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November 10, 2006

Mr. Aaron Yue
Project Manager
California Department of Toxic Substances Control
5796 Corporate Avenue
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Subject: Work Plan for Hydraulic Testing in Bedrock Wells
PG&E Topock Compressor Station, Needles, California

Dear Mr. Yue:

This letter transmits the *Work Plan for Hydraulic Testing in Bedrock Wells*. The work plan is submitted in conformance with DTSC's November 3, 2006 letter.

If you have any questions, please do not hesitate to contact me. I can be reached at (805) 234-2257.

Sincerely,

Julie Eakins for Yvonne Meeks

cc. Karen Baker/DTSC
Chris Guerre/ DTSC
John Earle/HNWR
Casey Padgett/DOI

Enclosure

Work Plan for Hydraulic Testing in Bedrock Wells

PG&E Topock Compressor Station Needles, California

Prepared for

California Department of Toxic Substances Control

on behalf of

Pacific Gas and Electric Company

November 10, 2006

CH2MHILL
155 Grand Avenue, Suite 1000
Oakland, California 94612

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This report was prepared under the supervision of a
California-Certified Professional Geologist/Hydrogeologist

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Acronyms and Abbreviations

µg/L	micrograms per liter
bgs	below ground surface
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CACA	Corrective Action Consent Agreement
cm/sec	centimeter per second
Cr(IV)	hexavalent chromium
Cr(T)	total chromium
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DO	dissolved oxygen
DOI	United States Department of the Interior
DTSC	California Department of Toxic Substances Control
E&E	Ecology & Environment
ft/day	feet per day
GMP	Groundwater Monitoring Program
gpd/ft	gallons per day per foot
gpm	gallons per minute
HNWR	Havasu National Wildlife Refuge
IM	Interim Measure
msl	above mean sea level
NTU	nephelometric turbidity units
ORP	oxidation reduction potential
PG&E	Pacific Gas and Electric Company
RCRA	Resource Conservation and Recover Act
RFI/RI	RCRA Facility Investigation and Remedial Investigation
RWQCB	Regional Water Quality Control Board

SC	Specific Conductance
USFWS	United States Fish and Wildlife Service
WDR	Waste Discharge Requirement

1.0 Introduction

Pacific Gas and Electric Company (PG&E) is addressing chromium in groundwater at the Topock Compressor Station near Needles, California, under the oversight of the California Department of Toxic Substances Control (DTSC). On November 3, 2006, DTSC issued a letter entitled "*Additional Bedrock Investigation Based Upon Review of Bedrock Technical Memorandum at Pacific Gas and Electric Company (PG&E) Topock Compressor Station, Needles, California*" to PG&E (DTSC 2006) requiring that PG&E prepare a work plan to conduct hydraulic tests at existing bedrock wells at the Topock site. Three existing bedrock wells (PGE-07 [hereafter referred to as PGE-7], PGE-08 [hereafter referred to as PGE-8], and MW-48) were selected for testing. This work plan has been prepared in response to DTSC's November 3, letter and describes the objectives, technical approach, and proposed field investigations for additional bedrock investigation.

In February 2006, PG&E submitted a technical memorandum entitled *Well Disposition Evaluation for Inactive Supply Well PGE-7* (CH2M HILL 2006), which evaluates various options for retrofitting PGE-7. This work plan incorporates the recommendations in that technical memorandum to clarify the type of flow logging and retrofitting necessary at PGE-7 for hydraulic testing and monitoring.

1.1 Project Background

The Topock Compressor Station is located in San Bernardino County, approximately 15 miles to the southeast of Needles, California (Figure 1-1). Investigative and remedial activities are being performed under the Resource Conservation and Recover Act (RCRA) Corrective Action as well as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In February 1996, PG&E and the California Environmental Protection Agency DTSC entered into a Corrective Action Consent Agreement (CACA) pursuant to Section 25187 of the California Health and Safety Code (DTSC 1996). Under the terms of the CACA, PG&E agreed to conduct a RCRA facility investigation (RFI) to identify and evaluate the nature and extent of hazardous waste and constituent releases at the compressor station. The United States Department of the Interior (DOI) is the lead Federal agency, on land under its jurisdiction, custody or control, and is responsible for oversight of response actions being conducted by PG&E pursuant to CERCLA. Portions of the site where hazardous substances from the Topock compressor station have come to be located are on or under land managed by BLM, USFWS, and the Bureau of Reclamation (BOR) (collectively the "federal agencies"). In July 2005, PG&E and the federal agencies entered into an Administrative Consent Agreement to implement response actions at the site as set forth in the National Oil and Hazardous Substances Pollution Contingency Plan (DOI 2005).

Under the terms of the CACA and Administrative consent agreement, PG&E is conducting the RCRA Facility Investigation/Remedial Investigation (RFI/RI) at the compressor station. The purpose of the RFI/RI is to identify and evaluate the nature and extent of hazardous waste and constituent releases at the compressor station. Since 1996, there have been six phases of investigation at the Topock site to collect data to complete the RFI/RI. Information obtained through the implementation of this work plan is intended to be combined with the existing data and included in the Final Groundwater RFI/RI for the site.

1.2 Objectives of Hydraulic Testing

The DTSC letter dated November 3, 2006, recommending hydraulic testing in PGE-7, PGE-8, and MW-48, described the following objectives and recommended the following related activities:

- Conducting camera surveys in PGE-7 and PGE-8 to verify whether these wells are screened within Miocene conglomerate or crystalline bedrock units.
- Retrofitting well PGE-7 to seal off the open portion of this well within the Alluvial Aquifer, leaving it open only within the bedrock for hydraulic testing.
- Conduct a long-term pumping test in PGE-8 to evaluate the hydraulic properties of the bedrock and the degree of hydraulic communication with other bedrock wells and Alluvial Aquifer wells.
- Conduct pumping tests in PGE-7 and MW-48 to further characterize hydraulic properties of the bedrock, and evaluate vertical gradients.
- Evaluate the distribution of chromium in crystalline bedrock through collection of groundwater samples at periodic intervals during the PGE-8 test.

1.3 Well Records

The following provides location and well record information for PGE-7, PGE-8 and MW-48. Table 1-1 summarizes well construction information for PGE-7, PGE-8, MW-48, and select other nearby wells. Figure 1-1 shows the locations of existing groundwater monitoring wells at the Topock site.

1.3.1 Well PGE-7

Well PGE-7 is located on the Havasu National Wildlife Refuge (HNWR) approximately 250 feet northwest of the north gate to the Topock Compressor Station in an area known as the MW-24 bench (Figure 1-2). PGE-7 was originally installed in 1964, to a depth of 182 feet below ground surface (bgs), as a replacement water supply well for the Topock Compressor Station. Figure 1-3 is a schematic well completion diagram that summarizes the original well construction details and observations from a video log recorded by PG&E's contractor in 1998. The original well was constructed with 14-inch steel casing, with perforations assumed from 110 feet to 180 feet bgs. In 1969, the well was deepened to 330 feet bgs, with a 7-inch-diameter blank steel liner installed to 195 feet bgs, and the remainder of the hole uncased to 330 feet bgs.

No geologic log for the drilling and deepening of PGE-7 is available in PG&E's records to provide lithologic description of the bedrock formation in this well.

Based on a review of the 1998 video log of the well, the depth of the contact of the Alluvial Aquifer with the Miocene conglomerate (bedrock) in PGE-7 is estimated at 220 feet bgs.

Therefore, approximately 25 feet of the open-hole portion of PGE-7 is open across the Alluvial Aquifer (Figure 1-3). Although the hydraulic gradient is upward in this area, there is the potential that PGE-7 could provide an interconnection between the Alluvial Aquifer and the bedrock, so it is desirable to retrofit or decommission this well. As previously identified in the technical memorandum *Well Disposition Evaluation for Inactive Supply Well PGE-7* (CH2M HILL 2006), there are a number of options available for reconstruction or decommissioning of this well.

1.3.2 Well PGE-8

Former injection well PGE-8 is located on the lower bench of the Topock Compressor Station property (Figure 1-2) and was completed in June 1969. The original boring extended to a depth of 530 feet bgs. Ground surface at this location is approximately 595 feet above mean sea level (msl). The well was drilled with a combination of mud and air rotary techniques. Figure 1-4 is a schematic well completion diagram that summarizes well construction details for PGE-8. The alluvium and the metadiorite bedrock contact was estimated to be at 175 feet bgs (421 feet msl) (Dames & Moore 1969). During drilling, a sharp increase in groundwater specific conductance was noted below 273 feet bgs (320 feet msl) (Dames & Moore 1969).

The boring was originally completed with 6-inch steel casing to 188 feet bgs (405 feet msl), with the remainder of the borehole open. Soon after wastewater injection began (June 1970), collapse of the bottom 15 feet of the well was noted (PG&E 1995). The well was subsequently cleaned and deepened from 530 to 562 feet bgs via air rotary drilling. A Johnson well screen and liner assembly, composed of 4-inch diameter stainless steel, was installed from 405 to 550 feet bgs.

1.3.3 Well MW-48

Well MW-48 is located on the HNWR approximately 1,000 feet northeast of the north gate to the Topock Compressor Station (Figure 1-1). This well was installed in May 2006 as part of the Interim Measures Performance Monitoring drilling program for better definition of the depth to bedrock in the southern part of the site. A ten-foot screen was installed within the bedrock from 362-352 ft MSL for monitoring bedrock water quality (Table 1-1).

