# GEOTHERMAL RESOURCE POTENTIAL
# VETERANS ADMINISTRATION MEDICAL CENTER
# RENO, NEVADA
# DEMONSTRATION PROJECT NO. 654-81-101

August 8, 1985

Project No.: 85-356

Prepared for:

Veterans Administration Medical Center
Reno, Nevada
Contract No. V654P-2134

Prepared by:

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# 1.0 FINDINGS

1. The 1,380 foot deep test hole which was drilled at the Reno VAMC penetrated unconsolidated alluvium comprising crudely stratified sand, gravel, silt and clay from land surface to a depth of 1,340 feet. Tuffaceous sedimentary rocks and volcanic tuff were encountered at a depth of 1,340 feet. The major geothermal production zone is present between depths of 980 and 1,340 feet.

2. The test hole was constructed with a total of 980 feet of blank steel casing which was installed in the borehole to isolate potential hot-water production zones from cooler ground water which is present at shallower depths.

3. Seven temperature surveys were conducted at various stages of completion. The surveys indicated a temperature gradient of approximately 4.3°F per 100 feet of depth. This compares to a normal gradient in the Reno-Sparks area of approximately 2.9°F per 100 feet. Bottom-hole temperature is projected to be as high as 120°F. These data suggest that a thermal anomoly is present beneath the VAMC at depths of less than 1,400 feet.

4. Step-drawdown and constant discharge aquifer pumping tests were conducted. Analysis of the pumping test data indicates that a production well located in the immediate vicinity of the VAMC may yield as much as 300 gpm of 115°F water.

5. As many as 749,700 BTUH may be generated by direct use of the geothermal fluid via fan coils. At Reno design temperatures this is sufficient to heat 38,000 square feet. Mechanical amplification of the temperature through the use of electrically powered water-source heat pumps could provide as many as 7,497,000 BTUH; enough to heat 380,000 square feet. A system utilizing water-source heat pumps for both heating and cooling will provide 6,000,000 BTUH for heating and 6,000,000 BTUH for cooling (500 tons) which is sufficient for a building of 175,000 square feet.

6. The payback for a geothermal production/injection/heat pump system versus a conventional gas heat/electric cool system for a building of 100,000 square feet is less than two years.

# 2.0 INTRODUCTION

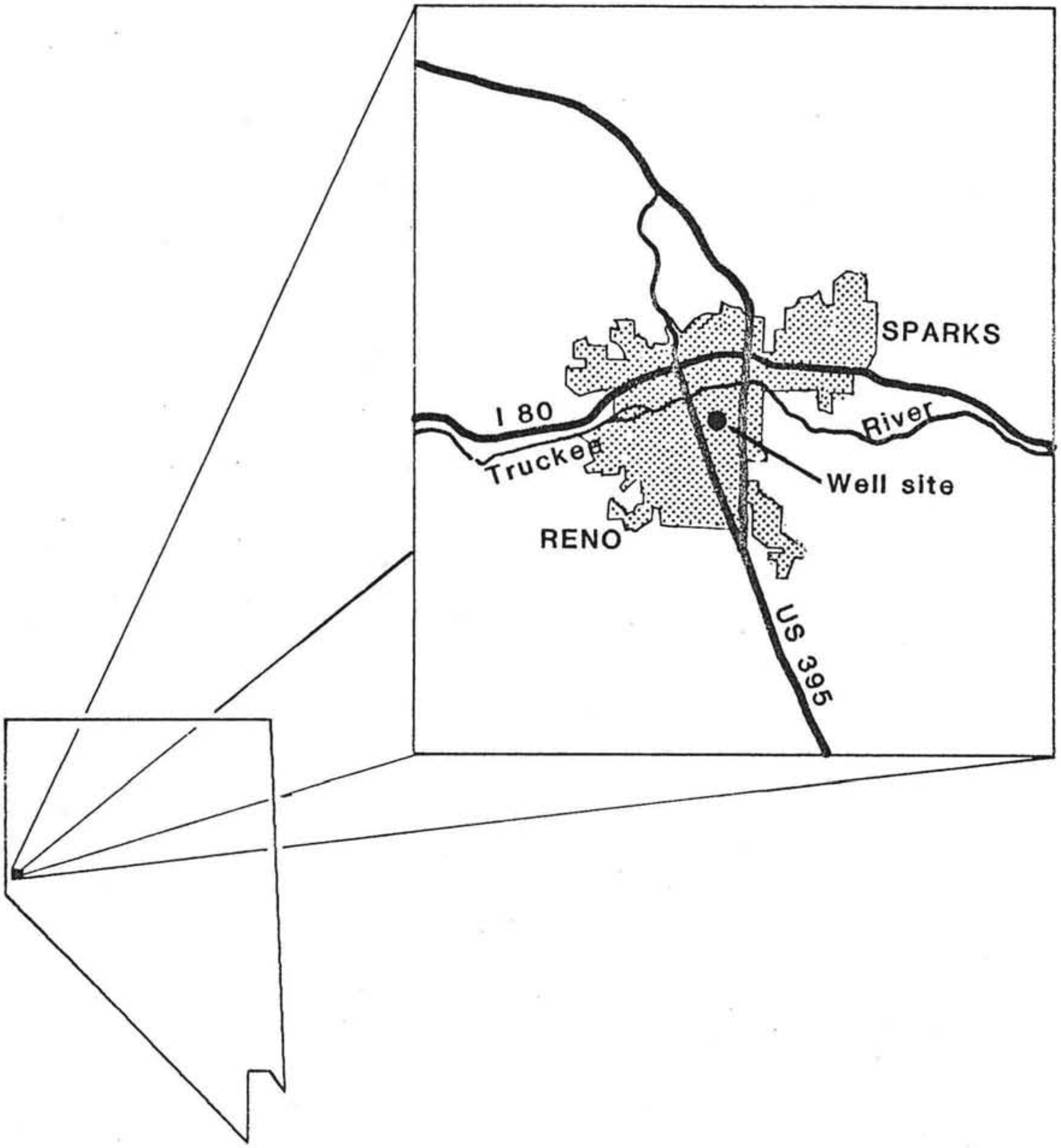
In the July 12, 1984, Issue No. PSA-8627 of the Commerce Business Daily, notice was given for small business firms within a 30-mile radius of Reno, Nevada who desired consideration for work on a Geothermal Demonstration Project at the Veterans Administration Medical Center (VAMC), Reno, Nevada (Figure 1) to furnish experience and general qualification data within 15 days of the notice to the contracting officer, G. W. Jones at the VA Medical Center, 1000 Locust Street, Reno, Nevada, 89520. WILLIAM E. NORK, INC. submitted the required information on July 25, 1984.

On September 10, 1984, WILLIAM E. NORK, INC. appeared before the architect/engineer evaluation board and presented information describing experience gained by the firm in geothermal investigations conducted by the firm during the six previous years.

On September 13, 1984, WILLIAM E. NORK, INC., was requested to submit a proposal to the VAMC by September 17, 1984.

On September 17, 1984, a proposal for work on the Geothermal Demonstration project was submitted. The Scope of Work outlined in the proposal is presented below:

1. Review of pertinent published and unpublished maps, records, and reports.
2. An inspection of the site, in general, and selection of the specific drilling site.
3. Submittal of all necessary water rights applications for permit, and waivers to drill.
4. Preparation and distribution of a test well drilling/testing specification, and solicatation.
5. Selection of a drilling/testing contractor, contract award and pre-construction conference.
6. Supervision of test well drilling and testing it for yield and temperature.
7. Evaluation of drilling and testing results.



PROJECT: **VAMC**
FILE: **85-356**
LOCATION: RENO NV

REFERENCE MAP

WILLIAM E. NORK, INC.

FIGURE: 1

8. Coordination with Dinter Engineering Co. Ltd. regarding practical application of geothermal fluids.

9. Preparation of a report of findings and recommendations.

On October 18, 1984, a meeting was conducted at the VA Medical Center to review WILLIAM E. NORK, INC.'s cost estimate and proposal.

On November 28, 1984 official notice was given to WILLIAM E. NORK, INC. to begin work under Contract No. V654P-2134 for services required for Geothermal Demonstration, Project No. 654-81-101.

A detailed listing of the Scope of Work as presented under Contract No. V654P-2134 is included below. Following each listing is a brief statement regarding the action which was taken by WILLIAM E. NORK, INC. .

1. Literature/data review.....Sources that will be consulted are records of the office of the Nevada State Engineer, Department of Minerals, records of local drillers or other consulting firms, and a review of the information that we have on file in our office.

* A review of the literature/data yielded information that geothermal water in the temperature range of 110 to 125 degrees Fahrenheit could be expected at a well-site located on the VA Hospital property at some unknown depth, but likely between 1,000 and 1,500 feet.

2. Site Inspection.....The number of equipment pieces and nature of the equipment needed for drilling and testing of the proposed test well will require a significant amount of space. The site selected must also avoid interference with buried utility lines/pipes, and proximity to storm sewer access.

* A well-site was selected which met all of the above criteria, provided for minimal interference with VAMC daily routine, and provided access to a storm sewer for disposal of drilling and testing fluids.

3. Permitting.....Permits from the Nevada Division of Water Resources and Department of Minerals are required to develop geothermal resources. A Waiver to drill and test the prepared well while the applications are being processed will be applied for.

* An Application (No. 48624) to Appropriate the Public Waters of the State of Nevada for geothermal purposes was submitted to the Division of Water Resources (Appendix A). A waiver request (No. G103) was submitted at this time (Appendix A).

4. Preparation and Distribution of Drilling/testing Specification/Solicatation.....A detailed specification for the drilling and testing of the test well will be prepared and distributed to qualified drilling contractors for competitive bidding. The specification/bid proposal form will include a line item description of all tasks to be completed by the driller, bond requirements, probable drilling conditions and special detailed drilling and testing criteria to be followed by the drilling contractor. Also included will be precautions related to noise abatement, air pollution, and site restoration (Appendix A).

* Thirteen bid proposals were prepared and distributed.

5. Drilling Contractor Selection/award.....Responses to the specification/bid proposal will be categorized in tabular form for comparison. Each respondent will be evaluated by line-item and overall cost, experience, and drilling/testing equipment to be employed. Evaluation forms will be given to the contracting officer for review and approval of a drilling contractor recommended by WILLIAM E. NORK, INC.

* Three bid proposals were received. An evaluation form was completed and submitted to the contracting officer. Potter Drilling Co., Fallon, Nevada was selected as the successful bidder.

6. Drilling and testing.....A test well will be drilled at a site to be selected in order to evaluate the geothermal resource at the Veterans

Administration Medical Center. Upon completion of drilling, an aquifer pumping test will be conducted to evaluate the resource temperature, well yield, chemical quality of water, and, ultimately, the number of BTU's the resource is capable of yielding. The test well will be drilled by the mud rotary drilling method. Hole diameter will be sufficient to accommodate nominal six-inch diameter well casing.

Ultimate depth of the test well has yet to be determined. It will be drilled and results evaluated in stages. Initial-stage target depth is approximately 500 feet. At this depth of completion a temperature log of the borehole will be conducted and results to date evaluated. A decision whether to drill deeper or terminate the hole will be made based on the cost/benefit of drilling deeper. Stage two target depth will be 1,000 feet and will involve drilling from 500 feet to that depth.

WILLIAM E. NORK, INC. personnel will monitor the progress of the drilling contractor.

Upon completion of drilling and installation of well casing all drilling fluids will be evacuated from the borehole and mud pits and removed from the site. Clean formation fluids generated during development and testing may be disposed of in the nearby City of Reno storm sewer.

Test pumping equipment will be supplied and maintained by the drilling contractor. The actual pumping test will be conducted by WILLIAM E. NORK, INC. personnel who will be responsible for collecting all test data. The testing sequence will include an approximately 24-hour duration step-drawdown pumping test followed by a minimum 24-hours duration constant-discharge pumping test.

* This report details the results of the drilling/testing program. Drilling Conditions and formation sloughing dictated minor alterations in test hole design and completion. The ultimate depth of the test well at the site selected by WILLIAM E. NORK was 1,380 feet. Seven temperature surveys were performed on the well. An air-lift test was conducted at the completion of developmental work. Formal step-drawdown and constant-discharge pumping tests were conducted during the period of July 17-20, 1985.

7. Evaluation of Drilling and Testing Results..... Drilling results and testing data will be analyzed to provide a quantitative model of the geothermal resource available to the Veterans Administration Medical Center. This model will be used to evaluate the long-term BTU yield of the system and examine possible future impact that developing the resource may have on the hydrogeologic regime.

* WILLIAM E. NORK, INC. and Dinter Engineering evaluated the appropriate sections of the drilling and testing results. A quantitative model was developed and was used to determine the long-term BTU yield of the geothermal system at this location.

8. Report Preparation.....A report detailing all aspects of the project will be compiled. This report will summarize all construction activities; contain detailed logs of the formation materials penetrated, temperature surveys, well construction logs; summarize testing procedures and results; examine potential impacts on the hydrogeologic regime; and ultimately assess the potential for geothermal resource utilization at the Veterans Administration Medical Center.

* This report was prepared and submitted on August 7, 1985 and contains all of the items described in Item 8, above.

9. Progress Reports, Informal Meetings, and Oral Presentation of Final Report.....WILLIAM E. NORK, INC. personnel will report to the contracting officer daily during the drilling and testing phase of the project to advise him/her of progress and/or problems. Upon completion of the project, the company is prepared to present the major findings orally to Veterans Administration Medical Center staff.

* Progress reports and informal meetings were held throughout the drilling phase of the project. Oral report was given upon submittal of the final written report.

## 3.0 WATER RIGHTS

On December 4, 1984, an Application to Appropriate the Public Waters of the State of Nevada for Geothermal Purposes was submitted to the State Engineer's Office. The application (No. 48624) requested a point of diversion (well) for a ground water right to be located in the SW 1/4 NE 1/4, Section 13, T.19N., R.19E., M.D.B.&M. The application was accompanied by a request for a drilling/testing waiver. The waiver was necessary because the Veterans Administration Medical Center is located within the Truckee Meadows which has been designated by the Nevada State Engineer as a critical ground water basin. In a designated basin no drilling and testing of an exploration well is permitted without an approved water right application. The waiver procedure allows for collection of hydrogeologic data during the statutory period between filing the application and its approval by the State Engineer. Approval could have delayed the program four to six months. The waiver request was granted (No. G103) on December 11 1984, (Appendix A).

# 4.0 GEOLOGY

Geologic materials in the immediate vicinity of the Veterans Administration Medical Center range from unconsolidated alluvial deposits to andesitic volcanic rocks. The alluvial deposits at the well site comprise crudely stratified sand and gravel beds with varying percentages of silt and clay. Individual sand and gravel strata are separated by silt or clay beds or lenses. These materials are approximately 1,340 feet thick at this locale and overlie andesitic rocks.

Permeability of these alluvial materials ranges from high to very high. Flowing artesian conditions were encountered in a zone between 650 and 700 feet.

At a depth of 1,340 feet, fractured andesitic volcanic rock was encountered. The rocks comprised volcanic tuff interbedded with tuffaceous sedimentary rocks. These units are tentatively ascribed to the Kate Peak Formation. Fractured lava flows and cinder beds of the Kate Peak elsewhere yield moderate to large amounts of ground water. However, no such units were penerated by the VAMC test hole.

An abbreviated lithologic column is illustrated in Figure 2. A detailed lithologic log of the exploration well is presented in Appendix B.

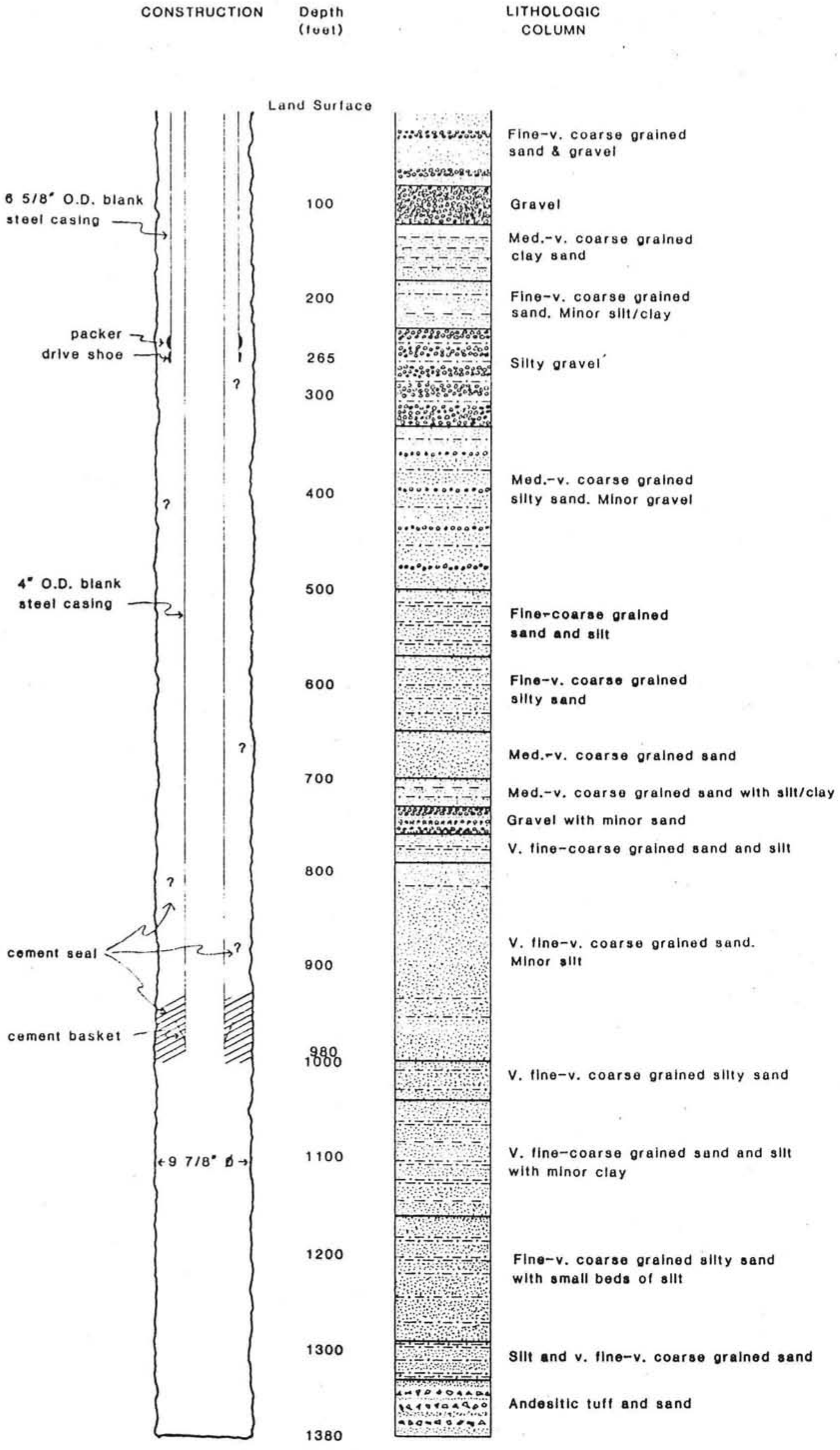


**Figure 2. Lithologic Log and Construction Diagram, VAMC Test Well, Reno, Nevada**

## 5.0 WELL CONSTRUCTION SUMMARY

### 5.1 CHRONOLOGIC SUMMARY

Drilling of the exploration well commenced January 19, 1985. Work was performed by Potter Drilling Co., a Fallon, Nevada-based drilling firm. History of the drilling program is presented below.

