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
17:59:36	17.993	1.724	103.44	7.18E-02	470.7	0.564767


Slug Test Plot
MCC 544 1000'-1066'
Bottom-hole Pressure (psig)
450
445
440
435
430
425
420
415
410
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Elapsed Time (min)

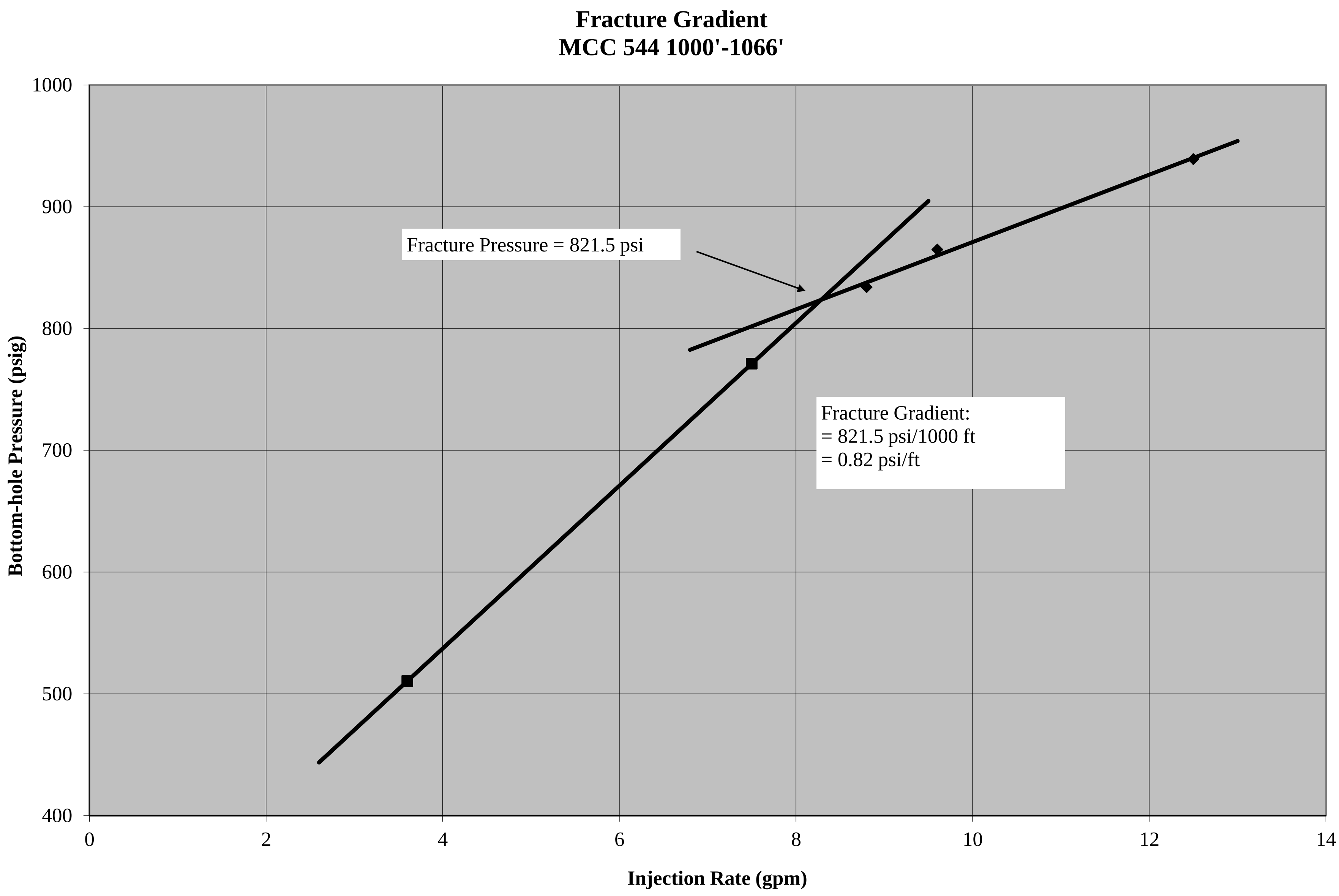

Horslev Plot
MCC 544 1000'-1066'
10.000
1.000
0.100
0.010
h/h$_o$
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Elapsed Time (min)

Slug Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
17:43:22	17.723	0.000	0.000	0.000	373.2	-
17:43:26	17.724	0.001	0.060	4.17E-05	430.1	0.993
17:43:31	17.725	0.002	0.120	8.33E-05	430.5	1.000
17:43:36	17.727	0.004	0.240	1.67E-04	430.4	0.998
17:43:41	17.728	0.005	0.300	2.08E-04	430.5	1.000
17:43:46	17.729	0.006	0.360	2.50E-04	430.4	0.998
17:43:50	17.731	0.008	0.480	3.33E-04	430.3	0.997
17:43:55	17.732	0.009	0.540	3.75E-04	430.2	0.995
17:44:00	17.733	0.010	0.600	4.17E-04	430.1	0.993
17:44:05	17.735	0.012	0.720	5.00E-04	430.1	0.993
17:44:09	17.736	0.013	0.780	5.42E-04	429.9	0.990
17:44:14	17.737	0.014	0.840	5.83E-04	430	0.991
17:44:19	17.739	0.016	0.960	6.67E-04	429.9	0.990
17:44:24	17.74	0.017	1.020	7.08E-04	429.6	0.984
17:44:29	17.741	0.018	1.080	7.50E-04	429.8	0.988
17:44:33	17.743	0.020	1.200	8.33E-04	429.3	0.979
17:44:38	17.744	0.021	1.260	8.75E-04	429.3	0.979
17:44:43	17.745	0.022	1.320	9.17E-04	429.1	0.976
17:44:48	17.747	0.024	1.440	1.00E-03	429.1	0.976
17:44:53	17.748	0.025	1.500	1.04E-03	428.9	0.972
17:44:57	17.749	0.026	1.560	1.08E-03	428.9	0.972
17:45:02	17.751	0.028	1.680	1.17E-03	428.9	0.972
17:45:07	17.752	0.029	1.740	1.21E-03	428.7	0.969
17:45:12	17.753	0.030	1.800	1.25E-03	428.7	0.969
17:45:16	17.755	0.032	1.920	1.33E-03	428.6	0.967
17:45:21	17.756	0.033	1.980	1.38E-03	428.6	0.967
17:45:26	17.757	0.034	2.040	1.42E-03	428.6	0.967
17:45:31	17.759	0.036	2.160	1.50E-03	428.4	0.963
17:45:36	17.76	0.037	2.220	1.54E-03	428.4	0.963
17:45:41	17.761	0.038	2.280	1.58E-03	428.3	0.962
17:45:45	17.763	0.040	2.400	1.67E-03	428.2	0.960
17:45:50	17.764	0.041	2.460	1.71E-03	428.2	0.960
17:45:55	17.765	0.042	2.520	1.75E-03	428.2	0.960
17:46:00	17.767	0.044	2.640	1.83E-03	428.1	0.958
17:46:04	17.768	0.045	2.700	1.88E-03	427.9	0.955
17:46:09	17.769	0.046	2.760	1.92E-03	427.9	0.955
17:46:14	17.771	0.048	2.880	2.00E-03	427.9	0.955
17:46:19	17.772	0.049	2.940	2.04E-03	427.9	0.955
17:46:24	17.773	0.050	3.000	2.08E-03	427.8	0.953
17:46:28	17.775	0.052	3.120	2.17E-03	427.8	0.953
17:46:33	17.776	0.053	3.180	2.21E-03	427.9	0.955
17:46:38	17.777	0.054	3.240	2.25E-03	427.6	0.949
17:46:43	17.779	0.056	3.360	2.33E-03	427.7	0.951
17:46:47	17.78	0.057	3.420	2.38E-03	427.4	0.946
17:46:52	17.781	0.058	3.480	2.42E-03	427.3	0.944

Slug Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
17:46:57	17.783	0.060	3.600	2.50E-03	427.4	0.946
17:47:02	17.784	0.061	3.660	2.54E-03	427.3	0.944
17:47:07	17.785	0.062	3.720	2.58E-03	427.2	0.942
17:47:11	17.786	0.063	3.780	2.63E-03	427.3	0.944
17:47:16	17.788	0.065	3.900	2.71E-03	427.1	0.941
17:47:21	17.789	0.066	3.960	2.75E-03	427	0.939
17:47:26	17.79	0.067	4.020	2.79E-03	427	0.939
17:47:30	17.792	0.069	4.140	2.88E-03	427	0.939
17:47:35	17.793	0.070	4.200	2.92E-03	426.9	0.937
17:47:40	17.794	0.071	4.260	2.96E-03	426.7	0.934
17:47:45	17.796	0.073	4.380	3.04E-03	426.7	0.934
17:47:50	17.797	0.074	4.440	3.08E-03	426.6	0.932
17:47:55	17.798	0.075	4.500	3.12E-03	426.7	0.934
17:47:59	17.8	0.077	4.620	3.21E-03	426.5	0.930
17:48:04	17.801	0.078	4.680	3.25E-03	426.2	0.925



Step-Rate Injection Test
MCC 544 1000'-1066'
Bottom-hole Pressure (psig)
1000
900
800
700
600
500
400
17.9
18
18.1
18.2
18.3
18.4
18.5
18.6
18.7
18.8
18.9
Time



Fracture Gradient
MCC 544 1000'-1066'
1000
900
800
700
600
500
400
0
2
4
6
8
10
12
14
Bottom-hole Pressure (psig)
Injection Rate (gpm)
Fracture Pressure = 821.5 psi
Fracture Gradient:
= 821.5 psi/1000 ft
= 0.82 psi/ft

