Existing and future domestic wells at the south edge of the basin will not be affected by pumping from the northwestern part of the basin. These domestic wells are located over 6 miles away from well BF-2, and are situated substantially up-gradient (Figure 8). The altitude of the water table in the existing domestic wells ranges from 5,400 to 5,700 feet above msl, while water levels at the valley floor are approximately 4,900 feet, and lower in the northwest (Table 2). The cone of depression created by pumping in the northwest part of the basin will not under any practical considerations, propagate this high up into the peripheries of the flow system.

Likewise, springs in the basin are situated at substantially higher altitudes, and flows will not be measurably affected. One exception is Campbell Ranch spring located directly down-gradient of the basin in Red Rock Valley (2 miles down-gradient of well BF-2). Some impacts to shallow ground and spring flows at Campbell Ranch are expected over the long-term; however, it appears from the water chemistry that a northern source of water contributes to spring flow at the ranch. This component of flow will not be affected.

Over time, water levels at the BLM stockwater well in the center of the valley could be lowered slightly. Any measurable effects are expected to be subtle and gradually occurring in time, and are not predicted to occur until after several years of pumping. Water levels should be monitored in this well as production pumping is initiated.

As is the case with any substantial long-term water resources development project, particularly for municipal purposes, a monitoring program should be initiated. Data on pumping rates, pumping water levels, and water chemistry should be collected periodically, along with measurements of water levels at regional locations. The collected data will aid in review of the distribution and rates of pumping, as related to long-term sustainability of pumping and ground water basin management. Only one well is currently known to exist in the center of valley (BLM stockwater well), and additional wells installed specially for monitoring water levels will be needed at some time in the future.

Conclusion and Recommendations

Average annual ground water recharge and discharge are estimated to be 1,300 af/yr, which defines an upper limit of potential ground water yield from Bedell Flat. Based on the available data, a conservative estimate of perennial yield for municipal uses in Lemmon Valley is 600 af/yr. This amount of ground water development allows for existing and future domestic water consumption in the south, and factors into consideration less than complete capture of ground water discharge from the basin. Capturing the suggested perennial yield via pumping from existing wells BF-1 and BF-2 may prove challenging, as the transmissivity of the aquifer is low at these locations. An additional production well located in east-central portion of the basin may be needed to realize the full perennial yield of the basin. Long-term sustainability in ground water resources development will ultimately depend on identification of the right balance in distribution and pumping rates from production wells in the basin, which can be defined by an active ground water monitoring program.

Recommendations for additional work are as follows:

1. Redevelop well BF-2, which is currently plugged by debris, and pump the well for a sufficient period of time to confirm well condition/yield and collect water samples for complete drinking water quality analyses, including radioactivity. Replace the well cap for security and well preservation purposes.

2. Drill one or more exploration wells on the eastern side of the basin, and assess potential subsurface outflow as postulated in this evaluation. Evaluate encountered hydrogeology for potential eastern production well site.

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APPENDIX A

GROUNDWATER INVESTIGATIONS
BEDELL FLAT
WASHOE COUNTY, NEVADA

sea incorporated
ENGINEERS/PLANNERS

SPARKS, NEVADA
LAS VEGAS, NEVADA
PORTLAND, OREGON
SEATTLE, WASHINGTON

sea incorporated
ENGINEERS/PLANNERS

November 6, 1978
Project 380-002-781

Mr. John Nash
RED ROCK RANCH, LTD.
103 Mill Street
Reno, Nevada (89501)

Dear Mr. Nash -

Accompanying this letter is the final report summarizing the results of our hydrogeologic study in Bedell Flat during the summer of 1978. A discussion of each of the individual phases of the project and the pertinent findings is included.

We believe that the two production water wells in Bedell Flat possess sufficient capacity to meet much of the anticipated water need in the Red Rock Ranch area. Recommendations for the use of both wells to meet project demands are discussed in the report.

Respectfully submitted,

SEA ENGINEERS/PLANNERS

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GROUNDWATER INVESTIGATIONS

BEDELL FLAT

WASHOE COUNTY, NEVADA

I. INTRODUCTION

This report presents the results of a groundwater study conducted in Bedell Flat, which lies approximately thirty (30) miles north of Reno in Washoe County, Nevada. The project was undertaken by S E A Engineers at the request of Red Rock Ranch, Ltd., a partnership.

Investigation efforts were centered around the development of a production water well at either of two sites for which Water Right Permits 30274 and 30275 have been issued by the Nevada State Engineer. Recently, Red Rock Ranch, Ltd. was given an additional year, until June 3, 1979, in which to prove completion of work for both of these permits. An existing Bedell Flat well, also owned by Red Rock Ranch, Ltd., was included in this study by S E A Engineers. The water rights on this latter well were filed for under Permit 26274.

Current plans call for the simultaneous use of two production wells in Bedell Flat to meet water system demands in a proposed residential development in the Red Rock Ranch area which lies immediately north of Lemmon Valley. To accomplish this, it will be necessary to connect the two wells to a pipeline that will extend about seven (7) miles to the south of the well sites and will lift needed water a total vertical distance of approximately 500-600 feet.

II. OBJECTIVES

The primary objective of this project was to supervise and administer the construction of a new water well which would act as an accessory to the existing Bedell Flat well. It was hoped that the new well would possess the same if not greater, capacity as the existing well. The general intent was to provide a well that would act as a simultaneous and/or backup source of water needed in the Red Rock Ranch area.

Secondary objectives included the determination of current productivity in the existing well and the capacity of the new well upon completion. Test pumping procedures comprised this phase of the project. Quality analyses of water samples collected during pumping were also included. Final steps in this investigation called for the determination of effects of pumping in the surrounding Bedell Flat region and recommendations for pump installation and pumping procedures when both wells are connected to a water system.

III. STUDY AREA

Bedell Flat is located approximately thirty (30) miles north of downtown Reno in Washoe

County, Nevada. Access to the region is primarily provided by Red Rock Road which passes through the west portion of Lemmon Valley before continuing north to Red Rock Ranch and Red Rock Valley. A secondary road leaving Red Rock Road in the vicinity ot the ranch is used to rech the valley floor.

Bedell Flat is actually an alluvial valley bordered on most sides by mountains. The flat portion of the basin generally lies within Sections 3 through 5, 9 through 16, and 22 through 28 of Township 23 North, Range 19 East. A map showing the general location of Bedell Flat is presented in Figure 1.

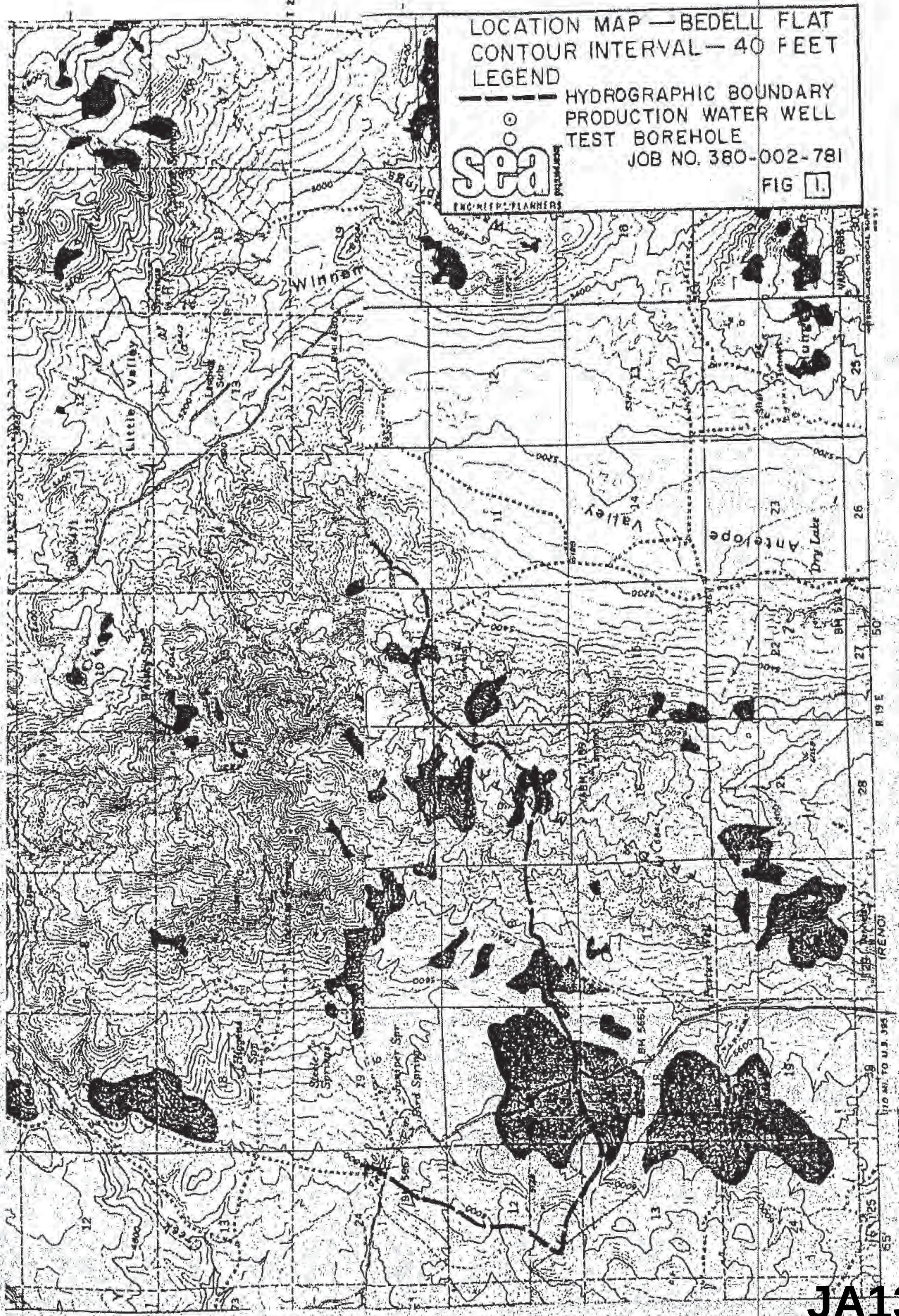
To the south and southeast of Bedell Flat a few small hills and topographic saddles separate the area from Antelope Valley. The west boundary of the basin is comprised of Granite Peak while the southwest border is formed by Fred's Mountain and a small series of foothills lying about one (1) mile west of Red Rock Road in Township 22 North, Range 18 East. Dogskin Mountain lies on the east and north margins of the basin. A drainage outlet for Bedell Flat is provided to the adjacent Red Rock Valley through the northwest corner of the alluvial valley.

The total area that collects surface runoff in the valley is called the Bedell Flat hydrographic area. This hydrographic basin contains an area of about fifty-three (53) square miles. Of this total about ten (10) square miles of relatively flat land are found in the valley floor. Slopes in this region vary from 0.5% to about 10%. The remaining areas are comprised of hilly and mountainous terrain with local slopes approaching twenty to thirty percent (20-30%). The highest elevation within the basin is approximately 7460 feet and is located at the top of Dogskin Mountain. The lowest point, at elevation 4800 feet, is situated at the valley outlet on the basin's northwest perimeter.

IV. GEOLOGY

Bedell Flat is typical of the numerous desert valleys which make up most of Nevada. As with most other basins in the Basin and Range province, Bedell Flat consists of an alluvial fill valley floor surrounded by mountains comprised of hard rock. Weathering of the mountain rocks continuously supplies new materials for transport to the valley fill. At the outlet of small drainages emanating from the mountain front, eroded materials are often deposited to form numerous alluvial fans. These fans coalesce in many areas to form long continual bans that line the base of each mountain for several miles.

Rocks in the mountainous areas surrounding Bedell Flat are composed of granodiorite and volcanic products primorily in the form of rhyolite. The granodiorite exhibits a minerol makeup of quartz, plagioclase feldspar, sodic feldspar, hornblende and biotite. These same minerals are found in many of the Pre-Lake Lahontan gravels and sands which form a large portion of the alluvial fill deposits in the vally floor. Thick, extensive layers of clay are also found in the alluvial deposits. These clays are thought to be the chemical weathering product of plagioclase feldspars originally found in the granodiorites above. It is possible, however, that many of the clays may be the result of weatherd rhyolite formations. A geologic map that shows the general locations of rock types and other geologic features



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is presented in Figure 2.

Topography in the Bedell Flat hydrographic region indicates that a lake or playa may have been located in the valley's southeast end at one time. The round shape and relatively large width of this area in comparison with the remaining basin floor suggest this possibility. Preliminary investigations show a preponderance of clays in the southeast corner of the valley. This latter observation also supports the feasibility for the existence of a lake or playa in the area.

If a lake did at one time exist in the southeast end of the valley, it is probable that constricted regions in the central and northeast parts of the basin acted as drainage outlets for the lake. Stream channels most likely meandered through these latter regions. During the wetter periods of geological history, these channels probably conveyed water from the lake continuously. However, within the drier post-glacial periods, the flow from the lake would have taken place sporadically, occurring mostly during times of flooding and high snowmelt events. The sediments deposited in the stream channels during these latter periods would normally be coarse in size. During times of both continual and sporadic flow, extensive sorting of stream gravels and other fluvial sediments in the constricted sections of the valley would take place.

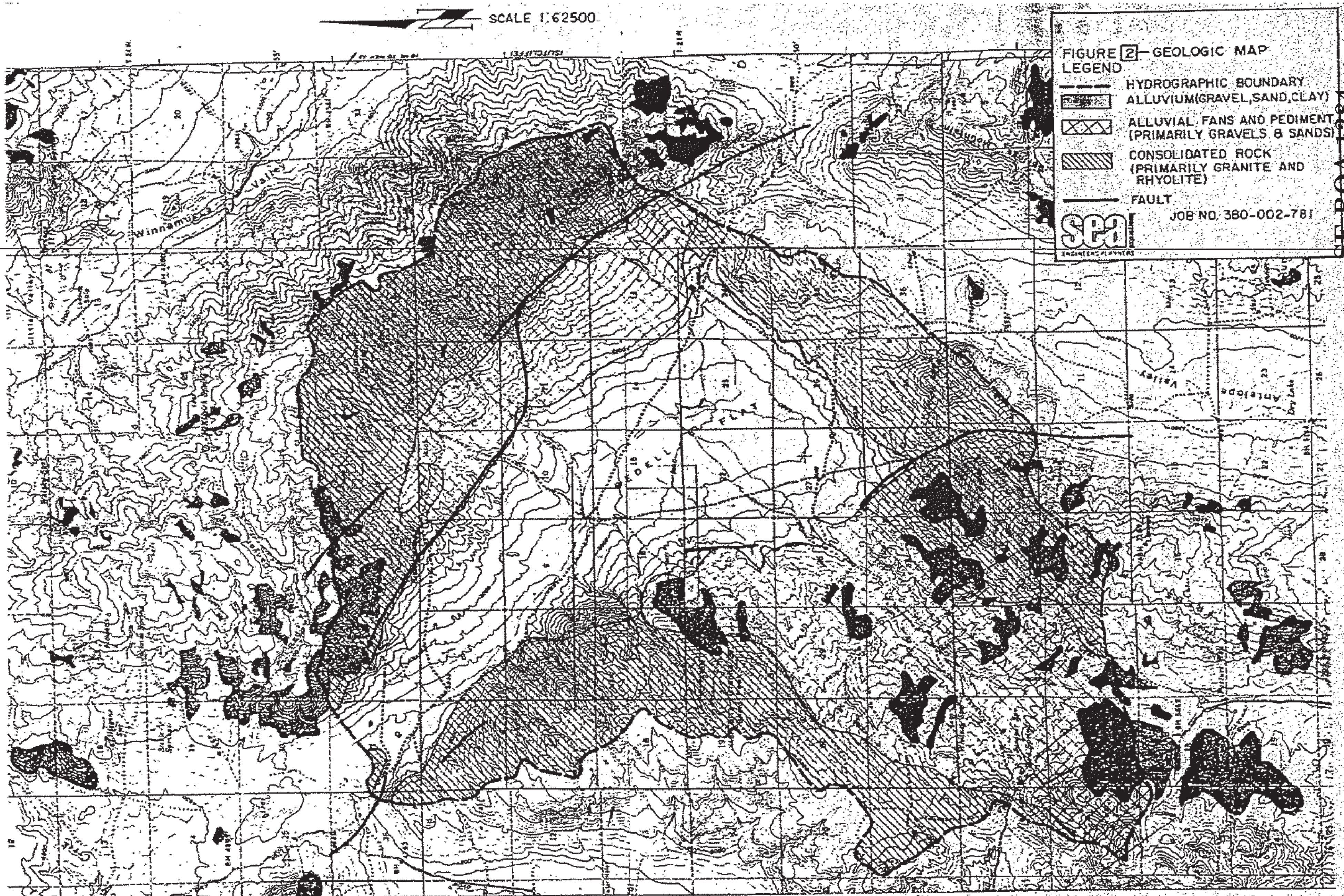
Depth to bedrock is estimated to be 900-1000 feet near the center of the southeast section of the valley floor. It is probable that the vertical extent of the alluvial fill thins considerable to the northwest where bedrock is exposed on the margins of the constricted valley fill.