| | |
|---|---|
| 1/18/85 | Drilling equipment was mobilized to well site. |
| 1/19/85 | Drilling of 9 7/8-inch diameter borehole commenced. |
| 1/22/85 | Drilling of 9 7/8-inch diameter borehole to a depth of 500 feet was completed. |
| 1/23/85 | Temperature survey of borehole was conducted; instrument failure prevented completion of survey (see Section 5.3) |
| 1/24/85 | Drilling of 9 7/8-inch diameter borehole below a depth of 500 feet commenced. |
| 1/26/85 | Reamed borehole from 9 7/8-inch to 13-inch diameter from ground surface to a depth of 40 feet to accommodate conductor casing necessary to stabilize loose, near-surface materials. Installed 35 feet of blank 10-inch diameter O.D. casing. |
| 2/2/85 | Drilling of 9 7/8-inch diameter borehole to a depth of 1,000 feet completed. |
| 2/4/85 | Conducted temperature survey to a depth of 1,000 feet. |
| 2/5/85 | Conducted second temperature survey to a depth of 950 feet. |
| 2/6/85 | Drilling of 9 7/8-inch diameter borehole below a depth of 1,000 feet commenced. |
| 2/12/85 | Drilling of 9 7/8-inch diameter borehole to a depth of 1,380 feet was completed. |
| 2/13/85 | Conducted temperature survey to a depth of 1,125 feet. Bore-hole sloughing precluded deeper temperature survey. |

| | |
|---|---|
| 2/15/85 | Installation of blank 6 5/8-inch O.D. casing commenced. |
| 2/17/85 | Installation of blank 6 5/8-inch O.D. casing to a depth of 1,324 feet was completed. |
| 2/19/85 | Cleaning residual cuttings and drilling fluid from borehole between bottom of casing and total depth commenced. 1,244 feet of drill steel became stuck inside the casing during cleaning operation. |
| 2/25/85 | Simultaneous retrieval of casing and drill steel commenced. |
| 3/1/85 | Retrieval of casing and drill steel was completed. |
| 3/12/85 | Cleaning of borehole with 7 7/8-inch diameter drill bit commenced. Cement plug was installed to seal off artesian flow zone between 650 and 700 feet. |
| 3/14/85 | Drilling through cement plug with 7 7/8-inch diameter drill bit commenced. Plug failed to stop artesian flow. |
| 3/15/85 | Cemented borehole from a depth of 770 feet to a depth of 400 feet to stop artesian flow. |
| 3/18/85 | Drilling through the cement plug commenced. |
| 3/24/85 | Drilling of 7 7/8-inch diameter borehole to a depth of 1,370 feet was completed. Installation of blank 6 5/8-inch O.D. casing commenced. Casing became stuck in borehole at a depth of 265 feet. |
| 3/29/85 | Installation of blank 4-inch O.D. casing commenced. |
| 3/30/85 | Blank 4-inch O.D. casing became stuck in the borehole at a depth of 980 feet. |
| 4/1/85 | Cement plug was installed from a depth of 1,000 feet to a depth of 560 feet to stabilize loose alluvium. |
| 4/3/85 | Commenced drilling out the cement plug. |

| | |
|---|---|
| 4/4/85 | Completed drilling out the cement plug and circulated lower portion of the borehole with clean water to dilute drilling fluids. |
| 4/5/85 | Conducted temperature survey to a total depth of 1,340 feet. |
| 4/6/85 | Drilling equipment removed from well site. |
| 4/9/85 | Attempted to conduct temperature survey. Temperature probe met resistence at a depth of 265 feet. |
| 5/14/85 | Television survey conducted to a depth of 265 feet. |
| 5/16/85 | Knoblock & Sons mobilized equipment to site. |
| 5/17/85 | Knoblock & Sons attempted to remove obstruction at 265 feet from well casing. |
| 7/10/85 | Drilling equipment and crew arrived on site and cleaned obstruction from casing. |
| 7/11/85 | Drilling equipment removed from well site. Conducted temperature survey to a depth of 965 feet. |
| 7/15/85 | Conducted temperature survey to a depth of 965 feet. |
| 7/16/85 | Pumping test equipment arrived on site and installed. |
| 7/17/85 | Step-drawdown pumping test conducted. |
| 7/18/85 | Constant-discharge pumping tested started, aborted after 10.5 hours due to generator failure. |
| 7/19/85 | Constant-discharge pumping test restarted. |
| 7/20/85 | Completed constant-discharge pumping test. |
| 7/22/85 | Pumping test equipment removed from site. |

## 5.2 WELL CONSTRUCTION

The original exploration well construction schedule included drilling a 9 7/8-inch diameter borehole. Blank 6 5/8-inch outside diameter (O.D.) casing was to be installed to the top of potential geothermal production zones. This casing would serve to isolate the cooler water at shallow depths in the alluvium from the warm to hot water producing zones expected at depth. After the casing was emplaced, a nominal 6-inch diameter hole was to be drilled a short distance into the potential production zone(s). Upon completion of these tasks, a test pump was to be installed to a depth of 200 feet and a pumping test conducted to evaluate the aquifer characteristics. Actual depth of the test well was unknown at the start of the demonstration project due to a dearth of information in the vicinity of the VAMC.

Based on experience in the Moana area, approximately two miles southwest of the VAMC, the contact between the alluvium and underlying fractured volcanic rock was a likely drilling target principally because the tops of volcanic lava flows are typically highly permeable. Secondly, temperatures in the rocks in the Moana Area are generally markedly higher than the overlying alluvium. The test hole encountered volcanic rocks at a depth of 1,340 feet. Beneath the VAMC, however, there was no evidence that the volcanic rocks were highly permeable or contained ground water of significantly higher temperature than the alluvium. Examination of the temperature logs, particularly the survey conducted 4/5/85, indicated a substantial increase in temperature at a depth of approximately 980 feet (in the alluvium) with a decrease in temperature gradient below 1,200 feet. These data suggested that the geothermal aquifer at this locale comprised unconsolidated alluvial deposits between depths of 980 and 1,350 feet

A 9 7/8-inch diameter borehole was drilled to a depth of 1,380 feet. Blank 6 5/8-inch O.D. casing was then installed to a depth of 1,324 feet. Considerable time and energy was expended by the drilling contractor attempting to install the casing in compliance with the Bid Proposal. In each instance refusal of the casing to reach the contact between the alluvium and the volcanics resulted from swelling of clays, collapse of the hole, a hole that was not plumb or straight, or a combination of these factors. The time period between drilling the borehole clean and the time required to weld and install the casing also played a role.

Upon completion of the installation of the casing to a depth of 1,324 feet, the portion of the borehole from the bottom of the casing to 1,380 feet was cleaned to remove the mud wall cake which resulted from the mud rotary drilling method. During well development the drill stem became sand locked in the well casing. Attempts to free the drill stem failed and the driller resorted to simultaneously retrieving the drill stem and casing.

Once casing and drilling tools were successfully removed from the borehole, the drilling contractor re-entered the borehole to clean it to its total depth. At this time flowing artesian conditions developed and had to be controlled. Control was accomplished by cementing the zone between 400 and 770 feet.

The cement was drilled out and the borehole cleaned to total depth. Hole stability was apparently degraded by the repeated drilling and cleaning operations. Blank 6 5/8-inch O.D. casing was installed to a depth of 265 feet. At this depth, casing met refusal and could not be withdrawn. Nominal four-inch diameter casing was then installed. The four-inch diameter casing met refusal at a depth of 980 feet. It too became stuck and could not be withdrawn.

Upon completion of casing installation the driller developed the open portion of the hole below 980 feet by circulating clean water to remove residual drilling fluids from the borehole. A temperature survey was then run through the drill-stem. Upon completion of the survey development of the well by air-lift pumping from a depth of 230 feet was accomplished utilzing the drill-rig mounted air compressor. Yield of the well, initially 25 gpm, increased to approximately 75 to 100 gpm as the well developed.

After completion of the short air-lift test, the drilling equipment was removed from the well site. The following day a cement seal was placed in the annulus between the four- and six-inch diameter casing by the drilling contractor. Cement was inadvertantly spilled inside the four-inch casing and solidified between depths of 275 and 325 feet. This cement was installed by the drilling contractor on his own initiative without prior approval by WILLIAM E. NORK, INC.

After considerable delay the drilling contractor returned to the site and cleaned out the cement blockage. The drilling crew probed the casing with the drill stem to ensure the casing was clean to the bottom.

At this time the well became available for test pumping.

## 5.3 TEMPERATURE SURVEYS

During the drilling of the exploration well, the borehole temperatures were surveyed on three separate occassions. After installation of the casing two more temperature surveys were conducted. Following clean out on 7/10/85, two additional temperature surveys were conducted. Temperature log data are all plotted in Figure 3 and tabulated in Table 1.

A survey, conducted on 1/23/85 at which time the hole was completed to a depth of 500 feet, was not completed due to failure of the temperature probe. However, on the basis of drilling returns temperatures it was concluded that increased temperature could be obtained by drilling the hole deeper.

The first successful temperature survey was conducted when the borehole was drilled to a depth of 1,000 feet. The bottom hole temperature at 1,000 feet was 84.0 degrees Fahrenheit. The borehole was allowed to equilibrate an additional 24 hours and a second temperature survey was conducted. The data showed an increase of three to five degrees Fahrenheit at corresponding depths compared to the first survey. Sloughing of material at the bottom of the bore-hole prevented logging the hole to its total depth.

The third temperature survey was conducted after the borehole was drilled to a depth of 1,380 feet. Only 1,100 feet were logged due to sloughing conditions below this depth. The temperature recorded at 1,100 feet was 98°F and the temperature was elevated by 7° to 8°F compared with the earlier surveys.

After casing was installed to a depth of 924 feet, the drilling fluid was removed from the well and a fourth temperature survey was conducted. This survey was completed to a depth of 1,335 feet. The bottom-hole temperature was measured at 118.6°F. This survey showed an increase in temperature as great as 16°F at corresponding depths compared to earlier surveys.

Table 1 TEMPERATURE SURVEYS
(All data in degrees Farenheit)

| DEPTH (FEET) | 2/4/85 | 2/5/85 | 2/13/85 | 4/5/85 | 4/9/85 | 7/11/85 | 7/15/85 |
|---|---|---|---|---|---|---|---|
| 50 | 60.9 | 57.9 | 64.9 | 62.8 | 63.6 | 56.7 | 52.5 |
| 100 | 61.9 | 58.9 | 65.2 | 65.3 | 63.9 | 55.2 | 57.0 |
| 150 | 62.9 | 60.8 | 68.9 | 67.1 | 68.7 | 58.4 | 59.4 |
| 200 | 63.9 | 62.7 | 71.6 | 68.1 | 70.7 | 61.1 | 61.5 |
| 250 | 65.6 | 65.0 | 73.0 | 70.6 | | 64.9 | 65.6 |
| 300 | 66.7 | 67.8 | 75.0 | 74.5 | | 68.1 | 69.0 |
| 350 | 68.7 | 69.5 | 77.0 | 78.4 | | 70.3 | 71.3 |
| 400 | 69.8 | 70.6 | 79.0 | 83.6 | | 72.1 | 73.6 |
| 450 | 70.0 | 70.8 | 81.0 | 86.3 | | 74.1 | 75.4 |
| 500 | 70.1 | 71.6 | 82.0 | 88.1 | | 86.4 | 77.3 |
| 550 | 70.8 | 72.6 | 83.0 | 89.8 | | 88.3 | 76.3 |
| 600 | 71.9 | 74.6 | 84.0 | 91.6 | | 90.1 | 81.2 |
| 650 | 73.7 | 77.0 | 85.0 | 93.3 | | 91.7 | 93.2 |
| 700 | 74.7 | 78.5 | 87.0 | 94.9 | | 93.7 | 95.2 |
| 725 | 75.9 | 79.9 | 87.0 | 95.6 | | 95.1 | 96.3 |
| 750 | 76.7 | 80.9 | 88.0 | 96.8 | | 95.9 | 97.5 |
| 775 | 77.3 | 81.3 | 88.0 | 98.2 | | 97.0 | 98.6 |
| 800 | 78.0 | 82.4 | 89.0 | 99.4 | | 98.0 | 99.6 |
| 825 | 78.6 | 82.8 | 89.0 | 100.1 | | 99.0 | 100.6 |
| 850 | 79.5 | 84.1 | 89.0 | 101.1 | | 99.9 | 101.7 |
| 875 | 79.6 | 84.3 | 90.0 | 102.3 | | 100.9 | 102.9 |
| 900 | 80.0 | 84.4 | 91.0 | 103.5 | | 102.0 | 104.0 |
| 925 | 81.4 | 85.7 | 92.0 | 104.2 | | 103.0 | 105.2 |
| 950 | 83.1 | 86.3 | 93.0 | 105.4 | | 104.2 | 106.4 |
| 965 | | | | | | 104.5 | 106.7 |
| 975 | 83.7 | | 95.0 | 105.9 | | | |
| 1000 | 84.0 | | 95.0 | 109.3 | | | |
| 1025 | | | 96.0 | 110.0 | | | |
| 1050 | | | 97.0 | 111.1 | | | |
| 1075 | | | 97.0 | 112.0 | | | |
| 1100 | | | 98.0 | 113.3 | | | |
| 1125 | | | 98.0 | 114.1 | | | |
| 1150 | | | | 114.4 | | | |
| 1175 | | | | 115.2 | | | |
| 1200 | | | | 116.2 | | | |
| 1225 | | | | 116.5 | | | |
| 1250 | | | | 116.8 | | | |
| 1275 | | | | 117.4 | | | |
| 1300 | | | | 118.2 | | | |
| 1335 | | | | 118.6 | | | |

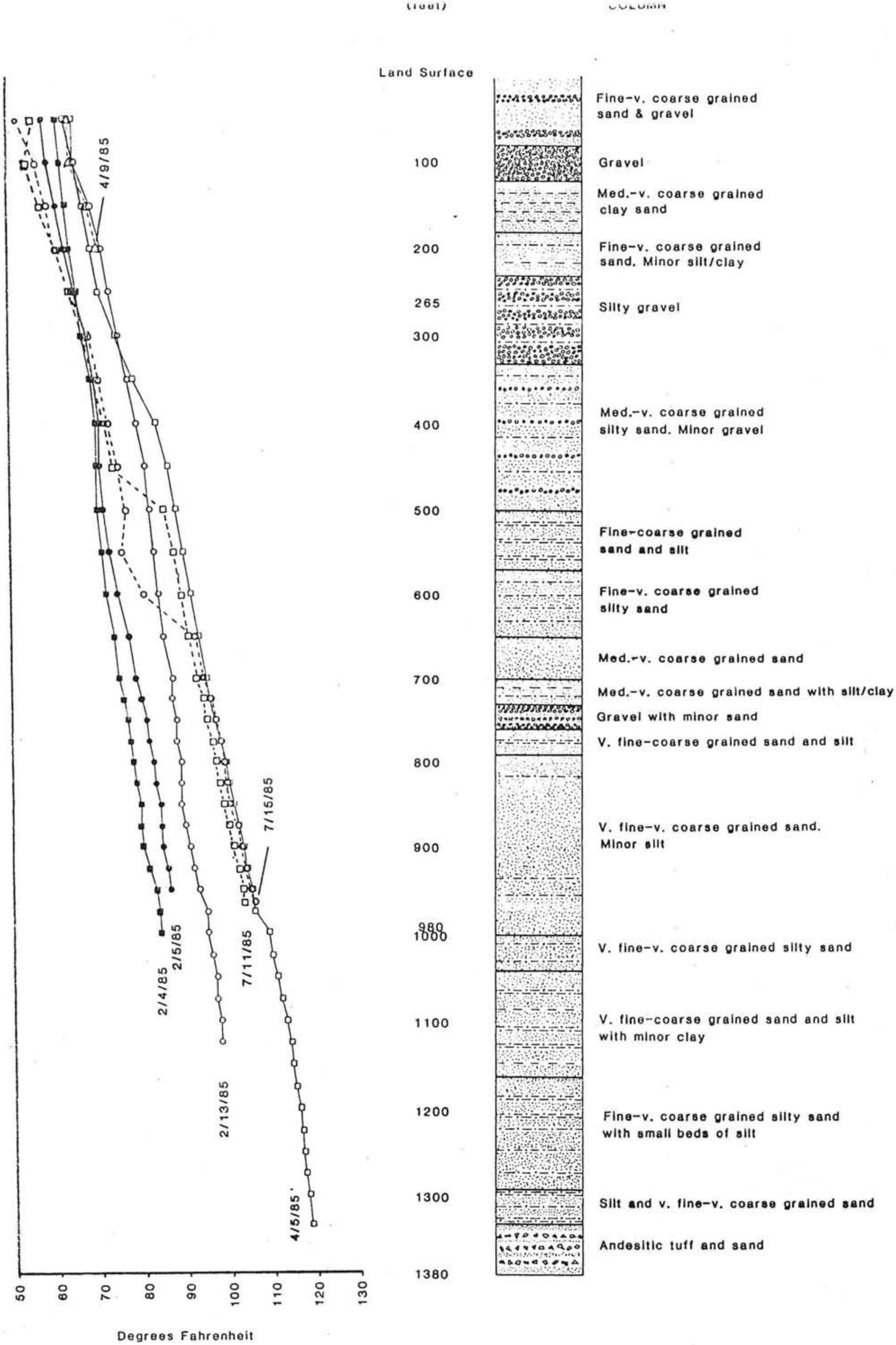


**Figure 3. Lithologic Log and Temperature Surveys, VAMC Test Well, Reno, Nevada**

The completed well was allowed to equilibrate for four days before the fifth temperature survey was conducted. This survey was only partially successful, due to an obstruction at a depth of 275 feet. Readings to this depth showed an additional increase of two degrees Fahrenheit compared to the previous survey. A projection made for the unsurveyed portion of the hole suggested that the bottom hole temperature may be as great as 120° F.

The obstruction in the casing at a depth of 275 feet was determined to be cement through the use of a downhole television camera and weighted objects which came in contact with it. The cement, which was removed by Potter Drilling Co. using the air-rotary drilling method, extended from 275 feet to 325 feet.

After the cement was removed from the well another temperature survey was conducted. The temperatures recorded were within a degree at corresponding depths with the previous surveys. Due to sloughing in the bottom portion of the hole the total depth surveyed was 965 feet.

Another temperature survey was conducted four days later. At depths corresponding to the warmest previous survey, the log showed an increase of one degree.

# 6.0 AQUIFER STRESS TESTING

## 6.1 STEP-DRAWDOWN TEST

After the clean out was completed by the drilling contractor, Knoblock and Sons, Reno, Nevada, installed a nominal four-inch diameter submersible test pump to a depth of 210 feet. For the duration of the testing program Knoblock and Sons maintained the pumping equipment. WILLIAM E. NORK, INC. personnel collected drawdown data, monitored flow rate, water temperature, field electrical conductivity and collected water samples for chemical analysis (12 and 24 hour).

Step-drawdown testing provided data which allowed determination of the efficiency of the well and selection of a pumping rate which would stress the aquifer adequately for the duration of the constant-discharge test. The results of the step-drawdown test are summarized below.