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
17:58:03	17.967	0.000	0.000	3.6	428.6	
17:58:08	17.969	0.002	0.120	3.6	431.4	
17:58:12	17.97	0.003	0.180	3.6	432.7	
17:58:17	17.971	0.004	0.240	3.6	435.9	
17:58:22	17.973	0.006	0.360	3.6	437.9	
17:58:27	17.974	0.007	0.420	3.6	443	
17:58:31	17.975	0.008	0.480	3.6	445.9	
17:58:36	17.977	0.010	0.600	3.6	452.4	
17:58:41	17.978	0.011	0.660	3.6	457.1	
17:58:46	17.979	0.012	0.720	3.6	468.6	
17:58:51	17.981	0.014	0.840	3.6	478.8	
17:58:55	17.982	0.015	0.900	3.6	497.8	
17:59:00	17.983	0.016	0.960	3.6	510.4	
17:59:05	17.985	0.018	1.080	3.6	535.4	
17:59:10	17.986	0.019	1.140	3.6	546.1	
17:59:15	17.987	0.020	1.200	3.6	556.2	
17:59:19	17.989	0.022	1.320	3.6	558.9	
17:59:24	17.99	0.023	1.380	3.6	544.4	
17:59:29	17.991	0.024	1.440	3.6	533.5	
17:59:34	17.993	0.026	1.560	3.6	522.3	
17:59:38	17.994	0.027	1.620	3.6	519.4	
17:59:43	17.995	0.028	1.680	3.6	518	
17:59:48	17.997	0.030	1.800	3.6	519.2	
17:59:53	17.998	0.031	1.860	3.6	520.3	
17:59:58	17.999	0.032	1.920	3.6	519.2	
18:00:03	18.001	0.034	2.040	3.6	523.6	
18:00:07	18.002	0.035	2.100	3.6	527.9	
18:00:12	18.003	0.036	2.160	3.6	531.2	
18:00:17	18.005	0.038	2.280	3.6	532	
18:00:22	18.006	0.039	2.340	3.6	533.7	
18:00:26	18.007	0.040	2.400	3.6	533.6	
18:00:31	18.009	0.042	2.520	3.6	533	
18:00:36	18.01	0.043	2.580	3.6	533.5	
18:00:41	18.011	0.044	2.640	3.6	532.3	
18:00:46	18.013	0.046	2.760	3.6	532	
18:00:50	18.014	0.047	2.820	3.6	532.2	
18:00:55	18.015	0.048	2.880	3.6	533.4	
18:01:00	18.017	0.050	3.000	3.6	533.4	
18:01:05	18.018	0.051	3.060	3.6	533.4	
18:01:09	18.019	0.052	3.120	3.6	533	
18:01:14	18.021	0.054	3.240	3.6	533.8	
18:01:19	18.022	0.055	3.300	3.6	532.7	
18:01:24	18.023	0.056	3.360	3.6	533.5	
18:01:29	18.025	0.058	3.480	3.6	531.9	
18:01:33	18.026	0.059	3.540	3.6	532.2	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:01:38	18.027	0.060	3.600	3.6	532.1	
18:01:43	18.029	0.062	3.720	3.6	532.5	
18:01:48	18.03	0.063	3.780	3.6	533.6	
18:01:53	18.031	0.064	3.840	3.6	533.3	
18:01:57	18.033	0.066	3.960	3.6	534	
18:02:02	18.034	0.067	4.020	3.6	533.7	
18:02:07	18.035	0.068	4.080	3.6	533.5	
18:02:12	18.037	0.070	4.200	3.6	532.7	
18:02:16	18.038	0.071	4.260	3.6	532.4	
18:02:21	18.039	0.072	4.320	3.6	532.9	
18:02:26	18.041	0.074	4.440	3.6	533.8	
18:02:31	18.042	0.075	4.500	3.6	533.7	
18:02:36	18.043	0.076	4.560	3.6	533.3	
18:02:40	18.045	0.078	4.680	3.6	533	
18:02:45	18.046	0.079	4.740	3.6	532.5	
18:02:50	18.047	0.080	4.800	3.6	533	
18:02:55	18.049	0.082	4.920	3.6	532.7	
18:03:00	18.05	0.083	4.980	3.6	532	
18:03:04	18.051	0.084	5.040	3.6	532.6	
18:03:09	18.053	0.086	5.160	3.6	532.9	
18:03:14	18.054	0.087	5.220	3.6	532.7	
18:03:19	18.055	0.088	5.280	3.6	532.3	
18:03:24	18.057	0.090	5.400	3.6	532.7	
18:03:28	18.058	0.091	5.460	3.6	532.1	
18:03:33	18.059	0.092	5.520	3.6	531.1	
18:03:38	18.061	0.094	5.640	3.6	531.1	
18:03:43	18.062	0.095	5.700	3.6	531.7	
18:03:47	18.063	0.096	5.760	3.6	531.5	
18:04:18	18.072	0.105	6.300	3.6	530.9	
18:04:48	18.08	0.113	6.780	3.6	531.3	
18:05:19	18.089	0.122	7.320	3.6	528.7	
18:05:49	18.097	0.130	7.800	3.6	527.5	
18:06:19	18.105	0.138	8.280	3.6	512.3	
18:06:50	18.114	0.147	8.820	3.6	506.6	
18:07:20	18.122	0.155	9.300	3.6	510	
18:07:50	18.131	0.164	9.840	3.6	512.9	
18:08:20	18.139	0.172	10.320	3.6	510.5	
18:08:31	18.142	0.175	10.500	3.6	511.6	
18:08:35	18.143	0.176	10.560	3.6	511.4	
18:08:40	18.144	0.177	10.620	3.6	510.9	
18:08:44	18.146	0.179	10.740	3.6	511.1	
18:08:49	18.147	0.180	10.800	3.6	510.6	
18:08:54	18.148	0.181	10.860	3.6	510.6	
18:08:59	18.15	0.183	10.980	3.6	509.7	
18:09:04	18.151	0.184	11.040	3.6	509.2	
18:09:08	18.152	0.185	11.100	3.6	508.7	
18:09:13	18.154	0.187	11.220	3.6	508.6	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:09:18	18.155	0.188	11.280	3.6	508	
18:09:23	18.156	0.189	11.340	3.6	508.5	
18:09:28	18.158	0.191	11.460	3.6	508.8	
18:09:32	18.159	0.192	11.520	3.6	508.9	
18:09:37	18.16	0.193	11.580	3.6	508.5	
18:09:42	18.162	0.195	11.700	3.6	508.4	
18:09:47	18.163	0.196	11.760	3.6	508.1	
18:09:51	18.164	0.197	11.820	3.6	507.5	
18:09:56	18.166	0.199	11.940	3.6	507.8	
18:10:01	18.167	0.200	12.000	3.6	508.3	
18:10:06	18.168	0.201	12.060	3.6	508.6	
18:10:11	18.17	0.203	12.180	3.6	507.8	
18:10:15	18.171	0.204	12.240	3.6	506.8	
18:10:20	18.172	0.205	12.300	3.6	510.5	
18:10:25	18.174	0.207	12.420	7.5	565.8	
18:10:30	18.175	0.208	12.480	7.5	594.8	
18:10:35	18.176	0.209	12.540	7.5	638.3	
18:10:39	18.178	0.211	12.660	7.5	656.8	
18:10:44	18.179	0.212	12.720	7.5	677.3	
18:10:49	18.18	0.213	12.780	7.5	678.5	
18:10:54	18.182	0.215	12.900	7.5	688.2	
18:10:58	18.183	0.216	12.960	7.5	686.1	
18:11:03	18.184	0.217	13.020	7.5	689.9	
18:11:08	18.186	0.219	13.140	7.5	689.9	
18:11:13	18.187	0.220	13.200	7.5	693.4	
18:11:18	18.188	0.221	13.260	7.5	697.6	
18:11:23	18.19	0.223	13.380	7.5	698.1	
18:11:53	18.198	0.231	13.860	7.5	707.2	
18:12:23	18.206	0.239	14.340	7.5	713.9	
18:12:53	18.215	0.248	14.880	7.5	719.8	
18:13:24	18.223	0.256	15.360	7.5	720.2	
18:13:54	18.232	0.265	15.900	7.5	717.4	
18:14:25	18.24	0.273	16.380	7.5	733.9	
18:14:55	18.249	0.282	16.920	7.5	734.1	
18:15:25	18.257	0.290	17.400	7.5	743.5	
18:15:55	18.265	0.298	17.880	7.5	742.4	
18:16:26	18.274	0.307	18.420	7.5	743.2	
18:16:56	18.282	0.315	18.900	7.5	754.5	
18:17:26	18.291	0.324	19.440	7.5	767.1	
18:17:57	18.299	0.332	19.920	7.5	750.6	
18:18:27	18.308	0.341	20.460	7.5	760.3	
18:18:53	18.315	0.348	20.880	7.5	754.3	
18:18:54	18.315	0.348	20.880	7.5	754.3	
18:18:56	18.316	0.349	20.940	7.5	757.9	
18:18:57	18.316	0.349	20.940	7.5	757.9	
18:18:59	18.316	0.349	20.940	7.5	765.9	
18:19:01	18.317	0.350	21.000	7.5	765.9	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:19:02	18.317	0.350	21.000	7.5	770.4	
18:19:04	18.318	0.351	21.060	7.5	770.4	
18:19:05	18.318	0.351	21.060	7.5	771.1	
18:19:07	18.319	0.352	21.120	7.5	771.1	
18:19:09	18.319	0.352	21.120	8.8	787.4	
18:19:10	18.319	0.352	21.120	8.8	787.4	
18:19:12	18.32	0.353	21.180	8.8	793	
18:19:13	18.32	0.353	21.180	8.8	793	
18:19:15	18.321	0.354	21.240	8.8	801.7	
18:19:17	18.321	0.354	21.240	8.8	801.7	
18:19:18	18.322	0.355	21.300	8.8	807.1	
18:19:20	18.322	0.355	21.300	8.8	807.1	
18:19:21	18.323	0.356	21.360	8.8	813.6	
18:19:23	18.323	0.356	21.360	8.8	813.6	
18:19:25	18.324	0.357	21.420	8.8	809.7	
18:19:26	18.324	0.357	21.420	8.8	809.7	
18:19:28	18.324	0.357	21.420	8.8	809	
18:19:29	18.325	0.358	21.480	8.8	809	
18:19:31	18.325	0.358	21.480	8.8	809	
18:19:33	18.326	0.359	21.540	8.8	809	
18:19:34	18.326	0.359	21.540	8.8	806.6	
18:19:36	18.327	0.360	21.600	8.8	806.6	
18:19:37	18.327	0.360	21.600	8.8	811	
18:19:39	18.328	0.361	21.660	8.8	811	
18:19:41	18.328	0.361	21.660	8.8	808.6	
18:19:42	18.328	0.361	21.660	8.8	808.6	
18:19:44	18.329	0.362	21.720	8.8	808.2	
18:19:45	18.329	0.362	21.720	8.8	808.2	
18:19:47	18.33	0.363	21.780	8.8	810.8	
18:19:49	18.33	0.363	21.780	8.8	810.8	
18:19:50	18.331	0.364	21.840	8.8	809.2	
18:19:52	18.331	0.364	21.840	8.8	809.2	
18:19:53	18.331	0.364	21.840	8.8	814.2	
18:19:55	18.332	0.365	21.900	8.8	814.2	
18:20:25	18.34	0.373	22.380	8.8	817	
18:20:56	18.349	0.382	22.920	8.8	832.9	
18:21:26	18.357	0.390	23.400	8.8	844.4	
18:21:56	18.366	0.399	23.940	8.8	840.1	
18:22:27	18.374	0.407	24.420	8.8	836.2	
18:22:57	18.382	0.415	24.900	8.8	835.3	
18:23:27	18.391	0.424	25.440	8.8	835.1	
18:23:57	18.399	0.432	25.920	8.8	837.8	
18:24:28	18.408	0.441	26.460	8.8	829.6	
18:25:30	18.425	0.458	27.480	8.8	833.9	
18:26:00	18.433	0.466	27.960	9.6	475.2	
18:26:17	18.438	0.471	28.260	9.6	524	
18:26:18	18.438	0.471	28.260	9.6	517.3	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:26:20	18.439	0.472	28.320	9.6	511.4	
18:26:21	18.439	0.472	28.320	9.6	511.4	
18:26:23	18.44	0.473	28.380	9.6	553.6	
18:26:24	18.44	0.473	28.380	9.6	553.6	
18:26:26	18.441	0.474	28.440	9.6	602	
18:26:28	18.441	0.474	28.440	9.6	602	
18:26:29	18.441	0.474	28.440	9.6	632.1	
18:26:31	18.442	0.475	28.500	9.6	632.1	
18:26:32	18.442	0.475	28.500	9.6	740	
18:26:34	18.443	0.476	28.560	9.6	740	
18:26:36	18.443	0.476	28.560	9.6	766.9	
18:26:37	18.444	0.477	28.620	9.6	766.9	
18:26:39	18.444	0.477	28.620	9.6	767.7	
18:26:40	18.445	0.478	28.680	9.6	767.7	
18:26:42	18.445	0.478	28.680	9.6	772.1	
18:26:44	18.445	0.478	28.680	9.6	772.1	
18:26:45	18.446	0.479	28.740	9.6	775.7	
18:26:47	18.446	0.479	28.740	9.6	775.7	
18:26:48	18.447	0.480	28.800	9.6	779.3	
18:26:50	18.447	0.480	28.800	9.6	779.3	
18:26:52	18.448	0.481	28.860	9.6	781.7	
18:26:53	18.448	0.481	28.860	9.6	781.7	
18:26:55	18.449	0.482	28.920	9.6	781.8	
18:26:56	18.449	0.482	28.920	9.6	781.8	
18:26:58	18.449	0.482	28.920	9.6	780.7	
18:27:00	18.45	0.483	28.980	9.6	780.7	
18:27:01	18.45	0.483	28.980	9.6	778.3	
18:27:03	18.451	0.484	29.040	9.6	778.3	
18:27:04	18.451	0.484	29.040	9.6	779.1	
18:27:06	18.452	0.485	29.100	9.6	779.1	
18:27:08	18.452	0.485	29.100	9.6	780.6	
18:27:09	18.453	0.486	29.160	9.6	780.6	
18:27:11	18.453	0.486	29.160	9.6	782.7	
18:27:12	18.453	0.486	29.160	9.6	782.7	
18:27:14	18.454	0.487	29.220	9.6	783.3	
18:27:16	18.454	0.487	29.220	9.6	783.3	
18:27:17	18.455	0.488	29.280	9.6	787.6	
18:27:19	18.455	0.488	29.280	9.6	787.6	
18:27:20	18.456	0.489	29.340	9.6	788.3	
18:27:22	18.456	0.489	29.340	9.6	788.3	
18:27:23	18.457	0.490	29.400	9.6	789.3	
18:27:25	18.457	0.490	29.400	9.6	789.3	
18:27:27	18.457	0.490	29.400	9.6	789	
18:27:28	18.458	0.491	29.460	9.6	789	
18:27:30	18.458	0.491	29.460	9.6	792.4	
18:27:31	18.459	0.492	29.520	9.6	792.4	
18:27:33	18.459	0.492	29.520	9.6	793.3	