Several geologic faults have been identified in the Bedell Flat hydrographic area. Most of these faults traverse the mountainous areas that surround the valley and the alluvial fans located at the mountain front (see Figure 2).

V. HYDROLOGY

The following hydrological terms and associated definitions are used in the description of groundwater resources of Bedell Flat:

> Recharge - flow to groundwater storage from infiltration of precipitation and surface water.
>
> Evapotranspiration - water withdrawn from soil by evaporation and plant transpiration.
>
> Perennial Yield - the maximum amount of groundwater of usable chemical quality that can be withdrawn and consumed economically each year for an indefinite period of time.
>
> Transitional Storage - the quantity of water in storage in a ground water reservoir that can be extracted and beneficially used during the transition


SCALE 1:62500
FIGURE 2 GEOLOGIC MAP
LEGEND
HYDROGRAPHIC BOUNDARY
ALLUVIUM(GRAVEL,SAND,CLAY)
ALLUVIAL FANS AND PEDIMENT (PRIMARILY GRAVELS & SANDS)
CONSOLIDATED ROCK (PRIMARILY GRANITE AND RHYOLITE)
FAULT
JOB NO. 380-002-781
sea
Winnemucca Valley
DELL FLAT
Antelope Valley
Dry Lake

period between equilibrium conditions in a state of nature and new equilibrium conditions under which water is extracted from the reservoir at a rate equal to the perennial yield.

Natural Inflow - inflow to a ground water reservoir from recharge of precipitation and surface water and from subsurface inflow.

Natural Outflow - outflow from a groundwater reservoir through evapotranspiration and subsurface outflow.

Inflow to Bedell Flat currently currently occurs only through natural processes. The major source of inflow is precipitation over the Bedell Flat hydrographic basin. A possible additional source of natural inflow is subsurface inflow from Antelope Valley which lies to the south. The magnitude of the subsurface component is estimated to be minimal. Currently no water is imported into the basin.

Much of the precipitation over the basin evaporates before flowing toward the valley floor. However, a certain percentage of the rain and snowfall does move across the ground surface as overland flow and ultimately ends up as channelized discharge in the several small drainages that dissect the mountain slopes. As this surface runoff flows toward and across the valley floor, a portion infiltrates into the ground and ultimately ends up as recharge to the ground water reservoir. Most recharge occurs in the coarse-grained deposits of the alluvial fans and valley floor, while a minor amount results from the deep percolation of water into joints and faults in the hard rock of the surrounding mountains.

Surface flow into the valley occurs sporadically. Most runoff is observed during frontal storms in the winter, snowmelt periods in early spring and the thunderstorms of middle and late summer. Because the small drainages within the valley only exhibit surface flow during part of the year, they are classified as ephemeral.

Outflow from the valley occurs through surface outflow to Red Rock Valley, evapotranspiration and subsurface outflow. The latter two of these components comprise the previously defined natural groundwater outflow. Most of the subsurface discharge flows to Red Rock Valley via the alluvium in the northwest corner of Bedell Flat. However, some possibility does exist for the trasnport of water through fractures in consolidated rock westward to Red Rock Valley or northwestward to Dry Valley.

The most current publication that includes estimates of Bedell Flat inflow and outflow is Report 43 of the Water Resources Reconnaissance Series entitled "Water Resources Appraisal of the Warm Springs - Lemmon Valley Area, Washoe County, Nevada". The study was prepared by F. Eugene Rush and Patrick A. Glancy of the U. S. Geological Survey (USGS) in November 1967. The report shows an estimated annual natural inflow of 1,100 acre feet and a natural outflaw of 250 acre feet in Bedell Flat. All of the inflow is attributed to recharge from precipitation and surface runoff. Of the natural outflow, approximately 200 acre feet is lost to subsurface outflow and about 30 to 50 acre feet leaves the basin through evapotranspiration. It is apparent that there is an imbalance of 900 acre feet between the estimates for inflow and outflow components. The actual amount of balanced flow under equilibrium conditions probably lies somewhere between these two values. In Report 43, the inflow-outflow value is estimated to be 700 acre feet.

As defined earlier, perennial yield is the amount of water that can be economically salvaged from a groundwater reservoir over the long term. In a basin where little or no subsurface outflow occurs, perennial yield is usually estimated to equal the balanced inflow-outflow value for that basin - i.e. the salvable yield is approximately equal to the recoverable natural outflow. In a basin such as Bedell Flat, however, in which substantial subsurface outflow occurs, the amount of salvable discharge is difficult to determine. In basins of this kind, an estimate must be made of the percent of subsurface outflow that can be beneficially retained. In Report 43, about half of the total Bedell Flat subsurface outflow, or 300 acre feet, is shown to be salvable. The USGS currently considers this value to also be the perennial yield.

In a recent feasibility study conducted by SEA Engineers for Red Rock Ranch, Ltd., an in-depth analysis was made of the groundwater yield in Bedell Flat. Research of a report entitled "Geology and Water Resources of Red Rock Ranch" was included. This study was conducted by George Maxey and others and was completed in August 1966. In the report, it is stated that "there is no appreciable loss of water from the basin (Bedell Flat) by subsurface interbasin flow". Based on this assessment and analyses of existing wells in the basin, SEA Engineers felt that the salvable portion of the subsurface outflow from the valley could be increased over that value given in Report 43. Consequently, a new estimate of perennial yield of 450-acre feet was given. For this report, this higher figure was felt to be much more reliable and is used herein as the perennial yield of Bedell Flat.

If a groundwater basin is pumped at a rate equal to its perennial yield, a transitional period occurs in which the basin slowly passes from a natural state to a new equilibrium condition. The amount of water pumped from the basin during that period is called transitional storage. In Report 43, the estimated transitional storage for Bedell Flat is 10,000 acre feet. If 450 acre feet is removed from Bedell Flat each year, the transitional storage will be completely depleted and a new equilibrium level will be reached in 44 years.

VI. EXISTING BEDELL FLAT WELL

In May through July of 1972, a water well was drilled and developed in Bedell Flat for Red Rock Ranch, Ltd. Drilling services were provided by Sage Brothers Drilling of Reno while engineering consultation and supervision of the well construction were administered by Keith Meador. The well was located in the NW1/4 of the NE1/4 of Section 9, Township 23 North, Range 19 East. Application Permit Number 26274 was filed to appropriate groundwater from this site.

A mud rotary drill rig was used to drill a 26-inch diameter hole. The formations encountered during drilling consisted mostly of fine-grained silty sands and sandy silts. The presence of silts at shallow depths suggested that subsurface flow at this site was semi-confined. The total well depth was 950 feet and bedrock was encountered at 944 feet. An electric log was run on the borehole. Using this information and the driller's log, Mr. Meador estimated that 550 vertical feet of water bearing and transmissive sand were available.

The existing well consisted of 950 feet of 16-inch casing, 616 feet of which contained 1/8-inch X 3-inch milled slot perforations. The full length of the borehole was gravel packed. A 30-inch conductor pipe was placed in the top 50-feet of the hole and a surface cement seal was constructed. The driller's well log, which describes some of the construction details, is included in Plate B-1, Appendix B, of this report.

Test pumping of the well and development was performed by the Wilson Pump Co. in July of 1972. Mr. Meador reported that drilling mud, silt and clay continued to be discharged from the well during the initial 12 hours of pumping. After this initial period, fine particles of biotite mica were observed in the pump discharge. Apparently, at the end of the test pumping period, the mica flakes were still in the well discharge samples.

The driller's log indicates that the well was pumped continuously at a rate of 700 gallons per minute (gpm) over a 20 hour period. Before pumping commenced the static water level was recorded at 49 feet below the ground surface. At the end of the 20 hour test the pumping level was 340 feet, which was approximately the same level as the pump bowls. Using the test data, the well's specific capacity after 20 hours of pumping was 2.41 gpm/ft.*

There is some evidence to indicate that the initial capacity of the well exceeded the 700 gpm rate used throughout the final pump test. From Keith Meador's reports, it appears that during well development, which consisted of pump surging and overpumping, the productivity of the well gradually decreased. Ultimately the highest achievable discharge rate was 700 gpm at the given level of the pump bowls. Mr. Meador attributed the reduced productivity to the interlocking of angular sand grains in the formations surrounding the gravel pack. There is, however, evidence to indicate that the reduced discharge may have been caused by the movement of fine-grained sands and silts into the voids within the gravel pack. Engineering reports by Mr. Meador which discuss test pumping and other aspects of well construction are included in Appendix F.

Water quality samples were collected during test pumping of the existing well. Results from chemical analyses performed by the State of Nevada Bureau of Laboratories and Research showed that this water passed all standards established by the Unites States Public Health Service (USPHS).

VII. SEQUENCE OF EVENTS AND WELL DESIGNATION

In late June of 1978, test drilling was begun to determine a location for a second groundwater source in Bedell Flat. Water Development Corporation of Woodland, California, provided a mud rotary drill rig for this phase of the project.

Test drilling took place at two separate sites for which permit applications to appropriate groundwater had previously been filed. The first test well site, under Permit 30274,

* For definitions of well testing terms, refer to Page 11.

was located in the south-central section of the valley floor. The second well location, under Permit Number 30275, was situated in the constricted portion of the valley floor closer to the northwest corner of Bedell Flat. The locations of both of these sites are shown in Figure 1.

The test borehole at the site of Permit 30274 was drilled to a total depth of 850 feet at which point bedrock was apparently encountered. Although some clean sands and silty-sands were encountered within the shallower formations, the predominant materials, particularly below the 400-foot depth, consisted of clays. An electric log (E-log), consisting of spontaneous potential, 16-inch normal and 64-inch normal resistivity curves, was run on the borehole. An additional E-log was also conducted in which single point resistivity and gamma ray emission were recorded. Based on the E-logs and the drill cuttings from the borehole, S E A Engineers felt that this site would not yield sufficient quantities of water. Thus, the decision was made to continue test drilling at alternative locations.

Test drilling at the site of Permit 30275 revealed an abundance of sands, interbedded with occasional layers of clay and clayey sands. Drilling of the borehole was stopped at a depth of 400 feet because the drill rig could not penetrate any further. It was not known whether bedrock started at this level or if boulders at the 400-foot depth were blocking the path of the drill bit. An E-log (single point resistivity, gamma ray) was once again run, which indicated the presence of about 160 vertical feet of water bearing sands. Because the cutting samples collected during the drilling process indicated that these sands were relatively clean, it was decided to drill a production water well at this site.

On July 20, 1978, the Water Development Corporation began drilling of a production well on the site of Permit 30275 with a reverse rotary drill rig. The rig was situated directly over the previously drilled test hole. A larger bit was used for the production well. At about the 30-foot depth the bit encountered boulders on the perimeter of the borehole and drilling was brought to a virtual standstill. Attempts were made to penetrate this hard rock barrier, but after three days of drilling, only an additional 30-feet of depth had been drilled. The decision was made to drill a production well at an alternative site a short distance from this location in hopes that the boulders could be avoided. The Water Development Corporation elected to use a larger drilling rig for the new site.

Before drilling commenced on the production well, a 36-hour pump test was conducted on the existing Bedell Flat well under Permit 26274. This was done by S E A Engineers at th request of Red Rock Ranch, Ltd., to determine any change in the capacity of the well since it was initially constructed and pumped. Testing of the well was completed on August 4th.

Drilling of the production water well recommenced on August 13th at a site about 150-feet to the northeast of the point of diversion for Permit 30275. No hard rock boulder problems were encountered and the well construction was completed by August 18th. Development and test pumping of this new well took place several days later.

This investigation involved a variety of projects ranging from test drilling to production well construction and testing. For the purposes of this report, the test boreholes and production wells have been labeled and will herein be referred to by the following designations:

LOCATION	LABEL	ABBREVIATION
Existing Well under Permit 26274	Bedell Flat Well No. 1	BF-1
Test Borehole under Permit 30274	Test Hole No. 1	TH-1
Test Borehole under Permit 30275	Test Hole No. 2	TH-2
New Well 150-feet from Test Borehole under Permit 30275	Bedell Flat Well No. 2	BF-2

VIII. EXPLORATORY DRILLING

As previously discussed, clays were generally quite abundant in Test Hole No. 1. Although relatively coarse sands were found in the first 200-feet of the borehole, the predominance of clay below this point indicated that the high water bearing aquifers at this site were limited. Between the 400-foot and 850-foot depths, subsurface formations consisted primarily of silty and sandy clays and the drilling rate was slow. A lithologic log of TH-1, as prepared by S E A Engineers is presented in Plate B-2 of Appendix B.

The lithologic log for Test Hole No. 2 is presented in Plate B-3 of Appendix B. As the log indicates, fine to coarse grained sands composed of granitic derivatives were the most predominant materials at this location. These relatively clean sands were interbedded with silty sand and clayey sand-sandy clay stringers.

Using the E-log and cutting samples collected from TH-2, S E A Engineers recommended that a production well be constructed on the site. Cutting samples were then analyzed in the laboratory for determination of proper well screen and gravel pack sizing. The resultant soil classifications for the sands sampled at selected depths are presented in Appendix C.

IX. CONSTRUCTION OF BEDELL FLAT WELL NO. 2

As previously discussed, Water Development Corporation was unable to drill through a boulder field at the TH-2 site. The boulders were thought to be associated with a drainage channel that once dissected an alluvial fan emanating from one of the adjacent mountain ranges. In the interest of avoiding further drilling problems, the site for the production well was moved 150-feet to the northeast of TH-1. This latter location then became known as Bedell Flat Well No. 2 or BF-2.

An 18-inch diameter hole was drilled at BF-2 to a depth of 400-feet. The formation samples collected during the drilling process showed that the materials encountered were very similar to those found at TH-2. However, clayey sands and sandy clays were observed to be more abundant at the production well site. The soils at this site showed that the aquifers contributing to the well were primarily of a confined to semi-confined nature. An E-log was not run on the well in the interest of minimizing costs and because the formations encountered correlated fairly well with those observed at TH-1. A lithologic log for BF-1, as prepared by S E A Engineers, is presented in Plate B-4 of Appendix B. The driller's report on the same well is presented in Plate B-5.

Using the log from BF-2 and the sand sample analyses developed for Test Hole No. 2, SEA Engineers recommended a screen opening size of .050 inches (50 slot) for the perforated sections of the well casing. The gravel was also sized to coordinate with the recommended screen size and the dominant aquifer materials.

The final well construction consisted of 400 feet of 12-inch diameter steel casing, 160-feet of which consisted of Johnson Irrigator Screen. A Monterrey sand gravel pack was placed in the annulus between the well casing and the borehole walls between the 400 and 50-foot depths. Two PVC gravel chutes, each 2-inches in diameter and 60-feet long were installed in the upper 60-feet of annulus and seated in 10-feet of gravel pack. A 50-foot cement sanitary seal was then constructed using grouting techniques. The levels of the well screens are indicated in the driller's well log in Plate B-5. A graphical description of the gravel pack gradation is shown in Plate C-6 of Appendix C.

X. WELL DEVELOPMENT AND TEST PUMPING

In the following text concerning the test pumping of the two Bedell Flat production wells, the following definitions apply:

Static Water Level - the depth from the ground surface to the water level in a well when it is not influenced by pumping.

Pumping Level - the level at which water stands in a well when pumping is in progress.

Drawdown - the difference between pumping level and static water level during pumping.

Residual Drawdown - the drawdown in a well as the water recovers after pumping has been stopped.

Specific Capacity - the instantaneous rate of yield of a well per unit of drawdown, in gallons per minute per foot (gpm/ft).

Transmissivity, T - the rate at which water will flow through a vertical strip of aquifer one foot wide and extending through the full saturated thickness of the aquifer, under a hydraulic gradient of 1.00. T is measured in gallons per day per foot (gpd/ft).

Storage Coefficient, S - the volume of water released from storage in an aquifer, per unit of surface area of the aquifer per unit change in hydraulic head. S is dimensionless.

Production Pump Test - a test of the yield of a well in which drawdown is recorded at several different pump rates.

Recovery Data Test - a test in which residual drawdown is recorded after pumping has stopped.