> Static water level prior to testing was 31.75 feet below the top of the stilling well. Pumping commenced at 0700 hours 7/17/85.

| °F STEP | PUMPING RATE (gpm) | DURATION (minutes) | DRAWDOWN (feet) | SPECIFIC CAPACITY (gpm/ft) | TEMP. — |
|---|---|---|---|---|---|
| I | 20 | 240 | 36.04 | 0.55 | 93 |
| II | 30 | 240 | 60.96 | 0.49 | 95 |
| III | 40 | 240 | 79.82 | 0.50 | 97 |

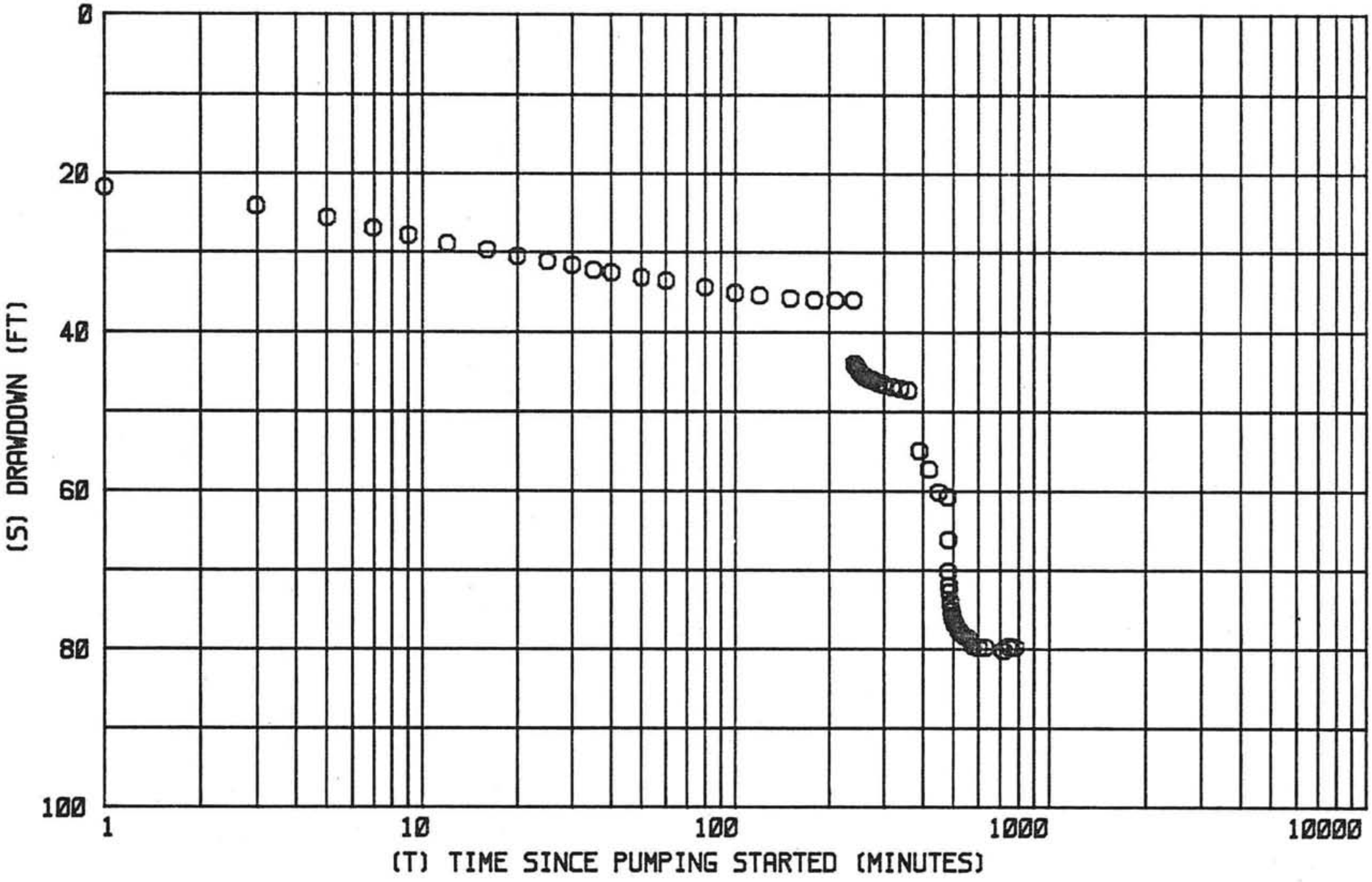
> Pumping was terminated after 12 hours at 1900 hours 7/17/85.

The step-drawdown pumping test data are tabulated in Appendix C and are plotted in Figure 4.

## 6.2 CONSTANT-DISCHARGE TEST

On the basis of the step-drawdown test, a pumping rate of 40 gallons per minute was selected for the 24-hour constant -discharge test. Water-level data were taken throughout the pumping test and for 12-hours of monitored recovery. The test results are summarized as follows.

PUMPING TEST ANALYSIS     STRAIGHT LINE APPROXIMATION METHOD



PROJECT: VAMC
FILE: 85-356
LOCATION: RENO-VAMC

WELL NO.: 1
Q=
S.W.L.= 31.75 FT

Δ S=
T=
S=

WILLIAM E. NORK, INC.

FIGURE 4

> Static water level prior to testing was 33.65 feet below the top of the stilling well. Testing commenced 0900 hours 7/19/85. Pumping rate was held constant at 40 gpm. Pumping was terminated after 1,440 minutes (24 hours) at 0900 hours 7/20/85. Drawdown in the well at the conclusion of the test was 83.48 feet, a pumping water level of 117.13 feet below the top of the stilling well. Recovery water levels were monitored for 12 hours after termination of the pumping. At the end of 12 hours the water level in the well was 98 per cent recovered.

Drawdown and recovery data for the exploration well are plotted in Figures 5, 6, and 7 and tabulated in Appendix C. The hydraulic characteristics of the aquifer were evaluated utilizing the Jacob leaky aquifer, the Cooper-Jacob approximation of the Theis Equation, and the Theis Recovery method. Results of the analyses are tabulated in Table 2.

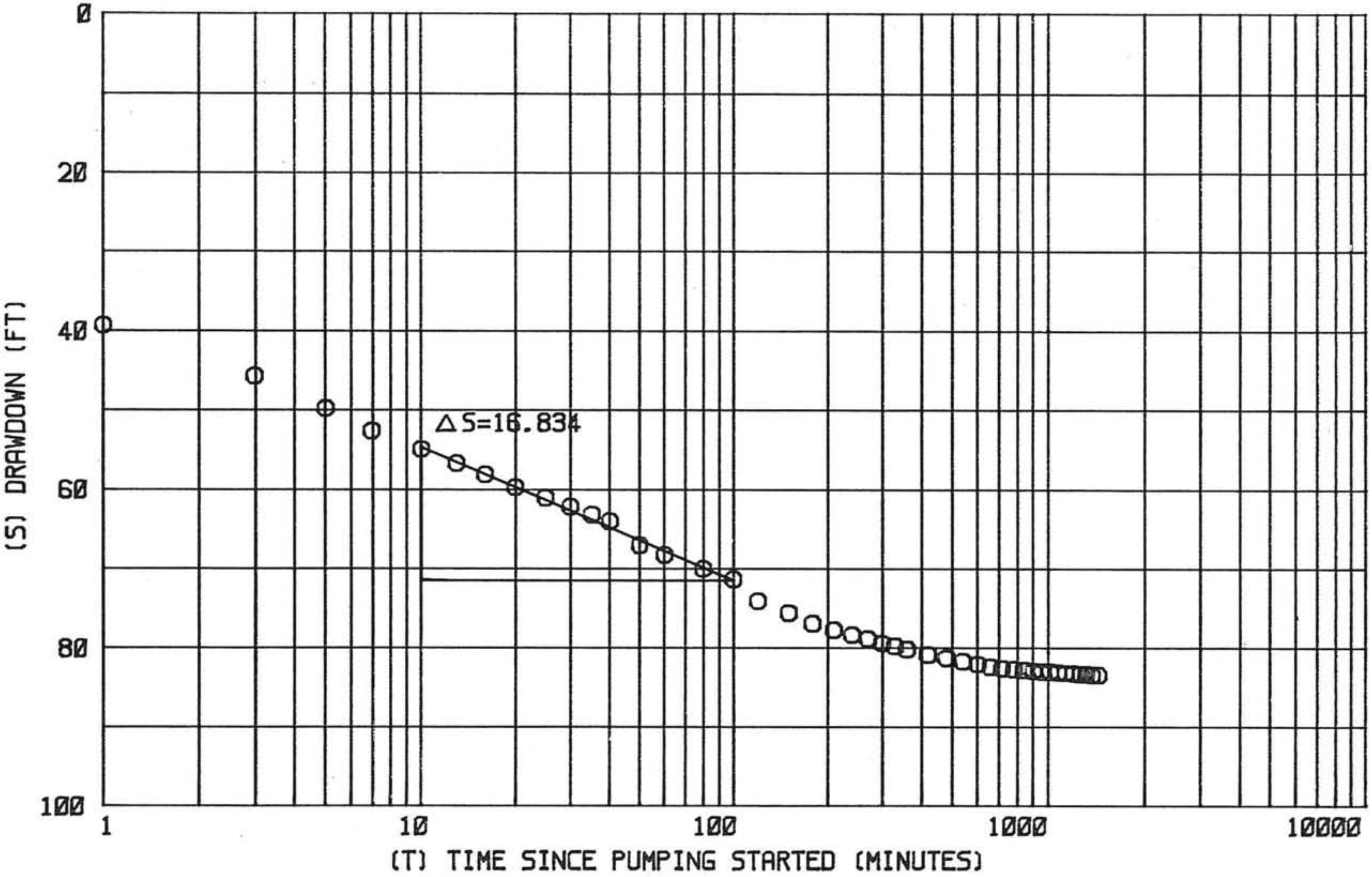
Table 2. Aquifer characteristics calculated from pumping test data.

| Data | Method | Transmissivity (GPD/ft) |
|---|---|---|
| Drawdown | Cooper-Jacob | 627 |
| Drawdown | Jacob | 487 |
| Residual-drawdown | Theis-recovery | 606 |
| Average | | 573 |

From data collected from the exploration pumping test, presented in Table 2, the value of transmissivity, the over all ability of the aquifer to transmit ground water, is taken as approximately 573 GPD/ft.

Test data suggest a classic leaky aquifer response. Considering the crudely stratified nature of the alluvium, leakage to the zone in direct communication with the open end of the casing is distinctly possible. The break in slope in Figures 5 & 7 may be caused by this leakage. Alternatively, the response may be attibutable to delayed yield due to gravity drainage of the sediments. However, the time for delayed yield to be clearly defined could take several days of pumping. Aquifer characteristics based on early-time data would be the same regardless of the theory applied.

PUMPING TEST ANALYSIS STRAIGHT LINE APPROXIMATION METHOD



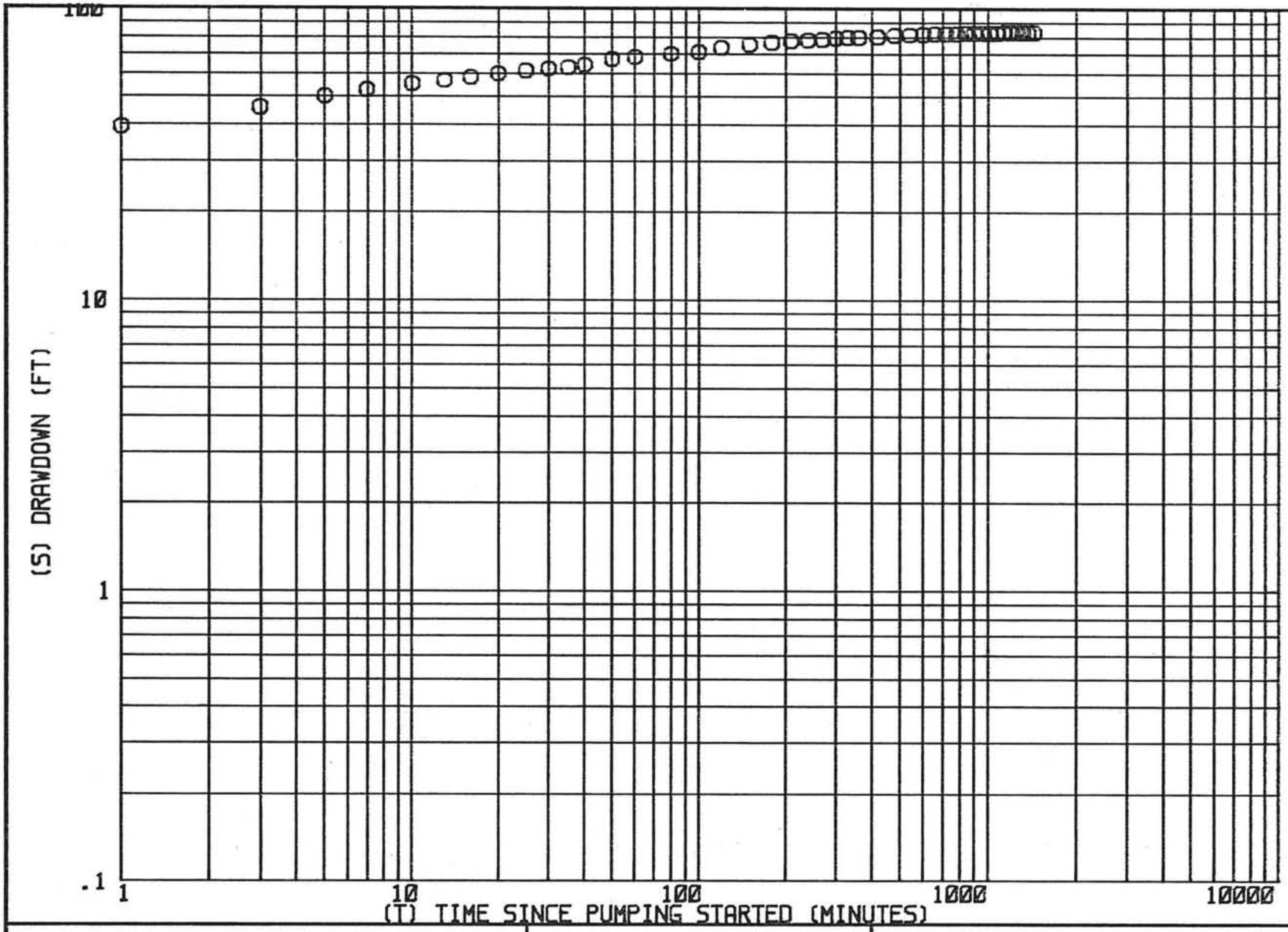
PROJECT: VAMC
FILE: 85-356
LOCATION: RENO-VAMC

WELL NO.: 1
Q= 40 USGPM
S.W.L.= 33.65 FT

ΔS= 16.834 FT
T= 627 USGPD/FT
S=

WILLIAM E. NORK, INC.

FIGURE 5



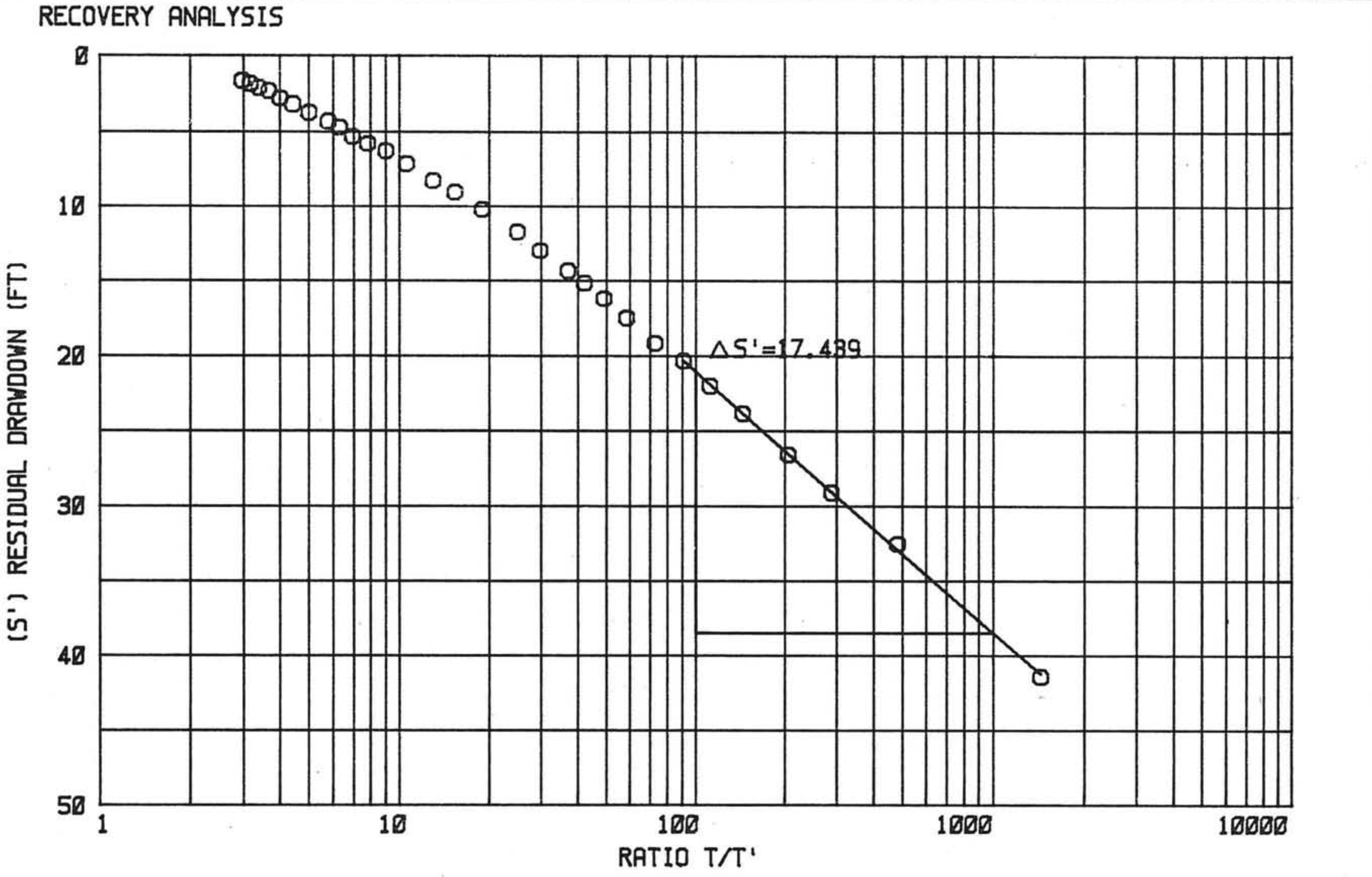
PROJECT VAMC
LOCATION RENO-VAMC

FILE 85-356
WELL No. 1

PUMPING TEST ANALYSIS
TYPE CURVE SOLUTION

WILLIAM E. NORK, INC.

FIGURE 6



PROJECT: VAMC
FILE: 85-356
LOCATION: RENO-VAMC

WELL NO.: 1
Q= 40
S.W.L.= 33.65 FT

ΔS'=17.439 FT
T= 606 USGPD/FT
S=

WILLIAM E. NORK, INC.

FIGURE 7

Considering the way the well is constructed and crudely stratified nature of the geologic materials it is likely that the average value of transmissivity is not representative of the geothermal aquifer as a whole, but only that portion directly tapped by the open-bottom well casing. From the lithologic log this zone appears to be the depth interval 950 to 990 feet.

From the relationship for transmissivity,

$$T = Kb$$

where

K is the hydraulic conductivity
b is the saturated thickness

$$K = \frac{T}{b} = \frac{573 \text{ GPD/ft.}}{40 \text{ feet}} = 14.3 \text{ GPD/ft}^2$$

This value is consistent with published values for fine sand.

A production well at the site should be constructed to fully penetrate the aquifer below 980 feet. The saturated thickness then becomes

$$1340 - 980 \text{ feet} = 360 \text{ feet}$$

Transmissivity for the entire production zone would then equal

$$Kb = 14.3 \text{ GPD/ft}^2 \times 360 \text{ feet} = 5{,}148 \text{ GPD/ft}$$

## 7.0 CHEMICAL QUALITY OF GROUND WATER

Water samples were collected for chemical analysis after 12 and 24 hours during the constant-discharge pumping test. The complete chemical data are listed in Table 3 and included in Appendix D.