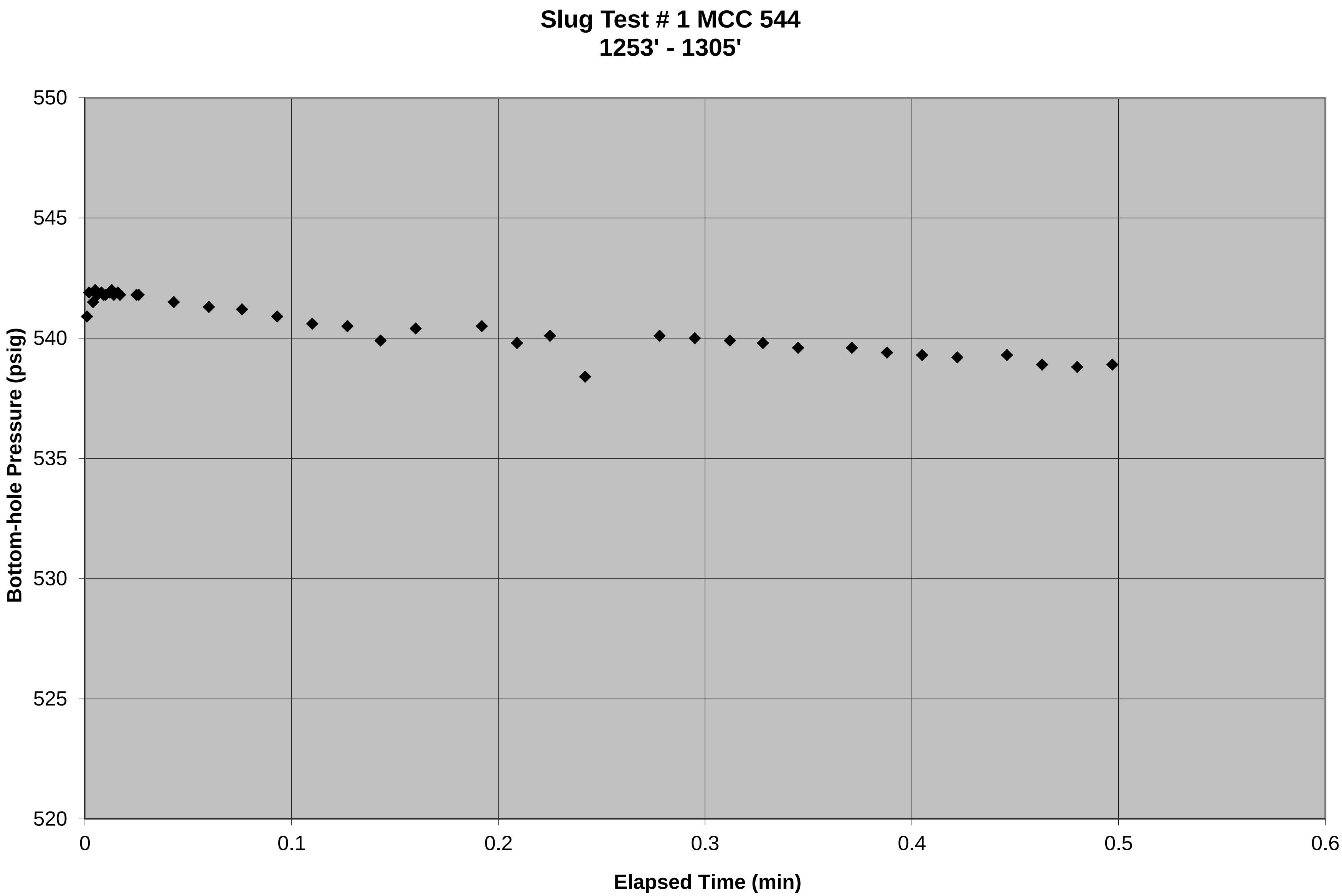
Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:27:35	18.46	0.493	29.580	9.6	793.3	
18:27:36	18.46	0.493	29.580	9.6	790.8	
18:27:38	18.46	0.493	29.580	9.6	790.8	
18:27:39	18.461	0.494	29.640	9.6	788.1	
18:27:41	18.461	0.494	29.640	9.6	788.1	
18:27:43	18.462	0.495	29.700	9.6	786.6	
18:27:44	18.462	0.495	29.700	9.6	786.6	
18:27:46	18.463	0.496	29.760	9.6	787.3	
18:27:47	18.463	0.496	29.760	9.6	787.3	
18:27:49	18.464	0.497	29.820	9.6	784.7	
18:27:51	18.464	0.497	29.820	9.6	784.7	
18:27:52	18.464	0.497	29.820	9.6	788.3	
18:27:54	18.465	0.498	29.880	9.6	788.3	
18:28:24	18.473	0.506	30.360	9.6	797.1	
18:28:54	18.482	0.515	30.900	9.6	797.4	
18:29:25	18.49	0.523	31.380	9.6	794.1	
18:29:55	18.499	0.532	31.920	9.6	800.3	
18:30:25	18.507	0.540	32.400	9.6	797.3	
18:30:56	18.515	0.548	32.880	9.6	802.3	
18:31:26	18.524	0.557	33.420	9.6	805.1	
18:31:56	18.532	0.565	33.900	9.6	804.4	
18:32:27	18.541	0.574	34.440	9.6	808.9	
18:32:57	18.549	0.582	34.920	9.6	809.1	
18:33:26	18.557	0.590	35.400	9.6	803.3	
18:33:27	18.558	0.591	35.460	9.6	794.7	
18:33:29	18.558	0.591	35.460	9.6	794.7	
18:33:31	18.559	0.592	35.520	9.6	794.5	
18:33:32	18.559	0.592	35.520	9.6	794.5	
18:33:34	18.559	0.592	35.520	9.6	796.7	
18:33:35	18.56	0.593	35.580	9.6	796.7	
18:33:37	18.56	0.593	35.580	9.6	800.2	
18:33:39	18.561	0.594	35.640	9.6	800.2	
18:33:40	18.561	0.594	35.640	9.6	799.6	
18:33:42	18.562	0.595	35.700	9.6	799.6	
18:33:43	18.562	0.595	35.700	9.6	805.8	
18:33:45	18.562	0.595	35.700	9.6	805.8	
18:33:46	18.563	0.596	35.760	9.6	864.7	
18:33:48	18.563	0.596	35.760	9.6	864.7	
18:33:50	18.564	0.597	35.820	9.6	871.6	
18:33:51	18.564	0.597	35.820	9.6	871.6	
18:33:53	18.565	0.598	35.880	9.6	867.9	
18:33:54	18.565	0.598	35.880	9.6	867.9	
18:33:56	18.566	0.599	35.940	9.6	865.3	
18:33:58	18.566	0.599	35.940	9.6	865.3	
18:33:59	18.566	0.599	35.940	9.6	868.6	
18:34:01	18.567	0.600	36.000	9.6	868.6	
18:34:03	18.567	0.600	36.000	9.6	871.3	

