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# Summary and Interpretation
# of
# Six Years of Groundwater Monitoring Data
# and
# Four Years of Geothermal Production
# and
# Injection Well Operations
# at the
# SB GEO, Inc
# Geothermal Binary Power Plant
# Steamboat Springs, Nevada

## Volume I
## Report Document

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for
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## Executive Summary

This report summarizes six years of monitoring data that have been obtained by SB GEO, Inc. since January 1985. Full scale geothermal production and injection operations at the SB GEO, Inc. geothermal binary power plant (formerly known as the ORMAT power plant and the GDA plant) began in January of 1987. Geothermal reinjection operations require a permit from the Nevada Division of Environmental Protection (DEP). This five year DEP permit was issued in September of 1986 and comes up for renewal in September of 1991. The permit requires that the operator monitor the geothermal production and injection well flow rates, fluid chemistry and well head pressure over time. In addition, monitoring of water levels in three on-site observation wells is performed. Several off-site shallow domestic groundwater wells and low temperature geothermal wells are also monitored for water level and produced fluid temperature and chemistry. The monitoring of several nearby domestic groundwater wells and shallow low temperature geothermal wells began in January of 1985.

Power plant operations require three production wells, PW-1, PW-2 and PW-3 and one injection well, IW-3. The geothermal supply wells are produced using downhole shaft driven pumps to supply ≈3700 gpm of geothermal fluid to a nominal 7 $MW_e$ binary type power plant. The produced geothermal fluid temperature is ≈338°F. The spent geothermal fluid, with a temperature that varies between 200°F to 230°F, is reinjected back into the geothermal system primarily through injection well IW-3. However, injection well IW-2 has been used as a back-up injection well on several occasions. The power plant uses an air cooled condensing process and, therefore, no cooling water is consumed in power plant operations.

The Steamboat Springs geothermal area has been classified as a Known Geothermal Resource Area (KGRA) by the United States Geological Survey (USGS). The Steamboat KGRA includes a high temperature area, with reservoir temperatures between 420°F to 460°F, located south of the SB GEO, Inc. operations area. A moderate temperature area, with temperatures between 320°F to 360°F encompasses the SB GEO, Inc. property. The reservoir data obtained to date indicates that the high and moderate temperature areas are isolated from each other. In addition to the high and moderate temperature areas, there are numerous low temperature areas in and around the Steamboat KGRA. The low temperature areas vary in measured temperatures, with temperatures >180°F noted. The low temperature areas have not been investigated in detail. Delineation of the low temperature areas is based on data from wells drilled for domestic groundwater use. The hydrogeologic environment of the low temperature fluid occurrence is not clear.

Subsurface production and injection intervals in the SB GEO, Inc. area occur in highly fractured granodiorite and volcanics at depths below ground surface of ≈400 feet to 600 feet. The permeability of this fractured

reservoir system is abnormally high, even when compared to other fractured geothermal systems in the world. The permeability of the geothermal system is orders of magnitude greater than the shallow groundwater system located to the north of the geothermal production and injection area. The fractures in the area are postulated to be steeply dipping vertical fractures striking in a north to northeast direction. The geothermal system being produced by SB GEO, Inc. is bounded to the north by a fault of unknown strike and dip.

The produced geothermal fluid has a total dissolved solids content (TDS) of ≈2200 parts per million. There is no consumptive use of geothermal fluid, and therefore, the reinjected fluid has the same chemistry as the produced fluid. Groundwater in the immediate vicinity of the SB GEO, Inc. power plant is classified as a calcium-bicarbonate type. The geothermal production fluid and shallow low temperature geothermal wells in the area are a sodium-chloride type brine.

Between January 1987 and January 1990 ≈7 billion gallons of fluid have been produced from the geothermal reservoir. Volumetrically, 6.6 billion gallons of water have been reinjected. However, on a mass basis 52 billion pounds of geothermal fluid have been produced and reinjected into the geothermal system. There have been no notable changes in either the produced geothermal fluid temperature or the produced fluid chemistry over the plant operating period.

Many of the domestic groundwater wells and shallow low temperature geothermal monitor wells in the area have well completions that allow for production from shallow groundwater aquifers and deeper geothermal zones. Monitoring data from nearby domestic groundwater wells and shallow low temperature geothermal wells have shown, in some cases, decreasing water levels and changes in fluid chemistry (increasing TDS). Decreasing groundwater levels in the groundwater and shallow low temperature geothermal wells is most likely due to the recent five year drought period and increases in water production from the shallow groundwater system in the South Truckee Meadows area. For wells completed in both groundwater aquifers and deeper geothermal zones, the decrease in available groundwater has manifested itself in a relative increase in the amount of geothermal fluid produced from the well. Thus, the TDS has slowly increased from wells where water levels have been decreasing over time.

In conclusion, the four years of production and injection operations at the SB GEO, Inc. geothermal power plant have shown no adverse impacts on either the geothermal system or the nearby groundwater system. The produced geothermal fluid chemistry and temperature have remained constant over time. Many of the domestic groundwater wells in the area have shown decreasing water levels and increasing TDS since the monitoring program was initiated, 2 years prior to geothermal operations at the SB GEO, Inc. power plant. The monitoring data indicates that

**increased production and injection from the geothermal system will not have any adverse impact on the nearby groundwater aquifers.**

## 1.0) Introduction

SB GEO, Inc. (SBG) owns and operates a nominal 7 $MW_e$ air cooled binary power plant which is located within the Steamboat Springs Known Geothermal Resource Area (KGRA). The Steamboat KGRA is approximately 9 miles south of the city of Reno, Nevada, as shown in Figure 1. Three production wells produce an aggregate ≈3700 gpm of 338°F fluid from production zones at depths between 530 feet and 630 feet below ground surface. Production and injection well locations are shown in Figure 2. Two injection wells, IW-2 and IW-3, are currently available to the project for brine disposal purposes. Well IW-3 is the primary reinjection well which currently returns fluid to the geothermal system at depths between 400 feet and 520 feet. Reinjection temperature varies during the year between 200°F to 230°F due to the air cooled condensing method used for power plant operations.

Water level and produced fluid temperature and chemistry monitoring of the local groundwater system began in 1985, two years prior to full scale geothermal production and injection operations. This monitoring program was initiated in response to concerns of several local homeowners that geothermal development may have an adverse impact on the local groundwater system. The monitoring well locations used in the SBG monitoring program are shown in Figure 3. Several of the monitor wells, Peigh, Pine Tree, Flame, Herz Geothermal, Herz Domestic, Brown School and Trans-Sierra #3, are existing domestic wells. Three additional observation, wells, OW-1, OW-2 and OW-3, are located within the lease area and are monitored for water levels. These three wells were drilled as geothermal exploration wells during the early portion of geothermal development. Water samples and water levels are taken on a monthly basis for several off-site monitor wells. Several of the monitor wells have experienced a change in use or have had well pump failures since the initiation of the project and, therefore, are no longer available for monitoring.

This report describes the monitoring data that has been obtained during the six year period between 1985 to 1990. The data are analyzed for selected geothermal wells and monitor wells . Comparisons of the data over time are shown. The detailed individual well data are given in the Appendices following this report.

## 2.0) Geologic Description of the Steamboat Area

(Geology by Peter van de Kamp, Cornelis Corp., Napa, California)

### 2.1) Introduction

The geology of the Steamboat Springs area was mapped in detail by Thompson and White (1964) and their work forms the basis for the geological evaluation of the SB GEO, Inc. leases in the northeastern Steamboat Hills area. That information is supplemented with considerable subsurface data obtained in drilling for geothermal production and injection by SBG. The Thompson and White report includes a detailed geological map and several cross-sections through the area. This report presents a new cross section through the SBG geothermal area based on surface and subsurface data obtained since Thompson and White completed their study.

2.2) Rocks Present in the Area

The oldest rock unit present in the northeast Steamboat Hills is the granodiorite of Jurassic-Cretaceous age (estimated as 150 to 80 million years old). The granodiorite underlies the SBG leases and is penetrated by several wells as indicated on a north-south cross-section, Figure 4. Younger sediments, volcanic rocks and alluvial deposits overlie the granodiorite.

The granodiorite ranges from very fine to coarse-grained and generally shows little internal structure other than faults, fractures, and joints. Within it there are quartz veins and aplite and pegmatite dikes. Major minerals in the granodiorite are quartz, plagioclase, and K-feldspar with variable biotite, muscovite, chlorite, and amphibole with accessory sphene, zircon, apatite, epidote, pyrite, and magnetite. In some samples, plagioclase is zoned and it ranges from fresh to intensely sericitized and some grains are partially replaced by calcite. K-feldspar includes orthoclase, microcline, and perthites.

In outcrop it is apparent that there has been fracturing and faulting in the granodiorite. These features are also evidenced in drill cuttings from the subsurface by fragments of protomylonite and calcite veins (fracture fillings) in rock fragments. Hydrothermal alteration in and adjacent to fractures is shown by intense sericitization +/- kaolinization of plagioclase, in some cases accompanied by calcite replacement of feldspar as well as altered biotite. The biotite is more or less "bleached" to pale tan from deep brown or green and contains numerous minute grains of opaque material, probably iron oxides.

An unconformity between the granodiorite and the overlying Miocene Alta Formation represents a time hiatus of approximately 60 million years. The hiatus represents the late Cretaceous and Early Tertiary Laramide uplift and erosion event which removed several kilometers thickness of older metamorphic rocks into which the granodiorite was intruded to expose the granodiorite. Subsequently, volcaniclastic sediments and volcanic flows of the Alta Formation and the Kate Peak Formation were deposited on the eroded granodiorite. These volcanic units represent volcanic activity which accompanied the Oligocene-Miocene tectonic extension in the Basin and Range Province. In the SBG lease area, these volcanics and volcaniclastic sediments are up to 500 feet thick.

The Alta Formation is an early to mid-Miocene soda trachyte occurring mostly as lava flows and pyroclastics. In well IW-1 there is a 300 foot thick section of volcaniclastic sediments underlying volcanic flow rocks of the Alta Formation Where fresh, the volcanics are black, glassy rocks with plagioclase and hornblende phenocrysts. More commonly the rock is altered and is grey to purple.

The Kate Peak Formation, overlying the Alta Formation, is late Miocene to Pliocene age and is composed of andesitic volcanic flows and tuff-breccias up to several hundred feet thick.

Above the Tertiary volcanics there is an erosional unconformity representing late Pliocene and Pleistocene uplift and erosion. This event caused erosion of volcanics and granodiorite toward the south as indicated on the cross-section, Figure 4,. Alluvium now covers the erosionally thinned volcanics and granodiorite southward across the SBG field.

The alluvial sands, gravels, and boulder conglomerates are the youngest deposits in the area and represent debris eroded from rocks in the mountains west of the SBG lease area. These deposits are about 100 feet to 300 feet thick in the lease area and thin to the south toward bedrock outcrops but thicken to the north and east into the South Truckee Meadows area. In the area of the SBG production and injection wells, there is abundant silica sinter in the alluvium deposited from ancient hot springs which once flowed in the vicinity of the wells. The effect of the sinter is to cement the unconsolidated alluvium into a hard rock with much lower porosity and permeability than the alluvium in the surrounding South Truckee Meadows area.

2.3) Geologic Structure

The SBG leases are in an area of the northeastern Steamboat Hills which is part of the larger Steamboat Hills structural block which was uplifted relative to areas to the east, north, and west in Late Tertiary and Recent times. The uplift is bounded by steep dipping north-northeast and east-northeast trending normal faults with displacements of hundreds to 1000 feet or more. Faults with similar orientations also cut through the Steamboat Hills Block but appear to have relatively small displacements. In the vicinity of the SBG leases, the north-northeast trending faults are most significant for production of geothermal fluids.

The SBG production and injection wells are located along a north-northeast trending fault zone. In the distant past, this fault zone issued geothermal fluids to the surface where active hot springs and silica sinter precipitation, similar to the modern situation at the Steamboat Hot Springs located to the east, occurred. The fault of importance to SBG production is parallel to the Mud Volcano Fault, which is located about 4000 feet to the west. The Mud Volcano fault also has previously active geothermal manifestations. From available data, a possible orientation of SBG productive fault is estimated to be striking north 10 to 20 degrees east and dipping 80 to 85+ degrees west. This interpretation is based on the geometry of the surface fault trace and the intersections of lost circulation zones in the subsurface.

Production wells PW-1 and PW-3 and injection wells IW-2 and IW-3 have high permeabilities which are apparently related to the fractures in the north-northeast trending fault zone. Production well PW-2, which has a lower productivity than the other production wells, may have only partially penetrated the fracture zone. Observation well IW-1 (formerly classified as an injection well) may have less transmissivity because it is located several hundred feet west of the productive fault zone. The geologic information also suggests that a fault is located to the north of injection well IW-3. This fault may isolate IW-1 from the production field. A comparison of temperature data (discussed below) between injection wells IW-3 and IW-1 indicates that this fault is acting as a boundary to the northerly movement of geothermal fluid. The strike and dip of this fault is unknown. The actual boundary mechanism is not clear at this time. However, there is a distinct vertical offset and a decrease in temperatures in well IW-1. This well, IW-1, is the most northerly deep well in the field and the only well in which the volcanoclastic sediments have been found.

## 3.0) Production and Injection Well Data

### 3.1) Introduction

Production and injection rates are monitored continuously. Produced and injected fluid temperatures and pressures are monitored. In addition, downhole pressures in the production and injection wells are monitored. Fluid samples are analyzed for chemistry, pH and electrical conductivity annually.

Three production wells, PW-1, PW-2 and PW-3 (PW denotes production well) and two injection wells, IW-2 and IW-3 (IW denotes injection well), are used for the project. Injection well IW-3 is the primary injector with IW-2 used as a back-up well. The locations of the wells are shown in Figure 2. The wells are spaced relatively close together, approximately 500 feet (≈5 acre well spacing in oil field terminology). This close spacing is allowable due to the high permeability of the reservoir (transmissivity of ≈2,000,000 md-ft). The injection area is located 500 feet from production well PW-1. No reservoir cooling has taken place due to reinjection. Reservoir testing has shown that there is hydraulic pressure communication between the production and injection wells.

### 3.2) Well Completion Data

The north-south cross section shown in Figure 4 also schematically represents the well completions for the production and injection wells (detailed well completion information are given in Appendices 1 through 5). The production intervals are located between 530 feet and 630 feet in granodiorite. Data from a recently drilled production well, located south of the existing production wells, indicates that the production interval extends to the south.

The injection zone is located between 400 feet and 520 feet. Injection well IW-2 was perforated at 400 feet in the volcanics and is also open to the granodiorite. The injection zone in IW-3 is located in both the volcanics and apparently at the contact between the volcanics and the deeper granodiorite.

3.3) Production and Injection Well Fluid Chemistry and Temperature

Table 1 shows the major chemical constituents of the produced fluid (detailed production fluid chemistry data are given in Appendices 1 through 3). Samples of production fluid are taken on a yearly basis. The geothermal brine chemistry has remained essentially constant over time and is similar for each of the production wells. The fluid is reinjected without removal of steam in the binary power plant process, and therefore, the injected fluid chemistry is the same as the produced fluid chemistry (ignoring a small amount of scale that forms in the heat exchangers). The brine is a sodium chloride type fluid which has a total dissolved solids (TDS) content of 2200 parts per million (ppm). The fluid is high in Boron (42 ppm) with an arsenic level of 1.5 ppm.

Table 1
Chemical Constituents of Geothermal Brine
at the SB GEO, Inc. Geothermal Field
Steamboat Springs, Nevada

| Constituent | Dissolved Content (ppm) |
|---|---|
| TDS | 2200 |
| Cl | 780 |
| Ca | 15 |
| Mg | 0 |
| Na | 605 |
| K | 59 |
| $SiO_2$ | 300 |
| F | 2.1 |
| B | 42.5 |
| As | 1.5 |
| $SO_4$ | 106 |

Figure 5 shows the static temperature versus depth data for selected wells in the well field. Maximum temperatures are approximately 338°F. Maximum temperatures occur between 300 feet to 600 feet in the production and injection wells (PW-1, PW-2, PW-3, IW-2, IW-3). Well IW-1, the northerly most well in the field, has a maximum temperature of ≈300°F at a depth of ≈800 feet. This data, along with the geologic information discussed above, and the fact that the transmissivity of well IW-1 is much lower than the production and injection wells, suggests that there is a flow boundary between this well and the production and injection field. The strike and dip of this boundary has not been determined.

Produced fluid temperature has remained relatively constant at 338°F. Injection temperature varies with time of the year due to atmospheric temperature effects on the plant cooling system. Power plant modifications in December of 1988 have reduced the injected fluid temperature to between 200°F and 230°F.

3.4) Production and Injection History

Figure 6 shows the monthly average production rates for each of the production wells. Flow rates varied considerably during the first year due to power plant modifications and well pump problems. Production rates have been relatively constant over the last 3 years at ≈3700 gpm.

Figure 6 also displays the injection rate versus time for injection wells IW-2 and IW-3. Well IW-3 is normally used during power plant operations with IW-2 acting as a back-up well. The casing in well IW-3 reportedly "fell" several inches during late 1988 (reports vary on the amount of casing drop from several inches to 18 inches). The well was shut-in and an additional casing string was cemented inside the existing casing from 366 feet to surface (see Appendix 4). There are no data to determine whether there was any damage to the original casing in IW-3. During the IW-3 shut-in and workover period, back-up injection well IW-2 was used for reinjection.

Figure 6 also shows the total produced fluid and total injected fluid versus time. Approximately 7 billion gallons of water have been produced as of the end of 1990. The total injected volume is on the order of 6.6 billion gallons of water. The produced fluid volume and injected fluid volume are not equal due to the difference in temperature between produced and injected fluid. On a mass basis, the produced and injected masses are equal at 52 billion pounds.

It should be noted that no production well cooling has been observed. If the production and injection wells were completed in a homogeneous sandstone type reservoir, breakthrough (the appearance of injection fluid at the production wells) at well PW-1 would have occurred after 15 days. Thermal breakthrough of cooled injected fluid would have been ≈25 days. By this time all of the production wells would have been cooled to the injected fluid temperature. The fact that there has been no cooling of the production wells indicates that the reservoir consists of steeply dipping fractures (as noted in the geologic structure). The reservoir structure and strong upward movement of hot geothermal fluids appears to cause the injected fluid to move vertically downward rather than laterally through the system.

## 4.0) Monitor Well Data

### 4.1) Introduction

Three observation wells are located on the site, OW-1, OW-2 and OW-3 (OW denotes observation well). These wells are small diameter wells drilled early in the geothermal project for exploration purposes. Well IW-1 was originally drilled as an injection well but the well injectivity was too low for use in the project. The well locations are shown in Figure 2. Well IW-1 and the observation wells are monitored for downhole pressure with capillary tubing and surface pressure gauge. In addition, these wells have low wellhead pressures that are measured. The pressure monitoring data are not shown in this report due to numerous measurement problems, unknown setting depth of the tubing, changes in equipment with time, incomplete data set, etc.

Seven privately owned domestically used wells are monitored off-site (these wells have been denoted by the owners name and termed monitor wells). The well locations are shown in Figure 3. The wells were drilled by local home owners or industrial users for private use. The owners have allowed SBG to monitor their wells. The wells were drilled as domestic groundwater wells. Drilling and completion data are ambiguous (except for the Herz Geothermal well).

Monitoring of the wells began in December 1984, two years prior to full scale geothermal production and injection operations. Full chemical analyses have been carried out quarterly and partial chemical analyses (partial analyses includes fluid temperature, TDS, Cl, B, As, $SO_4$, electrical conductivity and pH) are performed monthly. Water levels are measured monthly on wells with access for level equipment. Chemical analyses are carried out on waters from pumped wells. In some cases, well pumps have failed or wells have been modified in a manner that do not allow further monitoring. Table 2 details the type of monitoring performed on each of the wells.

Table 2
SB GEO, Inc. Off-site Monitoring Program
Steamboat Springs, Nevada

| Well Name | Chemical Analyses | Water Level | Fluid Temperature |
|---|---|---|---|
| Herz Geothermal | X | X | X |
| Herz Domestic | X | | X |
| Peigh | X | | X |
| Pine Tree | X | X | X |
| Flame[1] | X | X | X |
| Trans-Sierra #3[1] | X | X | X |
| Brown School | X | | |

Note 1: indicates well no longer available

4.2) Monitor Well Completions

The monitor wells have been drilled and completed to groundwater well standards set forth by the Nevada Division of Water Resources (DWR). Groundwater wells in this area are typically drilled and completed by drilling the well to its total depth. The casing string is inserted in the well with the desired amount of slotted section at the bottom of the string and the upper portion blank. The slotted interval is gravel packed from the bottom of the hole to the top of the slotted casing interval. The blank upper portion of the string is cemented to the surface. Well casing diameters vary. Geologic materials encountered during drilling are interpreted by the well driller.

Detailed well completions and geologic descriptions are not available for the monitor wells. One of the monitor wells, Herz Geothermal well, was drilled in 1948 and some data are available in USGS reports by White (1968). The other monitor wells are assumed to be drilled between 1950's through the 1970's. DWR records are available for several wells in the area. However, the DWR records do not give detailed locations of the wells. In many cases, several wells have been drilled at the same reported location. Owners of the wells are usually not clear which well is which due to the fact that the wells were drilled years ago. In some cases the original well owner is not available. Available data are presented in Appendices 6 through 11.

## 4.3) Monitor Well Fluid Chemistry, Water Level and Temperature Data

Data plots from the monitor wells (except Trans-Sierra #3) are discussed individually in the following sections. Comparisons of the data are then made. The chemistry data have been plotted on Piper Diagrams (Piper, 1944) to allow for a visual inspection of well fluid chemistry changes with time. Temperature and water level data are also plotted with time. Monthly data from the monitoring wells are given in Appendices 6 through 11.

### 4.3.1) Pine Tree Ranch Well

Figure 7 shows the water level and produced fluid temperature and TDS data obtained from the Pine Tree Ranch Well (see Figure 3 for well locations). The upper data plot shows the produced fluid temperature and TDS versus time. The plot shows that as the temperature of the fluid increases the TDS increases. The lower data plot shows the well water level and produced fluid temperature as a function of time. As well static water levels decrease fluid temperature increases. There is also an annual cyclic variation in temperature that correlates with the cyclic variation in water level. In addition, the data indicates that water levels were decreasing prior to 1985. It is not clear how long water levels have been declining in the South Truckee Meadows area.

Figure 8 shows the water chemistry plotted on a Piper Diagram. The Piper Diagram represents the major cations and anions as a percent of total milliequivalents per liter (meq/l). The the Pine Tree Ranch fluid has increased over time in Cl and Na+K while decreasing in Ca, Mg and $HCO_3$.

### 4.3.2) Peigh Domestic Well

Figure 9 shows the data on produced fluid temperature and TDS versus time. The data show the TDS cyclically varying with time. There does not seem to be any direct relationship between fluid temperature and TDS. There are no water level data for this well. The produced fluid temperature is 85°F to 90°F, elevated above the mean annual air temperature of 50°F for this area. The TDS is low at 240 ppm. The chloride content (see Appendix 6) is 5 ppm.

Figure 10 is a Piper Diagram for the fluid chemistry. The data show no change in fluid chemistry with time. The well water for the Peigh Well is assumed to be groundwater with little or no geothermal component (this will be discussed in more detail below). The water is classified as a Ca-$HCO_3$ (calcium - bicarbonate) type water.

4.3.3) Flame Well

Figure 11 shows the water level and temperature and TDS of the produced fluid for the Flame well. This well may have been in use when the Flame Bar (located on Highway 431) was in existence. It should be noted that this well is located approximately 400 feet south of the Pine Tree Ranch Well. The data shows the the TDS has been increasing since 1985, two years prior to geothermal operations in the area. The TDS was 425 ppm in 1985 and increased to 1200 ppm in 1986. The fluid temperature increased from 50°F to 130°F during the same period. The reason for the decrease in temperature and increase in water level beginning in the first quarter of 1989 is unclear. However, this decrease in temperature occurred near to the time when the Flame Bar closed. Changes in well use may have affected the data.

Figure 12 depicts the well fluid chemistry on a Piper Diagram. The Ca has remained low and the Na+K high. The Cl has increased with time while the $HCO_3$ has decreased.

4.3.4) Herz Geothermal Well

Figure 13 shows the water level and produced fluid temperature and TDS for the Herz Geothermal well. This well had a measured bottom hole temperature of 180°F and a water level of 60 feet 54 days after it was drilled in 1948. The well has a TDS of ≈1150 ppm and a produced fluid temperature of 125°F. The data plot shows that the water level was initially increasing from 1985 to the first quarter of 1988. During this period the TDS and temperature were falling slightly. The water level and temperature data indicate that as the water level increased the well temperature decreased. Following the first quarter of 1988, the fluid TDS and temperature increased as water levels decreased. This variation of temperature and TDS with water level is similar to the behavior in other wells. However, the increasing water level is not . The reason for this increasing water level is not clear. However, previous reports by van de Kamp and Goranson (1990) have noted this water level behavior in other wells in the area.

Figure 14 shows the water chemistry plotted on a Piper Diagram. The fluid chemistry has not changed with time. The fluid is classified as a Na-Cl brine. This fluid has the same signature as the SBG produced geothermal fluid.

4.3.5) Herz Domestic Well

Figure 15 shows the water level and the produced fluid temperature and TDS of the Herz Domestic well. The ≈220 ppm TDS is low. Prior to 1989, this well has large annual cyclic variations in the average produced fluid temperature. The fluid temperature varies with the time of the year by 35°F (from a minimum of 45°F to a maximum of 80°F). The TDS and temperature of the fluid began to increase in 1989. The water level began decreasing in 1986. In general, this well behaves similar to other wells in the area with an increase in temperature and TDS with decreasing water levels.

Figure 16 is a plot of the water chemistry on a Piper Diagram. The Cl has remained low while the Mg and Ca have decreased. The Na+K, $HCO_3$ and Cl have remained essentially constant over time. The trend in chemistry of this well is not clear. The 1990 data indicates that the Cl is beginning to increase and the $HCO_3$ is beginning to decrease. Additional data are needed to discern a trend.

4.3.6) Brown School Well

Figure 17 shows two plots of the TDS versus temperature for the Brown School Well at different TDS scale values. The TDS of this well has increased from 220 ppm to 1200 ppm since the middle of 1988. The upper plot demonstrates that the temperature and TDS of the fluid varies cyclically, as do other wells in the area, with the time of year. There is no increase in the average fluid temperature with time. This is clearly different from other monitor wells in the area that show good correlation between well temperature and TDS (ie, increase in TDS with an increase temperature).

Figure 18 shows plots of Cl, B and Cl/B ratio. The Cl-B plot shows that the Cl began increasing in the first quarter of 1988. However, the B did not begin to increase until about nine months later. The Cl-Cl/B plot indicates that the Cl/B ratio began to increase when the Cl began to increase. The Cl/B ratio reached a maximum of 310. The Cl/B ratio began decreasing as the B level began to increase.

Figure 19 is a Piper Diagram for the Brown School fluid. The data show that Cl is increasing and the Ca and Mg are decreasing. In addition the $HCO_3$ has decreased along with the Na+K.

It should be noted at this point that the geothermal water in the Steamboat Springs area has a constant Cl/B ratio of about 20. The fact that the Cl/B ratio reached a maximum of 310 in the Brown School well indicates that the source of the Cl was not geothermal fluid. It is also interesting to note that the CL/B ratio is exponentially declining to a level near that of geothermal fluids in the area. This exponential decline suggests that a slug of Cl rich solution had entered the aquifer system in which this well is completed.

5.0) Comparison and Interpretation of the Monitor Well Data

5.1) Introduction

Comparisons of the data obtained from the monitor wells can be made in several ways. The Piper Diagrams can be used to interpret the chemistry data in terms of mixing models and classify the well fluids as to there water facies (Back, 1962). The water classification can delineate groundwater, geothermal fluids and mixed groundwater-geothermal fluids. However, the fluid temperature data suggests that all of the monitor wells may have some geothermal component. Other methods can be used in geothermal evaluations to determine mixing models (Cl/B ratios, Cl-enthalpy plots, etc.) but they are not relevant to this report.

Detailed interpretation of the monitor well chemistry behavior versus time is hampered by the unknown well completions. Measured bottom hole temperatures in some wells are as high as 180°F. Produced fluid temperatures are elevated with respect to the mean annual air temperature in this area. The monitor wells have temperatures that vary with the time of the year. The produced fluid temperature variations correlate with the cyclic variation of well fluid water levels. There are no detailed temperature surveys for the monitor wells. nor are any geologic interpretations available. The correlation of cyclic water level variations with produced fluid temperature indicates that the monitor wells are completed in both a shallow groundwater aquifer(s) system and a deeper(?) geothermal system.

5.2) Water Chemistry Data Interpretation

Figure 20 is Piper Diagram with the water facies delineated. Data from 1985 and 1990 are shown on the plot (data for 1990 are not available for several wells and 1989 data are used). Also included on the Figure are data from the SBG production field. The Peigh well (P) is a Ca-$HCO_3$ type fluid. This fluid has low TDS, low Cl and low temperature and is assumed to be pure groundwater. The geothermal production fluid (X) is high in Cl and Na and low in $HCO_3$ and is classified as a Na-Cl brine. Mixing of geothermal fluid and groundwater (in the absence of any chemical reaction between the two) will be represented as a data point that would be located along a straight line drawn between the geothermal fluid (point X) and the groundwater well (point P). It is obvious that several of the wells fall along this line in 1985 and 1990.

Another graphical representation of the chemistry data that includes the magnitude of the dissolved solids content is made on a Schoeller Diagram (Schoeller, 1955). This plot is shown in Figure 21. This Figure also allows for a division to be made between the well fluid chemistries. The upper curve shows the Peigh groundwater well. The middle plot shows the wells that are mixed geothermal-groundwater wells and the lower plot shows the geothermal wells. The groundwater wells are high in Mg, Ca and $HCO_3$. The geothermal wells are high in Na and K, Cl and B ($SiO_2$ also) and low in Ca, Mg and $HCO_3$. Visually (or analytically) the groundwater and geothermal fluids can be mixed with the output being the middle plot of Figure 21.

(Note: The Herz Domestic well (HD) and the Brown School (B) initially show up in the "No Dominant" type category of water classification. It is assumed that they are mixed geothermal and groundwater fluids. However, as shown below, they do not behave over time exactly as would be predicted from a non-reactive mixing model. Additional fluids may be in the area that are mixing with the fluids in these two wells. Additional geothermal fluids (and possibly groundwater fluids) exist in the area immediately east of Brown School.)

Figure 22 is a Piper Diagram with data from 1985 and 1990 along with arrows showing the trend in the data for individual wells. As mentioned above there are three different types of well fluid; groundwater, mixed geothermal-groundwater, and geothermal fluid. An explanation of each of the wells is given below (letter(s) in parentheses in the text are the letter designations used in Figure 22):

The Peigh (P) well is a assumed to be a pure groundwater well (although its fluid temperature is 90°F, above the mean average annual surface temperature of 50°F). The chemistry data indicates that there has been no change in the fluid chemistry over time.

The Herz Geothermal (HG) well is essentially geothermal fluid. There has been no change over time in the type of fluid in the well, although the TDS has gone up with time.

The Pine Tree Ranch (PT) well originally had a low TDS and temperature. In 1985 the well clearly had the fluid signature of a groundwater well. Over time the well has slowly produced a larger portion of geothermal fluid relative to groundwater fluid. However, there are large excursions in the TDS in 1988 and 1989 the reason for which is unknown.

The Flame (F) well is located 400 feet south of the Pine Tree Ranch well. The Flame well had a TDS that was somewhat higher than the Peigh groundwater well in 1985. The TDS increased from 425 ppm to 1200 ppm between 1985 to 1986. However, the well has slowly increased in the amount of geothermal fluid produced. The TDS is much higher than the Pine Tree Ranch well, whereas the temperatures are similar. It is assumed that the Flame well and Pine Tree Ranch wells are completed in different horizons.

The Herz Domestic (HD) well chemistry behavior is somewhat odd. The well has not changed in Ca and Mg, while the chloride has increased slightly. The Na and K have remained the same while the $HCO_3$ has decreased slightly. This behavior is not consistent with mixing of the Peigh groundwater type fluid and the Herz Geothermal well type fluid. It is possible that other types of groundwater or geothermal fluids are in this area.

The Brown School (B) well chemistry behavior is also somewhat odd. The percent of Cl and $HCO_3$ in the fluid is similar to that of the geothermal fluids. However, the Na and K have decreased over time. This behavior also can not be explained by a mixing model with groundwater and geothermal fluids noted in the other monitoring wells. This may indicate that there are additional fluids in the area that are not noted in the monitor wells. It is also of interest that this well behaves similar to the Herz Domestic well. Both of these wells are located further north of the Steamboat Hills area than the other monitor and geothermal wells. It also should be noted that several geothermal wells are located east of the Brown School well with reported temperatures as high as 240°F.

5.3) Water Level and Temperature Data Interpretation

The groundwater levels in the South Truckee Meadows area have been declining since 1985. The South Truckee Meadows Improvement District (STMGID) has drilled several groundwater production wells and monitor wells north and northwest of the SBG monitor well area. In addition, Yankee Caithness Joint Venture, LP (YCJV) operates a steam flash power plant in the Steamboat Hills area south of the SB GEO, Inc. plant. YCJV monitors several wells in the area south, west and east of the SBG monitor wells area. The STMGID and YCJV monitor well data clearly show that water levels in South Truckee Meadows have been falling since 1985 and continue to fall (see van de Kamp and Goranson, 1990 and Goranson et al, 1990 ). The falling groundwater levels are most likely due to the prevailing drought conditions and the increased groundwater use by domestic and industrial users in the South Truckee Meadows area.

The SBG monitor well temperature and water level data show cyclic variations, long term decline in water levels and an increase in temperature over time. As water levels cyclically vary through the year the produced fluid temperature and TDS similarly vary. As well water levels fall the TDS and temperature of the produced fluids increase. When the water levels rise the TDS and temperature of the fluids decrease. Over time, produced fluid temperatures and TDS have increased as water levels have declined. This suggests that the monitor wells in this area are completed into aquifers that contain both groundwater and geothermal fluid. The monitor well completions and the aquifers penetrated are not known. However, it can be assumed that they are completed as other groundwater wells in the area with long slotted intervals and a 50 foot blank liner and cement cap at the top of the well.

There are two possible mechanisms to explain the temperature versus water level behavior. If we assume that monitor wells are completed in unconfined (or unsaturated) groundwater aquifers and a deeper geothermal aquifer (confined or completely saturated) then as groundwater levels decline the shallow unconfined aquifers will be reduced in the amount of groundwater they supply to the well bore. Since the flow rate from the monitor wells is constant over time (approximately) then the amount of geothermal fluid produced will increase with respect to the amount of groundwater produced from the well. Thus, the temperature and TDS of the fluid will increase and the chemical signature of the produced fluid will change with the fluid signature reflecting the increase in produced geothermal fluid (as shown in the Piper Diagrams for the well fluids).

Another possible mechanism is that as water levels decline geothermal influx into the shallow aquifer system increases. This allows for the geothermal fluid to "saturate" (or occupy) a larger thickness of the aquifer system that the well penetrates. Therefore, when the well is produced, a larger fraction (as compared to when water levels were high) of geothermal fluid will be produced. This again will allow for an increase in the temperature and TDS of the produced fluid and a change in its fluid signature.

The actual reservoir mechanism that has allowed the well temperatures and TDS to vary annually and increase over time is probably a combination of the above mechanisms. The cyclic variation is probably due to a decline in groundwater influx into the well, while the increase in temperature over time is due to an increased influx of geothermal fluid into the aquifer system.

6.0) Discussion of Production, Injection and Monitor Well Data

The geothermal fluid produced from the monitor wells is locally available to the wells. There are several low temperature geothermal areas located around the Steamboat Hills area. Wells have been drilled shallow to obtain cool groundwater, while a nearby (within 100 feet) deeper well will be drilled to intercept geothermal fluids for domestic heating. The low temperature geothermal aquifers have not been completely delineated. There are numerous low temperature systems to the north and east of Steamboat Hills. Several of these systems are located directly east of the Steamboat Hills area and hydraulically up gradient (ie; in locations that would require geothermal fluid to flow up "hill"). Several low temperature hot spring areas are located (or formerly located ) two to four miles north of the Steamboat Hills area (Zolezzi and Damonte Hot Springs). In addition there are several hot spring areas and warm wells located in the Reno and Huffaker Hills area, miles north of the Steamboat Hills area.

The origin of the low temperature geothermal fluids in the South Truckee Meadows area is not clear. The low temperature fluids have been produced from domestic wells for many years, prior to geothermal production and injection operations. It is not clear whether the heated fluids have moved laterally away from the Steamboat Hills area or whether they are flowing vertically upward through fractures in the bedrock underlying the alluvium. Fluid mixing calculations, using the Peigh type groundwater and the SBG geothermal fluid, do not yield consistent results.

Of main concern to the geothermal operators, local homeowners, and various State and County Agencies is "*What effect have geothermal production and injection operations had on the local groundwater system in the vicinity of Steamboat Hills?*". It is clear from the production, injection and monitoring data obtained over the last six years, by both of the geothermal operators at Steamboat Springs, that there has been no effect on the local groundwater system from geothermal operations. The geothermal fluids produced from the low temperature monitor wells are similar in chemical signature to the SBG production wells. The shallow domestic groundwater wells have intercepted and produced geothermal fluid long before geothermal operations began in the area. The chemistry of the monitor wells has changed with time for several of the wells. However, these changes were beginning before geothermal operations commenced and are in fact due to domestic well completions that intercept both groundwater aquifers and a deeper low temperature geothermal system. Recent drought conditions and increased use of groundwater in the South Truckee Meadows area have caused groundwater levels to decline. This appears to have allowed geothermal fluid in the subsurface to migrate vertically upwards into the domestically used shallow aquifers. This influx of geothermal fluid, along with the decline in the amount of groundwater supply available to enter the wells, has allowed well temperatures and TDS to increase with time.

Another aspect that should be noted is that if reinjected geothermal fluid were moving laterally away from the production and injection area, one would expect water levels to rise in the area to the north. This is due to the fact that the injection well(s) are located physically closer to the northern monitor wells than the production wells (see Goranson 1989). There have been no water level increases in the area, only water level declines. In addition, the closest wells, the SBG production wells would be the first to see the injected fluid, and, by this time, the production wells would have cooled to the injected fluid temperature.

The injection and production wells are completed into the same highly permeable geothermal system. This is born out in; 1) the temperature of the injection wells is the same as the production wells, 2) the productivity (injectivity) of the injection wells is similar to the production wells, and 3) the chemistry of the production and injection wells is similar. The local groundwater wells have permeabilities that are orders of magnitude lower than the geothermal system. Fluid flow is always along the path of least resistance, which in this case is through the geothermal system and not outward into the groundwater area. In addition, the geologic and well temperature data suggest that there are flow boundaries to the north of the injection area. This would also reduce fluid movement to the north.

There has been concern that geothermal injection operations have caused the changes noted in the chemistry of the Brown School well. The chemistry data indicates that Cl began increasing nine months before B increases were noted. Since Cl and B are, in most cases, conservative (non-reactive) elements there is no way to explain the time delay in the B reaching the well. In addition, the initial Cl/B ratio (310) is much greater than that of the geothermal fluids (20). It is obvious that the Cl increase had to come from an extraneous source, other than reinjected geothermal fluid. However, it is likely that the Brown School well is producing a larger portion of geothermal fluid than in the past, similar to other wells in the area. Again, it should be noted that the Brown School well is located very near to an area where shallow wells have been drilled into a low temperature geothermal system with measured temperatures >240°F.

## 7.0) Conclusion

This report summarizes and interprets the production, injection and monitor well data obtained over the past six years by SB GEO, Inc. Over 7 billion gallons of geothermal fluid have been produced and 6.6 billion gallons of geothermal fluid have been reinjected as of the end of 1990. The injection wells are completed in the same geothermal system as the production wells. The geothermal injection wells are located 500 feet from the production area. No production well cooling has been observed. Six shallow domestic groundwater wells have been monitored, beginning in 1985. Full scale geothermal production and injection operations were established in 1987.

The shallow groundwater monitoring program has established that the monitor wells are completed in both shallow groundwater aquifers and deeper(?) low temperature geothermal zones. Groundwater levels have been declining in the area since 1985, due to drought conditions and increased water use in the South Truckee Meadows area. The decrease in groundwater levels has caused the domestic monitor wells to produce a larger amount of low temperature geothermal fluid, relative to the amount of groundwater produced, than they had produced in the past. The increased low temperature fluid production is manifested as an increase in produced fluid temperature and total dissolved solids content. One well, the Brown School well, has shown an increase in the produced total dissolved solids content due to an extraneous, other than geothermal fluid, source of chloride.

The monitoring program has been completely successful in developing an understanding of the behavior of the local groundwater system. Geothermal production and injection operations at Steamboat have had no deleterious effects on the local groundwater system . In addition, no reduction in geothermal reservoir output has been noted.