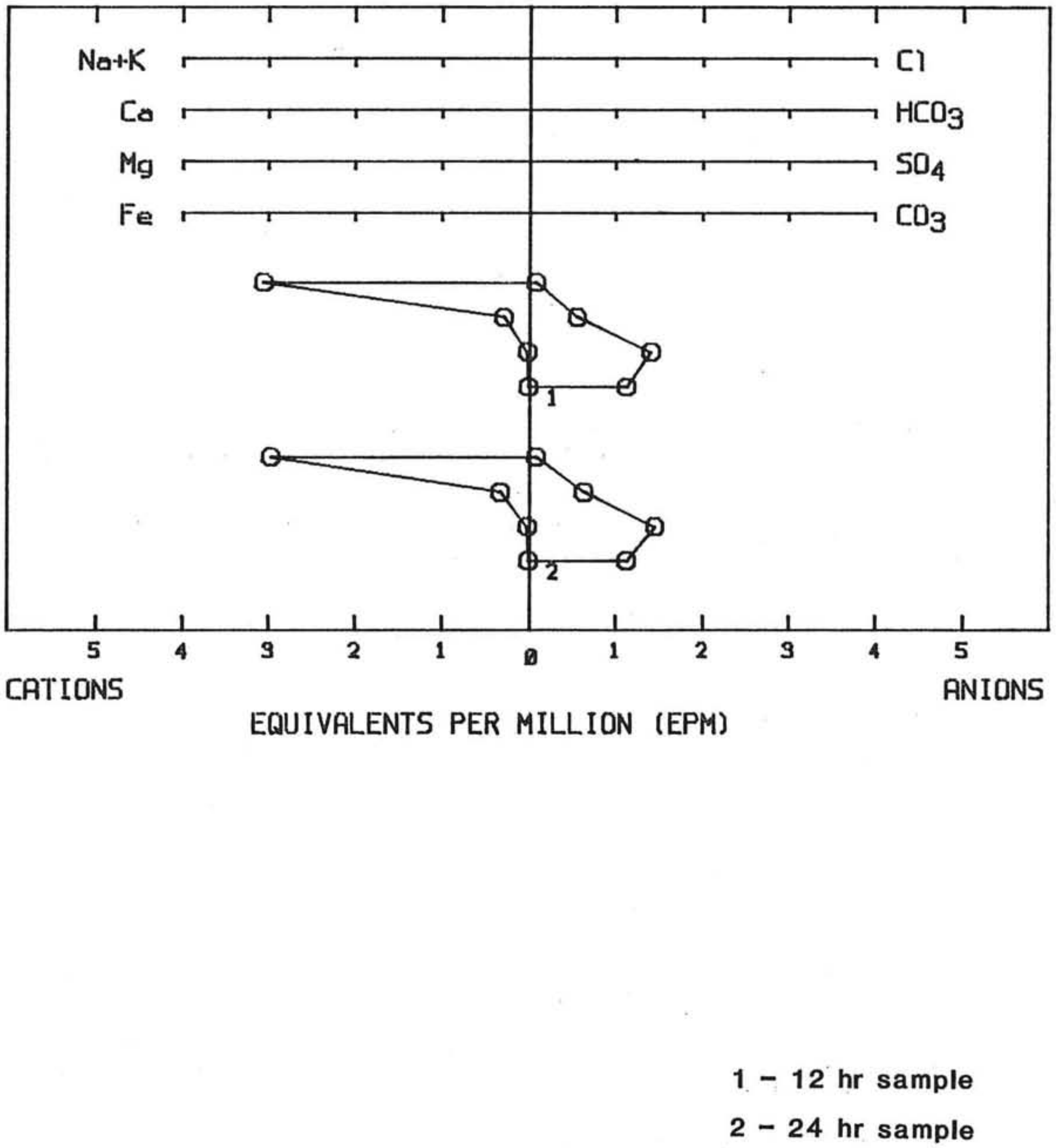
Figures 8, 9, & 10 shows that the samples collected were nearly identical and of good chemical quality. The water chemistry of these waters meets the Federal and State requirements for all components except pH. The maximum allowable value for pH is 8.5 compared to a measured pH of 9.0. This value is anomolously high for ground water within the Truckee Meadows. The high pH most probably results from direct contact between ground water in the production zone with cement which was installed to stablize sloughing alluvial deposits at this depth. This phenomenon has been observed elsewhere, particularly in monitoring wells with low abstraction rates which allow significant contact time between the formation waters and cement grout seals.

The chemical quality of ground water from the VAMC well was compared to the average chemistry of thermal ground water from the Moana area and non-thermal waters from the Truckee Meadows (Bateman & Scheibach, 1975). The inference drawn from the comparison is that the waters beneath the VAMC are a blend of thermal water probably originating in the Moana area and non-thermal ground water. These data are illustrated in Figure 10. VAMC data are represented by circles, the average Moana thermal and non-thermal waters by a square and triangle, respectively.

## TABLE 3. VAMC Water Chemistry Data

| Sample No. | 1 | 2 | Drinking Water Standards |
|---|---|---|---|
| Date | 7/19/85 | 7/20/85 | |
| Time | 2100 | 0900 | |
| Pumping Duration (hrs) | 12 | 24 | |
| Temperature ($^{\circ}$F) | 97 | 97 | |
| Field E.C. ($\mu$mho/cm) | 330 | 350 | |
| T.D.S. | 232 | 226 | 1,000[2] |
| pH | 9.0 | 9.0 | 6.5 - 8.5 |
| Ca | 5.9 | 6.6 | |
| Mg | 0.2 | 0.2 | 150[2] |
| Na | 70 | 68 | |
| K | 0.5 | 0.5 | |
| Alkalinity ($CaCO_3$) | 34 | 34 | |
| $SO_4$ | 68 | 70 | 500[2] |
| Cl | 3 | 3 | 400[2] |
| N (as $NO_3$) | 0.1 | 0.1 | 45[1] |
| F | 0.3 | 0.3 | 1.4-2.2[1] |
| Fe | 0.05 | 0.05 | 0.6[2] |
| Mn | 0.02 | 0.02 | 0.1[2] |
| As | 0.03 | 0.03 | 0.05[1] |
| B | 0.1 | 0.2 | |
| Ba | <0.01 | <0.01 | 1.0[1] |
| Cd | <0.01 | <0.01 | 0.01[1] |
| Cr | <0.02 | <0.02 | 0.05[1] |
| Cu | <0.02 | <0.02 | 1.0[2] |
| Pb | <0.05 | <0.05 | 0.05[1] |
| Ag | <0.01 | <0.01 | 0.05[1] |
| Zn | <0.01 | <0.01 | 5.0[2] |
| Si (as $SiO_2$) | 41 | 42 | |

1-USEPA Primary Drinking Water Standard
2-State of Nevada Secondary Drinking Water Standard

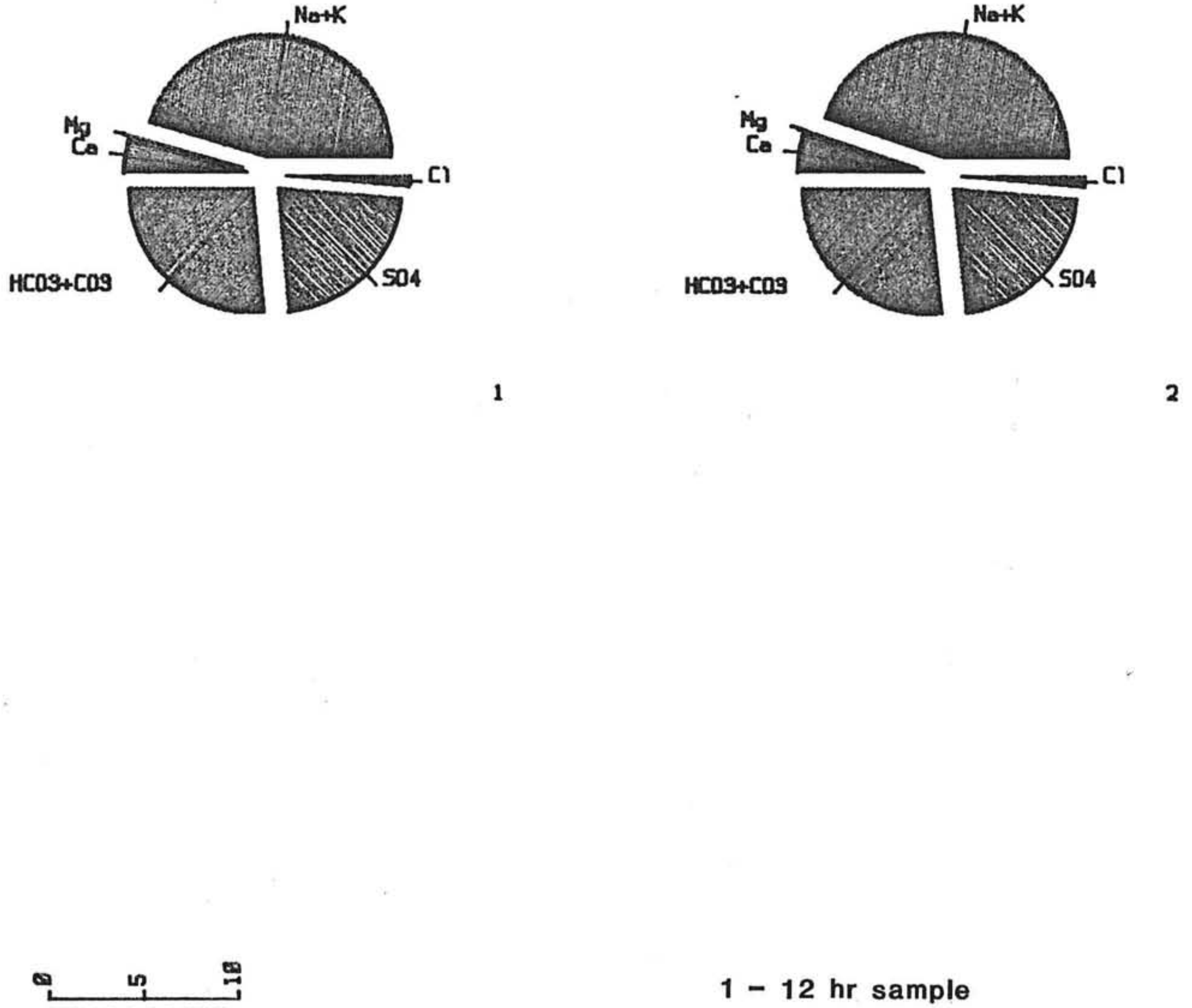


PROJECT: VAMC
FILE: 85-356
LOCATION: RENO-VAMC

STIFF GRAPH

WILLIAM E. NORK, INC.

FIGURE:8



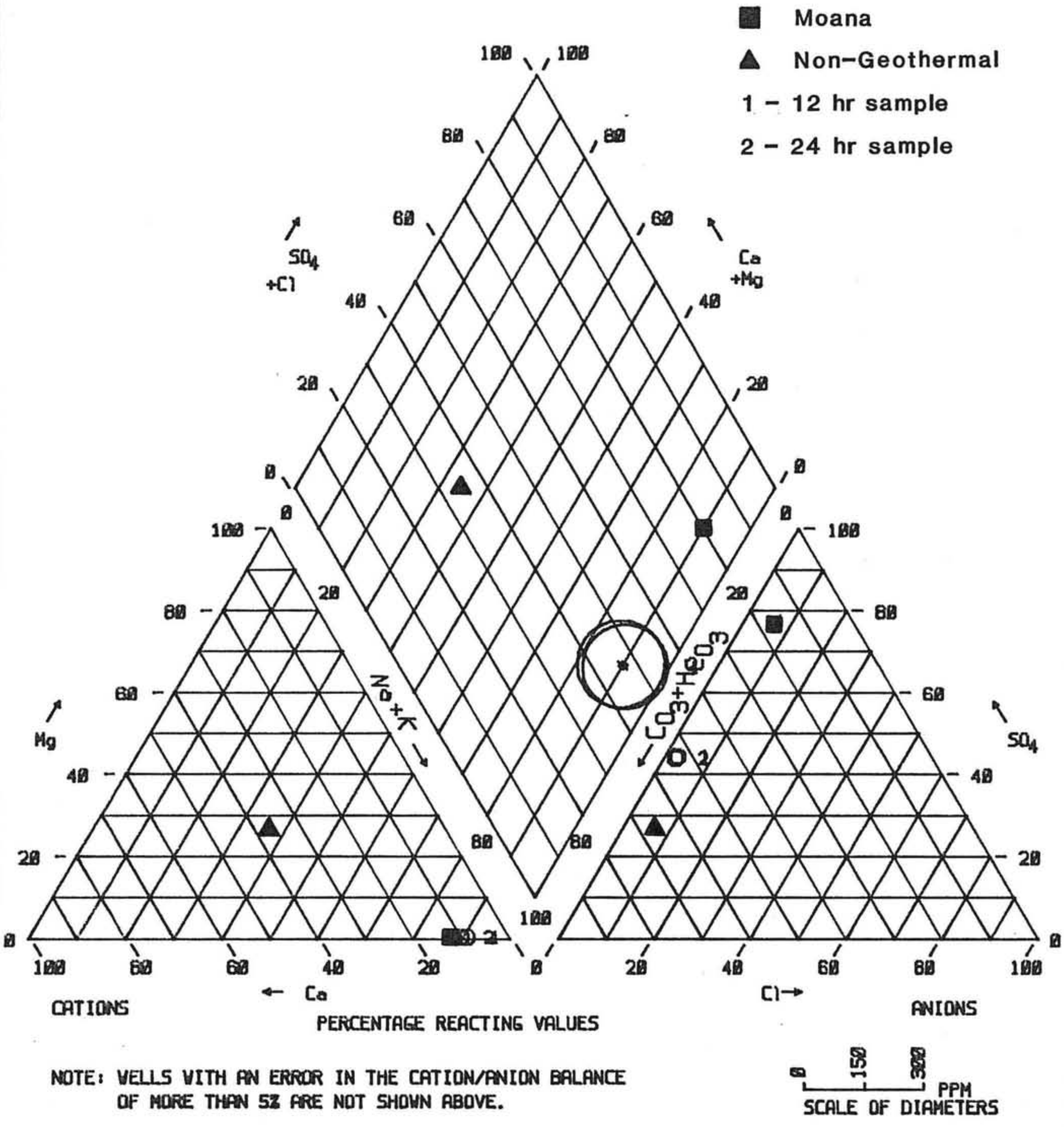
SCALE OF RADII
(TOTAL OF EQUIVALENTS
PER MILLION)

NOTE ERROR (IF ANY) IN CATION/ANION
BALANCE HAS BEEN REMOVED

1 – 12 hr sample

2 – 24 hr sample

| | |
|---|---|
| PROJECT: VAMC<br>FILE: 85-356<br>LOCATION: RENO-VAMC | PIE DIAGRAMS<br>SHOWING WATER QUALITY |
| WILLIAM E. NORK, INC. | FIGURE:9 |



NOTE: WELLS WITH AN ERROR IN THE CATION/ANION BALANCE OF MORE THAN 5% ARE NOT SHOWN ABOVE.

PROJECT: VAMC
FILE: 85-356
LOCATION: RENO-VAMC

PIPER TRILINEAR DIAGRAM

WILLIAM E. NORK, INC.

FIGURE: 10

# 8.0 GEOTHERMAL POTENTIAL

## 8.1 TEMPERATURE

Review of the temperature data collected from drilling return fluids and the seven temperature surveys, indicates a thermal anomoly beneath the VAMC. Bateman and Scheibach (1975), defined thermal waters in the Truckee Meadows as ground water with temperatures higher than 20°C (68°F) according to the criteria of Waring (1965). They (Bateman & Scheibach, op. cit.) determined the normal (non-geothermal) temperature gradient in the Truckee Meadows to be approximately 2.9 °F (1.6°C) per 100 feet. Borehole temperature survey data at the VAMC yielded an average gradient of 4.3°F/100 feet. Maximum temperature measured in the well was 118.6°F at a depth of 1,340 feet. Extrapolating the temperature trend observed near the bottom of the test hole suggested a bottom hole (1,380 feet) temperature of approximately 120°F.

The maximum water temperature recorded at the surface during test pumping was 97.2°F (36.25°C). Ground water entering the well at a depth of 980 feet was measured at approximately 106°F (Table 1). The reduction in temperature in transit to the surface is ascribed to cooling of the water by conductive heat transfer away from the casing as it moved up the interior of the well casing. This is supported by temperature data collected during step-drawdown testing during which an increase of 4°F accompanied an increase in pumping rate from 20 to 40 GPM. Assuming the linear relationship exhibited between pumping rate and temperature (Figure 11) remains constant, temperatures approaching 112°F may be realized at a pumping rate of 200 gpm. An additional temperature increase may be achieved by insulating the production casing from cooler water by means of a cement seal in the annular space between casing and formation.

A bottom hole temperature of 120°F is projected. However, the actual temperature of the water extracted from the well could be somewhat lower for the reasons discussed above.

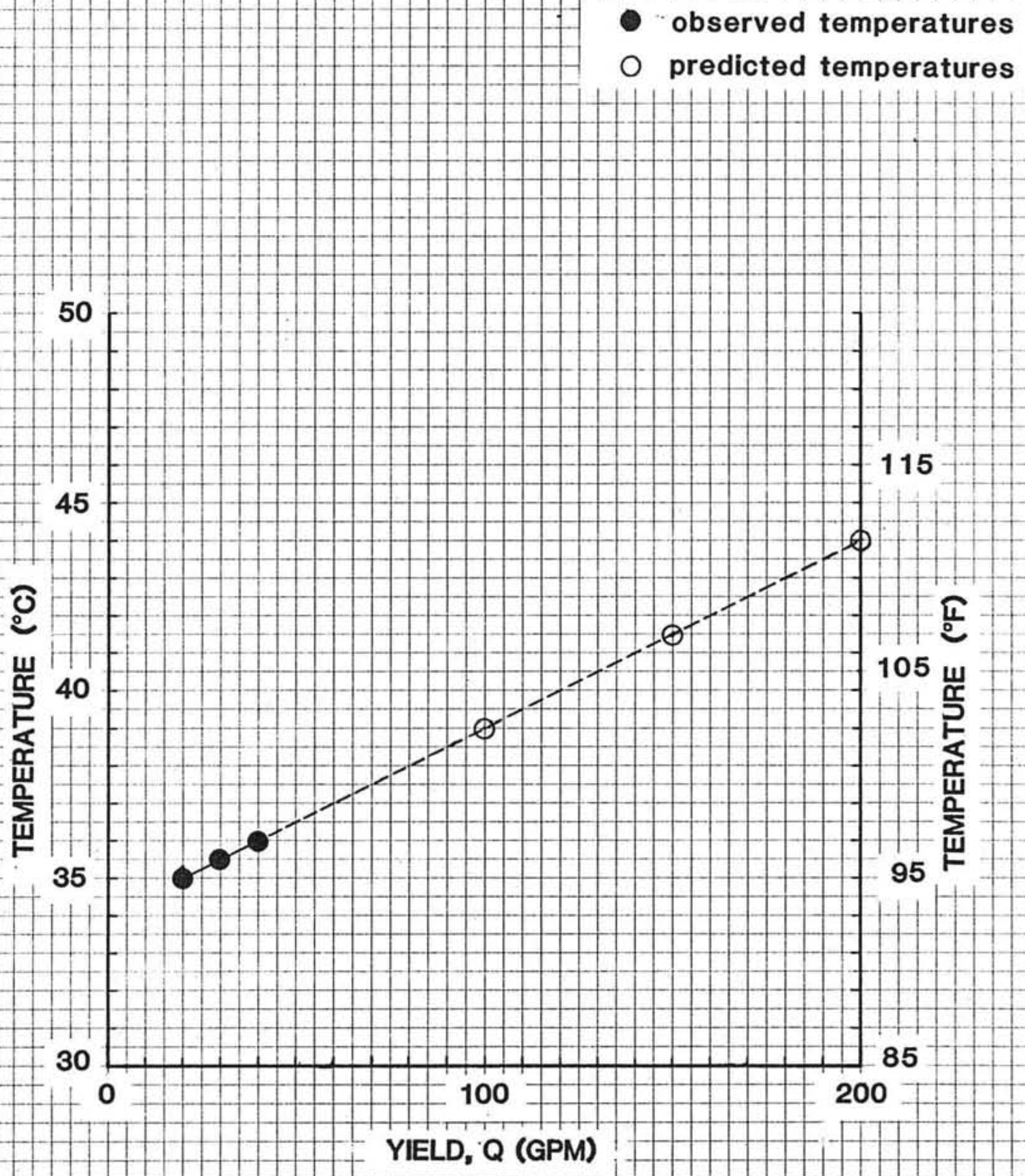


Figure 11. Temperature vs Yield, VAMC Test Well, Reno, Nevada

## 8.2 PRODUCTION WELL YIELD

The response of a production well at the VAMC can be advanced from the results of the pumping tests. The projected response assumes:

1. The production well is constructed in such a manner so as to be highly efficient (assume 80% efficiency).
2. The well fully penetrates the geothermal production zone (980 to 1,340 feet).
3. The transmissivity of the aquifer is 5,148 GPD/ft
4. The coefficient of storage of the aquifer is 0.001.
5. The well is pumped at a constant rate.
6. Recharge to the aquifer is not considered

The response of the well for a range of pumping rates calculated from the Theis Equation is illustrated in Figure 12. These results suggest that a properly constructed well could yield up to 300 gpm virtually indefinitely with peak short-term yield approaching 400 gpm.