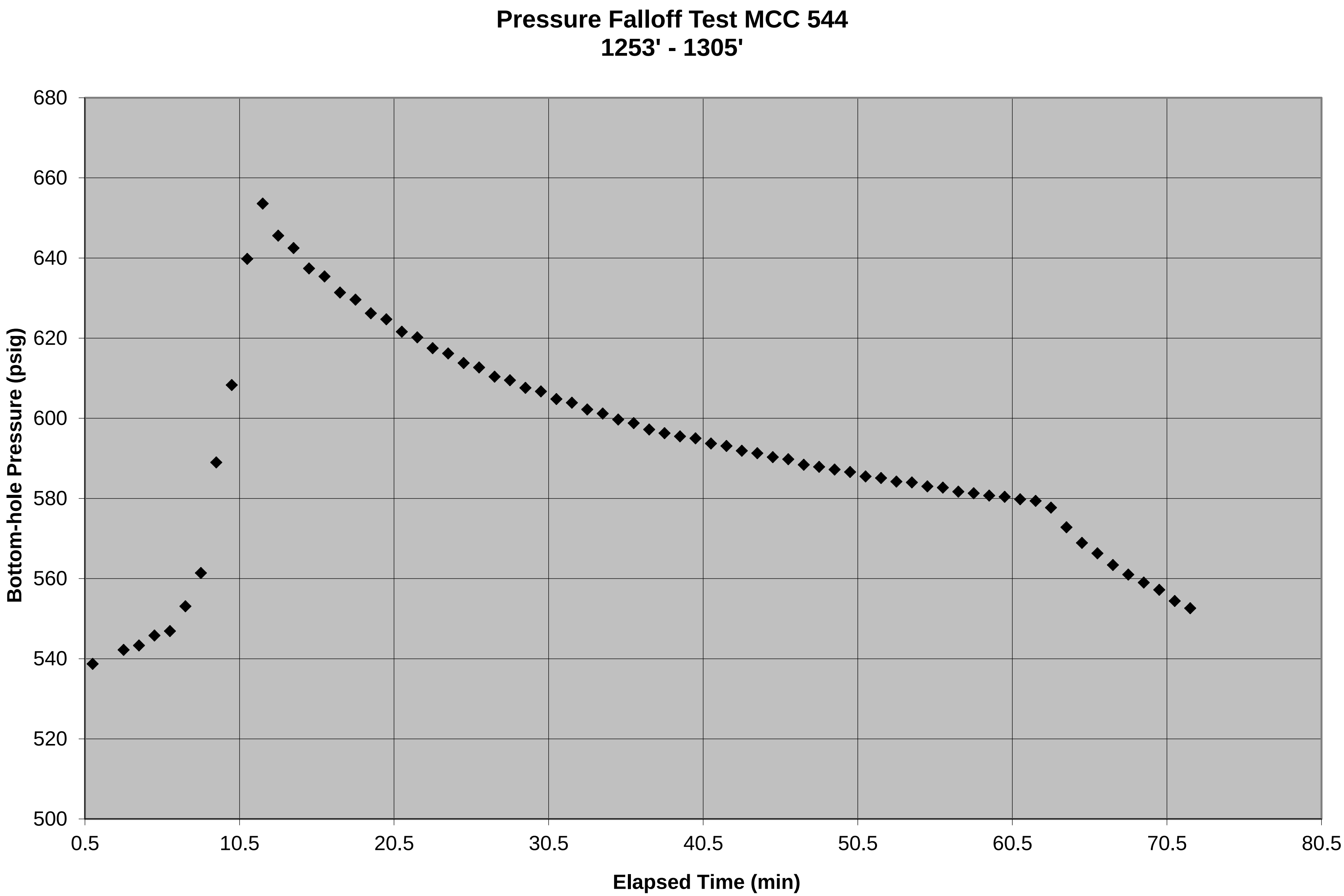
Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:34:04	18.568	0.601	36.060	9.6	871.3	
18:34:06	18.568	0.601	36.060	9.6	871.9	
18:34:07	18.569	0.602	36.120	9.6	871.9	
18:34:09	18.569	0.602	36.120	9.6	875.2	
18:34:10	18.57	0.603	36.180	9.6	875.2	
18:34:12	18.57	0.603	36.180	9.6	876.2	
18:34:14	18.57	0.603	36.180	9.6	876.2	
18:34:15	18.571	0.604	36.240	9.6	876	
18:34:17	18.571	0.604	36.240	9.6	876	
18:34:18	18.572	0.605	36.300	9.6	873.6	
18:34:20	18.572	0.605	36.300	9.6	873.6	
18:34:21	18.573	0.606	36.360	9.6	870.4	
18:34:23	18.573	0.606	36.360	9.6	870.4	
18:34:25	18.574	0.607	36.420	9.6	870.8	
18:34:26	18.574	0.607	36.420	9.6	870.8	
18:34:28	18.574	0.607	36.420	9.6	872.4	
18:34:30	18.575	0.608	36.480	9.6	872.4	
18:34:31	18.575	0.608	36.480	9.6	875.2	
18:34:33	18.576	0.609	36.540	9.6	875.2	
18:34:34	18.576	0.609	36.540	9.6	873.9	
18:34:36	18.577	0.610	36.600	9.6	873.9	
18:34:38	18.577	0.610	36.600	9.6	871.5	
18:34:39	18.578	0.611	36.660	9.6	871.5	
18:34:41	18.578	0.611	36.660	9.6	870.5	
18:34:42	18.578	0.611	36.660	9.6	870.5	
18:34:44	18.579	0.612	36.720	9.6	872.2	
18:34:45	18.579	0.612	36.720	9.6	872.2	
18:34:47	18.58	0.613	36.780	9.6	871.9	
18:34:49	18.58	0.613	36.780	9.6	871.9	
18:34:50	18.581	0.614	36.840	9.6	875.7	
18:34:52	18.581	0.614	36.840	9.6	875.7	
18:34:53	18.582	0.615	36.900	9.6	871.6	
18:34:55	18.582	0.615	36.900	9.6	871.6	
18:34:57	18.582	0.615	36.900	9.6	868.6	
18:34:58	18.583	0.616	36.960	9.6	868.6	
18:35:00	18.583	0.616	36.960	9.6	865.9	
18:35:02	18.584	0.617	37.020	9.6	865.9	
18:35:03	18.584	0.617	37.020	9.6	868.9	
18:35:05	18.585	0.618	37.080	9.6	868.9	
18:35:06	18.585	0.618	37.080	9.6	870.3	
18:35:08	18.586	0.619	37.140	9.6	870.3	
18:35:10	18.586	0.619	37.140	9.6	872.4	
18:35:11	18.586	0.619	37.140	9.6	872.4	
18:35:13	18.587	0.620	37.200	9.6	876.5	
18:35:14	18.587	0.620	37.200	9.6	876.5	
18:35:16	18.588	0.621	37.260	9.6	877.2	
18:35:17	18.588	0.621	37.260	9.6	877.2	