1.4 Work Plan Organization

The remainder of this work plan describes proposed activities to achieve the hydraulic testing objectives at the three existing wells. Section 2 provides a description of plans for well redevelopment and down hole logging prior to the aquifer testing. Section 3 describes the retrofitting that will be conducted at PGE-7 and PGE-8 to allow use of these wells for hydraulic testing. Sections 4 and 5 describe the hydraulic testing and data collection methods. Section 6 describes the management of water generated during the aquifer tests. Section 7 describes staging areas and other considerations. Section 8 provides the proposed schedule for this work. Section 9 lists the approvals and authorizations required to conduct the work. Aquifer test analysis and reporting are covered in Section 10.

2.0 Proposed Inspection and Redevelopment Activities

2.1 Downhole Surveys in PGE-7, PGE-8 and MW-48

2.1.1 PGE-7

Well PGE-7 was video-surveyed in 1998. This video log will be repeated in conjunction with the geophysical logging. Geophysical logging in the open hole section of PGE-7 will include induction, resistivity, natural gamma, acoustic televiewer, and caliper logs. One or more types of depth specific flow logging (either FLUTe™ liner installation, downhole flow meter or high-resolution temperature logging) will be conducted to identify conductive fractures. The video log will be used to determine the current conditions of the well casing. Video and acoustic televiewer logs will be used to identify fractures. Induction, resistivity, and natural gamma logs will be used to identify the bedrock contacts and changes in groundwater salinity with depth. Geophysical logging at PGE-7 will be necessary for determining where to screen and pack off this well, so that the approximately 25 feet of the hole that is exposed to the Alluvial Aquifer can be eliminated from testing and water levels can be monitored adjacent to conductive fracture zones. Flow logging will provide insight as to where to screen this well, and for planning aquifer-testing activities.

The 1998 video log of PGE-7 indicates angular rock with possible fractures is visible in the open borehole from 234 feet to the bottom of the borehole at 303 feet bgs (video log report included as Appendix A). Based on logs from nearby borings (MW-24BR and TW-1), the bedrock formation present in PGE-7 is believed to be consolidated/cemented Miocene conglomerate. The lower portion of the PGE-7 deepened borehole may have also encountered the pre-Tertiary metadiorite bedrock that was logged in the former injection well PGE-8 (located approximately 750 feet south of PGE-7).

Flow logging in PGE-7 with a FLUTe™ liner is described in Section 3.2 of this report, and is the recommended method for locating conductive fractures in the borehole. Using a down-hole flow meter could be problematic since the bedrock may not produce a high enough flow rate to conduct a flow meter test. In addition, since PGE-7 is an open hole without casing, interpretation of a flow meter log could be difficult due to complications associated with the rough edges of the borehole. Conductive fractures can also be located by monitoring temperature changes in response to initiation of pumping using a string of sensitive thermistors installed in the open borehole**.** The decision to use thermistors will be based on the results of the FLUTe™ liner installation and the availability of equipment sensitive enough to be successful in measuring the small temperature changes indicative of flow from individual fractures.

2.1.2 PGE-8

PGE-8 has not been video-surveyed. This well will be videoed prior to conducting geophysical logging. Acoustic (cement bond) and natural gamma geophysical logging will follow video surveying. Cement bond logs are run in cased wells to show that a cement seal was placed and to determine the relative quality of the bond between the grout and the casing. The natural gamma ray log is one of the few geophysical methods that can be used in steel-cased holes. It is intended to provide information on the lithology.

2.1.3 MW-48

Logging at well MW-48 will include natural gamma, resistivity, and induction.

2.2 Redevelopment of Wells PGE-7 and PGE-8

To help ensure that wells PGE-7 and PGE-8 produce good test results, each well will be redeveloped prior to hydraulic testing. Development procedures will also provide preliminary information about what sustainable pumping rates may be for constant rate pumping tests. Well MW-48 was developed recently in May 2006, so no development is planned at this location.

Depending on the condition of the well as seen in the video log, re-development of inactive supply well PGE-7, which has an open hole from 195 to 303 feet, will include brushing, bailing, and/or pumping. Re-development procedures at PGE-8 will be dependent on the condition of the casing (as seen in the video log) and the findings of the acoustic (cement bond) log. Once the condition of the casing is determined, well development will include either airlifting or swabbing, followed by bailing and pumping.

During development, temperature, pH, specific conductance, and turbidity will be measured using calibrated field instruments. Well development will continue until field parameters stabilize, and turbidity is reduced to less than 50 nephelometric turbidity units (NTUs). Documentation of well development activity will include development procedure, time and date of development, volume of water removed, and field parameter measurements.

Well development will be conducted in accordance with methods and procedures in the *Field Procedures Manual* (CH2M HILL 2005).

3.0 Proposed Well Retrofitting Activities

3.1 Retrofitting PGE-8 for Hydraulic Aquifer Testing

The type of retrofitting that PGE-8 will need for a constant rate pumping test will be determined from video, geophysical logging, and development. Assuming the casing is in acceptable condition, little retrofitting is anticipated other than installing the pump approximately 20 feet above the screen, and placing a pressure transducer above the pump. If the casing is in poor condition, it may be necessary to install a liner to isolate the portion of the casing that is perforated or in poor condition during testing. Alternatively, the portion of the well with perforated casing could be isolated using an inflatable packer.

For an injection test, PGE-8 will be equipped with injection tubing and an inflatable packer. The packer will be set in the blank casing above the screen. Injection tubing will extend to a depth near the top of the screen. The injection test will involve injecting at a constant pressure and measuring the changes in flow rate over time. The pressure to be used for the injection will be determined based on the results of the constant rate pumping test and the geophysical logs.

3.2 Retrofitting PGE-7 for Water Level Monitoring

PGE-7 is one of only five wells that are screened in the bedrock unit at the Topock site (along with MW-24BR, MW-23, PGE-8, and MW-48). As previously described in a technical memorandum (CH2M HILL 2006), with proper reconstruction PGE-7 could provide a valuable bedrock monitoring. Three options for reconstructing PGE-7 as a bedrock monitoring well were evaluated:

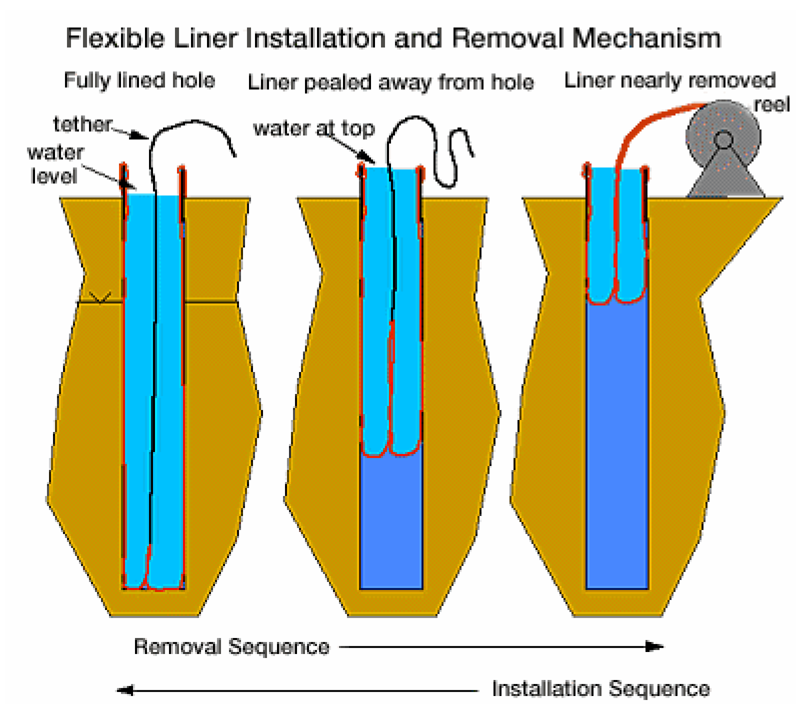
1. Installation of the Water FLUTe™ liner equipped with multilevel sampling ports
2. Installation of Barcad samplers or nested 1-inch diameter mini-wells to provide multi-level sampling ports within the existing open borehole
3. Installation of a standard 2-inch diameter PVC monitoring well within the existing open borehole

DTSC has identified that well PGE-7 may not be grouted across the alluvial aquifer and may therefore provide cross-connection between different depth intervals in the alluvium. DTSC has indicated that they will direct PG&E to assess options to abandon well PGE-7 after it is no longer needed as a bedrock monitoring well. The FLUTe™ liner system is therefore the preferred method of retrofitting this well because it can be easily removed to allow abandonment of the well. The other methods would likely require more intrusive measures such as drilling out the plastic casings, gravel pack, and grout materials in order to properly abandon the well. The manufacturer of the FLUTe™ liner system has viewed the 1998 video log of PGE-7 and indicates there are no sharp protrusions or abrupt changes in diameter that would preclude the use of the FLUTe™ system. Assuming that the video log to be conducted prior to the retrofit shows the well to be in a similar condition as in the 1998 video log, the FLUTe™ liner system will be used to retrofit this well for sampling and to blank off the alluvial section of the well, preventing cross connection between the alluvial aquifer and the bedrock.

3.2.1 FLUTe™ Liner

A method by which PGE-7 could be temporarily sealed has been identified, which would eliminate any potential for cross-connection between alluvium and bedrock at this well. This method involves the installation of a flexible membrane liner manufactured by Flexible Liner Underground Technologies, LLC (FLUTe). The description and schematic of the basic FLUTe™ system presented below are from the company's web site (http://flut.com/meth_1.htm).

> The FLUTe™ liner is usually made of a urethane coated nylon fabric in tubular form. The liner is often installed in a hole with the interior of the liner filled with water (see the diagram below). The water pressure presses the liner firmly against the borehole wall. A cord, called a tether, is attached to the bottom end of the liner. If that cord is pulled upward, the liner is peeled inside-out out of the hole. The liner is said to "invert" as it is pulled upward. The water level in the liner rises as the liner is shortened by the inversion. At the surface, the tether, followed by the liner, can be wound on a reel. The third drawing shows the liner nearly fully removed from the hole with the water spilling over the top of the pipe to which the top end of the liner is attached.