## 8.3 POTENTIAL HEAT OUTPUT

Utilization of geothermal heat energy may be catagorized as direct and indirect. Direct use for space-heating purposes is by far the most common application of the geothermal resource in the Truckee Meadows. The direct-use systems extract the heat from a heating loop or coil located in the well known as a downhole-heat-exchanger (DHE) or one located at the surface. Indirect systems, in contrast, mechanically amplify the water temperature via electrically powered water-source heat pumps.

Direct-use systems equipped with a DHE are feasible for domestic or individual residential applications for temperatures as low as 120°F. They are not practical for commercial applications at this temperature. Direct-use applications equipped with heat exchangers at the surface

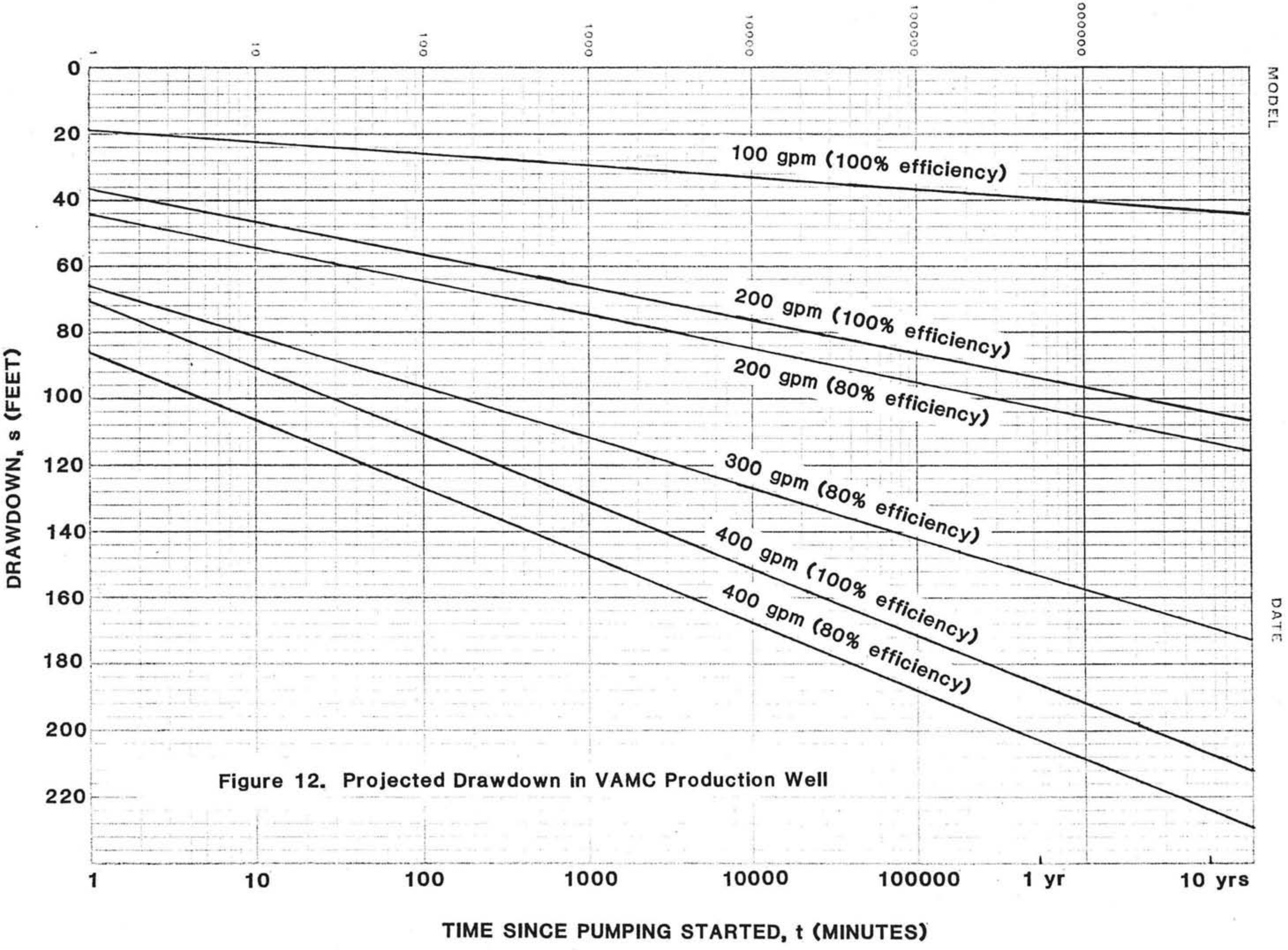


Figure 12. Projected Drawdown in VAMC Production Well

such as radiators can utilize water temperatures as low as 85 to 90°F. Forced-air systems equipped with fan coils require water tempertures in the range of 110 to 115°F to maintain air-supply temperatures of 100°F.

Above-ground heat exchangers require a flow of water from the well through the exchanger. For commercial applications, intermediate heat exchangers are often employed to isolate the geothermal fluids from the heating coils to reduce the potential for corrosion or incrustation.

The results of the drilling and testing program at the VAMC strongly suggests that a properly constructed production well can yield up to 300 gpm of ground water with temperatures of approximately 115°F virtually indefinitely. The available heat energy available from direct use of the heat via fan coils, assuming a 5°F temperature drop across both an intermediate exchanger and the fan coils is

300 gpm x 60 min/Hr x 8.33 BTU/gal/°F x 5°F=

749,700 BTUH

which at Reno design temperatures is sufficient to heat 38,000 square feet.

Indirect use of the geothermal heat source utilizing water-source heat pumps increases the heat output dramatically. Mechanical amplification by water-to-water or water-to-air heat pumps utilizes a much larger temperature drop than the direct circulation through heating coils - perhaps as large as 50°F. With this change in mind the available heat becomes

300 gpm x 60 min/hr x 8.33 BTU/gal/°F x 50°F =

7,497,000 BTUH

which is capable of heating 380,000 square feet at Reno design temperatures.

A third alternative utilizes water-to-air or water-to-water heat pumps for both heating and cooling. These devices operate efficiently with source temperatures of 90°F. Assuming a temperature differential of 40°F, the heating and cooling potential approximate 6,000,000 BTUH and 500 tons, respectively, which is sufficient for a 175,000 square feet building.

## 8.4 PRODUCTION/INJECTION WELL DESIGN CONSIDERATIONS

Development of the geothermal resource at the VAMC will entail drilling and constructing a 1,340 feet deep production well capable of yielding 300 to 400 gpm. The diameter of the well depends primarily on the size of a pump capable of these discharge rates. Nominal 8-inch diameter pumps which will meet this requirement are readily available. Minimum 10 3/4-inch O.D. casing is recommended to house the anticipated pumping equipment. A nominal 16-inch diameter borehole will accommodate the installation of the 10-inch casing and well screen, gravel envelope in the production zone, and cement seal from the top of the production zone to land surface.

The fact that the Reno VAMC is located in a designated basin precludes consumptive use of the geothermal fluid. As a consequence, the heat-spent fluid must be returned to the geothermal aquifer via an injection well. The design of the injection well will be identical to that of the production well. The distance between the two wells should be as large as possible to reduce the potential for temperature breakthrough of the injected water.

## 8.5 ECONOMIC CONSIDERATIONS

At this time the size of the building under consideration for geothermal space heating is unknown. As a result, a detailed economic analysis of the different heating system alternatives is not practical. For discussion purposes, however, the payback for development of a geothermal production/injection/heat-pump system versus a conventional gas heat/electric cool central plant for a building of 100,000 square feet is estimated at less than two years.

# SOURCES OF INFORMATION

Bateman, R.L. and Scheibach, R.B., 1975, Evaluation of Geothermal Activity in the Truckee Meadows, Washoe County, Nevada, Report 25, Nevada Bureau of Mines and Geology.

Flynn, Thomas, and Ghusn, George Jr., 1984, Geologic and Hydrologic Research of the Moana Geothermal System Washoe County, Nevada, Division of Earth Sciences, Environmental Research Center, University of Nevada, Las Vegas.

Garside, Larry J., 1974, Geothermal Exploration and Development in Nevada through 1973, Report 21, Nevada Bureau of Mines and Geology.

Garside, Larry J., and Schilling, John H., 1979, Thermal Waters of Nevada, Bulletin 91, Nevada bureau of Mines and Geology.

# APPENDIX A

# WATER RIGHT APPLICATION, WAIVER REQUEST AND APPROVAL

AMENDED

Serial No. 48624

# APPLICATION FOR PERMIT TO APPROPRIATE THE PUBLIC WATERS OF THE STATE OF NEVADA

**THIS SPACE FOR OFFICE USE ONLY**

Date of filing in State Engineer's Office DEC 7 1984

Returned to applicant for correction JAN 3 1985

Corrected application filed ______ Map filed ______

The applicant Veterans Administration Medical Center

1000 Locust Street (Street and No. or P.O. Box No.) of Reno (City and Town)

Nevada 89502 (State and Zip Code No.), hereby make.... application for permission to appropriate the public waters of the State of Nevada, as hereinafter stated. (If applicant is a corporation, give date and place of incorporation; if a copartnership or association give names of members.)

Is applicant a U.S. citizen? Yes ☒ No ☐

Is applicant 21 years of age or older? Yes ☒ No ☐

NRS 533.325 requires that applicant be a citizen of the United States or have legally declared their intention to become a citizen, and that they be 21 years of age or older.

1. The source of the proposed appropriation is underground (Name of stream, lake, spring, underground or other source.)

2. The amount of water applied for is 2.0 second feet. (One second foot equals 448.83 gallons per minute.)

   (a) If stored in reservoir give number of acre-feet

3. The water to be used for Commercial - Geothermal (Irrigation, power, mining, commercial, domestic or other use. Must limit to one major use.)

4. If use is for:

   (a) Irrigation, state number of acres to be irrigated

   (b) Stockwater, state number and kind of animals

   (c) Other use (describe fully under "No. 12. Remarks")

   (d) Power:

      (1) Horsepower developed

      (2) Point of return of water to stream

5. The water is to be diverted from its source at the following point SW¼ NE¼, Section 3, T 19N., R 19E., MDB&M, or at point from which the N¼ corner of said Section 13, bears N 8° 12' W. a distance of 1,535 feet.
Describe as being within a 40-acre subdivision of public survey, and by course and distance to a section corner. If on unsurveyed land, it should be so stated.

6. Place of use a portion of the SW¼ NE¼, NW¼ NE¼, SE¼ NW¼, NE¼ NW¼, Section 13, T 19N., R 19E., MDB&M as outlined on the supporting map.
Describe by legal subdivision. If on unsurveyed land, it should be so stated.

7. Use will begin about January 1 (Month and Day) and end about December 31 (Month and Day) of each year.

8. Description of proposed works (Under the provisions of NRS 535.010 you may be required to submit plans and specifications of your diversion or storage works.) well, pump, heat exchanger, and injection well.
State manner in which water is to be diverted, i.e. diversion structure, ditches and flumes, drilled well with pump and motor, etc.

9. Estimated cost of works $150,000

10. Estimated time required to construct works 2 years
If well completed, describe works.

11. Estimated time required to complete the application of water to beneficial use 5 years

12. Remarks: For use other than irrigation or stock watering, state number and type of units to be served or annual consumptive use.

A production well will be used in conjuction with an injection well and heat exchanger to boost the heating capacity for hospital use. The annual consumption will be zero acre-feet.

TELEPHONE NUMBER

(702) 322-2604

**APPLICATION MUST BE SIGNED BY THE APPLICANT OR AGENT**

By William E. Nork
Signature, applicant or agent

1026 W. First Street
Street and No., or P.O. Box No.

Reno, Nevada 89503
City, State, Zip Code No.

2888 (Rev. 8-83)

**$100 FILING FEE MUST ACCOMPANY APPLICATION**

WILLIAM E. NORK, Inc.

CONSULTING SERVICES IN HYDROLOGY AND GEOLOGY

1026 W. First Street • Reno, Nevada 89503

Phone (702) 322-2604

December 4, 1984
84-356

Mr. Peter Morros
Division of Water Resources
201 South Fall Street
Carson City, Nevada 89710

RE: Drilling waiver request

Dear Pete:

The object of this letter is to request a waiver for the drilling and testing of a geothermal exploration well at the Veterans Administration Medical Center in Reno. It is anticipated that an exploration hole will be drilled within the SW 1/4 NE 1/4, Section 13, T.19N., R.19E., MDB&M. An Application for Permit to Appropriate has been filed in your office. A copy of the application is attached.

The driller for this well has not been selected. However, our staff will be responsible for selection of drilling contractor in addition to the well site selection, and collection and evaluation of information.

Purpose of drilling the proposed exploration hole is to derive data which will provide the owner and the State of Nevada with information regarding adequacy of geothermal water available for use in the Veterans Administration Medical Center boiler plant.

The proposed method of geothermal energy use will be pumping the geothermal water from the well, running it through a heat exchanger, then injecting the heat spent fluid into the same aquifer but at a different well site on the property.

If we can provide you with any additional information regarding this request, please contact our office.

Sincerely,

WILLIAM E. NORK, INC.

David Carlson

David Carlson
Hydrogeologist

**RICHARD H. BRYAN**
*Governor*

**STATE OF NEVADA**

**ROLAND D. WESTERGARD**
*Director*

**PETER G. MORROS**
*State Engineer*

**DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES**
**DIVISION OF WATER RESOURCES**
**Capitol Complex**
**201 S. Fall Street**
**Carson City, Nevada 89710**

G-103

December 11, 1984

David Carlson
William E. Nork, Inc.
1026 W. Fisrt Street
Reno, Nevada 89503

Dear Mr. Carlson:

Waiver No. G-103 is hereby granted this date to drill one exploration well located within the SW¼ NE¼ of Section 13 T.19N., R.19E., M.D.B.&M.

Application 48624 is on file in the name of Veterans Administration Medical Center The intent to drill card and log when filed shall bear the above waiver number, name and license number of the driller performing the work.

The starting and completion dates of the exploratory well will not exceed one (1) year from the date of this waiver. An exploratory well will not be used for production until a permit has been granted by the Division of Water Resources. If an exploratory well is pumped or flowed, it will be tested not more than ten (10) days total unless otherwise waived.

The information concerning the geothermal resources shall be collected within Thirty (30) days of the completion of the exploratory well.

The granting of this waiver does not grant or infer any rights of appropriation of the resources and shall not be deemed to result in the development of any equity.

A copy of this waiver shall be conveyed to the well driller.

Sincerely,

Dick L. Williford
hydraulic Engineer

DLW/pr

RECEIVED
DEC 12 1984

# APPENDIX B

# LITHOLOGIC LOG

# LOG OF BOREHOLE

BOREHOLE EXPLORATION WELL

PAGE 1 of 8

LOCATION VAMC-RENO

LOGGED BY GARY KARST

PROJECT 85-356

LOC. or COORDS. VAMC-RENO

GROUND ELEV. 4,455 FEET

TOTAL DEPTH 1,380 FEET

BOREHOLE DIAM. 9 7/8-INCH

DRILLER POTTER DRILLING, FALLON, NV

RIG PORTADRILL

BIT(S) 9 7/8,

FLUID MUD

| | START | FINISH |
|---|---|---|
| DATE | 1/19/85 | 4/5/85 |
| TIME | | |

GEOPHYS LOG ___ YES X NO

HOW LEFT

| DEPTH | PENE-TRATE | CIRC. | | A-LIFT Q (gpm) | MATERIAL | SYM-BOL | DESCRIPTION AND COMMENTS |
|---|---|---|---|---|---|---|---|
| | | RET. | LOSS | | | | |
| 0-10' | | | | | Sand | | Grayish-tan med. – v. coarse grain clayey/muddy sand. |
| 10'-20' | | | | | " " | | Same. Clay/mud content reduced significantly. |
| 20'-30' | | | | | Gravel | | Very fine tan – med gray pebble gravel. |
| 30'-40' | | | | | Sand | | Fine – coarse grained tan gray silty sand |
| 40'-50' | | | | | " " | | Same. |
| 50'-60' | | | | | " " | | Fine – v. coarse grained tan gray sand. Minor clay/silt content. |
| 60'-70' | | | | | Gravel | | Very fine tan-gray pebble gravel. Minor clay/silt. |
| 70'-80' | | | | | Sand | | Med. – v. coarse grained tan-gray claysand. |
| 80'-90' | | | | | Gravel | | Very fine tan-gray sandy clay pebble gravel. |
| 90'-100' | | | | | " " | | Same. |
| 100'-110' | | | | | " " | | Same. |
| 110'-120' | | | | | " " | | Same |
| 120'-130' | | | | | Sand | | Med – v. coarse grained clay sand. Minor gravel. |
| 130'-140' | | | | | " " | | Same. |
| 140'-150' | | | | | " " | | Same. |
| 150'-160' | | | | | " " | | Same. |
| 160'-170' | | | | | " " | | Same. |
| 170'-180' | | | | | " " | | Same. |
| 180'-190' | | | | | Sand | | Fine – coarse grained brownish gray silty/clay sand. |

# LOG OF BOREHOLE

BOREHOLE EXPLORATION WELL PAGE 2 of 8

LOCATION VAMC-RENO

LOGGED BY GARY MARST

PROJECT 85-356

LOC. or COORDS. VAMC - RENO

GROUND ELEV. 4,455 FBBT

TOTAL DEPTH 1,380 FBBT

BOREHOLE DIAM. 9 7/8 - INCH

DRILLER POTTER DRILLING FALLON, NEVADA

RIG PORTADRILL

BIT(S) 9 7/8

FLUID MUD

| | START | FINISH |
|---|---|---|
| DATE | 1/19/85 | 4/5/85 |
| TIME | | |

GEOPHYS LOG __YES X NO

HOW LEFT

| DEPTH | PENE-TRATE | CIRC. RET. | CIRC. LOSS | A-LIFT Q (gpm) | MATERIAL | SYM-BOL | DESCRIPTION AND COMMENTS |
|---|---|---|---|---|---|---|---|
| 190'-200' | | | | | Sand | | Same. |
| 200'-210' | | | | | " " | | Same. |
| 210'-220' | | | | | " " | | Med - v. coarse grained brownish gray sand. Minor silt/clay. |
| 220'-230' | | | | | " " | | Fine - coarse grained tan-white - gray silty sand. |
| 230'-240' | | | | | Gravel | | Very fine olive gray pebble gravel. |
| 240'-250' | | | | | " " | | Same. Minor silt/clay |
| 250'-260' | | | | | " " | | Very fine olive gray silty pebble gravel. |
| 260'-270' | | | | | " " | | Same. |
| 270'-280' | | | | | " " | | Same. |
| 280'-290' | | | | | " " | | Same. |
| 290'-300' | | | | | " " | | Same. Minor silt. |
| 300'-310' | | | | | " " | | Very fine olive gray silty pebble gravel. |
| 310'-320' | | | | | " " | | Same |
| 320'-330' | | | | | " " | | Same |
| 330-340' | | | | | Sand | | Coarse - v. coarse grained tan - gray silty sand. |
| 340-350' | | | | | " " | | Same. Minor gravel |
| 350'-360' | | | | | " " | | Same. |
| 360'-370' | | | | | " " | | Same. |
| 370'-380' | | | | | " " | | Same. Increase in silt content. |