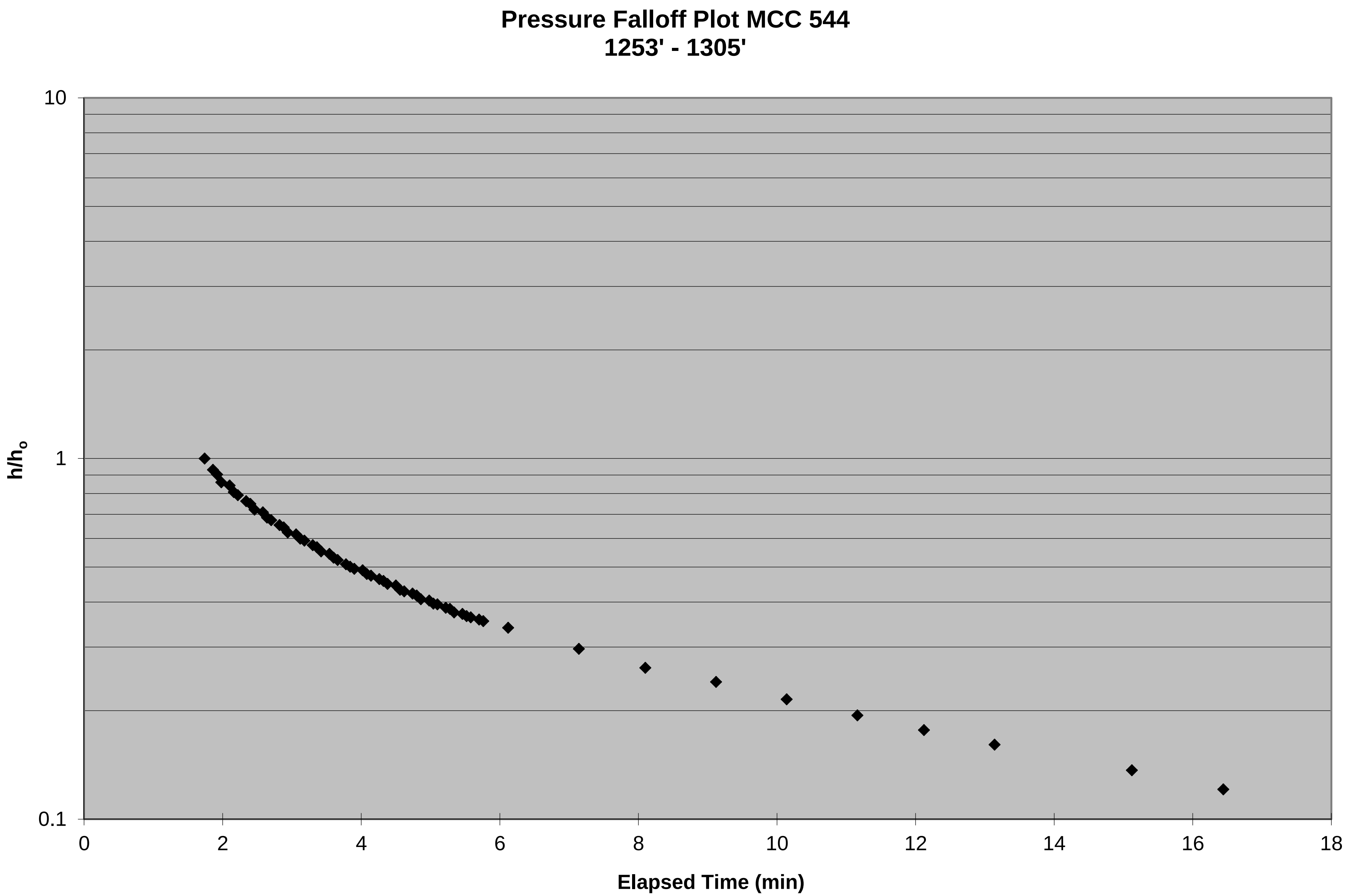
Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:35:19	18.589	0.622	37.320	9.6	872.3	
18:35:21	18.589	0.622	37.320	9.6	872.3	
18:35:22	18.59	0.623	37.380	9.6	873	
18:35:24	18.59	0.623	37.380	9.6	873	
18:35:26	18.59	0.623	37.380	9.6	875.4	
18:35:27	18.591	0.624	37.440	9.6	875.4	
18:35:29	18.591	0.624	37.440	9.6	875	
18:35:30	18.592	0.625	37.500	9.6	875	
18:35:32	18.592	0.625	37.500	9.6	873.4	
18:35:34	18.593	0.626	37.560	9.6	873.4	
18:35:35	18.593	0.626	37.560	9.6	870	
18:35:36	18.593	0.626	37.560	9.6	870	
18:35:38	18.594	0.627	37.620	9.6	868.6	
18:35:40	18.594	0.627	37.620	9.6	868.6	
18:35:41	18.595	0.628	37.680	9.6	870.5	
18:35:43	18.595	0.628	37.680	9.6	870.5	
18:36:13	18.604	0.637	38.220	9.6	871.5	
18:36:44	18.612	0.645	38.700	9.6	867.9	
18:37:14	18.621	0.654	39.240	9.6	867	
18:37:44	18.629	0.662	39.720	9.6	866.7	
18:38:15	18.637	0.670	40.200	9.6	864.9	
18:38:45	18.646	0.679	40.740	9.6	862.7	
18:39:15	18.654	0.687	41.220	9.6	865.9	
18:39:46	18.663	0.696	41.760	9.6	867.3	
18:40:02	18.667	0.700	42.000	9.6	865.5	
18:40:03	18.668	0.701	42.060	9.6	864.7	
18:40:05	18.668	0.701	42.060	9.6	864.7	
18:40:06	18.668	0.701	42.060	9.6	861.3	
18:40:08	18.669	0.702	42.120	9.6	861.3	
18:40:09	18.669	0.702	42.120	9.6	859.8	
18:40:11	18.67	0.703	42.180	9.6	859.8	
18:40:13	18.67	0.703	42.180	9.6	858.9	
18:40:14	18.671	0.704	42.240	9.6	858.9	
18:40:16	18.671	0.704	42.240	9.6	857.7	
18:40:17	18.672	0.705	42.300	9.6	857.7	
18:40:19	18.672	0.705	42.300	9.6	862.3	
18:40:21	18.672	0.705	42.300	9.6	862.3	
18:40:22	18.673	0.706	42.360	9.6	866.4	
18:40:24	18.673	0.706	42.360	9.6	866.4	
18:40:25	18.674	0.707	42.420	9.6	864.4	
18:40:27	18.674	0.707	42.420	9.6	864.4	
18:40:29	18.675	0.708	42.480	9.6	861.7	
18:40:30	18.675	0.708	42.480	9.6	861.7	
18:40:32	18.676	0.709	42.540	9.6	860.5	
18:40:33	18.676	0.709	42.540	9.6	860.5	
18:40:35	18.676	0.709	42.540	9.6	862.1	
18:40:37	18.677	0.710	42.600	9.6	862.1	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:40:38	18.677	0.710	42.600	9.6	863.6	
18:40:40	18.678	0.711	42.660	9.6	863.6	
18:40:41	18.678	0.711	42.660	9.6	864	
18:40:43	18.679	0.712	42.720	9.6	864	
18:40:45	18.679	0.712	42.720	9.6	863.4	
18:40:46	18.68	0.713	42.780	9.6	863.4	
18:40:48	18.68	0.713	42.780	9.6	863.1	
18:40:50	18.68	0.713	42.780	9.6	863.1	
18:40:51	18.681	0.714	42.840	9.6	864.8	
18:40:52	18.681	0.714	42.840	9.6	864.8	
18:40:54	18.682	0.715	42.900	12.5	890.2	
18:40:56	18.682	0.715	42.900	12.5	890.2	
18:40:57	18.683	0.716	42.960	12.5	920.5	
18:40:59	18.683	0.716	42.960	12.5	920.5	
18:41:00	18.683	0.716	42.960	12.5	942.1	
18:41:02	18.684	0.717	43.020	12.5	942.1	
18:41:04	18.684	0.717	43.020	12.5	946.6	
18:41:05	18.685	0.718	43.080	12.5	946.6	
18:41:07	18.685	0.718	43.080	12.5	943.5	
18:41:08	18.686	0.719	43.140	12.5	943.5	
18:41:10	18.686	0.719	43.140	12.5	939.7	
18:41:12	18.687	0.720	43.200	12.5	939.7	
18:41:13	18.687	0.720	43.200	12.5	940.2	
18:41:15	18.687	0.720	43.200	12.5	940.2	
18:41:16	18.688	0.721	43.260	12.5	945.2	
18:41:18	18.688	0.721	43.260	12.5	945.2	
18:41:20	18.689	0.722	43.320	12.5	947.6	
18:41:21	18.689	0.722	43.320	12.5	947.6	
18:41:23	18.69	0.723	43.380	12.5	944.9	
18:41:24	18.69	0.723	43.380	12.5	944.9	
18:41:26	18.691	0.724	43.440	12.5	942.7	
18:41:28	18.691	0.724	43.440	12.5	942.7	
18:41:29	18.691	0.724	43.440	12.5	942.1	
18:41:31	18.692	0.725	43.500	12.5	942.1	
18:41:33	18.692	0.725	43.500	12.5	943.3	
18:41:34	18.693	0.726	43.560	12.5	943.3	
18:41:36	18.693	0.726	43.560	12.5	941.1	
18:41:37	18.694	0.727	43.620	12.5	941.1	
18:41:39	18.694	0.727	43.620	12.5	940.1	
18:41:40	18.695	0.728	43.680	12.5	940.1	
18:41:42	18.695	0.728	43.680	12.5	938.5	
18:41:44	18.695	0.728	43.680	12.5	938.5	
18:41:45	18.696	0.729	43.740	12.5	936.8	
18:41:47	18.696	0.729	43.740	12.5	936.8	
18:41:48	18.697	0.730	43.800	12.5	936.2	
18:41:50	18.697	0.730	43.800	12.5	936.2	
18:41:51	18.698	0.731	43.860	12.5	935.8	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:41:53	18.698	0.731	43.860	12.5	935.8	
18:41:55	18.699	0.732	43.920	12.5	941.4	
18:41:56	18.699	0.732	43.920	12.5	941.4	
18:41:58	18.699	0.732	43.920	12.5	938.3	
18:42:00	18.7	0.733	43.980	12.5	938.3	
18:42:01	18.7	0.733	43.980	12.5	940.9	
18:42:03	18.701	0.734	44.040	12.5	940.9	
18:42:04	18.701	0.734	44.040	12.5	939.2	
18:42:06	18.702	0.735	44.100	12.5	939.2	
18:42:08	18.702	0.735	44.100	12.5	940	
18:42:09	18.703	0.736	44.160	12.5	940	
18:42:11	18.703	0.736	44.160	12.5	942.5	
18:42:12	18.703	0.736	44.160	12.5	942.5	
18:42:14	18.704	0.737	44.220	12.5	940.4	
18:42:15	18.704	0.737	44.220	12.5	940.4	
18:42:17	18.705	0.738	44.280	12.5	939.6	
18:42:19	18.705	0.738	44.280	12.5	939.6	
18:42:20	18.706	0.739	44.340	12.5	943.2	
18:42:22	18.706	0.739	44.340	12.5	943.2	
18:42:52	18.714	0.747	44.820	12.5	941.1	
18:43:22	18.723	0.756	45.360	12.5	937.3	
18:44:04	18.734	0.767	46.020	12.5	938.9	
18:44:34	18.743	0.776	46.560	12.5	937.8	
18:45:05	18.751	0.784	47.040	12.5	940.9	
18:45:35	18.76	0.793	47.580	12.5	939.9	
18:46:05	18.768	0.801	48.060	12.5	945.5	
18:46:36	18.777	0.810	48.600	12.5	945	
18:47:06	18.785	0.818	49.080	12.5	947.9	
18:47:36	18.793	0.826	49.560	12.5	938.5	
18:48:07	18.802	0.835	50.100	12.5	938.3	
18:48:37	18.81	0.843	50.580	12.5	939	End Test
18:49:07	18.819	0.852	51.120	-	435.8	
18:49:37	18.827	0.860	51.600	-	420.7	


Slug Test # 1 MCC 544
1253' - 1305'
Bottom-hole Pressure (psig)
550
545
540
535
530
525
520
0
0.1
0.2
0.3
0.4
0.5
0.6
Elapsed Time (min)


Pressure Falloff Test MCC 544
1253' - 1305'
Bottom-hole Pressure (psig)
680
660
640
620
600
580
560
540
520
500
0.5
10.5
20.5
30.5
40.5
50.5
60.5
70.5
80.5
Elapsed Time (min)


Pressure Falloff Plot MCC 544
1253' - 1305'
10
1
0.1
h/ho
0
2
4
6
8
10
12
14
16
18
Elapsed Time (min)

Pressure Falloff Data MCC 544 1253' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
13:00:23	13.006	-	-	-	538.7	-
13:01:24	13.023	0.017	1.02	0.0007083	542.2	0.0304613
13:01:29	13.025	0.019	1.14	0.0007917	543.3	0.0400348
13:01:34	13.026	0.02	1.2	0.0008333	545.8	0.0617929
13:01:39	13.027	0.021	1.26	0.000875	546.9	0.0713664
13:01:43	13.029	0.023	1.38	0.0009583	553.1	0.1253264
13:01:48	13.03	0.024	1.44	0.001	561.4	0.1975631
13:01:53	13.031	0.025	1.5	0.0010417	589	0.437772
13:01:58	13.033	0.027	1.62	0.001125	608.3	0.6057441
13:02:02	13.034	0.028	1.68	0.0011667	639.8	0.8798956
13:02:07	13.035	0.029	1.74	0.0012083	653.6	1
13:02:12	13.037	0.031	1.86	0.0012917	645.6	0.9303742
13:02:17	13.038	0.032	1.92	0.0013333	642.5	0.9033943
13:02:22	13.039	0.033	1.98	0.001375	637.4	0.8590078
13:02:26	13.041	0.035	2.1	0.0014583	635.4	0.8416014
13:02:31	13.042	0.036	2.16	0.0015	631.4	0.8067885
13:02:36	13.043	0.037	2.22	0.0015417	629.6	0.7911227
13:02:41	13.045	0.039	2.34	0.001625	626.2	0.7615318
13:02:46	13.046	0.04	2.4	0.0016667	624.7	0.7484769
13:02:50	13.047	0.041	2.46	0.0017083	621.6	0.721497
13:02:55	13.049	0.043	2.58	0.0017917	620.2	0.7093124
13:03:00	13.05	0.044	2.64	0.0018333	617.5	0.6858138
13:03:05	13.051	0.045	2.7	0.001875	616.2	0.6744996
13:03:09	13.053	0.047	2.82	0.0019583	613.8	0.6536118
13:03:14	13.054	0.048	2.88	0.002	612.7	0.6440383
13:03:19	13.055	0.049	2.94	0.0020417	610.4	0.6240209
13:03:24	13.057	0.051	3.06	0.002125	609.5	0.616188
13:03:29	13.058	0.052	3.12	0.0021667	607.6	0.5996519
13:03:34	13.059	0.053	3.18	0.0022083	606.7	0.591819
13:03:38	13.061	0.055	3.3	0.0022917	604.8	0.5752829
13:03:43	13.062	0.056	3.36	0.0023333	603.9	0.56745
13:03:48	13.063	0.057	3.42	0.002375	602.2	0.5526545
13:03:53	13.065	0.059	3.54	0.0024583	601.2	0.5439513
13:03:57	13.066	0.06	3.6	0.0025	599.7	0.5308964
13:04:02	13.067	0.061	3.66	0.0025417	598.8	0.5230635
13:04:07	13.069	0.063	3.78	0.002625	597.2	0.5091384
13:04:12	13.07	0.064	3.84	0.0026667	596.3	0.5013055
13:04:17	13.071	0.065	3.9	0.0027083	595.5	0.4943429
13:04:21	13.073	0.067	4.02	0.0027917	595	0.4899913
13:04:26	13.074	0.068	4.08	0.0028333	593.7	0.4786771
13:04:31	13.075	0.069	4.14	0.002875	593.1	0.4734552
13:04:36	13.077	0.071	4.26	0.0029583	591.9	0.4630113
13:04:41	13.078	0.072	4.32	0.003	591.3	0.4577894
13:04:45	13.079	0.073	4.38	0.0030417	590.3	0.4490862
13:04:50	13.081	0.075	4.5	0.003125	589.8	0.4447346