Bedell Flat Well No. 1

Prior to the test pumping of BF-1, some well development procedures were applied to the well. The development phase lasted for approximately four (4) hours and consisted of surging and overpumping. During this period, fine-grained sands and biotite mica were brought to the surface until the discharge was relatively clear.

On August 1st, a short production test was conducted on BF-1. Flow was measured with an 8-inch discharge pipe combined with a 4-inch and 5-7/8 inch orifice. Before pumping was started static water level was recorded at 53.2 feet below ground surface. The results of the production test are given in Table 1.

TABLE 1

Production Pump Test Data - Bedell Flat Well No. 1

Discharge (gpm)	Time Since Start of Pumping (Hours)	Drawdown (Feet)
180	1	90.4
285	2.1	124.3
440	3.4	169.6
690	5.7	295.1

On the day following the production test a 36-hour constant discharge pump test was begun. The discharge rate was 385 gpm. Because the water in the casing had not quite recovered to its natural level, the static water level was recorded at 53.9 feet below ground surface. No existing wells in Bedell Flat were located close enough to the pumping site for observation well data to be taken.

A semilogarithmic graph of drawdown vs. time for the pumping well is presented in Plate D-1, Appendix D. Applying the modified Theis non-equilibrium formula (i.e. Jacob's straight line solution) to this data, a transmissivity, T, of 3,000 gpd/ft was computed for BF-1. The graphical plot of drawdown vs. time after the initial eight (8) hours of pumping indicated that an impervious boundary may have been influencing the well yield. Biotite mica was still found in the discharge at the end of the test.

Well recovery data was collected over a 19 hour period after pumping stopped. The water level had recovered to within nine (9) feet of static water level in this time span, suggesting that recovery rates were moderately slow. A graph of residual drawdown vs. time is presented in Plate D-2. From this recovery data, transmissivity is computed to be 2,800 gpd/ft. This value is very close to the T derived from pumping drawdown information.

From pumping and recovery data, an average transmissivity, T, of 3,000 gpd/ft. can be assumed for BF-1. It is debatable, however, that this average value truly represents the aquifers contributing to the well. Based on Mr. Meador's reports in 1972, it is likely that the efficiency of the well and gravel pack was reduced during earlier pump tests. If this was the case, the T computed from this pump test is representative of the materials lying close to the well casing and not indicative of actual aquifer transmissivities.

Bedell Flat Well No. 2

Well development began on the newly constructed well (BF-2) on August 23rd. The well was surged and overpumped over a time span of three days. At the end of this period well discharge was free of sand except during the first few minutes after surging. The sand brought to the surface was very fine-grained.

A production pump test was administered on BF-2 on August 26th. Before pumping, the water level was recorded at 87.6 feet below ground surface. This level was considerably below the actual static water level which was logged at about the 63 foot depth prior to well development. Apparently, the recovery of groundwater levels at this site was very slow. In an attempt to avoid further delays the static water level was assumed to be at the 87.6 foot depth and all drawdowns were determined relative to this level. The production test data are given in Table 2.

TABLE 2

Production Pump Test Data - Bedell Flat Well No. 2

Discharge (gpm)	Time Since Start of Pumping (Hours)	Drawdown (Feet)
200	1.2	44.9
300	3.6	76.2
450	5.8	122.3

A 36 hour pump test was started on BF-2 on the day following the production test. As with the previous day, the water level had not fully recovered in the well. When the test began the water level was located 83.4 feet below ground surface. This was assumed to be static water level for all drawdown determinations in the 36 hour test. The constant flow rate was 300 gpm.

After 24 hours of pumping, discharge from BF-2 was free of nearly all sand and biotite mica, indicating that the Monterrey sand pack was successfully screening out fine-grained materials. At the end of the 36 hour test, the pumping level was 198 feet below ground surface.

The semilogarithmic graph of drawdown information during the 36-hours of pumping on BF-2 is given in Plate D-3. From this data the well's transmissivity was found to be 4200 gpd/ft. As with BF-1, impervious boundary effects appeared to influence the drawdown curve after eight (8) hours of pumping.

Recovery in BF-2 was very slow. The best possible explanation for this phenomenan was the relatively small transmissivity of the aquifers contributing to the well. The presence of clay in many of the sandy formations tapped by this well help to support this reasoning. Little or no evidence could be found for the possibility of reduced efficiency of the well casing and the surrounding gravel pack due to overpumping, etc. Reorientation of aquifer sand grains and influx of fine-grained materials into the matrix of the gravel pack probably did not occur because of the following factors:

1. No change in the specific capacity of the well was observed between the development stage and the test pumping phase of the project.

2. The gravel pack was designed to shield out most aquifer soils.

3. At the flow rates used for test pumping, the velocity of incoming water to the well should not have been sufficient enough to cause reorientation of aquifer formation sand grains.

The water level recovery graph is given in Plate D-4. Analysis of the recovery curve shows an aquifer transmissivity of 3800 gpd/ft for BF-2.

From the pumping drawdown graph and the recovery curve, a mean transmissivity, T, of 4000 gpd/ft can be assumed for BF-2. This value is quite low compared to the magnitudes of T normally found in wells used for community water supplies. The abundance of clays found in the sandy formations at this site offers the best explanation for the low transmissivity.

The following general conclusions can be reached from a brief analysis and comparison of test pumping results on BF-1 and BF-2:

1. The specific capacity of BF-2 is 1.3 to 2 times larger than the specific capacity of BF-1 for similar pump rates and pumping durations.

2. The average transmissivity of the aquifer formations tapped by BF-2 is 4,000 gpd/ft.

3. The average transmissivity observed in BF-1 is 3,000 gpd/ft. This T may actually reflect the transmissive qualities of the gravel pack and the soil materials within five (5) feet of the well casing. Aquifer transmissivities for BF-1 may actually be larger than 3,000 gpd/ft.

4. The T values for BF-1 and BF-2 are quite low for wells used for community water supplies.

5. Recovery of water levels in BF-1 is moderately slow. Recovery in BF-2 is very slow.

6. At the end of test pumping discharge from BF-1 contained biotite mica flakes while BF-2 was essentially free of mica particles.

XI. PROPOSED WELL USE

Under ultimate development, the two Bedell Flat wells will be connected to a pipeline which will convey water to a storage tank in the Red Rock Ranch area. From the valley floor of Bedell Flat, the anticipated vertical lift of the water system will be 500 to 600 feet. Because it is possible that pumping levels in the wells may approach 300 feet, the total vertical lift may be as much as 900 feet.

As previously discussed, the perennial yield of Bedell Flat is 450 acre feet. Under the assumption that this amount of water were pumped from the basin each year by Red Rock Ranch, Ltd., an average of 1.23 acre feet would be taken from the ground water system each day. If the wells were pumped 24 hours of each day to meet this demand, the pump rate would be 278 gpm. Under practical operating conditions, however, it is probable that pumping would occur only during part of each day. During non-pumping hours, the groundwater system would be allowed to recover. If, for instance, pumping occured 16 hours of each day, the average discharge rate would be 417 gpm.

Of the two Bedell Flat wells, BF-2 would be the most dependable water supply for Red Rock Ranch. Despite the lower transmissivity and specific capacity of ~~BF-2~~ BF-1, the greater depth of this well (950 feet) makes it more adaptable for meeting anticipated pumping demands. With proper selection of pump bowl levels, daily discharge rates of 400 gpm could be met continually. In contrast, the relatively shallow depth (400 feet) and slow recovery of BF-2 may limit this well's ability to meet 400 gpm pump rates each day of the year. For this reason, BF-2 would best serve as a backup water supply when BF-1 is out of service or unable to meet project demands.

An alternative well pumping system would be to use both well simultaneously. Under this operating condition, project demands could be met easily with each well being pumped at about 200 gpm during part of each day. The use of such a system would depend on further study of pertinent factors such as pumping and well maintenance costs.

XII. EFFECT ON REGIONAL WATER LEVELS

Using a mean transmissivity of 4,000 gpd/ft, an assumed storage coefficient of 0.005 and a pump rate of 400 gpm, the drawdown effects at selected distances from a pumping well in Bedell Flat were computed. Durations of 0.67, 1, 2 and 5 days were looked at. The Theis non-equilibrium formula was applied for drawdown calculations. The results of this analysis are shown in Table 3.

The two wells in Bedell Flat are estimated to lie about 3800 feet from each other. Of the other existing wells in Bedell Flat, none is known to lie within one mile of either BF-1 or

BF-2. Based on this information and the data presented in Table 3, the pumping of either of the two wells is not expected to seriously affect water levels at any of the neighboring well sites.

TABLE 3

Drawdown vs. Distance for Selected Pumping Durations

And a Discharge of 400 GPM

Discharge Rate (gpm)	Pumping Duration (days)	Distance From Well (feet)	Drawdown Influence (feet)
400	0.67	1,000	0.1
400	0.67	3,800	0
400	1	1,000	0.4
400	1	3,800	0
400	2	1,000	1.8
400	2	3,800	0
400	5	1,000	6.8
400	5	3,800	<0.1

XIII. WATER QUALITY

Water quality samples were collected during the test pumping of both wells. The temperature of the water in each well was about 61°F and water chemistries showed that quality was good. Copies of the mineral analyses for each well are presented in Appendix E.

XIV. RECOMMENDATIONS

Based on the construction and test pumping of the two Bedell Flat wells, S E A Engineers recommends that Well No. 1 be used as the primary water source for the Red Rock Ranch area. Under this operation, Bedell Flat Well No. 2 would be used as a backup or alternative supply.

Pump bowls and intakes should be installed at depths sufficient to meet a constant pumping demand of 400 gpm over a 16 hour period. A pump intake depth of 400 feet is suggested for BF-1. This action would compensate for possible reductions in well efficiency that may occur over the long term. The recommended pump intake depth for BF-2 is 350 feet.

Because pumping levels will undoubtedly draw below perforated and screened casing levels, air entrainment from cascading water may result. Although test pumping showed that air entrainment is a remote possibility in Bedell Flat, such a problem may be observed after several years of pump operation. To avoid any difficulties of this type, the installation of occurrence of Pre-Lake Lahontan deposits (Quaternary and Tertiary, less than 5.3 mya) and recent Quaternary alluvium (1.8 mya to present). The older alluvium is present at land surface in the southern part of the basin and along the lower flanks of Dogskin Mountain, while the younger alluvium occupies the lower altitude part of the valley floor (Bonham, 1969).

Using gravimetric and seismic-refraction geophysical methods, Berger and others (2001) defined an elongated north-south structural depression in the granitic bedrock beneath the center of the basin (Figure 3). The thickness of alluvium in the depression is estimated at 2,500 feet. Depths to bedrock encountered by wells near the southern edge of the basin are in good agreement with the depths to bedrock interpreted using the geophysical methods, however, the depth to bedrock predicted in the northwestern most part of the basin is shallower than actually reported for well BF-2 (Arden and Peterson, 1978). Well BF-2 and exploration borehole TH-2 encountered alluvium to 402 feet in depth, with probable volcanic bedrock at 402 feet. Depth to granitic bedrock at the location of BF-2 and TH-2 is predicted by Berger and others (2001) as less than 250 feet (Figure 3). Well BF-1, which encountered bedrock at 944 feet in depth, was used as a control point for the geophysical interpretations. A little over one mile southeast of well BF-2, exploration borehole TH-1 encountered 850 feet of alluvium, which is in good agreement with Berger and others (2001) predicted depth to bedrock between 750 to 1,000 feet.

Northwest trending faults are present along the base of Dogskin Mountain and across the northwest part of the valley floor (Figure 5). These faults are part of the Walker Lane Shear Zone system. Well BF-2 is located very close to three fault traces mapped by Bonham (1969), and well BF-1 is in the projected alignment of the these faults. Pumping tests in both BF-1 and BF-2 indicated a negative (low permeability) boundary effect influencing well yield, which most probably was the result of these faults being partial barriers to ground water flow to the wells.

In the northern end of Dogskin Mountain, uranium mineral deposits were discovered in the 1950s at the base of the Hartford Hill Rhyolite in a unit of carbonaceous to lignitic shale and sandstone (Bonham, 1969). This deposit is called the Red Rock Canyon prospect by Bonham (1969). While the prospects are located high up on the Dogskin mountain block, their presence points to a need to test for radioactivity in ground water developed from the northwestern-most part of the basin.

Precipitation

Precipitation in the form of rain and snow falling on the basin is the source of all known ~~ground water~~ and the occasion presence of surface water in the basin. Most of the precipitation occurs in the winter months, with greater amounts expected to fall on the higher altitude mountain blocks surrounding the valley floor. Bedell Flat is semi-arid in climate being subject to the rain shadow effect east of the Sierra Nevada Mountains.

Most of the precipitation is consumed by evaporation and plant transpiration processes. However, a portion results in surface water runoff to the valley floor, and in rare occasions produces surface water flows which drain out of the valley into Red Rock Valley. Another small portion of the precipitation results in infiltration through soils, past the root zone of plants, and down to the ground water aquifer(s). Studies throughout the Great Basin show that the precipitation that recharges ground water systems is typically 3 to 7 percent of the total precipitation falling on the basin (Rush and Glancy, 1967).

George Hardman, and others, produced a state-wide precipitation map for Nevada in 1936, which was subsequently reproduced by Hardman in 1965. The precipitation map defined regions receiving ranges of precipitation, as shown in Figure 6 for Bedell Flat. Most of the valley is estimated by Hardman (1965) to receive 8 to 12 inches of average annual precipitation. Using the Hardman (1965) map, Rush and Glancy (1967) estimated the average annual precipitation falling on the basin to be 28,000 acre-feet.

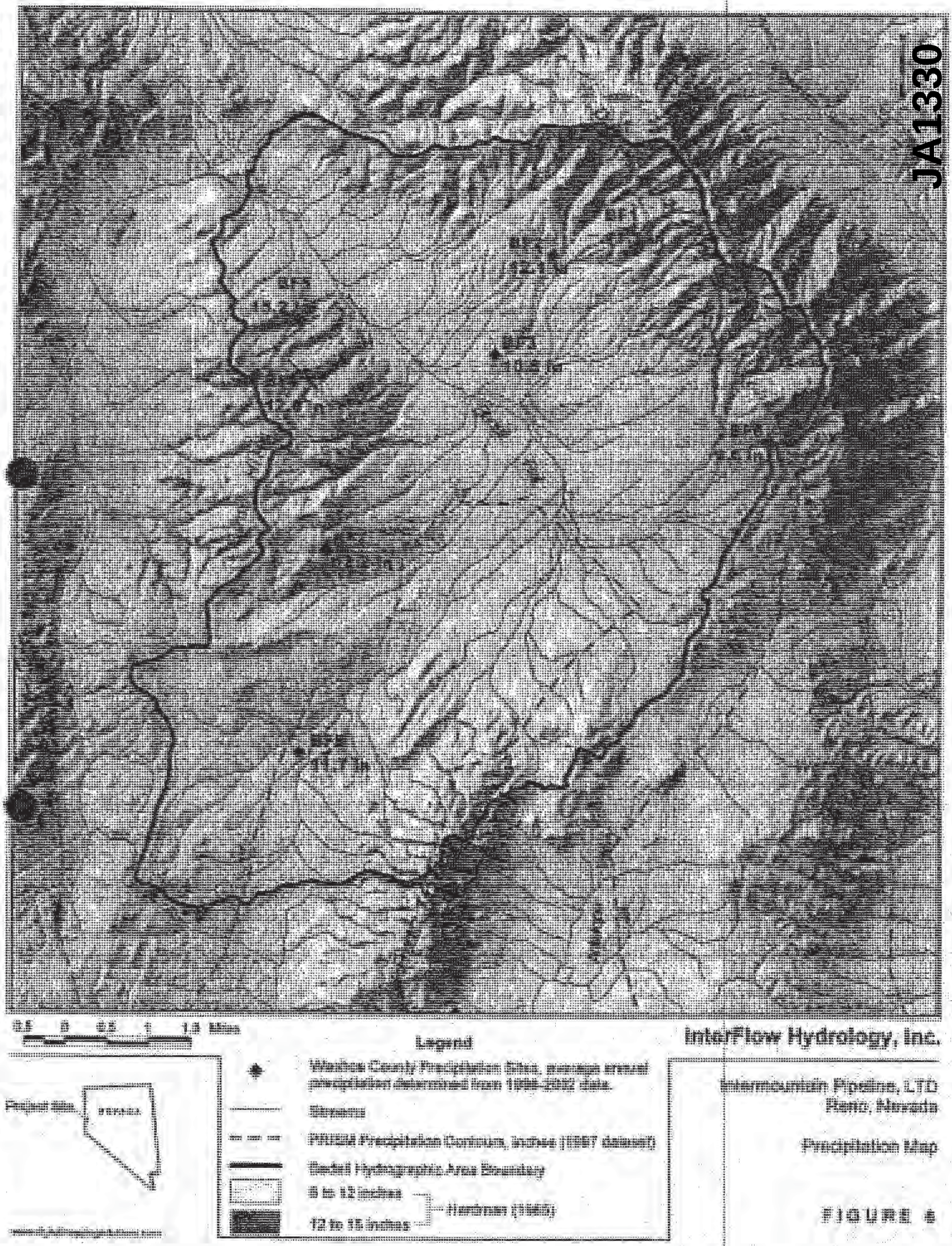
In 1994, Daly, and others, published a method of mapping regional average annual precipitation in mountainous regions, which is referred to as the PRISM map. This statistical method uses 30-year precipitation records, topography, and other meteorological variables. The PRISM map (1967 to 1997 dataset) was published by the Natural Resource Conservation Service (1998) for the state of Nevada defined by 2-inch precipitation contours. The portion of the 1997 dataset PRISM map for the Bedell Flat is shown as Figure 6, and predicts higher quantities of precipitation for Bedell Flat versus the Hardman (1965) map. Average annual precipitation ranges from 14 to 18 inches over much of Bedell Flat, with total average annual precipitation over the basin of approximately 46,000 acre-feet, based on the PRISM map.