# LOG OF BOREHOLE

BOREHOLE EXPLORATION WELL

PAGE 3 of 8

LOC. or COORDS. VAMC - RENO

GROUND ELEV. 4,455 FEET

TOTAL DEPTH 1,380 FEET

BOREHOLE DIAM. 9 7/8- INCH

DRILLER POTTER DRILLING FALLON, NEVADA

RIG PORTADRILL

BIT(S) 9 7/8

FLUID MUD

| | START | FINISH |
|---|---|---|
| DATE | 1/19/85 | 4/5/85 |
| TIME | | |

GEOPHYS LOG ___YES [✓ NO]

HOW LEFT

LOCATION VAMC-RENO

LOGGED BY GARY KARST

PROJECT 85-356

| DEPTH | PENE-TRATE | CIRC. RET. | CIRC. LOSS | A-LIFT Q (gpm) | MATERIAL | SYMBOL | DESCRIPTION AND COMMENTS |
|---|---|---|---|---|---|---|---|
| 380'-390' | | | | | Sand | | Coarse - v. coarse grained tan - gray silty sand. Minor gravel. |
| 390'-400' | | | | | " " | | Same. |
| 410'-420' | | | | | Gravel | | Very fine tan - gray silty pebble gravel. Minor coarse sand. |
| 420'-430' | | | | | Sand | | Coarse - v. coarse grained brownish gray silty sand. Minor gravel. |
| 430'-440' | | | | | " " | | Same. |
| 440'-450' | | | | | " " | | Same. |
| 450'-460' | | | | | " " | | Same. |
| 460'-470' | | | | | " " | | Same. |
| 470'-480' | | | | | " " | | Med. - v. coarse grained brownish gray silty sand. Minor gravel. |
| 480'-490' | | | | | " " | | Same. |
| 490'-500' | | | | | " " | | Same. |
| 500'-510' | | | | | Sand / silt | | Fine - coarse grained med gray sand and silt. |
| 510'-520' | | | | | " " | | Same. |
| 520'-530' | | | | | " " | | Same. |
| 530'-540' | | | | | " " | | Same. |
| 540'-550' | | | | | " - " | | Fine - med grained med gray sand and silt. |
| 550'-560' | | | | | " " | | Same. Minor clay. |
| 560'-570' | | | | | " " | | Fine - coarse grained med gray sand and silt. |
| 570'-580' | | | | | Sand | | Fine - v. coarse grained gray silty sand. Silt content decreasing. |

# LOG OF BOREHOLE

BOREHOLE EXPLORATION WELL

PAGE 4 of 8

LOC. or COORDS.
VAMC - RENO

GROUND ELEV. 4,455 FEET

TOTAL DEPTH 1,380 FEET

BOREHOLE DIAM. 9 7/8-INCH

DRILLER POTTER DRILLING
FALLON, NEVADA

RIG PORTADRILL

BIT(S) 9 7/8

FLUID MUD

| | START | FINISH |
|---|---|---|
| DATE | 1/19/85 | 4/5/85 |
| TIME | | |

GEOPHYS LOG ___YES X NO

HOW LEFT

| DEPTH | PENE-TRATE | CIRC. | | A-LIFT Q (gpm) | MATERIAL | SYMBOL | DESCRIPTION AND COMMENTS |
|---|---|---|---|---|---|---|---|
| | | RET. | LOSS | | | | |
| 580'-590' | | | | | Sand | | Same. |
| 590'-600' | | | | | " " | | Same. |
| 600'-610' | | | | | " " | | Same. |
| 610'-620' | | | | | " " | | Fine - coarse grained gray silty sand. |
| 620'-630' | | | | | " " | | Same. |
| 630'-640' | | | | | " " | | Same. |
| 640'-650' | | | | | " " | | Same. |
| 650'-660' | | | | | Sand | | Med. - v. coarse grained med gray sand. |
| 660'-670' | | | | | " " | | Same. |
| 670'-680' | | | | | " " | | Same |
| 680'-690' | | | | | " " | | Same |
| 690'-700' | | | | | " " | | Same |
| 700'-710' | | | | | Sand | | Med - v. coarse brownish gray sand. Minor clay/silt. |
| 710'-720' | | | | | " " | | Same. |
| 720'-730' | | | | | " " | | Med - v. coarse grained brownish gray silty sand. |
| 730'-740' | | | | | Gravel | | Very fine med gray pebble gravel. Minor sand |
| 740'-750' | | | | | " " | | Same. |
| 750'-760' | | | | | " " | | Same. |
| 760'-770' | | | | | Sand | | Fine - coarse grained brownish gray silty sand. |

LOCATION VAMC - RENO

LOGGED BY GARY KARST

PROJECT 85-356

# LOG OF BOREHOLE

BOREHOLE EXPLORATION WELL

PAGE 5 of 8

LOCATION VAMC-RENO

LOGGED BY GARY KARST

PROJECT 85-356

LOC. or COORDS. VAMC-RENO

GROUND ELEV. 4,455 FEET

TOTAL DEPTH 1,380 FEET

BOREHOLE DIAM. 9 7/8-INCH

DRILLER POTTER DRILLING FALLON, NEVADA

RIG PORTADRILL

BIT(S) 9 7/8

FLUID MUD

| | START | FINISH |
|---|---|---|
| DATE | 1/19/85 | 4/5/85 |
| TIME | | |

GEOPHYS LOG YES [✓ NO]

HOW LEFT

| DEPTH | PENETRATE | CIRC. | | A-LIFT Q (gpm) | MATERIAL | SYMBOL | DESCRIPTION AND COMMENTS |
|---|---|---|---|---|---|---|---|
| | | RET. | LOSS | | | | |
| 770'-750' | | | | | Sand/silt | | V.fine - coarse grained brownish gray sand and silt. Minor clay. |
| 780'-790' | | | | | Sand | | V.fine coarse grained brownish gray sand. Minor silt. |
| 790'-800' | | | | | Sand | | V.fine - v. coarse grained brownish gray sand. |
| 800'-810' | | | | | " " | | Same. |
| 810'-820' | | | | | " " | | Fine - v. coarse grained gray sand. Minor silt |
| 820'-830' | | | | | " " | | Med - v. coarse grained gray sand. |
| 830'-840' | | | | | " " | | V.fine - v. coarse grained gray sand. |
| 840'-850' | | | | | " " | | V.fine - med. grained gray sand. |
| 850'-860' | | | | | " " | | Med - v. coarse grained gray sand. |
| 860'-870' | | | | | " " | | Fine - v. coarse grained gray sand |
| 870'-880' | | | | | " " | | Same. |
| 880'-890' | | | | | " " | | Same. |
| 890'-900' | | | | | " " | | Same. |
| 900'-910' | | | | | " " | | Same. |
| 910'-920' | | | | | " " | | Same. |
| 920'-920' | | | | | " " | | Same. |
| 930'-940' | | | | | Sand | | Same. Minor silt. |
| 940'-950' | | | | | " " | | Same. Minor Silt. |
| 950-960' | | | | | " " | | Same. Minor silt |

# LOG OF BOREHOLE

BOREHOLE EXPLORATION WELL

PAGE 6 of 8

LOC. or COORDS.
VAMC-RENO

DRILLER POTTER DRILLING
FALLON, NEVADA

GROUND ELEV. 4,455 FEET

TOTAL DEPTH 1,380 FEET

BOREHOLE DIAM. 9 7/8-INCH

RIG PORTADRILL

BIT(S) 9 7/8

FLUID MUD

| | START | FINISH |
|---|---|---|
| DATE | 1/19/85 | 4/5/85 |
| TIME | | |

GEOPHYS LOG ☐ YES ☒ NO

HOW LEFT

| DEPTH | PENE-TRATE | CIRC. RET. | CIRC. LOSS | A-LIFT Q (gpm) | MATERIAL | SYMBOL | DESCRIPTION AND COMMENTS |
|---|---|---|---|---|---|---|---|
| 960'-970' | | | | | Sand | | V. fine - coarse grained gray sand. |
| 970'-980' | | | | | " " | | Same. |
| 980'-990' | | | | | " " | | Fine - v. coarse grained gray sand. |
| 990'-1000' | | | | | " " | | Same. |
| 1000'-1010' | | | | | " " | | V. fine - med. grained gray silty sand. |
| 1010'-1020' | | | | | " " | | Fine - v. coarse grained gray sand. Minor silt. |
| 1020'-1030' | | | | | " " | | Fine - v. coarse grained gray silty sand. |
| 1030'-1040' | | | | | " " | | Same |
| 1040'-1050' | | | | | Sand/silt | | V. fine - med. grained gray sand and silt |
| 1050'-1060' | | | | | Sand/silt/clay | | V. fine - med grained med. gray sand, silt and clay. |
| 1060'-1070' | | | | | Sand/silt | | V. fine - coarse grained med. gray sand and silt. |
| 1070'-1080' | | | | | " " | | Same. |
| 1080'-1090' | | | | | Sand | | V. fine - coarse grained med. gray silty sand. |
| 1090'-1100' | | | | | " " | | Same. |
| 1100'-1110' | | | | | Sand/silt | | V. fine - coarse grained med. gray sand and silt. |
| 1110'-1120' | | | | | " " | | Same. |
| 1120'-1130' | | | | | " " | | Same. |
| 1130'-1140' | | | | | Silt/sand | | V. fine - med grained med gray sand and silt with silt predominating over sand. |
| 1140'-1150' | | | | | " " | | Same. |

LOCATION VAMC-RENO

LOGGED BY GARY KARST

PROJECT 85-356

# LOG OF BOREHOLE

BOREHOLE EXPLORATION WELL

PAGE 7 of 8

LOC. or COORDS.
VAMC-RENO
GROUND ELEV. 4,455 FEET
TOTAL DEPTH 1,380 FEET
BOREHOLE DIAM. 9 7/8-INCH

DRILLER POTTER DRILLING
FALLON, NEVADA
RIG PORTA DRILL
BIT(S) 9 7/8
FLUID MUD

| | START | FINISH |
|---|---|---|
| DATE | 1/19/85 | 4/5/85 |
| TIME | | |

GEOPHYS LOG ☐ YES ☒ NO
HOW LEFT

LOCATION VAMC-RENO
LOGGED BY GARY KARST
PROJECT 85-356

| DEPTH | PENE-TRATE | CIRC. RET. | CIRC. LOSS | A-LIFT Q (gpm) | MATERIAL | SYMBOL | DESCRIPTION AND COMMENTS |
|---|---|---|---|---|---|---|---|
| 1150'-1160' | | | | | Sand/silt | | V. fine-coarse grained med gray sand and silt. Minor clay, |
| 1160'-1170' | | | | | Sand | | Med. to v. coarse grained med. gray silty sand. Andesitic volcanics starting to show up in sand. |
| 1170'-1180' | | | | | " " | | Same. |
| 1180'-1190' | | | | | Sand/silt | | V. fine - coarse grained med. gray sand and silt. |
| 1190'-1200' | | | | | Sand | | Med to v. coarse grained med gray silty sand. |
| 1200'-1210' | | | | | Sand/silt | | Fine - v. coarse grained med. gray sand and silt, Volcanics are common in sand and secondarily muneralized, Mineralization is pale blue - bluish gray |
| 1210'-1220' | | | | | Sand | | Med - v. coarse grained med. gray silty sand |
| 1220'-1230' | | | | | " " | | Same. |
| 1230'-1240' | | | | | " " | | Same. |
| 1240'-1250' | | | | | " " | | Same. |
| 1250'-1260' | | | | | " " | | Med to v. coarse grained med gray sand. Minor silt. |
| 1260'-1270' | | | | | " " | | Fine - v. coarse grained med gray silty sand. |
| 1270'-1280' | | | | | " " | | Saml. |
| 1280'-1290' | | | | | " " | | Same. |
| 1290'-1300' | | | | | Silt/sand | | V. fine - v. coarse grained med gray sand and silt, with silt predominating. |
| 1300'-1310' | | | | | " " | | Same |
| 1310'-1320' | | | | | " " | | Same. Sand is v. fine - coarse grained. |
| 1320'-1330' | | | | | " " | | Same. |
| 1330'-1340' | | | | | Andesitic Tuff / sand | | Med gray v. coarse grained volcanic sand and welded andesitic tuff. Pale blue secondary mineralization visible |

# LOG OF BOREHOLE

BOREHOLE EXPLORATION WELL

PAGE 8 of 8

LOC. or COORDS. VAMC-RENO

DRILLER POTTER DRILLING FALLON, NEVADA

START FINISH

DATE 1/19/85 4/5/85

TIME

GROUND ELEV. 4,455 FEET

TOTAL DEPTH 1,380 FEET

RIG PORTADRILL

GEOPHYS LOG __YES X NO

BOREHOLE DIAM. 9 7/8-INCH

BIT(S) 9 7/8-INCH

HOW LEFT

FLUID MUD

LOCATION VAMC-RENO

LOGGED BY GARY KARST

PROJECT 85-356

| DEPTH | PENE-TRATE | CIRC. |  | A-LIFT | MATERIAL | SYM-BOL | DESCRIPTION AND COMMENTS |
|---|---|---|---|---|---|---|---|
|  |  | RET. | LOSS | Q (gpm) |  |  |  |
| 1340'-1350' |  |  |  |  | "  " | ▨ | Same. |
| 1350'-1360' |  |  |  |  | "  " | ▨ | Same. |
| 1360'-1370' |  |  |  |  | "  " | ▨ | Same. |
| 1370'-1380' |  |  |  |  | "  " | ▨ | Same. |

# APPENDIX C

# PUMPING AND RECOVERY TESTING DATA

# PUMP TEST - DRAWDOWN DATA

PROJECT: VAMC
LOCATION: RENO-VAMC
DATUM POINT: TOP OF STILLING WELL
PUMPING RATE:
AQUIFER THICKNESS:
CONDITIONS: CONFINED

FILE NO.: 85-356
WELL NO.: 1
ELEV. OF DATUM POINT: 4455 FT
STATIC WATER LEVEL: 31.75 FT
R = ----- FROM
SCREEN INTERVAL: TO

| TIME | | | ELAPSED TIME | WATER LEVEL | DRAWDOWN | (Q) |
|---|---|---|---|---|---|---|
| DY | HR | MN | t (MIN) | (ft) | s (ft) | (USGPM) |
| 17 | 7 | 0 | 0.00 | 31.750 | 0.000 | 0.00 |
| 17 | 7 | 1 | 1.00 | 53.550 | 21.800 | 20.00 |
| 17 | 7 | 3 | 3.00 | 55.910 | 24.160 | 20.00 |
| 17 | 7 | 5 | 5.00 | 57.420 | 25.670 | 20.00 |
| 17 | 7 | 7 | 7.00 | 58.750 | 27.000 | 20.00 |
| 17 | 7 | 9 | 9.00 | 59.600 | 27.850 | 20.00 |
| 17 | 7 | 12 | 12.00 | 60.700 | 28.950 | 20.00 |
| 17 | 7 | 16 | 16.00 | 61.500 | 29.750 | 20.00 |
| 17 | 7 | 20 | 20.00 | 62.300 | 30.550 | 20.00 |
| 17 | 7 | 25 | 25.00 | 62.900 | 31.150 | 20.00 |
| 17 | 7 | 30 | 30.00 | 63.360 | 31.610 | 20.00 |
| 17 | 7 | 35 | 35.00 | 64.000 | 32.250 | 20.00 |
| 17 | 7 | 40 | 40.00 | 64.370 | 32.620 | 20.00 |
| 17 | 7 | 50 | 50.00 | 64.900 | 33.150 | 20.00 |
| 17 | 8 | 0 | 60.00 | 65.400 | 33.650 | 20.00 |
| 17 | 8 | 20 | 80.00 | 66.220 | 34.470 | 20.00 |
| 17 | 8 | 40 | 100.00 | 66.900 | 35.150 | 20.00 |
| 17 | 9 | 0 | 120.00 | 67.250 | 35.500 | 20.00 |
| 17 | 9 | 30 | 150.00 | 67.580 | 35.830 | 20.00 |
| 17 | 10 | 0 | 180.00 | 67.750 | 36.000 | 20.00 |
| 17 | 10 | 30 | 210.00 | 67.800 | 36.050 | 20.00 |
| 17 | 11 | 0 | 240.00 | 67.820 | 36.070 | 20.00 |
| 17 | 11 | 1 | 241.00 | 75.800 | 44.050 | 30.00 |
| 17 | 11 | 3 | 243.00 | 75.830 | 44.080 | 30.00 |
| 17 | 11 | 5 | 245.00 | 76.100 | 44.350 | 30.00 |
| 17 | 11 | 7 | 247.00 | 76.330 | 44.580 | 30.00 |
| 17 | 11 | 9 | 249.00 | 76.460 | 44.710 | 30.00 |
| 17 | 11 | 12 | 252.00 | 76.820 | 45.070 | 30.00 |
| 17 | 11 | 16 | 256.00 | 77.120 | 45.370 | 30.00 |
| 17 | 11 | 20 | 260.00 | 77.300 | 45.550 | 30.00 |

## PUMP TEST – DRAWDOWN DATA

PROJECT: VAMC
LOCATION: RENO-VAMC
DATUM POINT: TOP OF STILLING WELL
PUMPING RATE:
AQUIFER THICKNESS:
CONDITIONS: CONFINED

FILE NO.: 85-356
WELL NO.: 1
ELEV. OF DATUM POINT: 4455 FT
STATIC WATER LEVEL: 31.75 FT
R = ------ FROM
SCREEN INTERVAL: TO

| TIME | | | ELAPSED TIME | WATER LEVEL | DRAWDOWN | (Q) |
|---|---|---|---|---|---|---|
| DY | HR | MN | t (MIN) | (ft) | s (ft) | (USGPM) |
| 17 | 11 | 25 | 265.00 | 77.500 | 45.750 | 30.00 |
| 17 | 11 | 30 | 270.00 | 77.620 | 45.870 | 30.00 |
| 17 | 11 | 35 | 275.00 | 77.820 | 46.070 | 30.00 |
| 17 | 11 | 40 | 280.00 | 77.900 | 46.150 | 30.00 |
| 17 | 11 | 50 | 290.00 | 78.150 | 46.400 | 30.00 |
| 17 | 12 | 0 | 300.00 | 78.350 | 46.600 | 30.00 |
| 17 | 12 | 20 | 320.00 | 78.650 | 46.900 | 30.00 |
| 17 | 12 | 40 | 340.00 | 78.850 | 47.100 | 30.00 |
| 17 | 13 | 0 | 360.00 | 79.050 | 47.300 | 30.00 |
| 17 | 13 | 30 | 390.00 | 86.670 | 54.920 | 30.00 |
| 17 | 14 | 0 | 420.00 | 89.080 | 57.330 | 30.00 |
| 17 | 14 | 30 | 450.00 | 91.980 | 60.230 | 30.00 |
| 17 | 15 | 0 | 480.00 | 92.610 | 60.860 | 30.00 |
| 17 | 15 | 1 | 481.00 | 97.950 | 66.200 | 40.00 |
| 17 | 15 | 3 | 483.00 | 101.950 | 70.200 | 40.00 |
| 17 | 15 | 5 | 485.00 | 103.720 | 71.970 | 40.00 |
| 17 | 15 | 7 | 487.00 | 104.630 | 72.880 | 40.00 |
| 17 | 15 | 10 | 490.00 | 105.910 | 74.160 | 40.00 |
| 17 | 15 | 13 | 493.00 | 106.870 | 75.120 | 40.00 |
| 17 | 15 | 16 | 496.00 | 107.490 | 75.740 | 40.00 |
| 17 | 15 | 20 | 500.00 | 107.980 | 76.230 | 40.00 |
| 17 | 15 | 25 | 505.00 | 108.400 | 76.650 | 40.00 |
| 17 | 15 | 30 | 510.00 | 108.720 | 76.970 | 40.00 |
| 17 | 15 | 40 | 520.00 | 109.400 | 77.650 | 40.00 |
| 17 | 15 | 50 | 530.00 | 109.810 | 78.060 | 40.00 |
| 17 | 16 | 0 | 540.00 | 110.100 | 78.350 | 40.00 |
| 17 | 16 | 20 | 560.00 | 110.500 | 78.750 | 40.00 |
| 17 | 16 | 40 | 580.00 | 111.360 | 79.610 | 40.00 |
| 17 | 17 | 0 | 600.00 | 111.600 | 79.850 | 40.00 |
| 17 | 17 | 30 | 630.00 | 111.590 | 79.840 | 40.00 |

# PUMP TEST - DRAWDOWN DATA

PROJECT: VAMC
LOCATION: RENO-VAMC
DATUM POINT: TOP OF STILLING WELL
PUMPING RATE:
AQUIFER THICKNESS:
CONDITIONS: CONFINED

FILE NO.: 85-356
WELL NO.: 1
ELEV. OF DATUM POINT: 4455 FT
STATIC WATER LEVEL: 31.75 FT
R = ------ FROM
SCREEN INTERVAL: TO

| TIME | | | ELAPSED TIME | WATER LEVEL | DRAWDOWN | (Q) |
|---|---|---|---|---|---|---|
| DY | HR | MN | t (MIN) | (ft) | s (ft) | (USGPM) |
| 17 | 19 | 0 | 720.00 | 111.920 | 80.170 | 40.00 |
| 17 | 19 | 30 | 750.00 | 111.500 | 79.750 | 40.00 |
| 17 | 20 | 0 | 780.00 | 111.550 | 79.800 | 40.00 |

WILLIAM E. NORK, INC.

