PacifiCorp
Fuel Resources

RILDA CANYON PUMP TESTING

Final
Engineering Report
January 1991

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January 31, 1991

Mr. Rodger Fry
PacifiCorp Fuel Resources
324 South State Street - Room 563
Salt Lake City, Utah 84111

RE: Rilda Canyon Well Pump Test.
Project #: SG-078372.

Dear Mr. Fry:

Hansen, Allen & Luce, Inc. (HA&L) was retained in November 1990 by PacifiCorp Fuel Resources (PacifiCorp) to complete hydrologic testing of the shallow ground water system in Rilda Canyon near Huntington, Utah by pumping from a newly installed shallow ground water well and to prepare a summary report detailing the conclusions reached as a result of said testing. It is the intent of this report to help identify the general source of water collected by the NEWUA springs which are located within Rilda Canyon. This was proposed to be done by PacifiCorp through the installation of two new shallow ground water wells identified as P-6 and P-7. This report is a revision of an earlier draft report which was submitted to PacifiCorp in December of 1990 for review and comment. This final report discusses and summarizes activities and analyses completed in response to the work effort, as well as makes certain recommendations related to continued study efforts.

We appreciate your allowing us to work with you on this important effort.

Sincerely,

Marvin E. Allen, P.E.
President - Project Manager

David E. Hansen, Ph.D., P.E.
Vice President - Project Engineer

DEH/dh

INTRODUCTION

PacifiCorp (formerly Utah Power & Light Company) is currently planning to expand the Deer Creek mining operations into the area adjacent to Rilda Canyon in Emery County Utah. As part of the mine permit renewal granted by the Utah State Division of Oil, Gas & Mining (DOGM), the surface and ground water hydrologic regime must be defined for potential areas of impact. One such potentially impacted area is the North Emery Water Users Association (NEWUA) springs located in Rilda Canyon east of the proposed mine area.

The NEWUA spring system consists of a series of collection lines extending westward up Rilda Canyon and southward up a small side drainage as shown on Map 1 enclosed. The NEWUA spring system is metered at four locations. Meter 1 is located at the downstream end of a collection line which enters Rilda Canyon from the south. Meter 2 is located near the bottom of the main east-west trending collection line which lies to the south of Rilda Canyon Creek at a point just upstream (west) of the main spring collection box. Meter 2 records combined flows from both the south drainage (Meter 1) as well as additional inflows which enter the system below Meter 1. Meter 3 records flows for the east-west central collection line which was constructed through the central portions of the valley near Rilda Canyon Creek. Meter 4 collects data from the north collection line located on the north side of Rilda Canyon Creek.

In addition to the main spring collection lines there are two flumes in the vicinity which monitor flow rates within Rilda Canyon Creek. The upper flume, RCF-2 is located adjacent to the extreme west end of the spring collection system monitored by Meter 4. Flume RCF-3 is located in Rilda Canyon Creek adjacent to spring collection Meter 2.

Seven shallow wells have been located in the area surrounding the spring collection system to monitor ground water level fluctuations through time. The locations of these wells are shown on Map 1. Wells 1 through 5 are relatively shallow wells which were constructed prior to 1990. Wells 6 and 7 are larger wells which have been recently constructed adjacent to wells P-2 and P-3 respectively in order to obtain more complete ground water data through aquifer testing. During the initial stages of the project, both wells P-6 and P-7 were considered for pump testing and analysis.

The overall purpose of the hydrologic testing completed in response to this project was to determine to the degree possible 1) general hydrologic conditions associated with the NEWUA springs, including the general direction of ground water movement, 2) the potential origin of waters feeding the NEWUA springs, and 3) a determination of general aquifer characteristics, including transmissivity. Earlier reports prepared by Vaughn Hansen Associates in April of 1983 and in March of 1984 identified the source of water from the north spring to be originating from two general sources. In the earlier report it was believed that the source of water was originating from a north-south trending subsurface anomaly which may be a strike slip fault located immediately downstream of the main north spring area. The latter report using additional data collected concluded that there also appears to be an east-west trending anomaly which intersects the north-south anomaly just north of the north spring. Water collected in this east-west anomaly from surface and or fault sources located higher in the canyon may issue forth at the north spring as the water comes in contact with the north-south trending anomaly. It was believed at the onset of this project that the source of water (whether from the north-south trending anomaly or from sources farther up the canyon) could be determined by pumping strategically placed wells near these sources of water.

Upon initiation of the project PacifiCorp and HA&L counseled together to determine the most efficient method of proceeding with the proposed pumping tests. It was mentioned that because of the proximity of Well P-6 to the main spring collection area, pumping well P-7 might produce clearer test results. Pumping well P-6 would have an impact upon the main spring collection system, however any attempts to determine the source of spring water could be masked by the influence of the drawdown cone. That is, by pumping well P-6, both sources of recharge to the north spring would be drawn upon thereby making the attempt at isolation more difficult.

It was decided soon after initiation of the project that the most complete data could be obtained by pump testing well P-7 and not P-6. Well P-7 was chosen because of its location upgradient of the main spring collection area. If well P-7 could be pumped sufficiently, the potential source of recharge water feeding the north spring from the alluvial canyon fill west of the spring could be reduced without affecting water recharging the springs from the north-south trending anomaly or fault system. The level of impact due to pumping P-7 would then be an indicator of the general source of water issuing from the NEWUA springs.

The remainder of this report contains documentation related to field testing and office analyses completed to identify the source of water for the NEWUA springs. The report is broken into four basic sections. The first section includes information related to local geology, the second discusses pump tests completed on well P-7, the third discusses the data analyses completed, and the fourth presents the conclusions and recommendations related to the overall effort. Much of the information presented in the geologic section was taken directly from information provided by PacifiCorp in the initial request for proposal.

GEOLOGIC OVERVIEW

Sedimentary rocks present in the East Mountain area are upper Cretaceous or lower Tertiary in age and were deposited as part of a regressive sequence of the late Cretaceous seaway which covered much of the western interior. A brief description of formations present at the valley floor to the East Mountain follows. Formation sequences starting at the lowest and moving upward to the highest include the Masuk Shale, Starpoint Sandstone, Blackhawk, Castlegate Sandstone, Price River, North Horn and the Flagstaff Limestone formations. Coal seams including the Blind Canyon, Cottonwood and Hiawatha seams are located within the lower reaches of the Blackhawk Formation. Springs identified herein as the NEWUA springs are located within the Starpoint Sandstone group as shown in plan view on Map 1. Correlation between local area hydrology and geology is discussed within the "Aquifer Characteristics" section presented later within this report.

The structural geology of East Mountain is fairly simple. The sedimentary formations contain subtle regional folds but are fairly flat-lying and have been dissected by several normal faults. Northeast trending graben structures include the Roans Canyon Fault which lies approximately 1 1/2 miles south of Rilda Canyon and the NEWUA springs, and the Mill Fork

Canyon Graben which cuts across Rilda Canyon within the western portions of the mine permit boundary.

The strata on East Mountain are moderately jointed. The primary joint sets trend in a northeast direction and in the region of the Roans Canyon Fault system are spaced an average of five to ten feet apart. A secondary and complementary joint set, which trends in a northwest direction, is also present; however, this joint set is more subtle and the joints are more widely spaced.

A broad syncline crosses East Mountain in a northeast direction. Its axis is slightly to the south of the Roans Canyon Fault system. On the south limb of the syncline the beds dip very gently to the northwest at between 1 to 2 percent. On the north limb of the syncline the beds dip more steeply in the southeast direction at between 5 to 8 percent.

PUMP TESTS

The purpose of the pump test performed on well P-7 was to pump the well to its maximum potential for a period of time sufficient to note and record impacts upon the NEWUA springs or other wells located in the vicinity. The amount of pumping and the level of impact on the local systems was used subsequent to the test to help document the source of water discharging into the NEWUA spring collection system. A pump test was run on well P-7 throughout the period of time starting at 4:00 p.m. on November 13th through 12:30 p.m. on November 20th 1990. Throughout this period of time, records were kept related to pumping conditions and flow rate of discharging well P-7, water levels in wells P-1 through P-7, and spring flows recorded at NEWUA spring collection meters 1 through 4. Well P-3 was dry throughout the test. Data collected in response to the test is shown in Tables 1 through 3 in Appendix A.

As an aid to the reader, a brief summary description of data collected in Tables 1 through 3 in Appendix A is provided. Data presented in Table 1 includes date, flow, elapsed time and drawdown. The flow rate relates to pumped flow from the well. Elapsed time notes the total cumulative time since pumping started in minutes, and the drawdown notes the total water level decline from a prepumped static water level of 45.95 feet below the measuring reference point. Data shown in table 2 includes the date, time (based upon a 24 hour clock), time since pumping began (in minutes), cumulative time in days, recorded depth to water and total drawdown in water level from the prepumped static water level. Table 3 documents data including date, time (again based upon a 24 hour clock), the pumped flow rate from well P-7, time in seconds required to fill a 5 gallon bucket, converted flow rate in gallons per minute for each NEWUA spring collection meter, total combined flow rate, time since pumping began (in minutes), and time since pumping began in days.

As indicated in Table 1, the initial pumped flow rate of P-7 was 8.22 gallons per minute. The reading on the meter used to monitor the flow was initially recorded in the field to be 10 gpm, but a later check of the flow rate identified that the meter was reading incorrectly. Field data was then corrected to account for the discrepancy in measured and metered flow rates. Initial flow rate and water level measurements were taken at well P-7 at frequencies of approximately one minute for the first thirty minutes of the test. After that time, measurement frequencies were reduced to one every two to five minutes for the next hour. Time intervals increased further for the next 24 hours where they reached an approximate maximum of 30 minutes. After approximately 24 hours of pumping it was noted that the water level in well P-7 could be reduced further (thereby increasing the possibility of noting impacts at downstream locations) by increasing the flow rate from the well. As a result, the flow rate was increased shortly after 6:00 p.m. on the 14th.

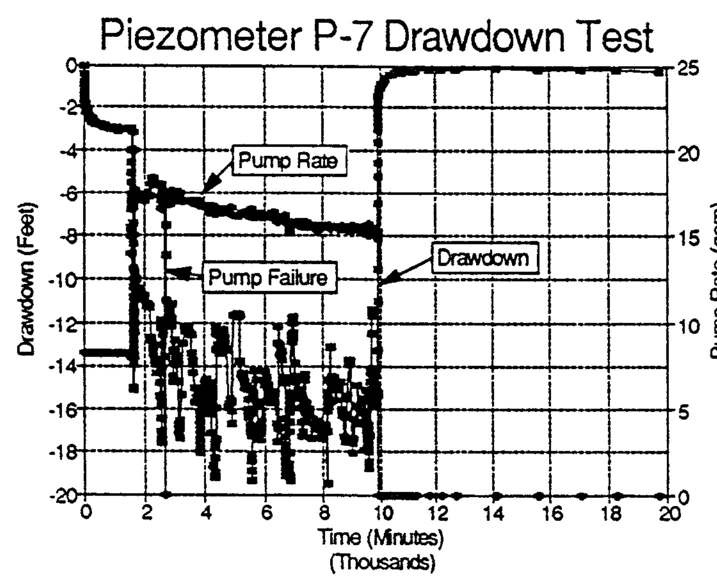
Attempts to stabilize both the water level and pumped flow rates resulted in flow fluctuations for the next one and a half to two hours until the flow was basically stabilized at a 17 to 18 gpm flow rate. Subsequent to this time the flow rate gradually decreased throughout the remaining days of the test in response to a gradually decreasing water table. At the end of the pump test at 12:30 p.m. on November 20, 1990 the pumped flow rate was 15.3 gpm. Water level recovery data was then collected through 8:00 a.m. on November 27, 1990. Throughout the testing period wells P-1 through P-6, and NEWUA spring flow meters were monitored to note fluctuations for later correlation with well pumping.

ANALYSIS OF DATA

Data analyses and figures to be presented within this report section include 1) data related to pumped well P-7, 2) water level fluctuations in wells P-1, P-2, and P-4 through P-6, 3) flow fluctuations in NEWUA springs, and 4) figures related to local aquifer characteristics. Each will be discussed separately.

Pumped Well P-7

FIGURE 1



Four figures (Figures 1 through 4) have been prepared for data collected during the pumping test of well P-1. Figure 1 displays the complete set of water level and pumped flow data for well P-7 during the pumping test. Note from Figure 1 the initial drawdown curve between time zero and approximately 1550 minutes. Figure 2, an expanded view of this portion of the curve has been inserted to aid in the interpretation of the drawdown data. The remaining data shown in Figure 1 is also expanded into two remaining graphs. Figure 3 and Figure 4 show expanded views of the intermediate and of the recovery portions of the drawdown curve respectively.

Figure 3 shows a large amount of variation in drawdown data throughout the intermediate testing period. It was noted from resistivity data provided by PacifiCorp that the inferred depth to bedrock (at the deepest point) in the vicinity of well P-7 is approximately 60 feet. Data given by PacifiCorp via a phone conversation indicates that at the well site, which is slightly to the north of the main channel, the depth to bedrock is 53 to 56 feet. Notes taken during well testing indicate that the well casing is 70.7 feet in total length. Adjusting the data for an approximate 1.5 feet of casing above the ground surface gives a well depth of about 69 feet. If the depth to bedrock at well P-7 is 55 feet, then the well was drilled into 14 feet of bedrock. With a static water table of approximately 46 feet below the top of the casing (44.5 feet below ground level), the total saturated depth of the well (that portion of the well completed in saturated alluvial deposits) is in the order of 10.5 feet.

FIGURE 2

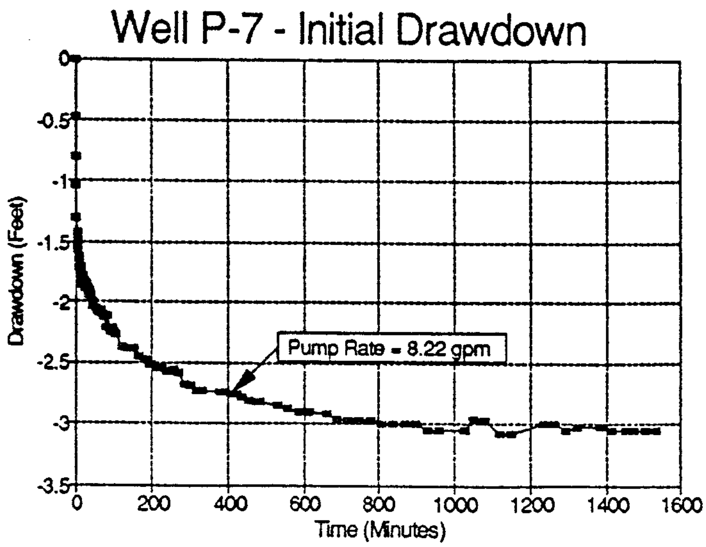
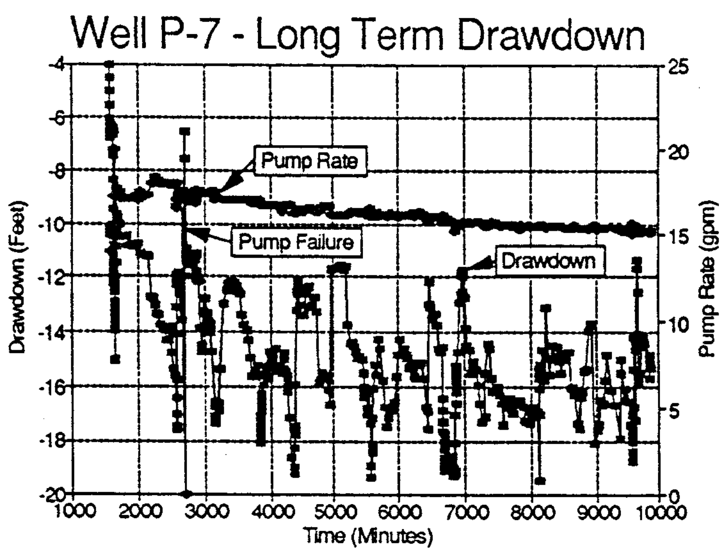


Figure 3 shows a total drawdown depth of approximately 19 feet at well P-7 which is 8.5 feet greater than the available saturated thickness of the shallow unconfined aquifer at that location. It is believed that the abnormal fluctuations noted in the well housing during pumping was due to surging of the well when the drawdown exceeded the total saturated thickness of the aquifer. Although no large variation in flow was noted to have occurred, the fluctuations seen in Figure 3 are harmonic and seem to indicate that surging did occur. Note also in Figure 3 that the pump rate decreased over the period of record from approximately 17 gpm to 15 gpm, and that the decline in water level appears to have stopped during the last half of the data. In fact, it may be that the data within the last two thousand minutes of the test was showing a slight recovery in response to the slight decrease in flow being withdrawn from the well. Based upon the data presented, it is believed that a pumping rate of approximately 16 gallons per minute will result in a decline in the water table

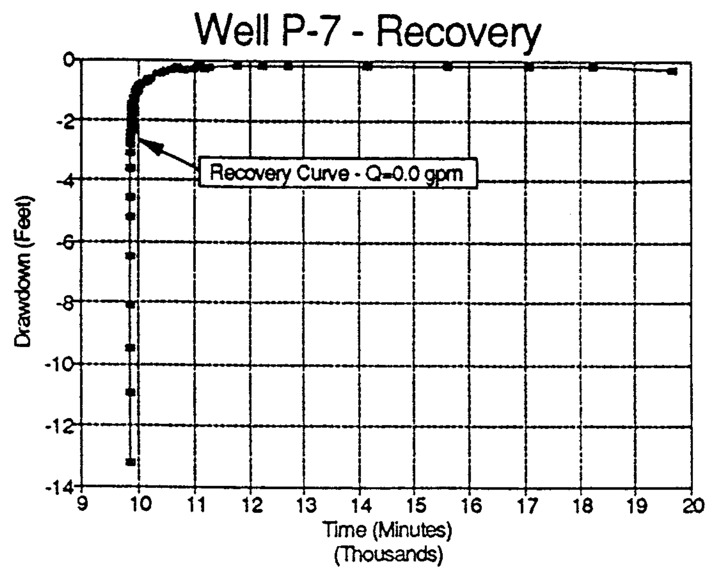
FIGURE 3



in the order of 16 feet. In terms of specific capacity, the production capacity of the aquifer is in the order of 1 gpm/ft. At the location of well P-7, this would essentially dry up the water bearing zone in the immediate vicinity of the well.

Water level recovery data identified in Figure 1 has been expanded for presentation in Figure 4. Data collected shows that water levels in well P-7 recovered to within 95 percent of the static water level within 500 minutes (8.33 hours). Data shown within the figure is uniform, thereby indicating consistent recovery and monitoring conditions. A discussion will be presented later which presents an analysis of the data shown in Figure 4 which was used to obtain estimates of aquifer Transmissivity.

FIGURE 4

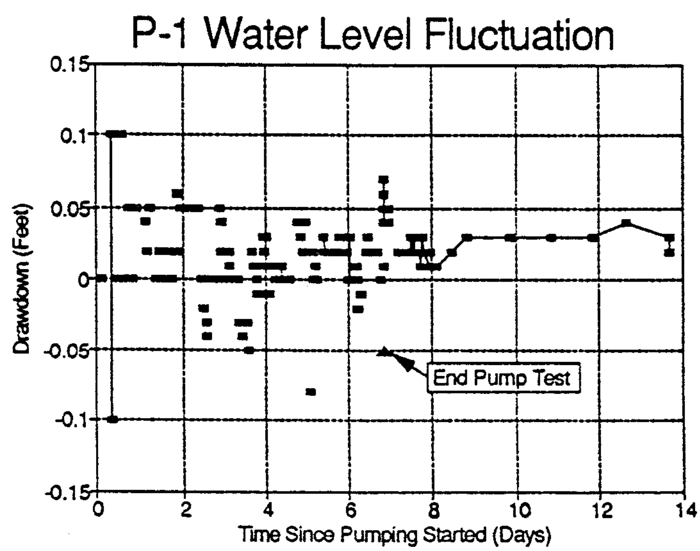


<u>Water Level Fluctuations in Wells P-1, P-2 and P-4 through P-6</u>

Water level fluctuations were also recorded within other wells or piezometers located in the immediate vicinity of the NEWUA springs. Data for these wells are presented in Figures 5 through 9.

Well P-1 is located at the far eastern end of the NEWUA spring collection system. As can be seen from the data shown in Figure 5, well P-1 was relatively uninfluenced by pumping of well P-7. Although it appears that a range of levels were noted, it should be remembered that the maximum range of fluctuations is only in the order of 0.1 feet. The fact that the sporadic measurements taken after the pump on P-7 was shut off are more stable than those measurements recorded during the test appear to indicate that the well was being influenced to a

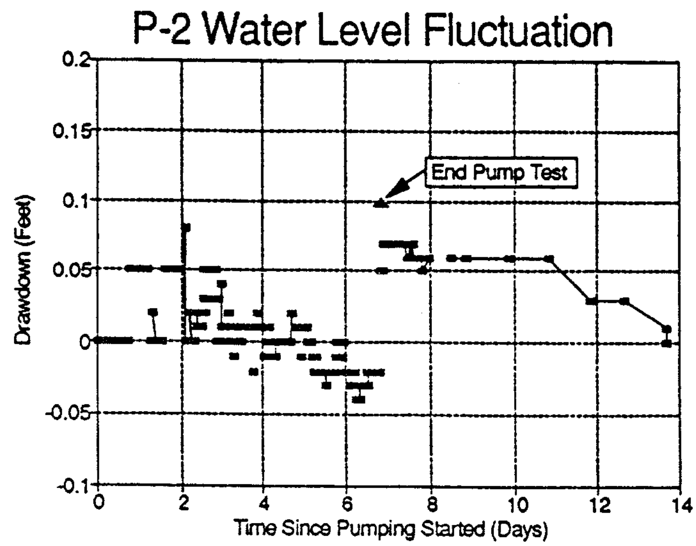
FIGURE 5



minor degree by pumping of the well.

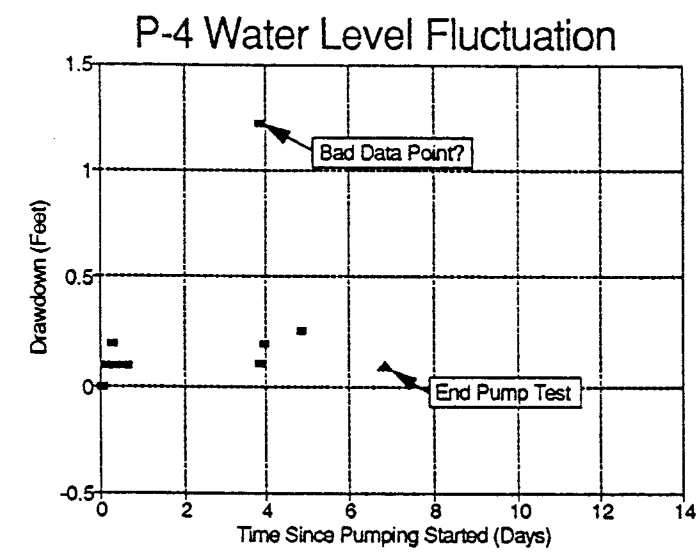
Well P-2 is located north of the main north spring collection area at the far west end of the NEWUA spring collection system. This well is also located adjacent to newly drilled well P-6. An interesting observation of this well is that the water levels within it remained relatively constant throughout the test in spite of the fact that marked changes in water level were noted within adjacent well P-6 (See Figures 6 and 9). It is believed that well P-2 may be plugged which would explain the fact that it does not appear to respond directly to changes in local water level. The minor changes in water level in well P-2 (shown on Figure 6) may be due to measurement error or to masked fluctuations (due to a plugged well) of the local water table which is responding to pumping.

FIGURE 6



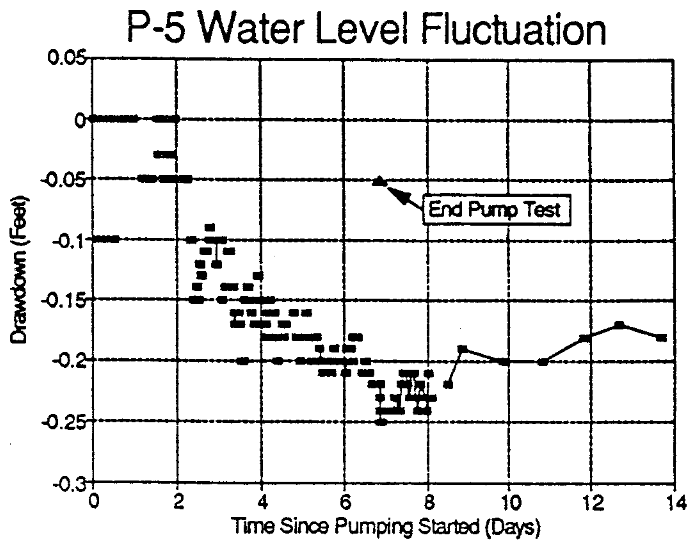
Well P-4 is located south of the main spring collection system at the mouth of the south side tributary. Little data is available for well P-4 as shown in Figure 7 because the total depth of the well was not sufficiently deep to maintain a water table within the well. The few data points which were recorded were obtained with the water level probe located at the bottom of the well. It is uncertain whether or not this well was influenced by pumping well P-7. Since it is located in the mouth of the side drainage it is possible that recharge waters entering the springs from the south may have been the cause of the small amount of fluctuation shown in the figure.

FIGURE 7



Well P-5 is located within the canyon bottom approximately 150 feet to the northwest of well P-4, and 290 feet to the southeast of well P-6. This well is situated directly east of the west NEWUA spring area collection lines. As seen from water level data shown in Figure 8, there is a fairly good response in the local water table resulting from pumping well P-7. Although a response is clear, the total impact is relatively negligible. A total water level decline in the order of 0.25 feet was noted at the well.

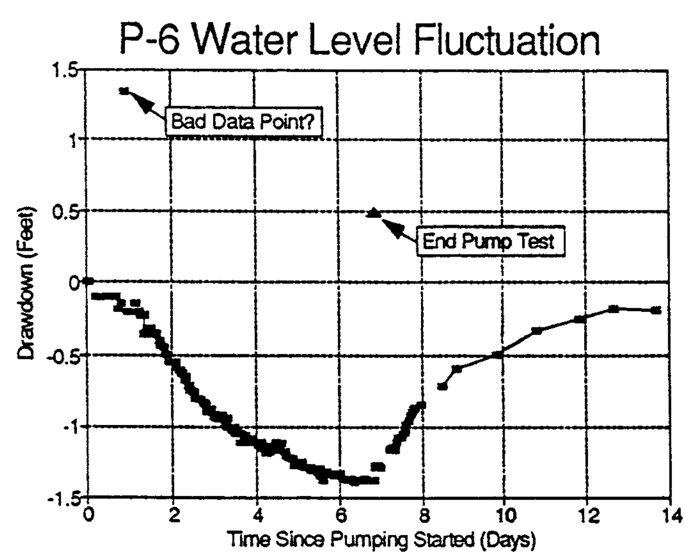
FIGURE 8



Note also from well P-5 data that there may only be a slight delayed response to the well from pumping. This response is best understood by evaluating water levels subsequent to pumping where it is noted that although varied, water levels appear to have reversed their downward trend within a relatively short time frame after pumping ceased. Another interesting note is that at the initial pump rate of 8.22 gpm, it appears that little impact was felt by well P-5. It wasn't until pumping rates increased to the 15 to 18 gpm rates that water levels were noted to start their decline.

Perhaps the most clear and responsive well (other than well P-7) was found in well P-6. As indicated earlier well P-6 is located immediately west of well P-2, and northeast of the far west end of the NEWUA spring collection system. Water level drawdown and recovery data shown in Figure 9 illustrates a classic response to pumping. Although this well is located approximately 500 feet east of well P-7, it noted a 1.5 foot water level decline over the period of pumping. Both the initial as well as the recovery data show an almost immediate response in the well to changed aquifer conditions. Water levels in well P-6 show a quick response at termination of pumping and a smooth transition back to approximate prepumped ground water levels. At first glance the initial portion of the data curve does not show the same immediate response to pumping as is noted during recovery. However, if initial pumping rates are considered fully it is seen that the small amount of ground water decline noted during day 1 was in response to the lower initial flow rate of 8.22 gpm. Not until flows doubled shortly after a time lag of one day did water levels start to decline noticeably.