Washoe County Department of Water Resources installed 8 precipitation stations in Bedell Flat in the fall of 1999. The approximate locations of these stations are shown on Figure 6 and their characteristics are listed in Table 3. Although data collection is still on-going, the apparent average annual precipitation quantities, normalized to percent average precipitation from the Reno station (65 years of record at the airport) are presented as follows.

Table 3 – Summary of Precipitation Measured by WCDWR in Bedell Flat (1999-2003)

WCDWR Station No.	Approx. Ground Elevation (ft above msl)	Precipitation measured from 12/23/99 to 12/14/00 (inches)	Precipitation Quantity divided by percent average at Reno Station (76.34%)	Precipitation measured from 3/18/01 to 3/2/02 (inches)	Precipitation Quantity divided by percent average at Reno Station (60.96%)	Precipitation measured from 9/30/01 to 10/06/02 (inches)	Precipitation Quantity divided by percent average at Reno Station (88.44%)	Estimated Average Annual Precipitation (inches)
BF-1	6070	10.20	13.4	6.72	11.0	8.52	9.6	11.3
BF-2	5377	11.16	14.6	7.20	11.8	8.76	9.9	12.1
BF-3	5016	10.08	13.2	6.12	10.0	8.16	9.2	10.8
BF-4	5770	9.96	13.0	8.64	14.2	9.48	10.7	12.6
BF-5	5206	11.04	14.5	9.72	15.9	–	–	15.2
BF-6	5721	8.28	10.8	6.72	11.0	6.24	7.1	9.6
BF-7	5853	9.60	12.6	7.56	12.4	10.20	11.5	12.2
BF-8	5480	10.2	13.4	6.84	11.2	9.24	10.4	11.7

Note: Average of all 8 stations over the 3-year period is 11.94 inches



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Precipitation Map

FIGURE 6

All three years of WCDWR precipitation data collection in Bedell Flat have been during below average precipitation conditions in southern Washoe County, as recorded at the Reno-Tahoe International Airport. Additional years of record will be required to more accurately arrive at average annual precipitation quantities; however, it is apparent from the precipitation data collected to date that the PRISM map (1997 dataset) is likely over estimating precipitation quantities, while the Hardman (1965) maps appears to be slightly underestimating precipitation quantities. Based on the available data, the average annual precipitation falling on the Bedell Flat basin is calculated to be approximately 32,000 af/yr (average precipitation of 11.9 inches over the 51 square mile area).

Ground Water Recharge

Maxey-Eakin Technique

Maxey, and others (1966), estimated the annual ground water recharge to Bedell Flat to be 990 af/yr, using a technique that Maxey helped develop in the late 1940s and early 1950s (Maxey and Eakin, 1949, and Eakin, and others, 1951). The well known Maxey-Eakin method was used by Rush and Glancy (1967) resulting in an estimate of 1,100 af/yr of recharge to Bedell Flat. The Maxey-Eakin Method relies upon precipitation zones defined by Hardman (1965), which are assumed by Rush and Glancy (1967) to correlate directly with altitude zones. The altitude zone 5,000 to 6,000 feet is estimated by Maxey, and others, (1966) to be 26,029 acres, while Rush and Glancy estimated the area for the same altitude zone to be 26,000 acres. The area above 6,000 feet altitude is estimated by Rush and Glancy to be 5,460 acres, while Maxey, and others, (1966) listed only 1,472 acres. It appears from George Maxey's computation table (Maxey, and others, 1966, p. 18) that the area between 6,000 to 6,600 feet is omitted, as the altitude zones jump from "5000 to 6000" feet to "Above 6,600" feet. Maxey had noted earlier in this work that the Hardman (1965) precipitation zone of 12 to 15 inches locally corresponds to altitude zones over 6,600 feet. Thus, the calculation made by Maxey, and others, (1966) appears to have omitted the precipitation (and subsequently the recharge) occurring between 6,000 to 6,600 feet in altitude, explaining the 110 acre-foot difference between the two Maxey-Eakin calculations.

Chloride-Balance Technique

As an independent calculation of recharge to Bedell Flat, the chloride-balance method has been employed. The technique, as explained by Dettinger (1989) uses the chloride concentration in precipitation compared to that of the ground water to arrive at an estimate of ground water recharge to the basin. There are several principal criteria which need to be met in order for this technique to produce valid results, including:

1. The chloride ion behaves as a conservative tracer with no sources or sinks of chloride in the system,
2. Surface water runoff out of the basin does not constitute a major loss of chloride in the system,

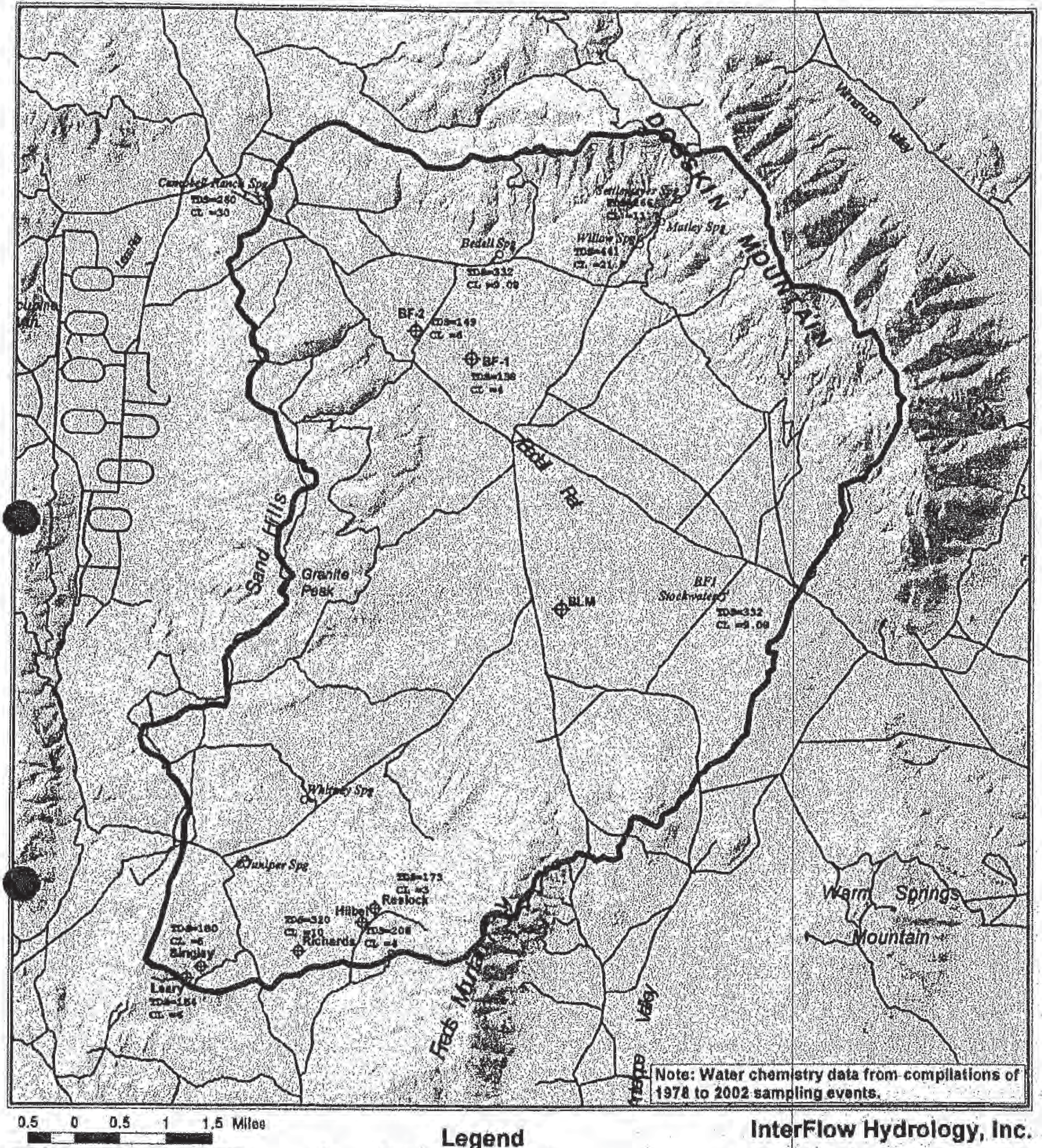
3. Subsurface or surface water inflow to the basin is not present, or is insignificant, or can be an accounted for as a chloride addition,
4. Chloride concentration data are available for the basin up-gradient of any influence of salt concentration by evapotranspiration, agricultural return flow, wastewater return flow, and beyond the solute dispersion effects of these sources of chloride.

Bedell Flat appears to be ideally suited for this method. There are no major areas of evapotranspiration on the valley floor, and no known major sources of chloride such as pre-historic lacustrian deposits (Lake Lahontan) nor any significant presence of septic system leach fields or agricultural return flow. There is no significant surface or subsurface water inflow to the basin, and relatively minor surface water flow out of the basin. And finally, a relatively significant number of chloride measurements have been made from ground water and springs broadly distributed over the basin (see Figure 7).

While the chloride concentration of precipitation in Bedell Flat has not been measured, Berger, and others (1997), determined the average chloride content of 24 samples collected at five precipitation stations in Spanish Springs Valley, 10 miles to the southeast, to be 0.38 milligrams per liter (mg/L). This value of chloride content in precipitation is comparable to observations of Dettinger (1989) elsewhere in Nevada, in which an average chloride concentration of 0.4 mg/L was derived from precipitation data from 74 sites. Average chloride content of 7 ground water samples and 3 springs within Bedell Flat is 8.04 mg/L (samples collected by various individuals over a 25-year time span, all analyses performed by the Nevada State Health Laboratory). Feth (1981) noted that where ground water contains less than 10 mg/L chloride content, no significant additional chloride sources other than atmospheric sources have likely influenced the ground water chloride content, further supporting acceptable application of the chloride-balance technique in Bedell Flat. The proportion of chloride in ground water to chloride in precipitation indicates 4.7 percent of the precipitation recharges the basin. Multiplying this factor times the average annual precipitation falling on the basin of 32,000 acre-feet, results in a recharge estimate of 1,510 af/yr.

PRISM Method

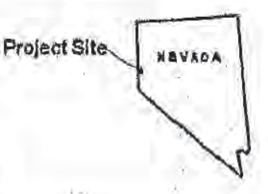
Nichols (2000) and Berger (2000) developed and applied recharge coefficients for the recently published PRISM map (1997 dataset) for basins predominantly located in northern and central Nevada. Application of the recharge coefficients outside the specific basins evaluated by Nichols and Berger is uncertain and problematic. It has been observed in southern Washoe County that the application of the Nichols coefficients produces several times greater recharge than the traditional Maxey-Eakin method (6.1 times greater in an eastern portion of Lemmon Valley (Smith and Smith, 2001) and 4.6 times greater in Dry Valley (Smith and Katzer, 2000). Most of Bedell Flat is within the 14 to 16 inch precipitation zone defined by PRISM, and applying the recharge factors developed by Nichols and Berger results in an estimated recharge of approximately 6,000 af/yr; a factor of 5.5 times greater than the Maxey-Eakin method. This is in part due to higher predicted precipitation in Bedell Flat using the PRISM versus Hardman map.



Legend

♂	Springs
⊕	Domestic Wells (locations approximate)
━━	Bedell Hydrographic Area Boundary, State
——	Roads and Trails
TDS	Total Dissolved Solids (mg/L)
CL	Chloride Concentration (mg/L)

Elevation background with shaded relief.



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Water Chemistry

FIGURE 7

However, it is currently felt that direct application of the coefficients developed by Nichols and Berger to basins in southern Washoe County tends to over estimate the quantity of recharge.

Summary of Estimated Ground Water Recharge

In summary, the average annual recharge to Bedell Flat is estimated to be in the range of 1,100 af/yr to 1,510 af/yr, based on the Maxey-Eakin and chloride-balance techniques. The fact that these two methods produce estimates of a similar magnitude lends some confidence in the numbers, even though both methods have commonality in the precipitation estimate. The best available estimate of annual recharge to Bedell Flat is 1,300 af/yr; the average of the two methods.

Depths to Ground Water and Movement

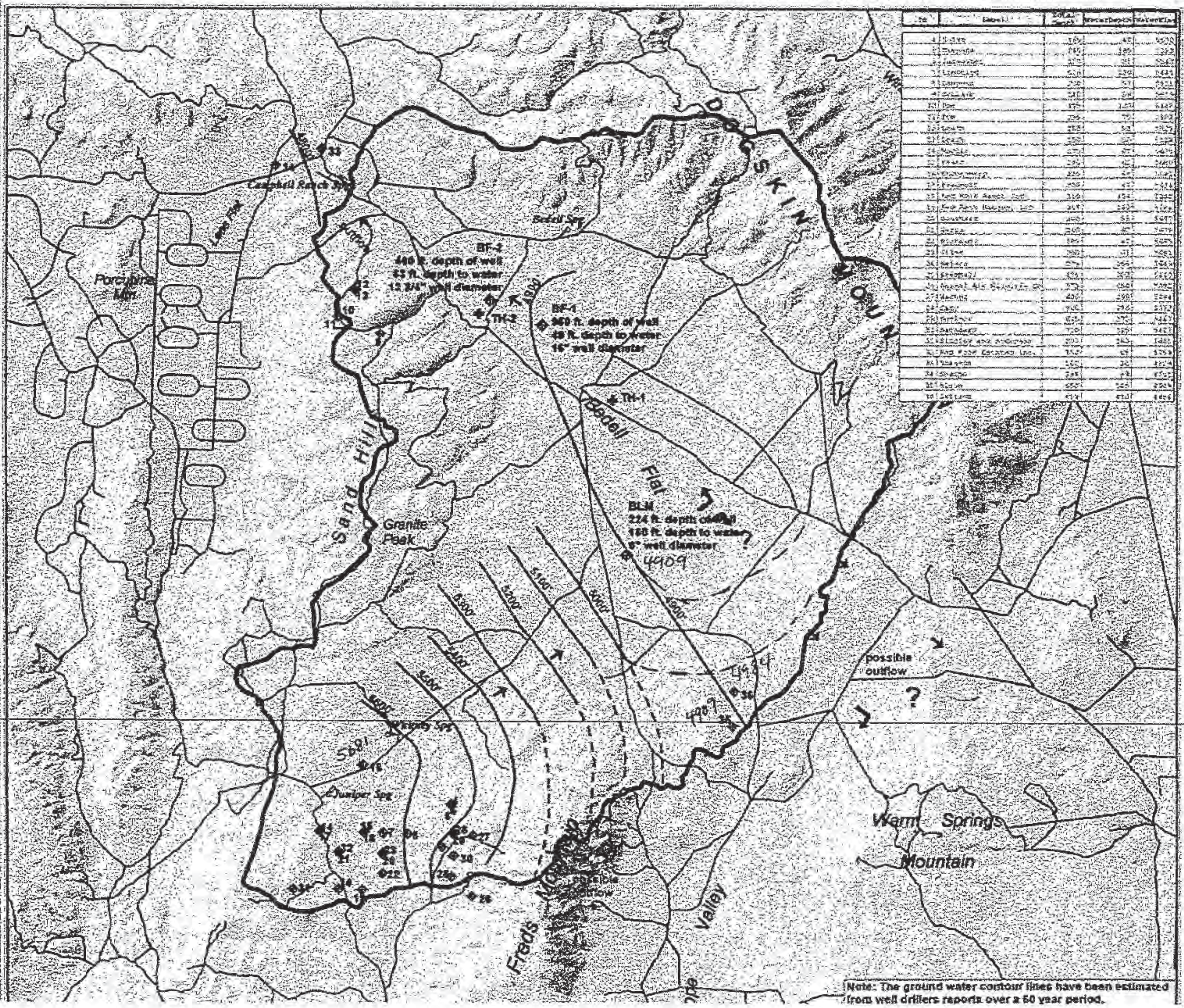
Ground water in Bedell Flat ranges from 180 feet in depth in the central part of the basin to near ground surface at the northwest edge of the basin (Table 2). Available water level measurement points define a northern flow gradient in the south half of the basin, with water level elevations from 5,600 to 5,000 feet above msl. A northwestern flow gradient exists in the northwestern arm of the basin as defined by wells BF-1 and BF-2 with water level elevations of approximately 4,900 feet above msl (see Figure 8). Water level elevations near the Campbell Ranch located just down-gradient of the northwestern edge of the basin are approximately 4,800 feet above msl, indicating subsurface outflow from Bedell Flat to Red Rock Valley.