# PUMP TEST - DRAWDOWN DATA

PROJECT: VAMC
LOCATION: RENO-VAMC
DATUM POINT: TOP OF STILLING WELL
PUMPING RATE: 40 USGPM
AQUIFER THICKNESS:
CONDITIONS: CONFINED

FILE NO.: 85-356
WELL NO.: 1
ELEV. OF DATUM POINT: 4455 FT
STATIC WATER LEVEL: 33.65 FT
R = ----- FROM
SCREEN INTERVAL: TO

| TIME | | | ELAPSED TIME | WATER LEVEL | DRAWDOWN | (Q) |
|---|---|---|---|---|---|---|
| DY | HR | MN | t (MIN) | (ft) | s (ft) | (USGPM) |
| 19 | 9 | 0 | 0.00 | 33.650 | 0.000 | 40.00 |
| 19 | 9 | 1 | 1.00 | 73.050 | 39.400 | 40.00 |
| 19 | 9 | 3 | 3.00 | 79.450 | 45.800 | 40.00 |
| 19 | 9 | 5 | 5.00 | 83.550 | 49.900 | 40.00 |
| 19 | 9 | 7 | 7.00 | 86.340 | 52.690 | 40.00 |
| 19 | 9 | 10 | 10.00 | 88.680 | 55.030 | 40.00 |
| 19 | 9 | 13 | 13.00 | 90.390 | 56.740 | 40.00 |
| 19 | 9 | 16 | 16.00 | 91.860 | 58.210 | 40.00 |
| 19 | 9 | 20 | 20.00 | 93.490 | 59.840 | 40.00 |
| 19 | 9 | 25 | 25.00 | 94.820 | 61.170 | 40.00 |
| 19 | 9 | 30 | 30.00 | 95.910 | 62.260 | 40.00 |
| 19 | 9 | 35 | 35.00 | 96.900 | 63.250 | 40.00 |
| 19 | 9 | 40 | 40.00 | 97.740 | 64.090 | 40.00 |
| 19 | 9 | 50 | 50.00 | 100.780 | 67.130 | 40.00 |
| 19 | 10 | 0 | 60.00 | 101.980 | 68.330 | 40.00 |
| 19 | 10 | 20 | 80.00 | 103.810 | 70.160 | 40.00 |
| 19 | 10 | 40 | 100.00 | 105.050 | 71.400 | 40.00 |
| 19 | 11 | 0 | 120.00 | 107.750 | 74.100 | 40.00 |
| 19 | 11 | 30 | 150.00 | 109.280 | 75.630 | 40.00 |
| 19 | 12 | 0 | 180.00 | 110.680 | 77.030 | 40.00 |
| 19 | 12 | 30 | 210.00 | 111.470 | 77.820 | 40.00 |
| 19 | 13 | 0 | 240.00 | 112.130 | 78.480 | 40.00 |
| 19 | 13 | 30 | 270.00 | 112.600 | 78.950 | 40.00 |
| 19 | 14 | 0 | 300.00 | 113.130 | 79.480 | 40.00 |
| 19 | 14 | 30 | 330.00 | 113.550 | 79.900 | 40.00 |
| 19 | 15 | 0 | 360.00 | 113.920 | 80.270 | 40.00 |
| 19 | 16 | 0 | 420.00 | 114.540 | 80.890 | 40.00 |
| 19 | 17 | 0 | 480.00 | 115.000 | 81.350 | 40.00 |
| 19 | 18 | 0 | 540.00 | 115.430 | 81.780 | 40.00 |
| 19 | 19 | 0 | 600.00 | 115.730 | 82.080 | 40.00 |

WILLIAM E. NORK, INC.

# PUMP TEST - DRAWDOWN DATA

PROJECT: VAMC
LOCATION: RENO-VAMC
DATUM POINT: TOP OF STILLING WELL
PUMPING RATE: 40 USGPM
AQUIFER THICKNESS:
CONDITIONS: CONFINED

FILE NO.: 85-356
WELL NO.: 1
ELEV. OF DATUM POINT: 4455 FT
STATIC WATER LEVEL: 33.65 FT
R = ------ FROM
SCREEN INTERVAL: TO

| TIME | | | ELAPSED TIME | WATER LEVEL | DRAWDOWN | (Q) |
|---|---|---|---|---|---|---|
| DY | HR | MN | t (MIN) | (ft) | s (ft) | (USGPM) |
| 19 | 20 | 0 | 660.00 | 116.080 | 82.430 | 40.00 |
| 19 | 21 | 0 | 720.00 | 116.300 | 82.650 | 40.00 |
| 19 | 22 | 0 | 780.00 | 116.400 | 82.750 | 40.00 |
| 19 | 23 | 0 | 840.00 | 116.500 | 82.850 | 40.00 |
| 20 | 0 | 0 | 900.00 | 116.650 | 83.000 | 40.00 |
| 20 | 1 | 0 | 960.00 | 116.720 | 83.070 | 40.00 |
| 20 | 2 | 0 | 1020.00 | 116.750 | 83.100 | 40.00 |
| 20 | 3 | 0 | 1080.00 | 116.800 | 83.150 | 40.00 |
| 20 | 4 | 0 | 1140.00 | 116.870 | 83.220 | 40.00 |
| 20 | 5 | 0 | 1200.00 | 116.950 | 83.300 | 40.00 |
| 20 | 6 | 0 | 1260.00 | 117.030 | 83.380 | 40.00 |
| 20 | 7 | 0 | 1320.00 | 117.080 | 83.430 | 40.00 |
| 20 | 8 | 0 | 1380.00 | 117.110 | 83.460 | 40.00 |
| 20 | 9 | 0 | 1440.00 | 117.130 | 83.480 | 40.00 |

WILLIAM E. NORK, INC.

# PUMP TEST - RECOVERY DATA

PROJECT: VAMC
LOCATION: RENO-VAMC
DATUM POINT: TOP OF STILLING WELL
PUMPING RATE: 40
AQUIFER THICKNESS:
CONDITIONS: CONFINED

FILE NO.: 85-356
WELL NO.: 1
ELEV. OF DATUM POINT: 4455 FT
STATIC WATER LEVEL: 33.65 FT
R = ----- FROM
SCREEN INTERVAL: TO

| TIME | | | PUMPING STARTED | PUMPING ENDED | RATIO | WATER LEVEL | RESIDUAL DRAWDOWN |
|---|---|---|---|---|---|---|---|
| DY | HR | MN | t (MIN) | t' (MIN) | t/t' | (ft) | (ft) |
| 20 | 9 | 0 | 1440.00 | 0.00 | 0.00 | 117.130 | 83.480 |
| 20 | 9 | 1 | 1441.00 | 1.00 | 1441.00 | 75.120 | 41.470 |
| 20 | 9 | 3 | 1443.00 | 3.00 | 481.00 | 66.250 | 32.600 |
| 20 | 9 | 5 | 1445.00 | 5.00 | 289.00 | 62.770 | 29.120 |
| 20 | 9 | 7 | 1447.00 | 7.00 | 206.71 | 60.270 | 26.620 |
| 20 | 9 | 10 | 1450.00 | 10.00 | 145.00 | 57.490 | 23.840 |
| 20 | 9 | 13 | 1453.00 | 13.00 | 111.77 | 55.690 | 22.040 |
| 20 | 9 | 16 | 1456.00 | 16.00 | 91.00 | 54.020 | 20.370 |
| 20 | 9 | 20 | 1460.00 | 20.00 | 73.00 | 52.840 | 19.190 |
| 20 | 9 | 25 | 1465.00 | 25.00 | 58.60 | 51.140 | 17.490 |
| 20 | 9 | 30 | 1470.00 | 30.00 | 49.00 | 49.880 | 16.230 |
| 20 | 9 | 35 | 1475.00 | 35.00 | 42.14 | 48.830 | 15.180 |
| 20 | 9 | 40 | 1480.00 | 40.00 | 37.00 | 48.050 | 14.400 |
| 20 | 9 | 50 | 1490.00 | 50.00 | 29.80 | 46.660 | 13.010 |
| 20 | 10 | 0 | 1500.00 | 60.00 | 25.00 | 45.440 | 11.790 |
| 20 | 10 | 20 | 1520.00 | 80.00 | 19.00 | 43.910 | 10.260 |
| 20 | 10 | 40 | 1540.00 | 100.00 | 15.40 | 42.770 | 9.120 |
| 20 | 11 | 0 | 1560.00 | 120.00 | 13.00 | 41.980 | 8.330 |
| 20 | 11 | 30 | 1590.00 | 150.00 | 10.60 | 40.870 | 7.220 |
| 20 | 12 | 0 | 1620.00 | 180.00 | 9.00 | 40.000 | 6.350 |
| 20 | 12 | 30 | 1650.00 | 210.00 | 7.86 | 39.500 | 5.850 |
| 20 | 13 | 0 | 1680.00 | 240.00 | 7.00 | 39.020 | 5.370 |
| 20 | 13 | 30 | 1710.00 | 270.00 | 6.33 | 38.440 | 4.790 |
| 20 | 14 | 0 | 1740.00 | 300.00 | 5.80 | 38.050 | 4.400 |
| 20 | 15 | 0 | 1800.00 | 360.00 | 5.00 | 37.430 | 3.780 |
| 20 | 16 | 0 | 1860.00 | 420.00 | 4.43 | 36.900 | 3.250 |
| 20 | 17 | 0 | 1920.00 | 480.00 | 4.00 | 36.510 | 2.860 |
| 20 | 18 | 0 | 1980.00 | 540.00 | 3.67 | 36.050 | 2.400 |
| 20 | 19 | 0 | 2040.00 | 600.00 | 3.40 | 35.820 | 2.170 |
| 20 | 20 | 0 | 2100.00 | 660.00 | 3.18 | 35.580 | 1.930 |

# PUMP TEST - RECOVERY DATA

PROJECT: VAMC
LOCATION: RENO-VAMC
DATUM POINT: TOP OF STILLING WELL
PUMPING RATE: 40
AQUIFER THICKNESS:
CONDITIONS: CONFINED

FILE NO.: 85-356
WELL NO.: 1
ELEV. OF DATUM POINT: 4455 FT
STATIC WATER LEVEL: 33.65 FT
R = ------ FROM
SCREEN INTERVAL: TO

| TIME | | | PUMPING STARTED | PUMPING ENDED | RATIO | WATER LEVEL | RESIDUAL DRAWDOWN |
|---|---|---|---|---|---|---|---|
| DY | HR | MN | t (MIN) | t' (MIN) | t/t' | (ft) | (ft) |
| 20 | 21 | 0 | 2160.00 | 720.00 | 3.00 | 35.350 | 1.700 |

WILLIAM E. NORK, INC.

Project No. 85-356

# PUMPING TEST DATA

Page 1 of 3

WELL NO. EXPLORATION WELL

TYPE OF PUMPING TEST STEP DRAWDOWN
[✓ PUMPING]/RECOVERY DATA
M.P. FOR WATER LEVELS TOP OF STILLING WELL
DISTANCE FROM PUMPING WELL ———
LOCATION VA HOSPITAL-RENO

[✓ PUMPING]/OBSERVATION WELL
OTHER OBSERVATION WELL(S)

PUMP ON: DATE 7/17/85 TIME 0700
PUMP OFF: DATE 7/17/85 TIME 1920

| CLOCK TIME | ELAPSED TIME (minutes) | | t/t' | WATER LEVEL MEASUREMENT (feet) | | PUMPING RATE (gpm) | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | t | t' | | | s or s' | | Q | |
| 0650 | 0 | | | 31.75 | | | | |
| 0701 | 1 | | | 53.55 | 21.80 | | 20 | 22°C |
| 0703 | 3 | | | 55.91 | 24.16 | | 20 | 23.5°C |
| 0705 | 5 | | | 57.42 | 25.67 | | 20 | 24°C |
| 0707 | 7 | | | 58.75 | 27.00 | | 20 | 25°C |
| 0709 | 9 | | | 59.60 | 27.85 | | 20 | 25+°C |
| 0712 | 12 | | | 60.70 | 28.95 | | 20 | 26°C |
| 0716 | 16 | | | 61.50 | 29.75 | | 20 | 27°C |
| 0720 | 20 | | | 62.30 | 30.55 | | 20 | 28°C |
| 0725 | 25 | | | 62.90 | 31.15 | | 20 | 29°C |
| 0730 | 30 | | | 63.36 | 31.61 | | 20 | 30°C |
| 0735 | 35 | | | 64.00 | 32.25 | | 20 | 30.5°C |
| 0740 | 40 | | | 64.37 | 32.62 | | 20 | 31°C 575 µmho's |
| 0750 | 50 | | | 64.90 | 33.15 | | 20 | 32°C |
| 0800 | 60 | | | 65.40 | 33.65 | | 20 | 33°C 510 µmho's |
| 0820 | 80 | | | 66.22 | 34.47 | | 20 | 33.5°C |
| 0840 | 100 | | | 66.90 | 35.15 | | 20 | 34°C |
| 0900 | 120 | | | 67.25 | 35.50 | | 20 | 34°C 440 µmho's |
| 0930 | 150 | | | 67.58 | 35.83 | | 20 | 34.5°C |
| 1000 | 180 | | | 67.75 | 36.00 | | 20 | 35°C 410 µmho's |
| 1030 | 210 | | | 67.80 | 36.05 | | 20 | 35°C |
| 1100 | 240 | | | 67.82 | 36.07 | | 20 | 35°C 395 µmho's $C_s = .55$ |
| 1101 | $^{1}$241 | | | 75.80 | 44.05 | | 30 | 35°C |
| 1103 | $^{3}$243 | | | 75.83 | 44.08 | | 30 | 35°C |
| 1105 | $^{5}$245 | | | 76.10 | 44.35 | | 30 | 35°C |
| 1107 | $^{7}$247 | | | 76.33 | 44.58 | | 30 | 35°C |
| 1109 | $^{9}$249 | | | 76.46 | 44.69 | | 30 | 35°C |
| 1112 | $^{12}$252 | | | 76.82 | 45.07 | | 30 | 35°C |
| 1116 | $^{16}$256 | | | 77.12 | 45.37 | | 30 | 35°C |
| 1120 | $^{20}$260 | | | 77.30 | 45.55 | | 30 | 35°C |
| 1125 | $^{25}$265 | | | 77.50 | 45.75 | | 30 | 35°C |

Project No. 85-356

## PUMPING TEST DATA

Page 2 of 3

WELL NO. EXPLORATION WELL

TYPE OF PUMPING TEST STEP DRAWDOWN
[✓ PUMPING]/RECOVERY DATA
M.P. FOR WATER LEVELS TOP OF STILLING WELL
DISTANCE FROM PUMPING WELL —
LOCATION VA HOSPITAL - RENO

[✓ PUMPING]/OBSERVATION WELL
OTHER OBSERVATION WELL(S)

PUMP ON: DATE 7/17/85 TIME 0700
PUMP OFF: DATE 7/17/85 TIME 1920

| CLOCK TIME | ELAPSED TIME (minutes) | | t/t' | WATER LEVEL MEASUREMENT (feet) | | PUMPING RATE (gpm) | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | t | t' | | 31.75 | s or s' | SEC/5GAL | Q | |
| 1130 | 30<br>270 | | | 77.62 | 45.87 | | 30 | 35 °C |
| 1135 | 35<br>275 | | | 77.82 | 46.07 | | 30 | 35 °C |
| 1140 | 40<br>280 | | | 77.90 | 46.15 | | 30 | 35+ °C |
| 1150 | 50<br>290 | | | 78.15 | 46.40 | | 30 | 35.5 °C |
| 1200 | 60<br>300 | | | 78.35 | 46.60 | | 30 | 35.5 °C 370 μMHO'S |
| 1220 | 80<br>320 | | | 78.65 | 46.90 | | 30 | 35.5 °C |
| 1240 | 100<br>340 | | | 78.85 | 47.10 | | 30 | 35.5 °C |
| 1300 | 120<br>360 | | | 79.05 | 47.30 | 10 | 30 | 35.5° C ADJ Q UP FROM 27 |
| 1330 | 150<br>390 | | | 86.67 | 54.92 | 10 | 30 | " |
| 1400 | 180<br>420 | | | 89.08 | 57.67 | 10.04 | 30- | " |
| 1430 | 210<br>450 | | | 91.98 | 60.23 | 10 | 30 | 35.5°C |
| 1500 | 240<br>480 | | | 92.61 | 60.96 | 10 | 30 | 35.5°C END STEP II / START STEP III |
| 1501 | 1<br>481 | | | 97.95 | 66.20 | 7.5 | 40 | |
| 1503 | 3<br>483 | | | 101.95 | 70.20 | 7.5 | 40 | |
| 1505 | 5<br>485 | | | 103.72 | 71.97 | 7.4 | 40+ | |
| 1507 | 7<br>487 | | | 104.63 | 72.88 | 7.6 | 40- | |
| 1510 | 10<br>490 | | | 105.91 | 74.16 | 7.5 | 40 | |
| 1513 | 13<br>493 | | | 106.87 | 75.12 | 7.3 | 41 | |
| 1516 | 16<br>496 | | | 107.49 | 75.74 | 7.4 | 40.5 | |
| 1520 | 20<br>500 | | | 107.98 | 76.23 | 7.4 | 40.5 | 35.75°C |
| 1525 | 25<br>505 | | | 108.40 | 76.60 | 7.5 | 40 | " |
| 1530 | 30<br>510 | | | 108.72 | 76.97 | 7.5 | 40 | " |
| 1540 | 40<br>520 | | | 109.40 | 77.65 | 7.5 | 40 | " E.C. = 325 μMHO/cm |
| 1550 | 50<br>530 | | | 109.81 | 78.06 | 7.5 | 40 | 36.0°C (98.8°F) |
| 1600 | 60<br>540 | | | 110.10 | 78.35 | 7.5 | 40 | " |
| 1620 | 80<br>560 | | | 110.50 | 78.75 | 7.4 | 40.5 | " |
| 1640 | 100<br>580 | | | 111.36 | 79.61 | 7.4 | 40.5 | " |
| 1700 | 120<br>600 | | | 111.60 | 79.85 | 7.4 | 40.5 | " |
| 1730 | 150<br>630 | | | 111.59 | 79.84 | 7.4 | 40.5 | . |
| 1800 | 180<br>720 | | | 111.92 | 80.17 | 7.4 | " | . |
| | | | | | | | | |