FIGURE 9



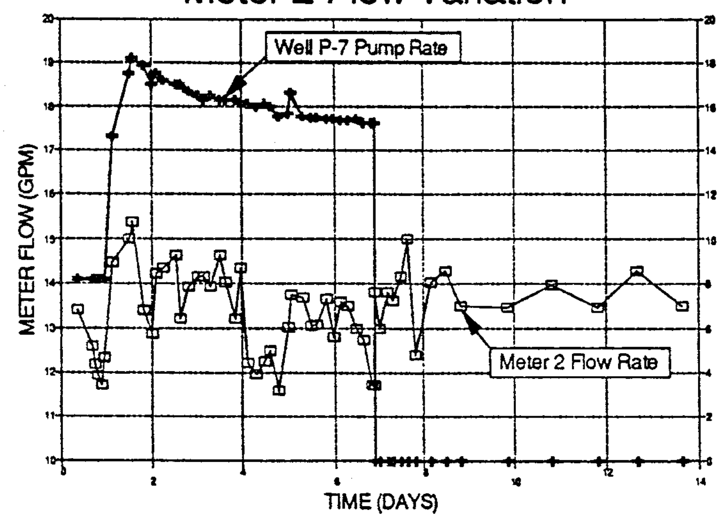
Static water levels after pumping were 0.1 feet lower than those identified prior to pumping. The fact that the water table did not return completely to prepumped static levels may indicate a gradually declining local water table.

Flow Fluctuations in NEWUA Springs

Spring flows were recorded throughout the period of testing as discussed earlier in this report. Data related to these meters is presented herein for review. Each of these figures compares flow variations recorded at the identified meter with recorded flows from well P-7. Flow variations for Meter 2 are illustrated in Figure 10.

FIGURE 10

Meter 2 Flow Variation

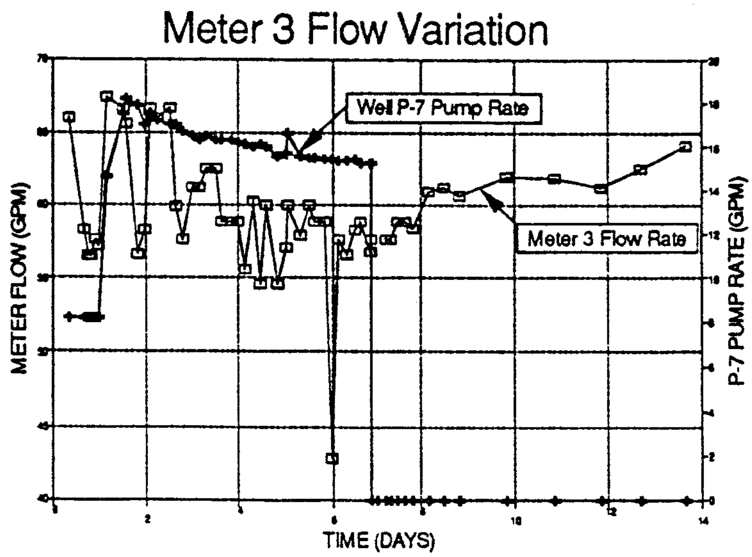


As stated earlier, well P-7 was initially pumped at a rate of 8.22 gpm throughout the first day of pumping whereafter the flow was increased over the next short period of time to approximately 17 gpm. The recorded flow gradually decreased over the next five days to an approximate level of 15 gpm at the time the pump was turned off. It is important to note that some amount of fluctuation in flow was noted to have occurred at meter 2 at 8:12 p.m. on the second day of the test. In order to obtain spring flow measurements flows were diverted from the NEWUA distribution lines into metered bypass lines. Field observers found that time was required for the flow from the spring collection boxes to stabilize subsequent to diversion of the flow. Once this observation was made flows were stabilized by postponing flow measurement for ten to fifteen minutes after flow diversion. As a result, less variation in flow was noted between samplings after the first day.

Because of the variability in flows recorded in Meter 2 during the first two days of monitoring, it is difficult to determine an accurate reading of flows, but it appears that the average flow in Meter 2 may be in the order of 14 gpm as shown in Figure 10. A low flow of approximately 13.2 gpm was recorded at the end of the well pumping period after 6 days, thereby indicating the level of impact due to pumping. Stated in another way, the pumping of well P-7 appears to have had an impact upon the spring area measured by Meter 2 in the order of 0.8 gpm or 6 percent. After pumping ceased, the flow rate returned to an average level of 13.8 gpm.

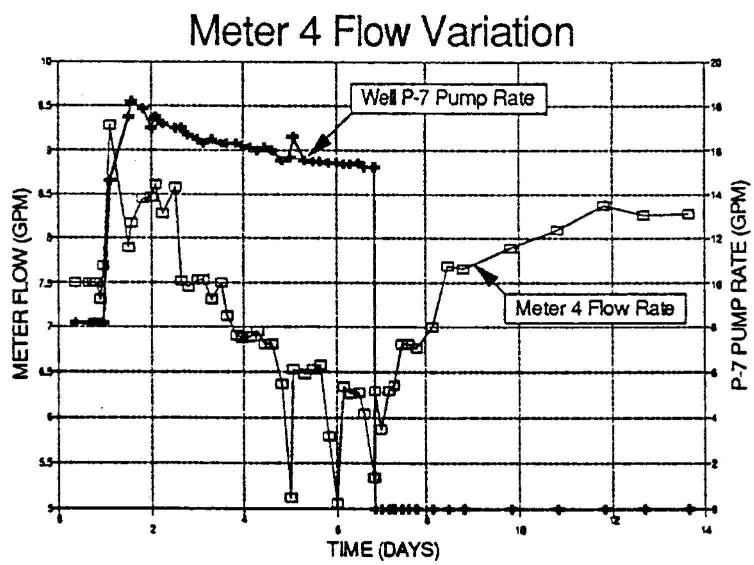
Variation in collected flows from Meter 3 are recorded and shown in Figure 11. As with Meter 2, less variability is noted in flows recorded after the second day due to the practice of allowing the flows to stabilize in the spring collection boxes subsequent to the diversion of flows. Data toward the end of the pumping period (at about 7 days) shows a total impacted flow rate

FIGURE 11



of about 57.5 gpm. Within the seven days after the cessation of pumping the flow rate returned to 63 to 64 gpm. Data shown at the beginning of the pump test indicates that the undisturbed flow rate was on the order of 62 to 64 gpm. Using an average initial value of 63 gpm, the total impact to flows in this spring collection line due to pumping of well P-7 is in the range of 5.5 gpm or 10 percent. It is noted from data collected at each of the meters that Meter 3 showed greater total flow impact due to the pumping of Well 7 than any other single meter monitored during the test.

FIGURE 12

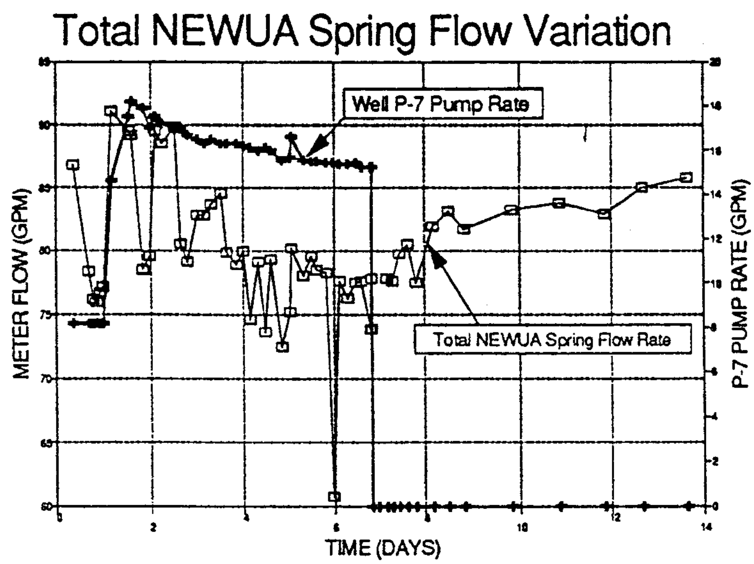


Pumping impacts to waters collected through Meter 4 appear to be on the order of 3 gpm as shown on Figure 12. More consistency was obtained at this meter than at others monitored during the pump test. It is believed that more measurement consistency was obtained here than at other springs because of the slightly closer proximity of the springs feeding the meter to pumped well P-7. Changes in flow rates as the spring responds to pumping in adjacent well P-7 is almost immediate. Average flow rates both at the start of the second day of testing as well as at the termination of monitoring were found to be in the range of 8.4 to 8.5 gpm. Data collected during the first day of pumping when pumped flow rates were 8.22 gpm show Meter 4 flow rates of 7.5 gpm. At the termination of pumping when well P-7 was being pumped at rates approximately equal to 15 gpm, flow rates in Meter 4 were in the order of 6.2 gpm. A comparison of data shows that the earlier flow rate of 8.22 gpm resulted in a decline of spring flow of 1.3 gpm or 17 percent. Data collected later in the test indicates a total flow decline from an initial rate of 8.4 to a final rate of 6.2 gpm (a 26 percent decline). During this time, it is believed that the average flow rate being pumped from well P-7 was 16.4 gpm. The data is fairly consistent in that a doubling of flow resulted in an approximate doubling of flow reduction at Meter 4.

An estimate of total combined impacts for the spring collection system resulting from pumping well P-7 can be obtained by adding all prepumped spring flows and dividing them into total combined flows monitored at the end of the pumping test. Using the above data, there was an initial total spring flow rate of 85.3 gpm and a total impacted flow rate at the end of pumping of 76.9 gpm. The total reduction in flow using this data is then estimated at 10 percent.

In order to filter out small changes in spring flows due to individual analyses, a check of impacts due to pumping was also made by combining all spring flows into a total flow chart. Figure 13 shows that total combined flows at the start of the testing period were on the order of 85 to 86 gpm. Total flows at the end of the pumping period were approximately 77.5 gpm. Total impact to the NEWUA spring collection system due to pumping using this data is estimated to be 7.5 gpm or a 9 to 10 percent reduction. This correlates well with the estimate made by analyzing each meter independently.

FIGURE 13



Aquifer Characteristics

The local ground water system in the vicinity of the NEWUA springs consists of an unconfined alluvial valley fill aquifer as well as bedrock and fracture systems. Resistivity data provided by PacifiCorp indicates that the total maximum depth of alluvium ranges from 50 to 73 feet at the three locations where cross sections were taken. The locations of the resistivity cross sections within Rilda Canyon are shown on Map 2. The width of the unconfined aquifer varies due to the influence of side drainages which also feed the area.

Water moving throughout Rilda Canyon appears to be originating from at least three sources. The first and most obvious source is through the alluvial valley fill. The second is through an east-west trending fault which is believed to lie to the north of the canyon floor and the third is potentially through a north-south trending fault which bisects the canyon just west of the NEWUA spring collection system. More is mentioned about water quality from these sources later within this report. Springs within Rilda Canyon are believed to indicate and verify the locations of changes in geologic structure.

Examples of local geologic structure, and their impact of hydrology have been verified historically through stream and spring flow observations. The canyon drainage west (or above) the interface with the upper contact of the Starpoint Sandstone is generally a discharging stream section. When alluvial waters come in contact with the more impermeable members of the upper Starpoint Sandstone formation they are often forced to the surface thereby creating springs. Local NEWUA springs confirm a recharging stream section. Once these more impermeable formations are crossed the stream once more becomes a loosing stream until subsurface waters again come in contact with the more impermeable members of the Starpoint Sandstone and underlying mancos shale formations. Some sections of the stream within Rilda Canyon gain flow thereby evidencing the locations where subsurface water is forced to the surface by these tighter formations.

Data collected during and following the pump test of well P-7 was used to provide estimates of local valley fill aquifer characteristics. For these analyses, data was used from both pumped well P-7 and from observation well P-6 during both the drawdown and recovery portions of the test. Well P-6 was used as an observation well over other local wells because 1) it is the closest to the pumped well, 2) it is upgradient from the north-south trending anomaly associated with the spring, 3) it showed the most response to pumping and 4) the data was more consistent than other data collected.

In order to analyze the data in an acceptable fashion, the data sets were broken into three separate portions. The first data set used has been termed the "initial" data set, and includes time and drawdown data from well P-7 for the beginning period of the test where the flow rate was recorded to be equal to 8.22 gpm. The "intermediate" data set includes data subsequent to that time when the flow rate was increased to an average value over time of 16.4 gpm. The third data set includes data taken during the "recovery" portion of the test after the pump in well P-7 was shut off.

Three basic analytical methods were used to estimate aquifer transmissivity for the data contained herein. These include the Cooper-Jacob, Theis, and Neuman methods. Each method, along with data applicable to it is discussed separately in the following sections.

Cooper-Jacob Drawdown and Recovery Analyses

Drawdown Methods.

The Cooper-Jacob straight line method of analysis utilizes a semi-log plot for the display and analysis of the data as shown on Plot 1 in Appendix B. The data shown on the plot entitled "PacifiCorp P-7 Initial Data Q=8.22 gpm" has three general slopes to the data. The first few data points are usually ignored in a pump test because they reflect initial drawdown anomalies generally due to evacuation of the well drill stem or casing. The next set of data, beginning at two minutes and running through 100 minutes, shows a good aquifer response and an associated transmissivity of approximately 35,650 gpd/ft. The plot however shows that a change in the slope of the data occurred at about 100 minutes. Such a change in grade generally indicates the presence of a boundary condition which in the case of Rilda Canyon reflects the bedrock of the canyon walls. Under such conditions it is generally the case that the slope of the curve after the time in which the boundary was encountered will double. Such is generally the case as is shown in Plot 2 within Appendix B. The slope of the straight line for the latter part of the data shows a transmissivity on the order of 21,100 gpd/ft, a 40 percent decrease. Based upon this data it is believed that the initial transmissivity of the alluvial valley is in the order of 35,000 gpd/ft for the initial period of pumping during which time the aquifer is unaffected by distant barriers.

After a barrier influences ground water hydrology, the transmissivity reduces to the estimated 21,100 gpd/ft.

Intermediate data provides similar data to that shown above. The barrier effects discussed occurred within the first 100 minutes of pumping, before data was collected for this data set. Therefore, the majority of the impacts due to the barrier will have already been accounted for, although some effects should occur due to an increased pumping rate. With this in mind, the straight line Cooper-Jacob analysis produces a transmissivity of 17,550 gpd/ft as shown in Plot 3 of Appendix B. Although slightly less, this value is similar in nature and magnitude to that found for the last half of the initial data set.

An analysis of the intermediate data was also made by using data collected from well P-6 located approximately 500 feet to the east of well P-7. The analysis shown in Plot 4 indicates that the long term transmissivity for this data set is in the range of 23,800 gpd/ft. Again, this is in the general range of estimates already made above.

Recovery Methods.

Straight line methods of analysis are also used for well recovery data which is taken after the pump is shut off. In the case of well P-7 the recovery curves are shown as Plots 5 and 6 of Appendix B. Immediately after pumping ceases in a well, water levels recover at an abnormally high rate in a similar fashion to that which occurred during the first two minutes of the pumping test as shown in Plot 1. By taking the next set of data, a straight line can be fit to obtain an approximation of long term transmissivity on the order of 13,700 gpd/ft as shown in Plot 5. Although this estimate is a little low as compared to the estimate given above, it is of the same order of magnitude.

Short term transmissivity is checked for the recovery data by the fitting of a straight line through the low end of the data. The transmissivity under short term pumping is estimated at 35,900 gpd/ft. This estimate matches very well the 35,650 gpd/ft estimate made by utilizing the Cooper-Jacob straight line drawdown analysis discussed above.

Theis Drawdown Analysis

The Theis method of solution utilizes a log-log plot of drawdown versus time as shown on Plot 7 of Appendix B. The solution is achieved by matching a well function curve to the data as shown. It should be noted that the data utilizing this method of solution does not show readily the boundary condition which was identified by the Cooper-Jacob solution method. There is a slight curvature of the data at about the 100 minute time mark as shown on the plot, however, without other methods, it is unlikely that a boundary condition would have been identified for this data set. Since the solution does not identify a boundary condition, the solution reached is a mix of both short and long term transmissivities. An analysis using this approximation method (resulting in an average transmissivity) results in an estimate of 28,450 gpd/ft.

A check of this estimate can be made by averaging transmissivities for both the initial short term and intermediate long term data sets obtained by using the Cooper-Jacob method of analysis. The average of 35,650 and 21,100 gpd/ft is 28,380 gpd/ft which is within 1/2 of a percent of the estimate given above using the Theis method.

An analysis of the intermediate data shown on Plot 8 shows that the estimated long term transmissivity using the Theis method is in the order of 17,900 gpd/ft. This can be compared to the 17,550 gpd/ft estimate made by using the Cooper-Jacob method. The estimates indicated are within two percent of each other again showing good correlation.

Neuman Drawdown Analysis

The third method of analysis is based upon unconfined aquifer solutions as determined by Neuman. His analysis utilizes two basic type curves. The "Type A" curve is characteristic of that shown on Plots 9 and 10 where the curve is a power curve asymptotic to the horizontal line. "Type B" curves bend in the opposite direction, ie. they start relatively flat and turn upwards as one moves to the right on the plot. Slight trends towards both the "Type A" and "Type B" curves can be seen on Plot 9. A "Type A" curve could be fit to the data between time 1 and time 30, and a "Type B" curve could be fit to the data between time 30 and time 1000. However, because the data is influenced by the presence of a boundary condition as discussed above, and because the Neuman solution does not identify boundary conditions in its methodology, such an analysis would provide inaccurate results. As a compromise, an average solution is attempted by analyzing the data based upon the complete data set wherein an estimate of 13,150 gpd/ft is obtained. Although lower than some of the earlier estimates made, this estimate again has the same relative order of magnitude.

The intermediate data set was also analyzed using the Neuman approach as shown in Plot 10. From the data it is seen that this solution predicts a low value of transmissivity. It is believed that the other predictions of transmissivity given above are more accurate and reliable than this estimate because of the reasons discussed in the previous paragraph.

Water Quality

A brief review of water quality data provided for this study has been made for both the NEWUA springs, well P-7, and surface sources in Rilda Canyon. Selected data reviewed is shown in the following Table, and computer plots of the data are presented in Appendix A. For the parameters identified, there appears to be a consistent correlation with conclusions reached in earlier reports which have been prepared for West Appa Coal Company. In summary, water quality of the springs do not generally correlate well with waters originating from the south as measured by Meters 1 and 2, nor do they correlate well with surface waters monitored within Rilda Canyon. The water appears to be more highly correlated with waters moving toward the NEWUA springs from the west. Water movement from the west is most likely through three source mechanisms. The first and most obvious water source is through the alluvial valley aquifer into which local wells have been drilled. The next sources may be through faulting and fracturing systems within Rilda Canyon or through the north-south anomaly which passes through the west end of the spring collection system as discussed above. These waters (those originating through faulting, fracturing and Rilda Canyon alluvial valley fill appear to have a different water quality characteristic than those of the southern springs.

1989 AND 1990 WATER QUALITY SUMMARY

Parameter	Station	Date											
		1989					1990						
		04/17	06/12	08/15	09/14	12/06	06/13	09/06	09/18	11/07	11/14	11/16	11/19
TDS	Meter 1							547		365			
	Meter 2							518	523	443	426		429
	Meter 3							447	414	419	324		406
	Meter 4							405	410	298	301		372
	P-7											310	321
	RCF-1		222				277						
	RCF-3	513	372		495	477	226	493					
	RCF-4		413		477	496	300	538					
SO4	Meter 1							100		70			
	Meter 2							140	100	80	50		75
	Meter 3							100	100	70	59		68
	Meter 4							50	100	50	38		45
	P-7											35	43
	RCF-1		23				80						
	RCF-3	150	125		70	100	60	110					
	RCF-4		95		85	150	250	250					
pH	Meter 1							7.0		8.1			
	Meter 2							7.5	7.3	7.2	7.2		7.3
	Meter 3							7.2	7.4	7.1	7.2		7.4
	Meter 4							7.4	7.5	7.2	7.4		7.6
	P-7											7.4	7.3
	RCF-1		8.15				8.3						
	RCF-3	7.9	8.0	8.0	7.9	8.0	8.1	7.9					
	RCF-4		8.1	8.3	8.3	8.2	8.3	8.15					
Fe (Total)	Meter 1							0.21		1.48			
	Meter 2							0.15	0.79	1.5	0.6		0.7
	Meter 3							0.23	0.19	0.87	0.6		0.16
	Meter 4							0.05	0.19	0.51	0.02		0.03
	P-7											0.03	0.06

Parameter	Station	Date											
		1989					1990						
		04/17	06/12	08/15	09/14	12/06	06/13	09/06	09/18	11/07	11/14	11/16	11/19
	RCF-1		0.02				0.05						
	RCF-3	0.08	0.51		0.11	0.17	0.33	0.06					
	RCF-4		0.12		0.02	0.02	0.04	0.06					
Na	Meter 1							17.27		13.95			
	Meter 2							16.4	16.56	13.72	13.33		12.42
	Meter 3							13.0	13.0	12.01	12.74		11.1
	Meter 4							11.27	26.3	11.5	9.01		9.08
	P-7											10.15	11.08
	RCF-1		5.6				4.3						
	RCF-3	15.9	10.4		13.4	13.4	7.63	15.6					
	RCF-4		13.9		17.1	17	52	19.08					

Water Source

In the report prepared originally by Vaughn Hansen Associates in April of 1983 for West Appa Coal Company, it was noted that the water appeared to be originating from the north along a north-south oriented anomaly in the vicinity of the main north spring. In a later response to an OSM Completeness Review for West Appa Coal Company in March of 1984 it was noted that additional data seemed to indicate that a portion of the flow may be originating from sources to the west which move into an east-west oriented anomaly or fracture, then intersect the north-south anomaly before discharging as spring water.

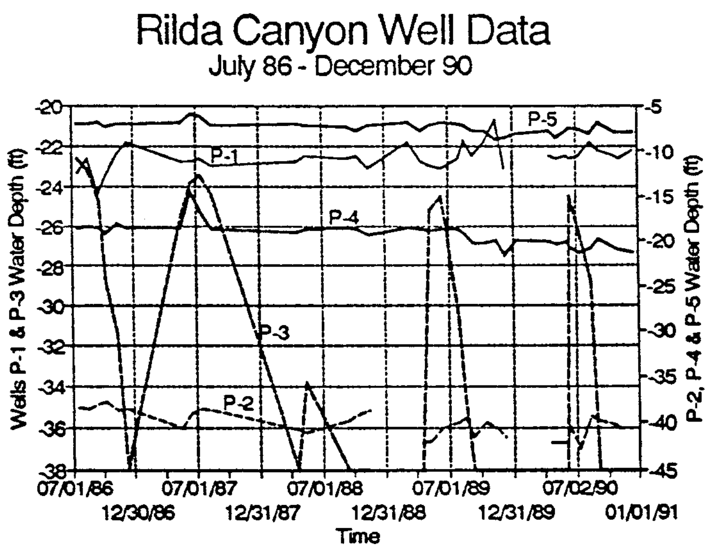
Piezometric Surface

Water level data collected at each of the wells or piezometers within Rilda Canyon has been compiled to indicate the general orientation and direction of ground water within the vicinity of the NEWUA springs as shown on Map 2. Note from the map that the general direction of ground water continues to be to the east along the axis of Rilda Canyon with flow contributions being received by the drainage entering from the south. Water table gradients for the area are dependent upon the time of year as well as overall ground water recharge characteristics. For example, from the map it can be found that the average slope of the monitored water table lying between well P-7 and well P-5 in November of 1990 was 4.3 percent. At this same time the average water table gradient increases downgradient of well P-5 where it was found to be 6.4 percent. The fact that the water table gradient increases downstream of well P-5 still tends to confirm the presence of the north-south anomaly reported earlier for the area. A check of water table gradients during high flow periods shows larger values than were noted in the latter part of 1990. Analyses of historic data shows that although flow patterns are relatively unchanged during high flow periods, the water table gradient above well P-5 may have been as high as 7.4 percent in 1987.

Pumping Impacts

An approximation of the total ground water flow moving eastward down Rilda Canyon was made by using data collected from the resistivity studies completed by PacifiCorp and from data collected at local area wells. This flow approximation was made by applying the general flow equation Q=VA. The area of ground water flow was determining using the inferred cross sectional area identified in the resistivity study as "R-3" (See Map 2) for the canyon adjacent to well P-7. The velocity of ground water movement was determined from the relationship between hydraulic permeability and ground water gradient, V=ki. Permeability was determined from the estimate for short term transmissivity obtained using the methods discussed earlier. It was felt that under flow conditions uninfluenced by man, this short term transmissivity is most representative of natural conditions. Using these relationships, the estimated amount of ground water moving down Rilda Canyon was determined for both high and low flow conditions.

FIGURE 14



Based upon historic data, low flow conditions were found to dominate during the period of the 1990 pump test, however, it has been noted by PacifiCorp employees that a rise in water level occurs within Rilda Canyon wells each year as the ground water aquifer responds to snowmelt runoff. Historical data reproduced in Figure 14 for wells 1 through 5 shows seasonal and annual water level fluctuations. Little data was available for well 6. Note from the figure the relative change in water level between wells. Little overall variation is noted except for well P-3 which shows changes over time totaling approximately 13 to 14 feet. Changes recorded in well P-3 are likely greater than those indicated by Figure 14 because well P-3 is only 38 feet deep, and water levels have been known to drop below the bottom of the well. A comparison of water level variations between wells P-3 and adjacent well P-7 indicates that the total water level fluctuation may be as much as 22 feet.

Low Flow. The first condition analyzed was based upon the relatively low flow condition found in November of 1990. Under these conditions the total alluvial valley aquifer flow in the area of well P-7 using the relationship Q=VA as discussed above was estimated to be approximately 151 gpm. Subtracting an average pumped volume of 16.4 gpm from well P-7, an estimated flow of 135 gpm bypassed well P-7 and continued downstream towards the NEWUA spring collection system. Impacts noted upon the NEWUA spring system as a result of pumping well P-7 appear to be confined to a reduction in flow from the springs on the order of 10 percent. Before pumping began, total combined spring flows were approximately 85 gpm. During the later stages of pumping just prior to termination of the test, spring flows had reduced to approximately 77.5 gpm, indicating a reduction in flow of 7.5 gpm during the pump test. Additional reductions in flow will probably occur as flows continue to stabilize.

As stated above, not all the water moving down Rilda Canyon in the alluvial valley aquifer was collected through pumping of well P-7. In order to obtain an estimate of what total impact may be possible should the entire alluvial aquifer be eliminated as a source of water, a straight line extrapolation was made of pumped flows versus decreased spring flows. A straight line extrapolation of the data in this fashion should be considered an approximation only, and not an accurate method of determining precise impacts. At an average pump rate at well P-7 of 16.4 gpm, NEWUA spring flows decreased by approximately 10 percent. Assuming all alluvial valley recharge bypassing well P-7 were eliminated as a potential source of water, the estimated impact to the NEWUA springs (using the straight line extrapolation method) could be approximately 69 gpm. The estimated spring impact based in percent would then be 69 gpm over an uninfluenced flow rate of 85 gpm or 81 percent. Using this methodology, the remaining 19% of the flow contributing to the NEWUA springs appears to be coming from other sources.

High Flow. High flow conditions were estimated by adding to the 151 gpm base flow calculated for the November 1990 period the additional flow which would move down the canyon given a 22 foot rise in water level which would occur during a wet year. The additional flow projected to occur during wet years was estimated by 1) measuring the cross sectional area which would result from a 22 foot rise in the water table and 2) by applying the flow relationship Q=kiA. As indicated earlier the water table gradient (i) used in this equation was found to be greater in 1987 than during the November 1990 test. As shown in calculations presented in Appendix C, increased water levels measured during the high flow period of 1987 resulted in an estimated alluvial valley aquifer flow rate of 372 gpm.

Data provided by PacifiCorp shows that total NEWUA spring flow during high flow periods is typically on the order of 400 gpm. If all alluvial flow entered the springs, then the total impact to the springs resulting from the loss of said flow would be on the order of 93 percent (372 gpm/400 gpm). An alternate method of approximating the potential impact is through the use of the same impact ratio as was determined from the low flow pump test completed on well P-7. Using this method, the total expected decrease in spring flows during high flow periods would be approximately 170 gpm, or a 43 percent decrease (170 gpm expected decrease/400 gpm total spring flow).

<u>Source Protection Rules</u>

The State of Utah has been required by the Federal Government under the Federal Safe Drinking Water Act to establish a Wellhead Protection Program to protect ground waters that supply drinking water to public water supply systems. Included within this classification is the NEWUA spring collection system within Rilda Canyon. The rules proposed to be adopted by the Utah Safe Drinking Water Committee can only be considered at this time to be preliminary in nature since they are still in draft form at the time of writing of this report. A brief summary of the proposed draft rules is included within the following table.

Based upon information contained in the table, it appears that the property included within Zone 1, a 100 foot radius around the NEWUA spring collection system, should be owned by the water supplier and be fenced. In addition, Zone 1 should be protected against anthropogenic sources of contamination. The "Master List of Potential Anthropogenic Sources of Contamination in Utah" as given in R449-113-8.1 includes coal companies within the designation "Concrete, asphalt, tar and **coal companies**". Note the designation difference between new and existing sources in the table just discussed in that new sources indicate a definitive action whereas existing sources indicate that the action "should" be done. It inferred by this distinction that existing facilities will be treated with more latitude than new facilities. It appears that this wording has been added to take into account the many possible configurations of public water supplies wherein little can be done to modify or correct long standing conditions.