No wells are known to exist in the northeastern part of the basin, and directions of flow along the eastern parts of the basin are uncertain. It is possible that an eastward gradient exists, resulting in ground water discharge to Warm Springs Valley and/or Antelope Valley. Water level elevations in Warm Springs Valley near the geothermal springs (located 3 miles to the east of Bedell Flat) are approximately 4,230 feet above msl (Katzer, 1997), which is over 600 feet lower in elevation than water levels in the center of Bedell Flat. A low altitude and moderately defined topographic divide exists between these two hydrographic basins. Likewise, water levels in the northern part of Antelope Valley, as determined from domestic well logs in Section 11, T22N, R19E, range from elevations of 4,700 to 5,000 feet above msl. Some subsurface flow through the hills dividing Antelope Valley from Bedell Flat is also possible.

Ground Water Discharge

Evapotranspiration and Springs

Ground water discharge in Bedell Flat occurs primarily via subsurface outflow. A small amount (30 af/yr) is estimate by Rush and Glancy (1967) to discharge via evapotranspiration in the northwestern most part of the basin, where the depth to ground water becomes shallow. Springs also discharge a small quantity of ground water. Maxey, and others (1966), measured a 0.5 gpm flow from Bedell Spring, 4.25 gpm from



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Project Site

0.5 0 0.5 1 1.5 Miles

Legend

- Springs
- Wells
- Bedell Hydrographic Area Bdy, State
- Roads and Trails
- Water Level Contour, inferred
- Water Level Contour
- Flow path

Well Locations and
Ground Water Contour Map

FIGURE 8

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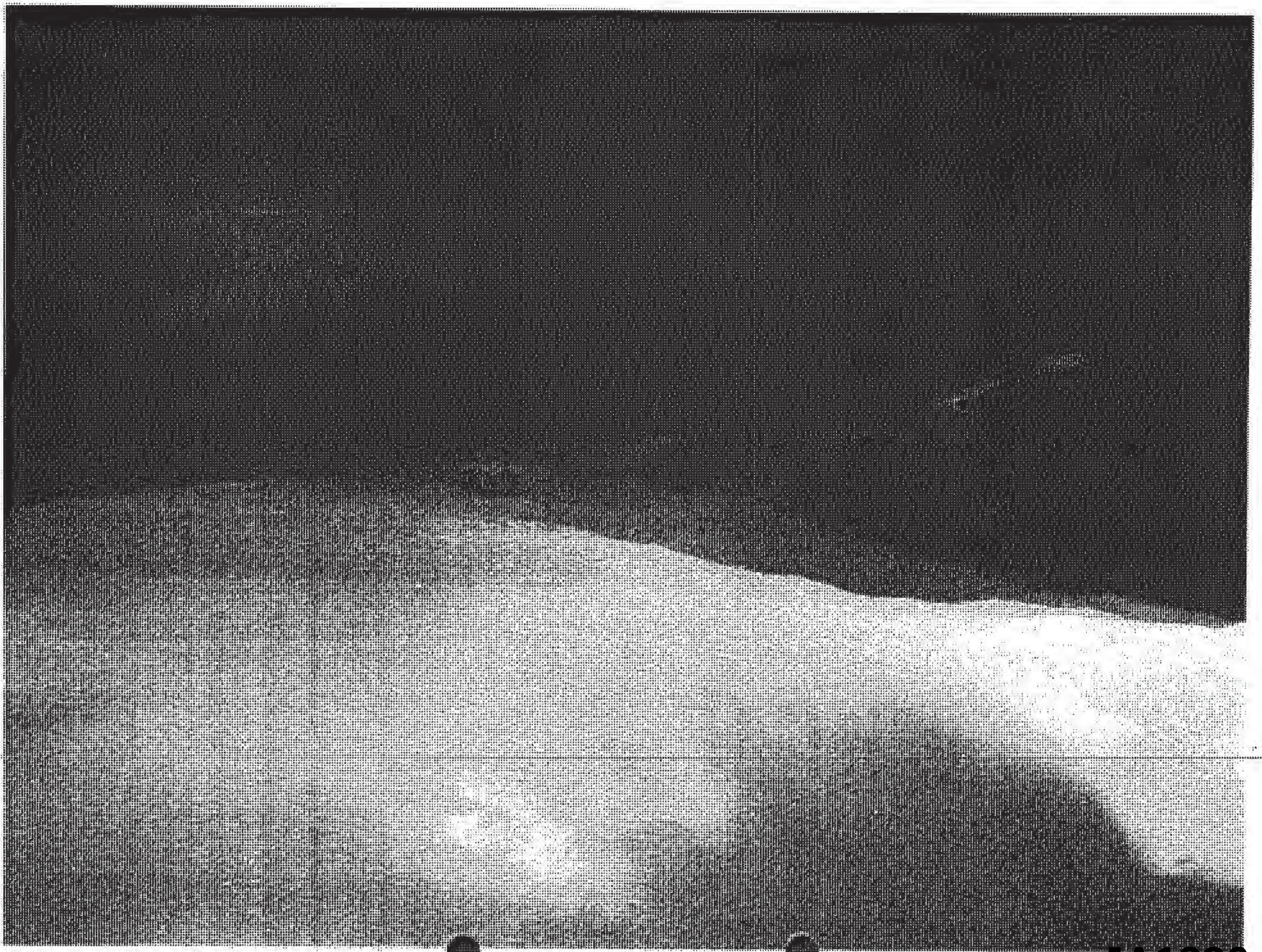

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Whitney Spring, 1.0 gpm from Juniper Spring, 0.15 gpm from Bird Spring, and 17.5 gpm from the down-gradient Campbell Ranch Spring (outside basin boundary). All total, spring discharge in Bedell Flat probably does not exceed 25 af/yr. The Campbell Ranch spring (Figure 4) accounts for another 30 af/yr, assuming all discharge is derived from the Bedell Flat basin.

Domestic and Livestock Wells

Pumping for domestic uses occurs in the southern part of the basin at developed parcels along Red Rock Road. Approximately 50 well logs are in the NDWR database for southern part of Bedell Flat, with approximately 33 well logs being confirmed based on physical addresses on the driller's logs. Landscaping is observed to be minimal for most residences in the vicinity, and house sizes are moderate. We suspect that average residential domestic well pumping does not exceed 1 af/yr per residence, and more realistically is probably in the range of 0.5 to 0.75 af/yr. Because wastewater from the residences is returned to the ground via individual septic systems, about half the water pumped from the domestic wells is actually consumed. Based on these numbers, it is estimated residential water consumption in Bedell Flat is currently in the range of 15 to 20 af/yr and probably does not exceed 30 af/yr. With approximately 140 private parcels located within Bedell Flat in the vicinity of Red Rock Road, the future ground water consumption by domestic uses is predicted to increase to perhaps 70 af/yr, and certainly not greater than 100 af/yr.

Pumping for livestock watering also occurs at the BLM well in the center of the basin. The well does not appear to be used extensively at present; however, water rights are for a duty not to exceed 22.4 af/yr.

Subsurface Outflow to Red Rock Valley

Subsurface outflow to Red Rock Valley in the northwest corner of the basin can be estimated using Darcy's Law, based on data from wells BF-1 and BF-2, and geologic interpretations of Berger and others (2001). The basic form of Darcy's Law used to calculate outflow is Q=KIA, where the flow (Q) is equal to the hydraulic conductivity (K) times the gradient (I) and the cross-sectional saturated area (A).

The gradient (I) was estimated between wells BF-1 and BF-2 to be 0.005 percent. Ground surface elevations and latitude-longitude coordinates were surveyed by Tri State Surveying, and a water level measurement was made in well BF-1. However, well BF-2 is currently plugged by debris, so the static water level reported in the well completion report (Arden and Peterson, 1978) was used to calculate the gradient between the wells.

The cross-sectional area (A) was estimated assuming a depth to bedrock of 670 feet at a midway point between wells BF-1 and BF-2 (saturated thickness of 600 feet). Bedrock was encountered at 944 feet at BF-1 and was questionably encountered at 402 feet in BF-2 (Appendix A). The cross-sectional saturated area at the midway point between these wells was estimated at approximately 2 million square feet, based on a bedrock profile constructed using Berger, and others (2001).

The hydraulic conductivity (K) was determined using the transmissivity (T) data from wells BF-1 and BF-2, applying the relationship T=Kb, where b is the saturated thickness. Aquifer tests (pumping tests) were conducted at both wells BF-1 and BF-2 in 1978 (Arden and Peterson, 1978). The coefficient of transmissivity was determined using the Cooper-Jacob straight-line method on both pumping and recovery water level data, resulting in estimates of 3,000 gpd/ft at BF-1 and 4,000 gpd/ft at BF-2 (Appendix A). Potential reduced well efficiency due to well and gravel pack plugging was expressed by Arden and Peterson (1978), based on reports of loss in well efficiency during initial development and pumping in 1972. The transmissivity for well BF-1 may be artificially low as compared to the aquifer.

Arriving at hydraulic aquifer characteristics from pumping tests is not an exact science. The equations used are theoretically derived and include simplifying assumptions. In calculating the transmissivity, the theoretical equations assume that a well fully penetrates the aquifer. While both these wells BF-1 and BF-2 are believed to be constructed down to bedrock, but the full thickness of the aquifer is not screened. The hydraulic flow paths take a more circuitous (distorted) pathway into the well, resulting in additional drawdown over what is predicted using a radial flow equation (Cooper-Jacob, Theis, and others). The effects of partial penetration become minor at a substantial radial distance from the well; however, in the case of BF-1 and BF-2 aquifer tests, data have only been collected from only the pumping well as no nearby observation wells are available. Effects of partial penetration of wells BF-1 and BF-2 therefore needs to be considered, and has some bearing on the calculation of the coefficient of transmissivity. Sixty-nine (69) percent of the aquifer is screened in well BF-1 and 47 percent in BF-2. Using Figures 9.11 and 9.12 in Driscoll (1986, see pages 217 and 250), approximate corrections from true to observed transmissivity are 80 percent of actual transmissivity for BF-1 and 73 percent for BF-2. For reference, Neuman (1974) discusses this issue partial penetration for unconfined aquifers in greater detail.

The aquifer materials encountered at wells BF-1 and BF-2 indicate the aquifer is unconfined in the northwestern part of the valley (Appendix A). This has potential ramifications to calculating the transmissivity using the Cooper-Jacob straight-line method, which was originally developed for confined aquifers. However, predictions are nearly correct as long as the drawdown is small in comparison with the saturated thickness (Freeze and Cherry, 1979). Drawdown in well BF-1 was 19 percent of the saturated thickness and drawdown in well BF-2 was 34 percent of the saturated thickness. This brings forth some additional concern in the transmissivity estimates, but without further evaluation is assumed to be minor.

Also, boundary effects were experienced in both wells, resulting in a late time increase in the rate of drawdown. This is not particularly surprising as several northwest trending faults are mapped in close proximity to well BF-2, and the projection of these faults heads directly towards well BF-1. The early drawdown trends were used by Arden and

Peterson (1978) to calculate aquifer transmissivity, which seems appropriate in this case as natural ground water flow is parallel with these structures (not across the structures).

Using the average transmissivity values calculated by Arden and Peterson (1978) corrected for effects of less than full screening of the aquifer, an average T value of 4,600 gpd/ft is assumed for the midway point between the wells. The corresponding K value, assuming a saturated thickness of 600 feet is 7.7 gpd/ft^2.

The completed Darcy's Law calculation yields 85 af/yr of ground water outflow to Red Rock Valley.

Unaccounted Subsurface Discharge

It becomes immediately apparent that the quantity of subsurface outflow calculated using Darcy's Law accounts for only a small fraction of the predicted recharge to the basin using both the Maxey-Eakin and chloride-balance techniques. It is most probable that unaccounted subsurface outflow is occurring. This outflow could be occurring at one or all of the following locations:

1. Additional northwest flow along faults in the volcanic rock comprising the western most part of Dogskin Mountain, into Dry Valley,—
2. To the east through the low topographic divide into the Warm Springs Valley alluvial system (presently no well data to evaluate this possibility),
3. To the southeast through the northern part of Fred's Mountain into Antelope Valley (supported by water level gradients at the southern edge of the basin, see Figure 8).
4. Downward along fault structures at the base of Dogskin Mountain, potentially resulting in deep circulation through the Walker Lane Shear Zone and possible reemergence at the geothermal springs in Warm Springs Valley.

Summary of Ground Water Discharge

Bedell Flat is considered to be a state of hydrologic equilibrium with recharge equaling discharge over the long-term. Recent domestic well development is not substantial enough to result in disequilibrium. Techniques to estimate the ground water recharge to the basin are in reasonably close agreement, lending some level of confidence in the recharge values. Discharge estimates total but a fraction of the recharge estimates, and undoubtedly some component(s) of discharge has not been fully accounted. Given the lack of phreatophyte vegetation in the basin, this component has to be subsurface outflow. Several possibilities have been presented, and the estimate of unaccounted subsurface outflow is 1,100 af/yr. Table 4 summarizes the discharge components quantified for the basin.

Table 4 - Summary of Ground-Water Discharge in Bedell Flat

Discharge Type	Estimated Quantity (af/yr)	Notes
Springs in Basin	25	Bedell, Settlemeyer, Matley, Willow, Juniper, Bird, and Whitney
Springs down-gradient of basin	30	Campbell Ranch spring
Domestic Wells	20	Future domestic consumption could increase to 100 af/yr
Livestock Watering	22.4	Maximum permitted
Evapotranspiration	30	Northwest edge of basin, Rush & Glancy (1967) estimated 30 acres of salt grass and very wet meadow at Campbell Ranch
Subsurface Outflow to Red Rock Valley	200 recom. 85	Calculated in this study
Subtotal (rounded)	*210*	*Total Accounted for Outflow*
Probable Unaccounted Subsurface Outflow	1,100	Estimated recharge of 1,300 af/yr based on chloride-balance and Maxey-Eakin methods.

Ground Water in Storage

Ground water in storage in upper 100-feet of the saturated alluvium in Bedell Flat is estimated to be 160,000 acre-feet, using a storage coefficient (specific yield) of 0.10 applied over 25 square miles (50 percent of the hydrographic area). A fraction of this ground water in storage in the upper 100-feet saturated alluvium will be removed as pumping from production wells commences, and new gradients of ground water flow are established toward the well(s). The removal of ground water from storage will occur mostly in the beginning years of pumping and is expected to gradually diminish as a new equilibrium is approached. Complete establishment of new equilibrium, however, will be a slow process and will take decades to be reached.

Water Quality

Basic water chemistry data were collected during pumping tests of wells BF-1 and BF-2 in 1978 (Arden and Peterson, 1978). Water chemistry from the wells is surprisingly low in total dissolved solids (TDS) content, at 138 mg/L and 149 mg/L (late-time pumping test samples). All general chemistry constituents are below the primary state and federal drinking water standards (Appendix B). One of the well BF-1 analyses detected arsenic at 0.005 mg/L, but all other samples were below this concentration. The new drinking water standard for arsenic is 0.010 mg/L. The recommended level of iron is 0.3 mg/L (secondary standard is 0.6 mg/L) and was initially exceeded in Well BF-1 at 0.33 mg/L; however, the later time sample detected only 0.06 mg/L. The initially higher concentration of iron was probably influenced by the fact that the well had sat dormant for 6 years prior to the pumping test in 1978 (BF-1 was constructed in 1972).