In conclusion, production and injection operations will continue to have no effect on the local groundwater system. Increased production and injection of geothermal fluids are similarly expected to have no effect on the local groundwater system. Continued monitoring of the nearby groundwater system is recommended to gain further understanding of the interaction between the low temperature geothermal system(s) and the

**shallow groundwater system located north of the SB GEO, Inc operations area.**

References

Back, W. 1966 *Hydrochemical Facies and Groundwater Flow Patterns in Northern Part of Atlantic Coastal Plain.* USGS Prof. Paper 498 -A

Goranson, C. 1989 *Reservoir Engineering Study of the Steamboat Springs Geothermal System, Washoe County, Nevada* Unpublished Report Prepared for Yankee Caithness Joint Venture, LP

Goranson, C. 1990 *An Interpretation of the Relationship Between the Local Groundwater System and the Shallow Moderate Temperature Geothermal Areas in the Steamboat Springs Geothermal and South Truckee Meadows Area* Unpublished Report Prepared for Yankee Caithness Joint Venture, LP

Goranson, C., van de Kamp, P. and DeLong, T. 1990 *Geothermal Injection and Monitoring Program at the Caithness Power, Inc. Flash Steam Power Plant Steamboat Springs, Nevada* Proceedings of the Symposium on Subsurface Injection of Geothermal Fluids. Oct. 1990, Santa Rosa, CA

Piper, A. M. 1944 *A Graphic Procedure in the Geochemical Interpretations of Water Analyses.* Trans. Amer. Geophys Union, 25.

Thompson, G.A. and White, D.E., 1964, *Regional geology of the Steamboat Springs area, Washoe County, Nevada*, U.S. Geol. Survey, Prof. Paper 458-A

Schoeller, H. 1955 *Geochimie des eaux Souterraines* Rev. Ins. Franc. Petrole, Paris

van de Kamp, P. and Goranson, C. 1990 *Summary of the Hydrological Characteristics of the Steamboat Hills Area, Nevada* Unpublished Report prepared for Yankee Caithness Joint Venture, LP

White, D. 1968 *Hydrology, Activity, and Heat Flow of the Steamboat Springs Thermal System, Washoe County, Nevada* USGS Prof. Paper 458-C

# Figures

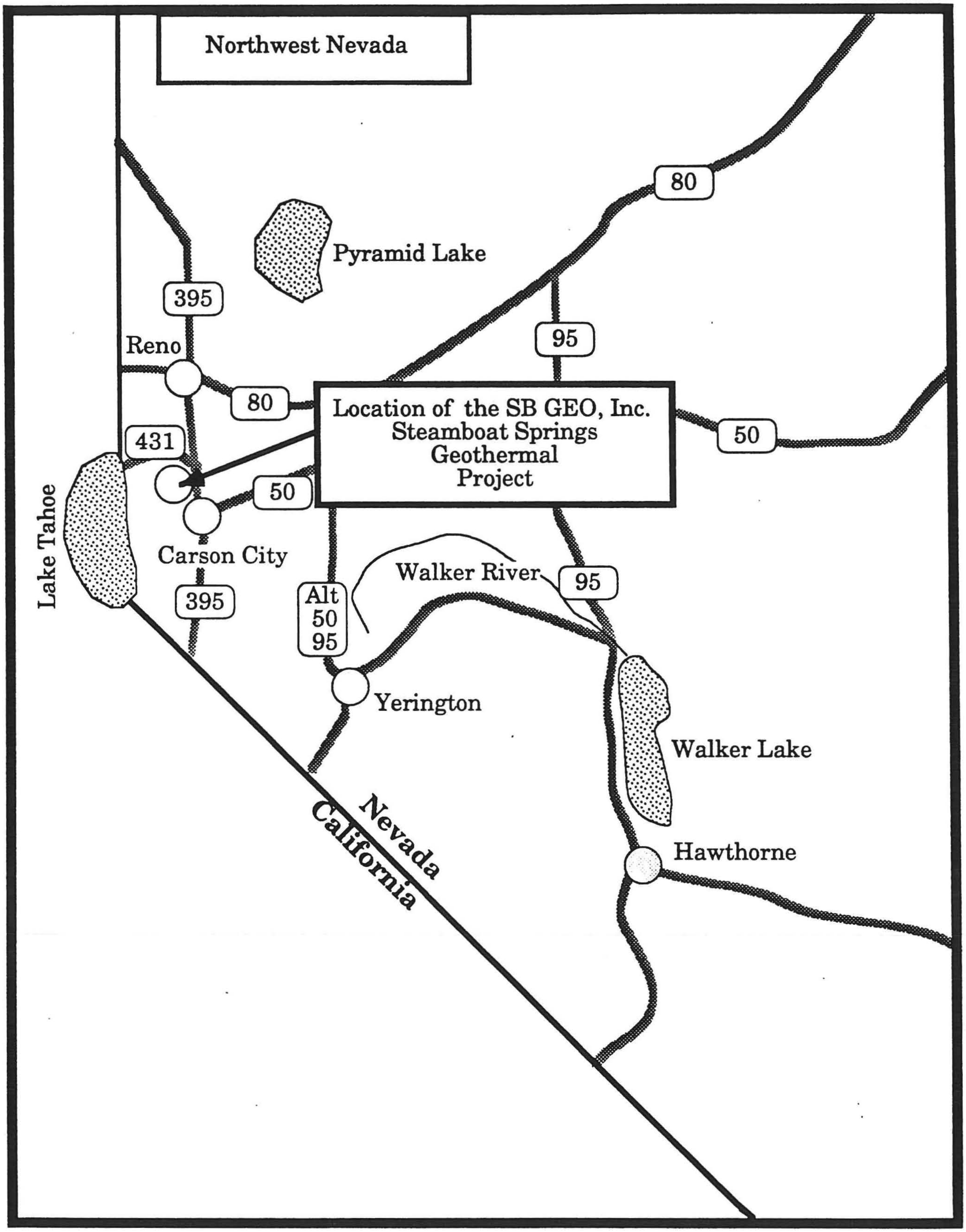



Figure 1) Location of the SB GEO, Inc. Steamboat Springs Geothermal Project

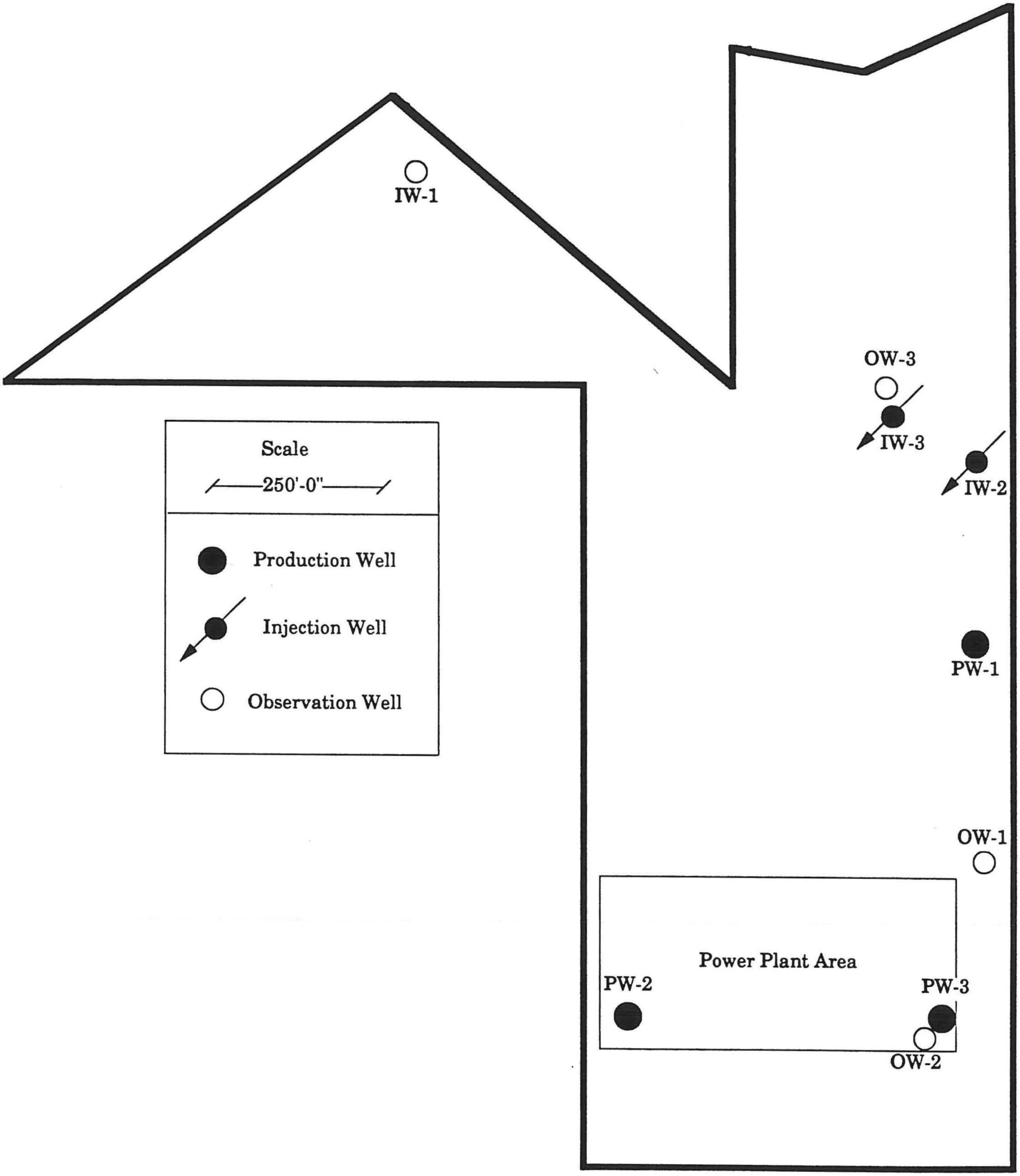



Figure 2) SB GEO, Inc. Production and Injection Well Locations

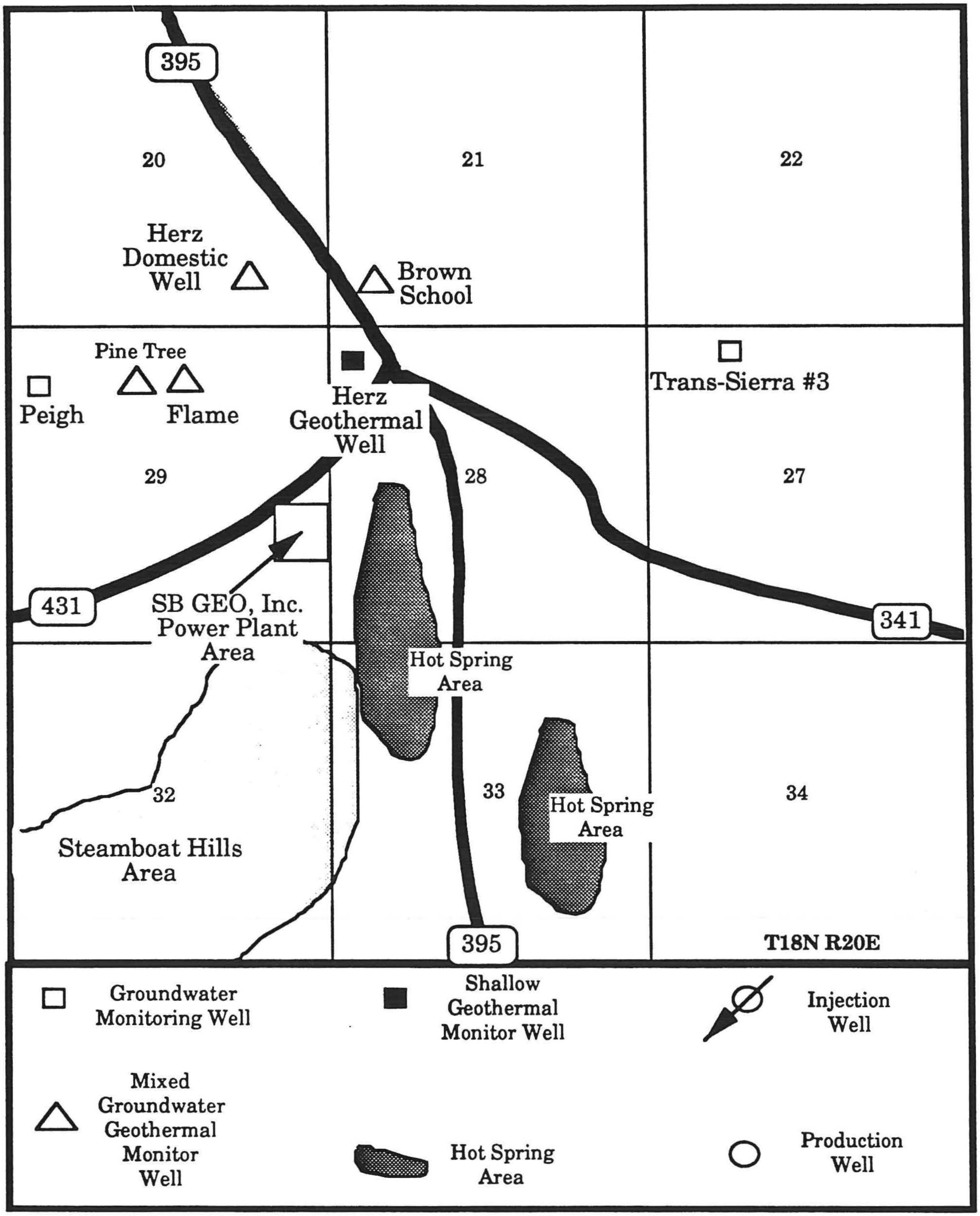



Figure 3) Location of SB GEO, Inc. Monitoring Wells

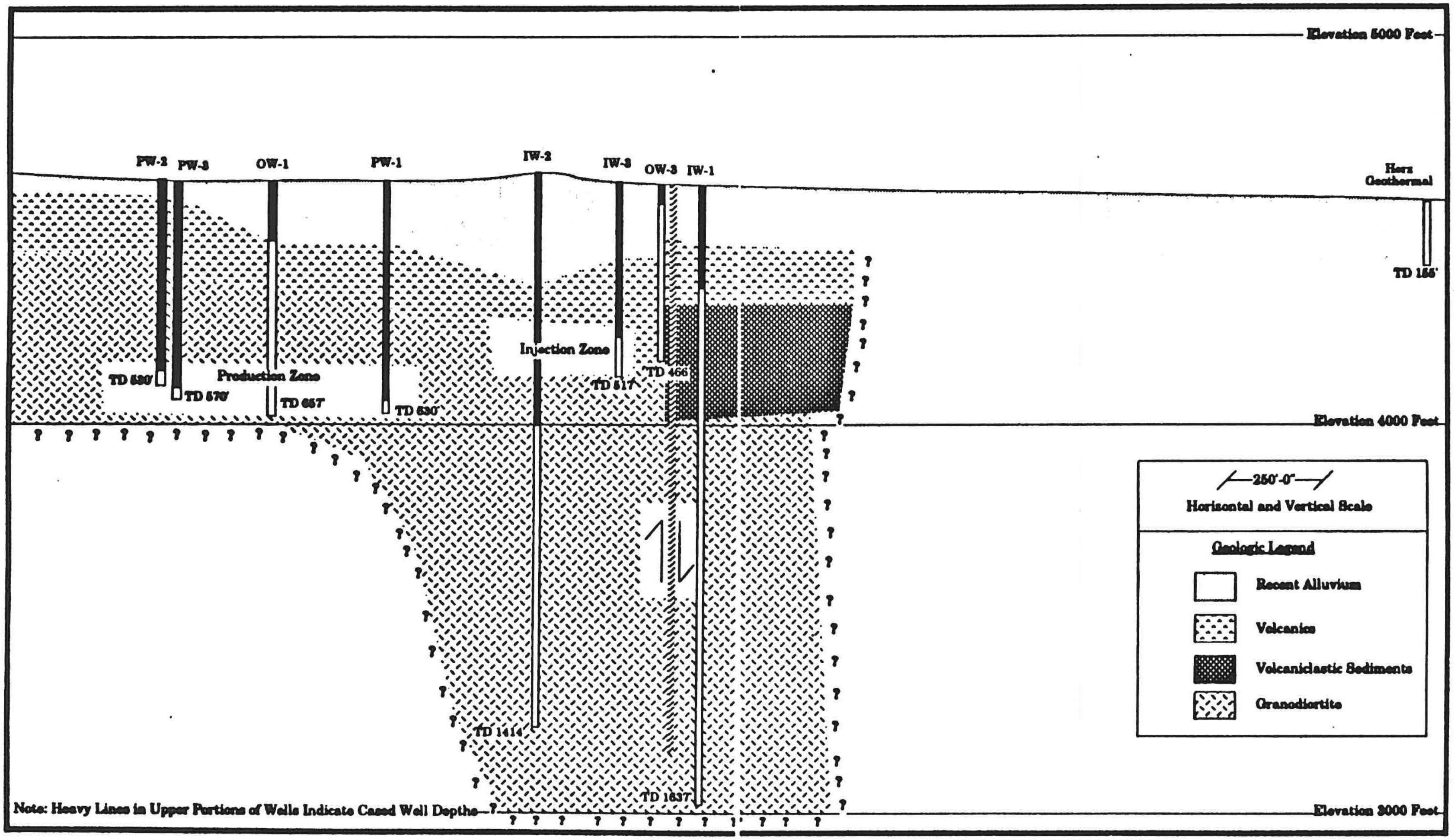



**Figure 4) North - South Cross Section Through the SB GEO, Inc. Field**

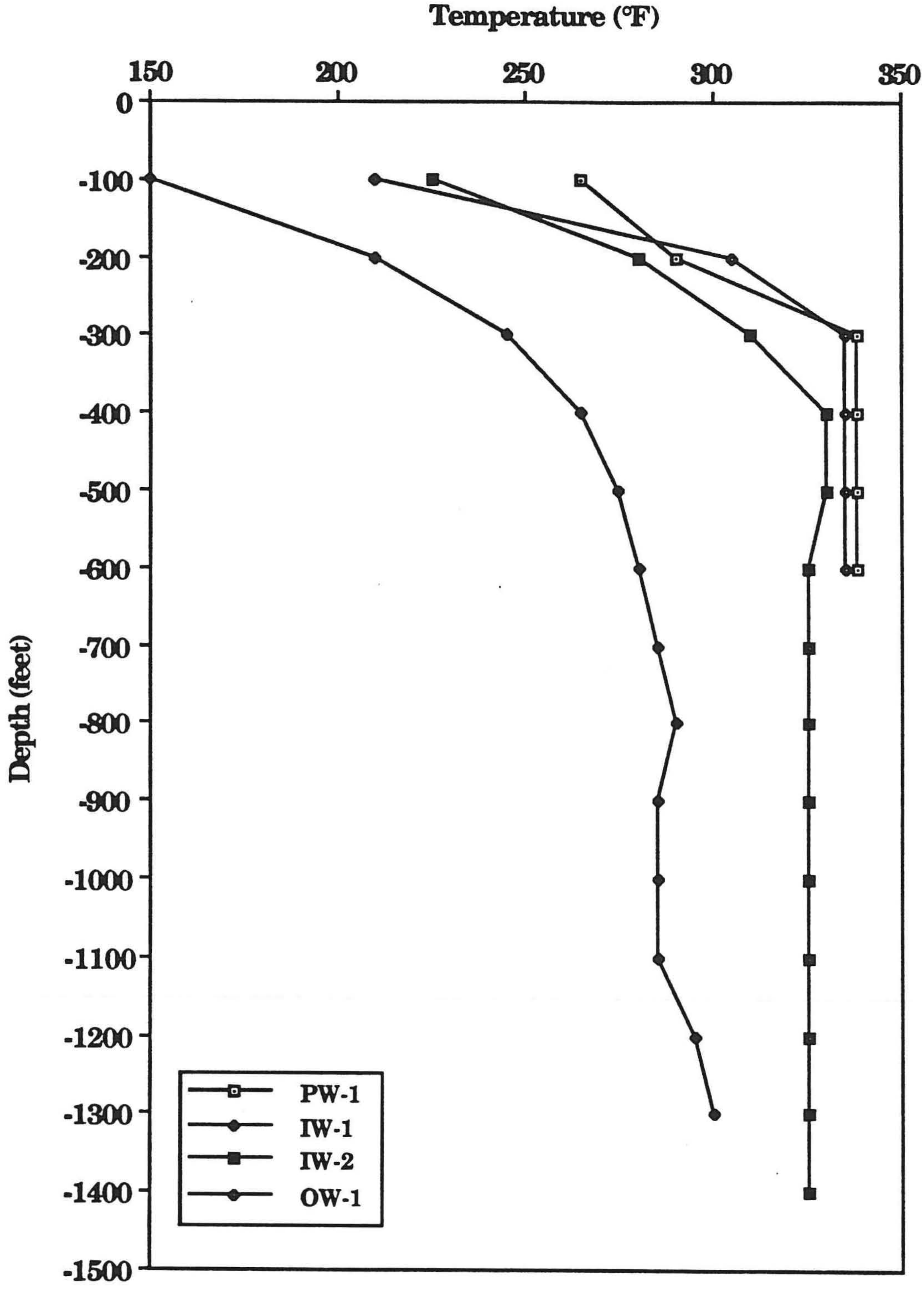



Figure 5) Temperature versus Depth for Selected Wells on the SB Geo, Inc. Lease

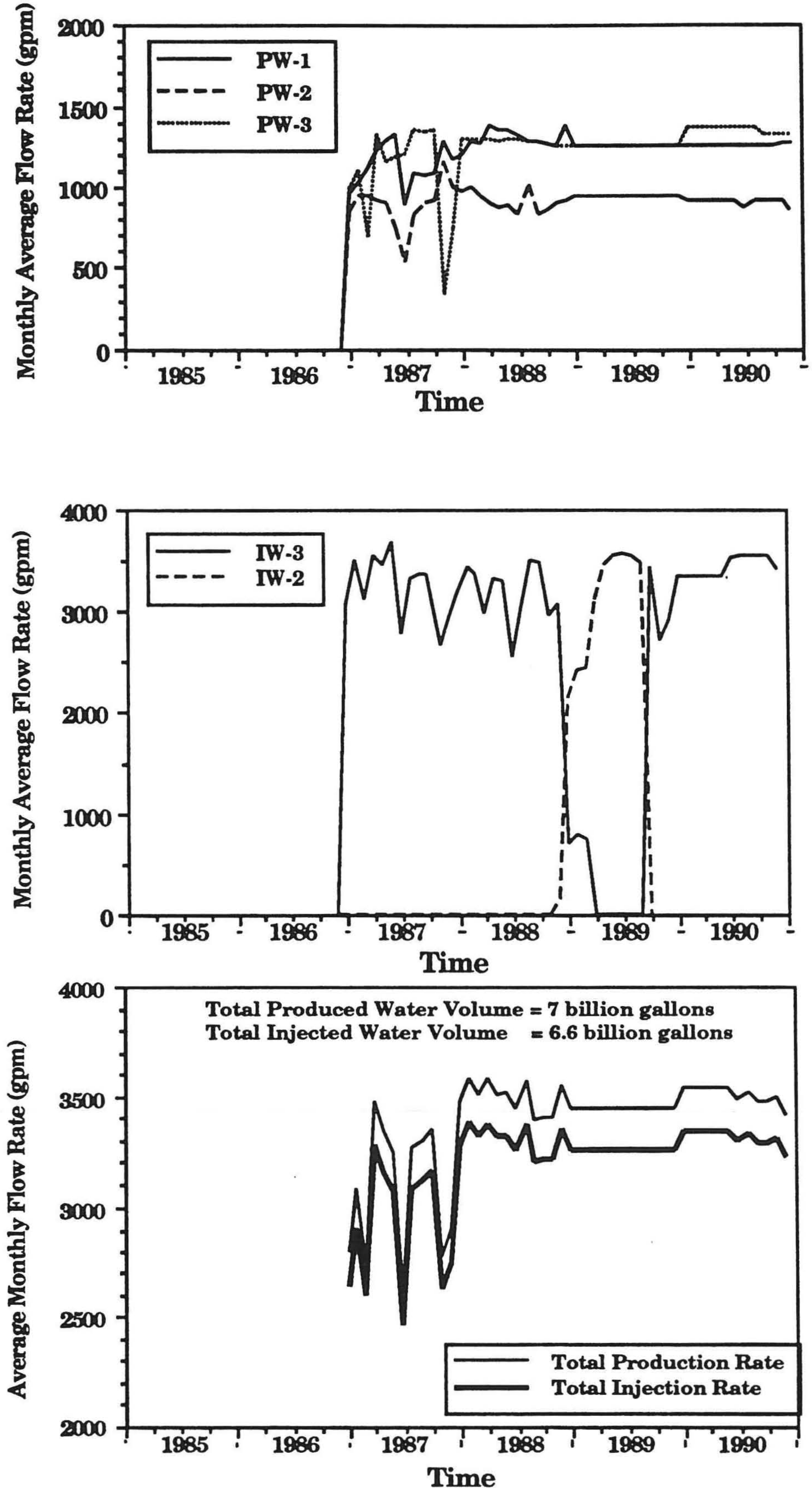
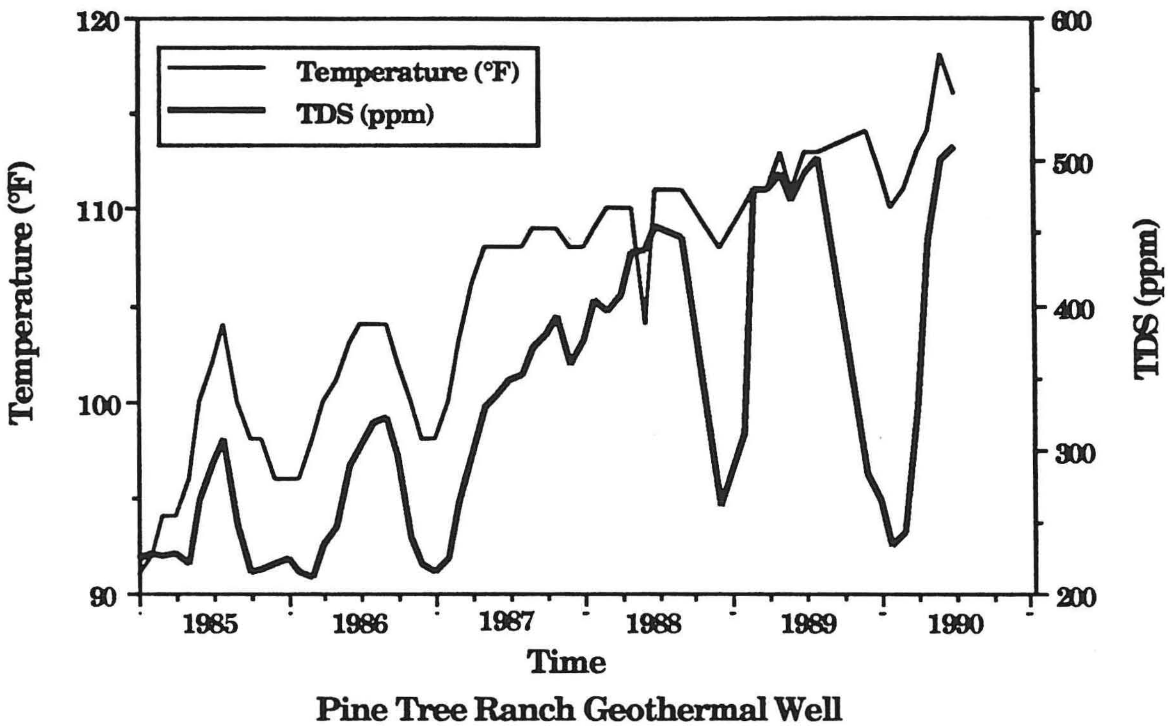



**Figure 6) SB GEO, Inc. Production and Injection Flow Rate Data**



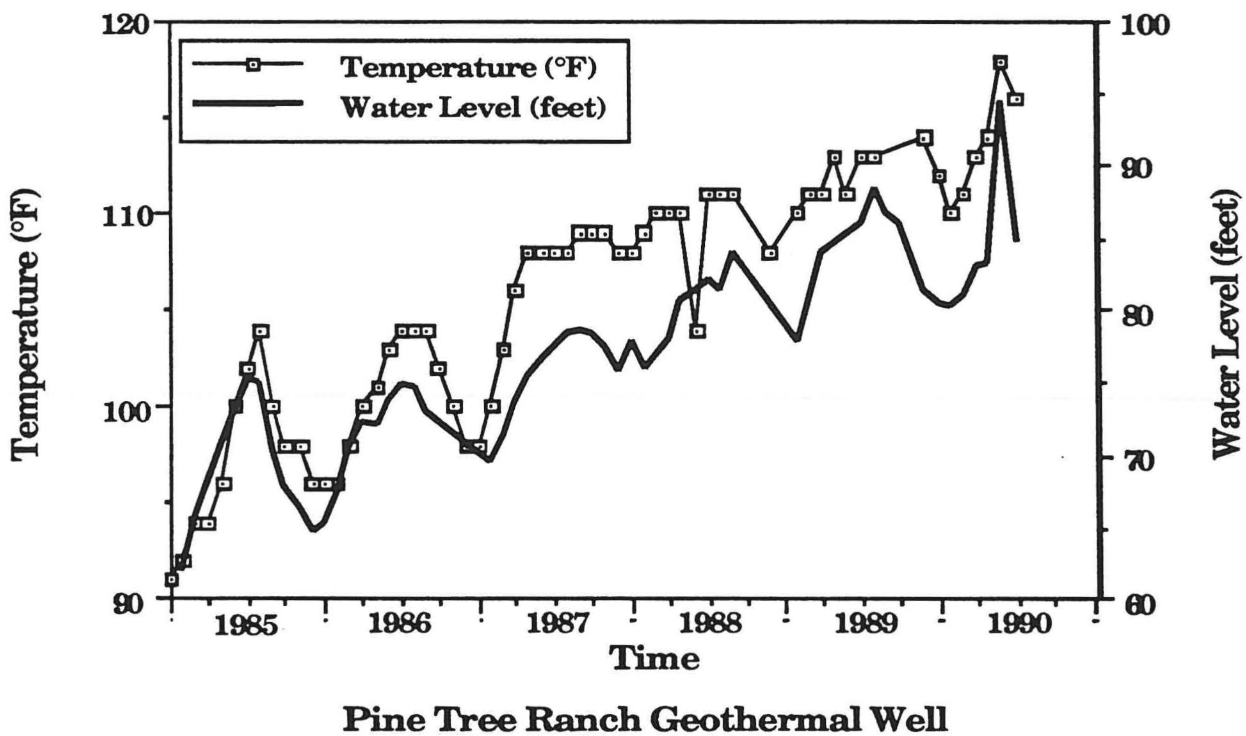




Figure 7) Pine Tree Ranch Well Temperature, TDS and Water Level Versus Time

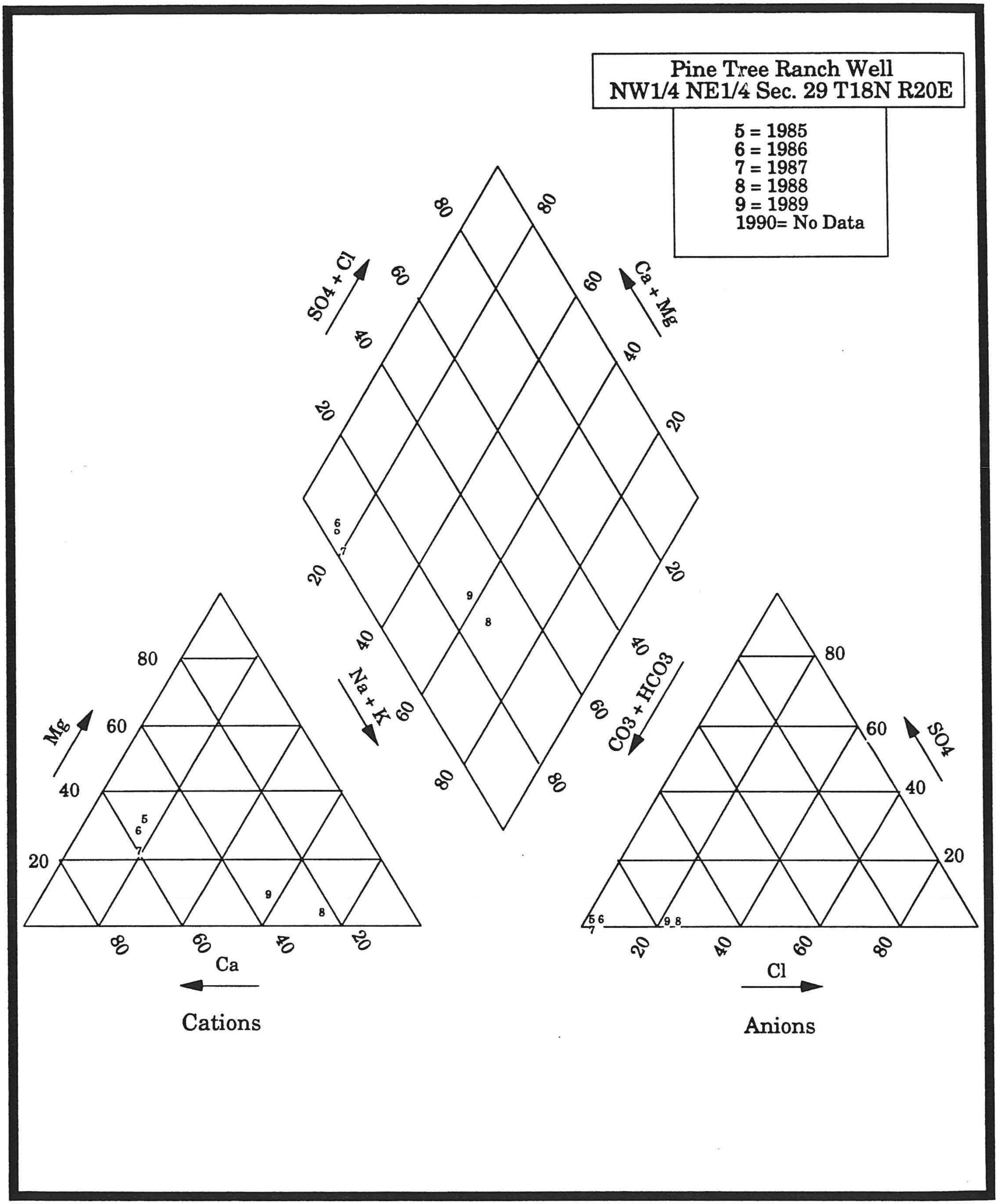



Figure 8) Pine Tree Ranch Well Piper Diagram (data in % milliequivalents per liter)

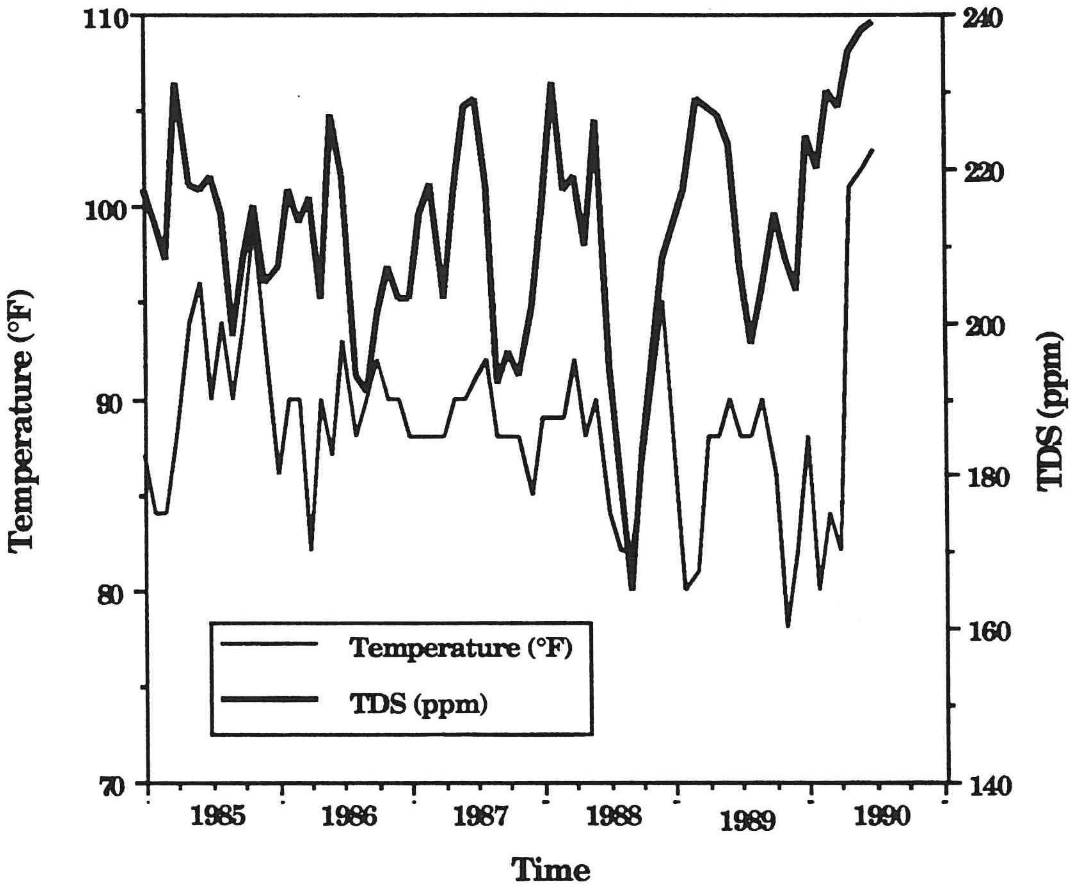



**Figure 9) Peigh Domestic Well Temperature and TDS Plot**

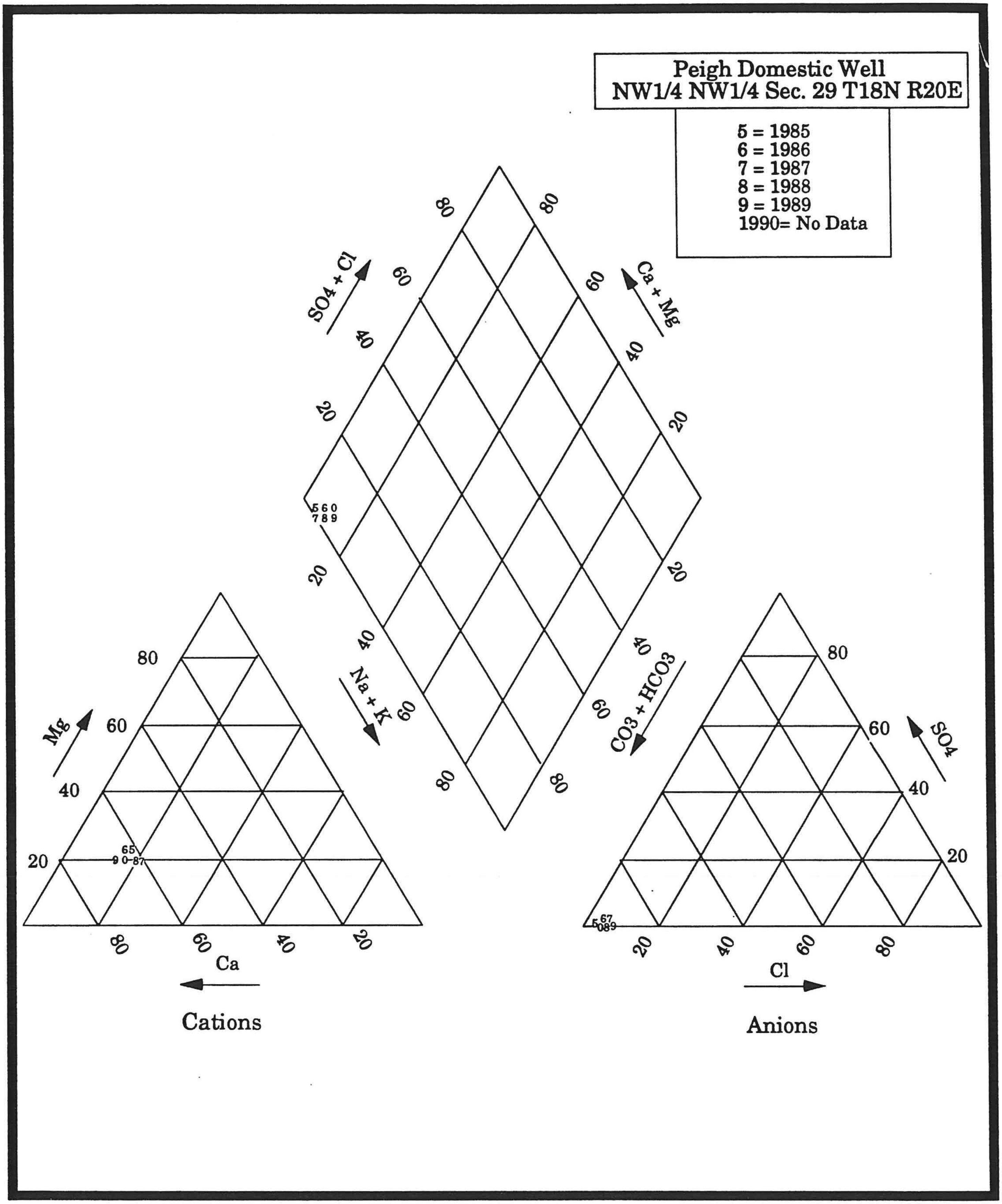
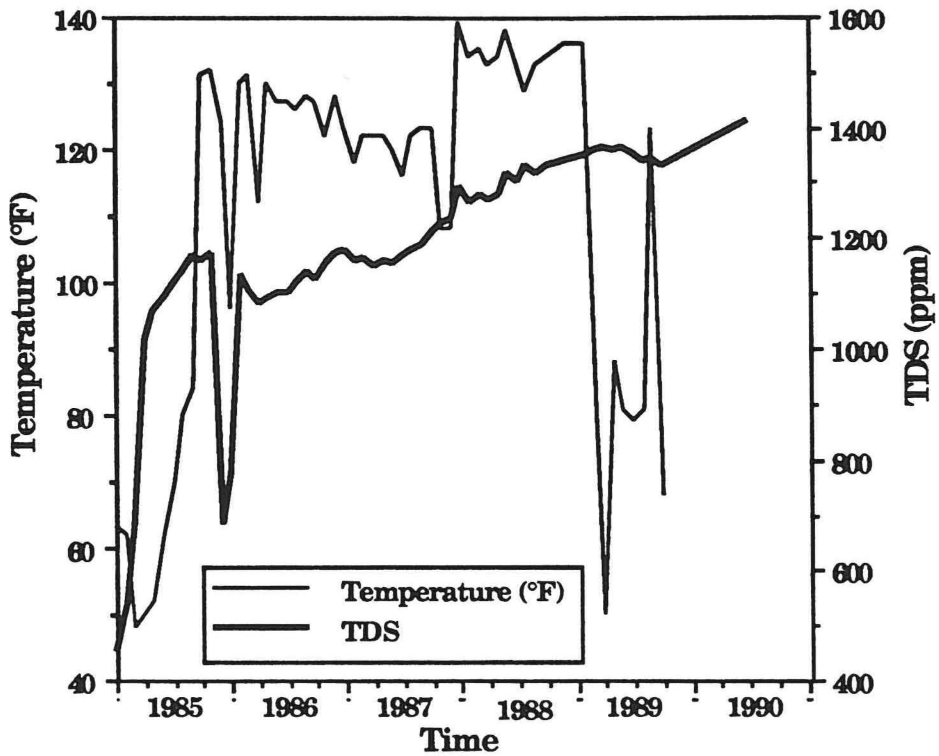