Because the area has a characteristically high ground water velocity, the criteria identified by zones 2 and 3 in the table do not apply. For example, a 250 day travel time for water found within in the alluvial aquifer (using a permeability of 167 ft/day as used in the calculations shown in Appendix C) would be 7.9 miles. Since the criteria require that the zone not extend beyond the natural hydrologic boundaries, the zone is reduced to the limit or extent of the canyon in which the NEWUA springs are located. Using this criteria, the north and south limits would include the land to the ridgeline of Rilda Canyon. The west boundary line would be placed at a two mile radius from the NEWUA spring collection system, and the east boundary would be located along the contour line 100 feet lower in elevation from the ground water source. A map showing the approximate ground water protection zone boundary as defined by the preliminary draft regulation is presented in Appendix D. It should be noted that this boundary is only an approximation of the two mile radial zone as defined in the regulation, and refinement will be needed as the regulation is further defined.

As of the date of this report, it is anticipated that public water suppliers will be required to prepare Drinking Water Source Protection plans between December 31, 1993 and December 31, 1996 according to the following schedule.

Population Served by the Public Water Supplier	Drinking Water Source Protection plan due by
Over 10,000 (all wells)	December 31, 1993
3,300 to 10,000 (all wells)	December 31, 1994
Less than 3,300 (all wells)	December 31, 1995
All springs and others	December 31, 1996

These plans will require the submittal of mapping and hydrogeologic information capable of demonstrating the potential impacts from contamination sources. As a minimum they will require 1) the delineation of the protection zone, 2) the inventory of potential contamination sources, 3) a control assessment of each contamination source, 4) land management strategies to be used to control the contamination source, and 5) an implementation schedule and resource evaluation.

SUMMARY OF PROPOSED DRAFT WATER SUPPLY PROTECTION ZONES

CRITERIA	ZONE	PROTECTION AREA(1)	LIMIT OF PROTECTION REQUIRED
Three Zone Method	1	100 foot radius	NEW SUPPLY o Protection zone shall be owned and fenced o Anthropogenic sources of contamination shall be prohibited EXISTING SUPPLY o **Protection zone should be owned and fenced** o **Should propose to prohibit or control potential anthropogenic sources of contamination**
	2	250 day travel time	NEW SUPPLY o Shall propose to prohibit any discharge or disposal of material potentially containing pathogenic microorganisms o Shall propose to prohibit or control potential anthropogenic sources of contamination EXISTING SUPPLY o **Should prohibit the discharge or disposal of material potentially containing pathogenic microorganisms** o **Should prohibit or control existing potential anthropogenic sources of contamination**
	3	15 year travel time	NEW SUPPLY o Shall propose to prohibit or control all potential anthropogenic sources of contamination EXISTING SUPPLY o **Should prohibit or control potential anthropogenic sources of contamination**

CRITERIA	ZONE	PROTECTION AREA[1]	LIMIT OF PROTECTION REQUIRED
Two-mile Fixed Radius Method	1	100 foot radius	NEW SUPPLY o Protection zone shall be owned and fenced o All potential anthropogenic sources of contamination shall be prohibited EXISTING SUPPLY o Protection zone should be owned and fenced o Should prohibit or control potential anthropogenic sources of contamination
	2 Mile Radius	2 mile fixed radius	NEW SUPPLY o Propose to prohibit or control all potential anthropogenic sources of contamination EXISTING SUPPLY o Should prohibit or control all potential anthropogenic sources of contamination

NOTE: (1) This protection area may be reduced if a margin of the collection area, aquifer boundary or a ground water divide is encountered prior to reaching the distances indicated.

CONCLUSIONS

Aquifer Characteristics

Aquifer transmissivities as determined by the methods outlined earlier in this report range from a low of 6,100 gpd/ft to a high of 35,900 gpd/ft. As a summary of values determined, the following table is provided. Included within the table is a column identified as "Credibility of Results". This column is intended to be a guide to the numbers given. A high credibility rating indicates that the method basically accounts for conditions believed to exist within Rilda Canyon. A medium credibility indicates that the numbers are within the range expected, but that the solution may not be as accurate as another method. A low credibility indicates that for these conditions, the solution does not appear to be accounting fully for identified field conditions. As outlined in the table, it is believed that long term transmissivities are on the order of 20,000 gpd/ft, and short term transmissivities are in the order of 35,000 gpd/ft. The variation in results appear to be due to boundary effects created by the canyon walls. If used for further analyses, the short term transmissivity estimates should govern.

SUMMARY OF CALCULATED TRANSMISSIVITIES

Analysis Used	Data Type	Well Data Used	Estimated Transmissivity (gpd/ft)		Credibility of Results		
			Short Term	Long Term	High	Medium	Low
Cooper-Jacob	Drawdown	P-7	35,650	17,550-21,000	■		
Cooper-Jacob	Drawdown	P-6	-	23,600	■		
Cooper-Jacob	Recovery	P-7	35,900	13,700	■	■	
Theis	Drawdown	P-7	28,450	17,900	■	■	
Neuman	Drawdown	P-7	13,150	6,100			■

Spring Impacts

Impacts noted upon on NEWUA springs during the pump test completed in November of 1990 were found to be in the range of approximately 10 percent. These impacts are based upon pump test, water level data collected from well P-7, other local piezometers, and spring discharge data. Continued pumping beyond the length of the test completed will likely result in additional declines beyond those noted during the seven day test. The impacts to the springs based upon varying local conditions and flow patterns have been reviewed as a result of this reporting effort. Some of the changes which could potentially occur to the local ground water system, thereby impacting local springs are discussed below.

Total Elimination of Alluvial Flow. In the event that all alluvial aquifer flow from the west up Rilda Canyon were eliminated as a spring recharge source, impacts to the NEWUA springs may be more severe than the 42 to 93 percent estimate made through the use of pumping test data. Impacts to the NEWUA springs would be most severe in the event that local alluvial water is providing the majority of the head driving the spring collection system during peak periods. This appears to be the case based on the large fluctuations noted in well P-3. Other flows including those related to faults and fractures may be providing a relatively constant base flow to the spring collection system. However, the majority of impact potential to the springs at this time appears to be related to alluvial recharge.

Elimination of Other Sources. Other sources of spring recharge water include faults and fractures as well as alluvial flow in the side canyon located adjacent to the NEWUA springs to the south. Should recharge waters feeding the faults be originating from areas proposed to be mined, and mining diverts the water from its natural course, impacts to the springs could be cumulative with those resulting from a reduction of alluvial flow as discussed above. Obviously, under these conditions the impacts will be greater than those estimated herein based upon alluvial flow near well P-7 alone.

Little seasonal variation was noted in the water level within the wells shown in Figure 14 with the exception of well P-3. The variation noted in well P-3 is insufficient however to account for the total flow variation measured in the NEWUA springs between high and low flow years. High and low flow alluvial recharge from the main canyon area was estimated earlier to be approximately 372 and 151 gpm respectively. The increase in alluvial recharge is then the difference between the two values which is 221 gpm. However, the increase in spring discharge between high and low flows has been reported to be approximately 320 gpm, 31 percent higher than the total alluvial flow increase originating from the main canyon area. This may indicate that the remaining portion of NEWUA spring flows come from either other "non alluvial" sources or additional alluvial flow from the south tributary.

Overall Impact Potential. As a summary statement regarding potential impacts to the NEWUA springs it must be said that the spring impact analyses provided throughout this report are based upon the hypothesis that all alluvial recharge is eliminated. In reality, little impact to spring flow may actually occur unless geologic conditions change as a result of mining. The projected mine is located beneath Rilda Canyon, and any major impact to spring flow will in likelihood be the direct result of a change in local water flowpaths due to subsidence. Subsidence could potentially result in the development of cracking or fracturing of the subsurface geologic stratum above the mine workings. Local recharge crossing these hypothetically subsided areas could be lost from the spring recharge system, thereby directly affecting local spring flows.

Mitigation

It is apparent from the study completed that should mining operations intersect or divert (through subsidence) water contributing to either the Rilda Canyon alluvial valley aquifer or the fault and fracture system feeding waters to the spring, that flows in the NEWUA springs will decrease. Complete interruption of the water sources feeding the alluvial aquifer will have a severe impact upon the spring system. In addition, a decrease in flow from water sources entering the springs from fault and fracture systems will result in additional impacts.

It would appear that options for mitigation might be to prepare plans to replace the NEWUA springs in the event that either 1) water quality is impacted as a result of mining efforts, 2) flows are decreased as a result of mine workings intersecting and diverting spring recharge waters, 3) subsidence creates man made diversions, or 4) a combination of all three. Plans to mitigate impacts to the NEWUA springs should proceed in light of the fact that the time required to locate replacement waters are in most cases the critical path to the solution of a water quality problem. In other words, water quality often deteriorates at a much higher rate than solutions are found. As recommended in previous studies, the most feasible replacement source of water may be Huntington Creek through either a surface or ground water diversion.

Recommendations

Extensive research and testing is required to determine with any degree of accuracy the source of recharge waters for seeps and springs within geologic settings typical of Utah. A determination of sources of water for the NEWUA springs is difficult to make because of the range of possible recharge sources. Potential additional studies which could be conducted to help define further anticipated impacts follows. They are listed in the following table in the recommended order of completion.

FUTURE STUDY ALTERNATIVES

ACTION	PURPOSE	TIMING
Prepare plans and agreements for an alternate water source	It has been determined that there will be an impact to NEWUA springs should mining affect either water quality or recharge quantity to waters within Rilda Canyon. The relative magnitude of such an impact has been estimated within this report. Because data will be difficult to obtain which would further refine the source of spring recharge waters, it is recommended that plans for an alternate water source be made. Such a replacement alternative can be easily adjusted to accommodate flow requirements should time indicate that impacts are less than initially projected, or in the event of quality impacts, that water quality improves to the point where the springs may once again be used.	As required or desired
Pump well P-6	Now that initial information has been obtained at well P-7, pump tests on well P-6 may aid in determining the amount of recharge water which originates from the fault fracture system. Well P-6 lies north of the main canyon drainage at a location closer to the east-west trending fault zone. If pumped sufficiently a correlation may be possible between the percent alluvial flow versus percent fault flow. Such a correlation would be made by using well hydraulics between wells P-6 and P-7 as well as geohydrologic information obtained during the November 1990 testing.	Could be done as soon as the snow melts, but it may be better to wait until high flow in June or July 1991
Repump well P-7 during high flow period	Define more accurately the relationships between alluvial valley aquifer flows and spring flows during high flow periods. Data from this type of test would allow additional flow correlations to be made regarding potential impacts from the loss of alluvial recharge water.	June or July 1991

APPENDIX A

HANSEN ALLEN & LUCE INC

TABLE 1. WELL P-7 TIME AND DRAWDOWN DATA

Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)
11/13	8.22	0.00	0.00	11/15	16.90	2730.00	-10.95	11/18	15.70	6846.00	-19.13
11/13	8.22	0.50	-0.47	11/15	16.90	2760.00	-11.25	11/18	15.70	6853.00	-19.14
11/13	8.22	1.25	-0.80	11/15	17.30	2791.00	-11.55	11/18	15.79	6861.00	-19.25
11/13	8.22	1.75	-1.04	11/15	17.00	2822.00	-11.50	11/18	15.22	6864.00	-18.05
11/13	8.22	2.00	-1.30	11/15	16.80	2850.00	-11.35	11/18	15.18	6867.25	-17.05
11/13	8.22	2.50	-1.42	11/15	17.00	2872.00	-11.11	11/18	15.52	6868.50	-16.59
11/13	8.22	3.00	-1.45	11/15	17.20	2875.00	-11.14	11/18	15.54	6871.00	-16.18
11/13	8.22	3.52	-1.45	11/15	17.60	2879.00	-11.79	11/18	15.60	6872.75	-16.05
11/13	8.22	4.00	-1.51	11/15	17.60	2881.00	-11.95	11/18	15.63	6875.00	-15.82
11/13	8.22	4.50	-1.56	11/15	17.60	2886.00	-12.09	11/18	15.63	6875.75	-15.72
11/13	8.22	5.10	-1.57	11/15	17.50	2896.00	-12.14	11/18	15.64	6878.00	-15.54
11/13	8.22	5.50	-1.55	11/15	17.50	2905.00	-12.05	11/18	15.64	6879.00	-15.41
11/13	8.22	6.50	-1.71	11/15	17.50	2912.00	-12.05	11/18	15.64	6880.75	-15.25
11/13	8.22	7.08	-1.63	11/15	17.40	2940.00	-13.87	11/18	15.63	6896.00	-14.73
11/13	8.22	7.67	-1.69	11/15	17.50	2955.00	-14.47	11/18	15.62	6939.25	-12.87
11/13	8.22	8.38	-1.65	11/15	17.50	2970.00	-14.70	11/18	15.62	6947.25	-12.55
11/13	8.22	9.00	-1.72	11/15	17.50	2985.00	-13.25	11/18	15.62	6956.00	-11.94
11/13	8.22	9.50	-1.65	11/15	17.40	3000.00	-12.79	11/18	15.62	6960.00	-11.79
11/13	8.22	10.00	-1.63	11/15	17.40	3040.00	-13.30	11/18	15.71	6964.00	-11.73
11/13	8.22	11.00	-1.70	11/15	17.40	3060.00	-13.60	11/18	15.76	6968.00	-11.89
11/13	8.22	12.00	-1.76	11/15	17.50	3079.00	-13.69	11/18	15.76	6969.00	-12.01
11/13	8.22	13.00	-1.76	11/15	17.50	3090.00	-13.96	11/18	15.66	6977.00	-12.52
11/13	8.22	14.00	-1.77	11/15	17.50	3120.00	-14.72	11/18	15.66	6995.00	-12.69
11/13	8.22	15.00	-1.85	11/15	17.50	3151.00	-16.72	11/18	15.64	7015.00	-13.87
11/13	8.22	16.00	-1.75	11/15	17.50	3157.00	-17.13	11/18	15.64	7034.00	-14.46
11/13	8.22	17.00	-1.80	11/15	17.50	3162.00	-17.35	11/18	15.71	7050.00	-14.67
11/13	8.22	18.32	-1.85	11/15	17.00	3166.00	-16.55	11/18	15.75	7077.00	-14.65
11/13	8.22	19.00	-1.79	11/15	17.10	3180.00	-16.59	11/18	15.68	7110.00	-15.50
11/13	8.22	20.00	-1.83	11/15	17.10	3195.00	-16.90	11/18	15.68	7132.00	-15.40
11/13	8.22	21.00	-1.82	11/15	17.10	3210.00	-16.58	11/18	15.68	7140.00	-15.06
11/13	8.22	22.50	-1.85	11/15	17.10	3240.00	-15.35	11/18	15.77	7170.00	-15.39
11/13	8.22	23.00	-1.86	11/15	17.00	3301.00	-12.95	11/18	15.73	7215.00	-15.92
11/13	8.22	24.00	-1.85	11/15	17.00	3330.00	-12.43	11/18	15.73	7230.00	-16.60
11/13	8.22	25.17	-1.88	11/15	17.00	3358.00	-12.22	11/18	15.67	7262.00	-17.29
11/13	8.22	26.00	-1.87	11/16	17.00	3401.00	-12.40	11/18	15.60	7293.00	-17.09
11/13	8.22	27.00	-1.88	11/16	17.00	3420.00	-12.18	11/18	15.52	7320.00	-15.52
11/13	8.22	28.25	-1.84	11/16	17.00	3450.00	-12.20	11/18	15.52	7350.00	-14.43
11/13	8.22	29.00	-1.90	11/16	17.00	3480.00	-12.32	11/18	15.67	7380.00	-14.60

TABLE 1. WELL P-7 TIME AND DRAWDOWN DATA

Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)
11/13	8.22	30.17	-1.87	11/16	17.00	3510.00	-12.53	11/18	15.75	7412.00	-15.70
11/13	8.22	32.17	-1.89	11/16	17.00	3540.00	-12.55	11/18	15.65	7440.00	-16.18
11/13	8.22	34.00	-1.91	11/16	17.00	3570.00	-13.39	11/18	15.64	7470.00	-16.18
11/13	8.22	36.17	-1.95	11/16	17.00	3600.00	-13.75	11/18	15.70	7502.00	-15.98
11/13	8.22	38.00	-1.94	11/16	17.00	3630.00	-13.92	11/18	15.62	7531.00	-16.32
11/13	8.22	40.00	-1.97	11/16	17.00	3660.00	-14.31	11/18	15.48	7560.00	-16.60
11/13	8.22	43.00	-2.00	11/16	17.00	3690.00	-14.98	11/18	15.63	7590.00	-17.38
11/13	8.22	44.00	-2.02	11/16	16.80	3720.00	-15.67	11/18	15.58	7620.00	-16.60
11/13	8.22	45.00	-2.03	11/16	17.00	3750.00	-15.49	11/18	15.62	7650.00	-16.55
11/13	8.22	50.00	-2.05	11/16	16.90	3780.00	-15.65	11/18	15.60	7680.00	-16.46
11/13	8.22	55.00	-2.08	11/16	16.90	3826.00	-15.29	11/19	15.53	7709.00	-16.77
11/13	8.22	60.17	-2.09	11/16	17.00	3838.00	-17.49	11/19	15.54	7735.00	-16.97
11/13	8.22	66.17	-2.07	11/16	17.00	3841.00	-17.89	11/19	15.54	7770.00	-16.62
11/13	8.22	70.00	-2.11	11/16	17.00	3842.00	-18.02	11/19	15.34	7829.00	-16.49
11/13	8.22	75.00	-2.13	11/16	17.00	3842.75	-18.05	11/19	15.54	7859.00	-16.68
11/13	8.22	80.00	-2.21	11/16	16.80	3844.00	-17.95	11/19	15.48	7892.00	-16.73
11/13	8.22	85.00	-2.12	11/16	16.70	3845.00	-17.85	11/19	15.53	7925.00	-17.23
11/13	8.22	90.00	-2.25	11/16	16.70	3846.00	-17.75	11/19	15.52	7950.00	-17.29
11/13	8.22	95.00	-2.22	11/16	16.70	3847.50	-17.65	11/19	15.54	7980.00	-17.35
11/13	8.22	100.00	-2.25	11/16	16.70	3849.00	-17.55	11/19	15.48	8010.00	-16.93
11/13	8.22	105.00	-2.27	11/16	16.70	3850.25	-17.45	11/19	15.45	8043.00	-17.10
11/13	8.22	123.00	-2.37	11/16	16.70	3851.60	-17.35	11/19	15.53	8066.00	-16.73
11/13	8.22	135.00	-2.39	11/16	16.70	3852.75	-17.25	11/19	15.53	8110.00	-16.93
11/13	8.22	150.00	-2.39	11/16	16.70	3854.00	-17.15	11/19	15.53	8132.75	-19.50
11/13	8.22	165.00	-2.45	11/16	16.70	3855.00	-17.05	11/19	15.53	8133.75	-17.05
11/13	8.22	183.00	-2.47	11/16	16.70	3857.50	-16.95	11/19	15.53	8134.75	-16.05
11/13	8.22	195.00	-2.52	11/16	16.70	3859.40	-16.85	11/19	15.53	8135.50	-15.38
11/13	8.22	211.00	-2.55	11/16	16.70	3862.20	-16.75	11/19	15.53	8136.50	-15.40
11/13	8.22	225.00	-2.55	11/16	16.70	3865.15	-16.65	11/19	15.53	8137.00	-15.40
11/13	8.22	240.00	-2.57	11/16	16.70	3867.00	-16.55	11/19	15.57	8140.00	-15.45
11/13	8.22	255.00	-2.56	11/16	16.70	3867.75	-16.45	11/19	15.57	8144.00	-15.70
11/13	8.22	271.00	-2.58	11/16	16.70	3871.25	-16.35	11/19	15.45	8149.00	-15.67
11/13	8.22	285.00	-2.68	11/16	16.70	3874.75	-16.25	11/19	15.45	8150.00	-15.60
11/13	8.22	300.00	-2.70	11/16	16.70	3888.00	-15.95	11/19	15.50	8155.00	-15.41
11/13	8.22	317.00	-2.73	11/16	16.70	3910.00	-15.56	11/19	15.50	8160.00	-15.22
11/13	8.22	330.00	-2.73	11/16	16.70	3930.00	-15.30	11/19	15.50	8190.00	-14.64
11/13	8.22	376.00	-2.75	11/16	16.70	3944.00	-15.55	11/19	15.55	8220.00	-15.75
11/13	8.22	390.00	-2.75	11/16	16.70	3960.00	-15.71	11/19	15.41	8250.00	-13.06

TABLE 1. WELL P-7 TIME AND DRAWDOWN DATA

Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)
11/13	8.22	405.00	-2.76	11/16	16.70	3985.00	-15.41	11/19	15.51	8280.00	-15.59
11/13	8.22	420.00	-2.76	11/16	16.70	3989.40	-15.25	11/19	15.50	8310.00	-14.94
11/13	8.22	435.00	-2.78	11/16	16.70	3996.00	-14.75	11/19	15.45	8340.00	-14.45
11/13	8.22	451.00	-2.81	11/16	16.70	4009.00	-15.04	11/19	15.45	8379.00	-15.05
11/13	8.22	465.00	-2.83	11/16	16.70	4014.00	-15.26	11/19	15.46	8400.00	-14.55
11/13	8.22	480.00	-2.83	11/16	16.70	4020.00	-15.43	11/19	15.46	8430.00	-15.10
11/14	8.22	530.00	-2.85	11/16	16.70	4043.00	-14.75	11/19	15.46	8460.00	-15.51
11/14	8.22	555.00	-2.88	11/16	16.70	4080.00	-14.60	11/19	15.52	8490.00	-15.01
11/14	8.22	585.00	-2.90	11/16	16.60	4120.00	-15.25	11/19	15.43	8520.00	-14.79
11/14	8.22	615.00	-2.91	11/16	16.60	4174.00	-15.43	11/19	15.43	8550.00	-15.05
11/14	8.22	660.00	-2.92	11/16	16.40	4199.00	-15.54	11/19	15.42	8580.00	-14.71
11/14	8.22	690.00	-2.95	11/16	16.70	4212.50	-14.80	11/19	15.42	8622.00	-16.05
11/14	8.22	720.00	-2.98	11/16	16.70	4216.25	-15.00	11/19	15.42	8640.00	-15.99
11/14	8.22	750.00	-2.98	11/16	16.70	4222.00	-15.35	11/19	15.56	8666.00	-16.30
11/14	8.22	780.00	-2.98	11/16	16.70	4250.00	-15.50	11/19	15.56	8670.00	-16.30
11/14	8.22	810.00	-3.00	11/16	16.70	4257.25	-15.62	11/19	15.39	8701.00	-17.31
11/14	8.22	840.00	-3.00	11/16	16.70	4263.00	-15.76	11/19	15.63	8730.00	-17.52
11/14	8.22	870.00	-3.00	11/16	16.70	4268.00	-15.97	11/19	15.40	8760.00	-16.40
11/14	8.22	900.00	-3.00	11/16	16.70	4270.00	-16.22	11/19	15.40	8792.00	-16.20
11/14	8.22	930.00	-3.05	11/16	16.70	4281.00	-17.15	11/19	15.38	8819.00	-15.48
11/14	8.22	961.00	-3.05	11/16	16.70	4315.00	-18.63	11/19	15.38	8853.00	-15.35
11/14	8.22	1025.00	-3.05	11/16	16.30	4358.00	-19.22	11/19	15.31	8881.00	-13.89
11/14	8.22	1050.00	-2.95	11/16	16.30	4360.00	-18.95	11/19	15.47	8912.00	-13.70
11/14	8.22	1080.00	-2.98	11/16	16.30	4369.00	-18.27	11/19	15.40	8942.00	-13.75
11/14	8.22	1115.00	-3.08	11/16	16.30	4385.00	-17.80	11/19	15.59	8971.00	-18.05
11/14	8.22	1147.00	-3.08	11/16	16.30	4388.30	-17.65	11/19	15.33	9000.00	-17.58
11/14	8.22	1233.00	-3.00	11/16	16.30	4390.00	-17.55	11/19	15.45	9031.00	-17.38
11/14	8.22	1260.00	-3.00	11/16	16.30	4393.00	-17.45	11/19	15.44	9060.00	-16.47
11/14	8.22	1292.00	-3.05	11/16	16.30	4395.00	-15.91	11/19	15.39	9087.00	-16.68
11/14	8.22	1320.00	-3.03	11/16	16.30	4425.00	-13.21	11/20	15.39	9122.00	-16.63
11/14	8.22	1380.00	-3.03	11/16	16.30	4430.00	-12.50	11/20	15.39	9149.00	-15.78
11/14	8.22	1411.00	-3.05	11/16	16.33	4440.00	-12.15	11/20	15.40	9175.00	-14.85
11/14	8.22	1450.00	-3.05	11/16	16.45	4443.00	-12.29	11/20	15.46	9240.00	-16.14
11/14	8.22	1470.00	-3.05	11/16	16.47	4450.00	-12.58	11/20	15.42	9300.00	-16.67
11/14	8.22	1502.00	-3.05	11/16	16.46	4470.00	-13.00	11/20	15.45	9365.00	-17.90
11/14	8.22	1530.00	-3.05	11/16	16.48	4500.00	-13.41	11/20	15.26	9395.00	-15.50
11/14	7.91	1560.00	-3.05	11/16	16.40	4533.00	-13.39	11/20	15.26	9403.00	-15.05
11/14	7.91	1568.00	-4.05	11/16	16.38	4560.00	-12.55	11/20	15.26	9450.00	-16.47

TABLE 1. WELL P-7 TIME AND DRAWDOWN DATA

Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)
11/14	7.91	1569.00	-4.52	11/16	16.42	4590.00	-12.39	11/20	15.29	9481.00	-16.03
11/14	14.00	1571.00	-5.05	11/16	16.51	4620.00	-12.35	11/20	15.29	9513.00	-16.54
11/14	14.90	1572.50	-5.56	11/16	16.49	4650.00	-13.05	11/20	15.39	9540.00	-17.39
11/14	14.90	1574.00	-6.05	11/16	16.52	4680.00	-12.99	11/20	15.30	9555.00	-17.68
11/14	14.90	1575.50	-6.36	11/16	16.39	4712.00	-12.72	11/20	15.30	9561.00	-17.89
11/14	15.30	1577.00	-6.65	11/16	16.42	4740.00	-13.23	11/20	15.67	9563.00	-18.65
11/14	15.30	1578.00	-6.75	11/16	16.40	4772.00	-15.88	11/20	15.67	9564.00	-18.76
11/14	15.50	1579.50	-6.78	11/16	16.44	4785.00	-15.74	11/20	15.26	9565.00	-18.71
11/14	15.00	1580.75	-6.48	11/17	16.60	4831.00	-15.53	11/20	15.26	9565.75	-18.65
11/14	15.00	1582.50	-6.33	11/17	16.60	4860.00	-15.72	11/20	15.06	9567.25	-18.40
11/14	15.00	1584.00	-6.30	11/17	16.60	4890.00	-15.62	11/20	15.13	9570.00	-18.01
11/14	15.00	1585.00	-6.26	11/17	16.60	4920.00	-16.09	11/20	15.13	9572.00	-17.80
11/14	15.00	1586.00	-6.20	11/17	16.60	4950.00	-16.64	11/20	15.13	9573.00	-17.55
11/14	15.00	1588.00	-6.17	11/17	16.20	4980.00	-11.70	11/20	15.13	9576.50	-17.06
11/14	15.00	1590.00	-6.29	11/17	16.20	5010.00	-11.67	11/20	15.13	9579.00	-16.75
11/14	15.00	1592.00	-6.30	11/17	16.20	5040.00	-11.65	11/20	15.13	9590.00	-15.36
11/14	15.00	1594.00	-6.32	11/17	16.20	5070.00	-11.67	11/20	15.13	9600.00	-14.19
11/14	15.00	1596.00	-6.35	11/17	16.20	5100.00	-11.62	11/20	15.13	9603.00	-14.35
11/14	15.00	1599.00	-6.35	11/17	16.20	5130.00	-11.52	11/20	15.13	9604.00	-14.67
11/14	15.00	1602.00	-6.31	11/17	16.20	5160.00	-11.72	11/20	15.13	9607.00	-17.25
11/14	15.00	1605.00	-6.32	11/17	16.20	5190.00	-11.61	11/20	15.13	9639.00	-11.35
11/14	15.00	1607.00	-6.39	11/17	16.20	5220.00	-13.76	11/20	15.45	9644.00	-11.69
11/14	15.00	1609.00	-6.39	11/17	16.30	5258.00	-14.40	11/20	15.47	9653.50	-12.53
11/14	15.00	1612.00	-6.40	11/17	16.37	5280.00	-14.40	11/20	15.38	9660.00	-14.06
11/14	15.00	1614.00	-6.41	11/17	16.37	5292.00	-14.33	11/20	15.43	9666.00	-15.55
11/14	15.00	1616.00	-6.42	11/17	16.33	5327.00	-14.55	11/20	15.43	9671.00	-15.82
11/14	15.00	1618.00	-6.45	11/17	16.37	5340.00	-14.72	11/20	15.23	9693.00	-15.53
11/14	15.00	1620.00	-6.45	11/17	16.37	5374.50	-14.97	11/20	15.16	9720.00	-14.51
11/14	15.00	1621.00	-6.68	11/17	16.31	5400.00	-14.92	11/20	15.34	9750.00	-14.15
11/14	17.20	1622.00	-7.48	11/17	16.38	5441.00	-15.05	11/20	15.24	9780.00	-14.40
11/14	17.20	1623.00	-8.39	11/17	16.40	5459.00	-15.52	11/20	15.26	9832.00	-14.85
11/14	17.20	1624.00	-9.47	11/17	16.40	5468.50	-15.99	11/20	15.26	9840.00	-15.68
11/14	20.00	1625.00	-10.35	11/17	16.30	5478.00	-16.35	11/20	15.26	9849.00	-15.15
11/14	20.00	1626.00	-10.83	11/17	16.30	5481.00	-16.25	11/20	15.16	9854.00	-15.27
11/14	20.00	1627.00	-11.22	11/17	16.30	5485.00	-16.27	11/20	15.17	9860.00	-15.31
11/14	20.00	1628.00	-11.50	11/17	16.22	5491.75	-16.20	11/20	15.30	9865.00	-15.31
11/14	20.00	1629.00	-11.60	11/17	16.36	5511.00	-16.78	11/20	15.30	9869.00	-15.34
11/14	20.00	1630.00	-11.82	11/17	16.36	5513.00	-16.90	11/20	0.00	9870.00	-13.25