Ground water quality also appears reasonably good in the southern part of the valley, with TDS concentrations ranging from 173 mg/L to 320 mg/L. The drinking water standard for zinc is 5.0 mg/L and is exceeded in the Reslock domestic well (14.8 mg/L). Recommended levels for secondary standards are slightly exceeded in a couple samples. The pH of ground water in the southern wells exceeds the recommended level of 8.5 in 2 of 5 samples. One domestic well in the south also contains iron at a level slightly above the recommended concentration, and two domestic wells in the south had slightly elevated levels of manganese at 0.06 mg/L, whereas the recommended level is 0.05 mg/L (secondary standard is 0.1 mg/L).

In conclusion, the basic water chemistry of Bedell Flat is quite good, particularly in the northwest portion. Localized areas in the southern portion of the basin have slightly elevated iron and manganese. Water chemistry sampling is summarized in Table 5, and detailed reports presented in Appendix B.

Table 5 – Summary of Water Chemistry Analyses (concentrations in mg/L, unless otherwise noted).

Site	NSHD Rpt. No.*	Location	Date	TDS	pH	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	NO_3 **	As	Fe	Mn	Cu	Zn	Ba	B
Northeast Red Rock Valley:																						
Campbell Ranch Spring	NA	Sec 31, T24N, R19E	11-19-02	260	7.36	42	10	40	2	120	50	30	0.12	34	--	<0.004	<0.005	0.002	--	--	--	--
Northern Bedell Flat Valley:																						
BF-1	46434	Sec. 9, T23N, R19E	8-2-78	173	8.18	24	5	25	3	117	20	8	0.25	--	1.26	0.000	0.33	0.02	--	--	--	--
BF-1	46475	same	8-3-78	138	8.16	22	5	23	3	110	19	4	0.29	--	0.65	0.005	0.06	0.01	--	--	--	--
BF-2	46681	Sec. 5, T23N, R19E	8-28-78	144	8.08	26	4	22	2	107	20	5	0.22	--	1.1	0.000	0.02	0.00	--	--	--	--
BF-2	46683	same	8-28-78	149	7.97	25	4	22	2	115	19	6	0.22	--	1.1	0.000	0.02	0.00	--	--	--	--
BF-1 Stockwater (East-Central Bedell Valley)***	142605	Sec 24, T23S, R19E	6-15-99	332	7.41	62	13	42	2	320	13	9.08	0.23	49	0.4	<0.003	0.00	0.00	0.00	0.05	0.07	0.1
BFS-1, Settlemeyer Spring	142619	T24N, R19E	6-16-99	266	8.09	46	13	30	8	261	11	11.78	0.13	27	0.0	<0.003	0.22	0.01	0.00	0.01	0.09	0.1
BFS-2 Willow Spring	142620	Sec 33, T24N, R19E	6-16-99	441	7.61	62	28	44	13	378	24	21.56	0.11	29	1.5	<0.003	0.00	0.00	0.00	0.01	0.07	0.1
Southern Bedell Flat Valley:																						
Richards Domestic Well, 1230 Bedell Rd.	124529	Sec 7, T22N, R19E	11-3-95	320	7.75	50	23	14	4	254	29	10	0.13	55	1.7	0.004	0.07	0.06	0.00	1.71	0.04	0.0
Hiibel Domestic Well 1265 Deer Lodge Rd.	82287	Sec 8, T22N, R19E	3-13-89	208	8.75	7	0	63	1	54	90	4	0.11	7	1.2	<0.003	0.32	0.01	0.00	0.21	0.00	0.1
Reslock Domestic Well, 1286 Deer Lodge Rd.	096545	Sec 8, T22N, R19E	4-23-92	173	9.04	10	3	38	9	112	41	3	0.43	12	0.0	<0.003	0.28	0.06	0.00	14.83	0.03	0.1
Singley Domestic Well, 106 Cobalt Ln.	147246	Sec 7, T22N, R19E	8-25-00	180	8.05	27	10	14	1	149	4	5	0.10	44	1.5	<0.003	0.07	0.00	0.00	0.04	0.03	0.0
Leary Domestic Well , 1091 Cobalt Ln.	147502	Sec 7, T22N, R19E	9-25-00	154	8.02	27	5	16	2	134	4	6	0.10	37	1.1	<0.003	0.03	0.00	0.00	0.40	0.03	0.0

-- = Not Analyzed; * Nevada State Health Laboratory, Reno, NV; ** Nitrate reported as Nitrogen; ***BF-1 water source unclear, spring fed stockwater trough

Water Chemistry Observations

The water samples listed in Table 5 are plotted on a tri-liner diagram (Piper plot) presented as Figure 9. The 3 springs sampled by WCDWR in 1999, wells BF-1 and BF-2, and the Singley and Leary domestic wells in the south, all show commonality in chemical proportions. The Richards domestic well has a slightly low proportion of sodium. All these water sources come from precipitation derived predominantly on granitic mountains, or alluvium derived from the adjacent granitic mountains. The resulting water chemistry is calcium-sodium-bicarbonate dominated. Two southern domestic wells (Reslock and Hiibel) show significant deviations in general chemistry. These two wells have substantially increased proportions of sulfate and sodium, perhaps resultant of localized geothermal alteration/mineralization of nearby bedrock. Both the Hiibel and Reslock domestic well water chemistry was also noted to have moderately elevated iron and zinc concentrations.

A water sample was collected from the Campbell Ranch spring in November, 2002 for general chemistry testing. The spring was sampled at the discharge point from the base of the hillside on the north side of the meadow (Figure 4b, Appendix B). Spring flow at the time of sampling was estimated at 10 gpm. The TDS content of the spring is similar to TDS concentrations observed in Bedell Flat, at 260 mg/L. However, the proportions of dissolved anions show a distinct difference (Figures 9 and 10, Appendix B). Water chemistry of the Campbell Ranch spring is more sulfate and chloride dominated, and lower in dominance by bicarbonate than Bedell Flat waters. Water elevation differences between wells BF-1 and BF-2 indicate a gradient toward the spring. The elevation of the spring was surveyed by Tri State Surveying at 4,803.42 feet, approximately 85 feet lower than the water table elevation at well BF-2, which is located a distance of 11,976 feet to the southeast, and approximately 100 feet lower that the water table elevation at well BF-1, located a distance of 16,993 feet to the southeast. While the water table gradient at these wells supports flow towards the Campbell Ranch spring from Bedell Flat, the water chemistry suggests that the source of water is not entirely Bedell Flat water, but rather a mix with another water source, or less probably an entirely different water source.

Campbell Ranch spring lies in a topographic depression between three mountain blocks, Dogskin Mountain, Sand Hills, and Seven Lakes Mountain. Seven Lakes Mountain and the western-most portion of Dogskin Mountain are comprised of volcanic rocks. Greater increased proportions of sulfate and chloride versus bicarbonate could be imparted to waters traveling through the volcanic rocks in the drainage areas to the north of the springs. Further supporting a northern water source, is the presence of numerous northwest trending faults through the vicinity of Campbell Ranch spring (Bonham, 1969), which extend up into the saddle between Dogskin and Seven Lakes mountains. The spring is likely situated on one of these faults, which serves as a conduit for water flow through the volcanic rocks.

Based on considerations of gradient, geology and chemical data, it is believed that the meadows and springs at Campbell Ranch are receiving combined ground water flow from

Legend:

⊕ Well Samples
✱ Spring Samples

Piper Plot of Bedell Flat Ground Water and Spring Chemistry

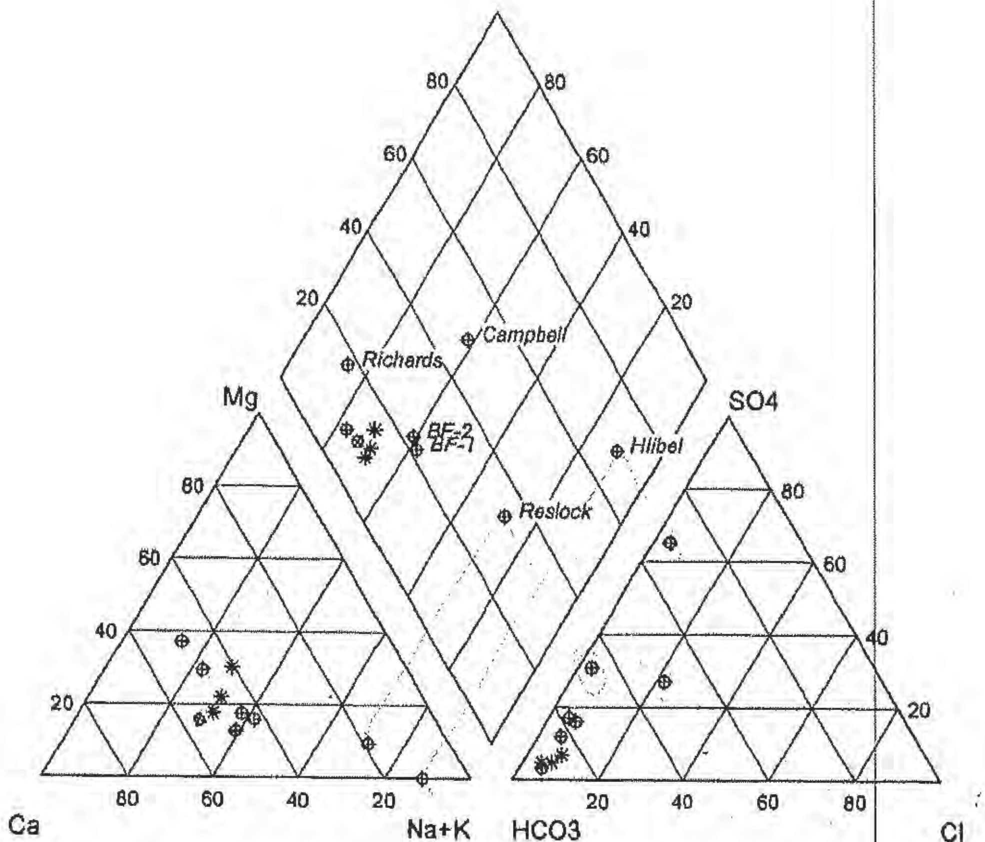

FIGURE 9 - TRI-LINEAR DIAGRAM OF BEDELL FLAT WATER CHEMISTRY

InterFlow Hydrology, Inc. Hydrogeology and Water Resource Consulting	CLIENT: Intermountain Pipeline, LTD
	PROJECT: Hydrogeology of Bell Flat
	NO.: InterFlow Rpt 2003-03 | DATE: February 2003

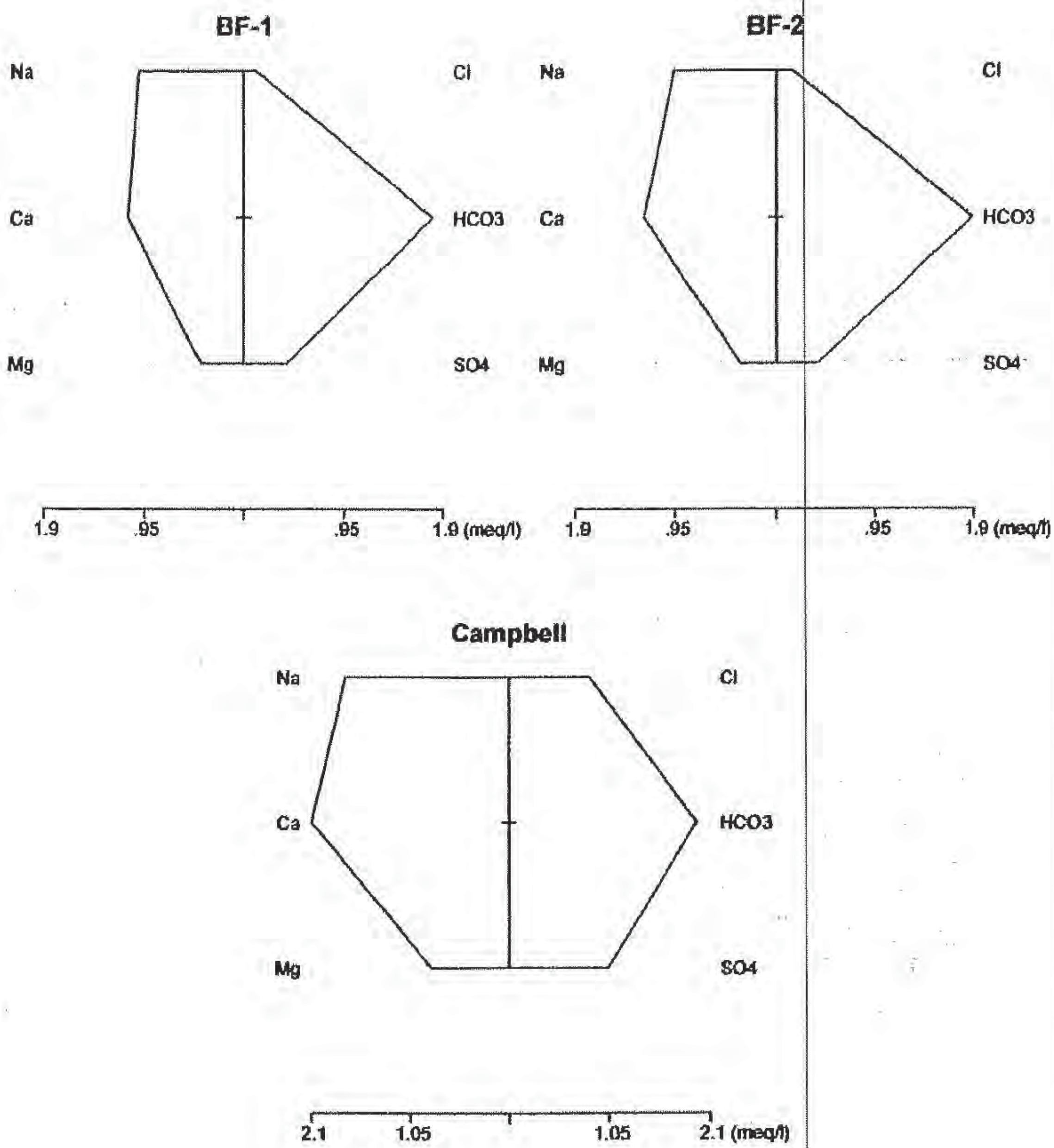

FIGURE 10 STIFF DIAGRAMS OF BF-1, BF-2 & CAMPBELL RANCH SPRING WATER

InterFlow Hydrology, Inc.	CLIENT: Intermountain Pipeline, LTD
	PROJECT: Hydrogeology of Bell Flat
	NO.: InterFlow Rpt 2003-03 — DATE: February 2003

both Bedell Flat and through fault structures from the Seven Lakes and Dogskin Mountains.

Surface Water

Bedell Flat topographically drains to the north and then west to Red Rock Valley. The unnamed ephemeral drainage between the two valleys receives flows only in extreme runoff events. No perennial streams exist in the basin, and there is no playa. Average annual runoff from the mountain blocks surrounding the valley floor is 3,000 af/yr, estimated using an altitude-runoff relationship developed by Riggs and Moore (1965), as presented in Rush and Glancy (1967). Most of this runoff is ultimately lost to evaporation on the valley floor, although a small portion may infiltrate down through soils becoming ground water recharge.

D.O. Moore, in Rush and Glancy (1967) estimated average annual surface water outflow to Red Rock Valley at 70 af/yr, acknowledging that this flow occurs as a result of infrequent precipitation/runoff events.

Perennial Yield

The perennial yield of a ground water basin is that portion of the ground water discharge that can be captured via pumping from wells and, in general terms, cannot exceed the estimated ground water recharge. In Bedell Flat, the primary means of ground water discharge is subsurface outflow. As presented in this report, subsurface outflow cannot be fully accounted in the basin. However, the magnitude of the subsurface discharge is equal to the magnitude of ground water recharge, because the basin is in a state of hydrologic equilibrium. Two methods of estimating ground water recharge to basins in the Great Basin have produced similar quantities of predicted recharge, lending some degree of confidence in estimates of the recharge side of the water budget for Bedell Flat. The applied methods support an average annual recharge of approximately 1,300 af/yr. Average annual ground water discharge is likewise predicted to be 1,300 af/yr. Data are available to quantify only one component of subsurface outflow, being through alluvium in the northwestern arm of the basin to Red Rock Valley. This value is calculated at 85 af/yr. Several possibilities exist for the occurrence of unaccounted subsurface outflow, including additional outflow to Dry Valley via prominent northwest trending fault structures, outflow to Antelope Valley and Warm Springs Valley through fractured bedrock and moderate topographic divides on the eastern side of the basin, and perhaps outflow through faults on the western side of the basin that constitute part of the Walker Lane Shear Zone.