Figure 10) Peigh Domestic Well Piper Diagram (data in % milliequivalents per liter)




Flame Well

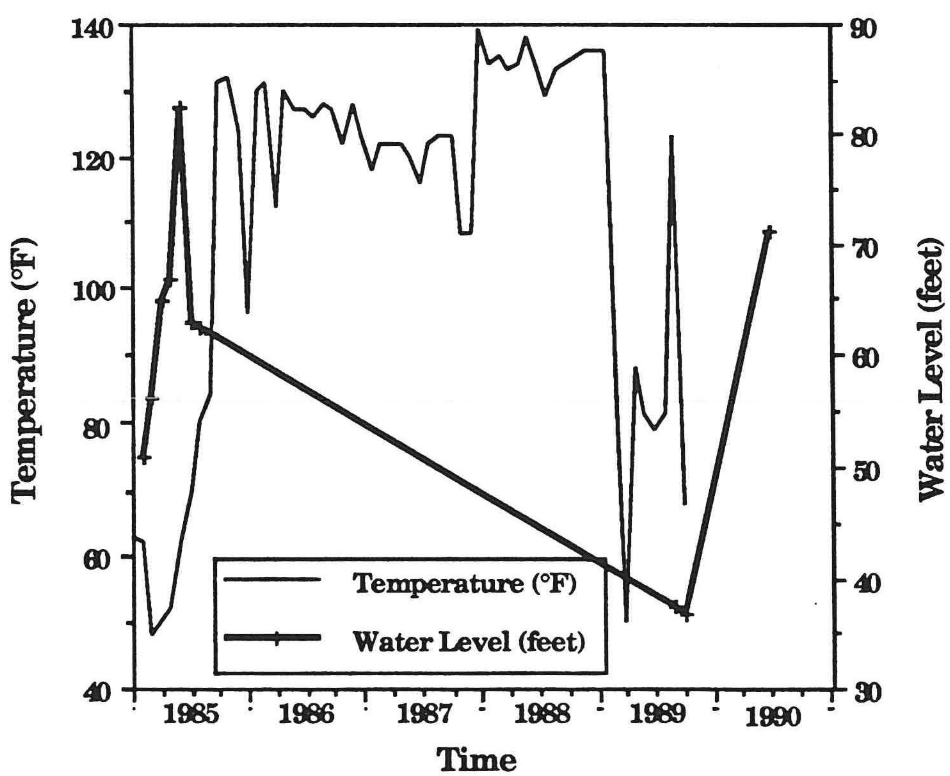



**Figure 11) Flame Well Temperature, TDS and Water Level Plot**

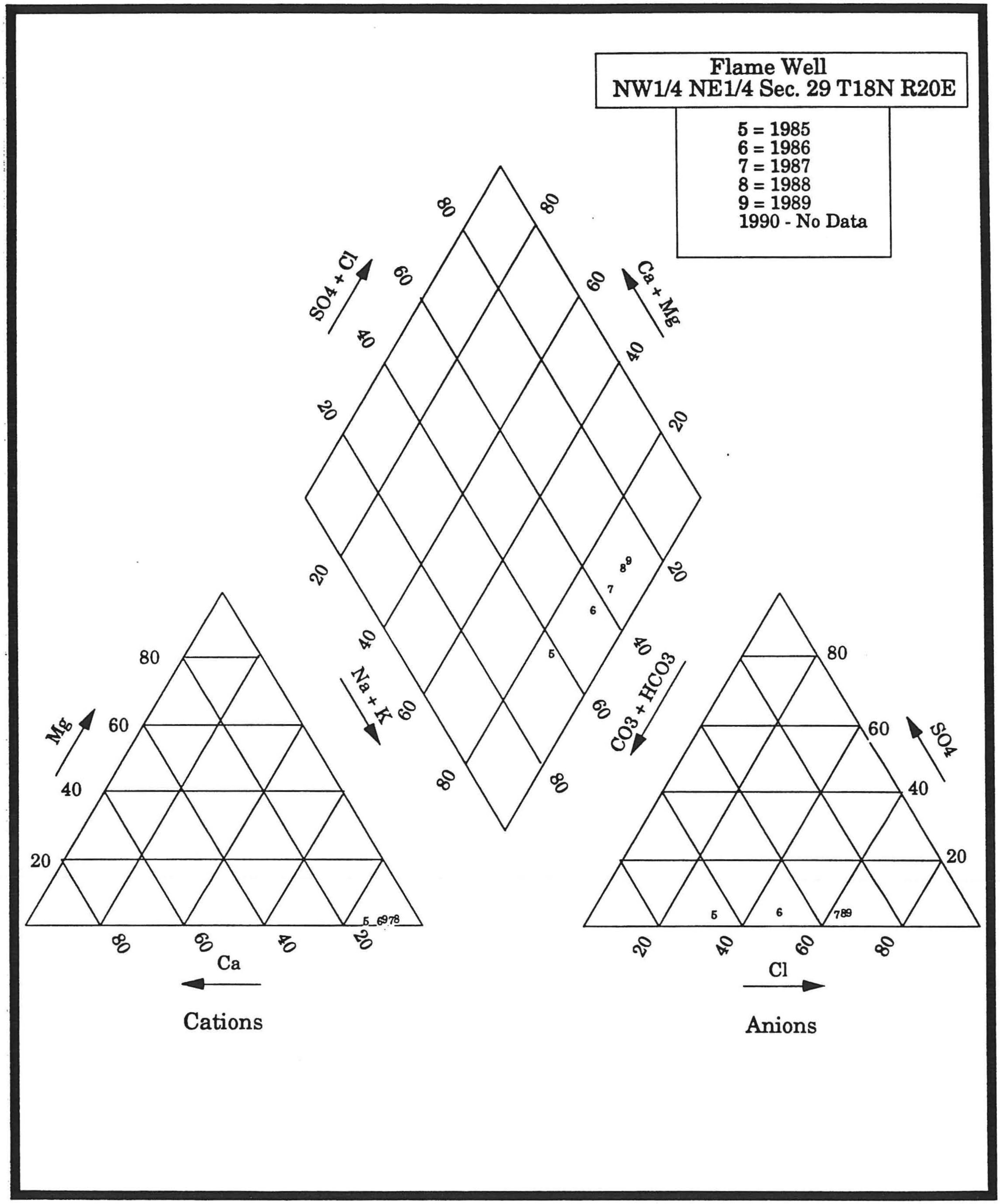
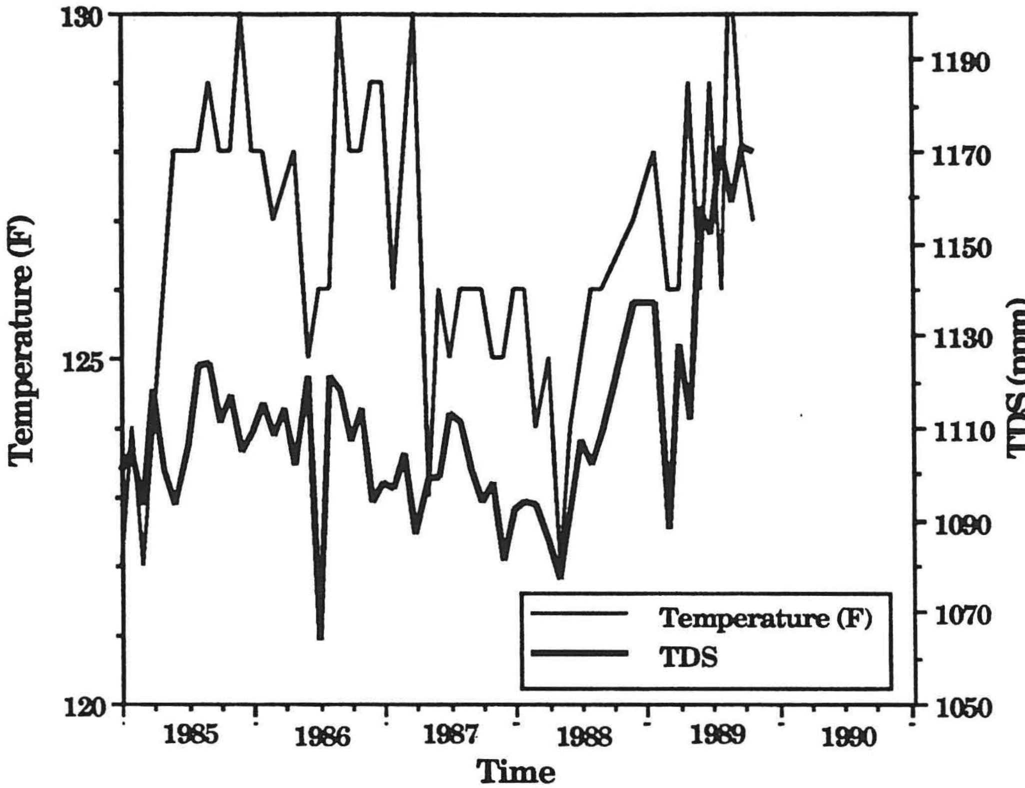



Figure 12) Flame Well Piper Diagram (data in % milliequivalents per liter)




Herz Geothermal well

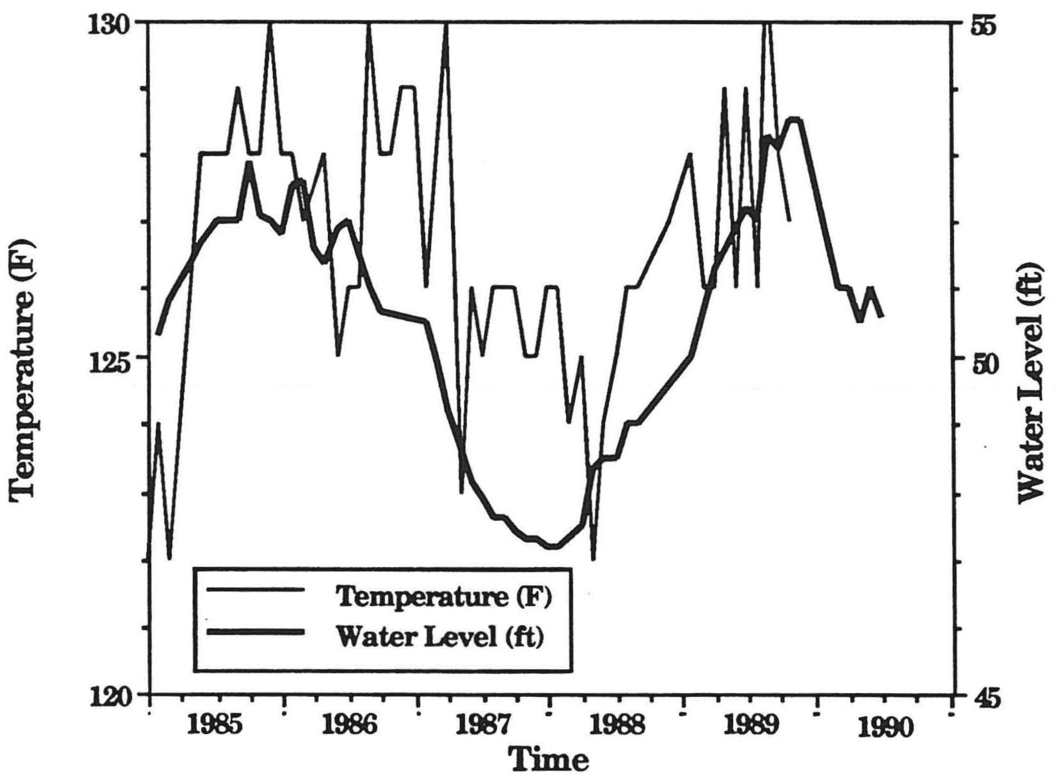



**Figure 13) Herz Geothermal Well Temperature, TDS and Water Level Plot**

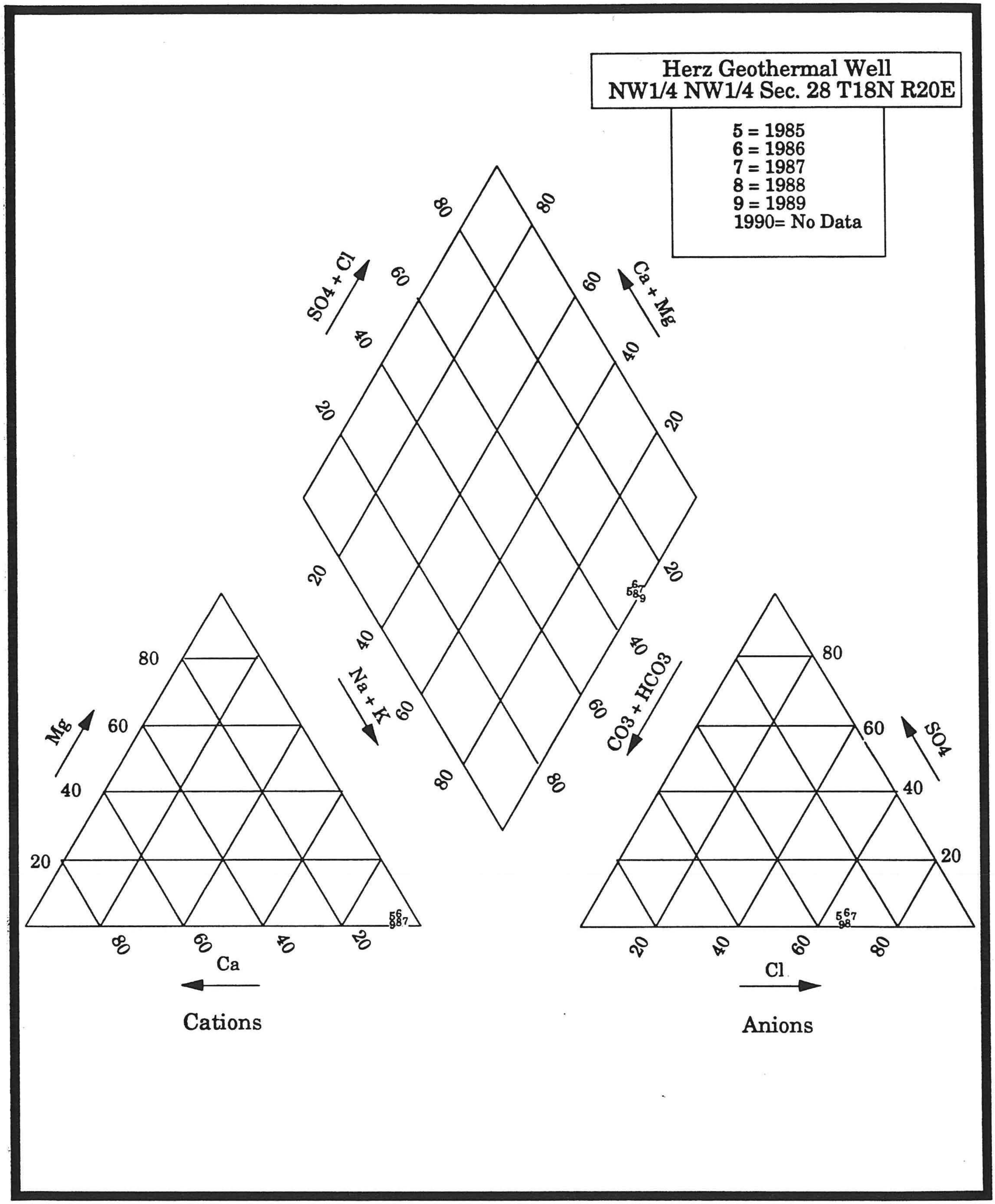
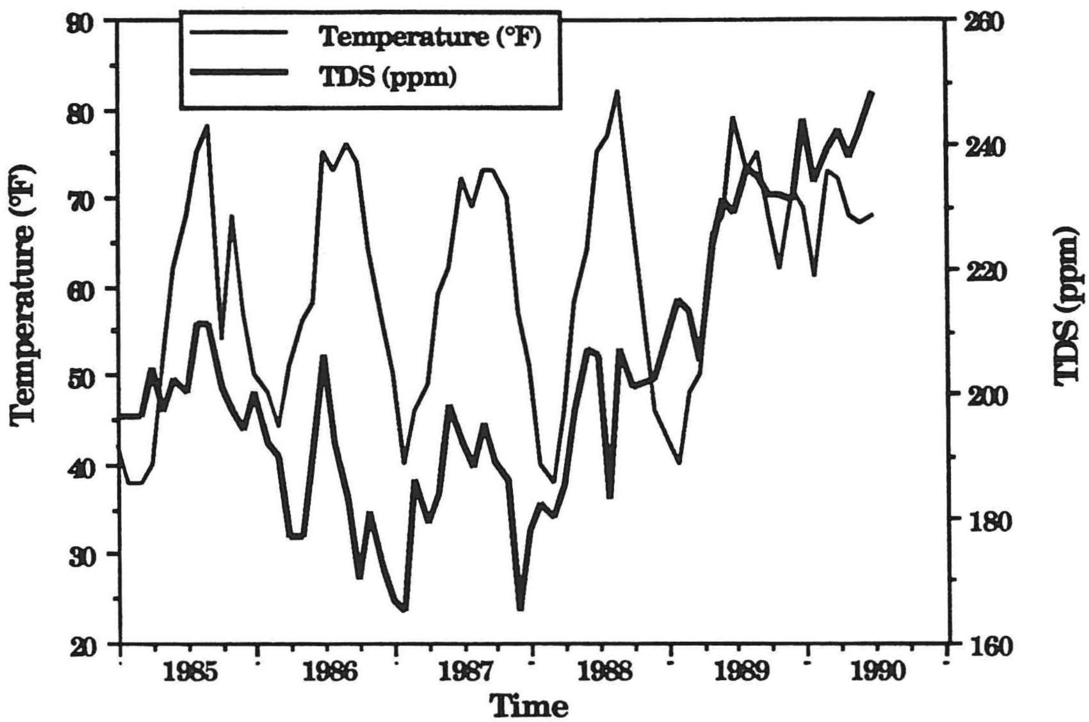



Figure 14) Herz Geothermal Well Piper Diagram (data in % milliequivalents per liter)




Herz Domestic Well

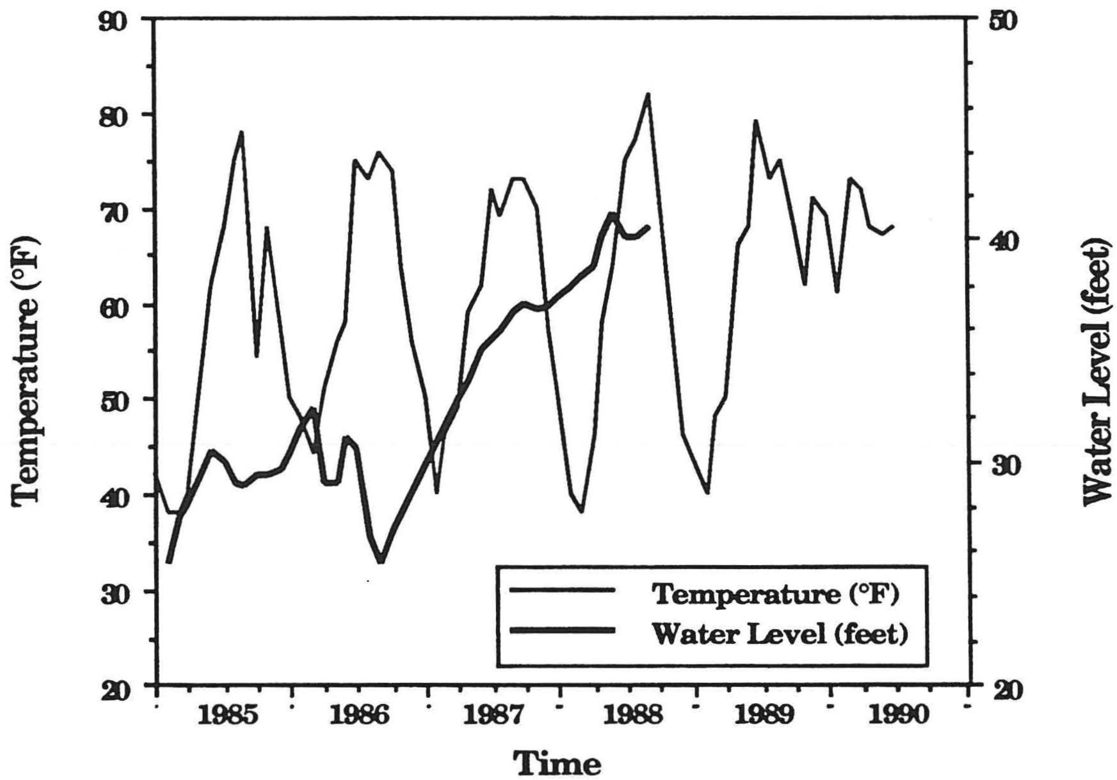



**Figure 15) Herz Domestic Well Temperature, TDS and Water Level Plot**

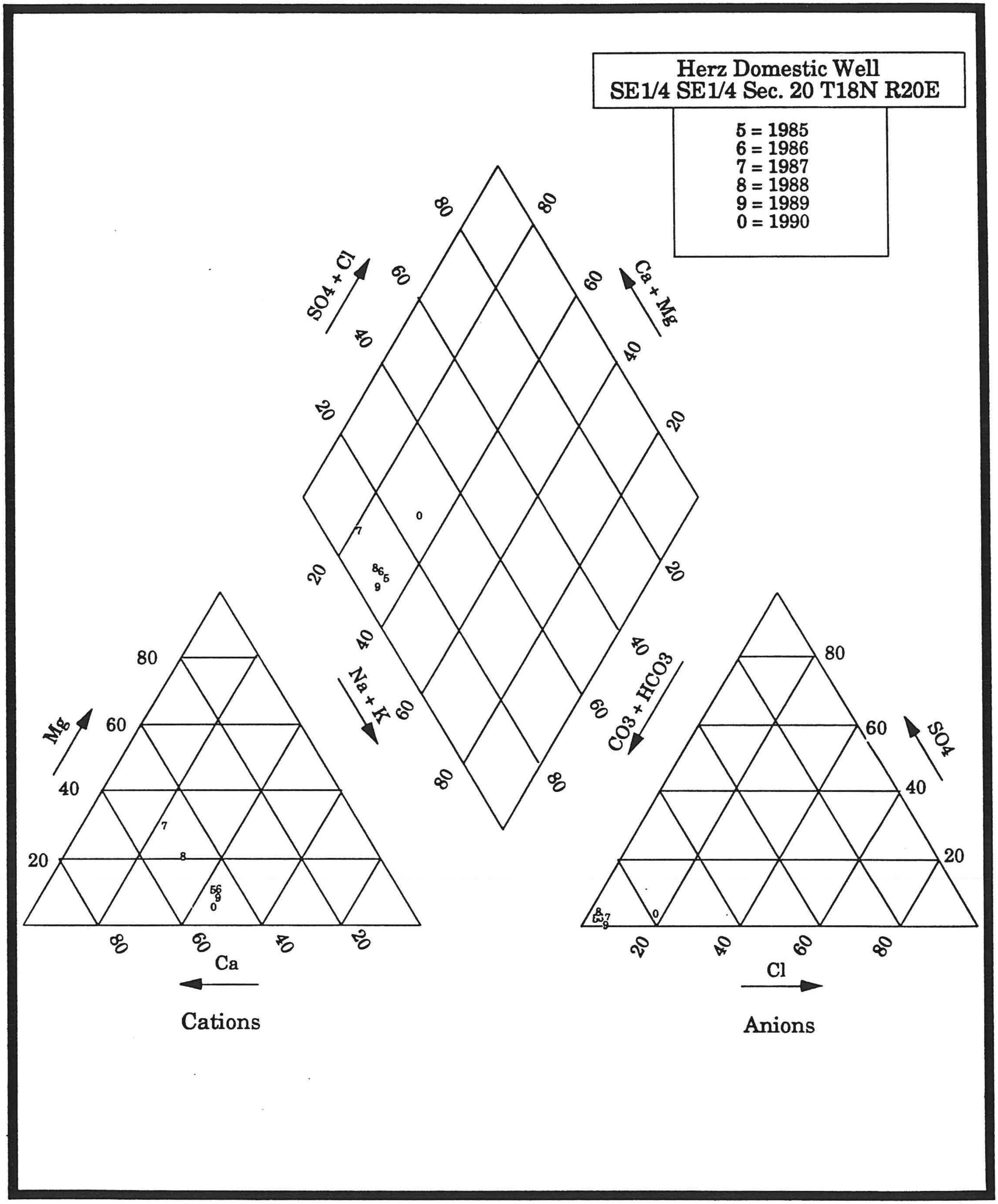
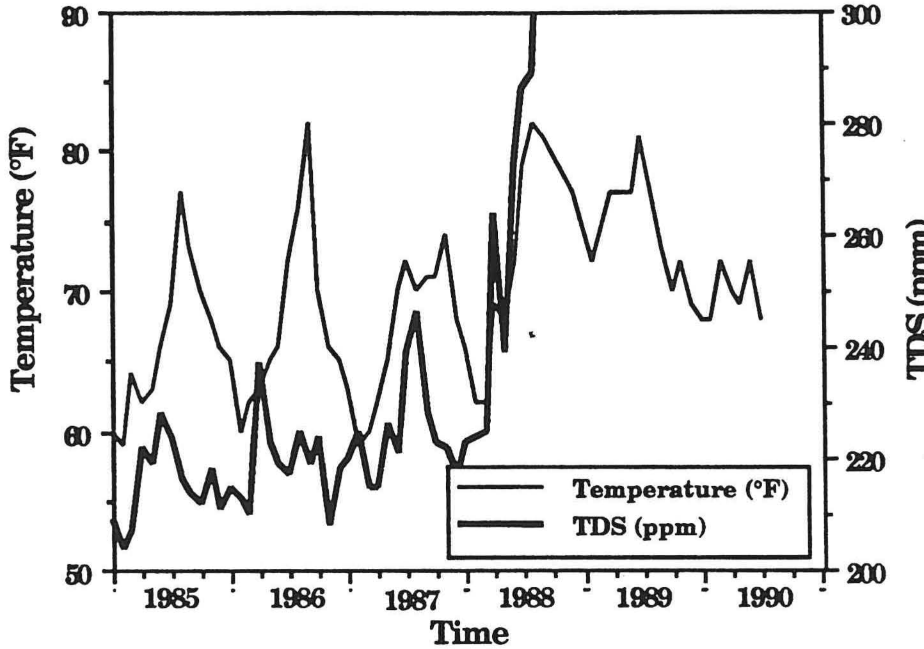



Figure 16) Herz Domestic Well Piper Diagram (data in % milliequivalents per liter)




Brown School Well

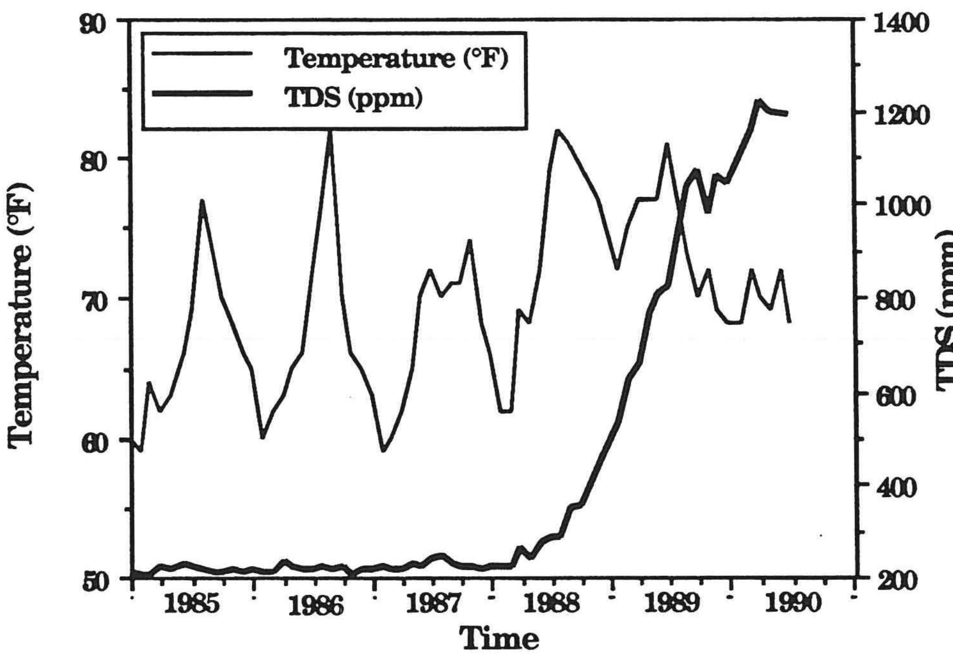
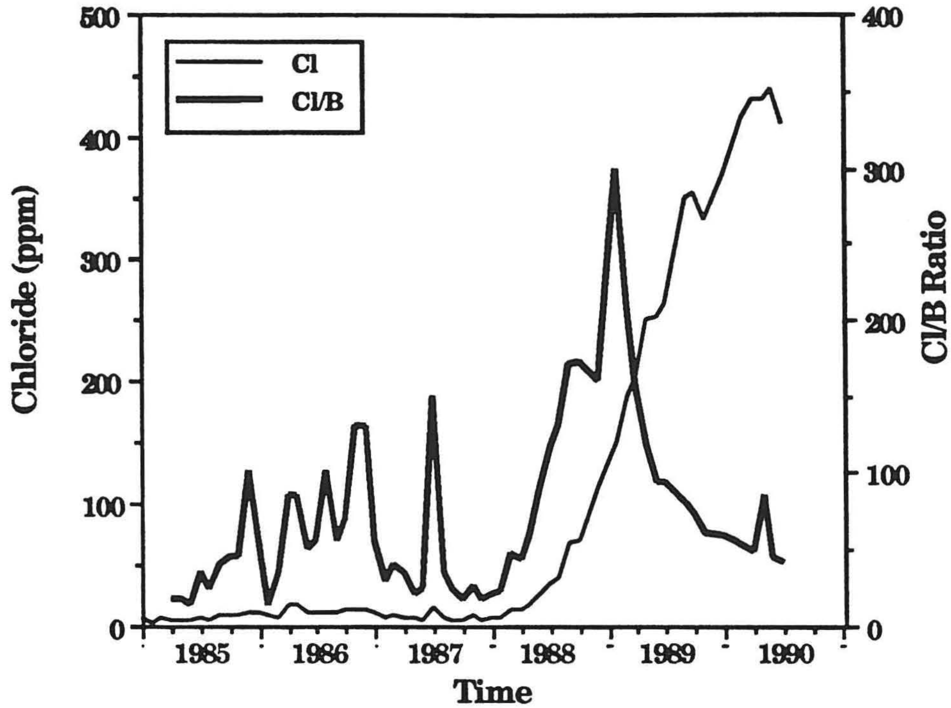



Figure 17) Brown School Well Temperature and TDS Plot




Brown School Well

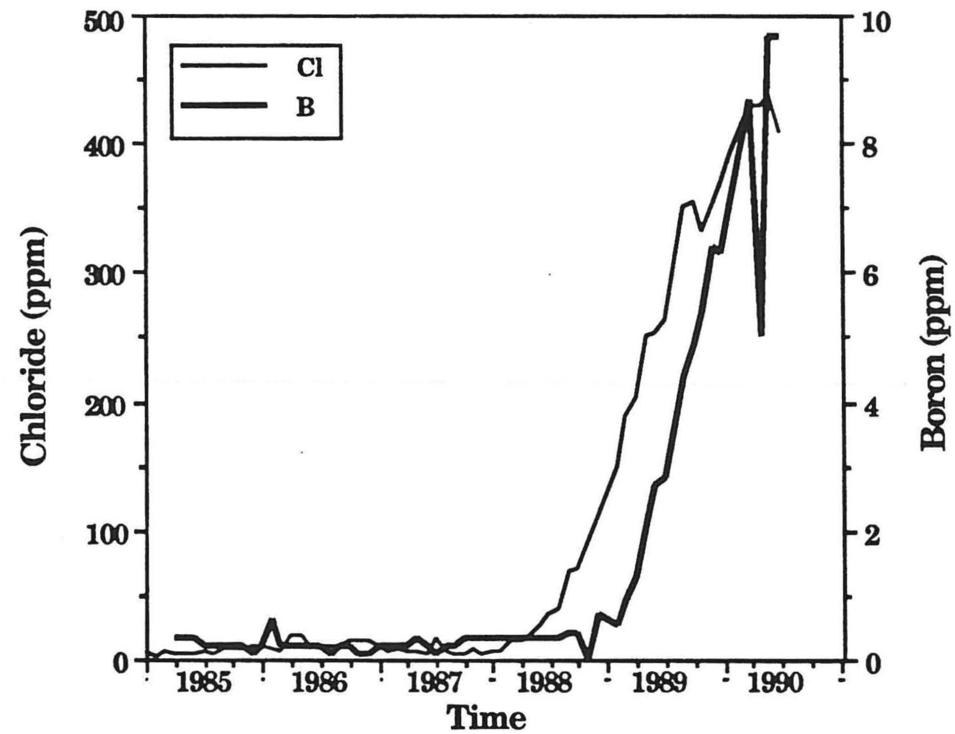



Figure 18) Brown School Well Chloride, Boron and Chloride/Boron Ratio Plot

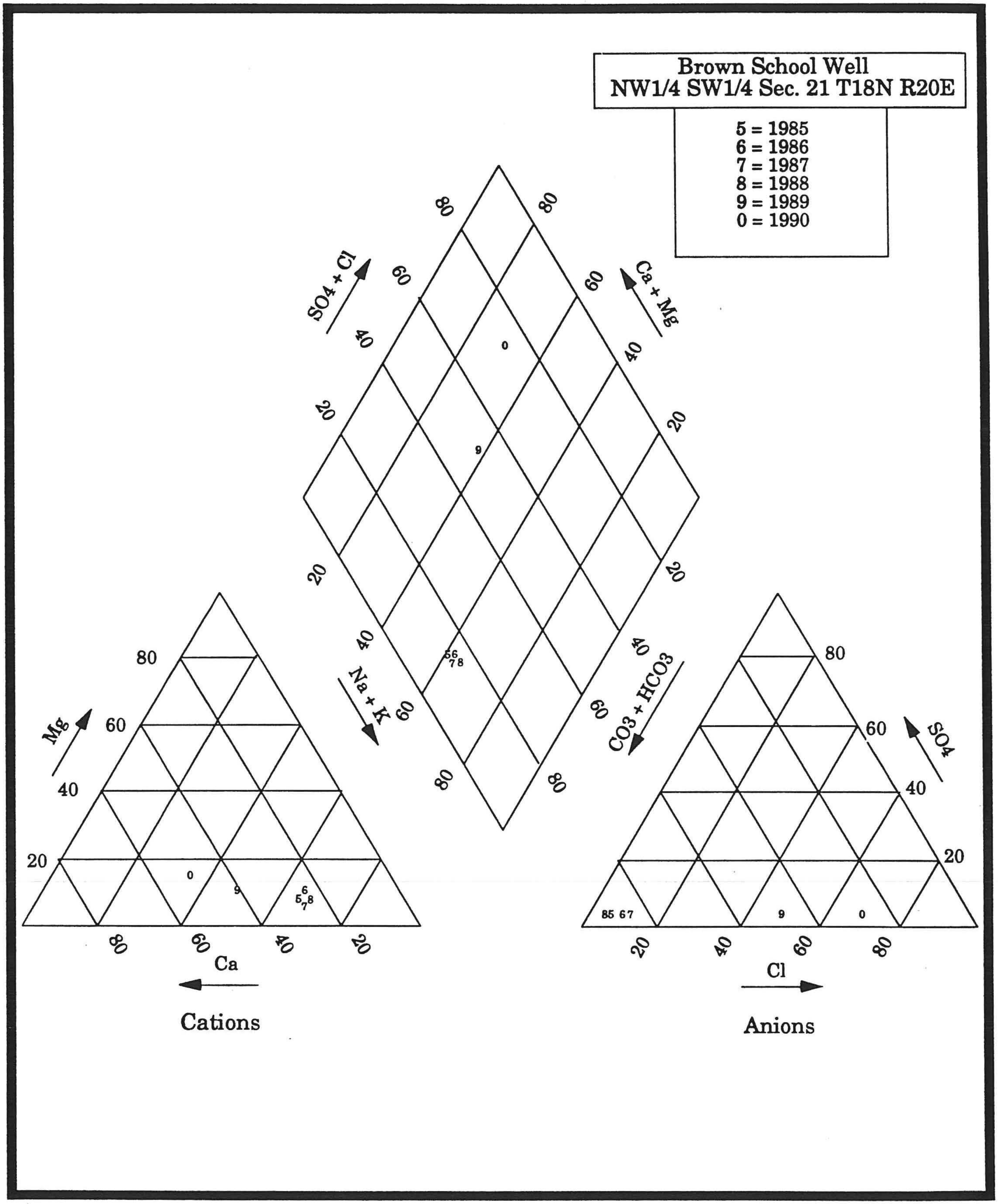



Figure 19) Brown School Piper Diagram (data in % milliequivalents per liter)