TABLE 1. WELL P-7 TIME AND DRAWDOWN DATA

Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)
11/14	21.00	1631.00	-12.00	11/17	16.36	5517.00	-17.05	11/20	0.00	9870.33	-10.95
11/14	21.00	1633.50	-12.07	11/17	16.25	5562.00	-16.16	11/20	0.00	9870.50	-9.52
11/14	20.00	1635.00	-12.17	11/17	16.49	5575.00	-17.33	11/20	0.00	9870.75	-8.09
11/14	20.00	1636.00	-12.00	11/17	16.53	5583.00	-18.92	11/20	0.00	9871.00	-6.50
11/14	20.00	1638.00	-12.24	11/17	16.10	5584.00	-19.36	11/20	0.00	9871.25	-5.22
11/14	20.00	1640.00	-12.30	11/17	16.08	5594.00	-18.43	11/20	0.00	9871.50	-4.60
11/14	20.00	1642.00	-12.51	11/17	16.08	5602.00	-18.15	11/20	0.00	9872.00	-3.61
11/14	20.00	1644.00	-12.87	11/17	16.20	5604.00	-17.15	11/20	0.00	9872.50	-3.07
11/14	20.00	1646.00	-13.11	11/17	16.11	5625.00	-16.03	11/20	0.00	9873.00	-2.81
11/14	20.00	1648.00	-13.30	11/17	16.14	5640.00	-15.22	11/20	0.00	9873.50	-2.63
11/14	20.00	1650.00	-13.55	11/17	16.27	5670.00	-15.56	11/20	0.00	9874.00	-2.45
11/14	20.00	1652.00	-13.62	11/17	16.11	5700.00	-14.22	11/20	0.00	9874.50	-2.34
11/14	20.00	1654.00	-13.80	11/17	16.26	5734.00	-14.59	11/20	0.00	9875.00	-2.26
11/14	20.00	1656.00	-13.93	11/17	16.19	5760.00	-15.77	11/20	0.00	9875.50	-2.18
11/14	20.00	1658.00	-15.01	11/17	16.18	5790.00	-16.73	11/20	0.00	9876.00	-2.12
11/14	20.00	1659.00	-15.10	11/17	16.11	5820.00	-17.46	11/20	0.00	9876.50	-2.05
11/14	20.00	1660.00	-13.53	11/17	16.11	5852.00	-17.18	11/20	0.00	9877.00	-2.05
11/14	12.50	1661.00	-12.37	11/17	16.24	5880.00	-16.73	11/20	0.00	9877.50	-2.03
11/14	12.50	1662.00	-12.05	11/17	16.23	5909.00	-16.86	11/20	0.00	9878.00	-1.97
11/14	17.70	1663.50	-11.50	11/17	16.15	5940.00	-16.57	11/20	0.00	9878.50	-1.96
11/14	17.50	1665.00	-10.88	11/17	16.05	5971.00	-15.64	11/20	0.00	9879.00	-1.92
11/14	17.50	1667.00	-10.20	11/17	16.15	6004.00	-14.85	11/20	0.00	9879.50	-1.90
11/14	17.50	1670.00	-9.82	11/17	16.10	6031.00	-14.24	11/20	0.00	9880.00	-1.87
11/14	17.50	1674.00	-9.67	11/17	16.20	6061.00	-14.57	11/20	0.00	9881.00	-1.80
11/14	17.50	1678.00	-9.84	11/17	16.17	6090.00	-14.57	11/20	0.00	9882.00	-1.83
11/14	17.50	1680.00	-9.84	11/17	16.14	6120.00	-14.88	11/20	0.00	9883.00	-1.76
11/14	17.50	1685.00	-9.75	11/17	16.16	6151.00	-14.98	11/20	0.00	9884.00	-1.72
11/14	17.40	1690.00	-9.75	11/17	16.16	6180.00	-15.32	11/20	0.00	9885.00	-1.70
11/14	17.50	1695.00	-9.75	11/17	16.23	6212.00	-15.28	11/20	0.00	9886.00	-1.72
11/14	17.50	1701.00	-9.95	11/18	16.09	6241.00	-15.64	11/20	0.00	9887.00	-1.65
11/14	17.50	1705.00	-10.01	11/18	16.20	6270.00	-15.72	11/20	0.00	9888.00	-1.65
11/14	17.50	1710.00	-10.10	11/18	16.30	6300.00	-15.14	11/20	0.00	9889.00	-1.63
11/14	17.50	1725.00	-10.00	11/18	16.40	6330.00	-15.22	11/20	0.00	9890.00	-1.61
11/14	17.50	1740.00	-10.01	11/18	16.20	6360.00	-15.17	11/20	0.00	9891.00	-1.59
11/14	17.14	1770.00	-10.52	11/18	16.20	6390.00	-15.72	11/20	0.00	9892.00	-1.57
11/14	17.14	1803.00	-10.53	11/18	16.20	6420.00	-16.70	11/20	0.00	9895.00	-1.55
11/14	17.14	1830.00	-10.43	11/18	16.10	6450.00	-17.53	11/20	0.00	9896.00	-1.53
11/14	17.14	1860.00	-10.80	11/18	15.80	6455.00	-16.95	11/20	0.00	9898.00	-1.50

TABLE 1. WELL P-7 TIME AND DRAWDOWN DATA

Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)
11/14	17.14	1890.00	-10.81	11/18	15.80	6480.00	-12.95	11/20	0.00	9900.00	-1.48
11/15	17.20	1920.00	-10.88	11/18	16.10	6485.00	-12.15	11/20	0.00	9902.00	-1.46
11/15	17.20	1960.00	-10.75	11/18	16.10	6510.00	-13.05	11/20	0.00	9904.00	-1.44
11/15	17.20	1980.00	-10.80	11/18	16.10	6540.00	-13.52	11/20	0.00	9906.00	-1.42
11/15	17.00	2010.00	-10.73	11/18	16.10	6570.00	-13.34	11/20	0.00	9908.00	-1.40
11/15	17.50	2040.00	-11.10	11/18	16.10	6600.00	-13.72	11/20	0.00	9910.00	-1.38
11/15	17.20	2070.00	-11.18	11/18	16.00	6630.00	-14.60	11/20	0.00	9915.00	-1.35
11/15	17.20	2100.00	-11.15	11/18	15.95	6653.00	-14.75	11/20	0.00	9920.00	-1.30
11/15	17.30	2130.00	-11.18	11/18	15.81	6672.50	-14.55	11/20	0.00	9925.00	-1.27
11/15	17.30	2160.00	-11.25	11/18	16.22	6679.75	-16.42	11/20	0.00	9933.00	-1.21
11/15	18.00	2205.00	-12.69	11/18	16.22	6682.00	-16.85	11/20	0.00	9935.00	-1.17
11/15	18.00	2220.00	-12.80	11/18	16.06	6684.50	-17.30	11/20	0.00	9940.00	-1.11
11/15	18.40	2250.00	-13.02	11/18	16.06	6686.50	-17.64	11/20	0.00	9950.00	-1.11
11/15	18.20	2280.00	-13.32	11/18	16.09	6687.00	-17.70	11/20	0.00	9960.00	-1.07
11/15	18.20	2310.00	-13.38	11/18	15.99	6688.25	-17.85	11/20	0.00	9970.00	-1.03
11/15	18.00	2340.00	-13.72	11/18	15.99	6690.00	-18.09	11/20	0.00	9980.00	-0.99
11/15	18.00	2382.00	-13.78	11/18	15.98	6693.00	-18.35	11/20	0.00	9990.00	-0.99
11/15	18.00	2403.00	-13.90	11/18	15.98	6696.00	-18.63	11/20	0.00	10005.00	-0.90
11/15	18.00	2431.00	-14.27	11/18	15.98	6697.00	-18.75	11/20	0.00	10020.00	-0.85
11/15	18.00	2460.00	-14.31	11/18	15.98	6699.00	-18.85	11/20	0.00	10079.00	-0.78
11/15	17.90	2492.00	-13.80	11/18	15.90	6701.50	-19.00	11/20	0.00	10136.00	-0.74
11/15	18.00	2518.00	-14.80	11/18	15.90	6703.00	-19.05	11/20	0.00	10170.00	-0.65
11/15	18.00	2528.00	-15.36	11/18	15.81	6705.00	-19.10	11/20	0.00	10200.00	-0.60
11/15	17.90	2552.00	-15.65	11/18	15.81	6706.00	-19.12	11/20	0.00	10320.00	-0.47
11/15	18.00	2568.00	-17.45	11/18	15.81	6707.00	-19.13	11/20	0.00	10380.00	-0.44
11/15	18.00	2569.00	-17.59	11/18	15.81	6708.00	-19.14	11/20	0.00	10440.00	-0.41
11/15	16.60	2570.50	-17.05	11/18	15.84	6709.00	-19.14	11/20	0.00	10500.00	-0.38
11/15	16.60	2571.00	-16.45	11/18	15.83	6710.50	-19.13	11/20	0.00	10560.00	-0.36
11/15	16.50	2572.00	-15.75	11/18	15.83	6711.50	-19.11	11/21	0.00	10620.00	-0.32
11/15	16.50	2574.00	-14.05	11/18	15.83	6713.00	-19.11	11/21	0.00	10680.00	-0.27
11/15	16.50	2575.00	-13.05	11/18	15.83	6714.50	-19.08	11/21	0.00	10740.00	-0.32
11/15	17.00	2577.50	-12.25	11/18	15.87	6729.00	-18.99	11/21	0.00	10800.00	-0.38
11/15	17.00	2579.00	-12.13	11/18	15.87	6732.00	-19.01	11/21	0.00	10860.00	-0.32
11/15	17.00	2580.50	-12.05	11/18	15.85	6733.50	-	11/21	0.00	10920.00	-0.29
11/15	17.00	2583.00	-11.98	11/18	15.85	6734.00	-19.08	11/21	0.00	10980.00	-0.29
11/15	17.00	2586.00	-11.89	11/18	15.78	6736.00	-19.07	11/21	0.00	11040.00	-0.28
11/15	17.00	2591.00	-11.85	11/18	15.80	6738.00	-19.06	11/21	0.00	11100.00	-0.22
11/15	17.20	2593.75	-11.91	11/18	15.80	6739.00	-19.06	11/21	0.00	11160.00	-0.29

TABLE 1. WELL P-7 TIME AND DRAWDOWN DATA

Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)	Date	Flow (gpm)	Elapsed Time (Min)	Drawdown (Ft)
11/15	17.30	2595.50	-11.99	11/18	15.79	6742.00	-19.01	11/21	0.00	11220.00	-0.27
11/15	17.40	2599.50	-12.06	11/18	15.77	6752.00	-18.79	11/21	0.00	11280.00	-0.25
11/15	17.40	2601.50	-12.14	11/18	15.77	6756.25	-18.68	11/21	0.00	11760.00	-0.22
11/15	17.30	2610.00	-12.09	11/18	15.77	6776.00	-18.69	11/22	0.00	12240.00	-0.22
11/15	17.50	2615.00	-12.45	11/18	15.82	6780.00	-18.66	11/22	0.00	12720.00	-0.19
11/15	17.50	2640.00	-12.57	11/18	15.82	6803.00	-18.59	11/23	0.00	14160.00	-0.18
11/15	17.50	2670.00	-13.54	11/18	15.80	6811.00	-18.68	11/24	0.00	15600.00	-0.20
11/15	17.50	2700.00	-11.96	11/18	15.80	6814.00	-18.81	11/25	0.00	17040.00	-0.21
11/15	17.50	2706.00	-6.55	11/18	15.79	6822.00	-18.99	11/26	0.00	18240.00	-0.22
11/15	17.50	2707.00	-7.55	11/18	15.79	6830.00	-19.20	11/27	0.00	19680.00	-0.29
11/15	17.50	2709.00	-8.85	11/18	15.73	6835.50	-19.31				
11/15	17.50	2723.00	-10.95	11/18	15.77	6838.25	-19.31				

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/13	16:45	45	0.03		40.50			47.50		0.00			0.00
11/13	16:50	50	0.03			21.30					0.00		
11/13	16:53	53	0.04				7.80					0.00	
11/13	17:02	62	0.04	22.20					0.00				
11/13	18:56	176	0.12	22.20					0.00				
11/13	19:04	184	0.13			21.20					0.10		
11/13	19:07	187	0.13				7.90					-0.10	
11/13	19:13	193	0.13		40.50			47.60		0.00			-0.10
11/13	21:43	343	0.24		40.50			47.60		0.00			-0.10
11/13	21:48	348	0.24				7.80					0.00	
11/13	21:52	352	0.24			21.10					0.20		
11/13	22:02	362	0.25	22.10					0.10				
11/14	00:29	509	0.35	22.30					-0.10				
11/14	00:35	515	0.36			21.20					0.10		
11/14	00:40	520	0.36				7.90					-0.10	
11/14	00:45	525	0.36		40.50			47.60		0.00			-0.10
11/14	02:15	615	0.43		40.50			47.60		0.00			-0.10
11/14	02:20	620	0.43				7.80					0.00	
11/14	02:25	625	0.43			21.20					0.10		
11/14	02:29	629	0.44	22.20					0.00				
11/14	04:10	730	0.51		40.50			47.60		0.00			-0.10
11/14	04:17	737	0.51				7.90					-0.10	
11/14	04:20	740	0.51			21.20					0.10		
11/14	04:25	745	0.52	22.10					0.10				
11/14	06:11	851	0.59		40.50			47.60		0.00			-0.10
11/14	06:18	858	0.60	22.20					0.00				
11/14	06:22	862	0.60			21.20					0.10		
11/14	06:25	865	0.60				7.80					0.00	
11/14	08:11	971	0.67		40.50			47.60		0.00			-0.10
11/14	08:30	990	0.69				7.80					0.00	
11/14	08:45	1005	0.70	22.20					0.00				
11/14	10:03	1083	0.75		40.45			47.68		0.05			-0.18
11/14	10:07	1087	0.75	22.15					0.05				
11/14	10:10	1090	0.76				7.80					0.00	
11/14	10:23	1103	0.77				7.80					0.00	
11/14	11:18	1158	0.80		40.45			47.65		0.05			-0.15
11/14	11:27	1167	0.81				7.80					0.00	
11/14	11:51	1191	0.83	22.20					0.00				

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/14	14:03	1323	0.92		40.45			46.15		0.05			1.35
11/14	14:09	1329	0.92	22.15					0.05				
11/14	14:29	1349	0.94				7.80					0.00	
11/14	15:37	1417	0.98		40.45			47.70		0.05			-0.20
11/14	15:41	1421	0.99				7.80					0.00	
11/14	15:45	1425	0.99	22.16					0.04				
11/14	19:15	1635	1.14		40.45			47.65		0.05			-0.15
11/14	19:23	1643	1.14	22.18					0.02				
11/14	20:12	1692	1.18				7.85					-0.05	
11/14	21:15	1755	1.22		40.50			47.70		0.00			-0.20
11/14	22:15	1815	1.26				7.85					-0.05	
11/14	22:19	1819	1.26	22.15					0.05				
11/14	22:24	1824	1.27		40.48			47.72		0.02			-0.22
11/14	23:08	1868	1.30		40.50			47.72		0.00			-0.22
11/15	00:30	1950	1.35		40.50			47.85		0.00			-0.35
11/15	00:33	1953	1.36	22.20					0.00				
11/15	00:35	1955	1.36				7.85					-0.05	
11/15	01:03	1983	1.38		40.50			47.83		0.00			-0.33
11/15	02:06	2046	1.42		40.50			47.81		0.00			-0.31
11/15	02:12	2052	1.43				7.85					-0.05	
11/15	02:14	2054	1.43	22.18					0.02				
11/15	03:05	2105	1.46		40.50			47.81		0.00			-0.31
11/15	04:15	2175	1.51		40.50			47.85		0.00			-0.35
11/15	04:23	2183	1.52	22.20					0.00				
11/15	04:30	2190	1.52				7.80					0.00	
11/15	05:10	2230	1.55		40.45			47.85		0.05			-0.35
11/15	06:09	2289	1.59		40.45			47.85		0.05			-0.35
11/15	06:13	2293	1.59				7.83					-0.03	
11/15	06:17	2297	1.60	22.20					0.00				
11/15	07:15	2355	1.64		40.45			47.85		0.05			-0.35
11/15	07:20	2360	1.64	22.20					0.00				
11/15	07:25	2365	1.64				7.85					-0.05	
11/15	09:10	2470	1.72		40.45			47.90		0.05			-0.40
11/15	09:15	2475	1.72				7.85					-0.05	
11/15	09:23	2483	1.72	22.20					0.00				
11/15	10:12	2532	1.76		40.45			47.93		0.05			-0.43
11/15	10:21	2541	1.76	22.18					0.02				
11/15	10:26	2546	1.77				7.80					0.00	

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/15	11:40	2620	1.82		40.45			47.94		0.05			-0.44
11/15	11:49	2629	1.83				7.83					-0.03	
11/15	11:54	2634	1.83	22.14					0.06				
11/15	12:36	2676	1.86		40.45			47.98		0.05			-0.48
11/15	12:50	2690	1.87	22.18					0.02				
11/15	12:55	2695	1.87				7.83					-0.03	
11/15	14:06	2766	1.92		40.45			48.05		0.05			-0.55
11/15	14:15	2775	1.93	22.15			7.85		0.05			-0.05	
11/15	15:06	2826	1.96		40.45			48.05		0.05			-0.55
11/15	15:11	2831	1.97	22.15					0.05				
11/15	15:15	2835	1.97				7.80					0.00	
11/15	15:45	2865	1.99				7.80					0.00	
11/15	15:55	2875	2.00	22.15					0.05				
11/15	16:05	2885	2.00		40.42			48.08		0.08			-0.58
11/15	18:04	3004	2.09		40.50			48.05		0.00			-0.55
11/15	18:15	3015	2.09	22.15					0.05				
11/15	18:21	3021	2.10				7.85					-0.05	
11/15	20:06	3126	2.17	22.15					0.05				
11/15	20:12	3132	2.18				7.85					-0.05	
11/15	20:18	3138	2.18		40.48			48.10		0.02			-0.60
11/15	21:36	3216	2.23		40.50			48.12		0.00			-0.62
11/15	22:12	3252	2.26				7.85					-0.05	
11/15	22:16	3256	2.26	22.15					0.05				
11/15	22:35	3275	2.27		40.50			48.15		0.00			-0.65
11/16	00:26	3386	2.35		40.50			48.17		0.00			-0.67
11/16	00:31	3391	2.35	22.15					0.05				
11/16	00:35	3395	2.36				7.90					-0.10	
11/16	01:04	3424	2.38		40.48			48.20		0.02			-0.70
11/16	02:07	3487	2.42		40.49			48.22		0.01			-0.72
11/16	02:11	3491	2.42				7.95					-0.15	
11/16	02:15	3495	2.43	22.20					0.00				
11/16	03:08	3548	2.46		40.49			48.24		0.01			-0.74
11/16	03:12	3552	2.47	22.22					-0.02				
11/16	03:15	3555	2.47				7.94					-0.14	
11/16	04:06	3606	2.50		40.49			48.25		0.01			-0.75
11/16	04:14	3614	2.51				7.95					-0.15	
11/16	04:17	3617	2.51	22.24					-0.04				
11/16	05:06	3666	2.55		40.45			48.30		0.05			-0.80

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/16	05:09	3669	2.55	22.23					-0.03				
11/16	05:12	3672	2.55				7.92					-0.12	
11/16	06:16	3736	2.59		40.47			48.30		0.03			-0.80
11/16	06:18	3738	2.60				7.93					-0.13	
11/16	06:24	3744	2.60	22.20					0.00				
11/16	07:08	3788	2.63		40.48			48.30		0.02			-0.80
11/16	07:13	3793	2.63	22.20					0.00				
11/16	07:22	3802	2.64				7.91					-0.11	
11/16	08:40	3880	2.69		40.47			48.31		0.03			-0.81
11/16	09:01	3901	2.71				7.91					-0.11	
11/16	09:05	3905	2.71	22.20					0.00				
11/16	10:08	3968	2.76		40.45			48.33		0.05			-0.83
11/16	10:12	3972	2.76	22.20					0.00				
11/16	10:15	3975	2.76				7.89					-0.09	
11/16	11:05	4025	2.80		40.47			48.34		0.03			-0.84
11/16	11:12	4032	2.80				7.90					-0.10	
11/16	11:16	4036	2.80	22.20			7.90		0.00			-0.10	
11/16	12:05	4085	2.84		40.45			48.40		0.05			-0.90
11/16	12:13	4093	2.84	22.15					0.05				
11/16	12:58	4138	2.87		40.50			48.39		0.00			-0.89
11/16	13:00	4140	2.88				7.90					-0.10	
11/16	13:05	4145	2.88	22.16					0.04				
11/16	14:04	4204	2.92		40.47			48.37		0.03			-0.87
11/16	14:07	4207	2.92	22.18					0.02				
11/16	14:07	4207	2.92	22.18					0.02				
11/16	14:13	4213	2.93				7.90					-0.10	
11/16	14:59	4259	2.96				7.92					-0.12	
11/16	15:02	4262	2.96	22.20					0.00				
11/16	15:06	4266	2.96		40.49			48.41		0.01			-0.91
11/16	16:03	4323	3.00		40.46			48.43		0.04			-0.93
11/16	16:07	4327	3.00	22.20					0.00				
11/16	16:12	4332	3.01				7.90					-0.10	
11/16	18:16	4456	3.09		40.49			48.45		0.01			-0.95
11/16	18:23	4463	3.10				7.95					-0.15	
11/16	18:27	4467	3.10	22.18					0.02				
11/16	19:04	4504	3.13		40.50			48.43		0.00			-0.93
11/16	19:12	4512	3.13	22.19					0.01				
11/16	19:21	4521	3.14				7.94					-0.14	

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/16	20:08	4568	3.17				7.94					-0.14	
11/16	20:13	4573	3.18	22.20					0.00				
11/16	20:16	4576	3.18		40.48			48.42		0.02			-0.92
11/16	21:07	4627	3.21	22.20					0.00				
11/16	21:11	4631	3.22				7.91					-0.11	
11/16	21:18	4638	3.22		40.49			48.48		0.01			-0.98
11/16	22:10	4690	3.26				7.91					-0.11	
11/16	22:16	4696	3.26	22.20					0.00				
11/16	22:20	4700	3.26		40.50			48.45		0.00			-0.95
11/16	23:07	4747	3.30	22.20					0.00				
11/16	23:27	4767	3.31		40.51			48.50		-0.01			-1.00
11/16	23:13	4753	3.30				7.94					-0.14	
11/17	00:20	4820	3.35		40.49			48.50		0.01			-1.00
11/17	00:21	4821	3.35	22.23					-0.03				
11/17	00:26	4826	3.35				7.97					-0.17	
11/17	01:04	4864	3.38				7.96					-0.16	
11/17	01:08	4868	3.38	22.23					-0.03				
11/17	01:12	4872	3.38		40.49			48.52		0.01			-1.02
11/17	02:07	4927	3.42	22.24					-0.04				
11/17	02:10	4930	3.42				7.97					-0.17	
11/17	02:16	4936	3.43		40.49			48.50		0.01			-1.00
11/17	03:09	4989	3.46				7.96					-0.16	
11/17	03:12	4992	3.47	22.23					-0.03				
11/17	03:17	4997	3.47		40.50			48.55		0.00			-1.05
11/17	04:11	5051	3.51	22.23					-0.03				
11/17	04:13	5053	3.51				7.97					-0.17	
11/17	04:25	5065	3.52		40.49			48.53		0.01			-1.03
11/17	05:08	5108	3.55				8.00					-0.20	
11/17	05:11	5111	3.55	22.23					-0.03				
11/17	05:16	5116	3.55		40.49			48.55		0.01			-1.05
11/17	06:11	5171	3.59	22.25					-0.05				
11/17	06:14	5174	3.59				8.00					-0.20	
11/17	06:18	5178	3.60		40.49			48.55		0.01			-1.05
11/17	07:10	5230	3.63		40.49			48.60		0.01			-1.10
11/17	07:15	5235	3.64				7.95					-0.15	
11/17	07:20	5240	3.64	22.18					0.02				
11/17	08:07	5287	3.67		40.49			48.60		0.01			-1.10
11/17	08:25	5305	3.68	22.19					0.01				

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/17	08:30	5310	3.69				7.94					-0.14	
11/17	09:06	5346	3.71		40.49			48.56		0.01			-1.06
11/17	09:17	5357	3.72				7.95					-0.15	
11/17	09:23	5363	3.72	22.20					0.00				
11/17	10:14	5414	3.76		40.52			48.59		-0.02			-1.09
11/17	10:20	5420	3.76	22.21					-0.01				
11/17	10:24	5424	3.77				7.96					-0.16	
11/17	10:30	5430	3.77			20.08					1.22		
11/17	12:05	5525	3.84		40.49			48.59		0.01			-1.09
11/17	12:16	5536	3.84			21.19					0.11		
11/17	12:22	5542	3.85				7.97					-0.17	
11/17	12:34	5554	3.86	22.19					0.01				
11/17	13:30	5610	3.90		40.48			48.58		0.02			-1.08
11/17	13:36	5616	3.90										
11/17	13:36	5616	3.90	22.17			7.93		0.03			-0.13	
11/17	15:00	5700	3.96		40.49			48.61		0.01			-1.11
11/17	15:04	5704	3.96				7.95					-0.15	
11/17	15:08	5708	3.96	22.18		21.10			0.02		0.20		
11/17	15:30	5730	3.98										
11/17	16:08	5768	4.01	22.17			7.97		0.03			-0.17	
11/17	16:15	5775	4.01		40.51			48.63		-0.01			-1.13
11/17	17:09	5829	4.05	22.21			7.97		-0.01			-0.17	
11/17	17:22	5842	4.06		40.50			48.62		0.00			-1.12
11/17	18:05	5885	4.09	22.21			7.98		-0.01			-0.18	
11/17	18:13	5893	4.09		40.51			48.61		-0.01			-1.11
11/17	19:10	5950	4.13	22.19			7.97		0.01			-0.17	
11/17	19:26	5966	4.14		40.49			48.65		0.01			-1.15
11/17	20:09	6009	4.17	22.19			7.96		0.01			-0.16	
11/17	20:18	6018	4.18		40.50			48.63		0.00			-1.13
11/17	21:09	6069	4.21	22.19			7.95		0.01			-0.15	
11/17	21:16	6076	4.22		40.50			48.69		0.00			-1.19
11/17	22:07	6127	4.25	22.20			7.98		0.00			-0.18	
11/17	22:16	6136	4.26		40.50			48.67		0.00			-1.17
11/17	23:12	6192	4.30	22.20			7.96		0.00			-0.16	
11/17	23:28	6208	4.31		40.51			48.68		-0.01			-1.18
11/17	23:53	6233	4.33		40.50			48.66		0.00			-1.16
11/17	23:49	6229	4.33	22.20			8.00		0.00			-0.20	
11/18	01:06	6306	4.38	22.19			8.00		0.01			-0.20	