> The installation of the liner is the precise reversal of this procedure. The liner is filled with water which forces it to roll out against the borehole wall as it descends into the hole. This process, the reverse of inversion, is called "eversion." By adding water and allowing the liner to pull itself to the bottom of the hole, one is back to the initial state with the liner fully extended in the hole.

A recently developed technique allows identification of permeable zones within the borehole during installation of the liner. The basis of the technique is that, as the sealing liner descends, it displaces the borehole water into the formation. The descending liner also seals the hole and therefore, it covers the flow paths from the higher portions of the hole as it descends. The descent rate is controlled by how easily the water flows from the hole back into the formation. Hence, by recording the descent rate of the liner and the level of excess head inside the liner, one can deduce the effective transmissivity of the remaining section of the hole. As each significant flow path is sealed by the liner descent, the remaining transmissivity decreases. That decrease is equal to the transmissivity of the portion of the hole just covered, and the end result is a plot of the transmissivity with depth. This technique is especially well suited to situations where flow from the hole is often dominated by a few, relatively free-flowing fractures. However, if the permeability of the bedrock is uniformly low, the everting liner technique may not be sensitive enough to identify very small changes in flow at each small fracture zone.

While the FLUTe™ system discussed here is designed to profile the hydraulic conductivity of the borehole and to provide a seal against vertical flow, the FLUTe™ system can be modified at some future date to allow for the collection of water quality samples from multiple depths in the borehole (see Water FLUTe™ below). If it is determined that PGE-7 is no longer needed, the FLUTe™ liner could be removed and the borehole permanently abandoned using conventional well abandonment techniques, such as pressure grouting. Although leakage of the liner has not been a problem for FLUTe™ users (up to ten years use in wells with no leakage), monitoring of water levels inside the liner provides a simple way to monitor liner integrity.

Water FLUTe™

As with the basic FLUTe™ liner described above, the Water FLUTe™ system allows for the sealing of a borehole, but includes tubes and ports for water quality sampling and hydraulic head measurements. The tubes and ports are added to the liner at the factory at the desired depths, and spacers can be installed around the ports to increase the area of sample collection if needed. Pressure transducers can be installed in-line with the sample tubes during construction of the liner, and slender electronic water level meters can measure hydraulic heads at depths of up to 150 feet in the 0.5-inch tubes. Each sample tube runs from the sample port to a central U-shaped tube and then to the surface. A check valve ensures that water can only flow from the sample tube to the U-tube. Samples are taken by applying pressurized gas to one side of the U-tube, forcing the water up and out the other side. When the pressure is reduced, the U-tube is refilled with water from the port. Each port has a dedicated sample tube and U-tube, so no water is shared between sampling depths. Since the opening of the sample tube is in direct contact with the geologic formation, only the sample tube needs to be purged, and purge volumes are dramatically reduced (i.e., 200 feet of 0.5-inch tubing = 2 gallon volume). More information is available at http://www.flut.com/meth_2.htm.

3.3 Retrofitting PGE-7 for Hydraulic Testing

3.3.1 Inflatable Packer to Isolate Bedrock from Alluvium with Pump below Packer

Once PGE-7 has undergone geophysical and flow logging, it will be evident what portion of the open hole has the largest or greatest density of fractures, and how much of the open hole will need to be packed off to eliminate the Alluvial Aquifer from testing. An inflatable packer will be installed near the top of the bedrock. A pump sized according to the expected yield of the bedrock section of the borehole will be placed below the packer. The packer will isolate the overlying Alluvial Aquifer from the pumped interval in the bedrock.

4.0 Proposed Hydraulic Testing Activities

4.1 PGE-7

PGE-7 has the greatest uncertainty in yield of all three wells proposed for hydraulic testing. Since this well is currently screened approximately 25 feet into the alluvium and this portion of the open hole will be eliminated from testing, there are no data to allow estimation of a pumping rate that this well might sustain once retrofitted as a bedrock well. Results of flow logging will aid in planning the rate and length of this test. Table 4-1 presents purge data and aquifer test results for PGE-7, PGE-8 and MW-48. Hydraulic testing results from two other bedrock wells on site, MW-24BR and MW-23, suggest that there could be very low yield from the bedrock at PGE-7.

- Bedrock well MW-24BR is approximately 150 feet north of PGE-7, with a similar length of screen in bedrock as PGE-7; however, this well is completed in cemented sandstone and/or crystalline metamorphic bedrock, which underlies the Miocene conglomerate unit which is penetrated by PGE-7. The Miocene conglomerate thought to be present at PGE-7 may produce more water than the cemented sandstone and/or crystalline metamorphic bedrock present at MW-24BR. In 2002, MW-24BR was pumped for one minute, resulting in an initial drawdown of 11.1 feet. The water level in the well almost fully recovered in 37 hours. During routine groundwater sampling, well MW-24BR typically takes up to six days to fully recover after a 3-casing-volume purge. Based on the 2002 rising-head test, the estimated hydraulic conductivity for the bedrock formation is 9.7×10^{-7} cm/sec (2.8×10^{-3} ft/day), similar to that of clay or well-cemented, unjointed sandstone (Ecology & Environment [E&E] 2002).
- Bedrock well MW-23 is completed in the Miocene conglomerate unit (referred to in some previous PG&E reports as Red Fanglomerate), with a 20-foot well screen. The formation is described as cemented, pebble conglomerate and sandstone. In 2002, a rising head slug-test was conducted to estimate the hydraulic properties of this bedrock formation. After a short duration of pumping generated 10.8 feet of drawdown, the well required almost 15.5 hours for water levels to fully recover. Based on this test, the estimated hydraulic conductivity of the formation was estimated to be 1.5×10^{-6} centimeter per second (cm/sec) (4.3×10^{-3} ft/day), similar to that of silt or poorly fractured bedrock (E&E 2002).

Once PGE-7 is retrofitted and/or packed off to test the bedrock interval of the open hole, testing will be designed so that the constant rate extration test runs for a long enough duration to drain primary fractures, so there is a chance to see response in MW-24BR, and perhaps other Alluvial observation wells. Table 4-2 identifies observation wells that may be instrumented with pressure transducers during pump testing. Electric power for the pump will come from the City of Needles power supply at MW-24 bench (if it is installed prior to testing), or from portable generators.

If it is determined that PGE-7 does not produce enough water for a constant rate pumping test, PG&E will confer with DTSC to evaluate alternative types of hydraulic testing that might be appropriate for this well. Depending on the number and permeability of fractures observed in the well, this could include packer tests to evaluate individual fracture zones, a slug, short term pumping, or an injection test.

4.2 PGE-8

As originally completed, PGE-8 was tested on various occasions for short durations (12-60 minutes) at flow rates ranging from 20 to 51 gallons per minute (gpm), then for a longer period (26 hours) at 26 gpm. Dames & Moore (1969) calculated a transmissivity of 10,000 gallons per day per foot (gpd/ft) (~1,300 ft^2/d), based on the longer duration test (using a porous media analysis). The results from the 26-hour test (rapid drawdown in early time followed by stabilized water levels for an extended period of time) show a response typical of double-porosity aquifers or leakage from overlying layers. In either case, a porous media analysis is inappropriate, and will yield erroneously high permeability values. Table 4-1 summarizes purge and aquifer-testing records for PGE-8 and other bedrock wells on site. Data and records from the 1969 well pumping test at PGE-8 are included in Appendix B.

The Dames and Moore test in 1969 was able to achieve a constant pumping rate of 26 gpm for 26 hours; however, the yield of this well in its current state is uncertain. The 1969 Dames and Moore test was conducted when this well was an open hole from 405-530 feet bgs, and before this well was used as an injection well. In April 1970, injection testing was conducted at 20-40 gpm with no pressure build-up observed during testing (PG&E 1995). However, results from this injection test have similar problems in quantitative analysis as the 1969 pumping data. From a strictly qualitative perspective, the aquifer takes water over a 24-hour period, but the data do not allow for quantitative analysis using either porous or fractured media techniques. These tests were designed to give the driller a general idea of whether the wells had sufficient capacity to achieve the pumping or injecting goals, and were not of sufficient quality or duration to allow for fractured media analysis.

After the injection testing in April 1970, injection of wastewater began on May 30, 1970, and pressure rapidly built to 30 psi. By June 4, 1970, pressure had built to 180 psi despite efforts to reduce pressure build-up by pouring 38 percent hydrochloric acid into the injection tubing. Upon sounding the well, it became evident that the lower 15 feet of the hole had collapsed. In June 1970, the well was cleaned out and deepened from 530 to 562 feet bgs using air rotary techniques. A Johnson well screen and liner composed of 316 stainless steel was lowered into the well and set from approximately 404.5 to 550 feet bgs (Figure 2-3). It is assumed that a sump was placed from 554 feet and the bottom of the boring. Well PGE-8 was used for disposal of treated cooling tower blowdown water from 1970 to August 1973. After August 1973, treated water was disposed of in PGE-8 and in the former evaporation ponds on a 3-day alternate cycle. The last record of injection into PGE-8 was in a report dated February 8, 1974, when 1,100 gallons was recorded as being injected since the last report on January 15, 1974 (PG&E 1995).