Maxey, and others, (1966) suggested Bedell Flat could support perhaps 300 acres of irrigated agriculture, at a duty of 3 to 4 feet per year. This equates to 900 to 1,200 af/yr of pumping, however, the consumptive use portion would be only about 750 af/yr. Maxey, and others, (1966) go on to suggest a perennial yield as follows: *"On the basis of the U.S. Geological Survey method of estimating recharge (see table) a minimum of approximately 1,000 acre feet of ground water is perennially available to Bedell Flat of* *which a considerable fraction could be developed if adequate aquifers are present in favorable stratigraphic positions."*

A portion of the subsurface outflow from Bedell Flat can undoubtedly be captured via production wells, although the placement of wells will need to be such that outflows can be effectively captured. A pumping water-level depression created in the northwestern portion of basin caused by pumping wells BF-1 and BF-2, while theoretically would propagate throughout the basin, is not predicted to be effective in capturing much of the hypothesized eastern outflow. An additional well, or wells, will be needed in the central and/or eastern side of the basin.

Rush and Glancy (1967), also encountered an imbalance between estimates of ground water recharge and discharge Common to their reconnaissance investigations, they split the difference between the two estimates, assuming equal probability that the discharge was underestimated or recharge over estimated, thereby arriving at 700 af/yr of ground water recharge and discharge. Given the data available today versus that available in the mid-1960s, it is much more probable that unaccounted subsurface discharge is the dominant factor in the imbalance.

Rush and Glancy (1967) applied a common, and conservative, assumption that one-half the recharge-discharge is a practical perennial yield for the basin. Then rounding down, they arrived at 300 af/yr as a perennial yield estimate for Bedell Flat. Because the predominance of ground water discharge is via subsurface flow, which is probably distributed over several locations along the basin boundary, we likewise feel that a conservative perennial yield for the basin is warranted, at this time. Allowing for some increased ground water consumption by domestic wells in the southern edge of the basin, and generally one-half recovery of the subsurface outflow, we suggest that 600 af/yr could be developed for municipal uses in Lemmon Valley. The ultimate manageable perennial yield from the basin could be higher, but would probably require a well network distributed over the valley floor to more effectively capture the subsurface discharge.

Pumping will initially be from storage until the cone of depression has expanded to capture ground water discharge from the valley of an equal magnitude to pumping. A gradual transition from storage withdrawal to discharge capture will take place, which is expected to extend over many decades.

Development of Ground Water Resources

Existing wells BF-1 and BF-2 were built with the intension of pumping for municipal water supply. Arden and Peterson (1978) recommended pumping BF-1 as a primary well, and BF-2 as a supplemental or back-up well.

In further review of the well construction and pumping test data presented by Arden and Peterson (1978), we suggest that well BF-2 may be more appropriate for municipal water supply. Well BF-1 is constructed with mill-slot perforated casing and 3/8-inch pea gravel for the filter pack (left over pea gravel observed at the site). The well is noted to have produced fine mica throughout the course of the pumping test conducted in 1978. The well likely produces fine sand along with the mica, which would require removal for use as a municipal water supply. Well BF-2 was constructed with Johnson well screen and a Monterey sand filter pack. Produced water was reported to be mica and sand free in later stages of pumping tests. For this reason, Intermountain Pipeline's application 66873 currently has a point of diversion at well BF-2.

It is the intent of application 66873 to appropriate the presently available perennial of the basin. However, distribution of pumping between multiple wells will likely be needed, due to the low transmissivity of the aquifer in the vicinity of wells BF-1 and BF-2. Monitoring of water levels during start-up of long-term pumping at the BF-1 and/or BF-2, coupled with exploration on the eastern side of the basin are suggested to refine an assessment of the need to distribute pumping regionally in basin. Numeric flow modeling could aid in assessment of the need for pumping distribution; however, additional geologic data for the eastern side of the basin would be desired prior to undertaking a numeric flow modeling effort.

A summary of well BF-1 and BF-2 pumping performance is presented below, and the complete SEA Incorporated (Arden and Peterson, 1978) well drilling and aquifer testing report is included as Appendix A to this report.

Well BF-1

Well BF-1 has been test pumped at rates up to 690 gpm; however, the specific capacity of the well is lower than BF-2 ranging from 2.0 to 2.6 gpm per foot of drawdown (about one-half of BF-2). The well can be pumped at higher rates because of its greater depth (950 feet) as compared to BF-2 (400 feet).

A 36-hour pumping test was conducted on this well in 1978, at a rate of 385 gpm. A low permeability boundary effect was observed during pumping, which is interpreted as being the intersection of the pumping cone of depression with a northwest-southeast trending fault (projection of faults mapped by Bonham, 1968; see Figure 5). Monitoring after the pumping period indicated recovery at a reasonable rate, with a late-time trend projecting to near zero drawdown at 36 hours.

Based on projection of the late-time (post boundary effect) water level drawdown trend observed during aquifer testing, pumping from well BF-1 at a rate of 400 gpm could be sustained (pumped continuously without recovery time) for approximately 4.5 years before exceeding 400 feet of water level drawdown in the well. Recommendations for sustainable long-term pumping from well BF-1 at 400 gpm were made by Arden and Peterson (1978) to include, as a long-term ratio, 1 hour recovery time to 2 hours of pumping.

Well BF-1 is constructed of 16-inch diameter casing, which would accommodate a filter packed liner to mitigate suspected sand problems. However, not all lining efforts are met with success. If needed, a new well could be drilled at location BF-1 using similar construction materials as BF-2.

Well BF-2

The specific capacity of well BF-2 ranges from 3.7 to 4.5 gpm per foot of drawdown, and the well has been pumped at rates up to 450 gpm with an observed pumping water level at approximately 210 feet below ground surface. In 1978, a 36-hour pumping test was conducted at 300 gpm, and at the end of test the pumping water level was at 198 feet below ground surface. Recovery of water levels was reported by Arden and Peterson (1978) to be slow. Upon closer review of the recovery data, it is noted that water level recovery was measured for 8 hours following the 36 hour pumping period. Residual drawdown was at 18 feet below the starting static water level of 83.4 feet reported at the beginning of the test. The trend of the late time recovery data projects back to 0 drawdown at 36 hours, indicating complete recovery within at time equal to the pumped period. However, it is noted that the static water level at the beginning of the test is 20 feet below the static water level reported prior to pumping for well development. The length of time of development pumping, and the length of time between completion of development and start of pumping tests is not presented, but we suspect that the not much time was allowed between the two events. Given this consideration, it appears that well BF-2 recovery was in keeping with theoretic recovery trends (Driscoll, 1986, p. 259) and the aquifer was not over stressed during the aquifer test.

The rate of water level drawdown in well BF-2 was also affected by a low permeability boundary encountered by the radius of influence during the pumping test. This boundary is probably one of several faults in the vicinity of the well (Figure 3). The late-time drawdown trend at 300 gpm (post boundary effect) indicates that the pumping water level in the well would approach 300 feet in depth (well is completed to 400 feet) after approximately 1 year of pumping without recovery time. It is likely that additional boundary effects could be experienced during pumping of this duration, accelerating the drawdown. Production pumping from well BF-2 can be maintained at 300 gpm only if periods of recovery time are allowed. For pumping at 300 gpm, we recommend equal recovery time to pumping time. Alternatively, the well could be pumped at a lower pumping rate for longer durations of time relative to recovery.

East-Side Basin Exploration

It will aid considerably in the future management and development of ground water resources in Bedell Flat if one or more exploration wells are drilled on the eastern side of the basin. Tentative locations are in Sections 24 and 26, T23N, R19E. The exploration wells should be sufficient in diameter and of adequate construction materials to conduct aquifer tests (pumping tests). Static water level elevations should be measured, and basic water chemistry analyzed. The data collected from these wells will refine ground water flow directions and provide data for outflow calculations. The wells should be maintained for long-term water level monitoring in the basin, and based on the data from these wells, along with long-term pumping observations at BF-1 and BF-2, it may be deemed appropriate to complete an additional production well on the east side of the basin.

Impacts of Pumping

A new hydrologic equilibrium will take decades to become established, once pumping is initiated. As is the case with all wells, ground water will be initially withdrawn from storage until gradients to the well are established and subsurface discharge is begun to be captured. The progression from storage withdrawal to discharge capture was estimated by Arden and Peterson (1978) to require approximately 44 years at an annual withdrawal of 450 af/yr (calculation method not cited).

A calculation of drawdown effects in the vicinity of wells BF-1 and BF-2 over time can be made using the Theis (1935) equation. The Theis equation applies numerous assumptions, including, as outlined by Todd (1980):

1. The aquifer is homogenous, isotropic, uniform in thickness, and of infinite areal extent,
2. The potentiometric surface is horizontal prior to pumping,
3. The well is pumped at a constant rate,
4. The pumping well penetrates the entire aquifer thickness (horizontal flow only),
5. Well storage is infinitesimal, and can be neglected, and
6. Water removed from storage occurs instantaneously with decline in head.

While numerous simplifying assumptions are necessary, the calculation is valuable for making first approximations of the water level drawdown effects from pumping wells. Using the following values in the Theis equation, results of the Theis calculation are as presented in Table 6:

Q (pumping rate) = 372 gallons per minute pumped continuously from one well (equal to 600 acre-feet per year);

T (transmissivity) = 4,600 gallons per day per foot;

S (storage coefficient) = 0.1 (unconfined in the vicinity of wells BF-1 and BF-2).

Table 6 - Predicted Pumping Drawdown Using Theis (1935) Non-Equilibrium Equation*

10 Years After Start of Pumping	100 Years After Start of Pumping
Radial Distance of 1 mile = 8.4 feet	Radial Distance of 1 mile = 27.5 feet
Radial Distance of 2 miles = 1.7 feet	Radial Distance of 2 miles = 15.8 feet
Radial Distance of 5 miles = 0.0006 feet	Radial Distance of 5 miles = 3.0 feet

* Drawdown (feet) = 114.6 Q W(u) / T, where $u = 1.87\, r^2\, S / T\, t$, where r = radial distance in feet, and t = time in days. Values for W(u) obtained from Todd (1980), Table 4.1, page 126.

IN THE SUPREME COURT OF THE STATE OF NEVADA

Case No. 73933

Electronically Filed
Feb 08 2018 04:45 p.m.
Elizabeth A. Brown
Clerk of Supreme Court

SIERRA PACIFIC INDUSTRIES, a California Corporation,

Appellant,

v.

JASON KING, P.E., in his capacity as Nevada State Engineer; THE DIVISION OF WATER RESOURCES, DEPARTMENT OF CONSERVATION, an agency of the State of Nevada; and INTERMOUNTAIN WATER SUPPLY, LTD., a Nevada Limited Liability Company,

Respondents

Appeal From Order Denying Petition for Judicial Review
District Court Case No.: CV16-01378
Second Judicial District Court of Nevada

JOINT APPENDIX

VOLUME VI Part 1 of 3

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Docket 73933 Document 2018-05401

CHRONOLOGICAL INDEX TO JOINT APPENDIX

DATE	DESCRIPTION OF DOCUMENT	VOLUME	PAGE(S)
10/7/2016	Petitioner's Sierra Pacific Industries' Opening Brief	X	JA2491 – JA2517
11/17/2016	Respondent-Intervenor Intermountain Water Supply's Answering Brief	XI	JA2518 – JA2561
11/28/2016	Respondent State Engineer's Answering Brief	XI	JA2562 – JA2583
12/30/2016	Petitioner's Sierra Pacific Industries' Reply Brief	XI	JA2584 – JA2603
12/30/2016	Exhibits 1-9: SROA 2406 – SROA 2475, to Petitioner Sierra Pacific Industries Motion to Supplement the Record, or in the Alternative, for Judicial Notice.	XI	JA2604 – JA2686
2/6/2017	Order Granting Sierra Pacific Industries' Motion to Supplement the Record	XI	JA2687 – JA2689
4/28/2017	Application for Setting via Teleconference	XI	JA2690 – JA2691
5/24/2017	Petition for Judicial Review – Minutes	XI	JA2692
5/24/2017	Petition for Judicial Review Oral Arguments Transcript	XI	JA2693 – JA2750
8/21/2017	Order Denying Petition for Judicial Review	XI	JA2751 – JA2759
8/22/2017	Notice of Entry of Order Denying Petition for Judicial Review (Order not recopied)	XI	JA2760 – JA2764
9/8/2017	Notice of Appeal with Clerk's Certificate (Notice of Entry & Order not recopied)	XI	JA2765 – JA2769

ALPHABETICAL INDEX TO JOINT APPENDIX

IN THE SUPREME COURT OF THE STATE OF NEVADA

AFFIRMATION

Pursuant to NRS 239B.030, the undersigned does hereby affirm that **JOINT APPENDIX VOLUME VI** does not contain the social security number of any person.

DATED this 8th Day of February, 2018.

MCDONALD CARANO LLP

BY: /s/ Debbie Leonard

Debbie A. Leonard, Esq.
Nevada Bar No. 8260
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Attorneys for Appellant

CERTIFICATE OF SERVICE

Pursuant to NRCP 5(b), I hereby certify that I am an employee of McDonald Carano, LLP and that on February 8, 2018, **JOINT APPENDIX VOLUME VI** was electronically filed with the Clerk of the Court for the Nevada Supreme Court by using the Nevada Supreme Court's E-Filing system (E-Flex). Pursuant to NRAP 30(f)(2), all Participants in the case will be served and provided an electronic copy via U.S. mail as follows:

Richard L. Elmore, Esq.
3301 S. Virginia Street, Suite 125
Reno, Nevada 89502

Office of the Nevada Attorney General
Micheline N. Fairbank, Esq.
100 North Carson Street
Carson City, NV 89701

/s/ Pamela Miller
An employee of McDonald Carano, LLP

4816-4068-7451, v. 1

KENNY C. GUINN
Governor

STATE OF NEVADA

R. MICHAEL TURNIPSEED, P.E.
Director

HUGH RICCI, P.E.
State Engineer

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES
123 W. Nye Lane, Suite 246
Carson City, Nevada 89706-0818
(775) 687-4380 · Fax (775) 687-6972
http://ndwr.state.nv.us

RE: 66873

February 15, 2001

Intermountain Pipeline LTD
PO Box 2790
Reno, NV 89505-2790

To Whom It May Concern:

You are hereby notified that formal protests were filed in this office on January 26, 2001, by Lassen County and on January 31, 2001, by Washoe County, against the granting of your application, under the above-mentioned serial number. A copy of these protests is enclosed herewith.

A brochure titled *Practice and Procedure in Protest Hearings Before State Engineer* is available from this office upon request. The contents of this brochure are contained in the Nevada Administrative Code, Chapter 533.

Sincerely,

Hugh Ricci, P.E.

Hugh Ricci, P.E.
State Engineer

HR/nsn
Enclosures

Certified Mail 7000 0520 0017 5361 6232

SENDER: COMPLETE THIS SECTION

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to: nsr 66873

Intermountain Pipeline LTD
PO Box 2790
Reno NV 89505-2790

COMPLETE THIS SECTION ON DELIVERY

A. Received by (Please Print Clearly) Dee Wheeler

B. Date of Delivery

C. Signature
X Dee W

☐ Agent
☐ Addressee

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

RENO NV DOWNTOWN
FEB 20 2001

3. Service Type
☐ Certified Mail ☒ Express Mail
☐ Registered ☐ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? (Extra Fee) ☐ Yes

2. Article Number (Copy from service label)
7000 0520 0017 5361 6232

PS Form 3811, July 1999 Domestic Return Receipt 102595-00-M-0952

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
Division of Water Resources
123 W. Nye Lane Suite 246
Carson City, Nevada 89706-0818
(775) 687-4381

CHECK NO. 31912

DATE: FEBRUARY 21, 2001

THE STATE OF NEVADA

FILE COPY

To: RENO GAZETTE JOURNAL
ACCOUNTING DEPT
PO BOX 22000
RENO NEVADA 89520

	To Publish Under Application No. 66873	50.00	

Kennedy/Jenks Consultants

Engineers & Scientists

5190 Neil Road
Suite 210
Reno, Nevada 89502
775-827-7900
FAX 775-827-7925

31 October 2001

Ms. Charlene Fumarol
Division of Water Resources
123 W. Nye Lane
Carson City, NV 89710

Dear Charlene:

I will continue representing Intermountain Pipeline Ltd, and Robert W. Marshall and Nanette Marshall as their water right Agent for the following permits and applications: R-014, 64073 through 64081, 64977, 64978, 66400, 66873, 66961, and 67037. Please update my mailing address to the following:

Dwight L. Smith, PE, WRS
Kennedy/Jenks Consultants
5190 Neil Road, Suite 210
Reno, Nevada 89502

Please contact me at 827-7900, if you have any questions.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Dwight L. Smith

Dwight L. Smith, PE, WRS
Senior Associate

DLS/kls

cc: Bob Marshall

Marshall – Intermountain Pipeline

State of Nevada Division of Water Resources
Request for Notice and Change of Address

In regards to permit number R-014, 64073–64081, 64977, 64978, 66400, 66873, 66961, 67037 : (Check applicable item.)