Project No. 85-358

# PUMPING TEST DATA

Page 3 of 3

WELL NO. VAMC

TYPE OF PUMPING TEST STEP-DD
[✓ PUMPING]/RECOVERY DATA
M.P. FOR WATER LEVELS TOP OF STILLING WELL
DISTANCE FROM PUMPING WELL —
LOCATION VA HOSPITAL-RBNO

[✓ PUMPING]/OBSERVATION WELL
OTHER OBSERVATION WELL(S) N/A
PUMP ON: DATE 7/17/85 TIME 0700
PUMP OFF: DATE 7/17/85 TIME 1920

| CLOCK TIME | ELAPSED TIME (minutes) | | t/t' | WATER LEVEL MEASUREMENT (feet) | | PUMPING RATE (gpm) | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | t | t' | | 31.75 | Ⓢ or s' | SEC/5GAL | Q | |
| 1830 | 210<br>750 | | | 111.50 | 79.75 | 7.5 | 40 | 36'C |
| 1900 | 240<br>780 | | | 111.55 | | | | 36°C E.C. = 325 μMHO/CM |
| 1901 | 1<br>781 | | | | | | | WIDE OPEN VALVE |
| 1903 | 3<br>783 | | | 114.25 | | 6.9 | 43.0 | |
| 1905 | 5<br>784 | | | | | | | |
| 1907 | 7<br>785 | | | 114.75 | | 6.99 | 42.5 | |
| 1910 | 10<br>790 | | | 115.18 | | " | " | |
| 1913 | 13<br>793 | | | 115.25 | | " | " | |
| 1916 | 16<br>796 | | | 115.41 | | " | " | |
| 1920 | 20<br>800 | | | 115.53 | | | | PUMP IS MAX'D OUT. TERMINATED TEST |
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Project No. 85-356

# PUMPING TEST DATA

Page 1 of 2

WELL NO. VA EXPLORATION

TYPE OF PUMPING TEST CONSTANT Q
[✓ PUMPING]/RECOVERY DATA
M.P. FOR WATER LEVELS TOP OF STILLING WELL
DISTANCE FROM PUMPING WELL —
LOCATION RENO VA HOSPITAL

[✓ PUMPING]/OBSERVATION WELL
OTHER OBSERVATION WELL(S) N/A
PUMP ON: DATE 7/19/85 TIME 0900
PUMP OFF: DATE 7/20/85 TIME 0900

| CLOCK TIME | ELAPSED TIME (minutes) | | t/t' | WATER LEVEL MEASUREMENT (feet) | | PUMPING RATE (gpm) | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | t | t' | | | s or s' | SEC/5GAL | Q | |
| 0900 | 0 | | | 33.65 | 0 | 7.5 | 40 | T = 25° C |
| 0901 | 1 | | | 73.05 | 39.40 | 7.5 | " | T = 26° C |
| 0903 | 3 | | | 79.45 | 45.80 | 7.5 | " | T = 27° C |
| 0905 | 5 | | | 83.55 | 49.90 | 7.5 | " | T = 28° C |
| 0907 | 7 | | | 86.34 | 52.69 | 7.5 | " | T = 29° C |
| 0910 | 10 | | | 88.68 | 55.03 | 7.5 | " | T = 30.5° C |
| 0913 | 13 | | | 90.39 | 56.74 | 7.5 | " | T = 31.5° C |
| 0916 | 16 | | | 91.86 | 58.21 | 7.5 | " | T = 32.75° C |
| 0920 | 20 | | | 93.49 | 59.84 | 7.5 | " | T = 33.5° C |
| 0925 | 25 | | | 94.82 | 61.17 | 7.5 | " | T = 34° C |
| 0930 | 30 | | | 95.91 | 62.26 | 7.7 | 39.0 | T = 34.5° C ADJ Q UP EC = 360 MMHO/CM |
| 0935 | 35 | | | 96.90 | 63.25 | 7.5 | 40 | T = 35° C |
| 0940 | 40 | | | 97.74 | 64.09 | 7.7 | 39.0 | T = 35° C ADJ Q UP |
| 0950 | 50 | | | 100.78 | 67.13 | 7.5 | 40 | T = 35° C |
| 1000 | 60 | | | 101.98 | 68.33 | 7.5 | " | T = 35.5° C EC = 365 μMHO/CM |
| 1020 | 80 | | | 103.81 | 70.16 | 7.5 | " | T = 35.5° C |
| 1040 | 100 | | | 105.05 | 71.40 | 7.5 | " | T = 35.75° C |
| 1100 | 120 | | | 107.75 | 74.10 | 7.5 | " | T = 36° C EC = 315 μMHO/CM |
| 1130 | 150 | | | 109.28 | 75.63 | 7.6 | 39.5 | T = 36° C ADJ Q UP |
| 1200 | 180 | | | 110.68 | 77.03 | 7.5 | 40 | T = 36.25° C EC = 340 μMHO/CM |
| 1230 | 210 | | | 111.47 | 77.82 | 7.5 | " | T = 36.25° C |
| 1300 | 240 | | | 112.13 | 78.48 | 7.5 | " | T = 36.5° C EC = 330 μMHO/CM |
| 1330 | 270 | | | 112.60 | 78.95 | 7.5 | " | T = 36.5° C |
| 1400 | 300 | | | 113.13 | 79.48 | 7.5 | " | T = 36.5° C E.C. = 320 μMHO/CM |
| 1430 | 330 | | | 113.55 | 79.90 | 7.5 | " | T = 36.5° C |
| 1500 | 360 | | | 113.92 | 80.27 | 7.5 | " | T = 36.5° C E.C. = 310 μMHO/CM |
| 1600 | 420 | | | 114.54 | 80.89 | 7.5 | " | T = 36.5° C E.C. = 310 μMHO/CM |
| 1700 | 480 | | | 115.00 | 81.35 | 7.5 | " | T = 36.5° C E.C. = 310 μMHO/CM |
| 1800 | 540 | | | 115.43 | 81.78 | 7.5 | " | T = 36.5° C E.C. = 330 μMHO/CM |
| 1900 | 600 | | | 115.73 | 82.08 | 7.5 | " | T = 36.5° C E.C. = 340 μMHO/CM |
| 2000 | 660 | | | 116.08 | 82.43 | 7.5 | " | T = 36.5° C E.C. = 340 μMHO/CM |

Project No. 85-356

# PUMPING TEST DATA

Page 2 of 2

WELL NO. VA EXPLORATION

TYPE OF PUMPING TEST CONSTANT DISCHARGE
[✓ PUMPING]/RECOVERY DATA
M.P. FOR WATER LEVELS TOP OF STILLING WELL
DISTANCE FROM PUMPING WELL —
LOCATION RENO VA HOSPITAL

[✓ PUMPING]/OBSERVATION WELL
OTHER OBSERVATION WELL(S) N/A
PUMP ON: DATE 7/19/85 TIME 0900
PUMP OFF: DATE 7/20/85 TIME 0900

| CLOCK TIME | ELAPSED TIME (minutes) | | t/t' | WATER LEVEL MEASUREMENT (feet) | | PUMPING RATE (gpm) | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | t | t' | | 33.65 | s or s' | SEC/5GAL | Q | |
| 2100 | 720 | | | 116.30 | 82.65 | 7.5 | 40 | COLLECTED WATER SAMPLE<br>T = 36.5°C EC = 330 µMHO/CM |
| 2200 | 780 | | | 116.40 | 82.75 | 7.4 | 40.5 | T = 36.5°C EC = 330 µMHO/CM |
| 2300 | 840 | | | 116.50 | 82.85 | 7.4 | 40.5 | T = 36.5°C EC = 340 µMHO/CM |
| 2400 | 900 | | | 116.65 | 83.00 | 7.5 | 40 | T = 36.5°C EC = 340 µMHO/CM |
| 0100 | 960 | | | 116.72 | 83.07 | 7.5 | 40 | T = 36.°C EC = 340 µMHO/CM |
| 0200 | 1020 | | | 116.75 | 83.10 | 7.5 | 40 | T = 36+ °C EC = 335 µMHO/CM |
| 0300 | 1080 | | | 116.80 | 83.15 | 7.4 | 40.5 | T = 36+ °C EC = 340 µMHO/CM |
| 0400 | 1140 | | | 116.87 | 83.22 | 7.4 | 40.5 | T = 36°C EC = 350 µMHO/CM |
| 0500 | 1200 | | | 116.95 | 83.30 | 7.4 | 40.5 | T = 36°C EC = 350 µMHO/CM |
| 0600 | 1260 | | | 117.03 | 83.38 | 7.5 | 40 | T = 36°C EC = 340 µMHO/CM |
| 0700 | 1320 | | | 117.08 | 83.43 | 7.5 | 40 | T = 36°C EC = 345 µMHO/CM |
| 0800 | 1380 | | | 117.11 | 83.46 | 7.5 | 40 | T = 36°C EC = 340 µMHO/CM |
| 0900 | 1440 | | | 117.13 | 83.48 | 7.5 | 40 | COLLECTED WATER SAMPLE<br>T = 36°C EC = 350 µMHO/CM |

Project No. 85-356

# PUMPING TEST DATA

Page 1 of 1

WELL NO. VA EXPLORATION

TYPE OF PUMPING TEST CONSTANT DISCHARGE
PUMPING/[✓ RECOVERY] DATA
M.P. FOR WATER LEVELS TOP OF STILLING WELL
DISTANCE FROM PUMPING WELL —
LOCATION RENO VA HOSPITAL

[✓ PUMPING]/OBSERVATION WELL
OTHER OBSERVATION WELL(S)
N/A
PUMP ON: DATE 7/19/85 TIME 0900
PUMP OFF: DATE 7/20/85 TIME 0900

| CLOCK TIME | ELAPSED TIME (minutes) | | t/t' | WATER LEVEL MEASUREMENT (feet) | | PUMPING RATE (gpm) | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | t | t' | | 33.65 | s or [✓ s'] | | Q | |
| 0900 | 1440 | | | 117.13 | 83.48 | | | |
| 0901 | 1441 | 1 | 1441 | 75.12 | 41.47 | | | PARTLY CLOUDY |
| 0903 | 1443 | 3 | 481 | 66.25 | 32.6 | | | |
| 0905 | 1445 | 5 | 289 | 62.77 | 29.12 | | | |
| 0907 | 1447 | 7 | 207 | 60.27 | 26.62 | | | |
| 0910 | 1450 | 10 | 145 | 57.49 | 23.84 | | | |
| 0913 | 1453 | 13 | 112 | 55.69 | 22.04 | | | |
| 0916 | 1456 | 16 | 91 | 54.02 | 20.37 | | | |
| 0920 | 1460 | 20 | 73 | 52.84 | 19.19 | | | |
| 0925 | 1465 | 25 | 58 | 51.14 | 17.49 | | | |
| 0930 | 1470 | 30 | 49 | 49.88 | 16.23 | | | |
| 0935 | 1475 | 35 | 42 | 48.83 | 15.18 | | | |
| 0940 | 1480 | 40 | 37 | 48.05 | 14.40 | | | |
| 0950 | 1490 | 50 | 30 | 46.66 | 13.01 | | | |
| 1000 | 1500 | 60 | 25 | 45.44 | 11.79 | | | |
| 1020 | 1520 | 80 | 19 | 43.91 | 10.26 | | | |
| 1040 | 1540 | 100 | 15 | 42.77 | 9.12 | | | |
| 1100 | 1560 | 120 | 13 | 41.98 | 8.33 | | | |
| 1130 | 1590 | 150 | 10.6 | 40.87 | 7.22 | | | |
| 1200 | 1620 | 180 | 9.0 | 40.00 | 6.35 | | | BILL N. DROPPED BY. |
| 1230 | 1650 | 210 | 7.8 | 39.50 | 5.85 | | | |
| 1300 | 1680 | 240 | 7.0 | 39.02 | 5.37 | | | |
| 1330 | 1710 | 270 | 6.3 | 38.44 | 4.79 | | | |
| 1400 | 1740 | 300 | 5.8 | 38.05 | 4.40 | | | |
| 1500 | 1800 | 360 | 5.0 | 37.43 | 3.78 | | | |
| 1600 | 1860 | 420 | 4.4 | 36.90 | 3.25 | | | |
| 1700 | 1920 | 480 | 4.0 | 36.51 | 2.86 | | | |
| 1800 | 1980 | 540 | 3.6 | 36.05 | 2.40 | | | |
| 1900 | 2040 | 600 | 3.4 | 35.82 | 2.17 | | | |
| 2000 | 2100 | 660 | 3.2 | 35.58 | 1.93 | | | |
| 2100 | 2160 | 720 | 3.0 | 35.35 | 1.70 | | | RECOVERY FINISHED |

# APPENDIX D

# WATER QUALITY ANALYSIS RECORD

## SIERRA ENVIRONMENTAL MONITORING

WATER QUALITY ANALYSIS RECORD (MULTIPLE PARAMETERS)

J.N. 379-722

SAMPLE IDENTIFICATION NO.

| SAMPLE COLLECTION DATE | | | SAMPLE COLLECTION TIME | STATION NO. |
|---|---|---|---|---|
| MON | DAY | YR | 0-2400 | |
| 7 - | 20 - | 85 | | #1, #2 |

PROJECT NAME William E. Nork, Inc. (85-356)

1026 West First Street Reno, NV 89503

| DESCRIPTOR UNITS | | | VALUE 1 | 2 | DESCRIPTOR UNITS | | | VALUE 1 | 2 |
|---|---|---|---|---|---|---|---|---|---|
| PH LABORATORY | | | 9.0 | 9.0 | CALCIUM | mg/l | | 5.9 | 6.6 |
| DO Alkalinity $HCO_3$<br>$CO_3$ | mg/l | $CaCO_3$ | 40<br>34 | 39<br>34 | CHROMIUM | mg/l | | <0.02 | <0.02 |
| TURBIDITY LAB | JTU | | | | COPPER | mg/l | | <0.02 | <0.02 |
| TOTAL SUSPENDED SOLIDS | mg/l | | | | IRON | mg/l | | < 0.02 | < 0.02 |
| TOTAL VOLATILE | mg/l | | | | LEAD | mg/l | | <0.05 | <0.05 |
| TOTAL RESIDUAL | mg/l | | | | MAGNESIUM | mg/l | | < 0.2 | <0.2 |
| SETTLEABLE SOLIDS | mg/l | | | | MANGANESE | mg/l | | <0.02 | < 0.02 |
| TOTAL DISSOLVED SOLIDS | mg/l | | 232 | 226 | MERCURY | mg/l | | | |
| BOD | mg/l | | | | POTASSIUM | mg/l | | 0.5 | 0.5 |
| COD | mg/l | | | | SELENIUM | mg/l | | | |
| TOC | mg/l | | | | SILVER | mg/l | | <0.01 | <0.01 |
| OIL AND GREASE | mg/l | | | | SODIUM | mg/l | | 70 | 68 |
| PHENOLS | mg/l | | | | ZINC | mg/l | | <0.01 | <0.01 |
| N-AMMONIA | mg/l | | | | TOTAL COLIFORM | MPN | | | |
| N-NITRATE | mg/l | $NO_3$ | <0.1 | <0.1 | FECAL COLIFORM | MPN | | | |
| N-NITRITE | mg/l | | | | TNT | mg/l | | | |
| TOTAL N (KJELDAHl) | mg/l | | | | CYANIDE | mg/l | | | |
| ORTHOPHOSPHATE | mg/l | P | 0.04 | 0.04 | PLANKTON | | | | |
| TOTAL PHOSPHORUS | mg/l | | | | Boron | mg/1 | | 0.1 | 0.2 |
| CHLORIDE | mg/l | | 3 | 3 | Sulfate | mg/1 | | 68 | 70 |
| ALUMINUM | mg/l | | | | Fluoride | mg/1 | | 0.3 | 0.3 |
| ARSENIC | mg/l | | 0.03 | 0.03 | Silica | mg/1 | $SiO_2$ | 41 | 42 |
| BARIUM | mg/l | | <0.4 | <0.4 | Samples from V. A. Hospital Geothermal Well | | | | |
| CADMIUM | mg/l | | <0.01 | <0.01 | #1 - 12 hrs. #2 - 24 hrs. | | | | |

SEM (10-73)-4

SAMPLES BY: WEN, Inc. - D. Carlson

ANALYSIS BY: SEM - J. Seher - C. Oliveira

APPROVED BY: J Seher

## APPENIDX E

## DINTER ENGINEERING CO. LTD., VA GEOTHERMAL POTENTIAL STUDY

# VA GEOTHERMAL POTENTIAL STUDY

August 6, 1985

Parameters: 300 gpm at 115°F

The use of the geothermal water directly in a heating system is not recommended due to the potential for scale buildup in coils and valves. Therefore, any use must entail an intermediate heat exchanger. This will drop the system water temperature to 110°F.

There are two basic possible methods for the use of this energy: 1) direct circulation through fan coils or radiant panels and 2) mechanical amplification of system water temperature by the use of water-source heat pumps.

Option 1) is not the most practical in that a realistic water temperature drop of only 5°F is available in order to produce a maximum supply air temperature of 100°F, which is required for forced heating. Thus, the available energy is:

300 gpm x 60 min/Hr x 8.33 BTU/gal/°F x 5°F = 749,700 BTUH.

At Reno design temperatures this potential is adequate for space heating of approximately 38,000 square feet.

Option 2) involves the use of electrically powered water-source heat pumps--either large water-to-water units (similar to "Templifier" by McQuay) or smaller water-to-air terminal units or air handlers. This mechanical amplification utilizes a much larger temperature drop of the source, possibly as much as 50°F. The available useful energy is thus:

300 gpm x 60 min/Hr x 8.33 BTU/gal/°F x 50°F = 7,497,000 BTUH
which can heat 380,000 square feet.

It must be kept in mind that the cost in dollars per BTUH of the two options is not equal. Option 1) entails only pump and fan costs while Option 2) additionally requires compressor costs. Without knowing the size of space to be heated, economic comparison is not practical.

A third option is possible which requires mixing the geothermal potential with other ground water to produce water at 90°F or locating an aquafer at 90°F. A source at this temperature makes possible the use of water source heat pumps for both heating and air conditioning. This is the most efficient use of low temperature geothermal resources. The payback for the development of a geothermal source well/injection well/heat pump system versus a conventional gas heat/electric cool central plant system for a building of 100,000 square feet is less than two years. Energy potentials for this type of operation are:

Heating ($\Delta T = 40°F$) $\Rightarrow$ 6 MMBTUH
Cooling ($\Delta T = 40°F$) $\Rightarrow$ 6 MMBTUH (500 tons),
which is sufficient for 175,000 square feet.

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