4.2.1 PGE-8 Pumping Test

The rate and duration for pumping at PGE-8 will be determined based on pumping rates observed during well development and with consideration for the logistics of managing the water pumped from this well during the aquifer test. It is anticipated that a 3-4 day test from this well will provide sufficient data for determination of aquifer properties at this location. Assuming that the sustainable pumping rate will be about 20 gpm, between 90,000 and 115,000 gallons of water would be produced in a 3-4 day test. Plans for temporary storage and management of this water are provided in Section 9. Observation wells that would be instrumented with pressure transducers during testing in PGE-8 are listed in Table 4-2. Electric power for the pump will be provided from the compressor station power supply or from portable generators.

4.2.2 PGE-8 Injection Test

If water level response is observed in multiple monitoring wells during the constant rate pumping test, there may be little benefit in conducting an injection test. However, if PGE-8 is not able to be pumped at a high enough rate to produce a measurable response at the observation wells and necessary approvals can be obtained in a timely manner, an injection test will be conducted. By pressurizing the screened interval of PGE-8, it should be possible to achieve higher flow rates than by pumping.

Subject to Regional Water Quality Control Board (RWQCB) approval, the injection test would involve re-injection of water pumped out during the constant rate-pumping test or injection of potable water from the Topock Compressor Station (TCS). The injection test will be conducted as a constant pressure, variable flow rate test. Because the injection pressures at a given flow rate won't be known prior to the test, a constant pressure test provides for a more certainty in specifying an injection pump and associated components. Pressure will be maintained using a pressure regulator and flow rates will be measured either manually or through use of an electronic flow meter/data logger. Filters will be installed to prevent any sediment in the water from plugging the injection well.

4.3 MW-48

Table 4-1 shows purge records for MW-48 (and other bedrock wells) since it was initially sampled upon completion in May 2006. This well has not been able to produce enough water for removal of three casing volumes (56 gallons) on all three sampling events. Sampling at this well has consisted of purging the well dry, as the pump is lowered to nearly the bottom of the well, then returning to the well a day to two later to collect a sample. In the October sampling event, MW-48 was pumped at about 1.5 gpm until the well went dry after 14 minutes. The well was left to recover for two days before samplers returned to collect the sample. After two days the depth to water was still nearly 30 feet below where the static water level had been two days previously.

Due to the extremely low yield, it is not feasible to conduct a constant rate-pumping test in MW-48. Slug testing is proposed instead. A pump will be installed 10 feet above the screen of the well and a pressure transducer will be installed above the pump. The well will then be pumped at the maximum flow of the pump (3 to 5 gpm) until the water level drops to just above the pressure transducer. The pump will then be shut off and the water level recovery will be measured with the pressure transducer. A one-way valve will be installed just above the pump to prevent backflow of water from the discharge line after the pump is shut down. Judging from previous sampling event data, recovery could take up to 4-5 days to occur. The test at this well will likely be coordinated with the next planned Groundwater Monitoring Program (GMP) sampling event after agency approvals.

5.0 Data Collection

5.1 Collection of Water Quality Data

Water quality will be measured routinely during well development and testing. A flow-thru cell will be used to monitor pH, specific conductance (SC), oxidation-reduction potential (ORP), dissolved oxygen (DO), and temperature during pumping activities. Wells PGE-7 and PGE-8 will be sampled for Cr(VI) and Cr(T) daily during the constant rate tests.

5.2 Collection of Water Level Data

Water levels during pre-test and test operations will be measured with an electric sounder and/or pressure transducers to a minimum of the nearest 0.01 foot, and water levels will be referenced to a permanent location established at each wellhead. The static water level measurements taken using an electric sounder will be recorded on standardized forms. Water levels measured using transducers will be downloaded frequently and stored on recordable media. Transducers will be installed in test wells and observation wells at least a week before testing such that ample antecedent data is collected (Table 4-2). Due to the constant fluctuation of water levels caused by changes in river stage, it will be necessary to have antecedent data in order to de-convolute the effects of the river level changes from the water level changes caused by pumping.

Water levels will be measured in the extraction well and designated observation wells with pressure transducers. Once pumping has started, manual water levels will be measured in the extraction well at the following intervals:

- Every minute during minutes 1 through 10
- Every 2 minutes during minutes 10 through 20
- Every 5 minutes during minutes 20 through 60
- Every 10 minutes during minutes 60 through 120
- Thereafter at a frequency to be determined by the onsite hydrogeologist.

Water level recovery will be measured in the extraction well and observation wells after the pumping portion of each test has ended. The frequency of water level recovery measurements will be the same as for the pumping portion of the test. Note that it will not be possible to manually measure water levels in the pumped interval below the packer during the pumping test at PGE-7. A transducer will be installed in the PGE-7 pumped interval to record water levels during pumping.

The recovery portion of the test will be conducted until water levels in the extraction well and observation wells have recovered to within approximately 0.05 foot of pre-test static water level conditions, taking into account the pre-test water level trend and stage of the Colorado River. The water level recovery data for the extraction well and observation wells will be plotted using appropriate computer plotting software.

6.0 Management of Water and Equipment during Well Development and Testing

6.1 Management of Generated Water

During testing activities, water will be pumped through flexible hoses from the wells directly into trucks or tanks near the wellhead. A temporary secondary containment pad will be placed beneath any removable couplings and beneath any storage tanks to minimize the possibility of spills during the retrofit and tests. Unless otherwise stated below, water generated during well development and testing will be treated at the IM-3 treatment plant, as authorized by Waste Discharge Requirements, Order R7-2006-0060 (RWQCB 2006). Water from testing will be trucked and taken to the IM-3 treatment plant. Water will trucked offsite if treatment at the IM- 3 treatment plant is not possible.

Prior to conveying the aquifer test water to the IM-3 facility, it will be sampled to confirm it can be blended with the plant influent without causing any problems to the treatment process. Water will then be conveyed to the IM-3 treatment plant at a rate that is consistent with the plant's available capacity to process the water. The water will be conveyed either by pumping the water through the existing pipeline to the IM-3 treatment plant from the MW-20 bench (at vault #1), or by tanker truck. Management of the aquifer test water at IM-3 will result in temporary pump rate reduction at extraction well TW-3D.

6.1.1 PGE-7

Since the permeability of the Miocene conglomerate (in which this well will be screened) is uncertain, there are several possibilities for how to manage test water at this location depending on the well's yield:

- If yield is low (1 gpm or less) water would be stored in a portable tank, tank trailer, or tank truck located on the MW-24 bench near the well.
- If yield is greater than 1 gpm, the amount of water generated would likely exceed the volume that could easily be stored at the wellhead (1,000 gallons). Due to the poor condition of the gravel road from the compressor station to PGE-7, it is not feasible to transport large volumes of water by truck up this road. Assuming the yield is as high was five gpm, and a three-day test is conducted, approximately 22,000 gallons of water would be produced. Water would need to be pumped from the well into a small holding tank at the well, and then transferred to one or two holding tanks or tank trailers located on compressor station property approximately 200 feet away. Temporary double-walled piping would be installed above ground to convey water from the wellhead-holding tank to the compressor station. This same method was used during the pumping test of well TW-1 in 2004.

6.1.2 PGE-8

PGE-8 is located on PG&E property. Groundwater removed from PGE-8 will be transferred from the wellhead to 6-8 temporary 20,000-gallon frac tanks, placed over secondary containment, located in close proximity to the wellhead. Historic sampling data for this well has not detected any hexavalent chromium. Water will be tested for Cr(VI) and total chromium (Cr[T]) and stored for a few days so that fines settle. Pending the need for an injection test and RWQCB approvals, the water may be re-injected into PGE-8, such that no water from PGE-8 testing will need to be taken to the IM-3 treatment plant. This test will be conducted similar to testing in the injection well field of the East Mesa in 2004 (CH2M HILL 2004). In the East Mesa testing, water extracted from the current injection wells (IW-2 and IW-3) was re-injected after it was tested and found to be less than the daily limit of 16 µg/L for Cr(VI) and 50 µg/L for Cr(T) (RWQCB 2006). If the water exceeds daily limit concentrations or the injection of test water is not approved this water would be taken to the IM No. 3 treatment plant daily for treatment.

6.1.3 MW-48

This well will not produce more than 50 gallons of water, so the use of a GMP sampling truck with a 200-gallon tank will be all that is necessary for containment. Water pumped from this well will be managed with other purge water at the IM-3 treatment plant.

7.0 Staging Areas and Access

Preparatory staging for testing activities at wells PGE-7, PGE-8, and MW-48 will occur at the laydown area (core storage yard) immediately in side the Topock Compressor Station (TCS) main entrance gate.

Well PGE-8 is on PG&E property, and has ample space around the wellhead for staging a well development rig, and water storage. All tanks, piping and manifolds will be placed over secondary containment (as a precautionary measure) during testing. TCS power or generators in tandem are planned to meet power supply requirements for constant rate pumping. The use of two generators in tandem will be necessary to maintain a constant power supply and pumping rate during constant rate pumping.

Access to well PGE-7, located on the Havasu National Wildlife Refuge, will follow previously established roads extending from the north gate of the TCS to the MW-24 bench (Figure 1-2). Staging for hydraulic testing activities at PGE-7 will occur at the TCS laydown area, and with limited daily staging at the MW-24 bench. As mentioned in section 6, the volume of water that this well will produce unknown at this time. If yield is low (less than 1 gpm), a development truck or pickup truck with a trailer holding tanks would be located close to the well head for water storage during testing for a one day test. If well yield is greater than one gpm, and a longer testing duration test planned, it will not be feasible to transport larger volumes of water on the gravel road from the MW-24 bench to the TCS. If this becomes the case, water storage during testing will be accomplished by running a temporary double walled pipe from a small tank (few hundred gallons) at the PGE-7 wellhead and pumping it up to the TCS into trailer tanks or holding tanks, until treatment at the IM No.3 treatment plant could occur. Power supply will come from the City of Needles power (scheduled to be installed at the MW-24 bench in early 2007), or using generators in tandem.