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/18	01:15	6315	4.39		40.50			48.65		0.00			-1.15
11/18	02:05	6365	4.42	22.20			8.00		0.00			-0.20	
11/18	02:11	6371	4.42		40.50			48.66		0.00			-1.16
11/18	03:11	6431	4.47	22.20			7.98		0.00			-0.18	
11/18	03:26	6446	4.48		40.50			48.60		0.00			-1.10
11/18	04:05	6485	4.50	22.20			7.97		0.00			-0.17	
11/18	04:12	6492	4.51		40.50			48.63		0.00			-1.13
11/18	05:10	6550	4.55	22.20			7.98		0.00			-0.18	
11/18	05:20	6560	4.56		40.50			48.62		0.00			-1.12
11/18	06:11	6611	4.59	22.20			7.97		0.00			-0.17	
11/18	06:27	6627	4.60		40.50			48.67		0.00			-1.17
11/18	08:26	6746	4.68		40.48			48.71		0.02			-1.21
11/18	08:42	6762	4.70	22.16			7.96		0.04			-0.16	
11/18	10:52	6892	4.79		40.49			48.72		0.01			-1.22
11/18	11:10	6910	4.80	22.17		21.04	7.98		0.03		0.26	-0.18	
11/18	12:49	7009	4.87		40.49			48.73		0.01			-1.23
11/18	13:05	7025	4.88	22.18			7.98		0.02			-0.18	
11/18	14:05	7085	4.92	22.16	40.49		8.00	48.77	0.04	0.01		-0.20	-1.27
11/18	15:03	7143	4.96		40.51			48.77		-0.01			-1.27
11/18	15:10	7150	4.97	22.16			7.98		0.04			-0.18	
11/18	16:08	7208	5.01		40.49			48.77		0.01			-1.27
11/18	17:11	7271	5.05	22.18			7.98		0.02			-0.18	
11/18	17:16	7276	5.05		40.50			48.75		0.00			-1.25
11/18	18:07	7327	5.09	22.28			7.96		-0.08			-0.16	
11/18	18:16	7336	5.09		40.50			48.79		0.00			-1.29
11/18	19:09	7389	5.13	22.18			7.98		0.02			-0.18	
11/18	19:24	7404	5.14		40.50			48.79		0.00			-1.29
11/18	20:06	7446	5.17	22.20			7.98		0.00			-0.18	
11/18	20:14	7454	5.18		40.51			48.79		-0.01			-1.29
11/18	21:08	7508	5.21	22.19			8.00		0.01			-0.20	
11/18	21:18	7518	5.22		40.52			48.79		-0.02			-1.29
11/18	22:06	7566	5.25	22.20			7.98		0.00			-0.18	
11/18	22:16	7576	5.26		40.51			48.79		-0.01			-1.29
11/18	23:24	7644	5.31		40.51			48.80		-0.01			-1.30
11/18	23:09	7629	5.30	22.18			7.98		0.02			-0.18	
11/19	00:33	7713	5.36		40.52			48.81		-0.02			-1.31
11/19	00:37	7717	5.36	22.17			7.99		0.03			-0.19	
11/19	02:30	7830	5.44	22.18			8.00		0.02			-0.20	

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/19	02:35	7835	5.44		40.52			48.82		-0.02			-1.32
11/19	03:36	7896	5.48	22.18			8.01		0.02			-0.21	
11/19	04:00	7920	5.50		40.53			48.80		-0.03			-1.30
11/19	05:00	7980	5.54		40.52			48.85		-0.02			-1.35
11/19	05:05	7985	5.55	22.18			8.01		0.02			-0.21	
11/19	06:31	8071	5.60		40.52			48.88		-0.02			-1.38
11/19	06:35	8075	5.61	22.18			8.01		0.02			-0.21	
11/19	08:07	8167	5.67		40.52			48.82		-0.02			-1.32
11/19	08:15	8175	5.68	22.18			8.00		0.02			-0.20	
11/19	09:06	8226	5.71		40.52			48.84		-0.02			-1.34
11/19	09:12	8232	5.72	22.18			7.99		0.02			-0.19	
11/19	10:04	8284	5.75		40.51			48.84		-0.01			-1.34
11/19	10:10	8290	5.76	22.17			8.00		0.03			-0.20	
11/19	11:05	8345	5.80		40.50			48.84		0.00			-1.34
11/19	11:20	8360	5.81	22.17			8.00		0.03			-0.20	
11/19	12:11	8411	5.84		40.51			48.84		-0.01			-1.34
11/19	12:22	8422	5.85	22.18			8.00		0.02			-0.20	
11/19	13:10	8470	5.88		40.50			48.85		0.00			-1.35
11/19	13:12	8472	5.88	22.18			8.00		0.02			-0.20	
11/19	14:05	8525	5.92		40.51			48.83		-0.01			-1.33
11/19	14:12	8532	5.93	22.18			8.00		0.02			-0.20	
11/19	15:05	8585	5.96		40.50			48.84		0.00			-1.34
11/19	15:17	8597	5.97	22.20			8.00		0.00			-0.20	
11/19	16:05	8645	6.00		40.52			48.83		-0.02			-1.33
11/19	16:15	8655	6.01	22.17			8.01		0.03			-0.21	
11/19	17:08	8708	6.05	22.20			8.00		0.00			-0.20	
11/19	17:15	8715	6.05		40.52			48.87		-0.02			-1.37
11/19	18:06	8766	6.09	22.20			7.99		0.00			-0.19	
11/19	18:13	8773	6.09		40.53			48.87		-0.03			-1.37
11/19	19:08	8828	6.13	22.20			7.99		0.00			-0.19	
11/19	19:29	8849	6.15		40.53			48.88		-0.03			-1.38
11/19	20:09	8889	6.17	22.19			8.00		0.01			-0.20	
11/19	20:16	8896	6.18		40.52			48.88		-0.02			-1.38
11/19	21:12	8952	6.22	22.20			7.98		0.00			-0.18	
11/19	21:17	8957	6.22		40.53			48.88		-0.03			-1.38
11/19	22:10	9010	6.26	22.22			7.98		-0.02			-0.18	
11/19	22:14	9014	6.26		40.54			48.87		-0.04			-1.37
11/19	23:10	9070	6.30	22.21			7.98		-0.01			-0.18	

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/19	23:22	9082	6.31		40.53			48.89		-0.03			-1.39
11/20	00:32	9152	6.36		40.54			48.89		-0.04			-1.39
11/20	00:37	9157	6.36	22.18			8.01		0.02			-0.21	
11/20	02:03	9243	6.42		40.53			48.88		-0.03			-1.38
11/20	02:05	9245	6.42	22.17			8.01		0.03			-0.21	
11/20	03:01	9301	6.46		40.53			48.88		-0.03			-1.38
11/20	03:07	9307	6.46	22.18			8.00		0.02			-0.20	
11/20	04:04	9364	6.50	22.18			8.00		0.02			-0.20	
11/20	04:17	9377	6.51		40.52			48.88		-0.02			-1.38
11/20	05:01	9421	6.54		40.53			48.88		-0.03			-1.38
11/20	05:12	9432	6.55	22.18			8.01		0.02			-0.21	
11/20	06:07	9487	6.59		40.52			48.87		-0.02			-1.37
11/20	06:12	9492	6.59	22.18			8.02		0.02			-0.22	
11/20	07:42	9582	6.65		40.52			48.88		-0.02			-1.38
11/20	08:20	9620	6.68		40.52			48.88		-0.02			-1.38
11/20	08:25	9625	6.68	22.18					0.02				
11/20	09:16	9676	6.72		40.52			48.88		-0.02			-1.38
11/20	10:07	9727	6.75		40.52			48.88		-0.02			-1.38
11/20	10:17	9737	6.76	22.20					0.00				
11/20	11:11	9791	6.80		40.52			48.89		-0.02			-1.38
11/20	11:28	9808	6.81	22.19			8.02		0.01			-0.22	
11/20	12:30	9870	6.85				8.04					-0.24	
11/20	12:30	9870	6.85		40.45			48.79		0.05			-1.29
11/20	12:31	9871	6.85				8.03	48.79				-0.23	-1.29
11/20	12:32	9872	6.86				8.03	48.79				-0.23	-1.29
11/20	12:33	9873	6.86	22.14			8.03	48.79	0.06			-0.23	-1.29
11/20	12:34	9874	6.86	22.16			8.03	48.79	0.04			-0.23	-1.29
11/20	12:35	9875	6.86	22.15			8.03	48.79	0.05			-0.23	-1.29
11/20	12:36	9876	6.86	22.14			8.04	48.79	0.06			-0.24	-1.29
11/20	12:37	9877	6.86	22.15			8.04	48.79	0.05			-0.24	-1.29
11/20	12:38	9878	6.86	22.14			8.05	48.79	0.06			-0.25	-1.29
11/20	12:39	9879	6.86	22.15			8.05	48.79	0.05			-0.25	-1.29
11/20	12:40	9880	6.86	22.15	40.45		8.05	48.79	0.05	0.05		-0.25	-1.29
11/20	12:41	9881	6.86	22.16				48.79	0.04				-1.29
11/20	12:42	9882	6.86	22.13				48.79	0.07				-1.29
11/20	12:45	9885	6.86				8.05	48.78				-0.25	-1.28
11/20	12:47	9887	6.87	22.15				48.78	0.05				-1.28
11/20	12:50	9890	6.87		40.45		8.05	48.78		0.05		-0.25	-1.28

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/20	12:52	9892	6.87	22.14				48.78	0.06				-1.28
11/20	12:55	9895	6.87				8.05	48.78				-0.25	-1.28
11/20	12:56	9896	6.87		40.45			48.78		0.05			-1.28
11/20	12:57	9897	6.87	22.14				48.78	0.06				-1.28
11/20	13:00	9900	6.88		40.45		8.04	48.79		0.05		-0.24	-1.29
11/20	13:02	9902	6.88	22.16					0.04				
11/20	13:05	9905	6.88				8.05	48.79				-0.25	-1.29
11/20	13:07	9907	6.88	22.15					0.05				
11/20	13:10	9910	6.88		40.45		8.05	48.79		0.05		-0.25	-1.29
11/20	13:12	9912	6.88	22.16					0.04				
11/20	13:15	9915	6.89				8.05	48.79				-0.25	-1.29
11/20	13:17	9917	6.89	22.15					0.05				
11/20	13:20	9920	6.89		40.45		8.05	48.79		0.05		-0.25	-1.29
11/20	13:22	9922	6.89	22.15					0.05				
11/20	13:25	9925	6.89				8.05	48.79				-0.25	-1.29
11/20	13:27	9927	6.89	22.15					0.05				
11/20	13:30	9930	6.90		40.45		8.04	48.78		0.05		-0.24	-1.28
11/20	13:32	9932	6.90	22.15					0.05				
11/20	13:35	9935	6.90				8.04					-0.24	
11/20	13:37	9937	6.90	22.15					0.05				
11/20	13:40	9940	6.90				8.04					-0.24	
11/20	13:45	9945	6.91		40.45		8.04	48.78		0.05		-0.24	-1.28
11/20	13:52	9952	6.91	22.15					0.05				
11/20	14:00	9960	6.92		40.43		8.04	48.78		0.07		-0.24	-1.28
11/20	14:07	9967	6.92	22.15					0.05				
11/20	14:15	9975	6.93		40.43		8.04	48.78		0.07		-0.24	-1.28
11/20	14:22	9982	6.93	22.15					0.05				
11/20	14:30	9990	6.94		40.43		8.04	48.78		0.07		-0.24	-1.28
11/20	14:37	9997	6.94	22.15					0.05				
11/20	14:45	10005	6.95		40.43		8.04	48.79		0.07		-0.24	-1.29
11/20	14:52	10012	6.95	22.15					0.05				
11/20	15:00	10020	6.96				8.04					-0.24	
11/20	15:07	10027	6.96	22.15					0.05				
11/20	15:15	10035	6.97		40.43		8.04	48.79		0.07		-0.24	-1.29
11/20	15:22	10042	6.97	22.16					0.04				
11/20	15:30	10050	6.98				8.04					-0.24	
11/20	15:45	10065	6.99				8.04					-0.24	
11/20	16:00	10080	7.00				8.04					-0.24	

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/20	20:00	10320	7.17	22.18	40.45		8.03	48.66	0.02	0.05		-0.23	-1.16
11/20	21:00	10380	7.21	22.18	40.43		8.03	48.65	0.02	0.07		-0.23	-1.15
11/20	22:00	10440	7.25	22.18	40.43		8.04	48.64	0.02	0.07		-0.24	-1.14
11/20	23:00	10500	7.29	22.18	40.43		8.04	48.66	0.02	0.07		-0.24	-1.16
11/21	00:00	10560	7.33	22.18	40.43		8.02	48.61	0.02	0.07		-0.22	-1.11
11/21	01:00	10620	7.38	22.18	40.43		8.01	48.57	0.02	0.07		-0.21	-1.07
11/21	02:00	10680	7.42	22.18	40.44		8.01	48.57	0.02	0.06		-0.21	-1.07
11/21	03:00	10740	7.46	22.17	40.44		8.02	48.55	0.03	0.06		-0.22	-1.05
11/21	04:00	10800	7.50	22.18	40.43		8.03	48.53	0.02	0.07		-0.23	-1.03
11/21	05:00	10860	7.54	22.17	40.43		8.01	48.51	0.03	0.07		-0.21	-1.01
11/21	06:00	10920	7.58	22.18	40.44		8.01	48.48	0.02	0.06		-0.21	-0.98
11/21	07:00	10980	7.63	22.18	40.44		8.01	48.46	0.02	0.06		-0.21	-0.96
11/21	08:00	11040	7.67	22.18	40.44		8.03	48.42	0.02	0.06		-0.23	-0.92
11/21	09:00	11100	7.71	22.19	40.44		8.04	48.40	0.01	0.06		-0.24	-0.90
11/21	10:00	11160	7.75	22.17	40.44		8.03	48.38	0.03	0.06		-0.23	-0.88
11/21	11:00	11220	7.79	22.18	40.45		8.02	48.36	0.02	0.05		-0.22	-0.86
11/21	12:00	11280	7.83	22.19	40.44		8.03	48.34	0.01	0.06		-0.23	-0.84
11/21	15:45	11505	7.99				8.04					-0.24	
11/21	15:49	11509	7.99	22.18					0.02				
11/21	15:53	11513	8.00										
11/21	16:23	11543	8.02										
11/21	16:29	11549	8.02				8.01					-0.21	
11/21	17:00	11580	8.04										
11/21	17:07	11587	8.05				8.03					-0.23	
11/21	17:11	11591	8.05	22.19					0.01				
11/21	17:35	11615	8.07										
11/21	17:42	11622	8.07				8.03					-0.23	
11/21	17:45	11625	8.07	22.19					0.01				
11/21	18:07	11647	8.09										
11/21	18:16	11656	8.09				8.03					-0.23	
11/21	18:22	11662	8.10	22.19					0.01				
11/21	20:00	11760	8.17	22.18	40.44		8.02	48.20	0.02	0.06		-0.22	-0.70
11/22	04:00	12240	8.50	22.17	40.44		7.99	48.09	0.03	0.06		-0.19	-0.59
11/22	12:00	12720	8.83	22.17	40.44		8.00	47.98	0.03	0.06		-0.20	-0.48
11/23	12:00	14160	9.83	22.17	40.44		8.00	47.83	0.03	0.06		-0.20	-0.33
11/24	12:00	15600	10.83	22.17	40.47		7.98	47.74	0.03	0.03		-0.18	-0.24
11/25	12:00	17040	11.83	22.16	40.47		7.97	47.68	0.04	0.03		-0.17	-0.18
11/26	08:00	18240	12.67	22.17	40.49		7.98	47.69	0.03	0.01		-0.18	-0.19

TABLE 2. PIEZOMETER P-1 THROUGH P-6 DATA

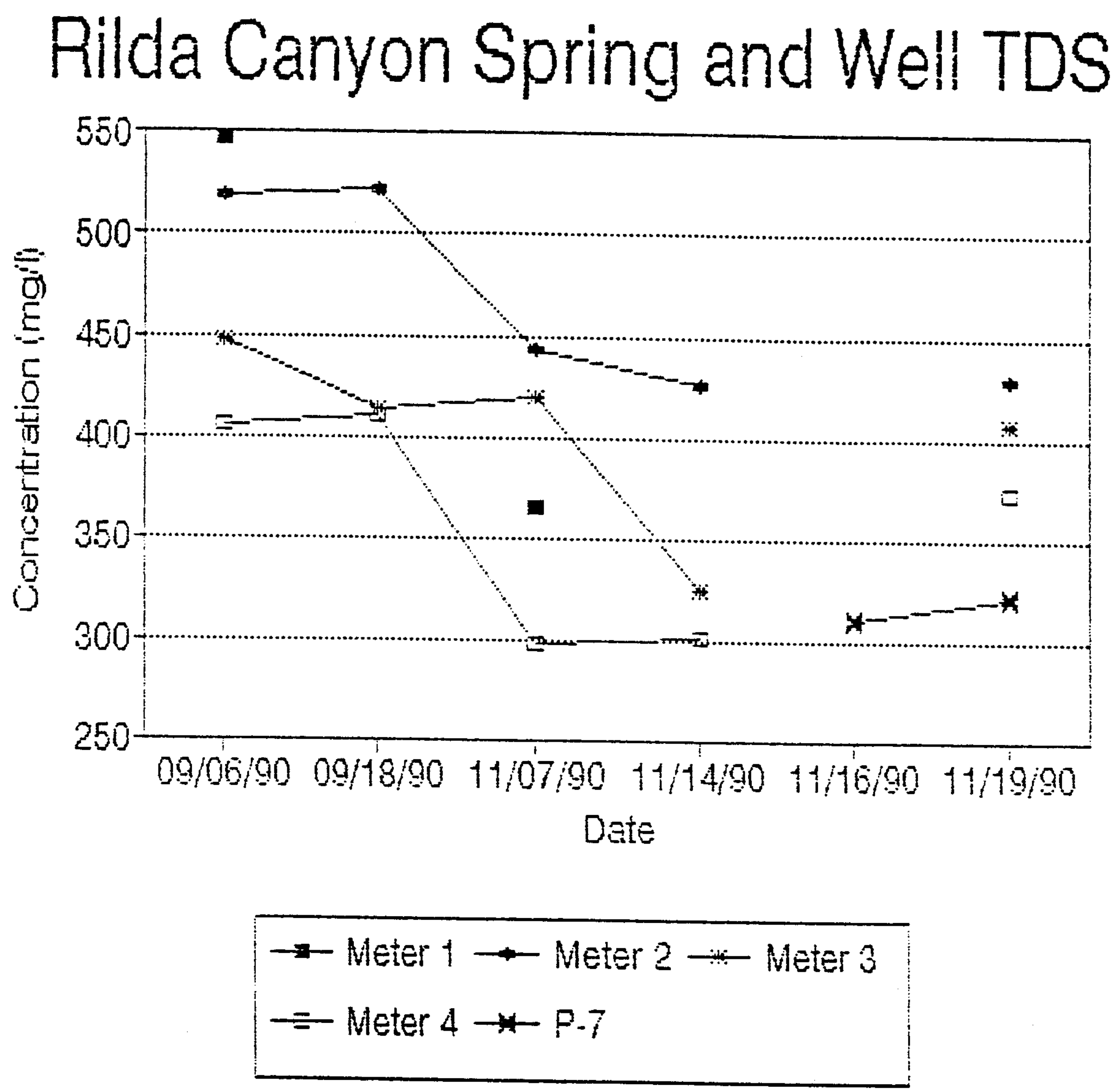
DATE	TIME	TIME SINCE PUMPING BEGAN	TIME IN DAYS	DEPTH TO WATER					DRAWDOWN (FEET)				
				P-1	P-2	P-4	P-5	P-6	P-1	P-2	P-4	P-5	P-6
11/27	08:00	19680	13.67	22.18	40.50		7.98	47.69	0.02	0.00		-0.18	-0.19

TABLE 3. RILDA CANYON NEWUA SPRING METER FLOW DATA

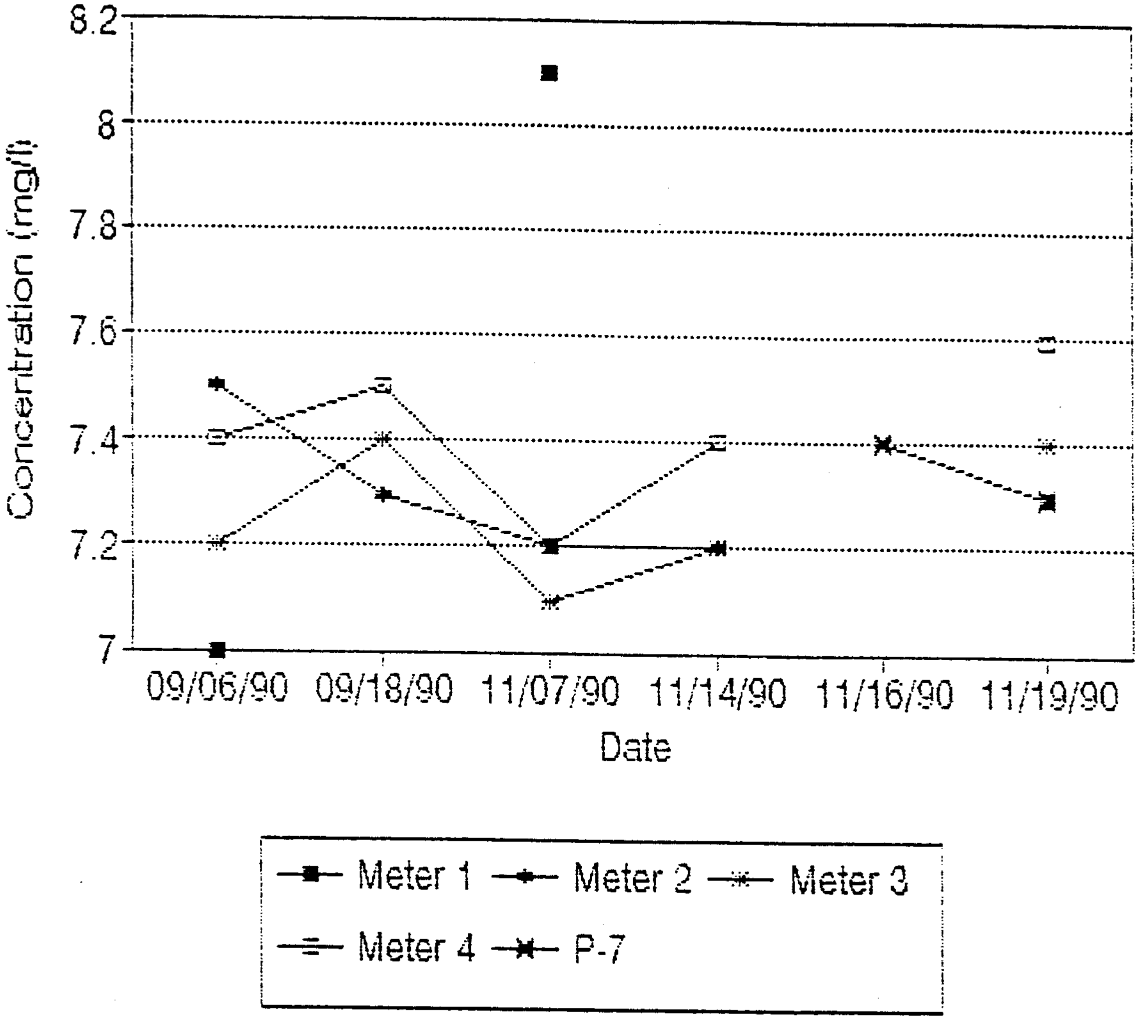
DATE	CLOCK TIME	PUMPED FLOW (gpm)	TIME TO FILL 5 GAL BUCKET (Sec)			SPRING FLOW (gpm)				TIME SINCE PUMPING BEGAN	
			Meter 2	Meter 3	Meter 4	Meter 2	Meter 3	Meter 4	Total	(Minutes)	(Days)
11/14/90	00:40	8.22	22.40	4.55	40.00	13.39	65.93	7.50	86.83	520	0.4
	08:30	8.22	23.81	5.15	40.00	12.60	58.25	7.50	78.35	990	0.7
	10:23	8.22	24.58	5.31	40.00	12.21	56.50	7.50	76.20	1103	0.8
	11:55	8.22	25.14	5.31	40.00	11.93	56.50	7.50	75.93	1195	0.8
	14:15	8.22	25.60	5.20	41.00	11.72	57.69	7.32	76.73	1335	0.9
	15:41	8.22	24.30	5.25	39.00	12.35	57.14	7.69	77.18	1421	1.0
	19:45	14.61	20.75	4.45	32.30	14.46	67.42	9.29	91.16	1665	1.2
11/15/90	04:30	17.50	20.00	4.50	38.00	15.00	66.67	7.89	89.56	2190	1.5
	06:13	18.20	19.50	4.57	36.68	15.38	65.65	8.18	89.21	2293	1.6
	11:49	17.90	22.40	5.30	35.50	13.39	56.60	8.45	78.45	2629	1.8
	15:50	17.00	23.30	5.15	35.40	12.88	58.25	8.47	79.60	2875	2.0
	18:27	17.50	21.10	4.50	34.80	14.22	66.67	8.62	89.51	3027	2.1
	22:12	17.20	20.90	4.55	36.20	14.35	65.93	8.29	88.58	3252	2.3
11/16/90	04:14	17.00	20.50	4.50	35.00	14.63	66.67	8.57	89.87	3614	2.5
	07:22	17.00	21.10	5.12	37.90	13.22	59.88	7.52	80.61	3802	2.6
	11:16	16.70	22.70	5.01	39.90	13.95	57.69	7.46	79.11	4036	2.8
	16:12	16.50	21.50	5.20	40.20	14.15	61.22	7.54	82.91	4332	3.0
	19:21	16.32	21.20	4.90	39.80	14.15	61.22	7.54	82.91	4521	3.1
	23.13	16.47	21.50	4.80	41.00	13.95	62.50	7.32	83.77	4753	3.3
11/17/90	04:13	16.35	20.50	4.80	40.00	14.63	62.50	7.50	84.63	5053	3.5
	07:15	16.33	21.40	5.10	42.10	14.02	58.82	7.13	79.97	5235	3.6
	12:22	16.29	22.70	5.10	43.40	13.22	58.82	6.91	78.95	5542	3.8
	15:30	16.20	20.90	5.10	43.60	14.35	58.82	6.88	80.06	5730	4.0
	19:15	16.15	24.56	5.40	43.50	12.21	55.56	6.90	74.67	5955	4.1
	23:15	16.00	25.10	4.98	43.10	11.95	60.24	6.96	79.15	6195	4.3
11/18/90	03:20	16.18	24.50	5.50	44.00	12.24	54.55	6.82	73.61	6440	4.5
	06:20	16.00	24.00	5.00	44.00	12.50	60.00	6.82	79.32	6620	4.6
	11:25	15.61	25.90	5.50	47.10	11.58	54.55	6.37	72.50	6925	4.8
	15:56	15.70	23.02	5.26	58.65	13.03	57.03	5.12	75.18	7196	5.0
	17:14	16.65	21.82	5.00	45.97	13.75	60.00	6.53	80.27	7274	5.1
	23:15	15.60	21.90	5.18	46.27	13.70	57.92	6.48	78.10	7635	5.3
11-19-90	03:45	15.50	23.00	5.00	46.00	13.04	60.00	6.52	79.57	7905	5.5
	06:45	15.53	22.90	5.10	45.60	13.10	58.82	6.58	78.50	8085	5.6
	11:23	15.45	21.94	5.10	51.70	13.67	58.82	5.80	78.29	8363	5.8
	15:25	15.42	23.44	7.00	59.19	12.80	42.86	5.07	60.72	8605	6.0
	19:15	15.38	22.07	5.20	47.30	13.59	57.69	6.34	77.63	8835	6.1
	23:15	15.40	22.22	5.30	47.86	13.50	56.60	6.27	76.37	9075	6.3
11-20-90	03:16	15.45	23.10	5.15	47.70	12.99	58.25	6.29	77.53	9316	6.5