Pressure Falloff Data MCC 544 1253' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
13:04:55	13.082	0.076	4.56	0.0031667	588.4	0.43255
13:05:00	13.083	0.077	4.62	0.0032083	587.9	0.4281984
13:05:05	13.085	0.079	4.74	0.0032917	587.2	0.4221062
13:05:09	13.086	0.08	4.8	0.0033333	586.6	0.4168842
13:05:14	13.087	0.081	4.86	0.003375	585.5	0.4073107
13:05:19	13.089	0.083	4.98	0.0034583	585.1	0.4038294
13:05:24	13.09	0.084	5.04	0.0035	584.2	0.3959965
13:05:28	13.091	0.085	5.1	0.0035417	584	0.3942559
13:05:33	13.093	0.087	5.22	0.003625	583	0.3855527
13:05:38	13.094	0.088	5.28	0.0036667	582.7	0.3829417
13:05:43	13.095	0.089	5.34	0.0037083	581.7	0.3742385
13:05:48	13.097	0.091	5.46	0.0037917	581.3	0.3707572
13:05:52	13.098	0.092	5.52	0.0038333	580.7	0.3655352
13:05:57	13.099	0.093	5.58	0.003875	580.4	0.3629243
13:06:02	13.101	0.095	5.7	0.0039583	579.8	0.3577023
13:06:07	13.102	0.096	5.76	0.004	579.4	0.3542211
13:06:28	13.108	0.102	6.12	0.00425	577.7	0.3394256
13:07:28	13.125	0.119	7.14	0.0049583	572.8	0.2967798
13:08:28	13.141	0.135	8.1	0.005625	568.9	0.2628372
13:09:28	13.158	0.152	9.12	0.0063333	566.3	0.2402089
13:10:29	13.175	0.169	10.14	0.0070417	563.4	0.2149695
13:11:30	13.192	0.186	11.16	0.00775	561	0.1940818
13:12:29	13.208	0.202	12.12	0.0084167	559	0.1766754
13:13:29	13.225	0.219	13.14	0.009125	557.2	0.1610096
13:15:29	13.258	0.252	15.12	0.0105	554.4	0.1366406
13:16:49	13.28	0.274	16.44	0.0114167	552.6	0.1209748

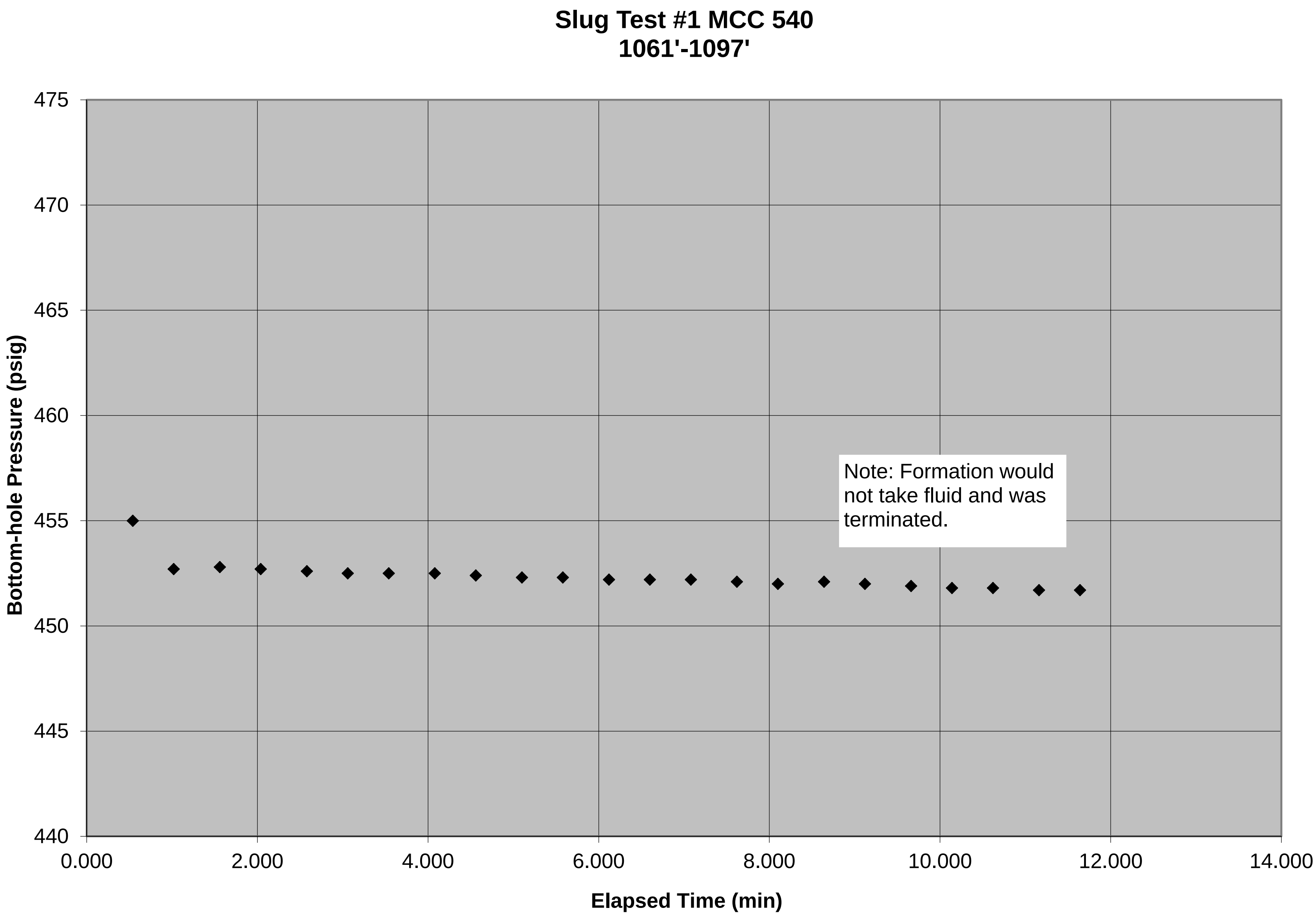
13:27:01	13.45	#REF!	#REF!	#REF!	486.8
13:28:01	13.467	#REF!	#REF!	#REF!	487.3
13:29:02	13.484	#REF!	#REF!	#REF!	487.4
13:30:03	13.501	#REF!	#REF!	#REF!	486.8
13:31:03	13.518	#REF!	#REF!	#REF!	486.8
13:32:04	13.534	#REF!	#REF!	#REF!	486.3
13:34:01	13.567	#REF!	#REF!	#REF!	532.3
13:35:02	13.584	#REF!	#REF!	#REF!	533.3
13:36:02	13.601	#REF!	#REF!	#REF!	533.4
13:36:44	13.612	#REF!	#REF!	#REF!	533.4
13:36:49	13.614	#REF!	#REF!	#REF!	533.4
13:36:54	13.615	#REF!	#REF!	#REF!	533.3
13:36:58	13.616	#REF!	#REF!	#REF!	533.4
13:37:03	13.618	#REF!	#REF!	#REF!	533.4
13:37:08	13.619	#REF!	#REF!	#REF!	533.4
13:37:13	13.62	#REF!	#REF!	#REF!	533.3
13:37:17	13.622	#REF!	#REF!	#REF!	533.5
13:37:22	13.623	#REF!	#REF!	#REF!	533.8
13:37:27	13.624	#REF!	#REF!	#REF!	534.4
13:37:32	13.625	#REF!	#REF!	#REF!	534.9
13:37:36	13.627	#REF!	#REF!	#REF!	535.1
13:37:41	13.628	#REF!	#REF!	#REF!	535.7
13:37:46	13.63	#REF!	#REF!	#REF!	536.3
13:37:51	13.631	#REF!	#REF!	#REF!	537.1
13:37:56	13.632	#REF!	#REF!	#REF!	537.7
13:38:01	13.634	#REF!	#REF!	#REF!	538.8
13:38:05	13.635	#REF!	#REF!	#REF!	539.7
13:38:10	13.636	#REF!	#REF!	#REF!	541.5
13:38:15	13.637	#REF!	#REF!	#REF!	542.4
13:38:20	13.639	#REF!	#REF!	#REF!	544.6
13:38:25	13.64	#REF!	#REF!	#REF!	545.6
13:38:29	13.641	#REF!	#REF!	#REF!	548.2
13:38:34	13.643	#REF!	#REF!	#REF!	549.6
13:38:39	13.644	#REF!	#REF!	#REF!	551.7
13:38:44	13.645	#REF!	#REF!	#REF!	553.2
13:38:48	13.647	#REF!	#REF!	#REF!	556.2
13:38:53	13.648	#REF!	#REF!	#REF!	558.6
13:38:58	13.649	#REF!	#REF!	#REF!	563.2
13:39:03	13.651	#REF!	#REF!	#REF!	565.1
13:39:08	13.652	#REF!	#REF!	#REF!	572.6
13:39:12	13.653	#REF!	#REF!	#REF!	576.5
13:39:17	13.655	#REF!	#REF!	#REF!	596.1
13:39:22	13.656	#REF!	#REF!	#REF!	603.1
13:39:27	13.657	#REF!	#REF!	#REF!	609.9
13:39:32	13.659	#REF!	#REF!	#REF!	620.2
13:39:36	13.66	#REF!	#REF!	#REF!	640.2
13:39:41	13.661	#REF!	#REF!	#REF!	645
13:39:46	13.663	#REF!	#REF!	#REF!	605.1
13:39:51	13.664	#REF!	#REF!	#REF!	588.7
13:39:56	13.665	#REF!	#REF!	#REF!	584.1
13:40:00	13.667	#REF!	#REF!	#REF!	588.4