Testing at well MW-48 will likely occur as part of the next routine GMP sampling event at this well, so no unique staging considerations or access issues are associated with testing at this location.

8.0 Schedule

The schedule for the inspection, redevelopment, retrofitting, and aquifer testing activities at existing wells PGE-7 and PGE-8 is provided in Table 8-1. The implementation schedule is subject to obtaining approvals and authorizations from DTSC, HNWR, and other agencies. The investigation fieldwork will be conducted during daylight hours.

TABLE 8-1
Project Implementation Schedule
Work Plan for Hydraulic Testing in Bedrock Wells PGE-7 and PGE-8
PG&E Topock Compressor Station, Needles, California

Activity	Duration
Mobilization and equipment set up	2 weeks
Well inspection, redevelopment, retrofitting and hydraulic testing	6 weeks
Aquifer Test Report	8 weeks from completion of testing activities

Three new deep monitoring wells are planned to be installed in the Alluvial Aquifer on the MW-24 bench as described in the *In Situ Hexavalent Chromium Reduction Pilot Test Work Plan – Upland Plume Treatment* (Arcadis 2006). These wells could provide observation wells during testing at PGE-7 and PGE-8. Ideally, the aquifer testing would be conducted after these wells are installed and prior to the start of the in-situ pilot test. The relatively large pumping rates associated with the in-situ pilot testing will mask any hydraulic effects caused by the relatively small pumping rates from the bedrock wells.

9.0 Approvals and Authorizations

Table 9-1 provides a listing of approvals and authorizations that have been identified as applicable to the implementation of the well inspection, redevelopment, retrofitting, and hydraulic testing activities as proposed herein.

TABLE 9-1
Approvals and Authorizations
Work Plan for Hydraulic Testing in Bedrock Wells
PG&E Topock Compressor Station, Needles, California

Agency	Approvals and Authorizations
California DTSC	As state lead agency, approval letter from DTSC is required. DTSC will comply with CEQA.
Havasu National Wildlife Refuge	Approval letter from USFWS HNWR required for activities at PGE-7 and MW-48. Approval subject to NHPA Section 106 and ESA Section 7 consultations (see below).
U. S. Fish and Wildlife Service	USFWS HNWR approval subject to completion of a Section 7 ESA consultation.
State Historic Preservation Office	USFWS HNWR approval subject to NHPA Section 106 process involving a 30-day Tribal consultation and a 30-day SHPO consultation.
Bureau of Reclamation	Subject to review of underlying land ownership of the project site, approval from the HNWR may require concurrence from the BOR.

Approval from the DTSC is subject to compliance with the California Environmental Quality Act (CEQA).

Existing wells PGE-7 and MW-48 are located on HNWR, and therefore the activities at these wells are subject to approval by the HNWR. The anticipated approval mechanism from the HNWR is expected to be an approval letter with conditions (if applicable). Prior to issuance of the approval letter, the HNWR is first required to comply with the Section 7 of the Endangered Species Act (ESA) and Section 106 of the National Historic Preservation Act (NHPA). Compliance with Section 106 of the NHPA is expected to involve a 30-day consultation with local Native American tribes and a 30-day consultation with the State Historic Preservation Office (SHPO).

10.0 Reporting

10.1 Data Analysis

When testing is complete, the data from the constant rate extraction tests, injection test (if conducted) and recovery tests will be analyzed to estimate bedrock hydraulic characteristics and possible connection between the bedrock and alluvial aquifers. The methods selected for data analysis will be based on the conceptual framework and the observations made during the test. The data analysis will include evaluation of the potential impacts of the test site conditions such as variations in pumping rates, atmospheric barometric variations, and partial penetration effects. As needed, the effects of the Colorado River on variations in water level data will be removed using a deconvolution method (Halford 2006), that has been used with success during analysis of previous aquifer testing at the Topock site to remove the influence of the river from analysis.

The test data first will be evaluated using conventional analytical techniques for single and multilayer aquifers. This analytical evaluation will be followed by simulating the testing in the Topock groundwater model. The groundwater model will have the ability to incorporate more realistic aquifer geometry and boundary conditions than commonly used analytical techniques.

10.2 Reporting

A letter report will be prepared and submitted to DTSC approximately 8 weeks following the conclusion of the aquifer test activities. The report will summarize the methods and procedures used during the aquifer test activities, field data, results of the data analyses, and estimates of the hydraulic characteristics of bedrock.

11.0 References

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U. S. Department of the Interior (DOI). 2005. IN THE MATTER OF: Topock Compressor Station, PACIFIC GAS AND ELECTRIC COMPANY (Respondent), Proceeding Under Sections 104 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act as amended 42 U.S.C. §§ 9604 and 9622 -- Administrative Consent Agreement. July 11.

Tables

TABLE 1-1
Well Construction Information for Test and Surrounding Monitoring Wells
Work plan for Hydraulic Testing in Topock Bedrock Wells
PG&E Topock Compressor Station

Well ID monitored zone	Completion Date	Ground Elevation ft MSL	Well Depth ft bgs	Well Material	Well Perforation / Screen Interval: Depth ft bgs	Well Perforation / Screen Interval: Elevation ft MSL	Screen Length ft	Remarks
PGE-7	Sep-1964	563	182	14" steel	110-180[1]	453-383[1]	---	Installed as replacement supply well for Station
Bedrock and 25' of basal interval of Alluvial Aquifer	Aug-1969		330	7" steel liner to 195'	195 - 330 6.7" openhole	368 - 283	135	Re-completed as a monitoring well in 1969. March 1998 video log: casing liner to 195' and openhole boring to silted bottom at 303' (108' openhole)
PGE-8	1-Jan-69	595	530	6" steel casing to 405'				
Bedrock				open hole completion 405-530	405-530	191-66		Initially an open hole completion in 6.7" borehole 405-530 ft bgs.
	1-Jun-70	595	562	4" stainless steel screen installed	498-550	98-46		1970 Well Recompletion. 4" stainless steel liner installed in open hole section, 2 foot sections of 4" 80 mesh screen, with 10 ft sections of 4" blank casing up to 498 ft. From 498-550 ft bgs, 4" stainless steel 80 mesh screen
MW-48 Bedrock	3-May-06	486	138	2" PVC	124-134	362-352	10	
MW-24A Upper Alluvial Aquifer	May-1998	565	125	4" PVC	104 - 124	461 - 441	20	
MW-24B Base Alluvial Aquifer	May-1998	563	214	4" PVC	194 - 214	369 - 349	20	
MW-24BR Bedrock	Apr-1998	563	438	4" PVC	378 - 438	185 - 125	60	Boring was logged as "Red Fanglomerate (rock) and Sandstone" from 225' to 441'

Notes:

(1) Well perforation depths for **original completion of PGE-7** are not available; assume similar well completion to the 70-foot perforated completion used for PGE-6.

MSL = mean sea level. ft bgs = feet below ground surface. (--) = data not available. PVC = polyvinyl chloride.

Ground surface elevations and well screen depths are rounded-off to whole-foot.

Static water levels in PGE-6, PGE-7, and MW-24 wells typically range from approximately 106 to 108 feet bgs.

TABLE 4-1
Purge and Aquifer Testing Results for Bedrock Wells
Work Plan for Hydraulic Testing in Topock Bedrock Wells
PG&E Topock Compressor Station

Well ID	Date	Drawdown (ft)	Average Pumping Rate (gpm)	Length of test	Remarks
PGE-7	10/13/2005	to dry	20	30 secs	Well purge prior to sampling, pumped dry in 30 seconds
PGE-7	12/10/2003	----	10	1 hour	Well purge prior to sampling, no final depth to water taken
PGE-8	10/12/2005	17	4.7	4.5 hours	Well purge prior to sampling part 1, 1/2 casing volume day 1
PGE-8	10/13/2005	40.9	17.2	1.5 hours	Well purge prior to sampling part 2. Increased flow rate day 2. Water cascading down well so drawdown not measured during final 45 minutes of testing, water level appeared to still be dropping
PGE-8	12/9/2003	----	20	2.25 hours	Well purge prior to sampling
PGE-8	5/1/1969	50	26	26 hours	Dames and Moore Pump Test
MW-48	5/17/2006	----	----	1.5 hrs	Pumped dry after 1.5 hrs
MW-48	6/5/2006	79.9	1.8	12 mins	Pumped dry after 12 minutes 6/5/2006 11:00 AM
MW-48	6/6/2006	67.7	----	----	Sample collected 6/6/2006 6:00AM well only 12% recovered
MW-48	10/4/2006	----	1.5	14 mins	Pumped dry after 14 minutes 10/4/2006 10:27 AM
MW-48	10/6/2006	----	----	----	Sample collected 10/6/2006 12:30 PM DTW 59.39 ft BTOC static on 10/4/0610:00 AM 30.98 ft BTOC