TABLE 3. RILDA CANYON NEWUA SPRING METER FLOW DATA

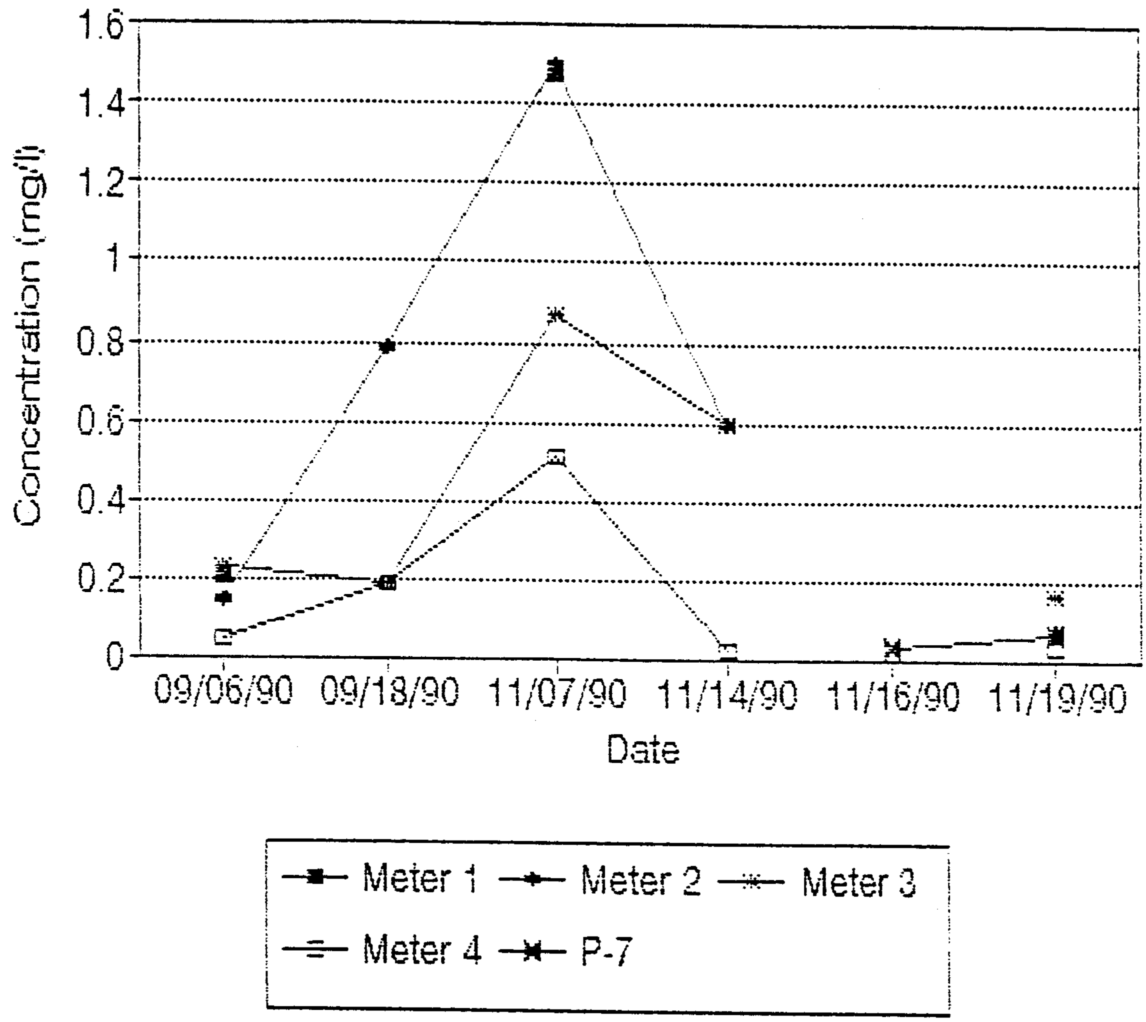
DATE	CLOCK TIME	PUMPED FLOW (gpm)	TIME TO FILL 5 GAL BUCKET (Sec)			SPRING FLOW (gpm)				TIME SINCE PUMPING BEGAN	
			Meter 2	Meter 3	Meter 4	Meter 2	Meter 3	Meter 4	Total	(Minutes)	(Days)
	06:21	15.29	23.50	5.10	49.60	12.77	58.82	6.05	77.64	9501	6.6
	11:33	15.25	25.63	5.28	56.11	11.71	56.82	5.35	73.87	9813	6.8
	12:29	15	25.63	5.28	56.11	11.71	56.82	5.35	73.87	9869	6.9
	12:30	0	21.70	5.20	47.63	13.82	57.69	6.30	77.82	9870	6.9
	15:45	0	23.00	8.00		13.01		5.88	55.56	10065	7.0
	20:00	0	21.70	5.20	47.63	13.82	57.69	6.30	77.82	10320	7.2
	23:00	0	22.00	5.20	47.23	13.64	57.69	6.35	77.68	10500	7.3
11-21-90	03:00	0	21.20	5.10	44.00	14.15	58.82	6.82	79.79	10740	7.5
	07:00	0	20.00	5.10	44.00	15.00	58.82	6.82	80.64	10980	7.6
	11:00	0	24.22	5.14	44.32	12.39	58.37	6.77	77.52	11220	7.8
	20:00	0	21.40	4.92	42.84	14.02	60.98	7.00	82.00	11760	8.2
11-22-90	04:00	0	21.00	4.90	39.00	14.29	61.22	7.69	83.20	12240	8.5
	12:00	0	22.20	4.95	39.15	13.51	60.61	7.66	81.78	12720	8.8
11-23-90	12:00	0	22.30	4.84	38.00	13.45	61.98	7.89	83.33	14160	9.8
11-24-90	12:00	0	21.47	4.85	37.06	13.97	61.86	8.09	83.92	15600	10.8
11-25-90	12:00	0	22.30	4.90	35.80	13.45	61.22	8.38	83.06	17040	11.8
11-26-90	08:00	0	21.00	4.80	36.30	14.29	62.50	8.26	85.05	18240	12.7
11-27-90	08:00	0	22.20	4.68	36.20	13.51	64.10	8.29	85.90	19680	13.7


Rilda Canyon Spring and Well TDS
Concentration (mg/l)
550
500
450
400
350
300
250
09/06/90
09/18/90
11/07/90
11/14/90
11/16/90
11/19/90
Date
Meter 1
Meter 2
Meter 3
Meter 4
P-7

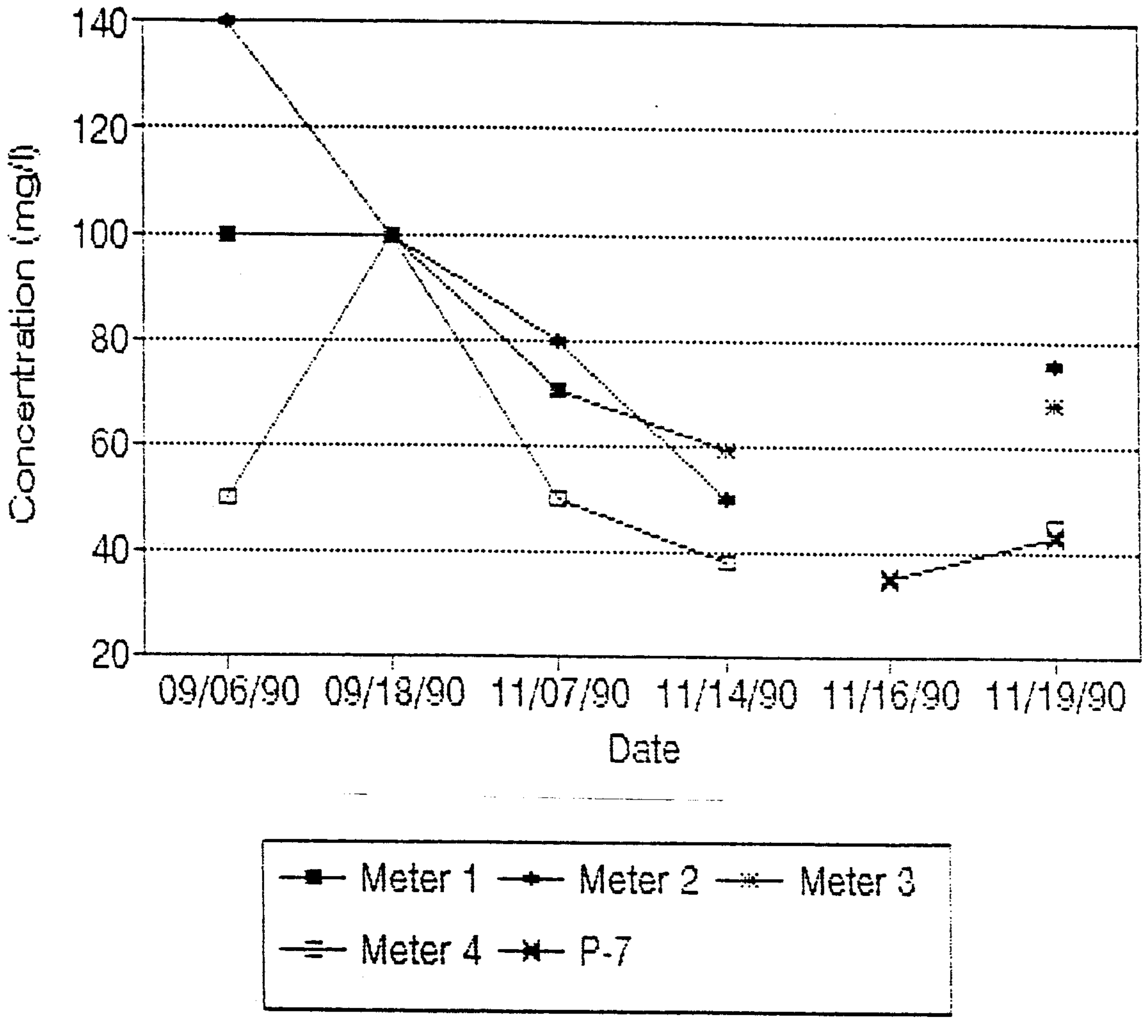
Rilda Canyon Spring and Well pH

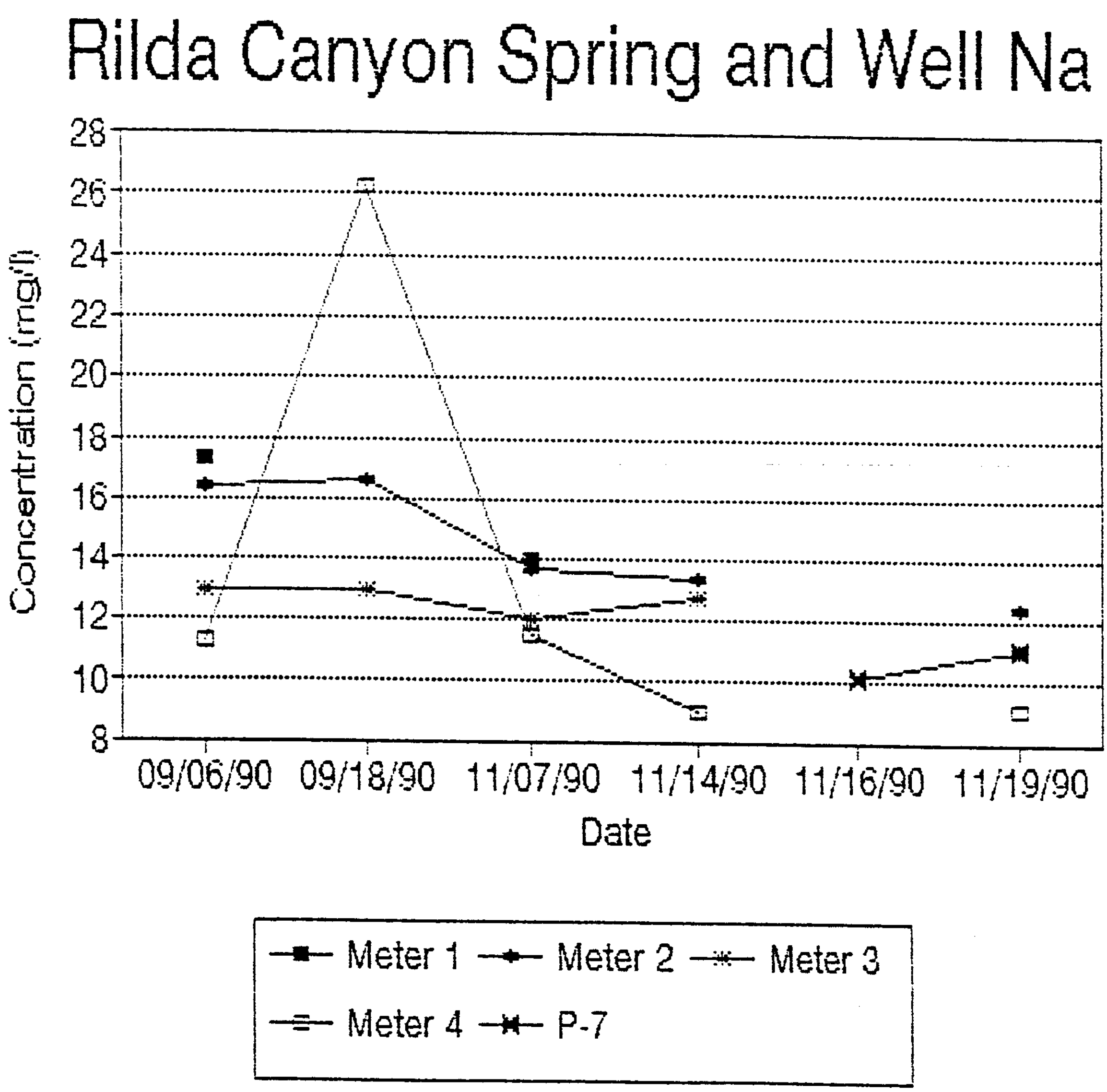


Rilda Canyon Spring and Well Fe (Tot)



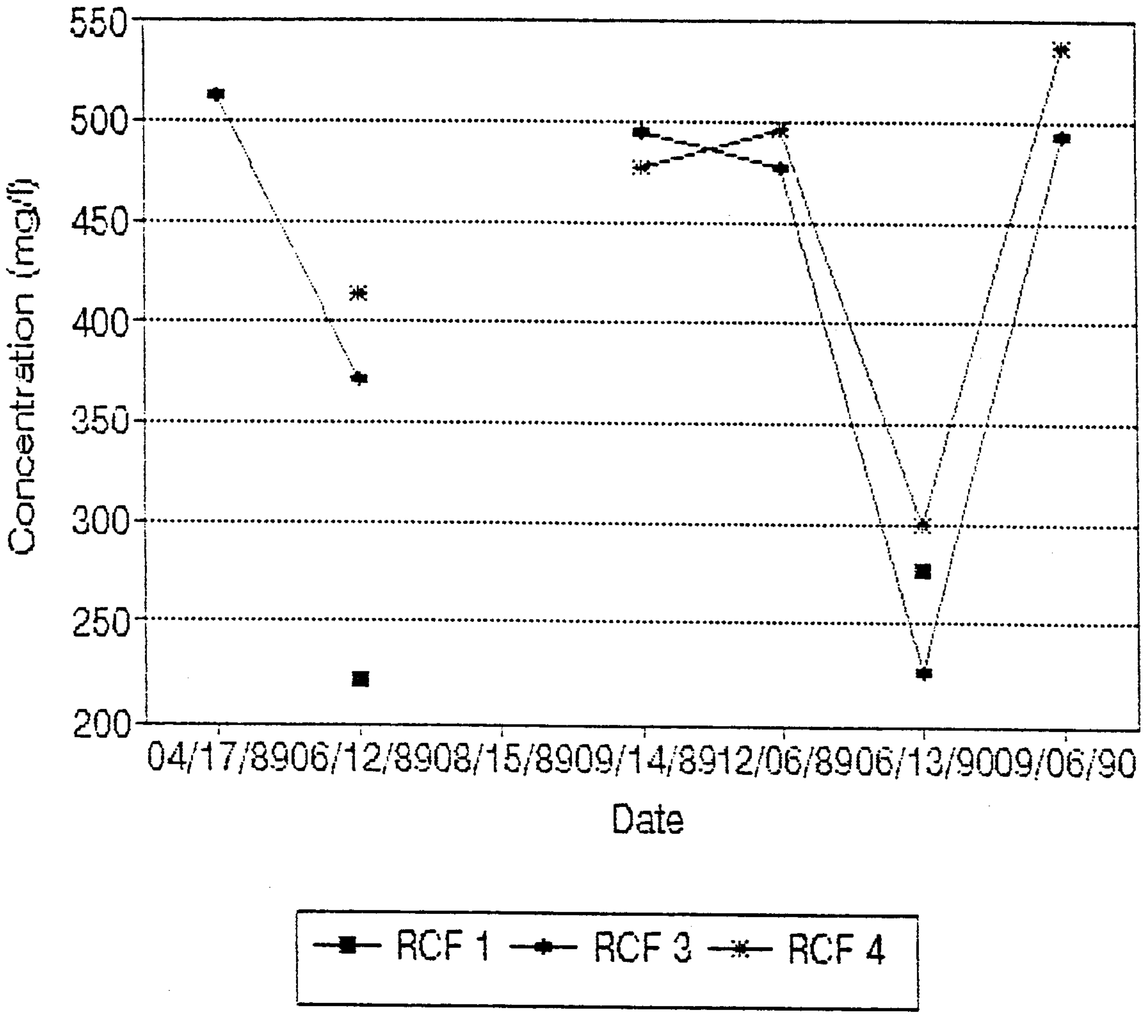
Rilda Canyon Spring and Well SO4

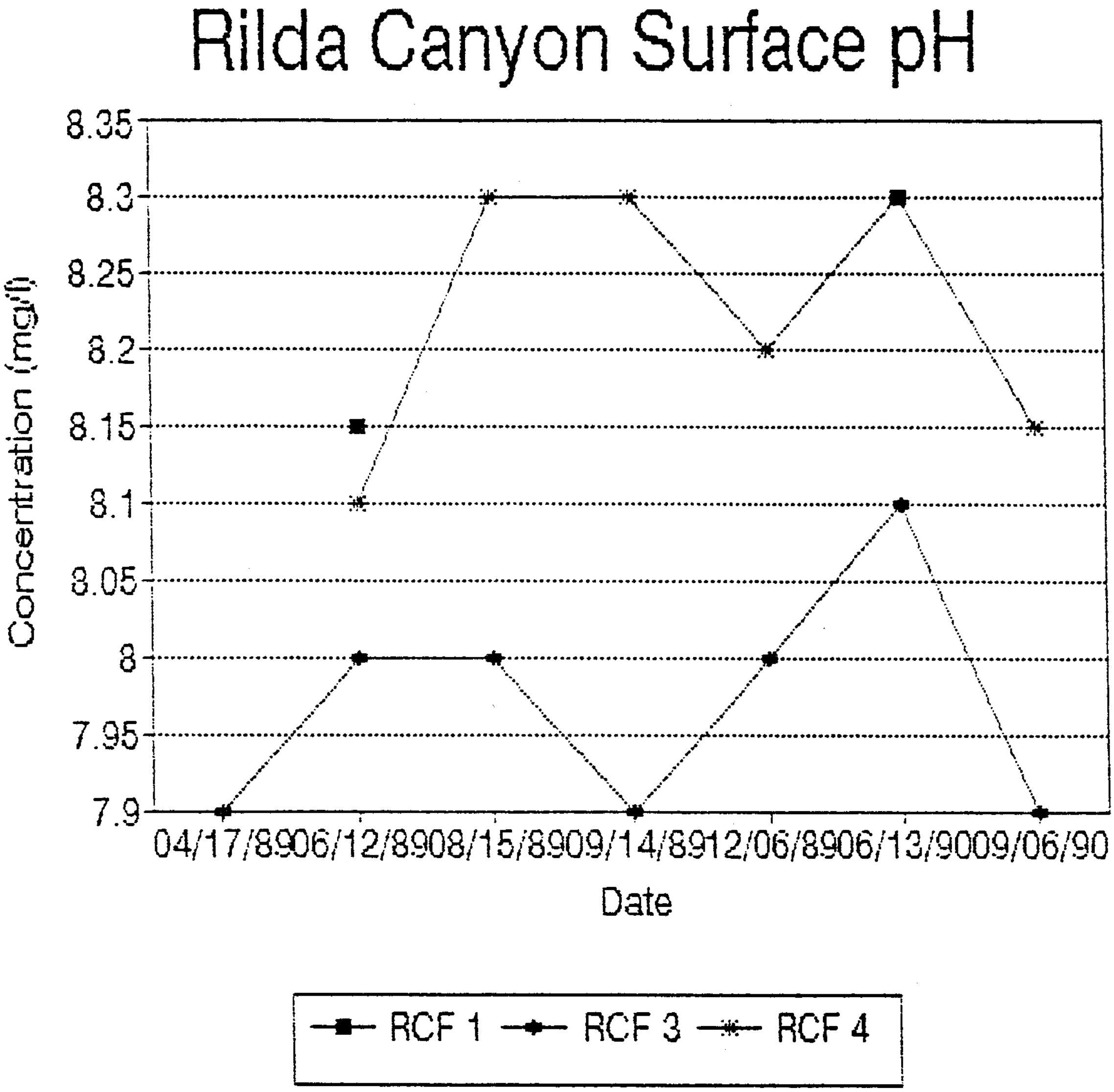




Rilda Canyon Spring and Well Na
Concentration (mg/l)
28
26
24
22
20
18
16
14
12
10
8
09/06/90
09/18/90
11/07/90
11/14/90
11/16/90
11/19/90
Date
Meter 1
Meter 2
Meter 3
Meter 4
P-7

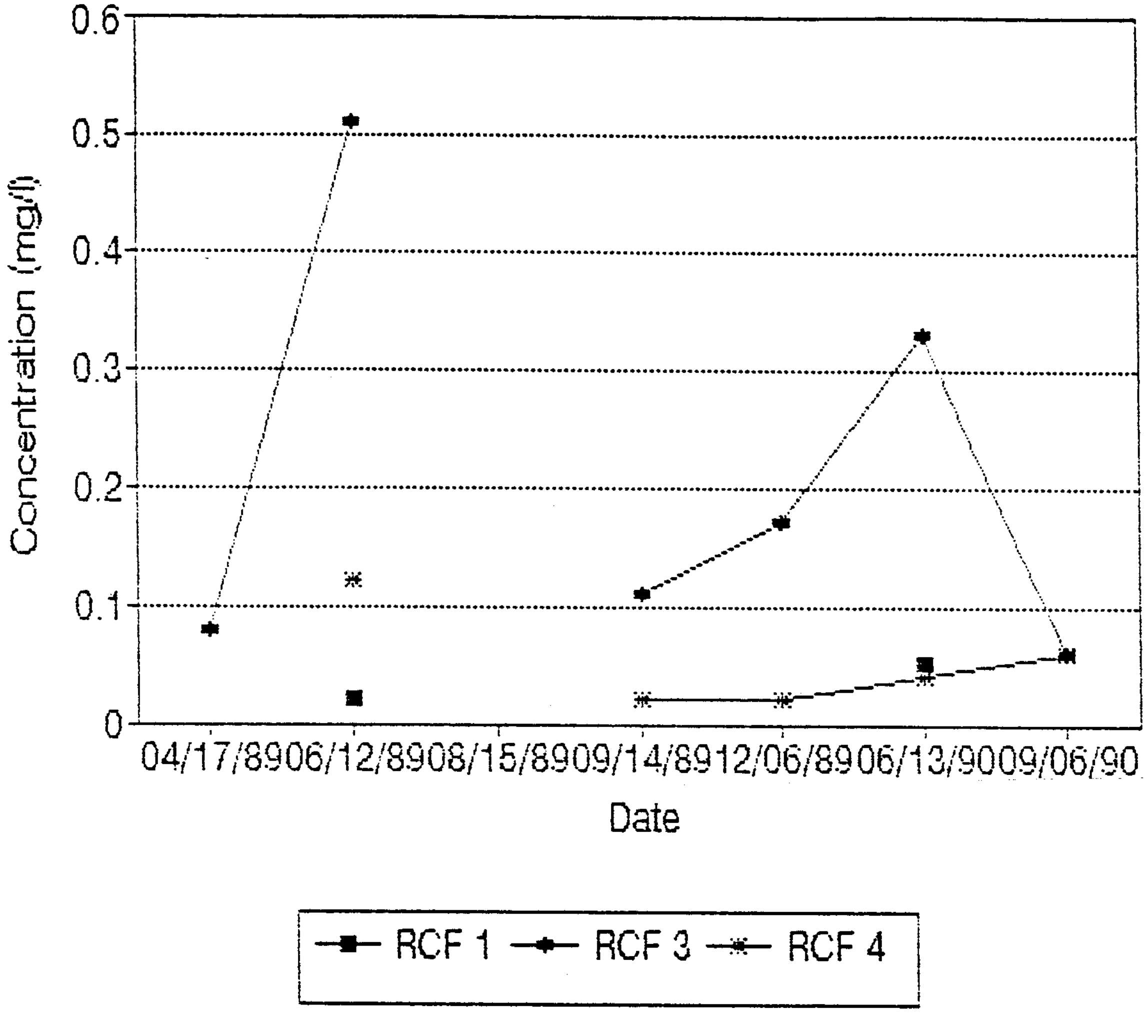
Rilda Canyon Surface TDS

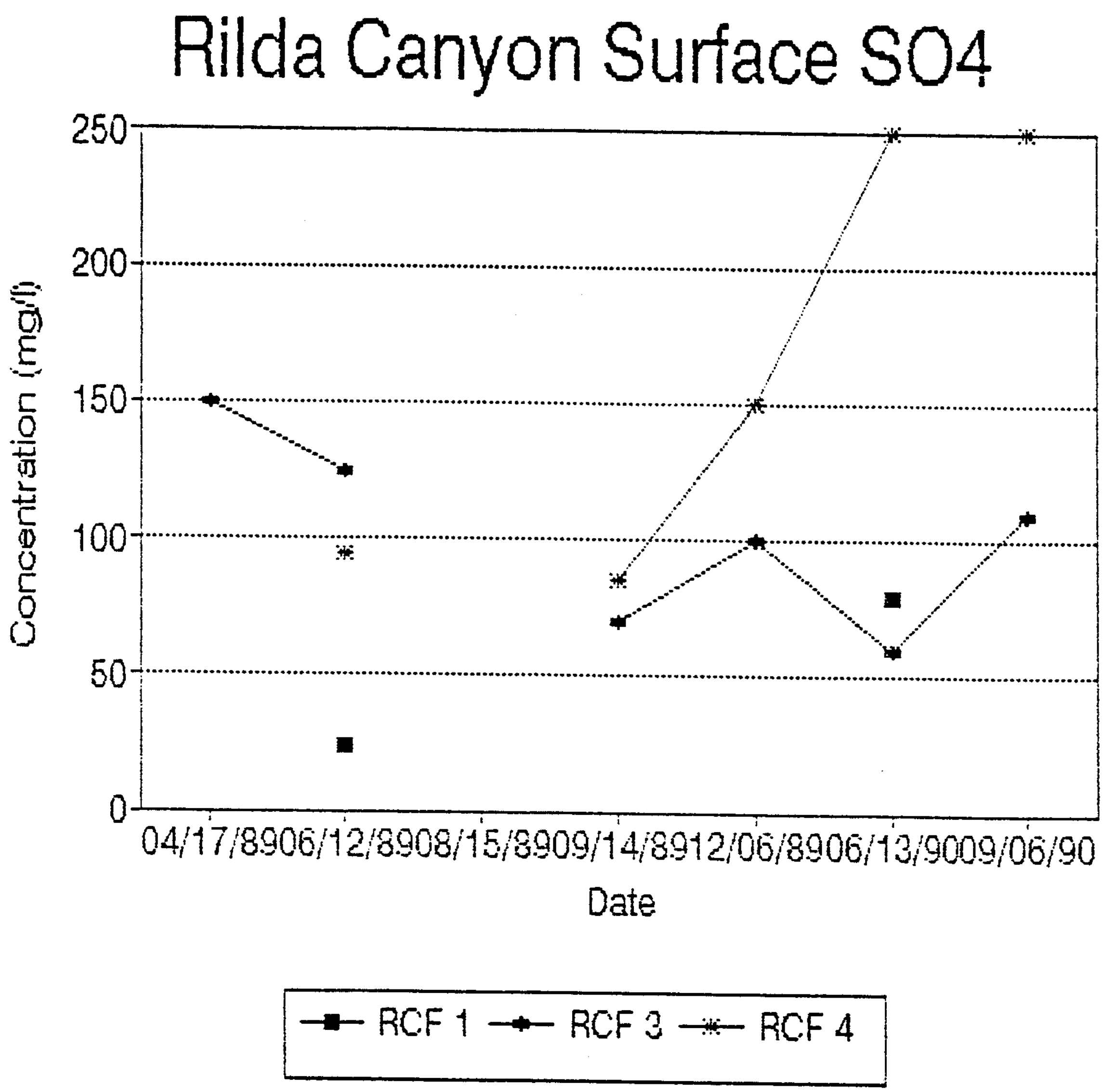




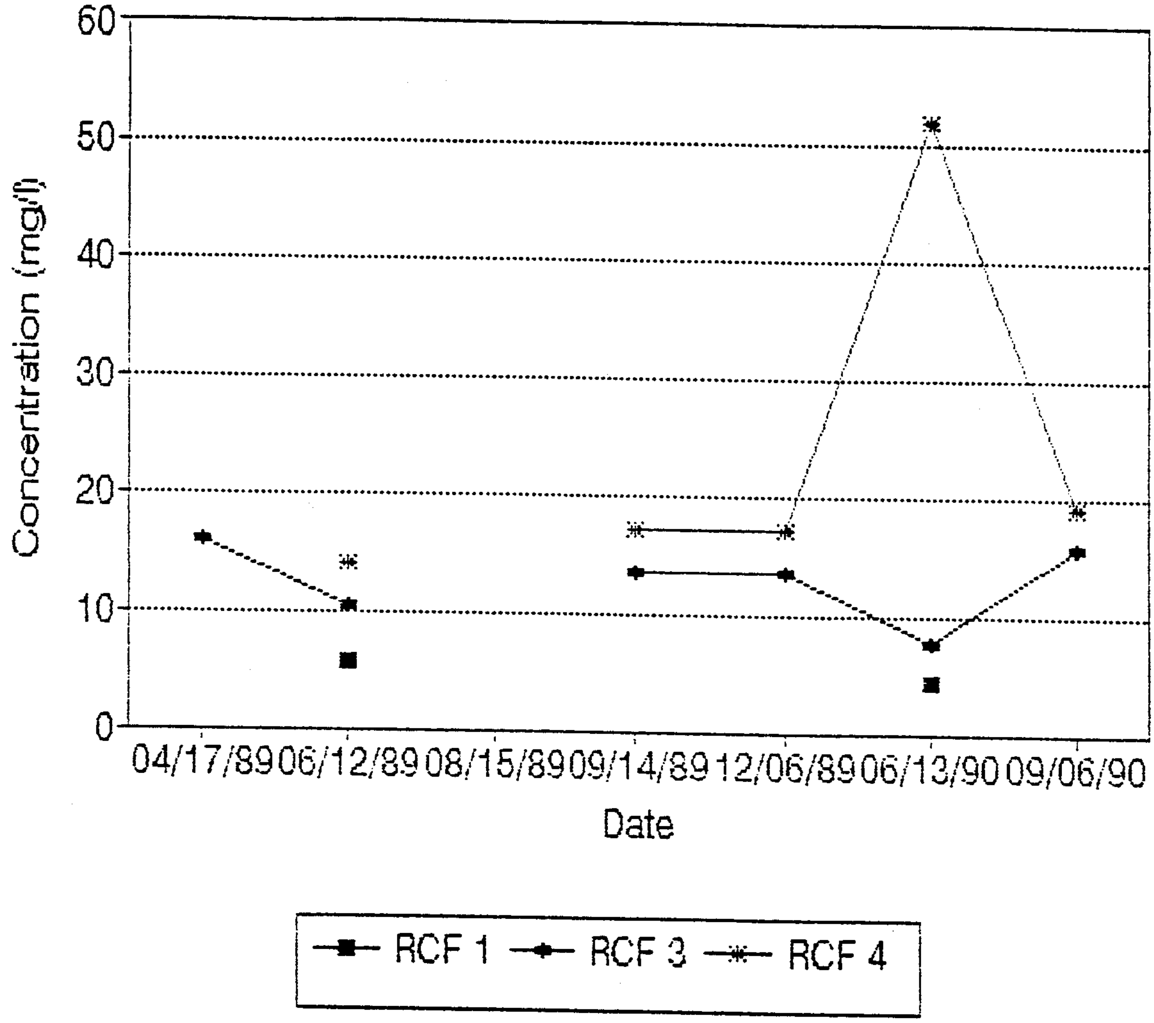
Rilda Canyon Surface pH
8.35
8.3
8.25
8.2
8.15
8.1
8.05
8
7.95
7.9
Concentration (mg/l)
04/17/89
06/12/89
08/15/89
09/14/89
12/06/89
06/13/90
09/06/90
Date
RCF 1
RCF 3
RCF 4