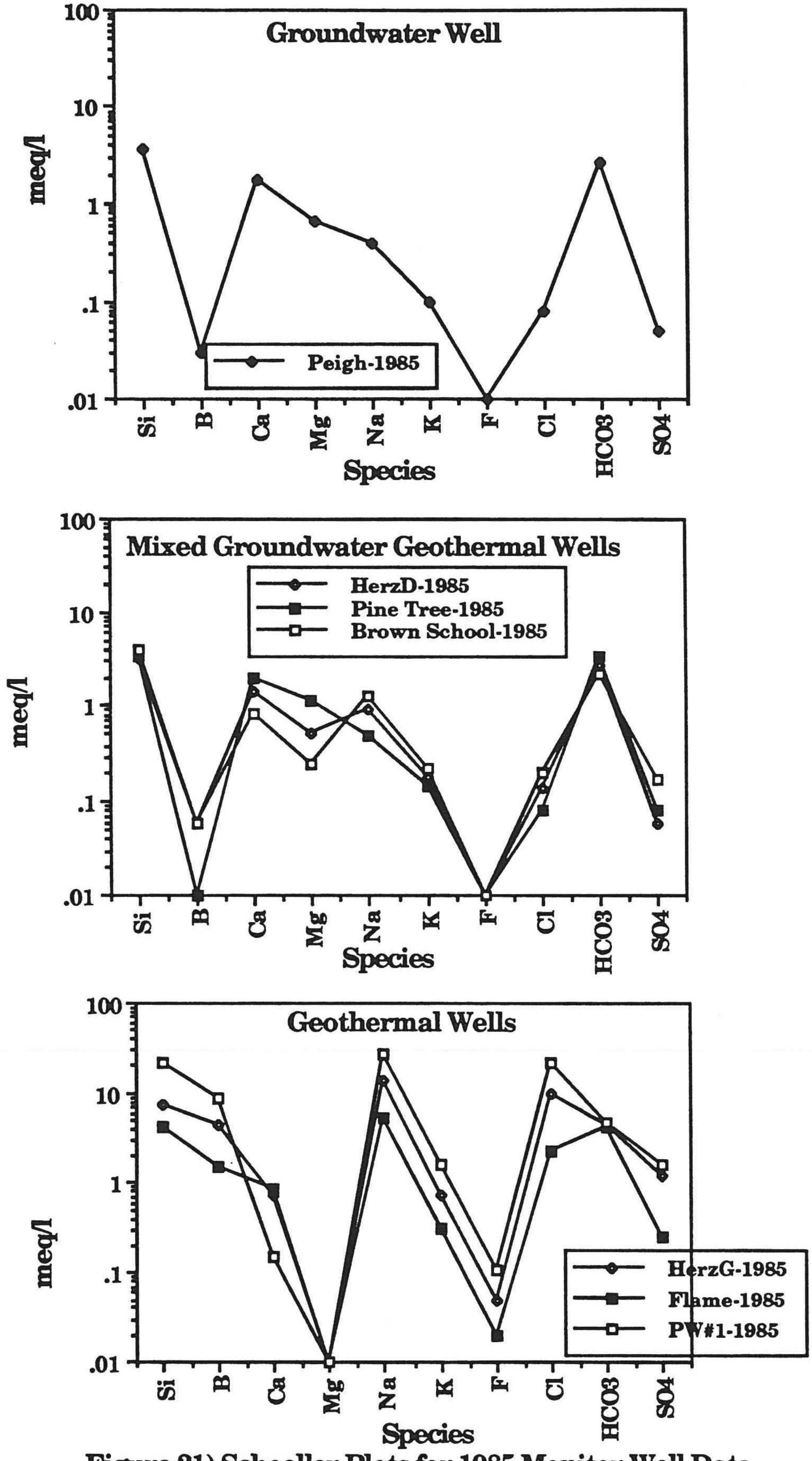



**Figure 21) Schoeller Plots for 1985 Monitor Well Data**

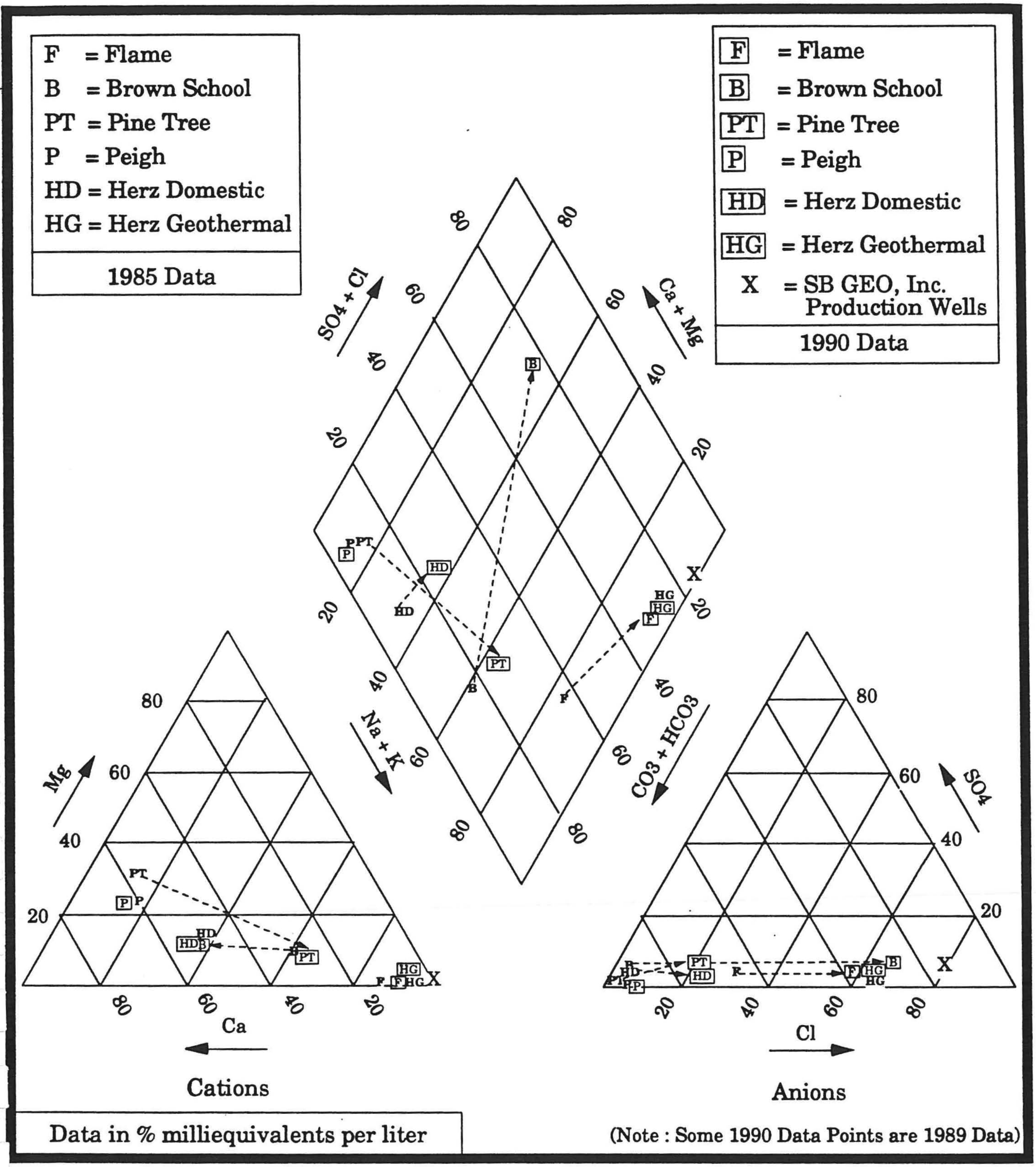



Figure 22) Piper Diagrams for Data from 1985 and 1990 for SB GEO, Inc. Monitor Wells and 1990 Data for SB GEO, Inc. Production Wells

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# Summary and Interpretation
# of
# Six Years of Groundwater Monitoring Data
# and
# Four Years of Geothermal Production
# and
# Injection Well Operations
# at the
# SB GEO, Inc
# Geothermal Binary Power Plant
# Steamboat Springs, Nevada

## Volume II
## Appendices

Prepared
for
SB GEO, Inc.

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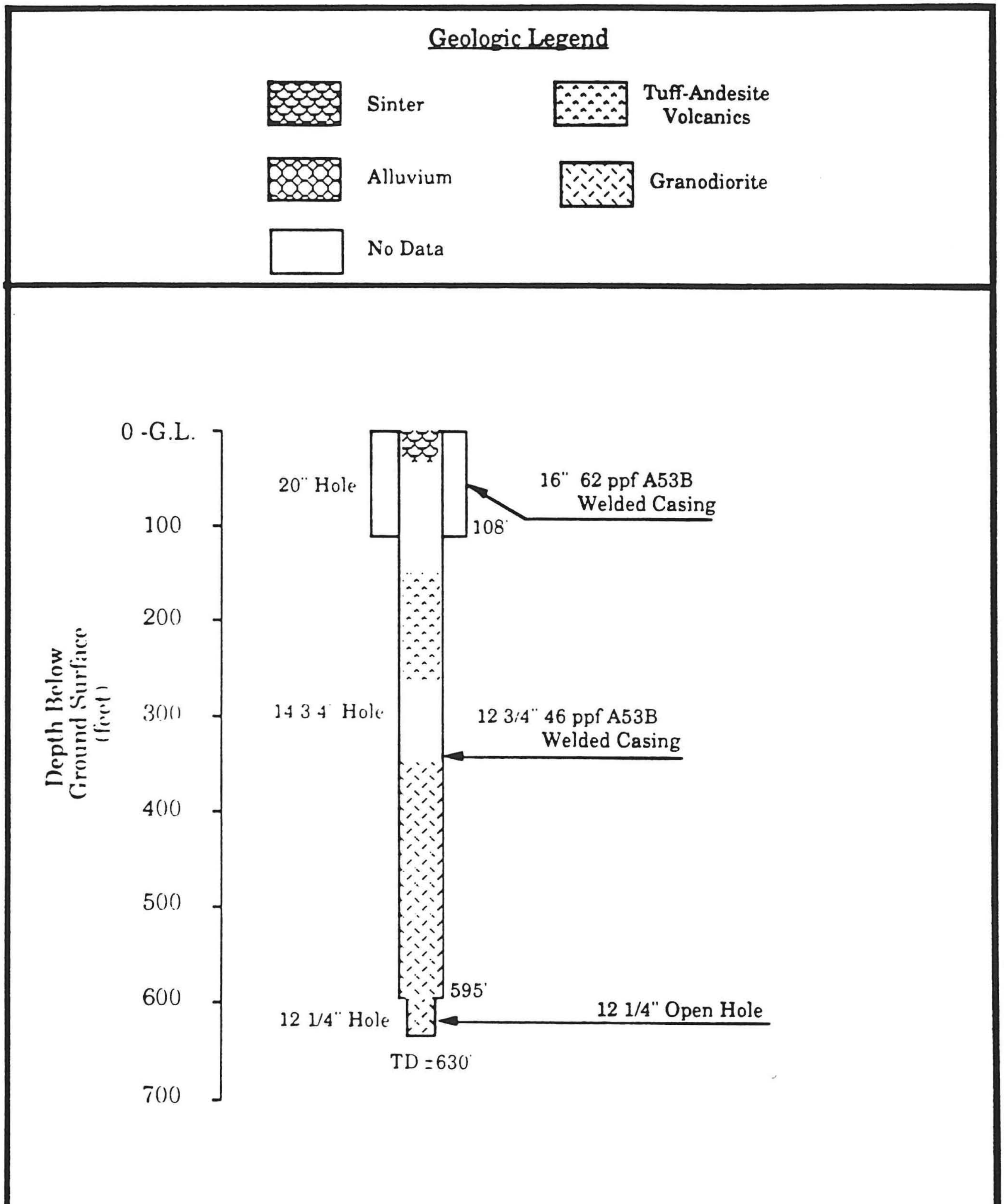
# Appendix 1 - Production Well #1 Data




PW-1 Well Completion and Geologic Information

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 771.0 | 0.0 | 800.0 | 780.0 | 810.0 | 811.0 | 21.72 | 0.00 | 22.54 | 21.97 | 22.82 | 22.85 | 37.7 | # # # | 38.6 | 37.9 | 36.6 | 39.1 |
| Ca | 3.0 | 0.0 | 8.0 | 15.0 | 14.0 | 15.5 | 0.15 | 0.00 | 0.40 | 0.75 | 0.70 | 0.78 | 0.3 | # # # | 0.7 | 1.3 | 1.1 | 1.3 |
| Mg | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.0 | # # # | 0.0 | 0.0 | 0.0 | 0.1 |
| Na | 637.0 | 0.0 | 614.0 | 605.0 | 676.0 | 618.0 | 27.70 | 0.00 | 26.70 | 26.30 | 29.39 | 26.87 | | | | | | |
| K | 64.0 | 0.0 | 63.0 | 59.0 | 68.0 | 59.0 | 1.64 | 0.00 | 1.62 | 1.51 | 1.74 | 1.51 | | | | | | |
| SiO2 | 319.0 | 0.0 | 304.0 | 290.0 | 309.0 | 276.0 | 21.24 | 0.00 | 20.24 | 19.31 | 20.57 | 18.37 | | | | | | |
| HCO3 | 296.0 | 0.0 | 329.0 | 351.0 | 356.0 | 273.0 | 4.85 | 0.00 | 5.39 | 5.75 | 5.84 | 4.48 | 8.4 | # # # | 9.2 | 9.9 | 9.4 | 7.7 |
| F | 2.0 | 0.0 | 2.0 | 2.1 | 2.3 | 2.0 | 0.11 | 0.00 | 0.11 | 0.11 | 0.12 | 0.11 | | | | | | |
| B | 31.0 | 0.0 | 44.0 | 42.5 | 42.0 | 42.0 | 8.61 | 0.00 | 12.22 | 11.81 | 11.67 | 11.67 | | | | | | |
| As | 2.8 | 0.0 | 2.2 | 1.4 | 2.6 | 2.6 | | | | | | | | | | | | |
| SO4 | 102.0 | 0.0 | 112.0 | 106.0 | 117.0 | 118.0 | 1.59 | 0.00 | 1.75 | 1.66 | 1.83 | 1.84 | 2.8 | # # # | 3.0 | 2.9 | 2.9 | 3.2 |
| Ca+Mg | | | | | | | 0.15 | 0.00 | 0.40 | 0.75 | 0.70 | 0.84 | 0.3 | # # # | 0.7 | 1.3 | 1.1 | 1.4 |
| SO4+Cl | | | | | | | 23.31 | 0.00 | 24.29 | 23.63 | 24.65 | 24.69 | 40.4 | # # # | 41.6 | 40.8 | 39.5 | 42.3 |
| Na+K | | | | | | | 29.34 | 0.00 | 28.31 | 27.82 | 31.13 | 28.38 | 50.9 | # # # | 48.5 | 48.0 | 50.0 | 48.6 |
| CO3+HCO3 | | | | | | | 4.85 | 0.00 | 5.39 | 5.75 | 5.84 | 4.48 | 8.4 | # # # | 9.2 | 9.9 | 9.4 | 7.7 |
| Total | 2227.8 | 0.0 | 2278.2 | 2252.0 | 2396.9 | 2217.9 | 57.65 | 0.00 | 58.39 | 57.95 | 62.32 | 58.39 | 2.3 | # # # | -1.7 | -1.4 | 2.2 | 0.1 |



**Production Well No. 1 Chemistry Data (meq/l)**

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Flow Rate (gpm) | | | | | | | | | | | | | |
| Water Level | | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | | 2066.0 |
| Cl | | | | | | | | | | | | | 771.0 |
| Ca | | | | | | | | | | | | | 3.0 |
| Mg | | | | | | | | | | | | | 0.0 |
| Na | | | | | | | | | | | | | 637.0 |
| K | | | | | | | | | | | | | 64.0 |
| SiO2 | | | | | | | | | | | | | 319.0 |
| HCO3 | | | | | | | | | | | | | 296.0 |
| F | | | | | | | | | | | | | 2.0 |
| B | | | | | | | | | | | | | 31.0 |
| As | | | | | | | | | | | | | 2.8 |
| SO4 | | | | | | | | | | | | | 102.0 |
| SiO2(°F) | | | | | | | | | | | | | 417 |
| Na/K (°F) | | | | | | | | | | | | | 365 |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | | 597 |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | | 3242 |
| Cl/B | | | | | | | | | | | | | 24.9 |

**Production Well No. 1 Chemistry Data (ppm, gpm) - Page 1**

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Flow Rate (gpm) | | | | | | | | | | | | 0 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| As | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | |

**Production Well No. 1 Chemistry Data (ppm, gpm) - Page 2**

| Date | Jan-87 | Feb-87 | Mar-87 | Apr-87 | May-87 | Jun-87 | Jul-87 | Aug-87 | Sep-87 | Oct-87 | Nov-87 | Dec-87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 760 | 790 | 821 | 851 | 882 | 912 | 942 | 973 | 1003 | 1034 | 1064 | 1094 |
| Flow Rate (gpm) | 959 | 1028 | 1114 | 1230 | 1280 | 1320 | 881 | 1091 | 1070 | 1088 | 1287 | 1162 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | 2200.0 |
| Cl | | | | | | | | | | | | 800.0 |
| Ca | | | | | | | | | | | | 8.0 |
| Mg | | | | | | | | | | | | 0.0 |
| Na | | | | | | | | | | | | 614.0 |
| K | | | | | | | | | | | | 63.0 |
| SiO2 | | | | | | | | | | | | 304.0 |
| HCO3 | | | | | | | | | | | | 329.0 |
| F | | | | | | | | | | | | 2.0 |
| B | | | | | | | | | | | | 44.0 |
| As | | | | | | | | | | | | 2.2 |
| SO4 | | | | | | | | | | | | 112.0 |
| SiO2(°F) | | | | | | | | | | | | 410 |
| Na/K (°F) | | | | | | | | | | | | 369 |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | 573 |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | 2245 |
| Cl/B | | | | | | | | | | | | 18.2 |

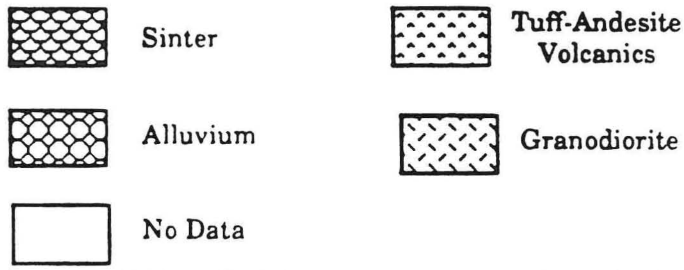
| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun-88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Flow Rate (gpm) | 1201 | 1278 | 1270 | 1381 | 1357 | 1352 | 1322 | 1283 | 1278 | 1266 | 1250 | 1382 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| As | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | |

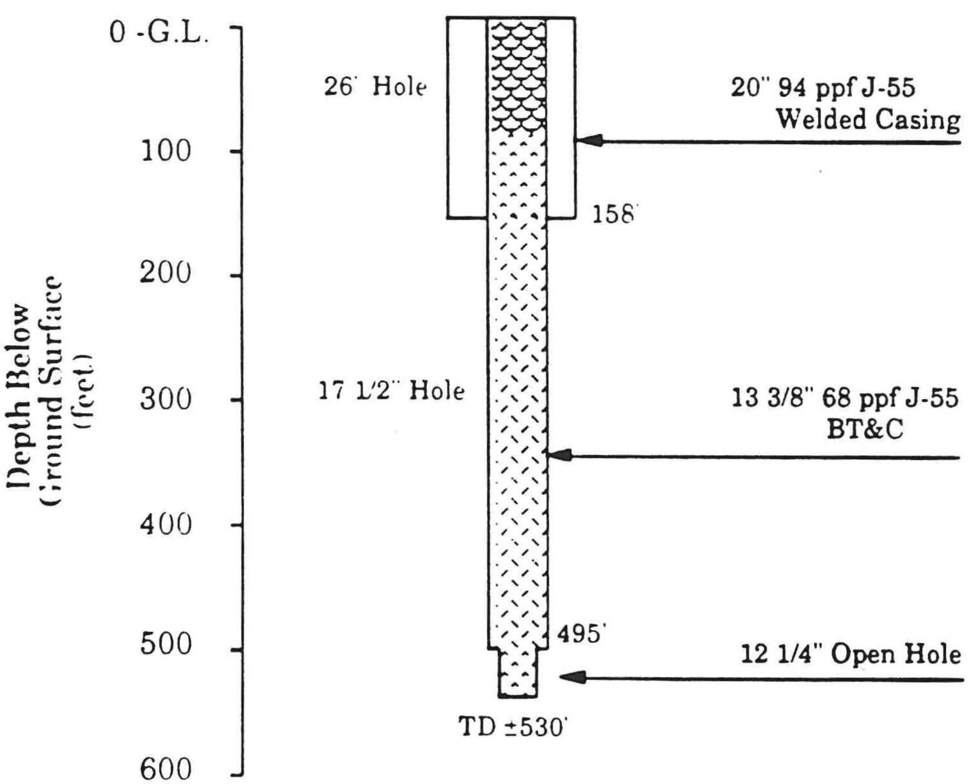
| Date | Jan-89 | Feb-89 | Mar-89 | May-89 | Jun-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 |
| Flow Rate (gpm) | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 |
| Water Level | | | | | | | | | | | |
| TDS | 2185.0 | | | | | | | | | | 2242.0 |
| Cl | 780.0 | | | | | | | | | | 810.0 |
| Ca | 15.0 | | | | | | | | | | 14.0 |
| Mg | 0.0 | | | | | | | | | | 0.0 |
| Na | 605.0 | | | | | | | | | | 676.0 |
| K | 59.0 | | | | | | | | | | 68.0 |
| SiO2 | 290.0 | | | | | | | | | | 309.0 |
| HCO3 | 351.0 | | | | | | | | | | 356.0 |
| F | 2.1 | | | | | | | | | | 2.3 |
| B | 42.5 | | | | | | | | | | 42.0 |
| As | 1.4 | | | | | | | | | | 2.6 |
| SO4 | 106.0 | | | | | | | | | | 117.0 |
| SiO2(°F) | 404 | | | | | | | | | | 412 |
| Na/K (°F) | 358 | | | | | | | | | | 365 |
| Na/K/Ca (°F) ß=.33 | 548 | | | | | | | | | | 560 |
| Na/K/Ca (°F) ß=1.33 | 1806 | | | | | | | | | | 1989 |
| Cl/B | 18.4 | | | | | | | | | | 19.3 |

Production Well No. 1 Chemistry Data (ppm, gpm) - Page 5

| Date | Jan-90 | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 | Dec-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1824 | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Flow Rate (gpm) | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1247 | 1251 | 1252 | 1252 | 1272 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | 2227.0 |
| Cl | | | | | | | | | | | | 811.0 |
| Ca | | | | | | | | | | | | 15.5 |
| Mg | | | | | | | | | | | | 0.8 |
| Na | | | | | | | | | | | | 618.0 |
| K | | | | | | | | | | | | 59.0 |
| SiO2 | | | | | | | | | | | | 276.0 |
| HCO3 | | | | | | | | | | | | 273.0 |
| F | | | | | | | | | | | | 2.0 |
| B | | | | | | | | | | | | 42.0 |
| As | | | | | | | | | | | | 2.6 |
| SO4 | | | | | | | | | | | | 118.0 |
| SiO2(°F) | | | | | | | | | | | | 397 |
| Na/K (°F) | | | | | | | | | | | | 354 |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | 545 |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | 1795 |
| Cl/B | | | | | | | | | | | | 19.3 |

# Appendix 2 - Production Well #2 Data




PW-2 Well Completion and Geologic Information

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 0.0 | 0.0 | 810.0 | 800.0 | 840.0 | 802.0 | 0.00 | 0.00 | 22.82 | 22.54 | 23.66 | 22.59 | # # # | # # # | 37.7 | 39.0 | 37.5 | 40.5 |
| Ca | 0.0 | 0.0 | 10.0 | 6.0 | 10.0 | 14.0 | 0.00 | 0.00 | 0.50 | 0.30 | 0.50 | 0.70 | # # # | # # # | 0.8 | 0.5 | 0.8 | 1.3 |
| Mg | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | # # # | # # # | 0.0 | 0.0 | 0.0 | 0.0 |
| Na | 0.0 | 0.0 | 649.0 | 616.0 | 684.0 | 576.0 | 0.00 | 0.00 | 28.22 | 26.78 | 29.74 | 25.04 | | | | | | |
| K | 0.0 | 0.0 | 63.0 | 63.0 | 73.0 | 59.0 | 0.00 | 0.00 | 1.62 | 1.62 | 1.87 | 1.51 | | | | | | |
| SiO2 | 0.0 | 0.0 | 331.0 | 319.0 | 325.0 | 275.0 | 0.00 | 0.00 | 22.04 | 21.24 | 21.64 | 18.31 | | | | | | |
| HCO3 | 0.0 | 0.0 | 337.0 | 290.0 | 337.0 | 248.0 | 0.00 | 0.00 | 5.52 | 4.75 | 5.52 | 4.07 | # # # | # # # | 9.1 | 8.2 | 8.7 | 7.3 |
| F | 0.0 | 0.0 | 2.2 | 2.2 | 2.4 | 2.4 | 0.00 | 0.00 | 0.12 | 0.12 | 0.13 | 0.13 | | | | | | |
| B | 0.0 | 0.0 | 44.5 | 43.8 | 42.2 | 41.5 | 0.00 | 0.00 | 12.36 | 12.17 | 11.72 | 11.53 | | | | | | |
| As | 0.0 | 0.0 | 1.9 | 0.2 | 2.0 | 2.7 | | | | | | | | | | | | |
| SO4 | 0.0 | 0.0 | 114.0 | 115.0 | 119.0 | 118.0 | 0.00 | 0.00 | 1.78 | 1.80 | 1.86 | 1.84 | # # # | # # # | 2.9 | 3.1 | 2.9 | 3.3 |
| Ca+Mg | | | | | | | 0.00 | 0.00 | 0.50 | 0.30 | 0.50 | 0.70 | # # # | # # # | 0.8 | 0.5 | 0.8 | 1.3 |
| SO4+Cl | | | | | | | 0.00 | 0.00 | 24.60 | 24.33 | 25.52 | 24.44 | # # # | # # # | 40.7 | 42.1 | 40.4 | 43.8 |
| Na+K | | | | | | | 0.00 | 0.00 | 29.83 | 28.40 | 31.61 | 26.56 | # # # | # # # | 49.3 | 49.1 | 50.1 | 47.6 |
| CO3+HCO3 | | | | | | | 0.00 | 0.00 | 5.52 | 4.75 | 5.52 | 4.07 | # # # | # # # | 9.1 | 8.2 | 8.7 | 7.3 |
| Total | 0.0 | 0.0 | 2362.6 | 2255.2 | 2434.6 | 2138.6 | 0.00 | 0.00 | 60.46 | 57.78 | 63.16 | 55.76 | # # # | # # # | 0.3 | -0.7 | 1.7 | -2.2 |

**Production Well No. 2 Chemistry Data (meq/l) (### = No Data)**

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Flow Rate (gpm) | | | | | | | | | | | | | |
| Water Level | | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | | |
| Na | | | | | | | | | | | | | |
| K | | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | |
| As | | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | | |

**Production Well No. 2 Chemistry Data (ppm, gpm) - Page 1**

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Flow Rate (gpm) | | | | | | | | | | | | 0 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| As | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | |

Production Well No. 2 Chemistry Data (ppm, gpm) - Page 2

| Date | Jan-87 | Feb-87 | Mar-87 | Apr-87 | May-87 | Jun-87 | Jul-87 | Aug-87 | Sep-87 | Oct-87 | Nov-87 | Dec-87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 760 | 790 | 821 | 851 | 882 | 912 | 942 | 973 | 1003 | 1034 | 1064 | 1094 |
| Flow Rate (gpm) | 849 | 943 | 943 | 921 | 899 | 740 | 531 | 833 | 900 | 914 | 1160 | 1000 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | 2234.0 |
| Cl | | | | | | | | | | | | 810.0 |
| Ca | | | | | | | | | | | | 10.0 |
| Mg | | | | | | | | | | | | 0.0 |
| Na | | | | | | | | | | | | 649.0 |
| K | | | | | | | | | | | | 63.0 |
| SiO2 | | | | | | | | | | | | 331.0 |
| HCO3 | | | | | | | | | | | | 337.0 |
| F | | | | | | | | | | | | 2.2 |
| B | | | | | | | | | | | | 44.5 |
| As | | | | | | | | | | | | 1.9 |
| SO4 | | | | | | | | | | | | 114.0 |
| SiO2(°F) | | | | | | | | | | | | 422 |
| Na/K (°F) | | | | | | | | | | | | 357 |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | 561 |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | 2112 |
| Cl/B | | | | | | | | | | | | 18.2 |



[redacted]

| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun 88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Flow Rate (gpm) | 978 | 1006 | 946 | 897 | 871 | 881 | 833 | 1014 | 834 | 866 | 900 | 918 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| As | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | |

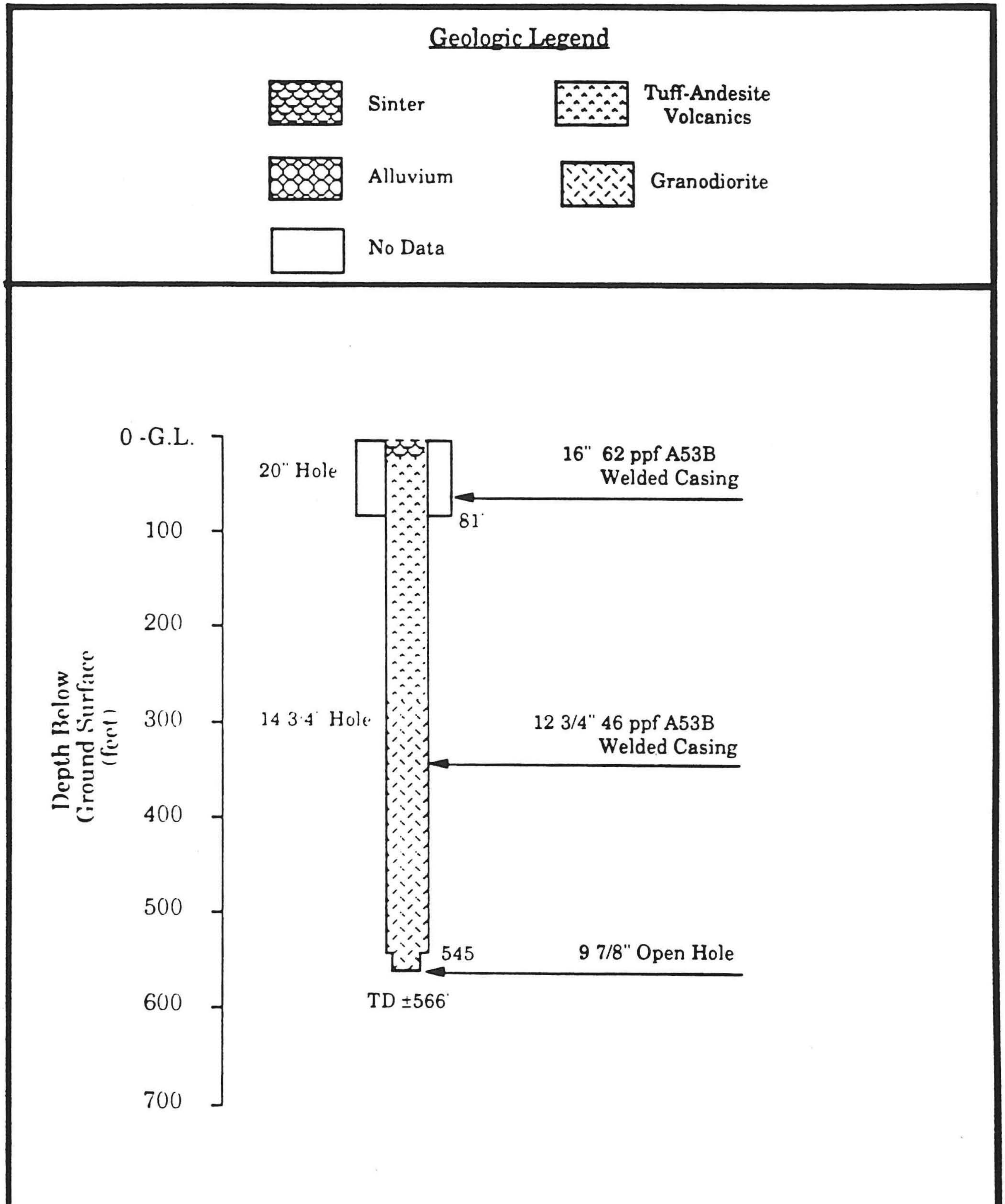
| Date | Jan-89 | Feb-89 | Mar-89 | Apr-89 | May-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 |
| Flow Rate (gpm) | 950 | 950 | 950 | 950 | 950 | 950 | 950 | 950 | 950 | 950 | 950 |
| Water Level | | | | | | | | | | | |
| TDS | 2176.0 | | | | | | | | | | 2318.0 |
| Cl | 800.0 | | | | | | | | | | 840.0 |
| Ca | 6.0 | | | | | | | | | | 10.0 |
| Mg | 0.0 | | | | | | | | | | 0.0 |
| Na | 616.0 | | | | | | | | | | 684.0 |
| K | 63.0 | | | | | | | | | | 73.0 |
| SiO2 | 319.0 | | | | | | | | | | 325.0 |
| HCO3 | 290.0 | | | | | | | | | | 337.0 |
| F | 2.2 | | | | | | | | | | 2.4 |
| B | 43.8 | | | | | | | | | | 42.2 |
| As | 0.2 | | | | | | | | | | 2.0 |
| SO4 | 115.0 | | | | | | | | | | 119.0 |
| SiO2(°F) | 417 | | | | | | | | | | 420 |
| Na/K (°F) | 368 | | | | | | | | | | 378 |
| Na/K/Ca (°F) ß=.33 | 580 | | | | | | | | | | 579 |
| Na/K/Ca (°F) ß=1.33 | 2468 | | | | | | | | | | 2282 |
| Cl/B | 18.3 | | | | | | | | | | 19.9 |

Production Well No. 2 Chemistry Data (ppm, gpm) - Page 5

| Date | Jan-90 | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 | Dec-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1824 | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Flow Rate (gpm) | 950 | 915 | 915 | 915 | 915 | 915 | 915 | 876 | 915 | 915 | 915 | 915 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | 2113.0 |
| Cl | | | | | | | | | | | | 802.0 |
| Ca | | | | | | | | | | | | 14.0 |
| Mg | | | | | | | | | | | | 0.0 |
| Na | | | | | | | | | | | | 576.0 |
| K | | | | | | | | | | | | 59.0 |
| SiO2 | | | | | | | | | | | | 275.0 |
| HCO3 | | | | | | | | | | | | 248.0 |
| F | | | | | | | | | | | | 2.4 |
| B | | | | | | | | | | | | 41.5 |
| As | | | | | | | | | | | | 2.7 |
| SO4 | | | | | | | | | | | | 118.0 |
| SiO2(°F) | | | | | | | | | | | | 396 |
| Na/K (°F) | | | | | | | | | | | | 369 |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | 555 |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | 1829 |
| Cl/B | | | | | | | | | | | | 19.3 |

**Production Well No. 2 Chemistry Data (ppm, gpm) - Page 6**

# Appendix 3 - Production Well #3 Data




PW-3 Well Completion and Geologic Information

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 0.0 | 0.0 | 820.0 | 800.0 | 840.0 | 811.0 | 0.00 | 0.00 | 23.10 | 22.54 | 23.66 | 22.85 | ### | ### | 37.7 | 38.6 | 37.3 | 39.8 |
| Ca | 0.0 | 0.0 | 8.0 | 9.0 | 17.0 | 13.0 | 0.00 | 0.00 | 0.40 | 0.45 | 0.85 | 0.65 | ### | ### | 0.7 | 0.8 | 1.3 | 1.1 |
| Mg | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | ### | ### | 0.0 | 0.0 | 0.0 | 0.0 |
| Na | 0.0 | 0.0 | 658.0 | 620.0 | 674.0 | 613.0 | 0.00 | 0.00 | 28.61 | 26.96 | 29.30 | 26.65 | | | | | | |
| K | 0.0 | 0.0 | 70.0 | 63.0 | 69.0 | 62.0 | 0.00 | 0.00 | 1.79 | 1.62 | 1.77 | 1.59 | | | | | | |
| SiO2 | 0.0 | 0.0 | 340.0 | 311.0 | 315.0 | 293.0 | 0.00 | 0.00 | 22.63 | 20.70 | 20.97 | 19.51 | | | | | | |
| HCO3 | 0.0 | 0.0 | 342.0 | 305.0 | 366.0 | 233.0 | 0.00 | 0.00 | 5.61 | 5.00 | 6.00 | 3.82 | ### | ### | 9.2 | 8.6 | 9.5 | 6.7 |
| F | 0.0 | 0.0 | 2.1 | 2.2 | 2.5 | 2.4 | 0.00 | 0.00 | 0.11 | 0.12 | 0.13 | 0.13 | | | | | | |
| B | 0.0 | 0.0 | 44.4 | 43.8 | 43.2 | 43.0 | 0.00 | 0.00 | 12.33 | 12.17 | 12.00 | 11.94 | | | | | | |
| As | 0.0 | 0.0 | 1.7 | 0.9 | 2.6 | 2.0 | | | | | | | | | | | | |
| SO4 | 0.0 | 0.0 | 108.0 | 112.0 | 119.0 | 119.0 | 0.00 | 0.00 | 1.69 | 1.75 | 1.86 | 1.86 | ### | ### | 2.8 | 3.0 | 2.9 | 3.2 |
| Ca+Mg | | | | | | | 0.00 | 0.00 | 0.40 | 0.45 | 0.85 | 0.65 | ### | ### | 0.7 | 0.8 | 1.3 | 1.1 |
| SO4+Cl | | | | | | | 0.00 | 0.00 | 24.79 | 24.29 | 25.52 | 24.70 | ### | ### | 40.5 | 41.7 | 40.2 | 43.0 |
| Na+K | | | | | | | 0.00 | 0.00 | 30.40 | 28.57 | 31.07 | 28.24 | ### | ### | 49.7 | 49.0 | 49.0 | 49.2 |
| CO3+HCO3 | | | | | | | 0.00 | 0.00 | 5.61 | 5.00 | 6.00 | 3.82 | ### | ### | 9.2 | 8.6 | 9.5 | 6.7 |
| Total | 0.0 | 0.0 | 2394.2 | 2266.9 | 2448.3 | 2191.4 | 0.00 | 0.00 | 61.20 | 58.31 | 63.44 | 57.42 | ### | ### | 0.7 | -0.5 | 0.6 | 0.6 |

**Production Well No. 3 Chemistry Data (meq/l) (### = No Data)**

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Flow Rate (gpm) | | | | | | | | | | | | | |
| Water Level | | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | | |
| Na | | | | | | | | | | | | | |
| K | | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | | |
| F | | | | | | | | | | | | | |
| B | | | | | | | | | | | | | |
| As | | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | | |

Production Well No. 3 Chemistry Data (ppm. gpm) - Page 1

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Flow Rate (gpm) | | | | | | | | | | | | 0 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| As | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | |

**Production Well No. 3 Chemistry Data (ppm. gpm) - Page 2**

| Date | Jan-87 | Feb-87 | Mar-87 | Apr-87 | May-87 | Jun-87 | Jul-87 | Aug-87 | Sep-87 | Oct-87 | Nov-87 | Dec-87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 760 | 790 | 821 | 851 | 882 | 912 | 942 | 973 | 1003 | 1034 | 1064 | 1094 |
| Flow Rate (gpm) | 988 | 1104 | 691 | 1329 | 1160 | 1186 | 1194 | 1346 | 1337 | 1354 | 333 | 748 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | 2169.0 |
| Cl | | | | | | | | | | | | 820.0 |
| Ca | | | | | | | | | | | | 8.0 |
| Mg | | | | | | | | | | | | 0.0 |
| Na | | | | | | | | | | | | 658.0 |
| K | | | | | | | | | | | | 70.0 |
| SiO2 | | | | | | | | | | | | 340.0 |
| HCO3 | | | | | | | | | | | | 342.0 |
| F | | | | | | | | | | | | 2.1 |
| B | | | | | | | | | | | | 44.4 |
| As | | | | | | | | | | | | 1.7 |
| SO4 | | | | | | | | | | | | 108.0 |
| SiO2(°F) | | | | | | | | | | | | 426 |
| Na/K (°F) | | | | | | | | | | | | 377 |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | 582 |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | 2390 |
| Cl/B | | | | | | | | | | | | 18.5 |

Production Well No. 3 Chemistry Data (ppm. gpm) - Page 3

| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun-88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Flow Rate (gpm) | 1300 | 1300 | 1300 | 1300 | 1288 | 1292 | 1298 | 1275 | 1283 | 1269 | 1250 | 1248 |
| Water Level | | | | | | | | | | | | |
| TDS | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| As | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | |