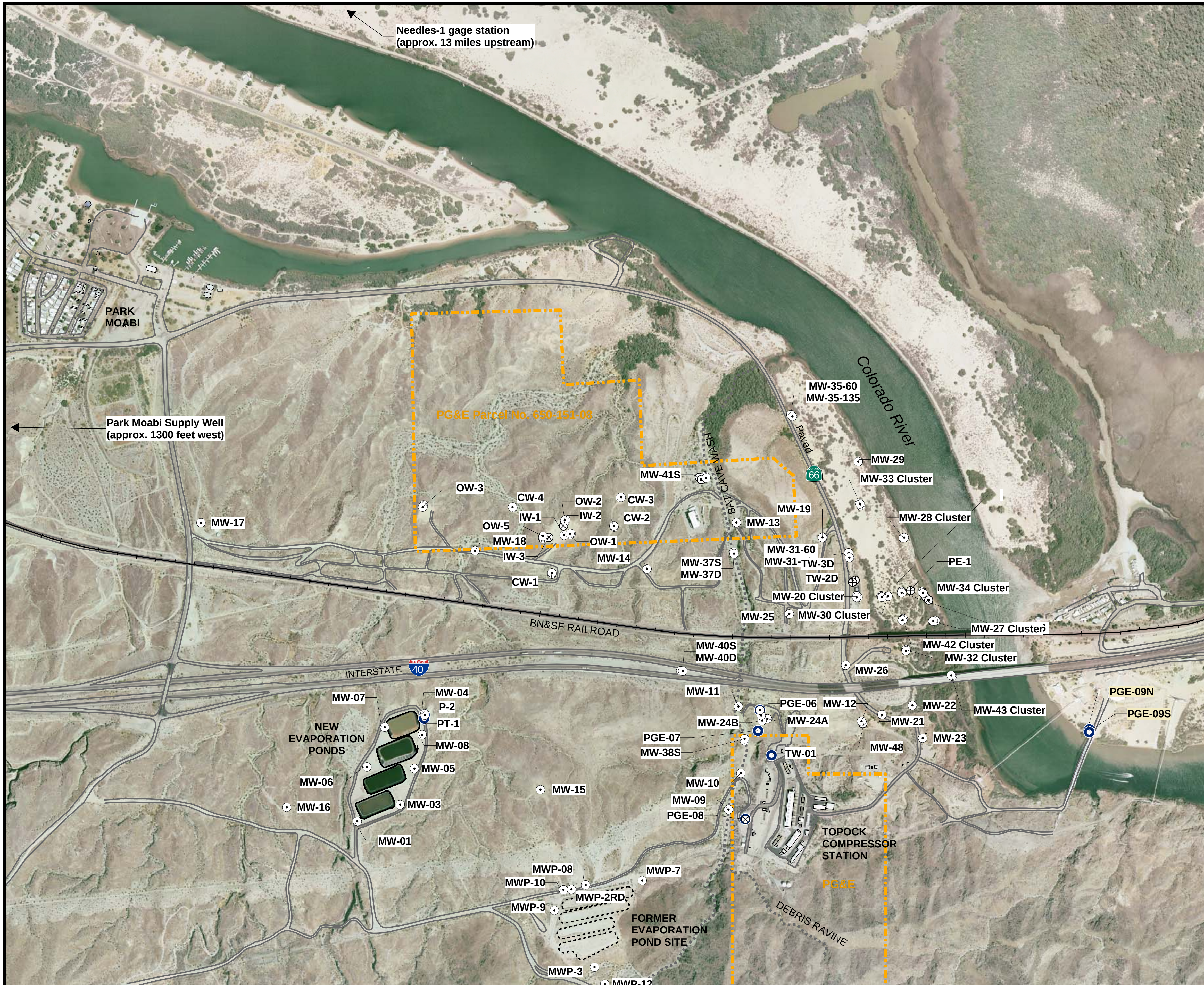
NOTES:
ft = feet
gpm = gallons per minute
(---) = data not available
DTW = depth to water
BTOC = below top of casing

TABLE 4-2
Observation Wells for Hydraulic Testing in Bedrock Wells
Work Plan for Hydraulic Testing in Topock Bedrock Wells
PG&E Topock Compressor Station

Well ID	Depth Monitored	Ground Elevation (ft MSL)	Screen Elevation (ft MSL)	Bedrock Elevation (ft MSL)	Well Construction	Distance from PGE-8 (ft)	Distance from PGE-7 (ft)
PGE-8	Bedrock	595.0	190.5 to 45	421	4" stainless steel. See Figure 1-4	----	768.3
PGE-7	Bedrock (once retrofitted)	562.6	(est) 324 to 261	343	6.75" open hole. See Figure 1-3	768.3	----
MW-48	bedrock	486.0	362 to 352	433	2" PVC	885.2	1302.0
MW-23	bedrock	507.3	447 to 427	504	4" PVC	1674.4	1415.2
MW-24B	basal Alluvial Aquifer	564.8	372 to 362	338	4" PVC	858.8	92.9
MW-24BR	Bedrock	564.0	186 to 127	338	4" PVC	901.3	133.2
PT-7D	basal Alluvial Aquifer	(est) 564	(est) 360 to 340	(est) 340	2" PVC	(est) 1000	(est) 230
PT-8D	basal Alluvial Aquifer	(est) 564	(est) 360 to 340	(est) 340	2" PVC	(est) 960	(est) 200
PT-9D	basal Alluvial Aquifer	(est) 564	(est) 360 to 340	(est) 340	2" PVC	(est) 1050	(est) 300
MW-38S	shallow Alluvial Aquifer	525.5	450 to 430	350.5	2" PVC	690.0	135.8
MW-38D	basal Alluvial Aquifer	525.3	362 to 342	350.3	2" PVC	674.7	144.3
MW-10	shallow Alluvial Aquifer	530.7	457 to 437	380	4" PVC	396.5	394.9
MW-9	basal Alluvial Aquifer	536.6	457 to 447	448	4" PVC	167.9	723.2
TW-01	Alluvial Aquifer	620.6	452 to 352	350	5" PVC	625.4	211.6
PGE-9S	Alluvial Aquifer	461.0	434 to 365	366	12" Steel	3047.9	2845.1
PGE-9N	Alluvial Aquifer	461.3	429 to 359	355	12" Steel	3056.0	2846.2

Notes:
(ft MSL) = feet above mean sea level
Screen elevation of PGE-7 is approximate and will be dependant on flow logging and retrofitting
PT wells will be installed as part of the Upland In Situ Pilot Study in Winter 2007.
PT Well and screen elevations are estimates at this time.
(est) = estimated well not yet completed (PT wells), or retrofited (PGE-7)

Figures



LEGEND

- Groundwater Monitoring Well
- Test Well or Supply Well (Inactive)
- Extraction Well
- PG&E Property Boundary

Note:
Wells PGE-09N, and PGE-09S are wells in Arizona that will be monitored during hydraulic testing at PGE-8.

N

0 800 1,600
Feet

California State Plane NAD83 Zone 5 US Feet

FIGURE 1-1
MONITORING WELL LOCATIONS AT TOPOCK COMPRESSOR STATION AND GREATER AREA

WORK PLAN FOR HYDRAULIC TESTING
IN BEDROCK WELLS
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

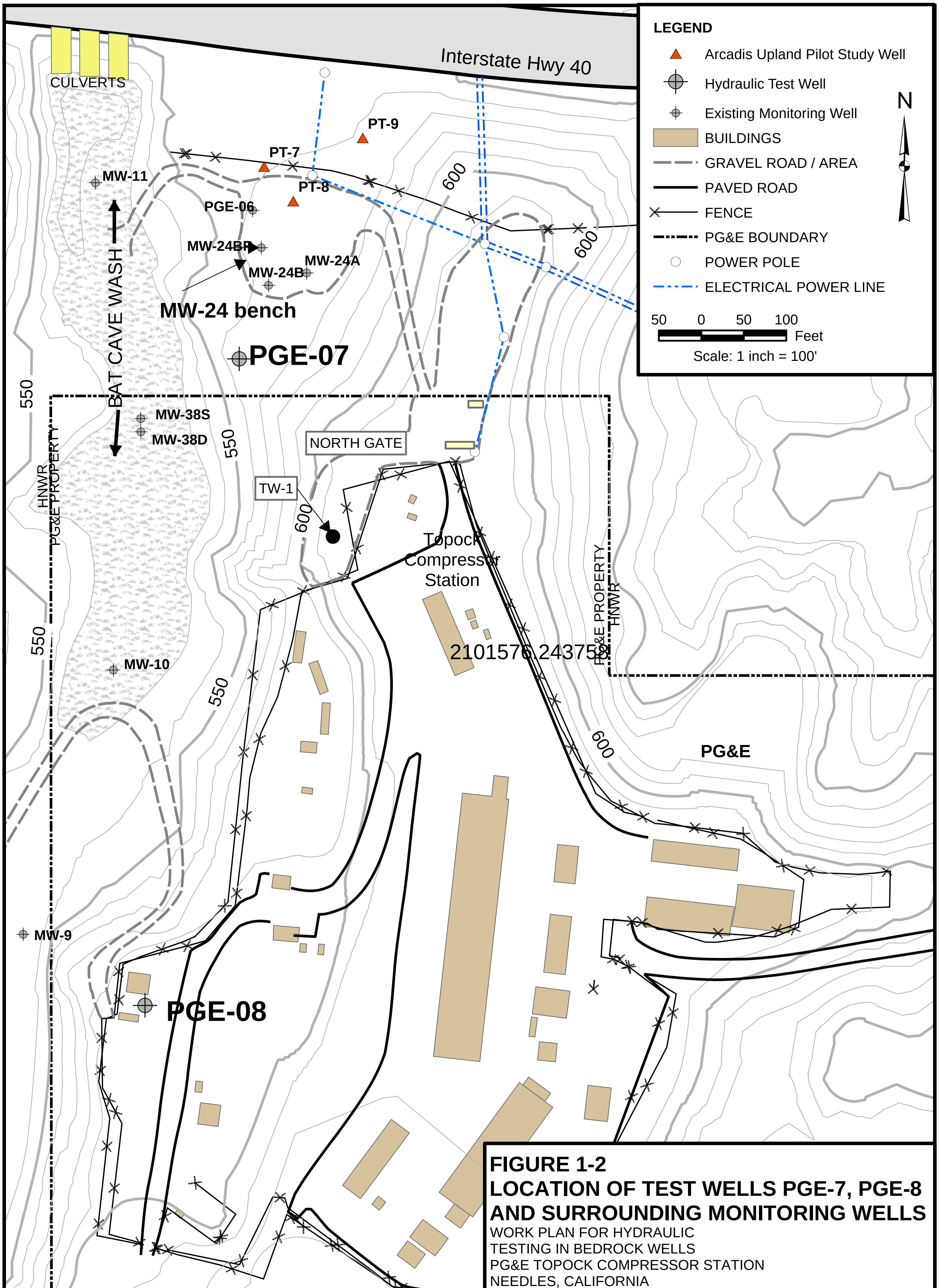


FIGURE 1-2
LOCATION OF TEST WELLS PGE-7, PGE-8 AND SURROUNDING MONITORING WELLS
WORK PLAN FOR HYDRAULIC TESTING IN BEDROCK WELLS
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