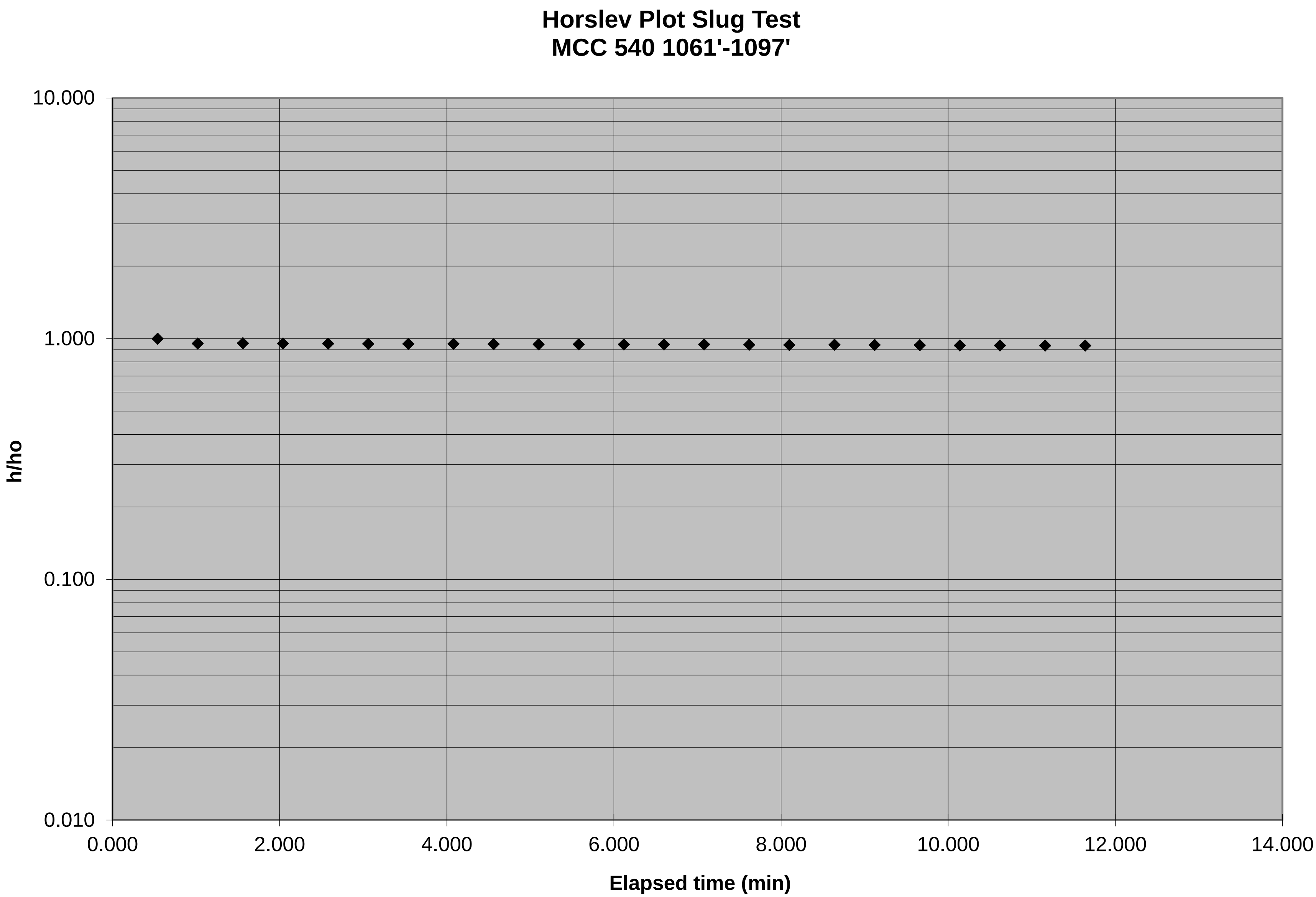
13:40:05	13.668	#REF!	#REF!	#REF!	599.8
13:40:10	13.669	#REF!	#REF!	#REF!	610.5
13:40:15	13.671	#REF!	#REF!	#REF!	633.3
13:40:20	13.672	#REF!	#REF!	#REF!	637.1
13:40:24	13.673	#REF!	#REF!	#REF!	641.4
13:40:29	13.675	#REF!	#REF!	#REF!	642.3
13:40:34	13.676	#REF!	#REF!	#REF!	625.4
13:40:39	13.677	#REF!	#REF!	#REF!	611.2
13:40:44	13.679	#REF!	#REF!	#REF!	605.1
13:40:48	13.68	#REF!	#REF!	#REF!	611.7
13:40:53	13.681	#REF!	#REF!	#REF!	630.9
13:40:58	13.683	#REF!	#REF!	#REF!	644.9
13:41:03	13.684	#REF!	#REF!	#REF!	655.5
13:41:07	13.685	#REF!	#REF!	#REF!	648.5
13:41:12	13.687	#REF!	#REF!	#REF!	630.7
13:41:17	13.688	#REF!	#REF!	#REF!	629
13:41:22	13.689	#REF!	#REF!	#REF!	628.2
13:41:27	13.691	#REF!	#REF!	#REF!	633.8
13:41:31	13.692	#REF!	#REF!	#REF!	640.9
13:41:36	13.693	#REF!	#REF!	#REF!	642.9
13:41:41	13.695	#REF!	#REF!	#REF!	644.5
13:41:46	13.696	#REF!	#REF!	#REF!	644.5
13:41:51	13.697	#REF!	#REF!	#REF!	632.7
13:41:55	13.699	#REF!	#REF!	#REF!	622.6
13:42:00	13.7	#REF!	#REF!	#REF!	617.1
13:42:05	13.701	#REF!	#REF!	#REF!	616.6
13:42:10	13.703	#REF!	#REF!	#REF!	615.2
13:42:14	13.704	#REF!	#REF!	#REF!	618
13:42:19	13.705	#REF!	#REF!	#REF!	627.3
13:42:24	13.707	#REF!	#REF!	#REF!	641.1
13:42:29	13.708	#REF!	#REF!	#REF!	654.2
13:42:46	13.713	#REF!	#REF!	#REF!	658.5
13:42:51	13.714	#REF!	#REF!	#REF!	656.9
13:42:58	13.716	#REF!	#REF!	#REF!	659.6
13:43:04	13.718	#REF!	#REF!	#REF!	658
13:43:10	13.72	#REF!	#REF!	#REF!	658.6
13:43:17	13.721	#REF!	#REF!	#REF!	657
13:43:23	13.723	#REF!	#REF!	#REF!	658
13:43:30	13.725	#REF!	#REF!	#REF!	656.1
13:43:36	13.727	#REF!	#REF!	#REF!	657.7
13:43:42	13.728	#REF!	#REF!	#REF!	657
13:43:49	13.73	#REF!	#REF!	#REF!	656.8
13:43:55	13.732	#REF!	#REF!	#REF!	657.6
13:44:00	13.733	#REF!	#REF!	#REF!	656.6
13:44:06	13.735	#REF!	#REF!	#REF!	658.5
13:44:13	13.737	#REF!	#REF!	#REF!	659.2
13:44:19	13.739	#REF!	#REF!	#REF!	659.2
13:44:25	13.74	#REF!	#REF!	#REF!	658.6
13:44:32	13.742	#REF!	#REF!	#REF!	659.1
13:44:38	13.744	#REF!	#REF!	#REF!	658.5
13:44:45	13.746	#REF!	#REF!	#REF!	659.9

13:44:51	13.747	#REF!	#REF!	#REF!	659.7
13:44:57	13.749	#REF!	#REF!	#REF!	660.3
13:45:02	13.751	#REF!	#REF!	#REF!	658.2
13:45:09	13.752	#REF!	#REF!	#REF!	660.4
13:45:15	13.754	#REF!	#REF!	#REF!	657.3
13:45:21	13.756	#REF!	#REF!	#REF!	659.2
13:45:26	13.757	#REF!	#REF!	#REF!	658.2
13:45:57	13.766	#REF!	#REF!	#REF!	662.5
13:46:27	13.774	#REF!	#REF!	#REF!	658.2
13:46:57	13.783	#REF!	#REF!	#REF!	659.2
13:47:28	13.791	#REF!	#REF!	#REF!	658.7
13:47:58	13.799	#REF!	#REF!	#REF!	657.8
13:48:28	13.808	#REF!	#REF!	#REF!	656.2
13:48:59	13.816	#REF!	#REF!	#REF!	657.7
13:49:29	13.825	#REF!	#REF!	#REF!	656.6
13:49:59	13.833	#REF!	#REF!	#REF!	656.3
13:50:30	13.842	#REF!	#REF!	#REF!	655.9
13:51:00	13.85	#REF!	#REF!	#REF!	660.9
13:51:30	13.858	#REF!	#REF!	#REF!	657.4
13:52:01	13.867	#REF!	#REF!	#REF!	659.9
13:52:31	13.875	#REF!	#REF!	#REF!	673.2
13:52:52	13.881	#REF!	#REF!	#REF!	864.6
13:52:57	13.882	#REF!	#REF!	#REF!	855.5
13:53:01	13.884	#REF!	#REF!	#REF!	855.2
13:53:06	13.885	#REF!	#REF!	#REF!	840.7
13:53:11	13.886	#REF!	#REF!	#REF!	842.8
13:53:16	13.888	#REF!	#REF!	#REF!	860.8
13:53:35	13.893	#REF!	#REF!	#REF!	855.7
13:53:40	13.894	#REF!	#REF!	#REF!	857.8
13:53:46	13.896	#REF!	#REF!	#REF!	843.4
13:53:53	13.898	#REF!	#REF!	#REF!	834.7
13:53:59	13.9	#REF!	#REF!	#REF!	848.1
13:54:05	13.902	#REF!	#REF!	#REF!	866
13:54:12	13.903	#REF!	#REF!	#REF!	856.5
13:54:18	13.905	#REF!	#REF!	#REF!	841.1
13:54:25	13.907	#REF!	#REF!	#REF!	841.6
13:54:31	13.909	#REF!	#REF!	#REF!	862.5
13:54:37	13.91	#REF!	#REF!	#REF!	859
13:54:44	13.912	#REF!	#REF!	#REF!	846.3
13:54:50	13.914	#REF!	#REF!	#REF!	852.2
13:54:56	13.916	#REF!	#REF!	#REF!	874.1
13:55:01	13.917	#REF!	#REF!	#REF!	859.4
13:55:08	13.919	#REF!	#REF!	#REF!	870.1
13:55:14	13.921	#REF!	#REF!	#REF!	874.6
13:55:20	13.922	#REF!	#REF!	#REF!	858.9
13:55:27	13.924	#REF!	#REF!	#REF!	847.1
13:55:33	13.926	#REF!	#REF!	#REF!	853.6
13:55:40	13.928	#REF!	#REF!	#REF!	868.6
13:55:45	13.929	#REF!	#REF!	#REF!	873.9
13:55:51	13.931	#REF!	#REF!	#REF!	856.6
13:56:21	13.939	#REF!	#REF!	#REF!	854.7