Production Well No. 3 Chemistry Data (ppm. gpm) - Page 4

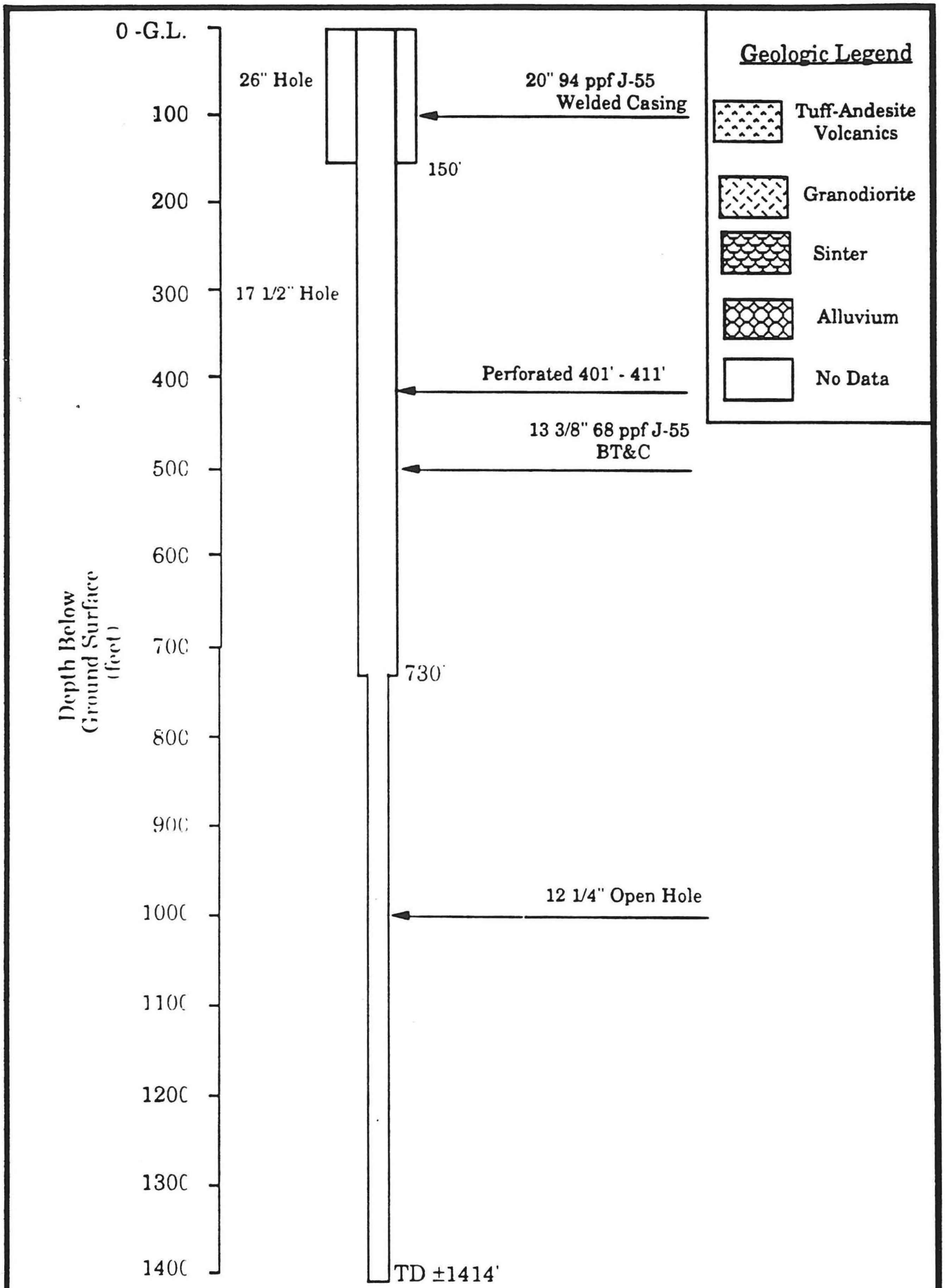
| Date | Jan-89 | Feb-89 | Mar-89 | Apr-89 | May-89 | Jun-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 | 1824 |
| Flow Rate (gpm) | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 |
| Water Level | | | | | | | | | | | | |
| TDS | 2177.0 | | | | | | | | | | 2296.0 | |
| Cl | 800.0 | | | | | | | | | | 840.0 | |
| Ca | 9.0 | | | | | | | | | | 17.0 | |
| Mg | 0.0 | | | | | | | | | | 0.0 | |
| Na | 620.0 | | | | | | | | | | 674.0 | |
| K | 63.0 | | | | | | | | | | 69.0 | |
| SiO2 | 311.0 | | | | | | | | | | 315.0 | |
| HCO3 | 305.0 | | | | | | | | | | 366.0 | |
| F | 2.2 | | | | | | | | | | 2.5 | |
| B | 43.8 | | | | | | | | | | 43.2 | |
| As | 0.9 | | | | | | | | | | 2.6 | |
| SO4 | 112.0 | | | | | | | | | | 119.0 | |
| SiO2(°F) | 413 | | | | | | | | | | 415 | |
| Na/K (°F) | 367 | | | | | | | | | | 369 | |
| Na/K/Ca (°F) ß=.33 | 568 | | | | | | | | | | 558 | |
| Na/K/Ca (°F) ß=1.33 | 2167 | | | | | | | | | | 1891 | |
| Cl/B | 18.3 | | | | | | | | | | 19.4 | |

Production Well No. 3 Chemistry Data (ppm. gpm) - Page 5

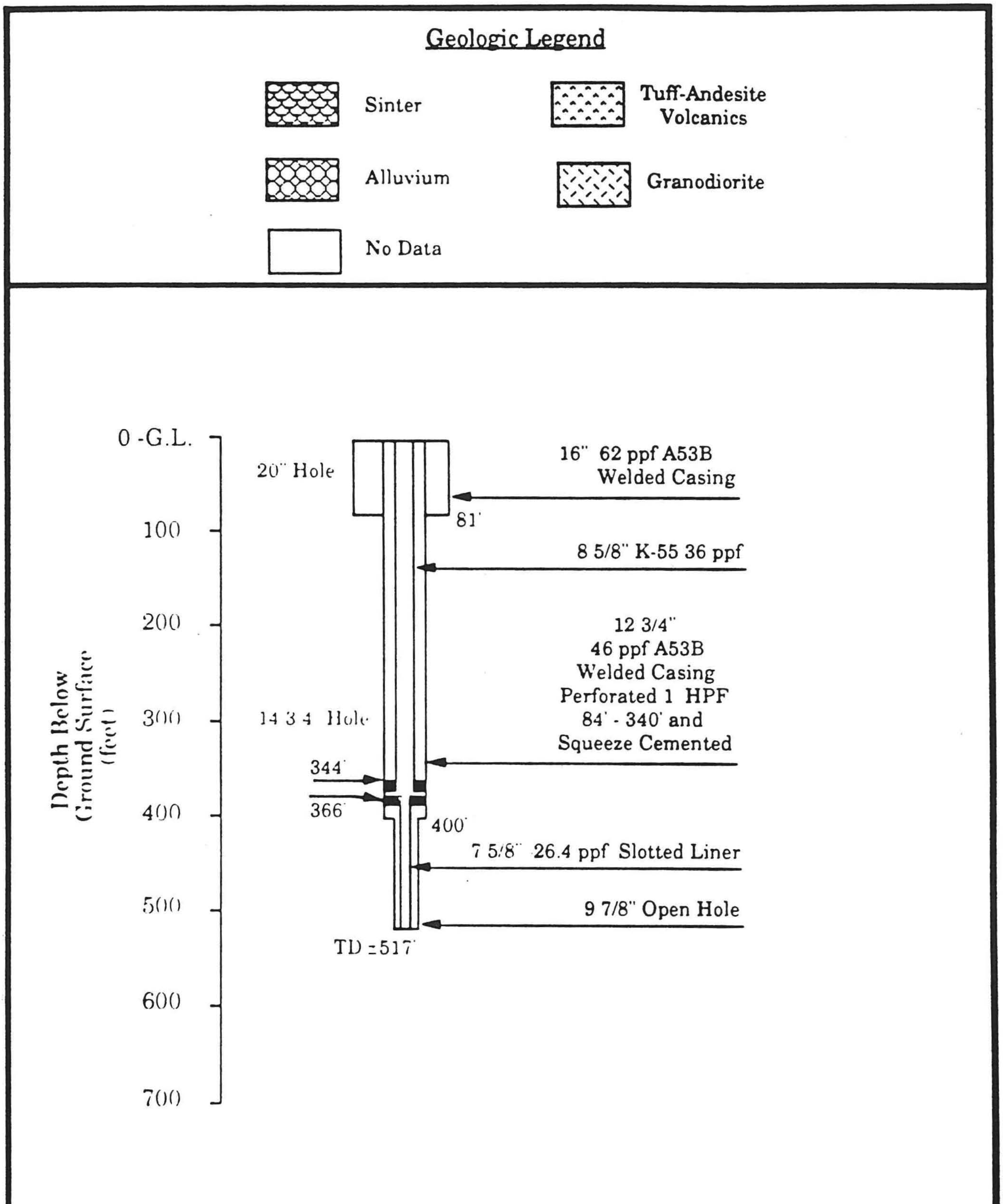
| Date | Jan-90 | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Flow Rate (gpm) | 1370 | 1370 | 1370 | 1370 | 1370 | 1370 | 1373 | 1361 | 1317 | 1317 | 1320 |
| Water Level | | | | | | | | | | | |
| TDS | | | | | | | | | | | 2130.0 |
| Cl | | | | | | | | | | | 811.0 |
| Ca | | | | | | | | | | | 13.0 |
| Mg | | | | | | | | | | | 0.0 |
| Na | | | | | | | | | | | 613.0 |
| K | | | | | | | | | | | 62.0 |
| SiO2 | | | | | | | | | | | 293.0 |
| HCO3 | | | | | | | | | | | 233.0 |
| F | | | | | | | | | | | 2.4 |
| B | | | | | | | | | | | 43.0 |
| As | | | | | | | | | | | 2.0 |
| SO4 | | | | | | | | | | | 119.0 |
| SiO2(°F) | | | | | | | | | | | 405 |
| Na/K (°F) | | | | | | | | | | | 366 |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | 558 |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | 1924 |
| Cl/B | | | | | | | | | | | 18.9 |

Production Well No. 3 Chemistry Data (ppm. gpm) - Page 6

# Appendix 4 - Injection Well Completions

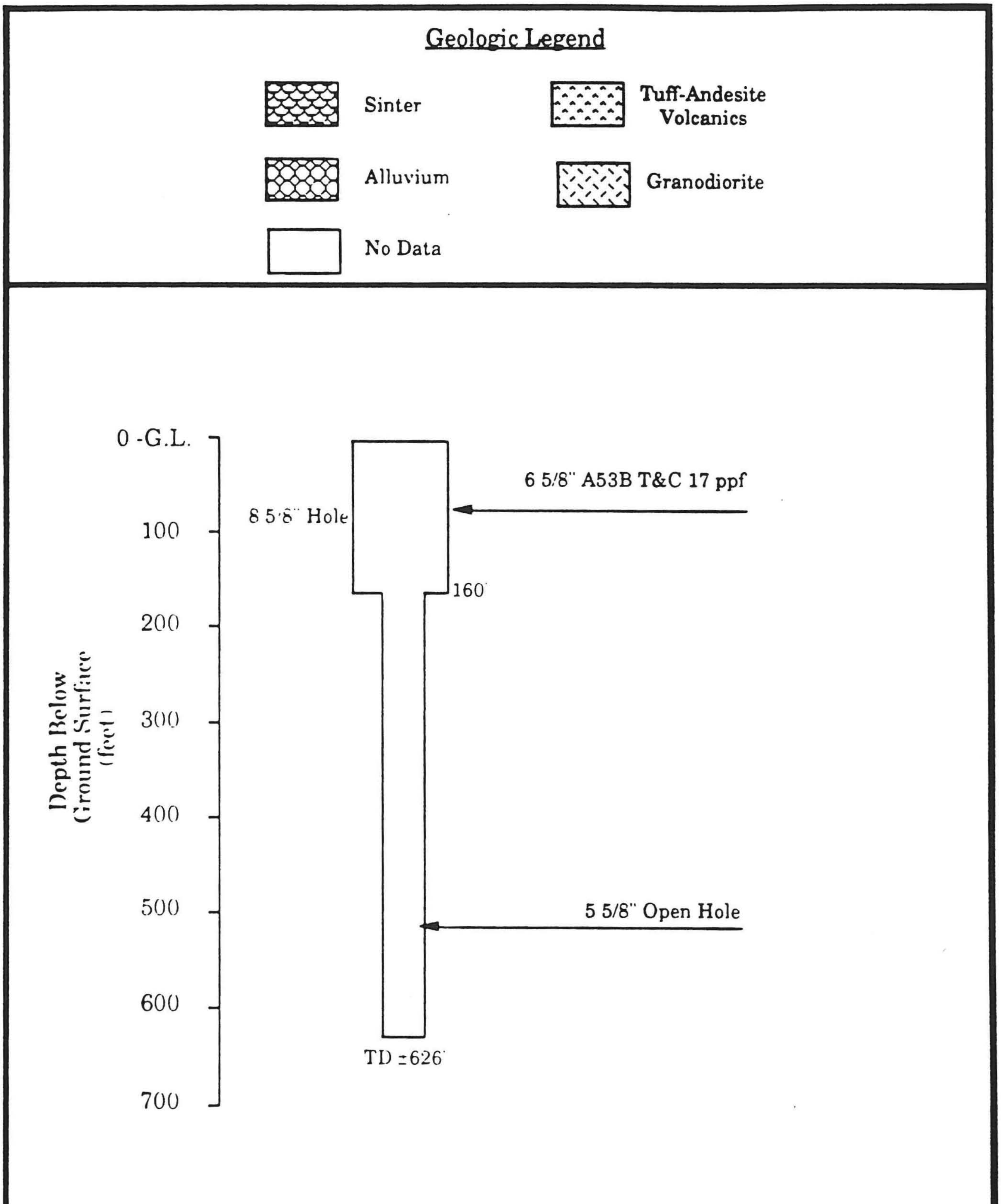



IW-2 Well Completion and Geologic Information

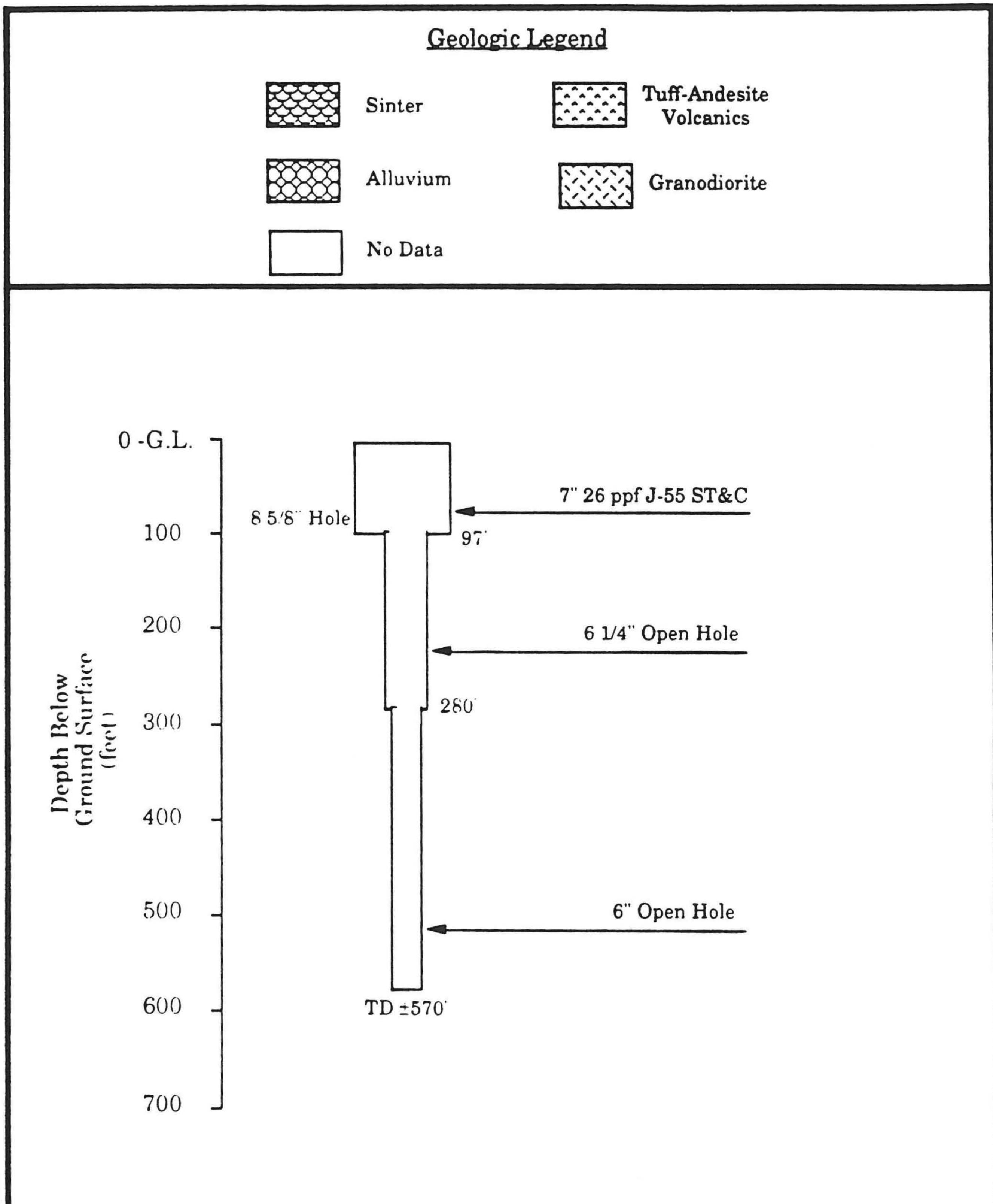



IW-3 Well Completion and Geologic Information

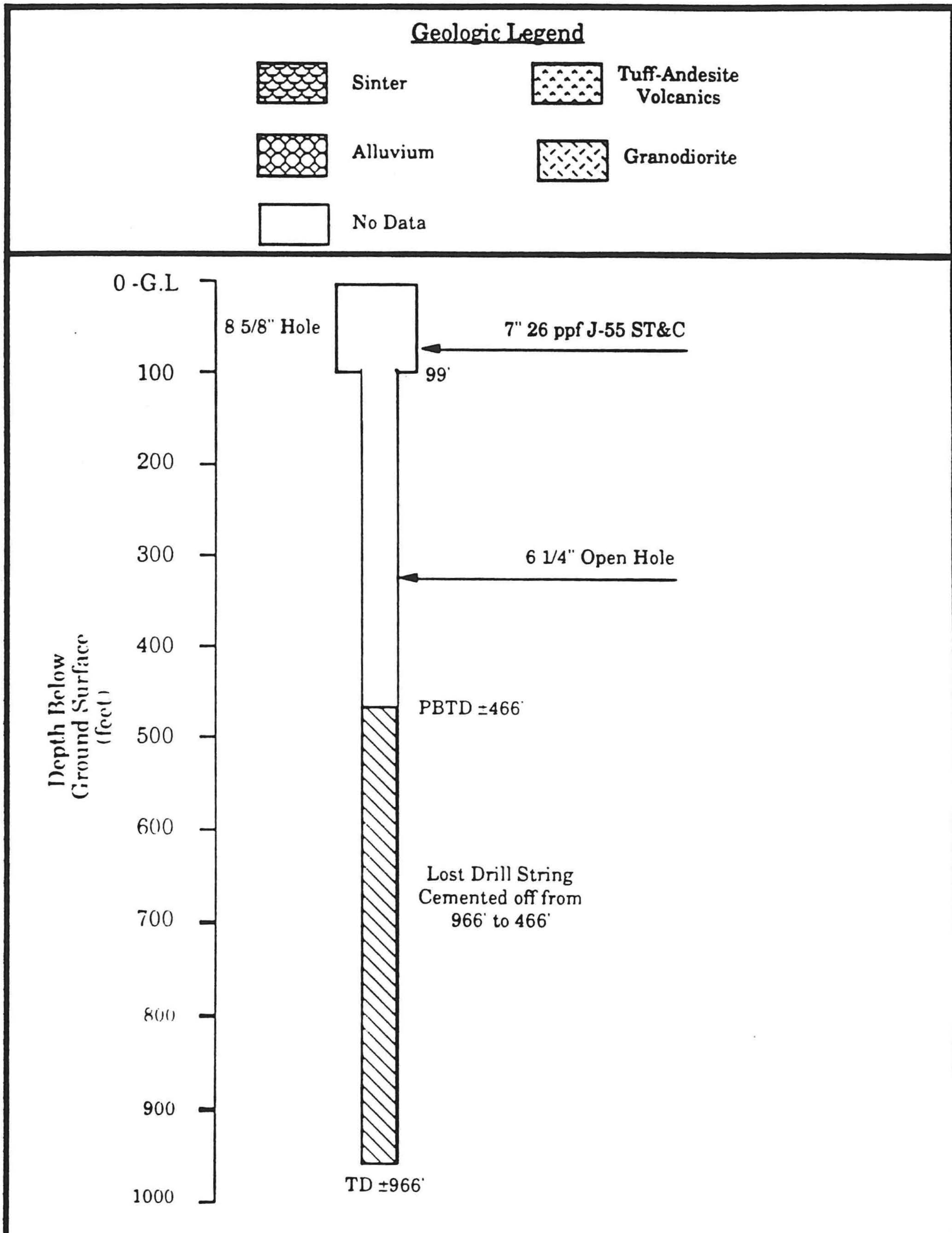
# Appendix 5 - Observation Well Completions



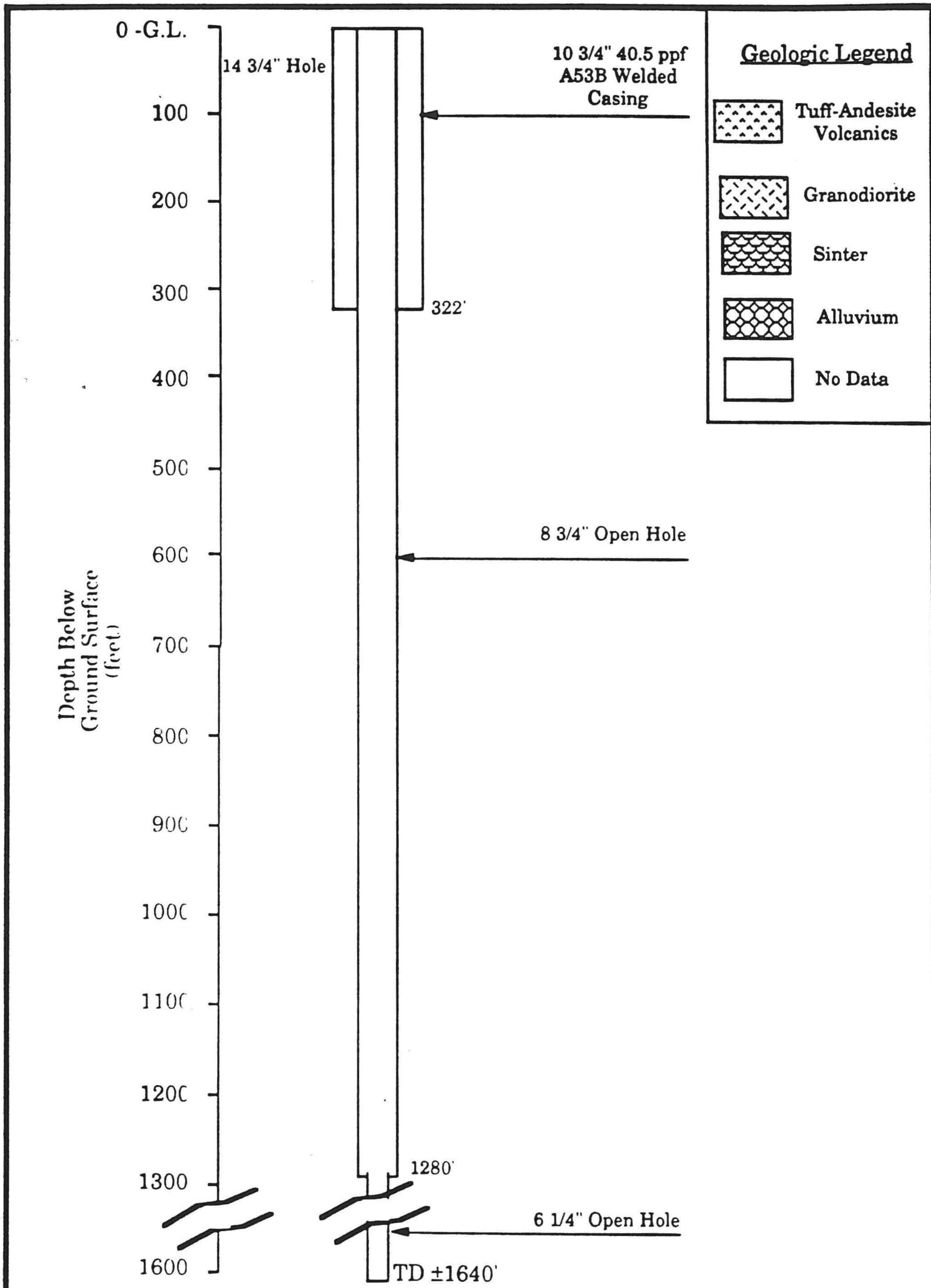

OW-1 Well Completion and Geologic Information




OW-2 Well Completion and Geologic Information

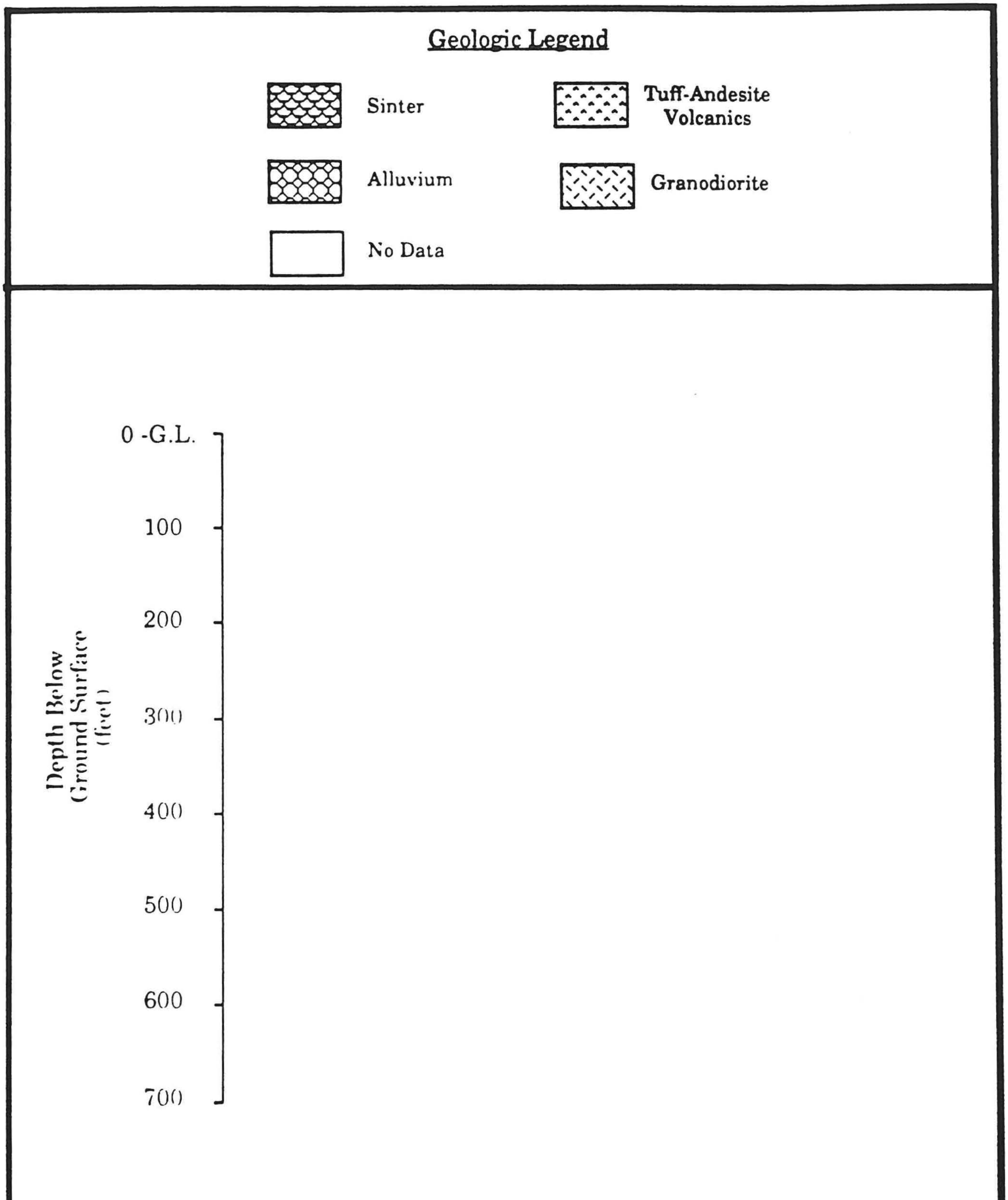



OW-3 Well Completion and Geologic Information

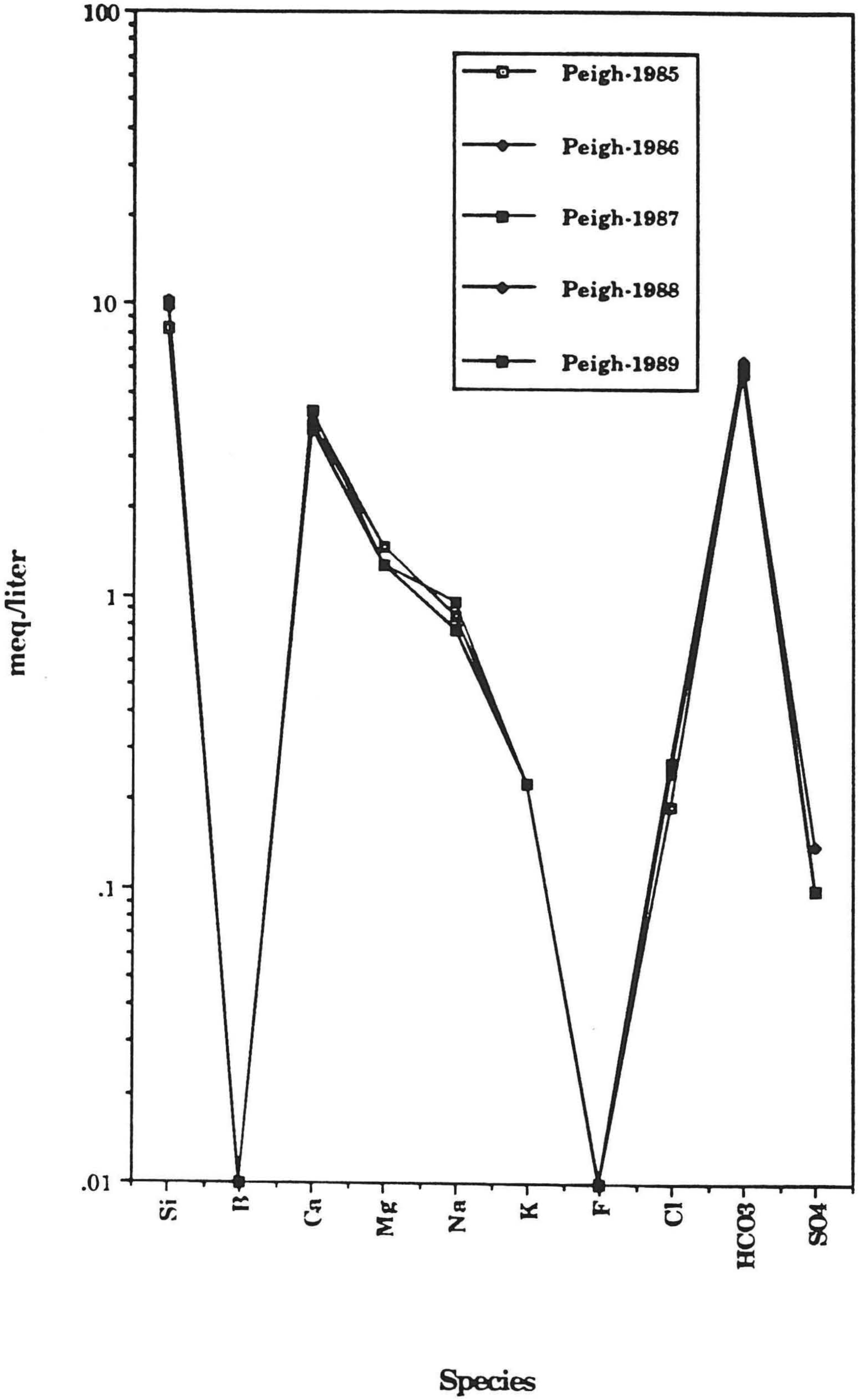



IW-1 Well Completion and Geologic Information

# Appendix 6 - Peigh Well Monitor Data




Peigh Well Completion and Geologic Information



100
10
1
.1
.01
meq/liter
Peigh-1985
Peigh-1986
Peigh-1987
Peigh-1988
Peigh-1989
Si
B
Ca
Mg
Na
K
F
Cl
HCO3
SO4
Species

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 3.0 | 3.0 | 4.0 | 3.0 | 6.0 | 5.0 | 0.08 | 0.08 | 0.11 | 0.08 | 0.17 | 0.14 | 1.5 | 1.5 | 2.0 | 1.4 | 2.8 | 2.2 |
| Ca | 35.0 | 35.0 | 34.0 | 38.0 | 39.0 | 42.0 | 1.75 | 1.75 | 1.70 | 1.90 | 1.95 | 2.10 | 30.6 | 30.5 | 30.1 | 31.3 | 32.3 | 32.4 |
| Mg | 8.0 | 8.0 | 7.0 | 8.0 | 7.0 | 8.0 | 0.67 | 0.67 | 0.58 | 0.67 | 0.58 | 0.67 | 11.7 | 11.6 | 10.3 | 11.0 | 9.7 | 10.3 |
| Na | 9.0 | 9.0 | 8.0 | 9.0 | 10.0 | 9.0 | 0.39 | 0.39 | 0.35 | 0.39 | 0.43 | 0.39 | | | | | | |
| K | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 5.0 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.13 | | | | | | |
| SiO2 | 56.0 | 66.0 | 67.0 | 70.0 | 68.0 | 71.0 | 3.73 | 4.39 | 4.46 | 4.66 | 4.53 | 4.73 | | | | | | |
| HCO3 | 163.0 | 163.0 | 168.0 | 178.0 | 171.0 | 181.0 | 2.67 | 2.67 | 2.75 | 2.92 | 2.80 | 2.97 | 46.8 | 46.6 | 48.8 | 48.1 | 46.4 | 45.8 |
| F | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | |
| B | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.2 | 0.00 | 0.03 | 0.00 | 0.00 | 0.03 | 0.06 | | | | | | |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | | | | | | |
| SO4 | 3.0 | 4.0 | 3.0 | 0.0 | 0.0 | 5.0 | 0.05 | 0.06 | 0.05 | 0.00 | 0.00 | 0.08 | 0.8 | 1.1 | 0.8 | 0.0 | 0.0 | 1.2 |
| Ca+Mg | | | | | | | 2.42 | 2.42 | 2.28 | 2.57 | 2.53 | 2.77 | 42.3 | 42.2 | 40.4 | 42.3 | 41.9 | 42.7 |
| SO4+Cl | | | | | | | 0.13 | 0.15 | 0.16 | 0.08 | 0.17 | 0.22 | 2.3 | 2.6 | 2.8 | 1.4 | 2.8 | 3.4 |
| Na+K | | | | | | | 0.49 | 0.49 | 0.45 | 0.49 | 0.54 | 0.52 | 8.6 | 8.6 | 8.0 | 8.1 | 8.9 | 8.0 |
| CO3+HCO3 | | | | | | | 2.67 | 2.67 | 2.75 | 2.92 | 2.80 | 2.97 | 46.8 | 46.6 | 48.8 | 48.1 | 46.4 | 45.8 |
| Total | 281.0 | 292.2 | 295.1 | 310.1 | 305.2 | 326.3 | 5.71 | 5.73 | 5.65 | 6.06 | 6.04 | 6.47 | 1.9 | 1.6 | -3.2 | 1.0 | 1.6 | 1.5 |

Peigh Domestic Well Chemistry Data (meq/l)

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Temperature | 87.0 | 84.0 | 84.0 | 88.0 | 94.0 | 96.0 | 90.0 | 94.0 | 90.0 | 94.0 | 99.0 | 93.0 | 86.0 |
| Water Level | | | | | | | | | | | | | |
| TDS | 217.0 | 213.0 | 208.0 | 231.0 | 218.0 | 217.0 | 219.0 | 214.0 | 198.0 | 208.0 | 215.0 | 205.0 | 207.0 |
| Cl | 3.0 | 3.0 | 4.0 | 3.0 | 3.0 | 3.0 | 2.0 | 2.0 | 4.0 | 2.0 | 2.0 | 3.0 | 3.0 |
| Ca | 35.0 | 39.0 | 38.0 | | | | 39.0 | | | 36.0 | | | 35.0 |
| Mg | 8.0 | 8.0 | 8.0 | | | | 8.0 | | | 8.0 | | | 8.0 |
| Na | 9.0 | 9.0 | 9.0 | | | | 9.0 | | | 9.0 | | | 9.0 |
| K | 4.0 | 4.0 | 4.0 | | | | 4.0 | | | 4.0 | | | 4.0 |
| SiO2 | 56.0 | 68.0 | 71.0 | | | | 73.0 | | | 68.0 | | | 66.0 |
| HCO3 | 163.0 | 163.0 | 168.0 | | | | 176.0 | | | 163.0 | | | 163.0 |
| F | 0.0 | 0.0 | 0.1 | | | | 0.0 | | | 0.0 | | | 0.1 |
| B | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.20 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 3.0 | 3.0 | 3.0 | 2.0 | 2.0 | 3.0 | 3.0 | 3.0 | 6.0 | 3.0 | 3.0 | 4.0 | 4.0 |
| SiO2(°F) | 225 | 242 | 246 | | | | 248 | | | 242 | | | 239 |
| Na/K (°F) | 871 | 871 | 871 | | | | 871 | | | 871 | | | 871 |
| Na/K/Ca (°F), ß=.33 | 546 | 544 | 544 | | | | 544 | | | 546 | | | 546 |
| Na/K/Ca (°F), ß=1.33 | 432 | 424 | 426 | | | | 424 | | | 430 | | | 432 |
| Cl/B | | | | 30.0 | 15.0 | 15.0 | 20.0 | 20.0 | 40.0 | 20.0 | 20.0 | 30.0 | 30.0 |

**Peigh Domestic Monitor Well Data (ppm, feet, °F) - Page 1**

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Temperature | 90.0 | 90.0 | 82.0 | 90.0 | 87.0 | 93.0 | 88.0 | 90.0 | 92.0 | 90.0 | 90.0 | 88.0 |
| Water Level | | | | | | | | | | | | |
| TDS | 217.0 | 213.0 | 216.0 | 203.0 | 227.0 | 219.0 | 193.0 | 191.0 | 201.0 | 207.0 | 203.0 | 203.0 |
| Cl | 3.0 | 3.0 | 3.0 | 3.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | 2.0 | 2.0 | 4.0 |
| Ca | | | 37.0 | | | 37.0 | | | 34.0 | | | 34.0 |
| Mg | | | 7.0 | | | 8.0 | | | 8.0 | | | 7.0 |
| Na | | | 9.0 | | | 9.0 | | | 9.0 | | | 8.0 |
| K | | | 4.0 | | | 4.0 | | | 4.0 | | | 4.0 |
| SiO2 | | | 66.0 | | | 68.0 | | | 67.0 | | | 67.0 |
| HCO3 | | | 176.0 | | | 176.0 | | | 161.0 | | | 168.0 |
| F | | | 0.0 | | | 0.0 | | | 0.0 | | | 0.1 |
| B | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 3.0 | 3.0 | 3.0 | 2.0 | 3.0 | 3.0 | 6.0 | 5.0 | 5.0 | 4.0 | 4.0 | 3.0 |
| SiO2(°F) | | | 239 | | | 242 | | | 241 | | | 241 |
| Na/K (°F) | | | 871 | | | 871 | | | 871 | | | 939 |
| Na/K/Ca (°F), ß=.33 | | | 545 | | | 545 | | | 547 | | | 559 |
| Na/K/Ca (°F), ß=1.33 | | | 428 | | | 428 | | | 434 | | | 430 |
| Cl/B | 30.0 | 30.0 | 30.0 | 30.0 | 40.0 | 30.0 | 30.0 | 15.0 | 30.0 | 20.0 | 20.0 | |