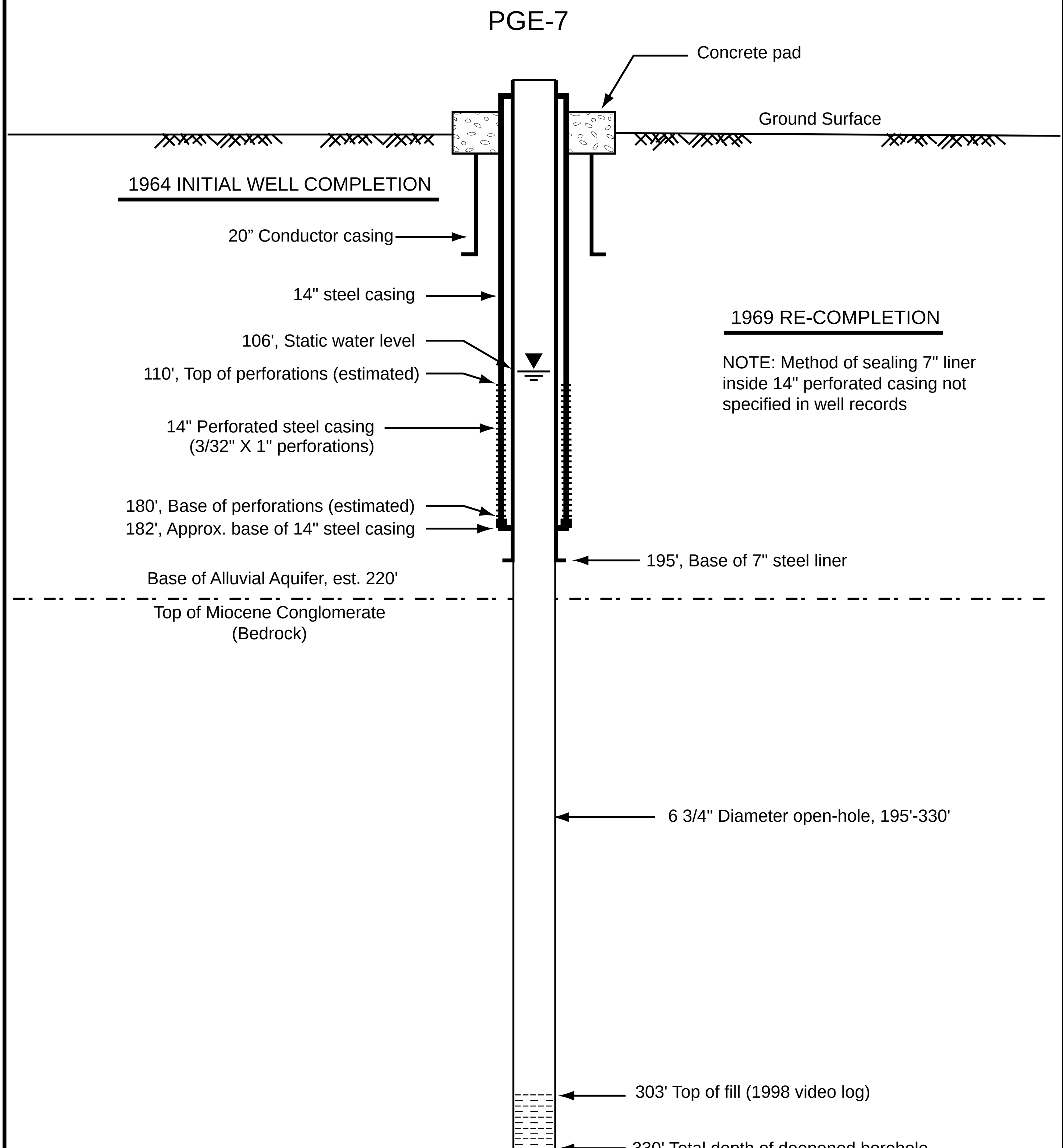


DIAGRAM NOT TO SCALE

All depths in feet below ground surface (bgs)

PGE-7 is an inactive water supply well that was deepened and re-completed in 1969 as an open-hole bedrock "monitoring well". Well contains Grundfos submersible pump for periodic sampling.

FIGURE 1-3
SCHEMATIC DIAGRAM FOR INACTIVE SUPPLY WELL PGE-7
WORK PLAN FOR HYDRAULIC TESTING IN BEDROCK WELLS
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

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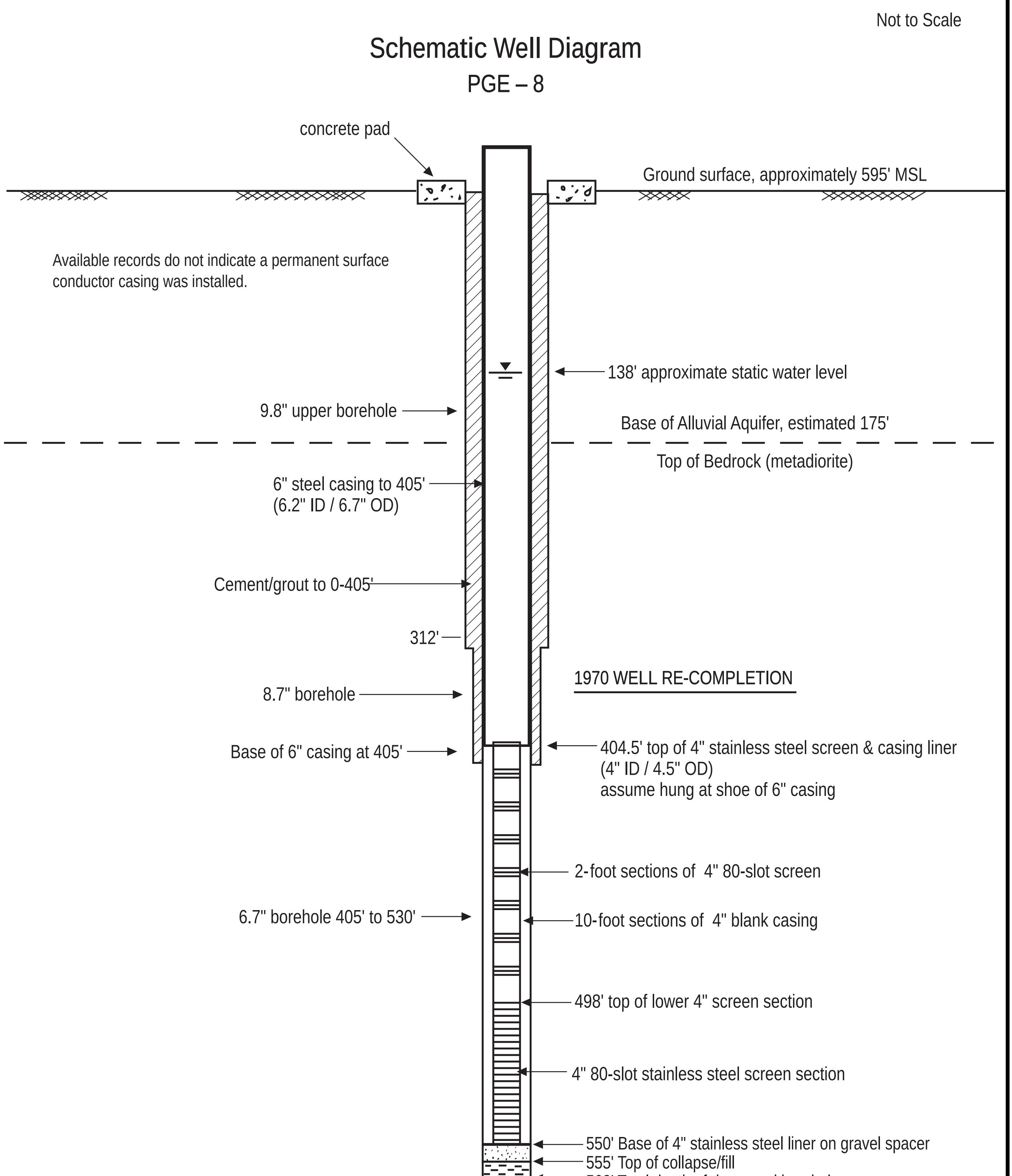


NOTES:

Data from Dames & Moore (1969, 1970) and PGE (1995) PGE-8.

All depths in feet below ground surface.

Well PGE-8 was initially completed June 1969 with 6" casing to 405' and open-hole from 405' to 530'. PGE-8 was deepened to 562' and 4" screen & casing liner installed June 1970. Tubing & packer equipment installed for injection 1969-1974 not shown.