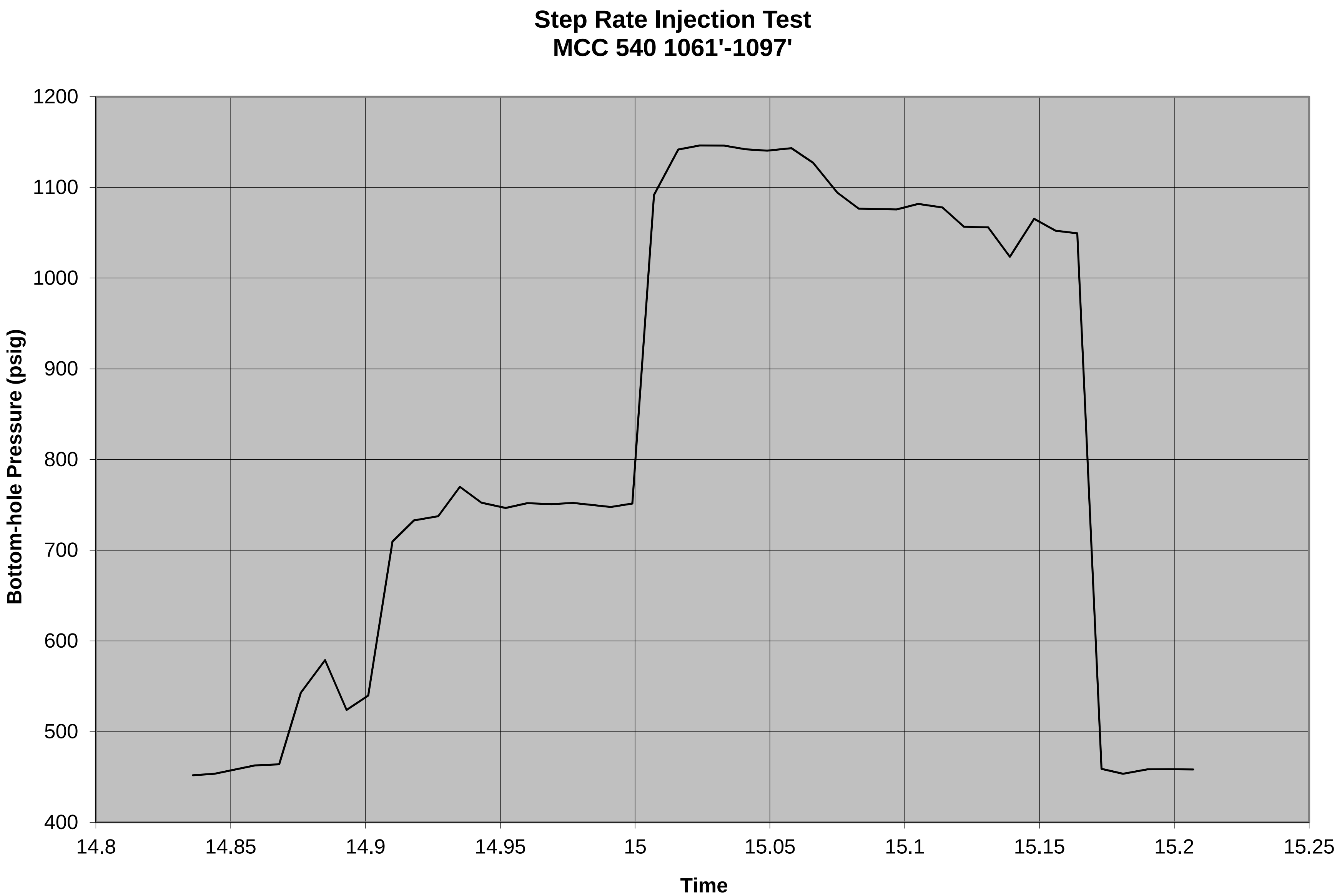
13:56:52	13.948	#REF!	#REF!	#REF!	854.8
13:57:22	13.956	#REF!	#REF!	#REF!	851.7
13:57:52	13.964	#REF!	#REF!	#REF!	853.9
13:58:23	13.973	#REF!	#REF!	#REF!	839.8
13:58:53	13.981	#REF!	#REF!	#REF!	840.2
13:59:23	13.99	#REF!	#REF!	#REF!	548.3
13:59:54	13.998	#REF!	#REF!	#REF!	539.9
14:00:24	14.007	#REF!	#REF!	#REF!	539.7
14:00:54	14.015	#REF!	#REF!	#REF!	539.6
14:01:25	14.024	#REF!	#REF!	#REF!	539.6
14:01:55	14.032	#REF!	#REF!	#REF!	539.3
17:21:18	17.355	#REF!	#REF!	#REF!	-7.8

Slug Test Data MCC 544 1253' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
12:29:33	12.493	-	-	-	486.4	-
12:29:38	12.494	0.001	0.06	4.167E-05	540.9	
12:29:43	12.495	0.002	0.12	8.333E-05	541.9	
12:29:48	12.497	0.004	0.24	0.0001667	541.5	
12:29:53	12.498	0.005	0.3	0.0002083	542	
12:29:57	12.499	0.006	0.36	0.00025	541.8	
12:30:02	12.501	0.008	0.48	0.0003333	541.9	
12:30:07	12.502	0.009	0.54	0.000375	541.8	
12:30:12	12.503	0.01	0.6	0.0004167	541.8	
12:30:17	12.505	0.012	0.72	0.0005	541.9	
12:30:21	12.506	0.013	0.78	0.0005417	542	
12:30:26	12.507	0.014	0.84	0.0005833	541.8	
12:30:31	12.509	0.016	0.96	0.0006667	541.9	
12:30:36	12.51	0.017	1.02	0.0007083	541.8	
12:31:04	12.518	0.025	1.5	0.0010417	541.8	
12:31:09	12.519	0.026	1.56	0.0010833	541.8	
12:32:10	12.536	0.043	2.58	0.0017917	541.5	
12:33:09	12.553	0.06	3.6	0.0025	541.3	
12:34:10	12.569	0.076	4.56	0.0031667	541.2	
12:35:10	12.586	0.093	5.58	0.003875	540.9	
12:36:10	12.603	0.11	6.6	0.0045833	540.6	
12:37:10	12.62	0.127	7.62	0.0052917	540.5	
12:38:11	12.636	0.143	8.58	0.0059583	539.9	
12:39:10	12.653	0.16	9.6	0.0066667	540.4	
12:41:05	12.685	0.192	11.52	0.008	540.5	
12:42:06	12.702	0.209	12.54	0.0087083	539.8	
12:43:06	12.718	0.225	13.5	0.009375	540.1	
12:44:07	12.735	0.242	14.52	0.0100833	538.4	
12:46:15	12.771	0.278	16.68	0.0115833	540.1	
12:47:16	12.788	0.295	17.7	0.0122917	540	
12:48:16	12.805	0.312	18.72	0.013	539.9	
12:49:17	12.821	0.328	19.68	0.0136667	539.8	
12:50:18	12.838	0.345	20.7	0.014375	539.6	
12:51:52	12.864	0.371	22.26	0.0154583	539.6	
12:52:53	12.881	0.388	23.28	0.0161667	539.4	
12:53:53	12.898	0.405	24.3	0.016875	539.3	
12:54:54	12.915	0.422	25.32	0.0175833	539.2	
12:56:20	12.939	0.446	26.76	0.0185833	539.3	
12:57:21	12.956	0.463	27.78	0.0192917	538.9	
12:58:22	12.973	0.48	28.8	0.02	538.8	
12:59:23	12.99	0.497	29.82	0.0207083	538.9	


Slug Test #1 MCC 540
1061'-1097'
Bottom-hole Pressure (psig)
475
470
465
460
455
450
445
440
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Elapsed Time (min)
Note: Formation would not take fluid and was terminated.


Horslev Plot Slug Test
MCC 540 1061'-1097'
10.000
1.000
0.100
0.010
h/ho
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Elapsed time (min)

Slug Test Data MCC 540 1061'-1097'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
14:38:00	14.633	0.000	0.000	0.000	403.8	-
14:38:31	14.642	0.009	0.540	0.00038	455	1.000
14:39:01	14.65	0.017	1.020	0.00071	452.7	0.955
14:39:31	14.659	0.026	1.560	0.00108	452.8	0.957
14:40:02	14.667	0.034	2.040	0.00142	452.7	0.955
14:40:32	14.676	0.043	2.580	0.00179	452.6	0.953
14:41:02	14.684	0.051	3.060	0.00213	452.5	0.951
14:41:33	14.692	0.059	3.540	0.00246	452.5	0.951
14:42:03	14.701	0.068	4.080	0.00283	452.5	0.951
14:42:33	14.709	0.076	4.560	0.00317	452.4	0.949
14:43:04	14.718	0.085	5.100	0.00354	452.3	0.947
14:43:34	14.726	0.093	5.580	0.00388	452.3	0.947
14:44:04	14.735	0.102	6.120	0.00425	452.2	0.945
14:44:35	14.743	0.11	6.600	0.00458	452.2	0.945
14:45:05	14.751	0.118	7.080	0.00492	452.2	0.945
14:45:35	14.76	0.127	7.620	0.00529	452.1	0.943
14:46:06	14.768	0.135	8.100	0.00563	452	0.941
14:46:36	14.777	0.144	8.640	0.00600	452.1	0.943
14:47:06	14.785	0.152	9.120	0.00633	452	0.941
14:47:37	14.794	0.161	9.660	0.00671	451.9	0.939
14:48:07	14.802	0.169	10.140	0.00704	451.8	0.938
14:48:37	14.81	0.177	10.620	0.00738	451.8	0.938
14:49:08	14.819	0.186	11.160	0.00775	451.7	0.936
14:49:38	14.827	0.194	11.640	0.00808	451.7	0.936
Note: Formation did not take fluid and test was terminated.						


Step Rate Injection Test
MCC 540 1061'-1097'
Bottom-hole Pressure (psig)
1200
1100
1000
900
800
700
600
500
400
14.8
14.85
14.9
14.95
15
15.05
15.1
15.15
15.2
15.25
Time

Step Rate Injection Test MCC 540 1061'-1097'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
14:50:09	14.836	0.000	0.000	3.5	451.9	
14:50:39	14.844	0.008	0.480	3.5	453.6	
14:51:33	14.859	0.023	1.380	3.5	462.8	
14:52:04	14.868	0.032	1.920	3.5	464	
14:52:34	14.876	0.040	2.400	3.5	542.9	
14:53:04	14.885	0.049	2.940	3.5	578.8	
14:53:35	14.893	0.057	3.420	3.5	523.9	
14:54:05	14.901	0.065	3.900	3.5	539.8	
14:54:35	14.91	0.074	4.440	3.5	709.5	
14:55:05	14.918	0.082	4.920	3.5	732.9	
14:55:36	14.927	0.091	5.460	3.5	737.5	
14:56:06	14.935	0.099	5.940	3.5	769.9	
14:56:37	14.943	0.107	6.420	3.5	752.4	
14:57:07	14.952	0.116	6.960	3.5	746.6	
14:57:37	14.96	0.124	7.440	3.5	751.9	
14:58:08	14.969	0.133	7.980	3.5	750.8	
14:58:38	14.977	0.141	8.460	3.5	752.1	
14:59:26	14.991	0.155	9.300	3.5	747.6	
14:59:56	14.999	0.163	9.780	3.5	751.4	
15:00:26	15.007	0.171	10.260	5.5	1091.6	
15:00:57	15.016	0.180	10.800	5.5	1141.7	
15:01:27	15.024	0.188	11.280	5.5	1146.2	
15:01:57	15.033	0.197	11.820	5.5	1146	
15:02:28	15.041	0.205	12.300	5.5	1142	
15:02:58	15.049	0.213	12.780	5.5	1140.5	
15:03:29	15.058	0.222	13.320	5.5	1143.2	Fm Fractured
15:03:59	15.066	0.230	13.800	5.5	1127.2	
15:04:29	15.075	0.239	14.340	5.5	1094.3	
15:05:00	15.083	0.247	14.820	5.5	1076.5	
15:05:49	15.097	0.261	15.660	5.5	1075.7	
15:06:19	15.105	0.269	16.140	5.5	1081.7	
15:06:50	15.114	0.278	16.680	5.5	1077.8	
15:07:20	15.122	0.286	17.160	6	1056.6	
15:07:50	15.131	0.295	17.700	6	1055.9	
15:08:21	15.139	0.303	18.180	6	1023.4	
15:08:51	15.148	0.312	18.720	6	1065.4	
15:09:21	15.156	0.320	19.200	6	1052.2	
15:09:52	15.164	0.328	19.680	6	1049.3	End Test
15:10:22	15.173	0.337	20.220	-	459	
15:10:52	15.181	0.345	20.700	-	453.6	
15:11:23	15.19	0.354	21.240	-	458.4	
15:11:53	15.198	0.362	21.720	-	458.6	
15:12:23	15.207	0.371	22.260	-	458.3	