Peigh Domestic Monitor Well Data (ppm, feet, °F) - Page 2

| Date | Jan-87 | Feb-87 | Mar-87 | Apr-87 | May-87 | Jun-87 | Jul-87 | Aug-87 | Sep-87 | Oct-87 | Nov-87 | Dec-87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 760 | 790 | 821 | 851 | 882 | 912 | 942 | 973 | 1003 | 1034 | 1064 | 1094 |
| Temperature | 88.0 | 88.0 | 88.0 | 90.0 | 90.0 | 91.0 | 92.0 | 88.0 | 88.0 | 88.0 | 85.0 | 89.0 |
| Water Level | | | | | | | | | | | | |
| TDS | 214.0 | 218.0 | 203.0 | 217.0 | 228.0 | 229.0 | 218.0 | 192.0 | 196.0 | 193.0 | 202.0 | 215.0 |
| Cl | 2.0 | 3.0 | 2.0 | 3.0 | 4.0 | 3.0 | 2.0 | 1.0 | 2.0 | 2.0 | 3.0 | 3.0 |
| Ca | | | 38.0 | | | 43.0 | | | 31.0 | | | 38.0 |
| Mg | | | 7.0 | | | 8.0 | | | 7.0 | | | 8.0 |
| Na | | | 9.0 | | | 9.0 | | | 9.0 | | | 9.0 |
| K | | | 4.0 | | | 4.0 | | | 4.0 | | | 4.0 |
| SiO2 | | | 70.0 | | | 71.0 | | | 67.0 | | | 70.0 |
| HCO3 | | | 181.0 | | | 190.0 | | | 140.0 | | | 178.0 |
| F | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 |
| B | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| As | 0.0 | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | 245 | | | 246 | | | 241 | | | 245 |
| Na/K (°F) | | | 871 | | | 871 | | | 871 | | | 871 |
| Na/K/Ca (°F), ß=.33 | | | 544 | | | 541 | | | 549 | | | 544 |
| Na/K/Ca (°F), ß=1.33 | | | 426 | | | 416 | | | 441 | | | 426 |
| Cl/B | | | 20.0 | | | | 20.0 | | 20.0 | | | |

Peigh Domestic Monitor Well Data (ppm, feet, °F) - Page 3

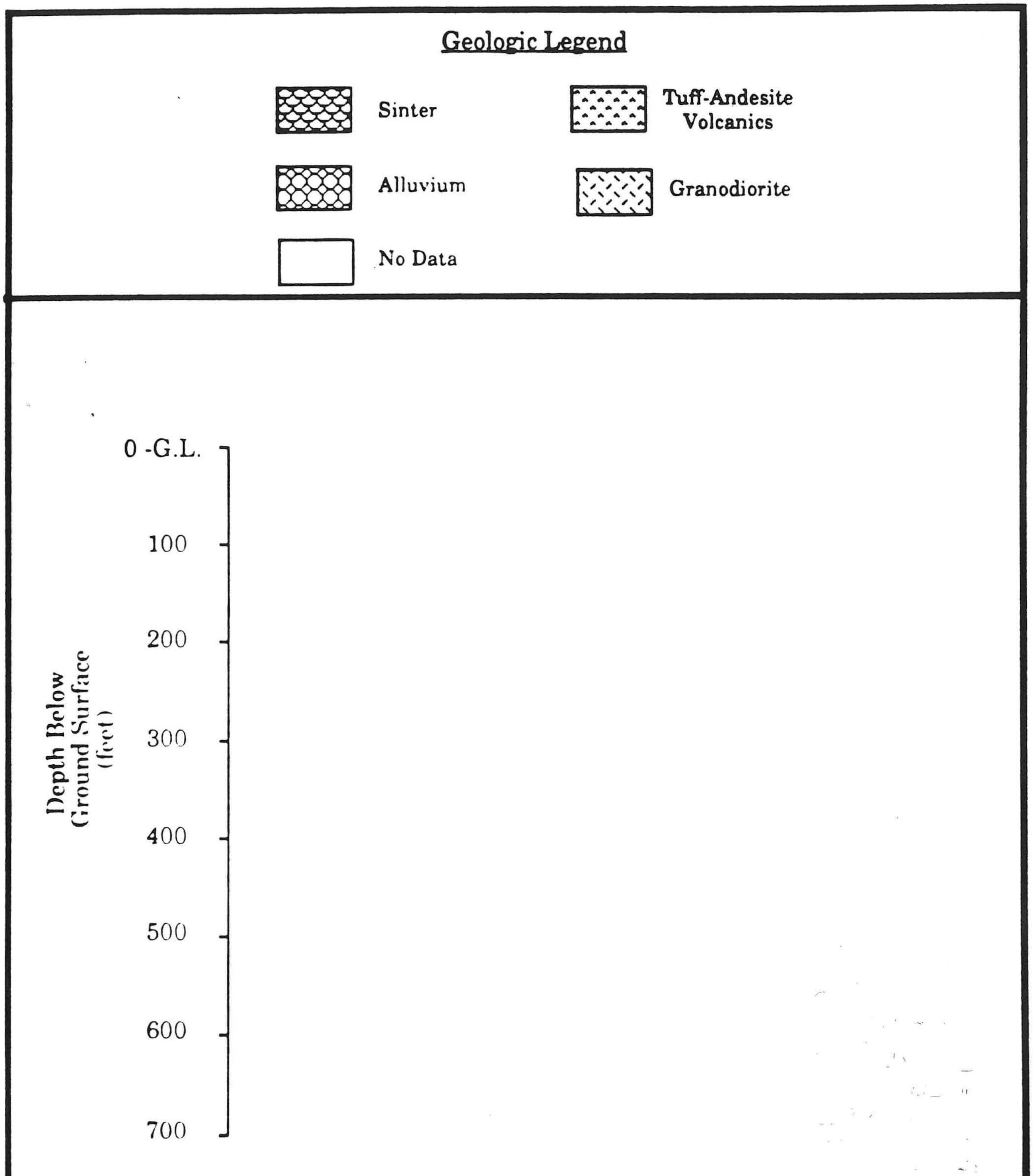
| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun-88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Temperature | 89.0 | 89.0 | 92.0 | 88.0 | 90.0 | 84.0 | 82.0 | 82.0 | | | 95.0 | |
| Water Level | | | | | | | | | | | | |
| TDS | 231.0 | 217.0 | 219.0 | 210.0 | 226.0 | 194.0 | 179.0 | 165.0 | 183.0 | | 208.0 | |
| Cl | 2.0 | 3.0 | 2.0 | 2.0 | 2.0 | 1.0 | 3.0 | 2.0 | 4.0 | | 5.0 | |
| Ca | | | 40.0 | | | 31.0 | | | 29.0 | | 38.0 | |
| Mg | | | 8.0 | | | 7.0 | | | 7.0 | | 8.0 | |
| Na | | | 9.0 | | | 9.0 | | | 9.0 | | 15.0 | |
| K | | | 4.0 | | | 3.0 | | | 3.0 | | 4.0 | |
| SiO2 | | | 68.0 | | | 67.0 | | | 64.0 | | | |
| HCO3 | | | 181.0 | | | 149.0 | | | 139.0 | | 168.0 | |
| F | | | 0.1 | | | 0.1 | | | 0.1 | | 0.1 | |
| B | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| As | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | 242 | | | 241 | | | 236 | | | |
| Na/K (°F) | | | 871 | | | 730 | | | 730 | | 639 | |
| Na/K/Ca (°F), ß=.33 | | | 543 | | | 508 | | | 510 | | 496 | |
| Na/K/Ca (°F), ß=1.33 | | | 422 | | | 408 | | | 413 | | 445 | |
| Cl/B | | | | | | | | | | | | |

Peigh Domestic Monitor Well Data (ppm, feet, °F) - Page 4

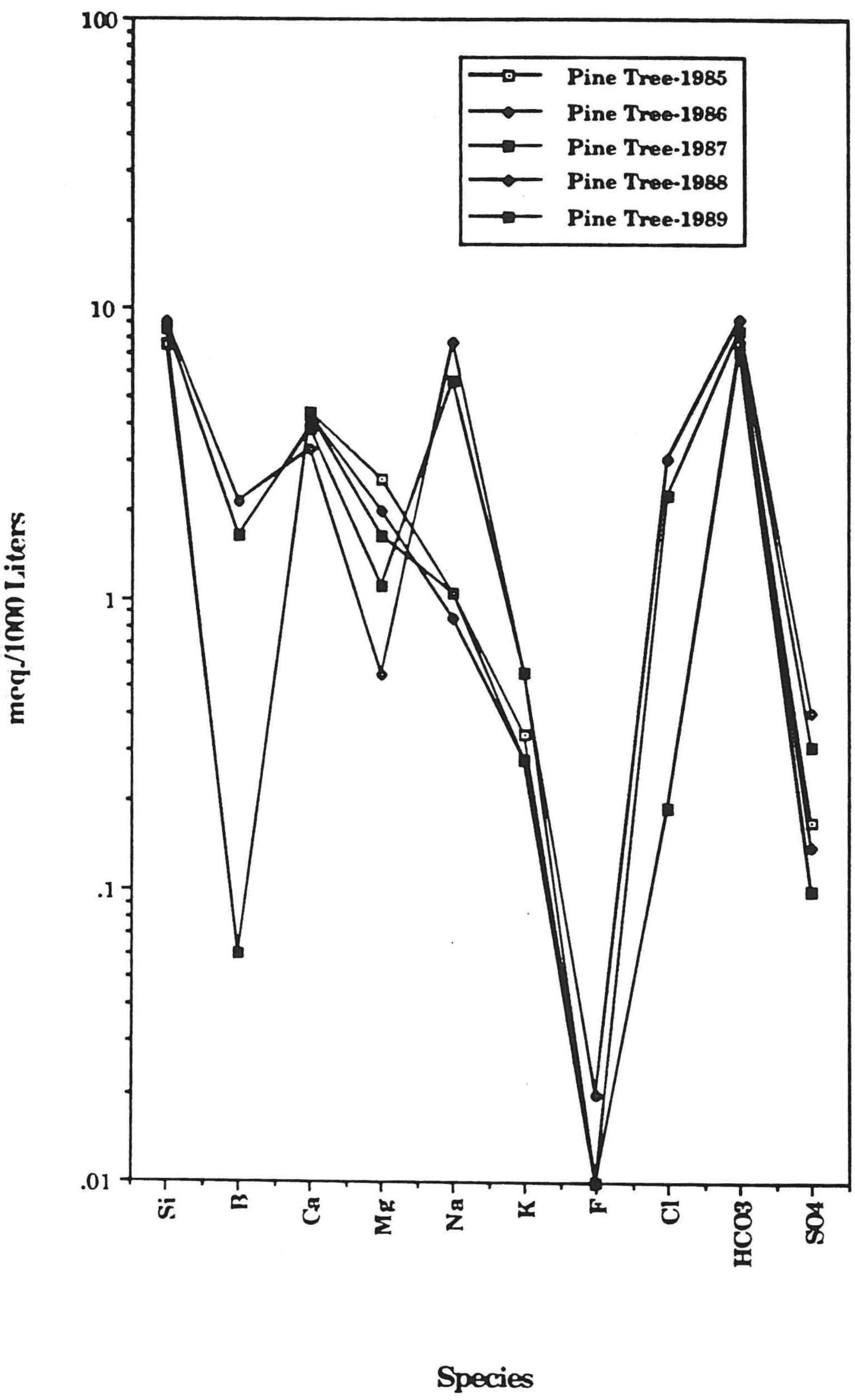
| Date | Jan-89 | Feb-89 | Mar-89 | May-89 | Jun-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 |
| Temperature | 80.0 | 81.0 | 88.0 | 88.0 | 90.0 | 88.0 | 88.0 | 90.0 | 86.0 | 78.0 | 82.0 |
| Water Level | | | | | | | | | | | |
| TDS | 217.0 | 229.0 | 228.0 | 227.0 | 223.0 | 207.0 | 197.0 | 204.0 | 214.0 | 208.0 | 204.0 |
| Cl | 6.0 | 7.0 | 6.0 | 5.0 | 6.0 | 3.0 | 4.0 | 4.0 | 3.0 | 3.0 | 3.0 |
| Ca | 39.0 | | | | | | | | | | |
| Mg | 7.0 | | | | | | | | | | |
| Na | 10.0 | | | | | | | | | | |
| K | 4.0 | | | | | | | | | | |
| SiO2 | 68.0 | | | | | | | | | | |
| HCO3 | 171.0 | | | | | | | | | | |
| F | 0.1 | | | | | | | | | 0.1 | 0.1 |
| B | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| As | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | | | | | | | | | | 7.0 | 6.0 |
| SiO2(°F) | 242 | | | | | | | | | | |
| Na/K (°F) | 816 | | | | | | | | | | |
| Na/K/Ca (°F), ß=.33 | 534 | | | | | | | | | | |
| Na/K/Ca (°F), ß=1.33 | 428 | | | | | | | | | | |
| Cl/B | 60.0 | | | | | | | | 30.0 | | |

| Date | Jan-90 | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 | Dec-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1824 | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Temperature | 88.0 | 80.0 | 84.0 | 82.0 | 101.0 | 102.0 | 103.0 | | | | | 94.0 |
| Water Level | | | | | | | | | | | | |
| TDS | 224.0 | 220.0 | 230.0 | 228.0 | 235.0 | 238.0 | 239.0 | | | | | 241.0 |
| Cl | 3.0 | 3.0 | 4.0 | 3.0 | 5.0 | 3.0 | 2.0 | | | | | 5.0 |
| Ca | | | | | | | | | | | | 42.0 |
| Mg | | | | | | | | | | | | 8.0 |
| Na | | | | | | | | | | | | 9.0 |
| K | | | | | | | | | | | | 5.0 |
| SiO2 | | | | | | | | | | | | 71.0 |
| HCO3 | | | | | | | | | | | | 181.0 |
| F | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | 0.1 |
| B | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | 0.2 |
| As | 0.0 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | | | | | 0.0 |
| SO4 | 4.0 | 5.0 | 6.0 | 5.0 | 5.0 | 5.0 | 5.0 | | | | | 5.0 |
| SiO2(°F) | | | | | | | | | | | | 246 |
| Na/K (°F) | | | | | | | | | | | | 1007 |
| Na/K/Ca (°F), ß=.33 | | | | | | | | | | | | 576 |
| Na/K/Ca (°F), ß=1.33 | | | | | | | | | | | | 444 |
| Cl/B | | | | | | | | | | | | 25.0 |

# Appendix 7 - Pine Tree Ranch Well Monitor Data




Pine Tree Well Completion and Geologic Information


Pine Tree-1985
Pine Tree-1986
Pine Tree-1987
Pine Tree-1988
Pine Tree-1989
100
10
1
.1
.01
meq./1000 Liters
Si
B
Ca
Mg
Na
K
F
Cl
HCO3
SO4
Species

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 3.0 | 3.0 | 3.0 | 49.0 | 37.0 | 0.0 | 0.08 | 0.08 | 0.08 | 1.38 | 1.04 | 0.00 | 1.1 | 1.2 | 1.3 | 12.2 | 10.4 | ### |
| Ca | 40.0 | 39.0 | 39.0 | 30.0 | 35.0 | 0.0 | 2.00 | 1.95 | 1.95 | 1.50 | 1.75 | 0.00 | 27.2 | 28.8 | 29.2 | 13.2 | 17.4 | ### |
| Mg | 14.0 | 11.0 | 9.0 | 3.0 | 6.0 | 0.0 | 1.17 | 0.92 | 0.75 | 0.25 | 0.50 | 0.00 | 15.9 | 13.5 | 11.2 | 2.2 | 5.0 | ### |
| Na | 11.0 | 9.0 | 11.0 | 80.0 | 59.0 | 0.0 | 0.48 | 0.39 | 0.48 | 3.48 | 2.57 | 0.00 | | | | | | |
| K | 6.0 | 5.0 | 5.0 | 10.0 | 10.0 | 0.0 | 0.15 | 0.13 | 0.13 | 0.26 | 0.26 | 0.00 | | | | | | |
| SiO2 | 51.0 | 58.0 | 58.0 | 62.0 | 58.0 | 0.0 | 3.40 | 3.86 | 3.86 | 4.13 | 3.86 | 0.00 | | | | | | |
| HCO3 | 207.0 | 198.0 | 198.0 | 261.0 | 232.0 | 0.0 | 3.39 | 3.25 | 3.25 | 4.28 | 3.80 | 0.00 | 46.1 | 47.9 | 48.6 | 37.8 | 37.8 | ### |
| F | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.0 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | | | | | | |
| B | 0.0 | 0.1 | 0.1 | 3.5 | 2.7 | 0.0 | 0.00 | 0.03 | 0.03 | 0.97 | 0.75 | 0.00 | | | | | | |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | | | | | | |
| SO4 | 5.0 | 4.0 | 3.0 | 12.0 | 9.0 | 0.0 | 0.08 | 0.06 | 0.05 | 0.19 | 0.14 | 0.00 | 1.1 | 0.9 | 0.7 | 1.7 | 1.4 | ### |
| Ca+Mg | | | | | | | 3.17 | 2.87 | 2.70 | 1.75 | 2.25 | 0.00 | 43.1 | 42.3 | 40.4 | 15.4 | 22.4 | ### |
| SO4+Cl | | | | | | | 0.16 | 0.15 | 0.13 | 1.57 | 1.18 | 0.00 | 2.2 | 2.2 | 2.0 | 13.8 | 11.8 | ### |
| Na+K | | | | | | | 0.63 | 0.52 | 0.61 | 3.73 | 2.82 | 0.00 | 8.6 | 7.7 | 9.1 | 33.0 | 28.1 | ### |
| CO3+HCO3 | | | | | | | 3.39 | 3.25 | 3.25 | 4.28 | 3.80 | 0.00 | 46.1 | 47.9 | 48.6 | 37.8 | 37.8 | ### |
| Total | 337.1 | 327.2 | 326.2 | 510.7 | 448.8 | 0.0 | 7.35 | 6.78 | 6.68 | 11.33 | 10.06 | 0.00 | 3.3 | -0.1 | -1.1 | -3.2 | 0.8 | ### |

**Pine Tree Ranch Well Chemistry Data (meq/l) (### = No Data)**

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Temperature | 91.0 | 92.0 | 94.0 | 94.0 | 96.0 | 100.0 | 102.0 | 104.0 | 100.0 | 98.0 | 98.0 | 96.0 | 96.0 |
| Water Level | | 61.8 | 65.7 | 68.2 | 70.8 | 73.2 | 75.2 | 75.0 | 70.3 | 67.8 | 66.2 | 64.7 | 65.4 |
| TDS | 224.0 | 227.0 | 225.0 | 227.0 | 220.0 | 264.0 | 290.0 | 306.0 | 248.0 | 214.0 | 217.0 | 220.0 | 224.0 |
| Cl | 3.0 | 3.0 | 4.0 | 3.0 | 4.0 | 12.0 | 23.0 | 28.0 | 15.0 | 4.0 | 3.0 | 3.0 | 3.0 |
| Ca | 40.0 | 41.0 | 41.0 | | | | 47.0 | | | 39.0 | | | 39.0 |
| Mg | 14.0 | 13.0 | 12.0 | | | | 13.0 | | | 10.0 | | | 11.0 |
| Na | 11.0 | 9.0 | 9.0 | | | | 21.0 | | | 11.0 | | | 9.0 |
| K | 6.0 | 6.0 | 6.0 | | | | 8.0 | | | 6.0 | | | 5.0 |
| SiO2 | 51.0 | 62.0 | 60.0 | | | | 64.0 | | | 60.0 | | | 58.0 |
| HCO3 | 207.0 | 203.0 | 200.0 | | | | 232.0 | | | 193.0 | | | 198.0 |
| F | 0.1 | 0.1 | 0.1 | | | | 0.1 | | | 0.1 | | | 0.1 |
| B | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.40 | 1.1 | 1.6 | 0.4 | 0.2 | 0.1 | 0.1 | 0.1 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 5.0 | 3.0 | 3.0 | 3.0 | 3.0 | 12.0 | 8.0 | 8.0 | 5.0 | 2.0 | 2.0 | 2.0 | 4.0 |
| SiO2(°F) | 217 | 234 | 231 | | | | 236 | | | 231 | | | 228 |
| Na/K (°F) | 994 | 1139 | 1139 | | | | 792 | | | 994 | | | 1007 |
| Na/K/Ca (°F), ß=.33 | 585 | 606 | 606 | | | | 558 | | | 586 | | | 578 |
| Na/K/Ca (°F), ß=1.33 | 479 | 468 | 468 | | | | 533 | | | 481 | | | 450 |
| Cl/B | | | | 30.0 | 13.3 | 30.0 | 20.9 | 17.5 | 37.5 | 20.0 | 30.0 | 30.0 | 30.0 |

Pine Tree Ranch Monitor Well Data (ppm, feet, °F) - Page 1

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Temperature | 96.0 | 98.0 | 100.0 | 101.0 | 103.0 | 104.0 | 104.0 | 104.0 | 102.0 | 100.0 | 98.0 | 98.0 |
| Water Level | 67.5 | 70.4 | 72.3 | 72.3 | 73.7 | 74.9 | 74.7 | 73.0 | | | | |
| TDS | 214.0 | 211.0 | 234.0 | 247.0 | 289.0 | 302.0 | 318.0 | 321.0 | 296.0 | 239.0 | 221.0 | 214.0 |
| Cl | 2.0 | 4.0 | 8.0 | 13.0 | 20.0 | 26.0 | 28.0 | 30.0 | 28.0 | 9.0 | 4.0 | 3.0 |
| Ca | | | 39.0 | | | 48.0 | | | 44.0 | | | 39.0 |
| Mg | | | 9.0 | | | 11.0 | | | 9.0 | | | 9.0 |
| Na | | | 17.0 | | | 23.0 | | | 35.0 | | | 11.0 |
| K | | | 6.0 | | | 8.0 | | | 9.0 | | | 5.0 |
| SiO2 | | | 56.0 | | | 62.0 | | | 56.0 | | | 58.0 |
| HCO3 | | | 207.0 | | | 239.0 | | | 239.0 | | | 198.0 |
| F | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 |
| B | 0.1 | 0.1 | 0.3 | 0.5 | 1.0 | 1.5 | 1.9 | 2.2 | 1.6 | 0.2 | 0.1 | 0.1 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 3.0 | 3.0 | 5.0 | 5.0 | 7.0 | 9.0 | 9.0 | 9.0 | 9.0 | 5.0 | 3.0 | 3.0 |
| SiO2(°F) | | | 225 | | | 234 | | | 225 | | | 228 |
| Na/K (°F) | | | 756 | | | 749 | | | 626 | | | 884 |
| Na/K/Ca (°F), ß=.33 | | | 541 | | | 548 | | | 527 | | | 557 |
| Na/K/Ca (°F), ß=1.33 | | | 500 | | | 535 | | | 583 | | | 458 |
| Cl/B | 20.0 | 40.0 | 26.7 | 26.0 | 20.0 | 17.3 | 14.7 | 13.6 | 17.5 | 45.0 | 40.0 | 30.0 |

Pine Tree Ranch Monitor Well Data (ppm, feet, °F) - Page 2

| Date | Jan-87 | Feb-87 | Mar-87 | Apr-87 | May-87 | Jun-87 | Jul-87 | Aug-87 | Sep-87 | Oct-87 | Nov-87 | Dec-87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 760 | 790 | 821 | 851 | 882 | 912 | 942 | 973 | 1003 | 1034 | 1064 | 1094 |
| Temperature | 100.0 | 103.0 | 106.0 | 108.0 | 108.0 | 108.0 | 108.0 | 109.0 | 109.0 | 109.0 | 108.0 | 108.0 |
| Water Level | 69.5 | 71.5 | 73.6 | 75.4 | 76.8 | | 78.5 | 78.6 | 78.5 | 77.6 | 75.9 | 78.0 |
| TDS | 224.0 | 263.0 | 296.0 | 329.0 | 337.0 | 347.0 | 351.0 | 369.0 | 379.0 | 391.0 | 358.0 | 375.0 |
| Cl | 5.0 | 19.0 | 27.0 | 32.0 | 36.0 | 39.0 | 42.0 | 44.0 | 48.0 | 51.0 | 52.0 | 49.0 |
| Ca | | | 43.0 | | | 35.0 | | | 32.0 | | | 30.0 |
| Mg | | | 8.0 | | | 5.0 | | | 3.0 | | | 3.0 |
| Na | | | 36.0 | | | 62.0 | | | 76.0 | | | 80.0 |
| K | | | 8.0 | | | 10.0 | | | 11.0 | | | 10.0 |
| SiO2 | | | 60.0 | | | 63.0 | | | 62.0 | | | 62.0 |
| HCO3 | | | 239.0 | | | 256.0 | | | 261.0 | | | 261.0 |
| F | | | 0.1 | | | 0.2 | | | 0.2 | | | 0.2 |
| B | 0.2 | 1.0 | 2.2 | 2.8 | 3.1 | 3.2 | 3.2 | 3.5 | 3.3 | 3.7 | 3.6 | 3.5 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 3.0 | 7.0 | 12.0 | 10.0 | 10.0 | 10.0 | 11.0 | 12.0 | 11.0 | 12.0 | 12.0 | 12.0 |
| SiO2(°F) | | | 231 | | | 235 | | | 234 | | | 234 |
| Na/K (°F) | | | 575 | | | 478 | | | 450 | | | 414 |
| Na/K/Ca (°F), ß=.33 | | | 508 | | | 494 | | | 490 | | | 475 |
| Na/K/Ca (°F), ß=1.33 | | | 568 | | | 659 | | | 701 | | | 694 |
| Cl/B | 25.0 | 19.0 | 12.3 | 11.4 | 11.6 | 12.2 | 13.1 | 12.6 | 14.5 | 13.8 | 14.4 | 14.0 |

Pine Tree Ranch Monitor Well Data (ppm, feet, °F) - Page 3

| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun-88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Temperature | 109.0 | 110.0 | 110.0 | 110.0 | 104.0 | 111.0 | 111.0 | 111.0 | | | 108.0 | |
| Water Level | 76.0 | 77.0 | 78.2 | 80.5 | 81.3 | 82.1 | 81.3 | 84.0 | | | | |
| TDS | 403.0 | 395.0 | 407.0 | 436.0 | 438.0 | 454.0 | 450.0 | 447.0 | | | 261.0 | |
| Cl | 57.0 | 57.0 | 59.0 | 67.0 | 68.0 | 71.0 | 75.0 | 74.0 | | | 25.0 | |
| Ca | | | 29.0 | | | 29.0 | | | | | 34.0 | |
| Mg | | | 2.0 | | | 1.0 | | | | | 6.0 | |
| Na | | | 91.0 | | | 107.0 | | | | | 35.0 | |
| K | | | 11.0 | | | 12.0 | | | | | 13.0 | |
| SiO2 | | | 65.0 | | | 67.0 | | | | | 53.0 | |
| HCO3 | | | 273.0 | | | 283.0 | | | | | 215.0 | |
| F | | | 0.2 | | | 0.2 | | | | | 0.1 | |
| B | 3.9 | 4.0 | 4.1 | 4.1 | 4.2 | 4.3 | 4.4 | 4.3 | | | 2.0 | |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0.0 | |
| SO4 | 12.0 | 13.0 | 13.0 | 14.0 | 14.0 | 15.0 | 14.0 | 15.0 | | | 7.0 | |
| SiO2(°F) | | | 238 | | | 241 | | | | | 220 | |
| Na/K (°F) | | | 406 | | | 389 | | | | | 779 | |
| Na/K/Ca (°F), ß=.33 | | | 476 | | | 474 | | | | | 589 | |
| Na/K/Ca (°F), ß=1.33 | | | 726 | | | 756 | | | | | 676 | |
| Cl/B | 14.6 | 14.3 | 14.4 | 16.3 | 16.2 | 16.5 | 17.0 | 17.2 | | | 12.5 | |

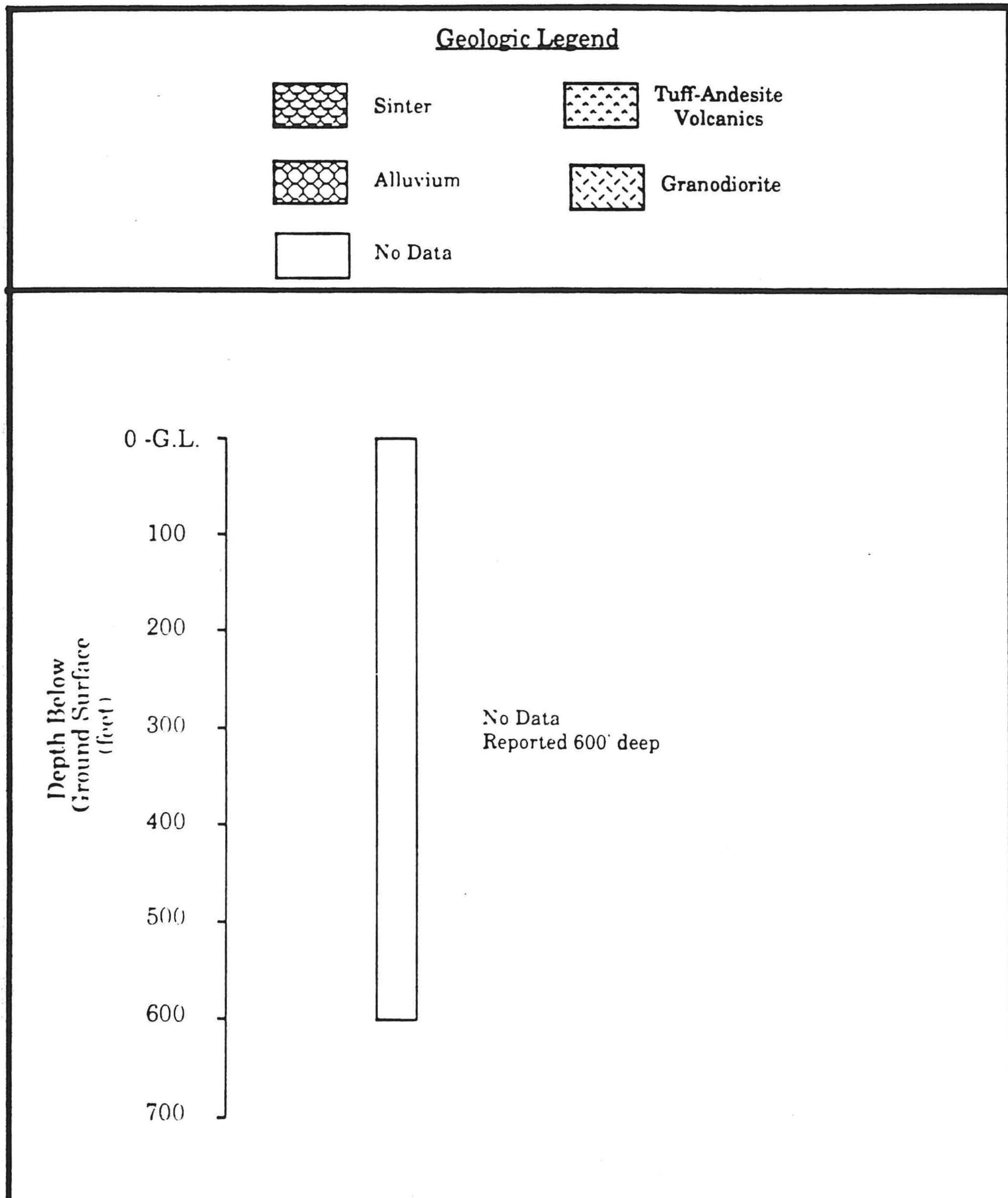
| Date | Jan-89 | Feb-89 | Mar-89 | May-89 | Jun-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 |
| Temperature | 110.0 | 111.0 | 111.0 | 113.0 | 111.0 | 113.0 | 113.0 | | | | 114.0 |
| Water Level | 77.9 | | 84.0 | | | 86.0 | 88.3 | 86.6 | 85.9 | | 81.4 |
| TDS | 311.0 | 481.0 | 480.0 | 492.0 | 473.0 | 492.0 | 502.0 | | | | 283.0 |
| Cl | 37.0 | 84.0 | 83.0 | 91.0 | 82.0 | 89.0 | 90.0 | | | | 24.0 |
| Ca | 35.0 | | | | | | | | | | |
| Mg | 6.0 | | | | | | | | | | |
| Na | 59.0 | | | | | | | | | | |
| K | 10.0 | | | | | | | | | | |
| SiO2 | 58.0 | | | | | | | | | | |
| HCO3 | 232.0 | | | | | | | | | | |
| F | 0.1 | | | | | | | | | | 0.1 |
| B | 2.7 | 4.4 | 4.7 | 4.6 | 4.5 | 4.8 | 4.9 | | | | 1.6 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | 0.0 |
| SO4 | 9.0 | 16.0 | 16.0 | 17.0 | 16.0 | 17.0 | 17.0 | | | | 7.0 |
| SiO2(°F) | 228 | | | | | | | | | | |
| Na/K (°F) | 492 | | | | | | | | | | |
| Na/K/Ca (°F), ß=.33 | 498 | | | | | | | | | | |
| Na/K/Ca (°F), ß=1.33 | 656 | | | | | | | | | | |
| Cl/B | 13.7 | 19.1 | 17.7 | 19.8 | 18.2 | 18.5 | 18.4 | | | | 15.0 |

**Pine Tree Ranch Monitor Well Data (ppm, feet, °F) - Page 5**

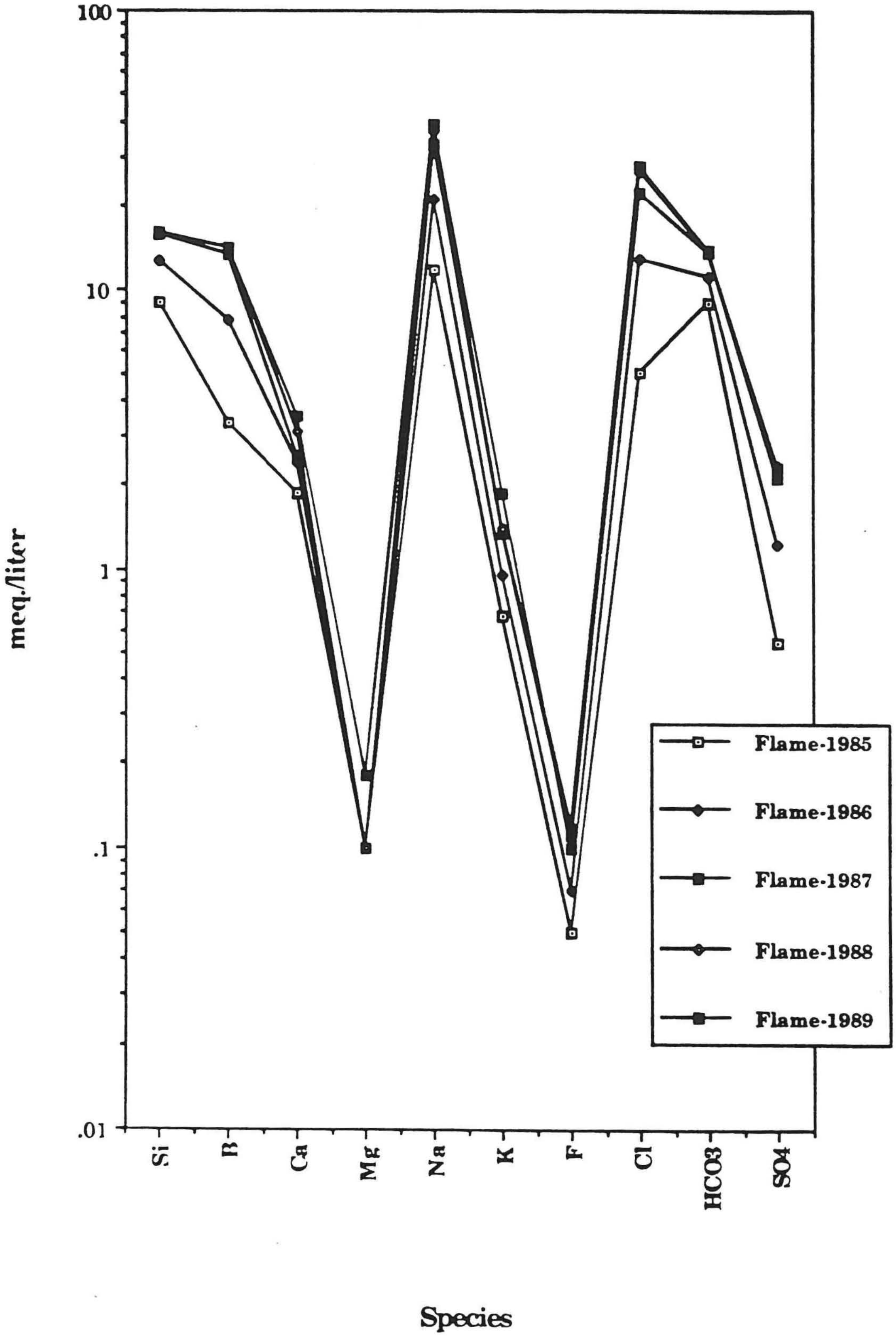
| Date | Jan-90 | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 | Dec-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1824 | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Temperature | 112.0 | 110.0 | 111.0 | 113.0 | 114.0 | 118.0 | 116.0 | | | | | |
| Water Level | 80.4 | 80.2 | 81.0 | 83.0 | 83.3 | 94.5 | 84.8 | | | | | |
| TDS | 265.0 | 234.0 | 243.0 | 329.0 | 443.0 | 500.0 | 509.0 | | | | | |
| Cl | 12.0 | 10.0 | 11.0 | 45.0 | 79.0 | 94.0 | 94.0 | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.0 | | | | | |
| B | 1.5 | 1.1 | 1.0 | 2.0 | 3.8 | 4.4 | 4.7 | | | | | |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | |
| SO4 | 6.0 | 5.0 | 5.0 | 10.0 | 15.0 | 17.0 | 17.0 | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F), ß=.33 | | | | | | | | | | | | |
| Na/K/Ca (°F), ß=1.33 | | | | | | | | | | | | |
| Cl/B | 8.0 | 9.1 | 11.0 | 22.5 | 20.8 | 21.4 | 20.0 | | | | | |

Pine Tree Ranch Monitor Well Data (ppm, feet, °F) - Page 6

# Appendix 8 - Flame Well Monitor Data




Flame Well Completion and Geologic Information


100
10
1
.1
.01
meq./liter
Si
B
Ca
Mg
Na
K
F
Cl
HCO3
SO4
Species
Flame-1985
Flame-1986
Flame-1987
Flame-1988
Flame-1989

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 81.0 | 208.0 | 360.0 | 430.0 | 450.0 | ND | 2.28 | 5.86 | 10.14 | 12.11 | 12.68 | ### | 17.3 | 25.8 | 29.8 | 31.6 | 31.5 | ### |
| Ca | 17.0 | 22.0 | 23.0 | 28.0 | 32.0 | ND | 0.85 | 1.10 | 1.15 | 1.40 | 1.60 | ### | 6.5 | 4.8 | 3.4 | 3.7 | 4.0 | ### |
| Mg | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | ND | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | ### | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | ### |
| Na | 123.0 | 222.0 | 346.0 | 389.0 | 406.0 | ND | 5.35 | 9.65 | 15.04 | 16.91 | 17.65 | ### | | | | | | |
| K | 12.0 | 17.0 | 24.0 | 25.0 | 33.0 | ND | 0.31 | 0.44 | 0.62 | 0.64 | 0.85 | ### | | | | | | |
| SiO2 | 62.0 | 86.0 | 108.0 | 108.0 | 109.0 | ND | 4.13 | 5.73 | 7.19 | 7.19 | 7.26 | ### | | | | | | |
| HCO3 | 251.0 | 312.0 | 376.0 | 376.0 | 388.0 | ND | 4.11 | 5.11 | 6.16 | 6.16 | 6.36 | ### | 31.3 | 22.5 | 18.1 | 16.1 | 15.8 | ### |
| F | 0.4 | 0.6 | 0.9 | 1.0 | 0.9 | ND | 0.02 | 0.03 | 0.05 | 0.05 | 0.05 | ### | | | | | | |
| B | 5.5 | 12.8 | 21.8 | 23.1 | 23.2 | ND | 1.53 | 3.56 | 6.06 | 6.42 | 6.44 | ### | | | | | | |
| As | 0.4 | 0.8 | 1.2 | 1.5 | 1.0 | ND | | | | | | | | | | | | |
| SO4 | 16.0 | 36.0 | 62.0 | 69.0 | 68.0 | ND | 0.25 | 0.56 | 0.97 | 1.08 | 1.06 | ### | 1.9 | 2.5 | 2.8 | 2.8 | 2.6 | ### |
| Ca+Mg | | | | | | | 0.85 | 1.10 | 1.15 | 1.40 | 1.68 | ### | 6.5 | 4.8 | 3.4 | 3.7 | 4.2 | ### |
| SO4+Cl | | | | | | | 2.53 | 6.42 | 11.11 | 13.19 | 13.74 | ### | 19.2 | 28.3 | 32.6 | 34.4 | 34.1 | ### |
| Na+K | | | | | | | 5.66 | 10.09 | 15.66 | 17.55 | 18.50 | ### | 43.0 | 44.4 | 45.9 | 45.8 | 45.9 | ### |
| CO3+HCO3 | | | | | | | 4.11 | 5.11 | 6.16 | 6.16 | 6.36 | ### | 31.3 | 22.5 | 18.1 | 16.1 | 15.8 | ### |
| Total | 568.3 | 917.2 | 1322.9 | 1450.6 | 1512.1 | 0.0 | 13.15 | 22.72 | 34.08 | 38.31 | 40.28 | ### | -1.1 | -1.5 | -1.4 | -1.0 | 0.2 | ### |