FIGURE 1-4
SCHEMATIC DIAGRAM FOR FORMER INJECTION WELL PGE-8
WORK PLAN FOR HYDRAULIC TESTING IN BEDROCK WELLS
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

Appendix A
1998 Video Survey Report for PGE-7

welenco
VIDEO SURVEY REPORT

Fax (805) 834-2550 • (800) 445-9914 • (805) 834-8100

Customer: ECOLOGY + ENVIRONMENT	Job No. 29098 Run No. ONE
Address: 350 SANSOM ST, STE-300	Well No. PG+E #7 Date 3/ /98
City: SAN FRANCISCO State: CA Zip: 94104	Location: TOPOCK COMPRESSOR STATION -
Request By: RALPH LAMBERT Cust. P.O.	NEEDLES AREA - I-40 +
Copy To:	COLORADO RIVER
Reason for Survey: GENERAL INSPECTION	Zero Datum: TOP OF CASING
	Survey By: DAN IHOS Truck No. 1-17

DEPTH	REMARKS
0 FT	RECORDING STARTS
50	CORROSION INCREASES
106	STATIC WATER LEVEL - MURKY
125	VISIBILITY IMPROVES
195	BOTTOM OF CASING. OPEN HOLE BEGINS
234	ANGULAR ROCK - FRACTURES ?
247	ANGULAR ROCK - FRACTURES ?
250	ANGULAR ROCK - FRACTURES ?
258	ANGULAR ROCK - FRACTURES ?
265	ANGULAR ROCK - FRACTURES
270+	ANGULAR ROCK - FRACTURES
303	FILL - BOTTOM OF WELL

NOTE:

CASING CONDITION:

ID at Surface 7" Reduces to OPEN HOLE at 195' : ______ at ______ : ______ at ______

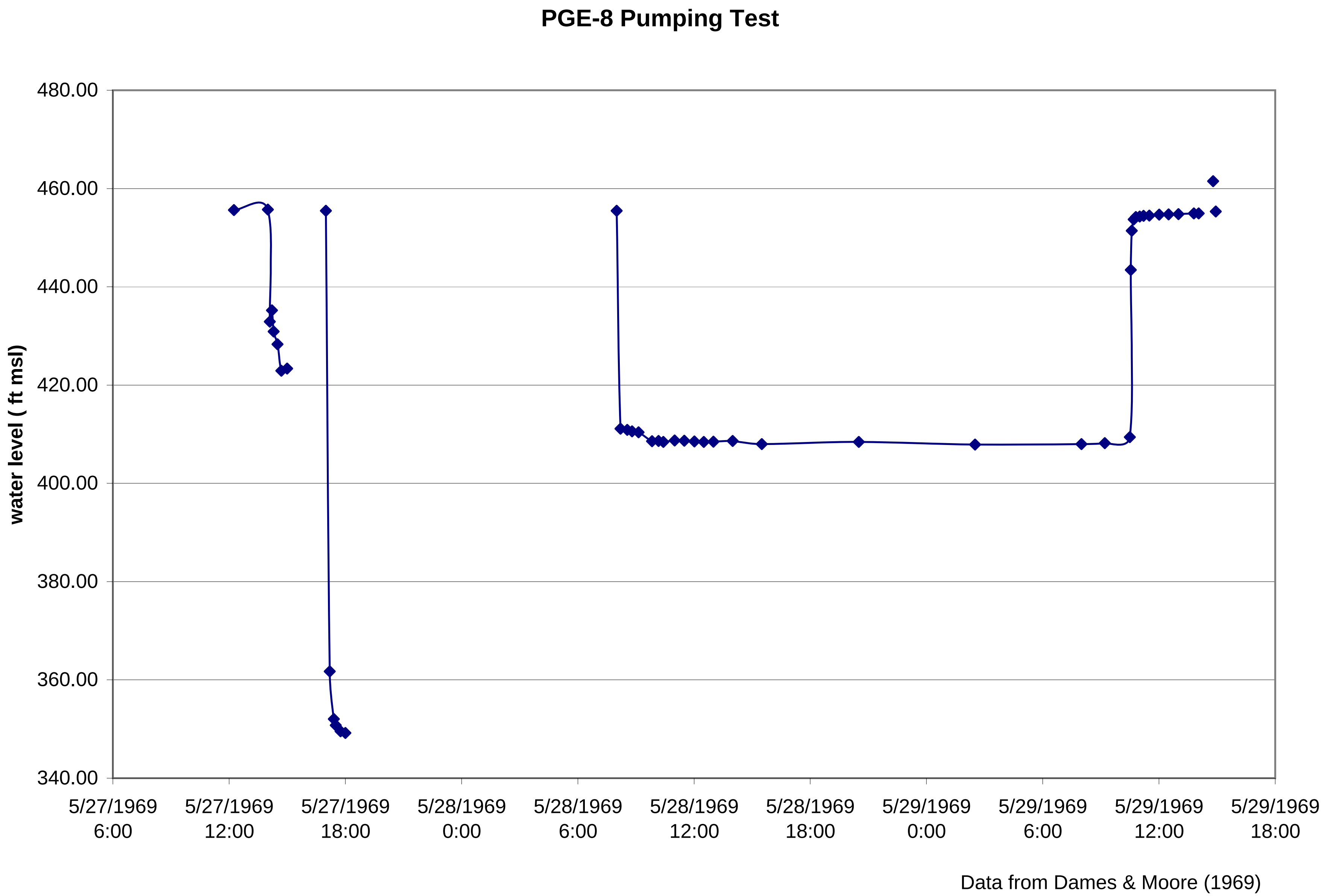
Diameter Reference: ☐ Caliper Survey ☐ Estimate from TV/Photo Survey ☐ Well Records

Corrosion/Incrustation Build-up ☐ Light ☐ Moderate ☒ Heavy ☒ Increases with Depth

Appendix B
Well Records from 1969 PGE-8 Pumping Test

TABLE B-1
Pumping Test Information for Former Injection PGE-8

Date	Time	Water Level Elevation	Drawdown or Recovery	Pumping Rate	Remarks
		ft MSL	feet	gpm	
29-Apr-69	17:30	455.47	--	--	baseline water level
27-May-69	12:15	455.63	--	--	pre-test water level
27-May-69	14:00	455.70	0.00	17.9	pumping started
27-May-69	14:06	432.93	22.77	14.5	
27-May-69	14:13	435.22	20.48	14.5	
27-May-69	14:18	430.92	24.78	20.3	
27-May-69	14:30	428.32	27.38	20.3	
27-May-69	14:42	422.91	32.79	20.3	Max DD = 32.8'
27-May-69	15:00	423.38	32.32	19.1	
27-May-69	15:28		--	--	pumping stopped
27-May-69	17:00	455.50	--	51.0	pumping started
27-May-69	17:12	361.75	93.75	51.0	
27-May-69	17:24	352.06	103.44	43.8	
27-May-69	17:30	350.76	104.74	43.8	
27-May-69	17:45	349.55	105.95	43.8	Max DD = 106.3'
27-May-69	18:00	349.20	106.30	43.8	pumping stopped
28-May-69	8:00	455.50	--	26.4	pumping started
28-May-69	8:12	411.14	44.36	26.4	
28-May-69	8:33	410.89	44.61	26.4	
28-May-69	8:48	410.57	44.93	26.4	
28-May-69	9:08	410.40	45.10	26.4	salinity 14,000 ppm
28-May-69	9:50	408.59	46.91	26.4	
28-May-69	10:10	408.63	46.87	26.4	
28-May-69	10:25	408.42	47.08	26.4	
28-May-69	11:00	408.73	46.77	26.4	
28-May-69	11:30	408.70	46.80	26.4	
28-May-69	12:01	408.53	46.97	26.4	
28-May-69	12:30	408.42	47.08	26.4	
28-May-69	13:00	408.49	47.01	26.4	
28-May-69	14:00	408.65	46.85	26.4	salinity 14,000 ppm
28-May-69	15:30	408.00	47.50	26.4	
28-May-69	20:30	408.44	47.06	26.4	salinity 14,000 ppm
29-May-69	2:30	407.89	47.61	26.4	Max DD = 47.6'
29-May-69	8:00	407.98	47.52	26.4	temperature 91.5 F
29-May-69	9:12	408.19	47.31	26.4	salinity 14,000 ppm
29-May-69	10:30	409.41	--	26.4	pumping stopped, start recovery
29-May-69	10:33	443.45	-34.04	--	
29-May-69	10:36	451.40	-41.99	--	
29-May-69	10:42	453.72	-44.31	--	
29-May-69	10:48	454.20	-44.79	--	
29-May-69	11:00	454.32	-44.91	--	
29-May-69	11:12	454.46	-45.05	--	
29-May-69	11:30	454.52	-45.11	--	
29-May-69	12:01	454.68	-45.27	--	
29-May-69	12:30	454.72	-45.31	--	
29-May-69	13:00	454.80	-45.39	--	
29-May-69	13:48	454.92	-45.51	--	99% recovery in 3.5 hrs
29-May-69	14:03	454.95	-45.54	--	end recovery measurements
29-May-69	14:06		--	8.3	begin injection
29-May-69	14:48	461.50	--	8.3	
29-May-69	14:50		--	--	stop injection
29-May-69	14:56	455.33	--	--	
NOTE : Data compiled from Dames & Moore 1970 report.					


PGE-8 Pumping Test
480.00
460.00
440.00
420.00
400.00
380.00
360.00
340.00
water level (ft msl)
5/27/1969 6:00
5/27/1969 12:00
5/27/1969 18:00
5/28/1969 0:00
5/28/1969 6:00
5/28/1969 12:00
5/28/1969 18:00
5/29/1969 0:00
5/29/1969 6:00
5/29/1969 12:00
5/29/1969 18:00
Data from Dames & Moore (1969)