Rilda Canyon Surface Fe (tot)




Rilda Canyon Surface SO4
250
200
150
100
50
0
Concentration (mg/l)
04/17/89
06/12/89
08/15/89
09/14/89
12/06/89
06/13/90
09/06/90
Date
RCF 1
RCF 3
RCF 4

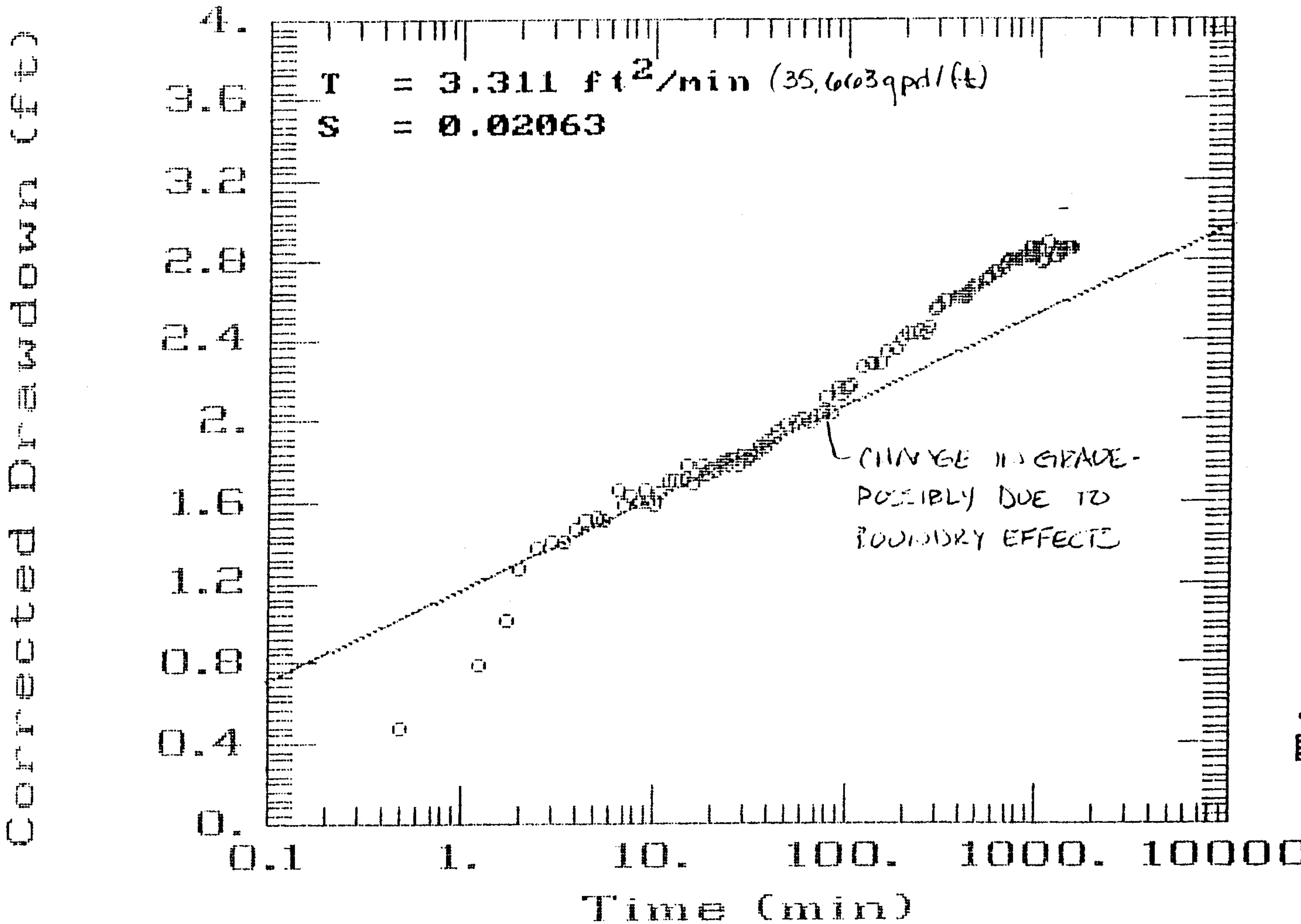
Rilda Canyon Surface Na



APPENDIX B

HANSEN ALLEN & LUCE INC

Pacificorp P-7 Initial Data Q=8.22 gpm



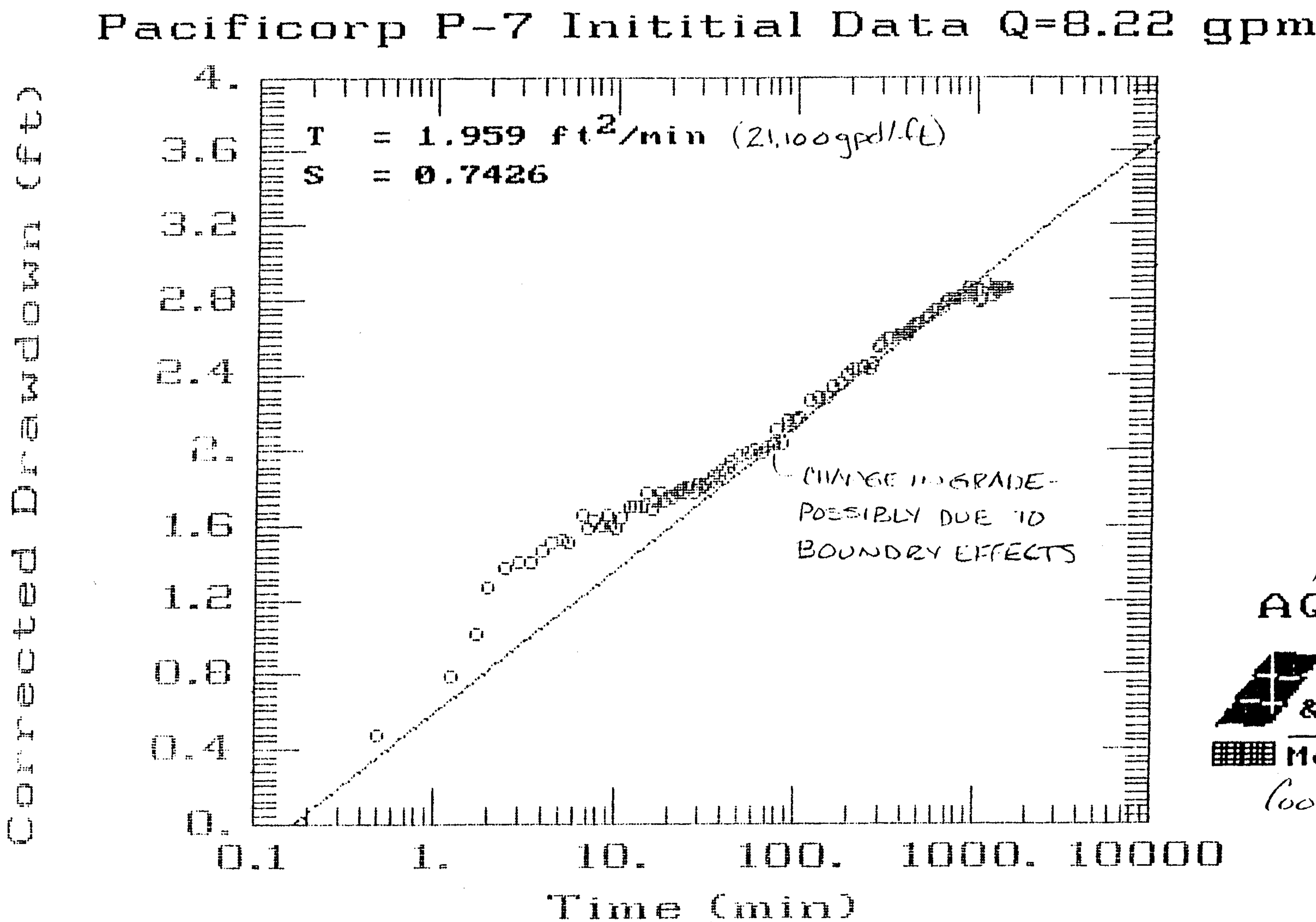
PLOT 1

AQTESOLV

GERAGHTY & MILLER, INC

Modeling Group

COOPER-JACOB



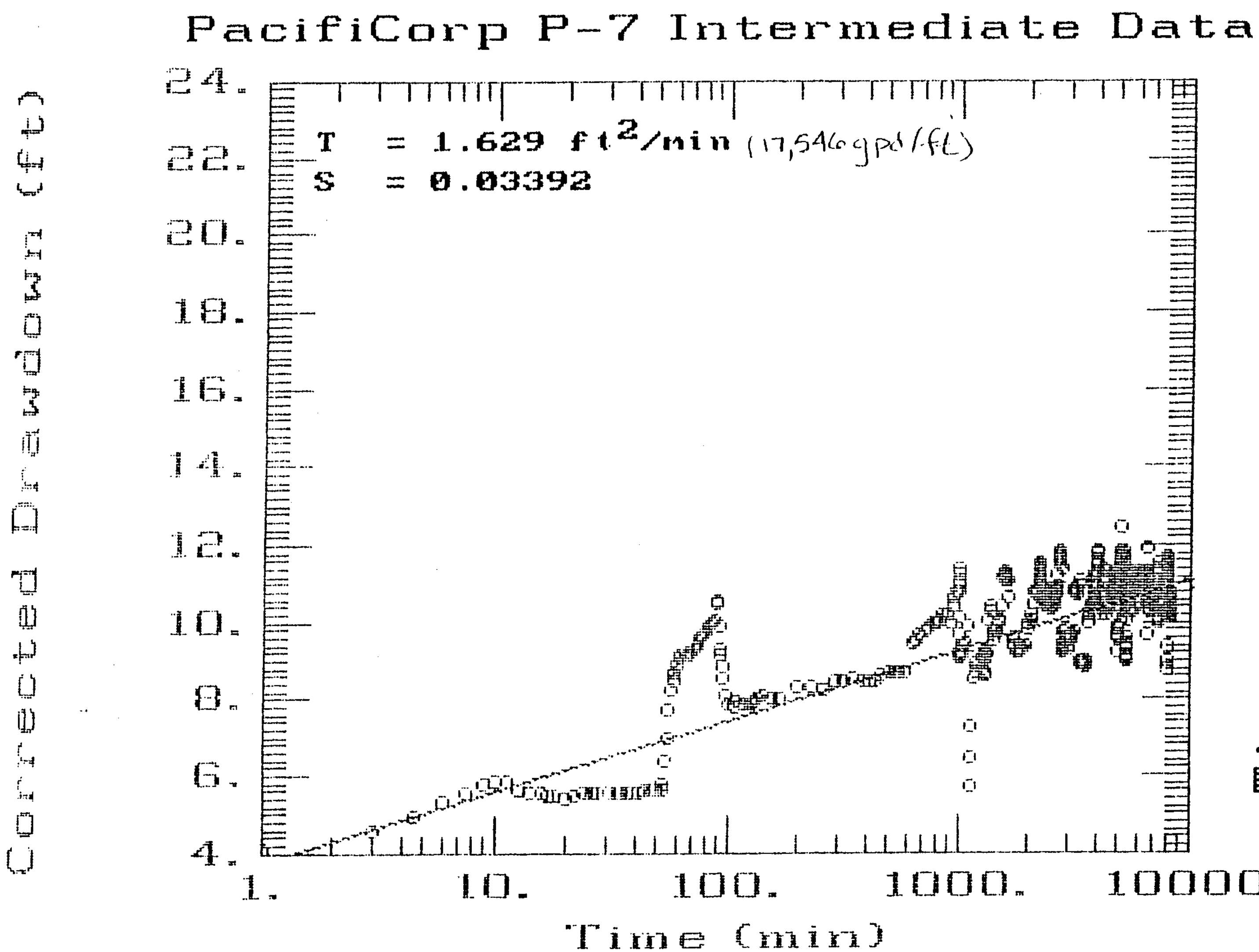
PLOT 2

AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

Cooper - Jacob



PLOT 3

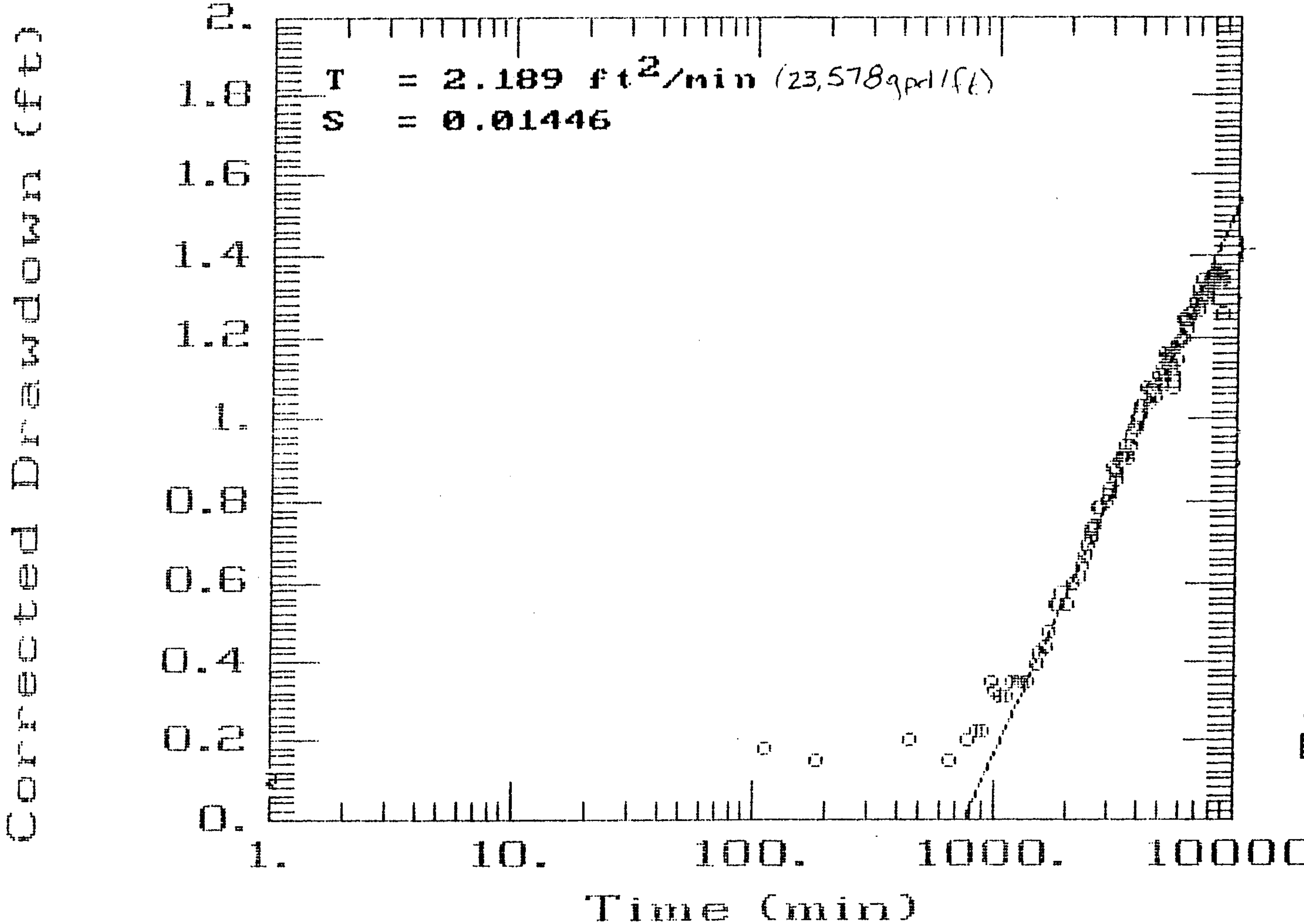
AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

Cooper-Jacob: Unconf.

PacifiCorp Piezometer P-6 Data



PLOT -1

AQTESOLV

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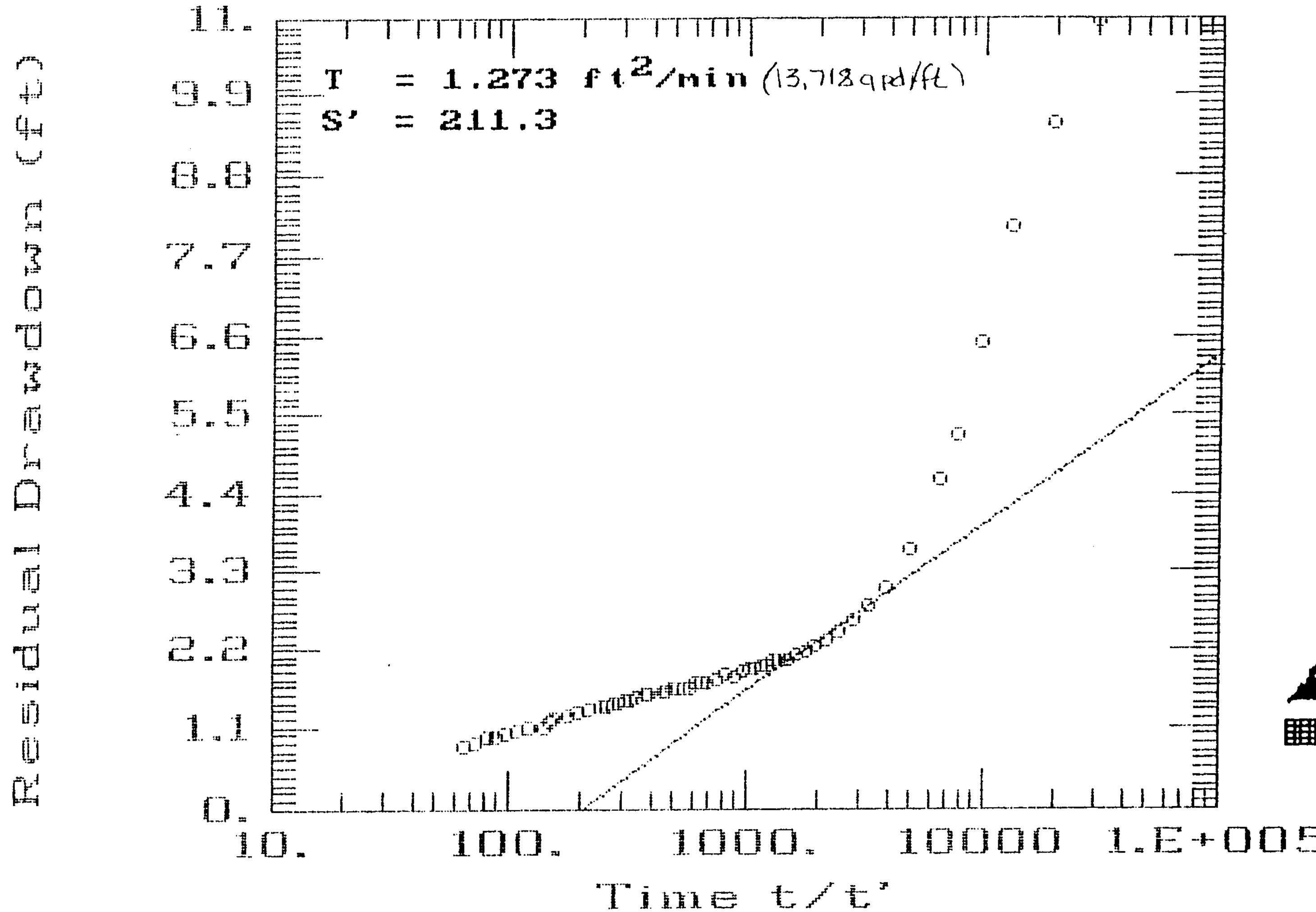
Cooper-Jacob

PacifiCorp P-7 Recovery Test



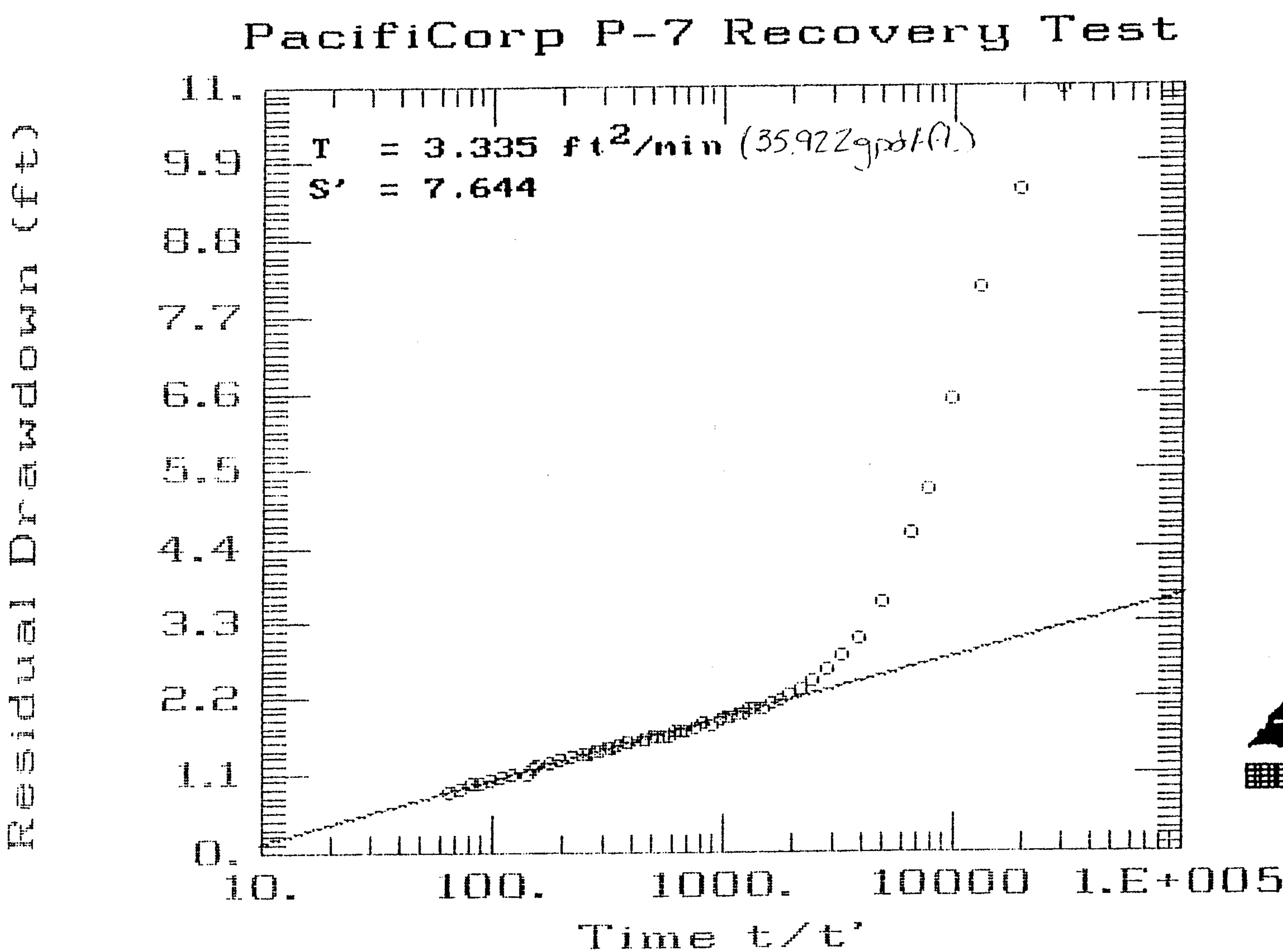
PLOT 5

AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

CONFINED RECOVERY



PLOT 6

AQTESOLV

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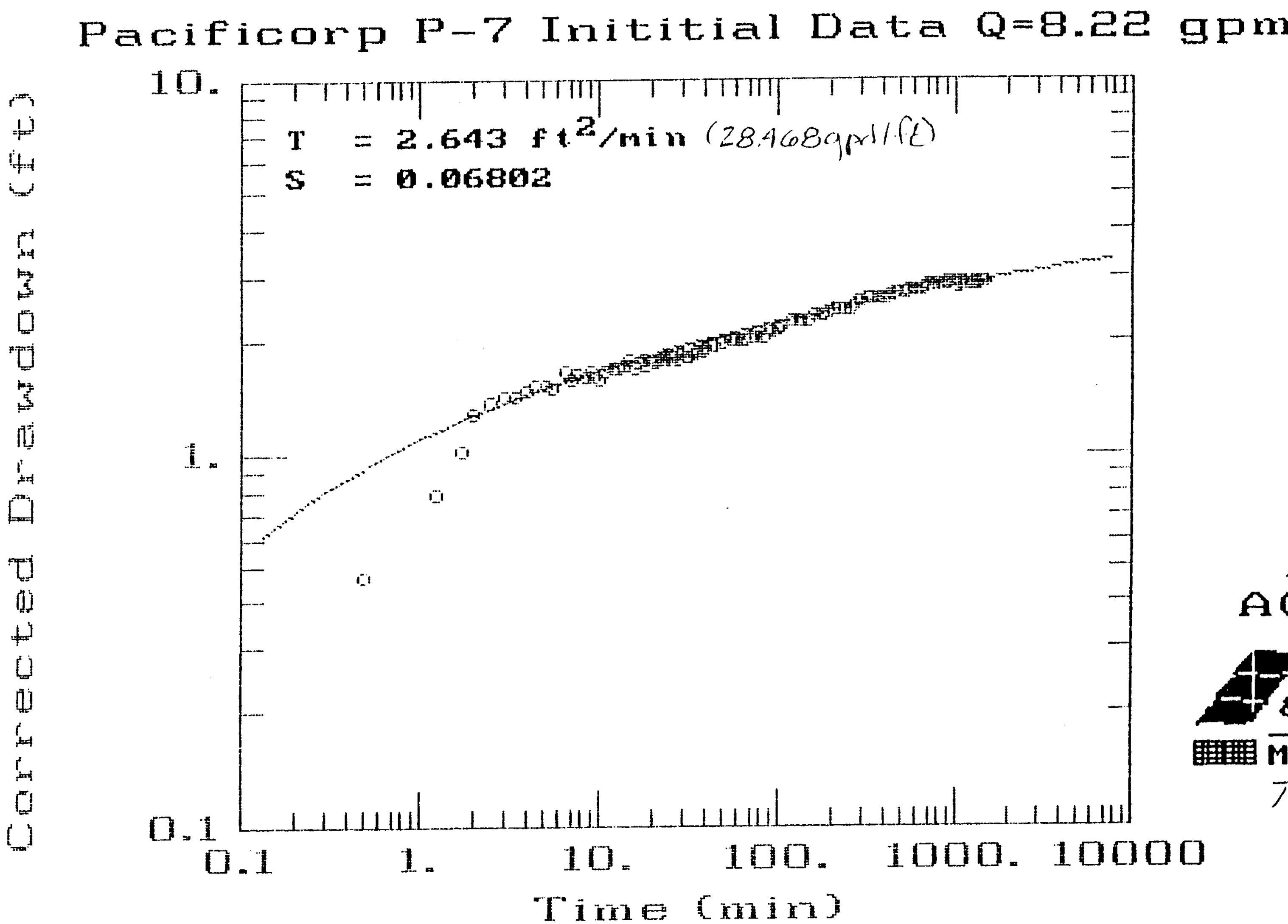
Modeling Group