**Flame Well (meq./l) Chemistry Data (### = No Data)**

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Temperature | 63.00 | 62.00 | 48.00 | | 52.00 | 62.00 | 70.00 | 80.00 | 84.00 | 131.00 | 132.00 | 124.00 | 96.00 |
| Water Level | | 51.04 | 56.02 | 64.77 | 66.77 | 82.55 | 62.87 | 62.53 | 61.94 | | | | |
| TDS | 451.00 | 541.00 | 685.00 | 1014.00 | 1068.00 | 1090.00 | 1118.00 | 1140.00 | 1169.00 | 1156.00 | 1174.00 | 681.00 | 776.00 |
| Cl | 81.00 | 112.00 | 165.00 | 290.00 | 325.00 | 330.00 | 345.00 | 350.00 | 355.00 | 360.00 | 365.00 | 162.00 | 208.00 |
| Ca | 17.00 | 19.00 | 20.00 | | | | 22.00 | | | 23.00 | | | 22.00 |
| Mg | 0.00 | 0.00 | 0.00 | | | | 0.00 | | | 0.00 | | | 0.00 |
| Na | 123.00 | 149.00 | 199.00 | | | | 338.00 | | | 360.00 | | | 222.00 |
| K | 12.00 | 13.00 | 16.00 | | | | 23.00 | | | 24.00 | | | 17.00 |
| SiO2 | 62.00 | 77.00 | 83.00 | | | | 105.00 | | | 107.00 | | | 86.00 |
| HCO3 | 251.00 | 271.00 | 298.00 | | | | 368.00 | | | 368.00 | | | 312.00 |
| F | 0.44 | 0.46 | 0.52 | | | | 1.08 | | | 1.01 | | | 0.63 |
| B | 5.50 | 6.90 | 10.60 | 17.60 | 18.40 | 18.50 | 19.80 | 21.00 | 19.40 | 22.30 | 21.70 | 9.30 | 12.80 |
| As | 0.37 | 0.58 | 0.62 | 1.23 | 1.35 | 1.22 | 1.25 | 1.22 | 1.24 | 1.15 | 1.20 | 0.57 | 0.79 |
| SO4 | 16.00 | 22.00 | 31.00 | 52.00 | 56.00 | 57.00 | 64.00 | 61.00 | 60.00 | 61.00 | 61.00 | 31.00 | 36.00 |
| SiO2(°F) | 234 | 253 | 260 | | | | 284 | | | 286 | | | 264 |
| Na/K (°F) | 359 | 336 | 320 | | | | 290 | | | 286 | | | 311 |
| Na/K/Ca (°F) ß=0.33 | 473 | 465 | 465 | | | | 464 | | | 463 | | | 462 |
| Na/K/Ca (°F) ß=1.33 | 850 | 867 | 940 | | | | 1091 | | | 1103 | | | 950 |
| Cl/B | 14.7 | 16.2 | 15.6 | 16.5 | 17.7 | 17.8 | 17.4 | 16.7 | 18.3 | 16.1 | 16.8 | 17.4 | 16.3 |

Flame Well Monitor Data (ppm, feet, °F) - Page 1

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Temperature | 130.00 | 131.00 | 112.00 | 130.00 | 127.00 | 127.00 | 126.00 | 128.00 | 127.00 | 122.00 | 128.00 | 123.00 |
| Water Level | | | | | | | | | | | | |
| TDS | 1134.00 | 1107.00 | 1083.00 | 1092.00 | 1103.00 | 1103.00 | 1120.00 | 1137.00 | 1127.00 | 1154.00 | 1174.00 | 1179.00 |
| Cl | 345.00 | 330.00 | 325.00 | 330.00 | 325.00 | 317.00 | 330.00 | 333.00 | 340.00 | 355.00 | 365.00 | 360.00 |
| Ca | | | 25.00 | | | 21.00 | | | 22.00 | | | 23.00 |
| Mg | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.00 |
| Na | | | 308.00 | | | 317.00 | | | 339.00 | | | 346.00 |
| K | | | 22.00 | | | 23.00 | | | 22.00 | | | 24.00 |
| SiO2 | | | 101.00 | | | 103.00 | | | 103.00 | | | 108.00 |
| HCO3 | | | 361.00 | | | 304.00 | | | 366.00 | | | 376.00 |
| F | | | 1.03 | | | 1.06 | | | 1.07 | | | 0.93 |
| B | 20.50 | 20.40 | 19.70 | 20.20 | 19.40 | 19.90 | 20.00 | 20.10 | 21.00 | 21.20 | 21.40 | 21.80 |
| As | 1.15 | 1.28 | 1.24 | 1.25 | 1.26 | 1.35 | 1.30 | 1.25 | 1.30 | 1.24 | 1.20 | 1.18 |
| SO4 | 58.00 | 60.00 | 57.00 | 61.00 | 55.00 | 60.00 | 59.00 | 56.00 | 60.00 | 68.00 | 64.00 | 62.00 |
| SiO2(°F) | | | 280 | | | 282 | | | 282 | | | 286 |
| Na/K (°F) | | | 298 | | | 301 | | | 282 | | | 293 |
| Na/K/Ca (°F) ß=0.33 | | | 464 | | | 471 | | | 459 | | | 467 |
| Na/K/Ca (°F) ß=1.33 | | | 1037 | | | 1095 | | | 1076 | | | 1099 |
| Cl/B | 16.8 | 16.2 | 16.5 | 16.3 | 16.8 | 15.9 | 16.5 | 16.6 | 16.2 | 16.7 | 17.1 | 16.5 |

Flame Well Monitor Data (ppm, feet, °F) - Page 2

| Date | Jan-87 | Feb-87 | Mar-87 | Apr-87 | May-87 | Jun-87 | Jul-87 | Aug-87 | Sep-87 | Oct-87 | Nov-87 | Dec-87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 760 | 790 | 821 | 851 | 882 | 912 | 942 | 973 | 1003 | 1034 | 1064 | 1094 |
| Temperature | 118.00 | 122.00 | 122.00 | 122.00 | 120.00 | 116.00 | 122.00 | 123.00 | 123.00 | 108.00 | 108.00 | 139.00 |
| Water Level | | | | | | | | | | | | |
| TDS | 1160.00 | 1164.00 | 1149.00 | 1159.00 | 1153.00 | 1168.00 | 1179.00 | 1189.00 | 1210.00 | 1227.00 | 1236.00 | 1293.00 |
| Cl | 350.00 | 350.00 | 345.00 | 355.00 | 355.00 | 360.00 | 375.00 | 375.00 | 390.00 | 405.00 | 405.00 | 430.00 |
| Ca | | | 23.00 | | | 23.00 | | | 24.00 | | | 28.00 |
| Mg | | | 0.00 | | | 0.00 | | | 0.00 | | | 0.00 |
| Na | | | 351.00 | | | 348.00 | | | 369.00 | | | 389.00 |
| K | | | 23.00 | | | 24.00 | | | 24.00 | | | 25.00 |
| SiO2 | | | 107.00 | | | 104.00 | | | 106.00 | | | 108.00 |
| HCO3 | | | 373.00 | | | 373.00 | | | 368.00 | | | 376.00 |
| F | | | 0.97 | | | 1.03 | | | 0.99 | | | 1.03 |
| B | 21.50 | 22.20 | 21.80 | 21.30 | 21.70 | 22.00 | 21.60 | 21.80 | 22.40 | 22.10 | 22.30 | 23.10 |
| As | 1.18 | 1.14 | 1.13 | 2.50 | 1.29 | 1.20 | 1.23 | 1.20 | 1.07 | 1.20 | 1.15 | 1.45 |
| SO4 | 63.00 | 62.00 | 62.00 | 61.00 | 62.00 | 59.00 | 65.00 | 64.00 | 64.00 | 64.00 | 67.00 | 69.00 |
| SiO2(°F) | | | 286 | | | 283 | | | 285 | | | 286 |
| Na/K (°F) | | | 283 | | | 292 | | | 282 | | | 280 |
| Na/K/Ca (°F) ß=0.33 | | | 460 | | | 466 | | | 460 | | | 458 |
| Na/K/Ca (°F) ß=1.33 | | | 1085 | | | 1099 | | | 1096 | | | 1081 |
| Cl/B | 16.3 | 15.8 | 15.8 | 16.7 | 16.4 | 16.4 | 17.4 | 17.2 | 17.4 | 18.3 | 18.2 | 18.6 |

Flame Well Monitor Data (ppm, feet, °F) - Page 3

| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun-88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Temperature | 134.00 | 135.00 | 133.00 | 134.00 | 138.00 | 133.00 | 129.00 | 133.00 | | | 136.00 | |
| Water Level | | | | | | | | | | | | |
| TDS | 1263.00 | 1277.00 | 1269.00 | 1277.00 | 1316.00 | 1303.00 | 1330.00 | 1319.00 | 1331.00 | | 1342.00 | |
| Cl | 415.00 | 442.00 | 405.00 | 415.00 | 425.00 | 430.00 | 450.00 | 435.00 | 445.00 | | 455.00 | |
| Ca | | | 27.00 | | | 29.00 | | | 30.00 | | 31.00 | |
| Mg | | | 0.00 | | | 0.00 | | | 0.00 | | 1.00 | |
| Na | | | 370.00 | | | 393.00 | | | 389.00 | | 379.00 | |
| K | | | 26.00 | | | 27.00 | | | 26.00 | | 33.00 | |
| SiO2 | | | 107.00 | | | 108.00 | | | 107.00 | | 108.00 | |
| HCO3 | | | 378.00 | | | 381.00 | | | 383.00 | | 386.00 | |
| F | | | 0.93 | | | 0.95 | | | 0.90 | | 0.88 | |
| B | 22.40 | 23.30 | 23.00 | 22.90 | 23.50 | 23.70 | 23.80 | 24.20 | 23.30 | | 24.60 | |
| As | 1.10 | 1.17 | 1.17 | 1.16 | 1.15 | 1.09 | 1.07 | 1.16 | 1.04 | | 1.08 | |
| SO4 | 66.00 | 66.00 | 64.00 | 65.00 | 68.00 | 69.00 | 66.00 | 69.00 | 68.00 | | 68.00 | |
| SiO2(°F) | | | 286 | | | 286 | | | 286 | | 286 | |
| Na/K (°F) | | | 296 | | | 292 | | | 287 | | 336 | |
| Na/K/Ca (°F) ß=0.33 | | | 468 | | | 466 | | | 461 | | 494 | |
| Na/K/Ca (°F) ß=1.33 | | | 1097 | | | 1101 | | | 1078 | | 1154 | |
| Cl/B | 18.5 | 19.0 | 17.6 | 18.1 | 18.1 | 18.1 | 18.9 | 18.0 | 19.1 | | 18.5 | |

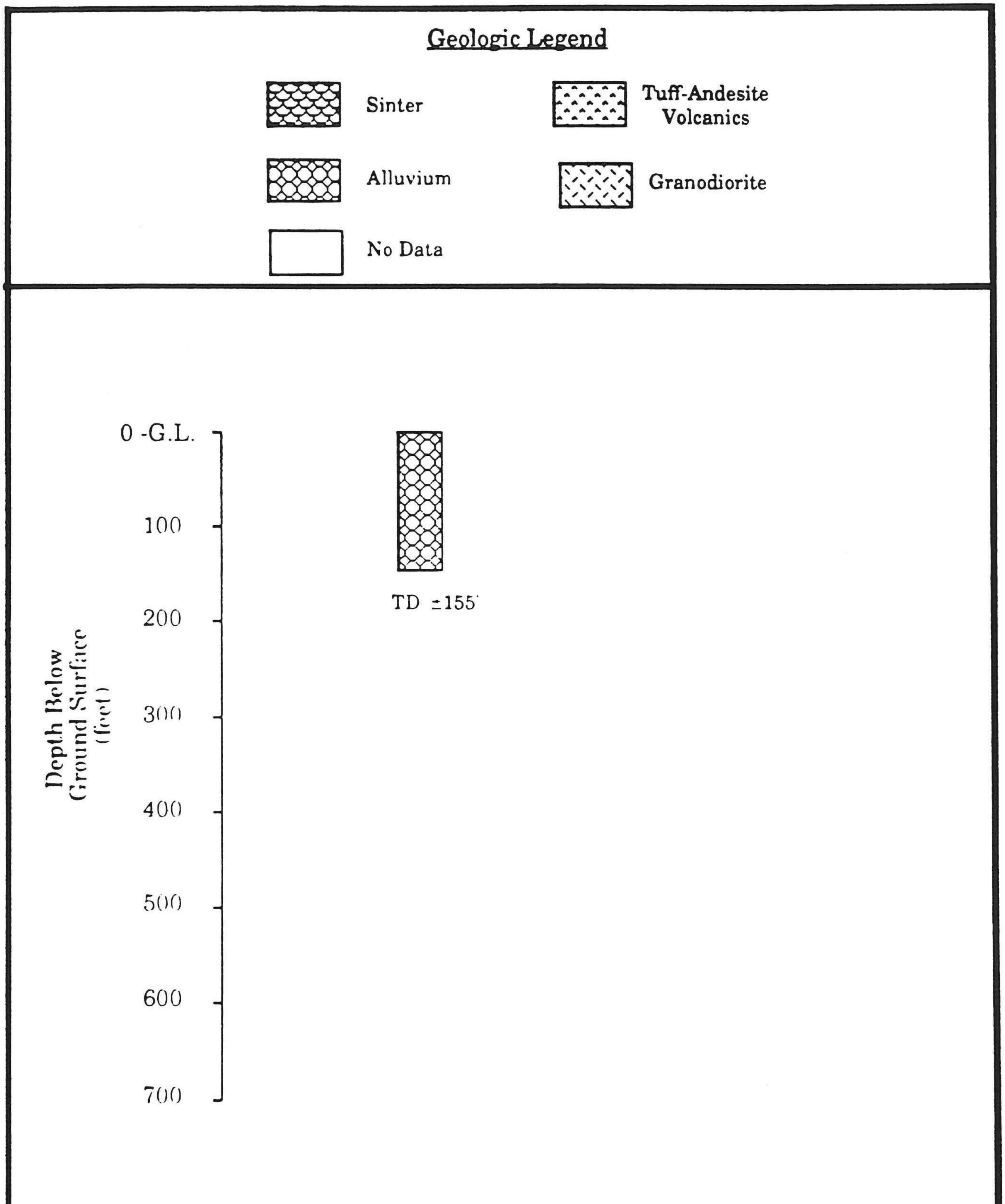
Flame Well Monitor Data (ppm, feet, °F) - Page 4

| Date | Jan-89 | Feb-89 | Mar-89 | May-89 | Jun-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 |
| Temperature | 136.00 | 82.00 | 50.00 | 88.00 | 81.00 | 79.00 | 81.00 | 123.00 | 68.00 | | |
| Water Level | | | | | | | | 37.50 | 36.80 | | |
| TDS | 1352.00 | 1362.00 | 1366.00 | 1362.00 | 1363.00 | 1354.00 | 1342.00 | 1345.00 | 1331.00 | | |
| Cl | 450.00 | 450.00 | 455.00 | 455.00 | 450.00 | 450.00 | 450.00 | 450.00 | 445.00 | | |
| Ca | 32.00 | | | | | | | | | | |
| Mg | 1.00 | | | | | | | | | | |
| Na | 406.00 | | | | | | | | | | |
| K | 33.00 | | | | | | | | | | |
| SiO2 | 109.00 | | | | | | | | | | |
| HCO3 | 388.00 | | | | | | | | | | |
| F | 0.89 | | | | | | | | | | |
| B | 23.20 | 24.80 | 23.70 | 24.40 | 24.20 | 24.00 | 23.70 | 24.10 | 24.10 | | |
| As | 1.01 | 1.01 | 1.19 | 0.91 | 0.96 | 1.10 | 0.81 | 0.77 | 0.82 | | |
| SO4 | 68.00 | 69.00 | 68.00 | 69.00 | 70.00 | 69.00 | 69.00 | 67.00 | 68.00 | | |
| SiO2(°F) | 287 | | | | | | | | | | |
| Na/K (°F) | 322 | | | | | | | | | | |
| Na/K/Ca (°F) ß=0.33 | 487 | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | 1154 | | | | | | | | | | |
| Cl/B | 19.4 | 18.1 | 19.2 | 18.6 | 18.6 | 18.8 | 19.0 | 18.7 | 18.5 | | |

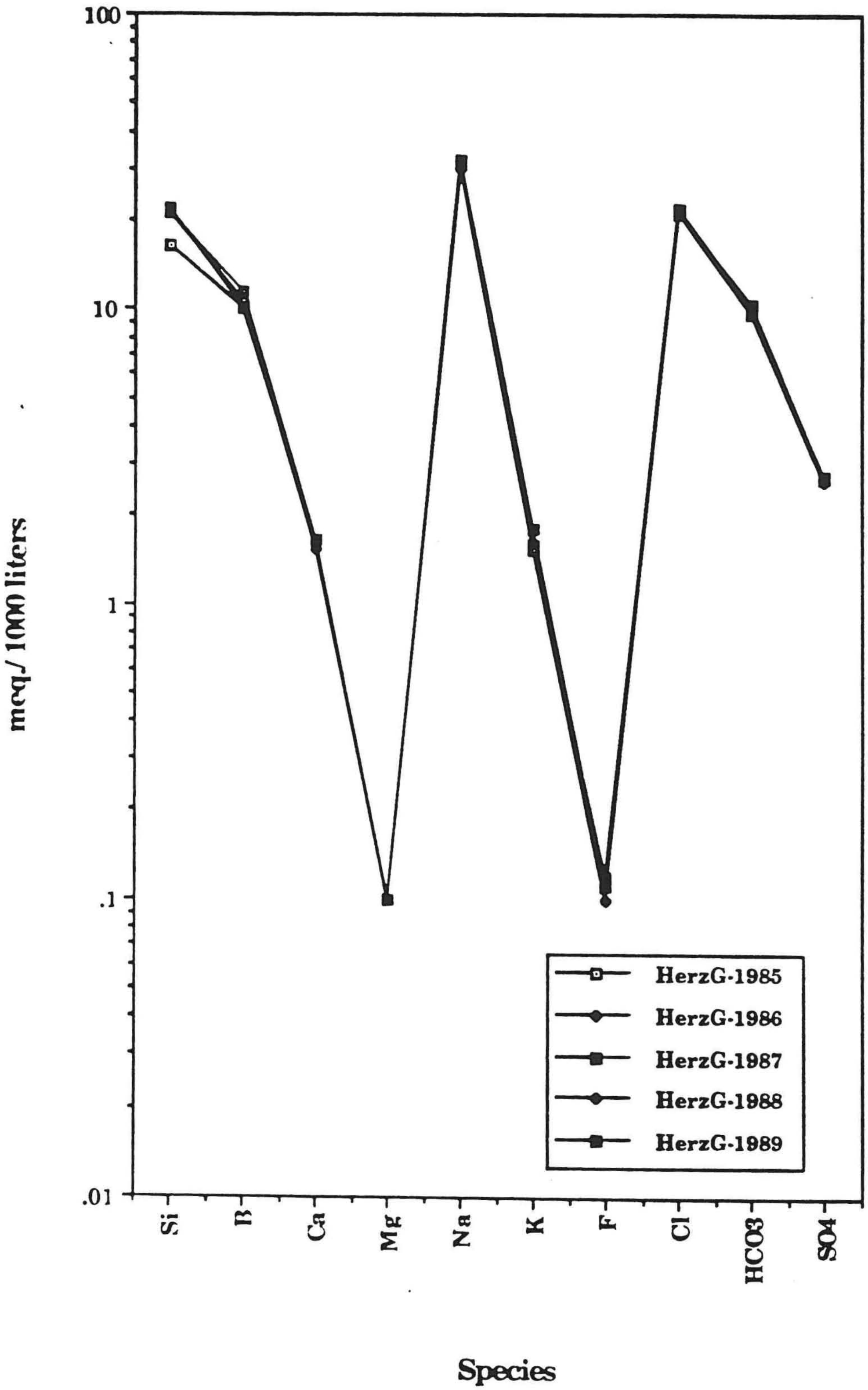
Flame Well Monitor Data (ppm, feet, °F) - Page 5

| Date | Jan-90 | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 | Dec-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1824 | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Temperature | | | | | | | | | | | | |
| Water Level | | | | | | | 71.10 | | | | | |
| TDS | | | | | | | 1415.00 | | | | | |
| Cl | | | | | | | 485.00 | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | | | | | | | 0.84 | | | | | |
| B | | | | | | | 25.70 | | | | | |
| As | | | | | | | 1.27 | | | | | |
| SO4 | | | | | | | 72.00 | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=0.33 | | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | | |
| Cl/B | | | | | | | 18.9 | | | | | |

# Appendix 9 - Herz Geothermal Well Monitor Data




Herz Geothermal Well Completion and Geologic Information


100
10
1
.1
.01
meq / 1000 liters
Si
B
Ca
Mg
Na
K
F
Cl
HCO3
SO4
Species
HerzG-1985
HerzG-1986
HerzG-1987
HerzG-1988
HerzG-1989

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 355.0 | 350.0 | 340.0 | 340.0 | 355.0 | 0.0 | 10.00 | 9.86 | 9.58 | 9.58 | 10.00 | 0.00 | 32.1 | 31.9 | 30.8 | 33.2 | 32.6 | ### |
| Ca | 15.0 | 15.0 | 15.0 | 14.0 | 15.0 | 0.0 | 0.75 | 0.75 | 0.75 | 0.70 | 0.75 | 0.00 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | ### |
| Mg | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | ### |
| Na | 323.0 | 321.0 | 326.0 | 311.0 | 334.0 | 0.0 | 14.04 | 13.96 | 14.17 | 13.52 | 14.52 | 0.00 | | | | | | |
| K | 28.0 | 27.0 | 27.0 | 27.0 | 32.0 | 0.0 | 0.72 | 0.69 | 0.69 | 0.69 | 0.82 | 0.00 | | | | | | |
| SiO2 | 111.0 | 133.0 | 136.0 | 133.0 | 131.0 | 0.0 | 7.39 | 8.85 | 9.05 | 8.85 | 8.72 | 0.00 | | | | | | |
| HCO3 | 268.0 | 271.0 | 288.0 | 268.0 | 276.0 | 0.0 | 4.39 | 4.44 | 4.72 | 4.39 | 4.52 | 0.00 | 14.1 | 14.4 | 15.2 | 15.2 | 14.7 | ### |
| F | 1.0 | 0.0 | 1.0 | 1.0 | 1.0 | 0.0 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.00 | | | | | | |
| B | 16.5 | 16.9 | 18.5 | 17.5 | 16.6 | 0.0 | 4.58 | 4.69 | 5.14 | 4.86 | 4.61 | 0.00 | | | | | | |
| As | 0.5 | 0.5 | 0.6 | 0.5 | 0.5 | 0.0 | | | | | | | | | | | | |
| SO4 | 80.0 | 77.0 | 78.0 | 0.0 | 0.0 | 0.0 | 1.25 | 1.20 | 1.22 | 0.00 | 0.00 | 0.00 | 4.0 | 3.9 | 3.9 | 0.0 | 0.0 | ### |
| Ca+Mg | | | | | | | 0.75 | 0.75 | 0.75 | 0.70 | 0.83 | 0.00 | 2.4 | 2.4 | 2.4 | 2.4 | 2.7 | ### |
| SO4+Cl | | | | | | | 11.25 | 11.06 | 10.80 | 9.58 | 10.00 | 0.00 | 36.1 | 35.8 | 34.7 | 33.2 | 32.6 | ### |
| Na+K | | | | | | | 14.76 | 14.65 | 14.87 | 14.21 | 15.34 | 0.00 | 47.4 | 47.4 | 47.7 | 49.2 | 50.0 | ### |
| CO3+HCO3 | | | | | | | 4.39 | 4.44 | 4.72 | 4.39 | 4.52 | 0.00 | 14.1 | 14.4 | 15.2 | 15.2 | 14.7 | ### |
| Total | 1198.0 | 1211.4 | 1230.1 | 1112.0 | 1162.0 | 0.0 | 31.15 | 30.90 | 31.13 | 28.88 | 30.70 | 0.00 | -0.4 | -0.3 | 0.3 | 3.3 | 5.4 | ### |

Herz Geothermal Well Chemistry Data (meq/l) (### = No Data)

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Temperature | 122 | 124 | 122 | 124 | 126 | 128 | 128 | 128 | 129 | 128 | 128 | 130 | 128 |
| Water Level | | 50.32 | 50.8 | 51.12 | 51.36 | 51.69 | 51.97 | 52 | 51.98 | 52.89 | 52.06 | 51.95 | 51.75 |
| TDS | 1101 | 1105 | 1093 | 1118 | 1101 | 1093 | 1106 | 1123 | 1124 | 1111 | 1117 | 1105 | 1109 |
| Cl | 355 | 350 | 340 | 340 | 350 | 340 | 350 | 350 | 355 | 345 | 345 | 340 | 350 |
| Ca | 15 | 15 | 15 | | | | 15 | | | 15 | | | 15 |
| Mg | 0 | 0 | 0 | | | | 0 | | | 0 | | | 0 |
| Na | 323 | 318 | 315 | | | | 318 | | | 324 | | | 321 |
| K | 28 | 28 | 28 | | | | 28 | | | 28 | | | 27 |
| SiO2 | 111 | 133 | 131 | | | | 137 | | | 133 | | | 133 |
| HCO3 | 268 | 264 | 266 | | | | 268 | | | 264 | | | 271 |
| F | 0.98 | 0.98 | 0.97 | | | | 1.02 | | | 0.99 | | | 0 |
| B | 16.5 | 16.3 | 16.6 | 17.4 | 17.2 | 17.5 | 17.5 | 17.5 | 18.2 | 18.3 | 17 | 18.1 | 16.9 |
| As | 0.543 | 0.595 | 0.555 | 0.565 | 0.6 | 0.558 | 0.52 | 0.525 | 0.545 | 0.567 | 0.57 | 0.495 | 0.525 |
| SO4 | 80 | 77 | 75 | 79 | 75 | 77 | 77 | 76 | 78 | 81 | 79 | 78 | 77 |
| SiO2(°F) | 289 | 309 | 307 | | | | 312 | | | 309 | | | 309 |
| Na/K (°F) | 335 | 338 | 340 | | | | 338 | | | 334 | | | 329 |
| Na/K/Ca (°F), ß=.33 | 502 | 504 | 504 | | | | 504 | | | 502 | | | 498 |
| Na/K/Ca (°F), ß=1.33 | 1262 | 1260 | 1258 | | | | 1260 | | | 1262 | | | 1245 |
| Cl/B | 21.5 | 21.5 | 20.5 | 19.5 | 20.3 | 19.4 | 20.0 | 20.0 | 19.5 | 18.9 | 20.3 | 18.8 | 20.7 |

Herz Geothermal Monitor Well Data (ppm, feet, °F) - Page 1

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Temperature | 128 | 127 | 120 | 128 | 125 | 126 | 126 | 130 | 128 | 128 | 129 | 129 |
| Water Level | 52.54 | 52.56 | 51.61 | 51.35 | 51.87 | 52.03 | 51.46 | 50.98 | 50.71 | | | |
| TDS | 1115 | 1108 | 1114 | 1102 | 1121 | 1064 | 1121 | 1118 | 1107 | 1114 | 1094 | 1098 |
| Cl | 345 | 345 | 345 | 345 | 345 | 355 | 375 | 350 | 350 | 345 | 345 | 340 |
| Ca | | | 15 | | | 15 | | | 15 | | | 15 |
| Mg | | | 0 | | | 0 | | | 0 | | | 0 |
| Na | | | 314 | | | 309 | | | 322 | | | 326 |
| K | | | 28 | | | 27 | | | 27 | | | 27 |
| SiO2 | | | 126 | | | 131 | | | 132 | | | 136 |
| HCO3 | | | 276 | | | 298 | | | 273 | | | 288 |
| F | | | 0.98 | | | 0.97 | | | 1 | | | 1.04 |
| B | 15.2 | 17.1 | 17.6 | 17.6 | 17.3 | 17.4 | 17.7 | 17.4 | 18.1 | 17.7 | 17.6 | 18.5 |
| As | 0.5 | 0.55 | 0.48 | 0.475 | 0.41 | 0.32 | 0.465 | 0.49 | 0.5 | 0.51 | 0.54 | 0.575 |
| SO4 | 80 | 76 | 75 | 78 | 74 | 60 | 77 | 76 | 75 | 79 | 84 | 78 |
| SiO2(°F) | | | 303 | | | 307 | | | 308 | | | 311 |
| Na/K (°F) | | | 340 | | | 336 | | | 328 | | | 326 |
| Na/K/Ca (°F), ß=.33 | | | 505 | | | 501 | | | 497 | | | 496 |
| Na/K/Ca (°F), ß=1.33 | | | 1258 | | | 1240 | | | 1246 | | | 1248 |
| Cl/B | 22.7 | 20.2 | 19.6 | 19.6 | 19.9 | 20.4 | 21.2 | 20.1 | 19.3 | 19.5 | 19.6 | 18.4 |

Herz Geothermal Monitor Well Data (ppm, feet, °F) - Page 2

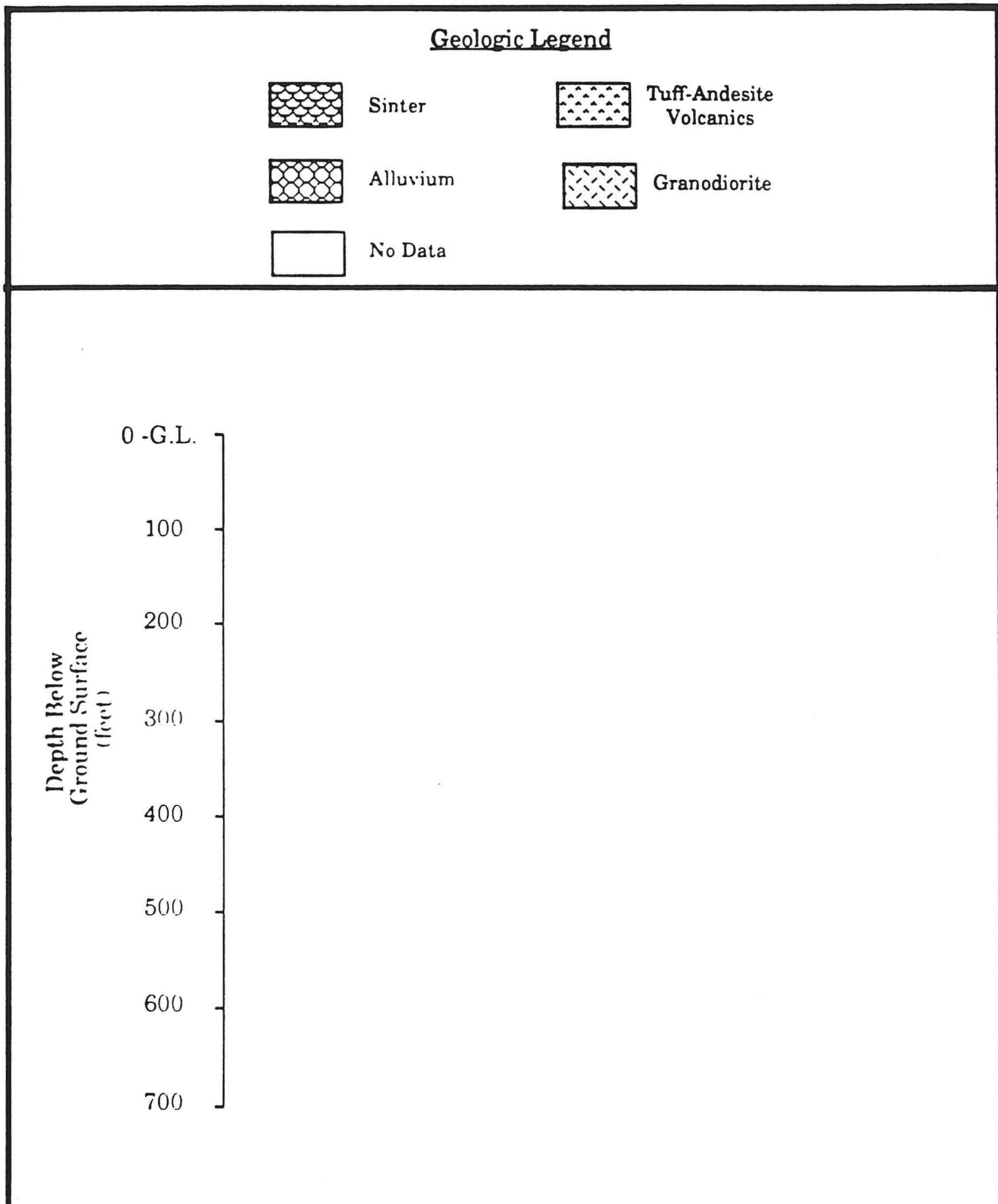
| Date | Jan-87 | Feb-87 | Mar-87 | Apr-87 | May-87 | Jun-87 | Jul-87 | Aug-87 | Sep-87 | Oct-87 | Nov-87 | Dec-87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 760 | 790 | 821 | 851 | 882 | 912 | 942 | 973 | 1003 | 1034 | 1064 | 1094 |
| Temperature | 126 | 128 | 130 | 123 | 126 | 125 | 126 | 126 | 126 | 125 | 125 | 126 |
| Water Level | 50.45 | 49.9 | 49.2 | 48.6 | 48.1 | 47.9 | 47.6 | 47.6 | 47.4 | 47.3 | 47.3 | 47.2 |
| TDS | 1097 | 1104 | 1087 | 1099 | 1099 | 1113 | 1111 | 1101 | 1094 | 1098 | 1081 | 1092 |
| Cl | 340 | 340 | 340 | 340 | 340 | 340 | 340 | 335 | 340 | 345 | 340 | 340 |
| Ca | | | 14 | | | 15 | | | 14 | | | 14 |
| Mg | | | 0 | | | 0 | | | 0 | | | 0 |
| Na | | | 327 | | | 320 | | | 324 | | | 311 |
| K | | | 27 | | | 28 | | | 27 | | | 27 |
| SiO2 | | | 137 | | | 132 | | | 134 | | | 133 |
| HCO3 | | | 273 | | | 276 | | | 267 | | | 268 |
| F | | | 0.92 | | | 0.97 | | | 0.99 | | | 1.03 |
| B | 18.2 | 18.6 | 18 | 18 | 18.1 | 18.2 | 18.2 | 18 | 18.2 | 17.4 | 17.4 | 17.5 |
| As | 0.45 | 0.55 | 0.505 | 0.55 | 0.51 | 0.445 | 0.58 | 0.57 | 0.495 | 0.505 | 0.478 | 0.49 |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | 312 | | | 308 | | | 310 | | | 309 |
| Na/K (°F) | | | 325 | | | 337 | | | 327 | | | 335 |
| Na/K/Ca (°F), ß=.33 | | | 498 | | | 503 | | | 498 | | | 502 |
| Na/K/Ca (°F), ß=1.33 | | | 1268 | | | 1261 | | | 1267 | | | 1261 |
| Cl/B | 18.7 | 18.3 | 18.9 | 18.9 | 18.8 | 18.7 | 18.7 | 18.6 | 18.7 | 19.8 | 19.5 | 19.4 |

| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun-88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Temperature | 126 | 124 | 125 | 122 | 124 | 125 | 126 | 126 | | | 127 | |
| Water Level | 47.2 | | 47.5 | 48.3 | 48.5 | 48.5 | 49 | 49 | | | | |
| TDS | 1094 | 1093 | 1085 | 1077 | 1092 | 1107 | 1102 | 1109 | 1118 | | 1137 | |
| Cl | 340 | 340 | 325 | 355 | 360 | 340 | 350 | 345 | 350 | | 360 | |
| Ca | | | 14 | | | 15 | | | 15 | | 16 | |
| Mg | | | 0 | | | 0 | | | 0 | | 1 | |
| Na | | | 305 | | | 315 | | | 323 | | 321 | |
| K | | | 27 | | | 27 | | | 28 | | 33 | |
| SiO2 | | | 134 | | | 132 | | | 132 | | 129 | |
| HCO3 | | | 273 | | | 273 | | | 249 | | 281 | |
| F | | | 0.96 | | | 0.99 | | | 0.98 | | 0.89 | |
| B | 17.5 | 17.6 | 17.2 | 17.1 | 17.2 | 17.4 | 17.5 | 17.6 | 17.4 | | 18.3 | |
| As | 0.486 | 0.508 | 0.445 | 0.455 | 0.447 | 0.47 | 0.47 | 0.43 | 0.45 | | 0.455 | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | 310 | | | 308 | | | 308 | | 305 | |
| Na/K (°F) | | | 339 | | | 332 | | | 335 | | 370 | |
| Na/K/Ca (°F), ß=.33 | | | 504 | | | 499 | | | 502 | | 524 | |
| Na/K/Ca (°F), ß=1.33 | | | 1258 | | | 1243 | | | 1262 | | 1315 | |
| Cl/B | 19.4 | 19.3 | 18.9 | 20.8 | 20.9 | 19.5 | 20.0 | 19.6 | 20.1 | | 19.7 | |

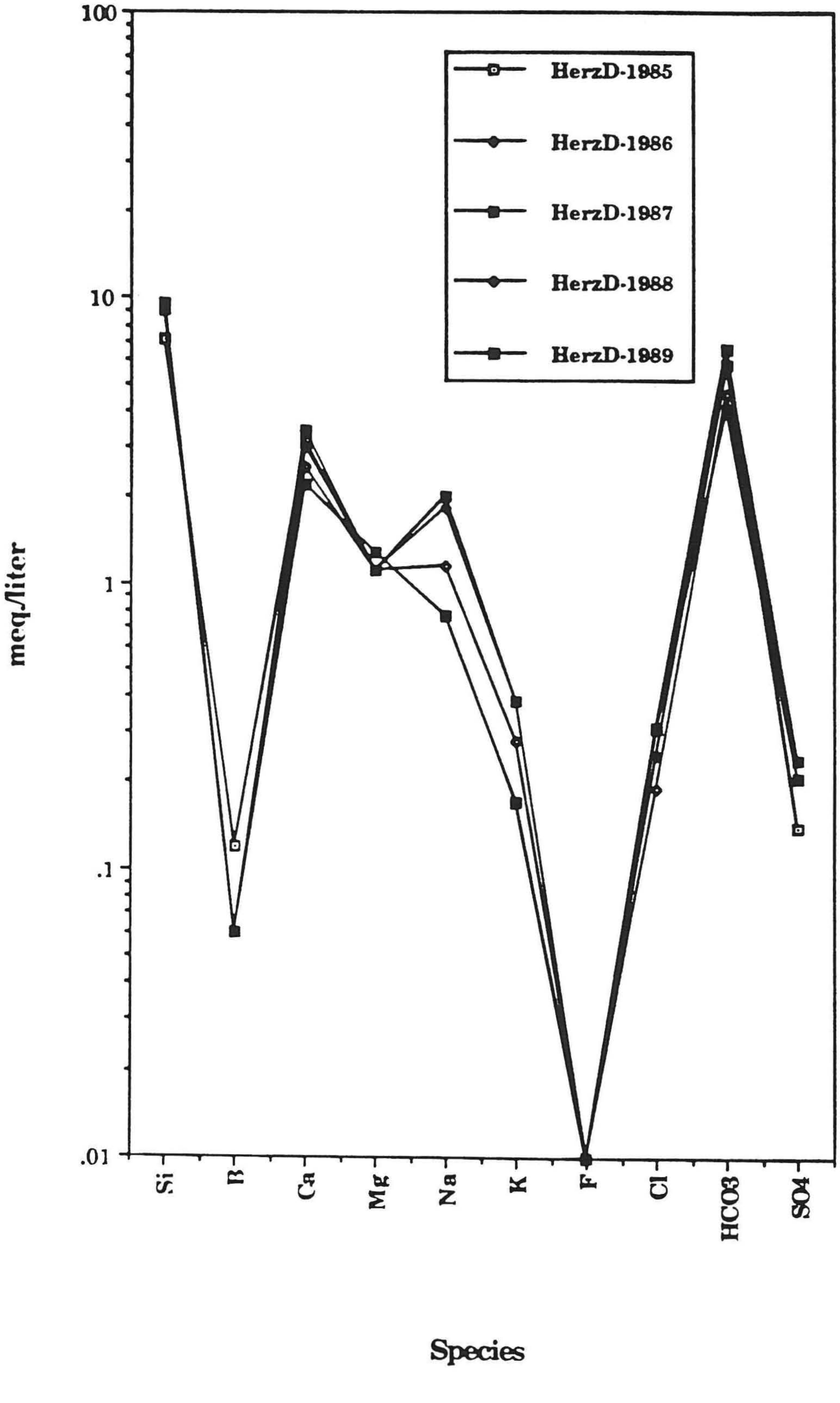
| Date | Jan-89 | Feb-89 | Mar-89 | May-89 | Jun-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 |
| Temperature | 128 | 126 | 126 | 129 | 126 | 129 | 126 | 131 | 128 | 127 | |
| Water Level | 50 | | 41.3 | | | 52.2 | 52 | 53.3 | 53.1 | 53.5 | 53.5 |
| TDS | 1137 | 1088 | 1128 | 1112 | 1158 | 1152 | 1171 | 1159 | 1171 | 1170 | |
| Cl | 355 | 365 | 370 | 370 | 375 | 375 | 390 | 375 | 370 | 380 | |
| Ca | 15 | | | | | | | | | | |
| Mg | 1 | | | | | | | | | | |
| Na | 334 | | | | | | | | | | |
| K | 32 | | | | | | | | | | |
| SiO2 | 131 | | | | | | | | | | |
| HCO3 | 276 | | | | | | | | | | |
| F | 0.97 | | | | | | | | | 0.94 | |
| B | 16.6 | 17.8 | 17.9 | 18.2 | 18.2 | 18.1 | 18.7 | 18.6 | 18.7 | 19 | |
| As | 0.45 | 0.296 | 0.38 | 0.348 | 0.439 | 0.495 | 0.4 | 0.405 | 0.4 | 0.408 | |
| SO4 | | | | | | | | | | 86 | |
| SiO2(°F) | 307 | | | | | | | | | | |
| Na/K (°F) | 355 | | | | | | | | | | |
| Na/K/Ca (°F), ß=.33 | 517 | | | | | | | | | | |
| Na/K/Ca (°F), ß=1.33 | 1327 | | | | | | | | | | |
| Cl/B | 21.4 | 20.5 | 20.7 | 20.3 | 20.6 | 20.7 | 20.9 | 20.2 | 19.8 | 20.0 | |

| Date | Jan-90 | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 | Dec-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1824 | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Temperature | | | | | | | | | | | | |
| Water Level | | 46.4 | 51 | 51 | 50.5 | 51 | 50.6 | | | | | |
| TDS | | | | | | | | | | | | |
| Cl | | | | | | | | | | | | |
| Ca | | | | | | | | | | | | |
| Mg | | | | | | | | | | | | |
| Na | | | | | | | | | | | | |
| K | | | | | | | | | | | | |
| SiO2 | | | | | | | | | | | | |
| HCO3 | | | | | | | | | | | | |
| F | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| As | | | | | | | | | | | | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | | | | | | | | | | |
| Na/K (°F) | | | | | | | | | | | | |
| Na/K/Ca (°F), ß=.33 | | | | | | | | | | | | |
| Na/K/Ca (°F), ß=1.33 | | | | | | | | | | | | |
| Cl/B | | | | | | | | | | | | |

# Appendix 10 - Herz Domestic Well Monitor Data




Herz Domestic Well Completion and Geologic Information


100
10
1
.1
.01
meq/liter
HerzD-1985
HerzD-1986
HerzD-1987
HerzD-1988
HerzD-1989
Si
B
Ca
Mg
Na
K
F
Cl
HCO3
SO4
Species

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 5.0 | 4.0 | 5.0 | 3.0 | 5.0 | 33.0 | 0.14 | 0.11 | 0.14 | 0.08 | 0.14 | 0.93 | 2.4 | 2.0 | 3.5 | 1.8 | 2.2 | 10.7 |
| Ca | 28.0 | 27.0 | 20.0 | 23.0 | 31.0 | 46.0 | 1.40 | 1.35 | 1.00 | 1.15 | 1.55 | 2.30 | 24.0 | 23.8 | 24.5 | 25.1 | 24.7 | 26.6 |
| Mg | 6.0 | 6.0 | 7.0 | 6.0 | 6.0 | 7.0 | 0.50 | 0.50 | 0.58 | 0.50 | 0.50 | 0.58 | 8.6 | 8.8 | 14.3 | 10.9 | 8.0 | 6.7 |
| Na | 21.0 | 19.0 | 8.0 | 12.0 | 21.0 | 30.0 | 0.91 | 0.83 | 0.35 | 0.52 | 0.91 | 1.30 | | | | | | |
| K | 7.0 | 7.0 | 3.0 | 5.0 | 7.0 | 10.0 | 0.18 | 0.18 | 0.08 | 0.13 | 0.18 | 0.26 | | | | | | |
| SiO2 | 49.0 | 62.0 | 62.0 | 64.0 | 65.0 | 61.0 | 3.26 | 4.13 | 4.13 | 4.26 | 4.33 | 4.06 | | | | | | |
| HCO3 | 161.0 | 159.0 | 112.0 | 127.0 | 183.0 | 193.0 | 2.64 | 2.61 | 1.84 | 2.08 | 3.00 | 3.16 | 45.2 | 45.9 | 45.0 | 45.5 | 47.7 | 36.5 |
| F | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | | | | | | |
| B | 0.2 | 0.1 | 0.0 | 0.0 | 0.1 | 0.5 | 0.06 | 0.03 | 0.00 | 0.00 | 0.03 | 0.14 | | | | | | |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | | | | | | |
| SO4 | 4.0 | 7.0 | 6.0 | 7.0 | 0.0 | 8.0 | 0.06 | 0.11 | 0.09 | 0.11 | 0.00 | 0.13 | 1.1 | 1.9 | 2.3 | 2.4 | 0.0 | 1.4 |
| Ca+Mg | | | | | | | 1.90 | 1.85 | 1.58 | 1.65 | 2.05 | 2.88 | 32.6 | 32.5 | 38.8 | 36.1 | 32.6 | 33.3 |
| SO4+Cl | | | | | | | 0.20 | 0.22 | 0.23 | 0.19 | 0.14 | 1.05 | 3.5 | 3.9 | 5.8 | 4.2 | 2.2 | 12.2 |
| Na+K | | | | | | | 1.09 | 1.01 | 0.42 | 0.65 | 1.09 | 1.56 | 18.7 | 17.7 | 10.4 | 14.2 | 17.4 | 18.0 |
| CO3+HCO3 | | | | | | | 2.64 | 2.61 | 1.84 | 2.08 | 3.00 | 3.16 | 45.2 | 45.9 | 45.0 | 45.5 | 47.7 | 36.5 |
| Total | 281.3 | 291.2 | 223.1 | 247.1 | 318.2 | 388.6 | 5.84 | 5.68 | 4.08 | 4.58 | 6.28 | 8.66 | 2.6 | 0.5 | -1.5 | 0.5 | 0.0 | 2.6 |

Herz Domestic Well Chemistry Data (meq/l)

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Temperature | 42.0 | 38.0 | 38.0 | 40.0 | 52.0 | 62.0 | 68.0 | 75.0 | 78.0 | 54.0 | 68.0 | 57.0 | 50.0 |
| Water Level | | 25.4 | 27.5 | 28.2 | 29.4 | 30.4 | 29.9 | 29.1 | 29.0 | 29.4 | 29.4 | 29.6 | 30.3 |
| TDS | 196.0 | 196.0 | 196.0 | 204.0 | 197.0 | 202.0 | 200.0 | 211.0 | 211.0 | 201.0 | 197.0 | 194.0 | 200.0 |
| Cl | 5.0 | 3.0 | 4.0 | 3.0 | 3.0 | 4.0 | 4.0 | 5.0 | 3.0 | 3.0 | 3.0 | 5.0 | 4.0 |
| Ca | 28.0 | 28.0 | 28.0 | | | | 27.0 | | | 26.0 | | | 27.0 |
| Mg | 6.0 | 6.0 | 6.0 | | | | 6.0 | | | 5.0 | | | 6.0 |
| Na | 21.0 | 18.0 | 19.0 | | | | 20.0 | | | 23.0 | | | 19.0 |
| K | 7.0 | 7.0 | 7.0 | | | | 6.0 | | | 7.0 | | | 7.0 |
| SiO2 | 49.0 | 60.0 | 60.0 | | | | 62.0 | | | 5.0 | | | 62.0 |
| HCO3 | 161.0 | 151.0 | 159.0 | | | | 156.0 | | | 159.0 | | | 159.0 |
| F | 0.1 | 0.1 | 0.1 | | | | 0.1 | | | 0.1 | | | 0.1 |
| B | 0.2 | 0.0 | 0.0 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 4.0 | 4.0 | 5.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 6.0 | 6.0 | 6.0 | 6.0 | 7.0 |
| SiO2(°F) | 213 | 231 | 231 | | | | 234 | | | 65 | | | 234 |
| Na/K (°F) | 730 | 802 | 776 | | | | 685 | | | 691 | | | 776 |
| Na/K/Ca (°F), ß=.33 | 551 | 566 | 561 | | | | 534 | | | 544 | | | 562 |
| Na/K/Ca (°F), ß=1.33 | 564 | 556 | 559 | | | | 542 | | | 576 | | | 563 |
| Cl/B | 25.0 | | | 15.0 | 10.0 | 20.0 | 13.3 | 25.0 | 15.0 | 15.0 | 15.0 | 50.0 | 40.0 |

**Herz Domestic Well Monitor Data (ppm, feet, °F) - Page 1**

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Temperature | 48.0 | 44.0 | 51.0 | 56.0 | 58.0 | 75.0 | 73.0 | 76.0 | 74.0 | 64.0 | 56.0 | 50.0 |
| Water Level | 31.4 | 32.5 | 29.1 | 29.1 | 31.1 | 30.5 | 26.7 | 25.4 | 27.0 | | | |
| TDS | 192.0 | 190.0 | 177.0 | 177.0 | 191.0 | 206.0 | 192.0 | 183.0 | 170.0 | 181.0 | 172.0 | 167.0 |
| Cl | 3.0 | 3.0 | 4.0 | 3.0 | 2.0 | 4.0 | 3.0 | 2.0 | 3.0 | 1.0 | 3.0 | 5.0 |
| Ca | | | 24.0 | | | 27.0 | | | 23.0 | | | 20.0 |
| Mg | | | 8.0 | | | 5.0 | | | 6.0 | | | 7.0 |
| Na | | | 8.0 | | | 21.0 | | | 13.0 | | | 8.0 |
| K | | | 4.0 | | | 7.0 | | | 5.0 | | | 3.0 |
| SiO2 | | | 62.0 | | | 60.0 | | | 60.0 | | | 62.0 |
| HCO3 | | | 132.0 | | | 168.0 | | | 134.0 | | | 112.0 |
| F | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 |
| B | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 5.0 | 6.0 | 9.0 | 5.0 | 7.0 | 6.0 | 7.0 | 5.0 | 5.0 | 5.0 | 5.0 | 6.0 |
| SiO2(°F) | | | 234 | | | 231 | | | 231 | | | 234 |
| Na/K (°F) | | | 939 | | | 730 | | | 796 | | | 784 |
| Na/K/Ca (°F), ß=.33 | | | 568 | | | 552 | | | 553 | | | 530 |
| Na/K/Ca (°F), ß=1.33 | | | 457 | | | 568 | | | 511 | | | 437 |
| Cl/B | 6.0 | 30.0 | 40.0 | 30.0 | 20.0 | 40.0 | 15.0 | 10.0 | 30.0 | 10.0 | 30.0 | |

Herz Domestic Well Monitor Data (ppm, feet, °F) - Page 2

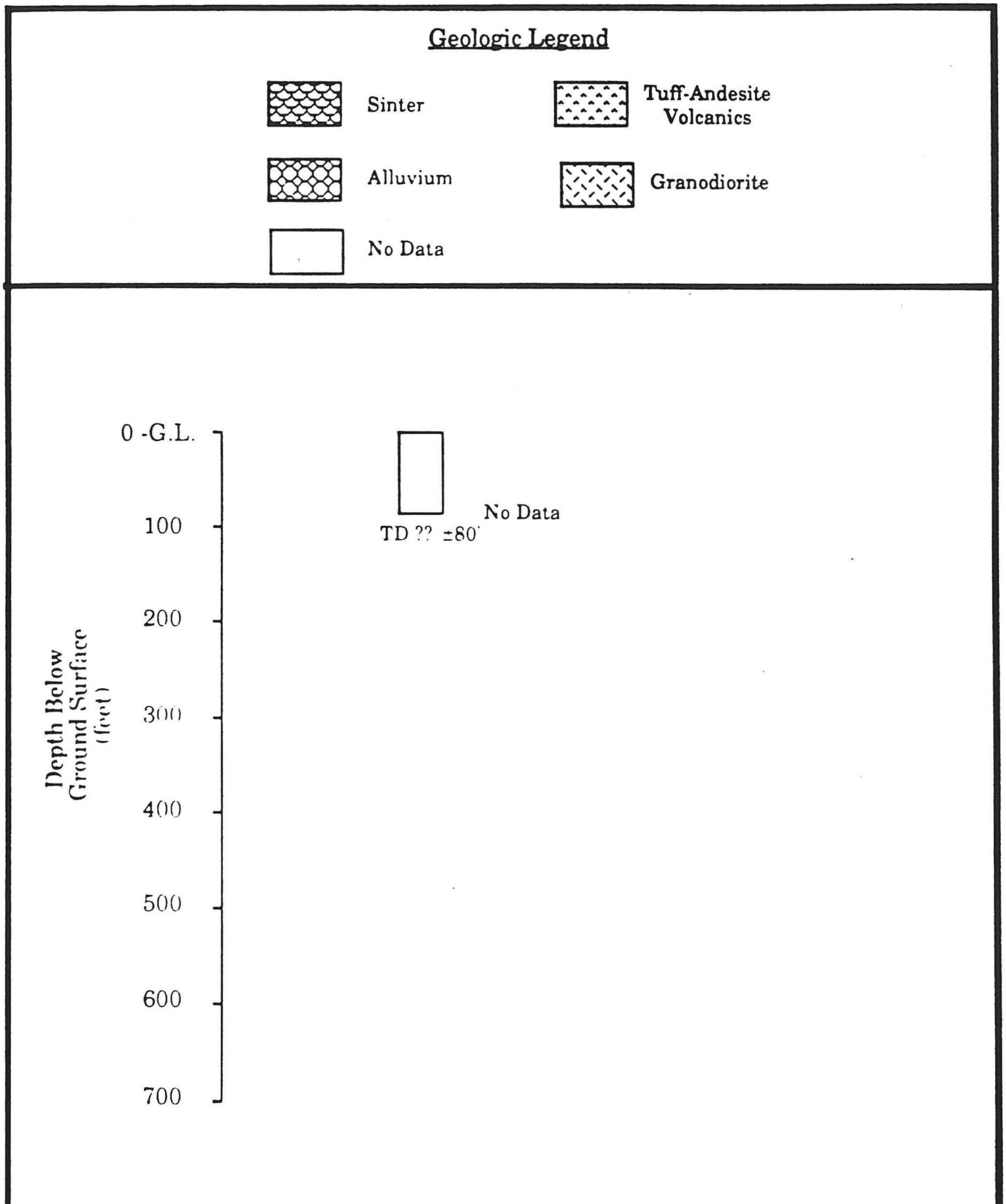
| Date | Jan-87 | Feb-87 | Mar-87 | Apr-87 | May-87 | Jun-87 | Jul-87 | Aug-87 | Sep-87 | Oct-87 | Nov-87 | Dec-87 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 760 | 790 | 821 | 851 | 882 | 912 | 942 | 973 | 1003 | 1034 | 1064 | 1094 |
| Temperature | 40.0 | 46.0 | 49.0 | 59.0 | 62.0 | 72.0 | 69.0 | 73.0 | 73.0 | 70.0 | 57.0 | 51.0 |
| Water Level | 30.8 | 31.5 | 32.8 | 33.7 | 35.0 | 35.5 | 35.9 | 36.7 | 37.1 | 36.9 | 37.0 | 37.3 |
| TDS | 165.0 | 186.0 | 179.0 | 184.0 | 198.0 | 192.0 | 188.0 | 195.0 | 189.0 | 186.0 | 165.0 | 178.0 |
| Cl | 3.0 | 3.0 | 0.0 | 4.0 | 3.0 | 3.0 | 6.0 | 2.0 | 5.0 | 3.0 | 3.0 | 3.0 |
| Ca | | | 27.0 | | | 26.0 | | | 25.0 | | | 23.0 |
| Mg | | | 6.0 | | | 6.0 | | | 6.0 | | | 6.0 |
| Na | | | 15.0 | | | 17.0 | | | 19.0 | | | 12.0 |
| K | | | 6.0 | | | 6.0 | | | 6.0 | | | 5.0 |
| SiO2 | | | 61.0 | | | 61.0 | | | 61.0 | | | 64.0 |
| HCO3 | | | 151.0 | | | 154.0 | | | 142.0 | | | 127.0 |
| F | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 |
| B | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.0 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 6.0 | 6.0 | 7.0 | 9.0 | 6.0 | 7.0 | 8.0 | 6.0 | 7.0 | 6.0 | 7.0 | 7.0 |
| SiO2(°F) | | | 232 | | | 232 | | | 232 | | | 236 |
| Na/K (°F) | | | 816 | | | 756 | | | 707 | | | 837 |
| Na/K/Ca (°F), ß=.33 | | | 562 | | | 551 | | | 541 | | | 562 |
| Na/K/Ca (°F), ß=1.33 | | | 528 | | | 538 | | | 547 | | | 507 |
| Cl/B | 30.0 | 30.0 | 0.0 | 40.0 | 30.0 | | 30.0 | 20.0 | 25.0 | 30.0 | 30.0 | |

| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun-88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Temperature | 40.0 | 38.0 | 46.0 | 58.0 | 64.0 | 75.0 | 77.0 | 82.0 | | | 46.0 | |
| Water Level | 37.8 | 38.3 | 38.8 | 40.1 | 41.1 | 40.0 | 40.1 | 40.5 | | | | |
| TDS | 182.0 | 180.0 | 185.0 | 197.0 | 207.0 | 206.0 | 183.0 | 207.0 | 201.0 | | 202.0 | |
| Cl | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 3.0 | 3.0 | 3.0 | | 5.0 | |
| Ca | | | 26.0 | | | 28.0 | | | 28.0 | | 31.0 | |
| Mg | | | 6.0 | | | 6.0 | | | 7.0 | | 6.0 | |
| Na | | | 18.0 | | | 21.0 | | | 22.0 | | 26.0 | |
| K | | | 6.0 | | | 7.0 | | | 7.0 | | 7.0 | |
| SiO2 | | | 60.0 | | | 61.0 | | | 61.0 | | | |
| HCO3 | | | 154.0 | | | 171.0 | | | 166.0 | | 178.0 | |
| F | | | 0.1 | | | 0.1 | | | 0.1 | | 0.1 | |
| B | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | | | |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| SO4 | | | | | | | | | | | | |
| SiO2(°F) | | | 231 | | | 232 | | | 232 | | | |
| Na/K (°F) | | | 730 | | | 730 | | | 710 | | 643 | |
| Na/K/Ca (°F), ß=.33 | | | 545 | | | 551 | | | 546 | | 527 | |
| Na/K/Ca (°F), ß=1.33 | | | 541 | | | 564 | | | 566 | | 564 | |
| Cl/B | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 30.0 | 30.0 | 15.0 | | | |

| Date | Jan-89 | Feb-89 | Mar-89 | May-89 | Jun-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 |
| Temperature | 40.0 | 48.0 | 50.0 | 66.0 | 68.0 | 79.0 | 73.0 | 75.0 | 68.0 | 62.0 | 71.0 |
| Water Level | | | | | | | | | | | |
| TDS | 215.0 | 213.0 | 205.0 | 224.0 | 231.0 | 229.0 | 236.0 | 235.0 | 232.0 | 232.0 | 231.0 |
| Cl | 5.0 | 4.0 | 2.0 | 6.0 | 8.0 | 9.0 | 12.0 | 15.0 | 12.0 | 11.0 | 13.0 |
| Ca | 31.0 | | | | | | | | | | |
| Mg | 6.0 | | | | | | | | | | |
| Na | 21.0 | | | | | | | | | | |
| K | 7.0 | | | | | | | | | | |
| SiO2 | 65.0 | | | | | | | | | | |
| HCO3 | 183.0 | | | | | | | | | | |
| F | 0.1 | | | | | | | | | 0.1 | 0.1 |
| B | 0.1 | 0.2 | 0.0 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.0 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | | | | | | | | | | 6.0 | 6.0 |
| SiO2(°F) | 238 | | | | | | | | | | |
| Na/K (°F) | 730 | | | | | | | | | | |
| Na/K/Ca (°F), ß=.33 | 548 | | | | | | | | | | |
| Na/K/Ca (°F), ß=1.33 | 554 | | | | | | | | | | |
| Cl/B | 50.0 | 20.0 | | 60.0 | 40.0 | 90.0 | 120.0 | 150.0 | 60.0 | 110.0 | |

| Date | Jan-90 | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 | Dec-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1824 | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Temperature | 69.0 | 61.0 | 73.0 | 72.0 | 68.0 | 67.0 | 68.0 | | | | | 47.0 |
| Water Level | | | | | | | | | | | | |
| TDS | 244.0 | 234.0 | 239.0 | 242.0 | 238.0 | 242.0 | 248.0 | | | | | 277.0 |
| Cl | 12.0 | 12.0 | 12.0 | 12.0 | 13.0 | 16.0 | 16.0 | | | | | 33.0 |
| Ca | | | | | | | | | | | | 46.0 |
| Mg | | | | | | | | | | | | 7.0 |
| Na | | | | | | | | | | | | 30.0 |
| K | | | | | | | | | | | | 10.0 |
| SiO2 | | | | | | | | | | | | 61.0 |
| HCO3 | | | | | | | | | | | | 193.0 |
| F | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | 0.1 |
| B | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | 0.5 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | 0.0 |
| SO4 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | | | | | 8.0 |
| SiO2(°F) | | | | | | | | | | | | 232 |
| Na/K (°F) | | | | | | | | | | | | 730 |
| Na/K/Ca (°F), ß=.33 | | | | | | | | | | | | 556 |
| Na/K/Ca (°F), ß=1.33 | | | | | | | | | | | | 587 |
| Cl/B | 120.0 | | | | | | | | | | | 66.0 |

# Appendix 11 - Brown School Well Monitor Data




Brown School Well Completion and Geologic Information

| | Dissolved solids content (ppm) | | | | | | meq./liter | | | | | | % meq. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| Cl | 7.0 | 10.0 | 11.0 | 6.0 | 150.0 | 480.0 | 0.20 | 0.28 | 0.31 | 0.17 | 4.23 | 13.52 | 3.8 | 5.0 | 5.4 | 3.1 | 27.4 | 35.4 |
| Ca | 17.0 | 18.0 | 19.0 | 17.0 | 64.0 | 194.0 | 0.85 | 0.90 | 0.95 | 0.85 | 3.20 | 9.70 | 16.3 | 16.0 | 16.4 | 15.5 | 20.8 | 25.4 |
| Mg | 3.0 | 3.0 | 3.0 | 3.0 | 10.0 | 34.0 | 0.25 | 0.25 | 0.25 | 0.25 | 0.83 | 2.83 | 4.8 | 4.5 | 4.3 | 4.6 | 5.4 | 7.4 |
| Na | 30.0 | 33.0 | 33.0 | 35.0 | 73.0 | 126.0 | 1.30 | 1.43 | 1.43 | 1.52 | 3.17 | 5.48 | | | | | | |
| K | 9.0 | 9.0 | 9.0 | 9.0 | 19.0 | 34.0 | 0.23 | 0.23 | 0.23 | 0.23 | 0.49 | 0.87 | | | | | | |
| SiO2 | 58.0 | 71.0 | 75.0 | 80.0 | 88.0 | 87.0 | 3.86 | 4.73 | 4.99 | 5.33 | 5.86 | 5.79 | | | | | | |
| HCO3 | 134.0 | 142.0 | 149.0 | 137.0 | 181.0 | 271.0 | 2.20 | 2.33 | 2.44 | 2.25 | 2.97 | 4.44 | 42.2 | 41.5 | 42.2 | 41.1 | 19.2 | 11.6 |
| F | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | | | | | | |
| B | 0.0 | 0.2 | 0.2 | 0.3 | 0.5 | 13.2 | 0.00 | 0.06 | 0.06 | 0.08 | 0.14 | 3.67 | | | | | | |
| As | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | | | | | | | | | | | | |
| SO4 | 11.0 | 12.0 | 11.0 | 13.0 | 34.0 | 87.0 | 0.17 | 0.19 | 0.17 | 0.20 | 0.53 | 1.36 | 3.3 | 3.3 | 3.0 | 3.7 | 3.4 | 3.6 |
| Ca+Mg | | | | | | | 1.10 | 1.15 | 1.20 | 1.10 | 4.03 | 12.53 | 21.2 | 20.5 | 20.7 | 20.1 | 26.2 | 32.8 |
| SO4+Cl | | | | | | | 0.37 | 0.47 | 0.48 | 0.37 | 4.76 | 14.88 | 7.1 | 8.4 | 8.3 | 6.8 | 30.9 | 38.9 |
| Na+K | | | | | | | 1.54 | 1.67 | 1.67 | 1.75 | 3.66 | 6.35 | 29.5 | 29.7 | 28.8 | 32.0 | 23.7 | 16.6 |
| CO3+HCO3 | | | | | | | 2.20 | 2.33 | 2.44 | 2.25 | 2.97 | 4.44 | 42.2 | 41.5 | 42.2 | 41.1 | 19.2 | 11.6 |
| Total | 269.1 | 298.3 | 310.3 | 300.5 | 619.6 | 1326.3 | 5.20 | 5.61 | 5.79 | 5.47 | 15.42 | 38.21 | 1.3 | 0.3 | -1.0 | 4.3 | -0.2 | -1.2 |

**Brown School (meq./L) Chemistry Data**

## Brown School Well Data

| Date | Dec-84 | Jan-85 | Feb-85 | Mar-85 | Apr-85 | May-85 | Jun-85 | Jul-85 | Aug-85 | Sep-85 | Oct-85 | Nov-85 | Dec-85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 0 | 30 | 61 | 91 | 122 | 152 | 182 | 213 | 243 | 274 | 304 | 334 | 365 |
| Temperature | 60.0 | 59.0 | 64.0 | 62.0 | 63.0 | 66.0 | 69.0 | 77.0 | 73.0 | 70.0 | 68.0 | 66.0 | 65.0 |
| Water Level | | | | | | | | | | | | | |
| TDS | 209.0 | 204.0 | 207.0 | 222.0 | 219.0 | 228.0 | 224.0 | 216.0 | 214.0 | 212.0 | 218.0 | 211.0 | 215.0 |
| Cl | 7.0 | 3.0 | 7.0 | 5.0 | 5.0 | 4.0 | 7.0 | 5.0 | 8.0 | 9.0 | 9.0 | 10.0 | 10.0 |
| Ca | 17.0 | 19.0 | 20.0 | | | | 18.0 | | | 18.0 | | | 18.0 |
| Mg | 3.0 | 3.0 | 4.0 | | | | 3.0 | | | 3.0 | | | 3.0 |
| Na | 30.0 | 30.0 | 31.0 | | | | 32.0 | | | 34.0 | | | 33.0 |
| K | 9.0 | 9.0 | 9.0 | | | | 9.0 | | | 9.0 | | | 9.0 |
| SiO2 | 58.0 | 71.0 | 71.0 | | | | 73.0 | | | 73.0 | | | 71.0 |
| HCO3 | 134.0 | 137.0 | 144.0 | | | | 142.0 | | | 142.0 | | | 142.0 |
| F | 0.1 | 0.1 | 0.1 | | | | 0.1 | | | 0.1 | | | 0.1 |
| B | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 | 0.30 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 11.0 | 11.0 | 12.0 | 13.0 | 12.0 | 12.0 | 13.0 | 12.0 | 12.0 | 11.0 | 11.0 | 11.0 | 12.0 |
| SiO2(°F) | 228 | 246 | 246 | | | | 248 | | | 248 | | | 246 |
| Na/K (°F) | 685 | 685 | 672 | | | | 660 | | | 637 | | | 648 |
| Na/K/Ca (°F) ß=.33 | 565 | 562 | 558 | | | | 557 | | | 551 | | | 554 |
| Na/K/Ca (°F) ß=1.33 | 684 | 670 | 666 | | | | 681 | | | 685 | | | 683 |
| Cl/B | | | | 16.7 | 16.7 | 13.3 | 35.0 | 25.0 | 40.0 | 45.0 | 45.0 | 100.0 | 50.0 |

| Date | Jan-86 | Feb-86 | Mar-86 | Apr-86 | May-86 | Jun-86 | Jul-86 | Aug-86 | Sep-86 | Oct-86 | Nov-86 | Dec-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 395 | 426 | 456 | 486 | 517 | 547 | 578 | 608 | 638 | 669 | 699 | 730 |
| Temperature | 60.0 | 62.0 | 63.0 | 65.0 | 66.0 | 72.0 | 76.0 | 82.0 | 70.0 | 66.0 | 65.0 | 63.0 |
| Water Level | | | | | | | | | | | | |
| TDS | 213.0 | 210.0 | 237.0 | 223.0 | 219.0 | 217.0 | 225.0 | 219.0 | 224.0 | 208.0 | 218.0 | 220.0 |
| Cl | 8.0 | 7.0 | 17.0 | 17.0 | 10.0 | 11.0 | 10.0 | 11.0 | 14.0 | 13.0 | 13.0 | 11.0 |
| Ca | | | 19.0 | | | 18.0 | | | 19.0 | | | 19.0 |
| Mg | | | 3.0 | | | 3.0 | | | 3.0 | | | 3.0 |
| Na | | | 37.0 | | | 32.0 | | | 33.0 | | | 33.0 |
| K | | | 9.0 | | | 9.0 | | | 9.0 | | | 9.0 |
| SiO2 | | | 73.0 | | | 71.0 | | | 72.0 | | | 75.0 |
| HCO3 | | | 139.0 | | | 139.0 | | | 139.0 | | | 149.0 |
| F | | | 0.1 | | | 0.1 | | | 0.1 | | | 0.1 |
| B | 0.6 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 12.0 | 12.0 | 17.0 | 12.0 | 12.0 | 13.0 | 12.0 | 12.0 | 11.0 | 10.0 | 12.0 | 11.0 |
| SiO2(°F) | | | 248 | | | 246 | | | 247 | | | 251 |
| Na/K (°F) | | | 606 | | | 660 | | | 648 | | | 648 |
| Na/K/Ca (°F) ß=.33 | | | 541 | | | 557 | | | 553 | | | 553 |
| Na/K/Ca (°F) ß=1.33 | | | 683 | | | 681 | | | 676 | | | 676 |
| Cl/B | 13.3 | 35.0 | 85.0 | 85.0 | 50.0 | 55.0 | 100.0 | 55.0 | 70.0 | 130.0 | 130.0 | 55.0 |

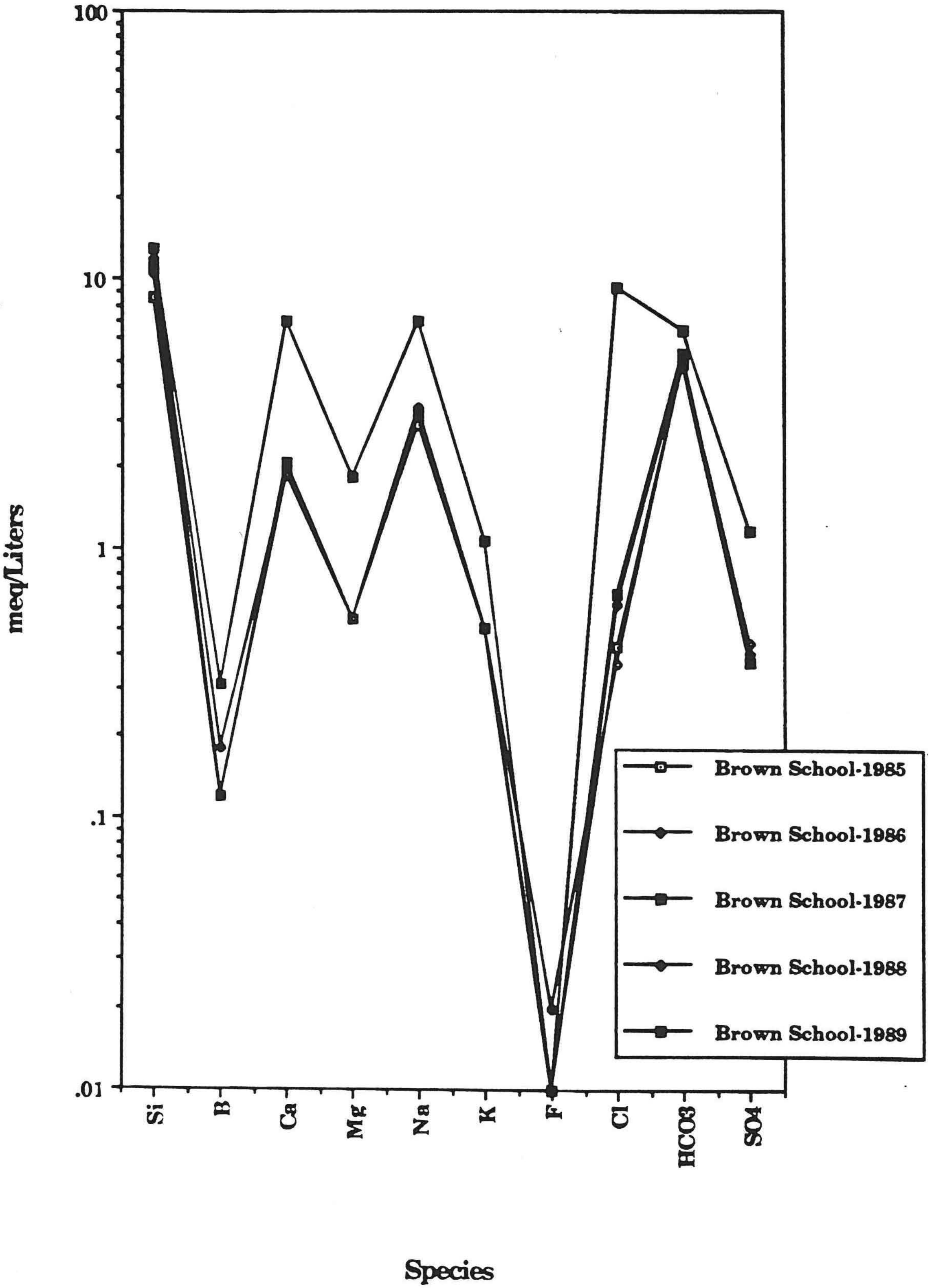
Brown School Monitor Data (ppm, feet, °F) - Page 2

| Date | Jan-88 | Feb-88 | Mar-88 | Apr-88 | May-88 | Jun-88 | Jul-88 | Aug-88 | Sep-88 | Oct-88 | Nov-88 | Dec-88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1125 | 1155 | 1186 | 1216 | 1246 | 1277 | 1307 | 1338 | 1368 | 1398 | 1429 | 1459 |
| Temperature | 62.0 | 62.0 | 69.0 | 68.0 | 72.0 | 79.0 | 82.0 | 81.0 | | | 77.0 | |
| Water Level | | | | | | | | | | | | |
| TDS | 224.0 | 225.0 | 264.0 | 239.0 | 273.0 | 286.0 | 289.0 | 350.0 | 353.0 | | 449.0 | |
| Cl | 7.0 | 14.0 | 13.0 | 18.0 | 27.0 | 35.0 | 39.0 | 68.0 | 69.0 | | 112.0 | |
| Ca | | | 18.0 | | | 26.0 | | | 37.0 | | 55.0 | |
| Mg | | | 3.0 | | | 4.0 | | | 6.0 | | 11.0 | |
| Na | | | 38.0 | | | 40.0 | | | 51.0 | | 50.0 | |
| K | | | 9.0 | | | 12.0 | | | 15.0 | | 19.0 | |
| SiO2 | | | 81.0 | | | 86.0 | | | 86.0 | | 90.0 | |
| HCO3 | | | 139.0 | | | 149.0 | | | 156.0 | | 163.0 | |
| F | | | 0.1 | | | 0.1 | | | 0.1 | | 0.1 | |
| B | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | | 0.7 | |
| As | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| SO4 | 13.0 | 14.0 | 14.0 | 15.0 | 15.0 | 16.0 | 17.0 | 20.0 | 19.0 | | 27.0 | |
| SiO2(°F) | | | 258 | | | 264 | | | 264 | | 268 | |
| Na/K (°F) | | | 597 | | | 685 | | | 677 | | 790 | |
| Na/K/Ca (°F) ß=.33 | | | 540 | | | 569 | | | 569 | | 599 | |
| Na/K/Ca (°F) ß=1.33 | | | 692 | | | 704 | | | 718 | | 711 | |
| Cl/B | 23.3 | 46.7 | 43.3 | 60.0 | 90.0 | 116.7 | 130.0 | 170.0 | 172.5 | | 160.0 | |

Brown School Monitor Data (ppm, feet, °F) - Page 4

| Date | Jan-89 | Feb-89 | Mar-89 | May-89 | Jun-89 | Jul-89 | Aug-89 | Sep-89 | Oct-89 | Nov-89 | Dec-89 | Jan-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1490 | 1520 | 1550 | 1581 | 1611 | 1642 | 1672 | 1702 | 1733 | 1763 | 1794 | 1824 |
| Temperature | 72.0 | 75.0 | 77.0 | 77.0 | 77.0 | 81.0 | | 73.0 | 70.0 | 72.0 | 69.0 | 68.0 |
| Water Level | | | | | | | | | | | | |
| TDS | 537.0 | 625.0 | 661.0 | 767.0 | 804.0 | 825.0 | | 1035.0 | 1073.0 | 976.0 | 1060.0 | 1045.0 |
| Cl | 150.0 | 188.0 | 203.0 | 250.0 | 253.0 | 263.0 | | 350.0 | 355.0 | 333.0 | 730.0 | 370.0 |
| Ca | 64.0 | | | | | | | | | | | |
| Mg | 10.0 | | | | | | | | | | | |
| Na | 73.0 | | | | | | | | | | | |
| K | 19.0 | | | | | | | | | | | |
| SiO2 | 88.0 | | | | | | | | | | | |
| HCO3 | 181.0 | | | | | | | | | | | |
| F | 0.1 | | | | | | | | | 0.1 | 0.1 | 0.1 |
| B | 0.5 | 0.9 | 1.3 | 2.1 | 2.7 | 2.8 | | 4.4 | 4.9 | 5.4 | 6.4 | 6.3 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SO4 | 34.0 | 39.0 | 51.0 | 49.0 | 54.0 | 54.0 | | 67.0 | 69.0 | 65.0 | 71.0 | 73.0 |
| SiO2(°F) | 266 | | | | | | | | | | | |
| Na/K (°F) | 630 | | | | | | | | | | | |
| Na/K/Ca (°F) ß=.33 | 555 | | | | | | | | | | | |
| Na/K/Ca (°F) ß=1.33 | 716 | | | | | | | | | | | |
| Cl/B | 300.0 | 208.9 | 156.2 | 119.0 | 93.7 | 93.9 | | 79.5 | 72.4 | 61.7 | 114.1 | 58.7 |

| Date | Feb-90 | Mar-90 | Apr-90 | May-90 | Jun-90 | Jul-90 | Aug-90 | Sep-90 | Oct-90 | Nov-90 | Dec-90 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | 1854 | 1885 | 1915 | 1946 | 1976 | 2006 | 2037 | 2067 | 2098 | 2128 | 2158 |
| Temperature | 68.0 | 72.0 | 70.0 | 69.0 | 72.0 | 68.0 | | | | | 74.0 |
| Water Level | | | | | | | | | | | |
| TDS | 1107.0 | 1155.0 | 1222.0 | 1198.0 | | 1190.0 | | | | | 1349.0 |
| Cl | 395.0 | 415.0 | 430.0 | 430.0 | 440.0 | 410.0 | | | | | 480.0 |
| Ca | | | | | | | | | | | 194.0 |
| Mg | | | | | | | | | | | 34.0 |
| Na | | | | | | | | | | | 126.0 |
| K | | | | | | | | | | | 34.0 |
| SiO2 | | | | | | | | | | | 87.0 |
| HCO3 | | | | | | | | | | | 271.0 |
| F | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | 0.1 |
| B | 7.2 | 3.8 | 8.7 | 5.0 | 9.7 | 9.7 | | | | | 13.2 |
| As | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | 0.0 |
| SO4 | 78.0 | 80.0 | 84.0 | 80.0 | 86.0 | 82.0 | | | | | 87.0 |
| SiO2(°F) | | | | | | | | | | | 265 |
| Na/K (°F) | | | | | | | | | | | 644 |
| Na/K/Ca (°F) ß=.33 | | | | | | | | | | | 560 |
| Na/K/Ca (°F) ß=1.33 | | | | | | | | | | | 721 |
| Cl/B | 54.9 | 109.2 | 49.4 | 86.0 | 45.4 | 42.3 | | | | | 36.4 |



100
10
1
.1
.01
meq/Liters
Si
B
Ca
Mg
Na
K
F
Cl
HCO3
SO4
Species
Brown School-1985
Brown School-1986
Brown School-1987
Brown School-1988
Brown School-1989