CONFINED RECOVERY



PLOT 7

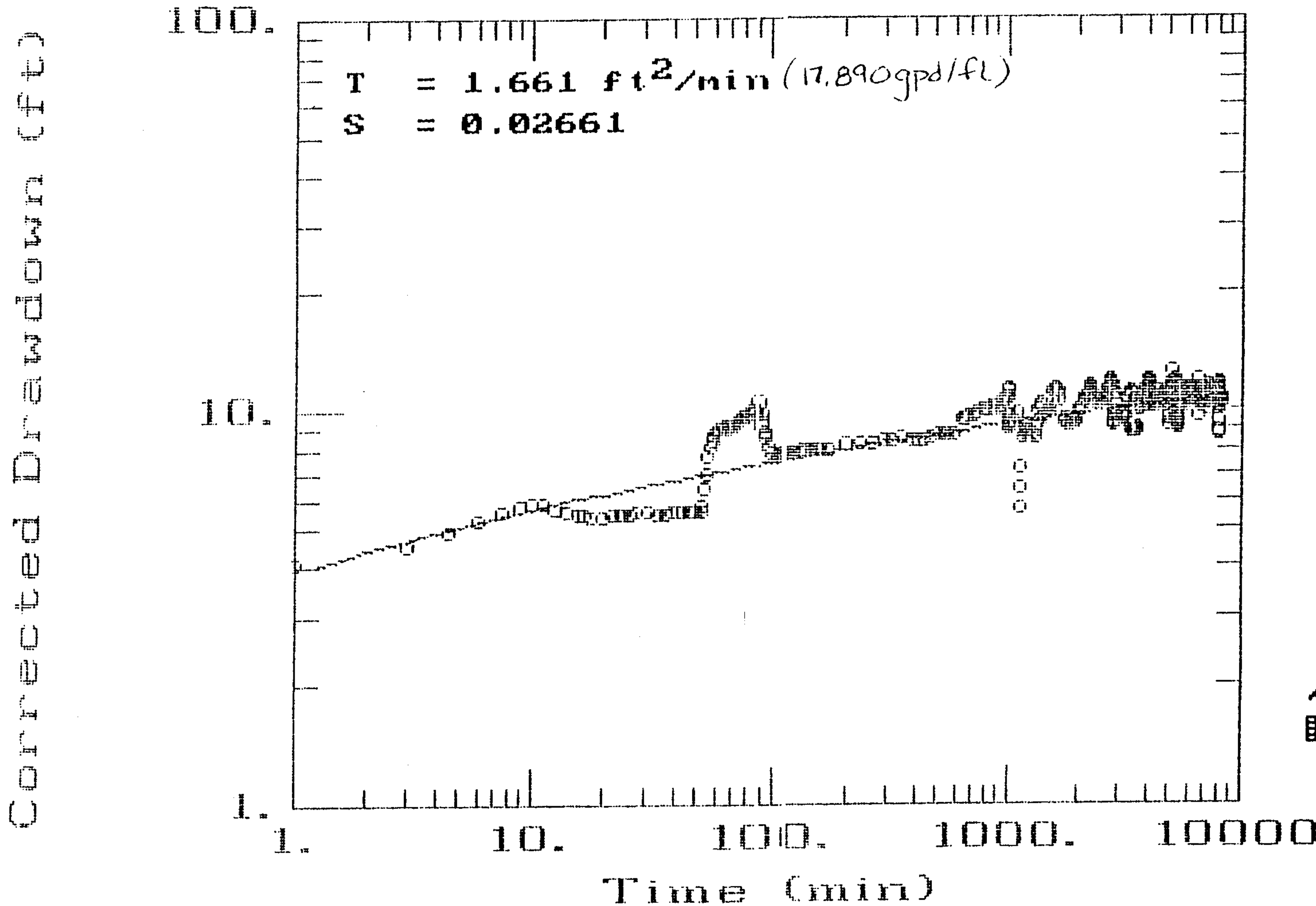
AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

Theis UNCONFINED

PacifiCorp P-7 Intermediate Data



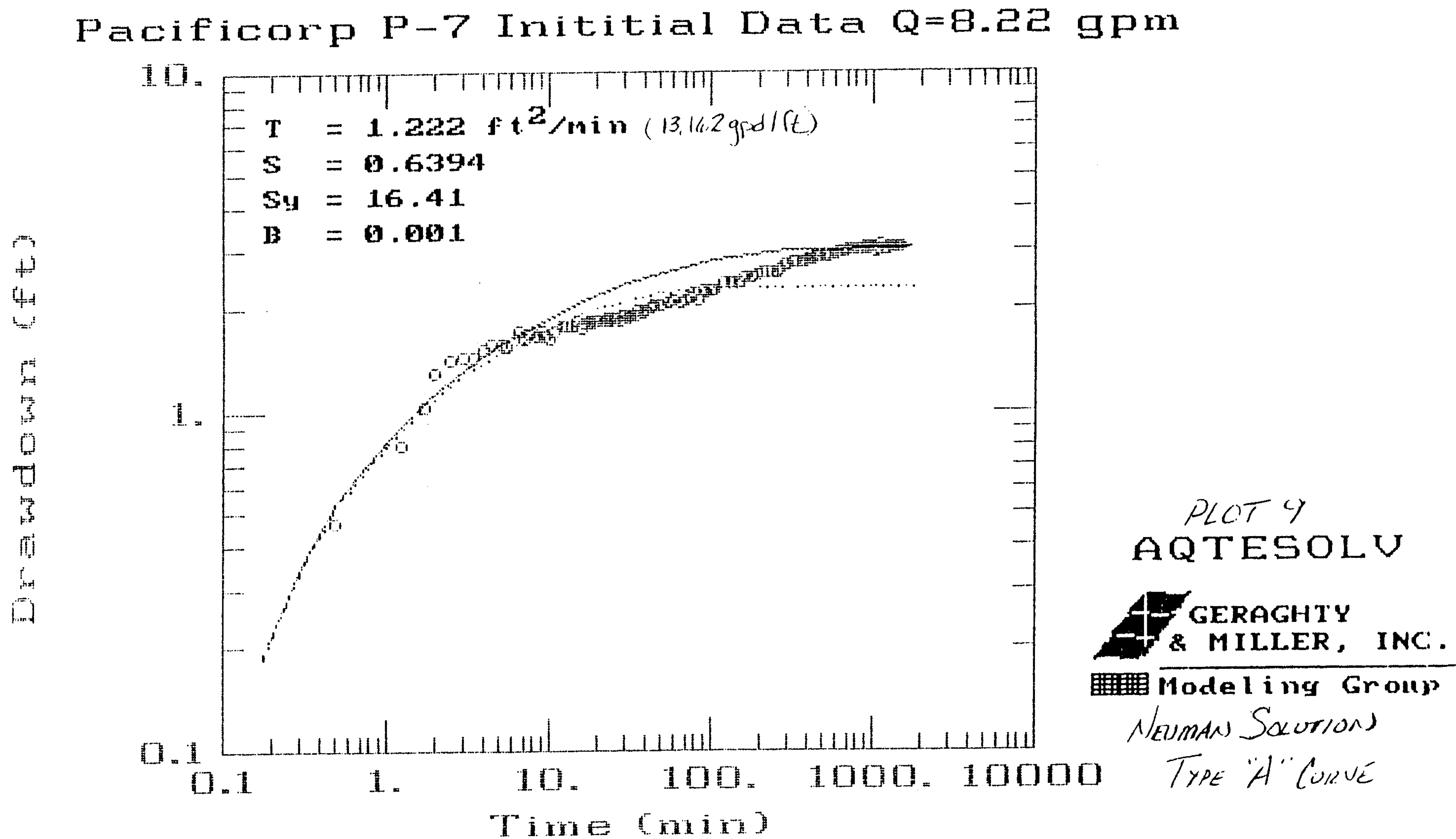
PLOT 8

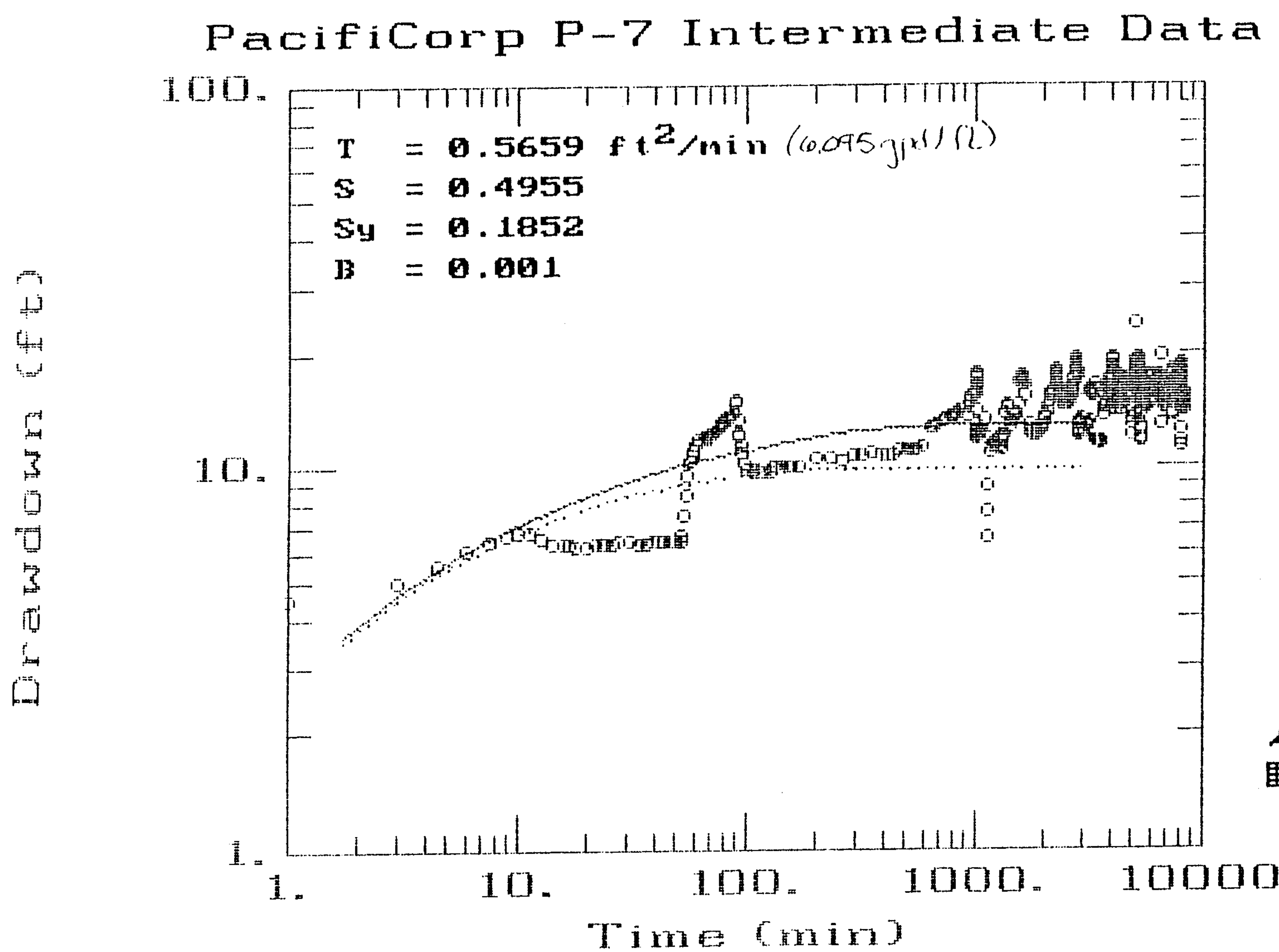
AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

THEIS SOLUTION (UNCONFINED)


Pacificorp P-7 Initial Data Q=8.22 gpm
T = 1.222 ft²/min (13,162 gpd/ft)
S = 0.6394
Sy = 16.41
B = 0.001
Drawdown (ft)
Time (min)
10.
1.
0.1
0.1
1.
10.
100.
1000.
10000
PLOT 9
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group
NEUMAN SOLUTION
TYPE "A" CURVE



PLOT 10

AQTESOLV

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Modeling Group

NEUMAN UNCONFINED

APPENDIX C

HANSEN
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Ground Water Movement

Check Comparison of Flow Rates using $v = Ki$ $Q = VA$

- Find Saturated Area for Each Cross Section

R-3

Grnd Surface	(Add 12.8' bust in P-7 to Contour Map Elev of 7604)	7617
Wtr Surface		7585
		32 ft
Inferred Depth to Bedrock ~		60 ft
Sat. Thickness		28 ft

R-4

Grnd Surf	(Add 7579.3 - 7568 = 11.3' bust in P-1 to Contour Map Elev of 7537 @ Creek Center)	7548
Wtr Surf		7543
		5 ft
Inferred Depth to Bedrock		70 ft
Sat Thickness		65 ft

R-5

Grnd Surface	(Add 7516.8 - 7506 = 10.8' bust in P-3 to Contour Map Elev @ Creek Center of 7484)	7494.8
Wtr Surface		7495.0
		1.8
Inferred Depth to Bedrock		60'
Saturated Thickness		58 ft

$K = T/b$

Long Term Transmissivity ~ 20,000 gpd/ft

$K = 20000/28 = 714.3 \text{ gpd/ft}^2$ (Upper Region)

$$\frac{714.3 \text{ gal}}{\text{day ft}^2} \cdot \frac{\text{ft}^3}{7.48 \text{ gal}} = 95.49 \text{ ft/day}$$

HANSEN ALLEN & LUCE INC

CLIENT [illegible]
PROJECT
FEATURE
PROJECT NO. 87.01.100

SHEET 2 OF 3
COMPUTED DEH
CHECKED
DATE 20 DEC 90

Estimate Spring Impact
Ground Water Gradient near P-7

$i = 5'/115' = 0.0435$

$v = Ki = 95.49(.0435) = 4.15$ ft/day

Planimeter Saturated Area @ R-4

100'

100'

10,000 ft²

$\frac{10{,}000\,ft^2}{65} * Rdg = Area\,ft^2 = 153.85 * Rdg$

$26 * 153.85 = 4{,}000\,ft^2$ · Sat. area @ R-4

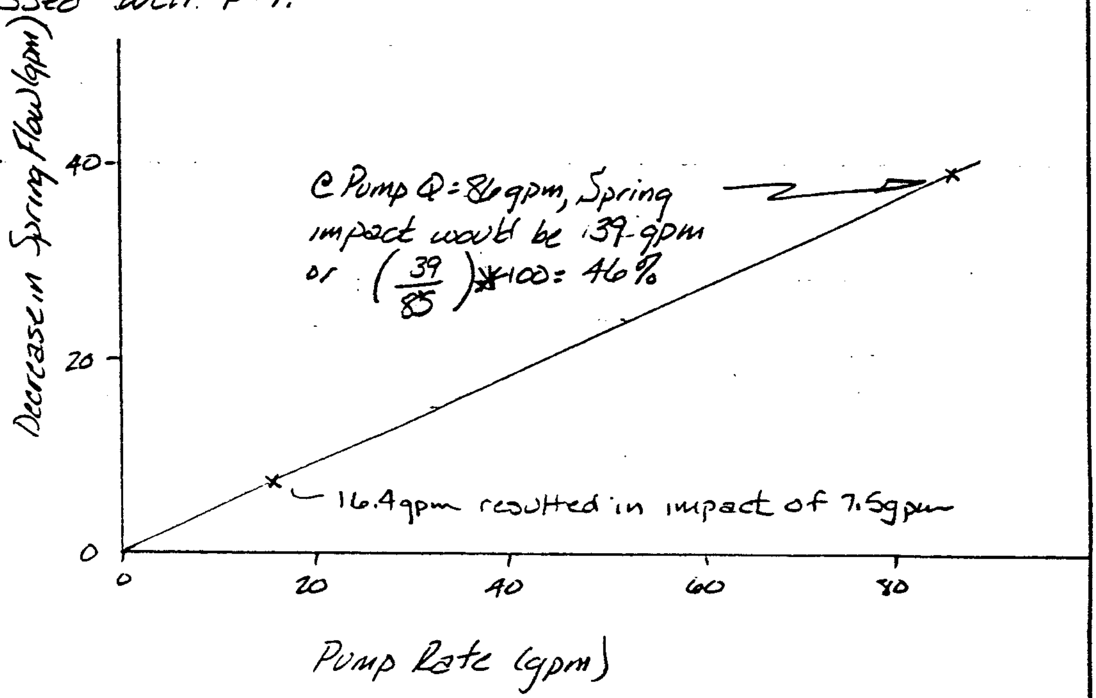
Assume Porosity = 30%

$Q = VA = 4.15\frac{ft}{d} * 4000\,ft^2 = 16{,}600\frac{ft^3}{d}$

$16{,}600\frac{ft^3}{d} * \frac{7.48\,g}{ft^3} * \frac{d}{24\,hr} * \frac{hr}{60\,m} = 86.2$ gpm

Use 86 gpm

TOTAL Avg Pump RATE ~ 16 gpm leaving 70 gpm which bypassed Well P-7.



If P-7 has a 9-10% impact @ Q=16gpm, an increase to 86gpm (all flow from West), a proportional impact would be approximately 46%. - May be low due to bndry Conds.

Check using Short Term Transmissivity - This is the one most natural for the area

$T \sim 35{,}000$ gpd/ft $K = 35{,}000/28 = 1{,}250$ gpd/ft²

$= 167.11$ ft/day

$Q = VA = KiA = 167.11 \frac{ft}{d} * 0.0435 * 4000 ft^2 = 29{,}077.1\ ft^3/d$

151.0 gpm

Avg Pump Rate ~ 16 gpm leaving 135.0 gpm moving downgradient.

Check decrease in Flow Ratio

$\frac{7.5 \text{ gpm decrease}}{16.4 \text{ gpm pump}} * 151 \text{ gpm} =$ 69.1 gpm decrease Expected if all flow is eliminated from Alluvium

% Impact: $\frac{69 \text{ gpm}}{85 \text{ gpm}} * 100 = 81\%$ decrease (IMPACT)

These estimates are straight line approximations only.

Purpose Evaluate high flow conditions at Rilda Canyon.

The attached figures plot the variation in recorded flow of P-1, 2, 3, 4 + 5 as reported by Pacificorp. P-3 represents the flow variation of interest.

It is also reported that the depth of P-3 = 38.0' (El. 7597.1)

Also, it is noted that P-3 is not properly located on the map given this elevation. It has been confirmed with DEH that a 12.8' elevation error exists. The reported top of casing elevation for P3 is 7634.9

Assumptions.

1. Groundwater conditions in P-3 ≈ P-7
2. Average peak flow (over period of record) ≈ Elev. 7611
3. Static elevation in P-3 at time of pump test would be 7589 (if P-3 were deep enough to record this)
4. $\eta = 0.30$
   $K_{long\ term} \simeq 95.49$ ft/day } from DEH 12/17/90
   $K_{short\ term} \simeq 167.11$ ft/day }
   $i = .0435$
5. Assume sub surface at R-3 is similar to that at P-3.
6. Assume Δh between creek and P-3 ≈ 10.0'

Given that P-3 is located ≈65' N of ℄ creek. + Using R-3 data
1. depth to bedrock is 50' below creek elevation
2. inferred depth to bedrock from top of P-3 ⇒ 60', or elevation is 7574.9 at bedrock.

Calculate the additional flow Q, available when flow is at peak rate (Elev 7611) vs flow at static level (7589)
(Well P-3 Average) (Well P-7 in Nov 1990)

Short term

$$Q = KiA \Rightarrow \left(167.11 \frac{ft}{day}\right)\left(.0435 \frac{ft}{ft}\right)\left(\frac{265+200}{2} * 22'\right)$$

$$Q_{short} = 37{,}182.4 \ ft^3/day \Rightarrow \underline{193\ gpm}$$

long term

$$Q = KiA \Rightarrow \left(95.49 \frac{ft}{day}\right)\left(.0435 \frac{ft}{ft}\right)\left(\frac{265+200}{2} * 22\right)$$

$$Q_{long} = 21{,}247 \ ft^3/day \Rightarrow \underline{110\ gpm}$$

Adjust Spring Flow rate to account for increased spring gradient:

7/87 data shows Δh between P-2 and P-3 is

7611.6 - 7574.2 = 37.4 ft   ΔL = 515 ft

i = 37.4/515 ft = 0.0726   Correct gradient by orienting flow path perpendicular to contours.

Correct gradient by using same ratio which is noted on Map 2 for Nov 1990 data.

Measured Gradient between P-2 + P-3 → (15/350)*100 = 4.29
Actual Gradient (Projected) → (20/460)*100 = 4.35

4.35/4.29 = 1.45% increase

(0.0726 * 1.0145)*100 = 7.37%

Flow Variations $Q = KiA$

Short Term

$Q = 167.11 \frac{ft}{d}(0.0737)(5115 ft^2) = 62,996\ ft^3/day = 327\ gpm$

Long Term

$Q = 95.49 \frac{ft}{d}(0.0737)(5115 ft^2) = 35,997\ ft^3/d = 187\ gpm$

Use these estimates based on Increased gradients with Short Term transmissivities.

Total Alluvium Flow - (High Flow Period)

327 gpm + 45.3 gpm = 372.3 gpm
(45.3 gpm: Pumped)

Peak NEWUA Spring flow recorded is ~ 400gpm (Aug 1987)

If all Alluvial flow contributed to Spring Flow then the impact from this Source would be

$$(372/400)*100 = \underline{93\%}$$

But, not all Alluvial flow enters the Spring System.

If same impact ratios apply during heavy runoff as were accounted for in Nov. 1990, then impact would be

$$Q = \frac{7.5\text{gpm Spring decrease}}{16.4\text{gpm Pump Rate}} * 372\text{ gpm total Alluvial Flow}$$

Q = 170 gpm expected decrease

$$\%\text{ Impact} = \frac{170\text{ gpm}}{400\text{ gpm (8/87)}} * 100 = \underline{42.5\%\text{ decrease}}$$

In Reality, the impact will probably be somewhere between the two estimates because.

1) It is not likely that all alluvial flow will be eliminated.
2) The impact ratio used above will change (likely increase) as alluvial flow decreases.
3) As alluvial flow decreases, Some fault flow will be lost as the fault flow moves to now vacant alluvial zones.

In the extreme, All alluvial flow could be lost plus some fault flow from east-west trending faults. This being the case the remaining flow could be inadequate to feed the spring system.

APPENDIX D

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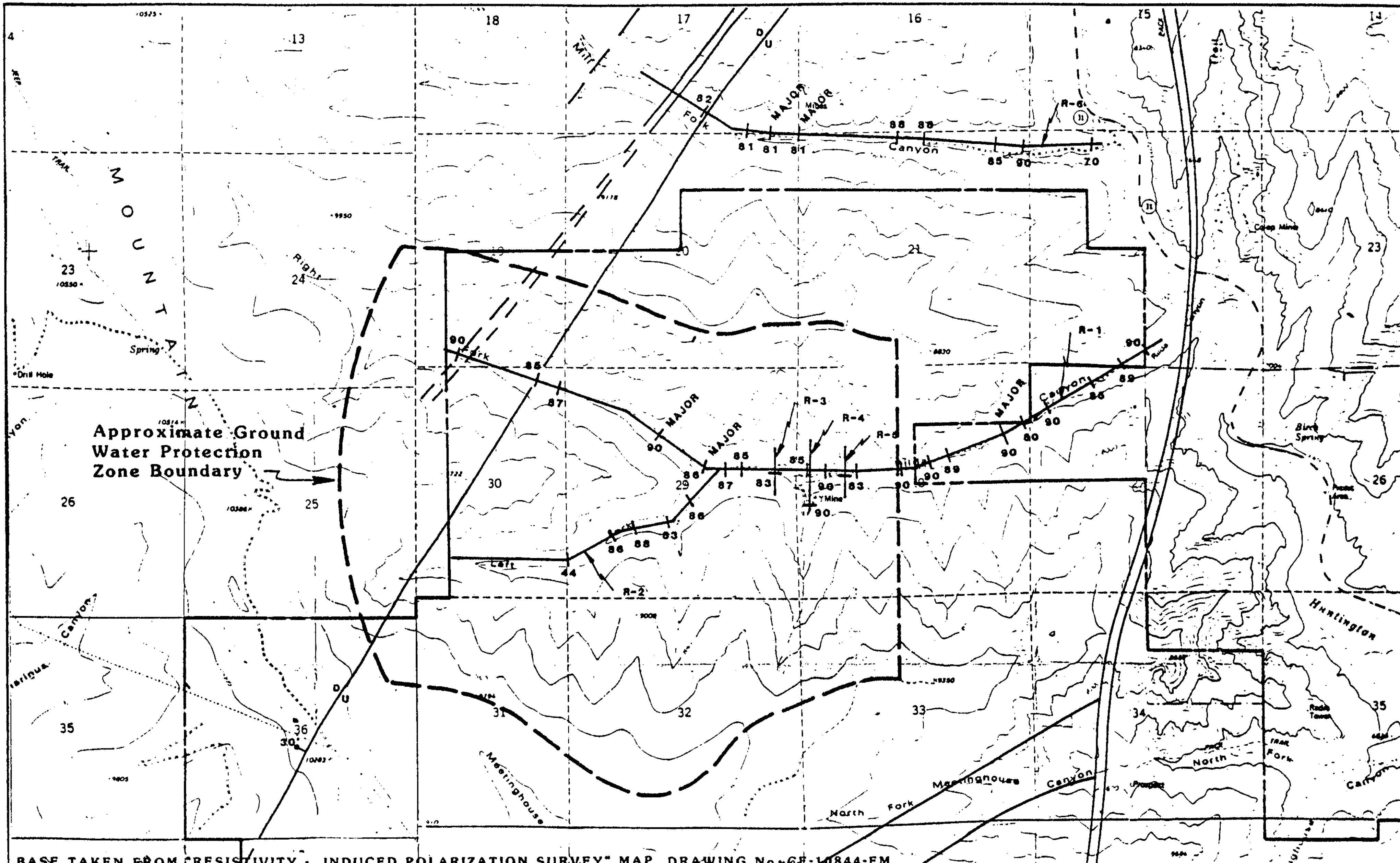

BASE TAKEN FROM "RESISTIVITY - INDUCED POLARIZATION SURVEY" MAP DRAWING No. CE-10844-EM

HANSEN ALLEN & LUCE inc	PACIFICORP FUEL RESOURCES	WATER PROTECTION ZONES	FIGURE D1