[ ] Please add my name to the mailing list and send copies of all correspondence to the address below: (Fill in NEW ADDRESS information only.)

[✓] Please change the address for copies to be sent as indicated below: (Fill in NEW ADDRESS and OLD ADDRESS information.)

[ ] I am the permit holder. Please change my address as indicated below: (Fill in NEW ADDRESS and OLD ADDRESS information.)

NEW ADDRESS

NAME: InterFlow Hydrology, Inc.

ADDRESS: P.O. Box 1482

CITY, STATE, ZIP: Truckee, CA 96160

TELEPHONE: (530) 582-1622

OLD ADDRESS

NAME: Kennedy / Jenks Consultants

ADDRESS: 5190 Neil Road, Suite 210

CITY, STATE, ZIP: Reno, NV 89502

TELEPHONE: (775) 827-7900

I am the:

[ ] Individual named above. (Complete signature below only.)

[✓] Agent or representative. (Complete the signature, name, and address below.)

This form accurately reflects the mailing address for the permit holder or other individual identified above.

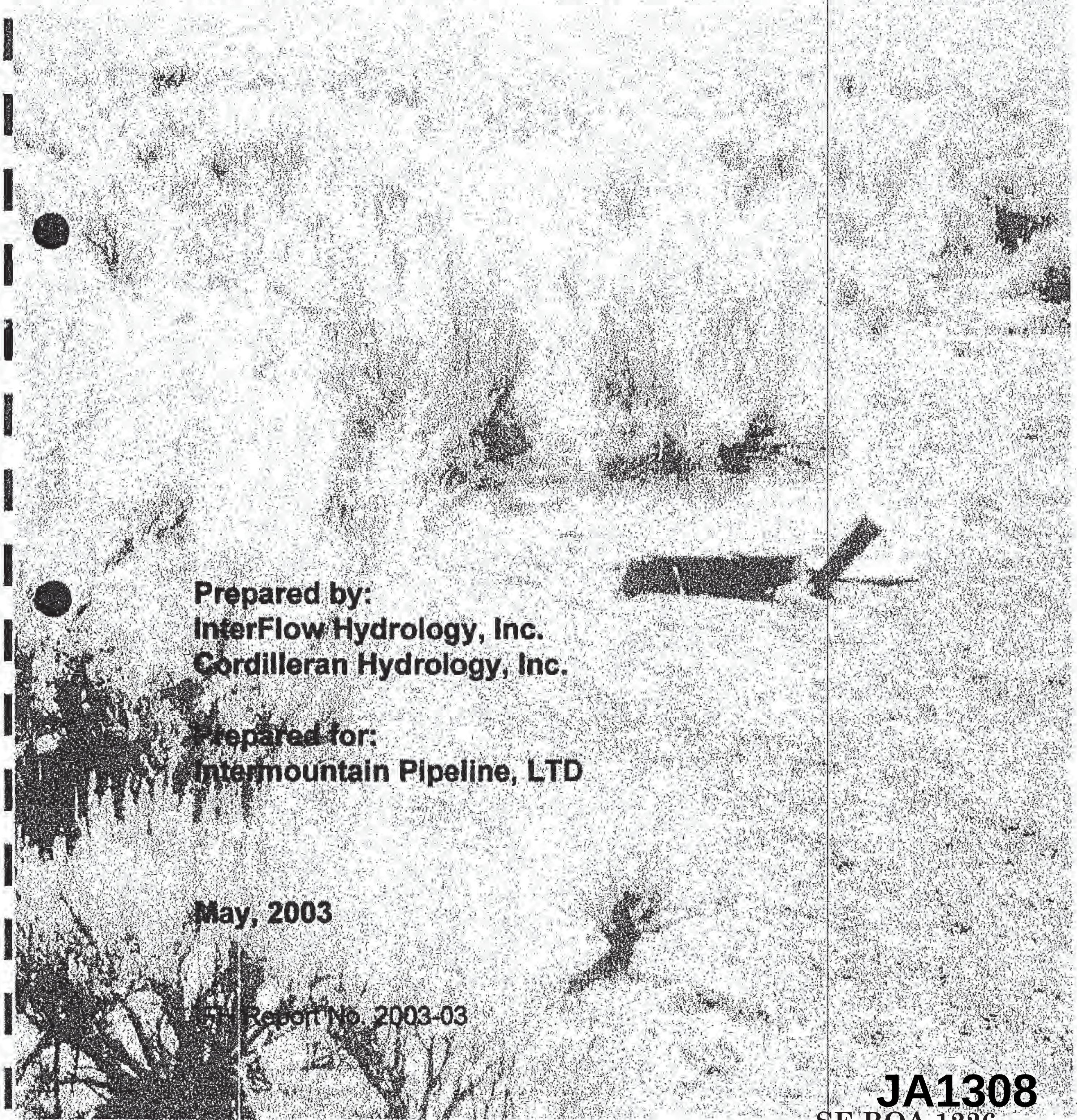
SIGNATURE: Dwight L. Smith

NAME: Dwight L. Smith

ADDRESS: P.O. Box 1482

CITY, STATE, ZIP: Truckee, CA 96160

Hydrogeology of Bedell Flat and Potential for Ground Water Development
Washoe County, Nevada



Prepared by:
InterFlow Hydrology, Inc.
Cordilleran Hydrology, Inc.

Prepared for:
Intermountain Pipeline, LTD

May, 2003

IFH Report No. 2003-03

Hydrogeology of Bedell Flat and Potential for Ground Water Development, Washoe County, Nevada

Prepared by:

PROFESSIONAL ENGINEER-STATE OF NEVADA
DWIGHT L. SMITH
GEOLOGICAL
3/31/04
No. 11906

Dwight L. Smith, PE, RG
Principal Hydrogeologist
INTERFLOW HYDROLOGY, INC.

Terry Katzer
Principal Hydrogeologist
CORDILLERAN HYDROLOGY, INC.

Prepared for:
INTERMOUNTAIN PIPELINE, LTD.
RENO, NEVADA

May 2003

IFH Report No. 2003-03

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Hydrogeology of Bedell Flat and Potential for Ground Water Development, Washoe County, Nevada

Executive Summary

The Bedell Flat hydrographic basin comprises 51 square miles situated north of Lemmon Valley and east of Red Rock Valley, in southern Washoe County, Nevada (Figure 1). The basin is completely surrounded by mountain ranges and lower bedrock hills with a minor ephemeral drainage exiting the basin in the northwest corner, to Red Rock Valley. Over 90 percent of Bedell Flat is public lands, with private property associated with the Red Rock Estates development existing in the south.

Minimal ground water development exists in Bedell Flat. One stockwater well has been drilled on the valley floor, with 22.4 acre-feet of associated ground water rights. Approximately 33 domestic wells have been drilled for single-family residences in the south. Two production wells were constructed in the mid to late 1970s in the northwest, with the expectation of pumping water to Lemmon Valley, but are not currently used. These two wells were test pumped at rates up to 450 and 690 gallons per minute.

Ground water occurs at depths ranging from 30 to 650 feet below ground surface. Over a majority of the basin, depth to ground water exceeds 50 feet, and no significant areas of evapotranspiration by phreatophyte plants occurs, except in small areas located around low-flow springs in surrounding mountains, and the northwestern edge of the valley floor where depth to ground water is less than 50 feet.

Ground water recharge is a product of precipitation falling on the mountain blocks surrounding the valley, and to a lesser extent falling on the valley floor. Using 3 years of precipitation records from 8 stations operated in Bedell Flat by Washoe County Department of Water Resources, combined with regional precipitation mapping previously published, estimated annual precipitation falling on Bedell Flat is 32,000 acre-feet per year (af/yr). Only a small percentage of this precipitation becomes ground water recharge. Two recharge estimating techniques, the Maxey-Eakin method and chloride-balance method have been applied and yield similar results, indicating approximately 1,300 af/yr of average annual ground water recharge in Bedell Flat.

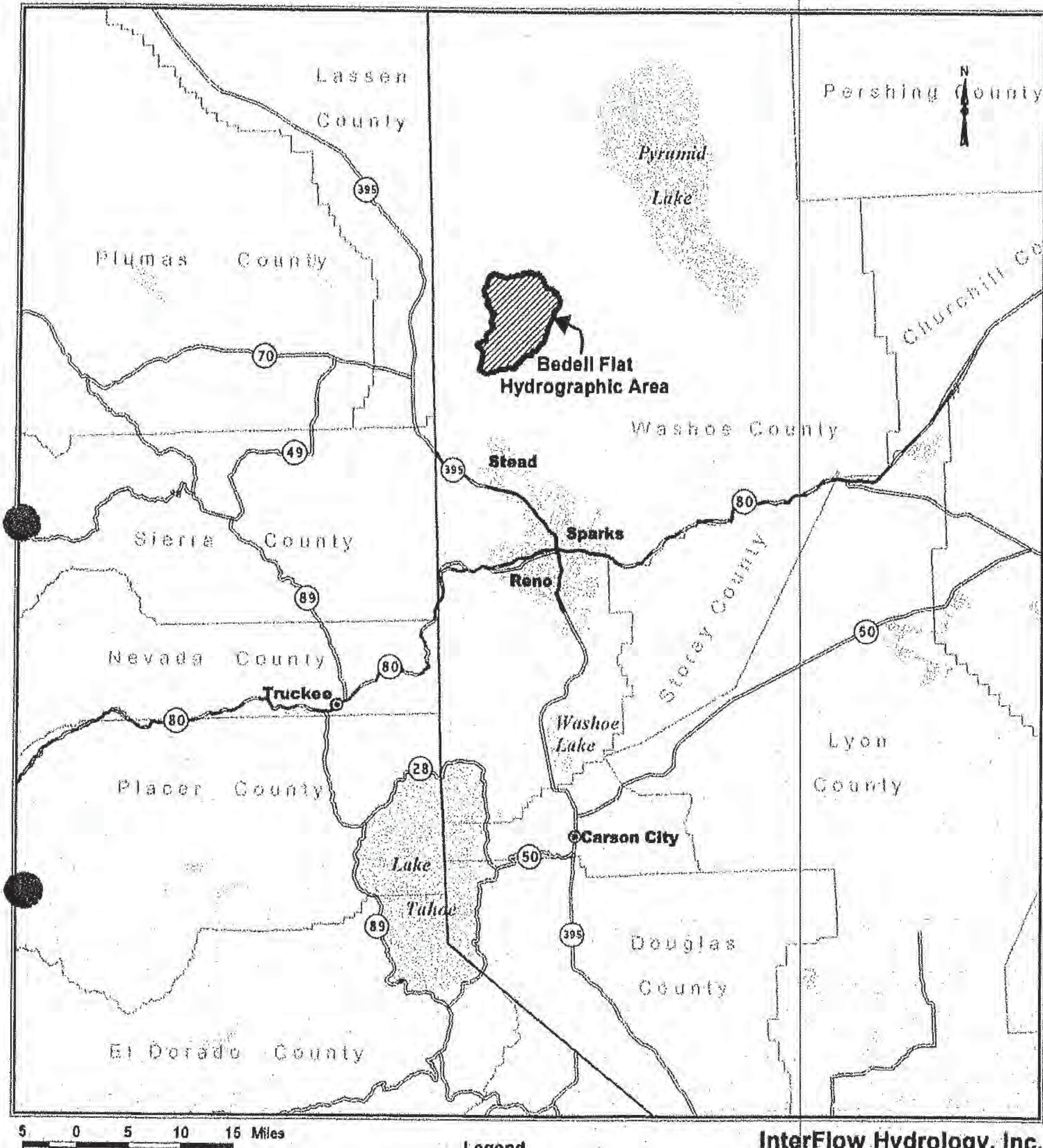
Ground water discharge in the basin is primarily via subsurface outflow, given the lack of spring discharge or phreatophyte vegetation in the valley. Existing data are not sufficient to fully define magnitudes and directions of outflow, although a component of outflow is

known to exist through alluvium in the northwest corner of the basin. Additional subsurface outflow could be occurring to the east, to Warm Springs Valley and Antelope Valley, and to the northwest through fractured bedrock to Dry Valley. The basin is in a state of hydrologic equilibrium and the total subsurface discharge is approximately equal to average annual recharge, being approximately 1,300 af/yr.

Ground water quality in Bedell Flat is excellent, with total dissolved solids concentrations typically below 300 mg/L. General chemical constituents meet current state and federal drinking water standards, including the upcoming (year 2006) lowered arsenic standard.

Perennial yield for ground water from Bedell Flat is conservatively estimated in this study to be 600 af/yr, after accounting for existing livestock water rights and continued domestic well uses in south. The perennial yield is approximately one-half of the estimated ground water budget. Realization of the perennial yield will require spatial distribution wells and management of pumping, in order to achieve capture of ground water outflow from the basin. The two existing productions wells constructed in the northwest part of Bedell Flat may be used to capture a part of the basin ground water resources. Future exploration, pumping, and long-term water-level monitoring may support a higher perennial yield, depending on the ability to capture subsurface outflow. Initial pumping by wells will remove water from storage, until ground water gradients are changed sufficiently to redirect subsurface outflow to the production wells. The estimated volume of water stored in the upper 100 feet of the alluvial aquifer is 160,000 acre-feet.

Recommendations for future hydrogeologic work in Bedell Flat includes rehabilitation of production wells in the northwest and drilling one or two exploration wells along the eastern part of the basin, both to assess potential eastern ground water outflow and determine suitability for an eastern production well site.



InterFlow Hydrology, Inc.

Legend

	Bedell Flat Hydrographic Area	Road classification	
	State Boundary		Divided highway
	County line		Heavy-duty
	Urban Areas		Light duty
	Lakes		Medium dut

Intermountain Pipeline, LTD
Reno, Nevada

Vicinity Map

FIGURE 1

Introduction

This evaluation of water resources in Bedell Flat has been performed to assess the potential for development of ground water resources in the valley. Intermountain Pipeline, Ltd., for whom this study has been prepared, has a pending application (Application 66873) to appropriate underground water from the basin for municipal uses in Lemmon Valley, a northern suburb of Reno, Washoe County, Nevada.

Bedell Flat has not been the subject of a comprehensive hydrogeologic assessment since the mid-1960s, and since that time significant data have been collected in the valley, including drilling and testing of two municipal wells in the 1970's, drilling of domestic wells in the southern edge of the valley, assessment of the hydrogeologic structure of the basin by the U.S. Geological Survey (USGS) completed in 2001, collection of precipitation data ongoing by Washoe County Department of Water Resources (WCDWR), and ground water and spring chemistry sampling. This evaluation has relied upon the available body of work and data, supplemented by field observations and measurements made as part of this study.

Location and Physiographic Setting

Bedell Flat has been assigned Hydrographic Basin No. 94 by the Nevada Division of Water Resources (NDWR). The hydrographic basin occupies approximately 51 square miles, situated north of Reno-Stead and Lemmon Valley (Figures 1 and 2). Bedell Flat can be accessed in the south off of Red Rock Road, from the northwest from Red Rock Valley and Dry Valley, from the northeast from Warm Springs Valley, and from the south from Antelope Valley, all via unimproved or minimally improved dirt roads. Bedell Flat topographically drains north and west to Red Rock Valley, although flow between the two valleys occurs only in significant runoff events, and is not a normal occurrence. No perennial streams exist in the valley.

Northwest of Bedell Flat is Dry Valley and northeast is Warm Springs Valley; both valleys have been the subject of recent evaluations in support of water resources development by Intermountain Pipeline, Ltd (Katzer, 1997; and Smith and Katzer, 2000). Antelope Valley is situated to the southeast.

The valley floor ranges in elevation from approximately 5,040 feet to 4,950 feet above mean sea level (Figure 2). Land surface elevation near the outflow of Bedell Flat to Red Rock Valley is approximately 4,820 feet. The valley floor is roughly L-shaped with a northwestern arm extending toward Dry Valley and a southwest arm extending towards Lemmon Valley. The width of the valley is approximately 5.5 miles east-west, and the length is approximately 8.5 miles north-south.

Mountain ranges surrounding the valley include Dogskin Mountain to the north, rising to 7,460 feet in altitude, Sand Hills to the west rising to approximately 6,100 feet at Granite Peak, Fred's Mountain to the south rising to 6,940 feet, and some unnamed lower altitude

InterFlow Hydrology, Inc.	Intermountain Pipeline, LTD	IFH Report No. 2003-03
	Figure 2 – Bedell Flat and General Vicinity	

hills that trend in a northeast direction defining the east boundary of the basin. Seven Lakes Mountain, with summit elevation of 6,060 feet lies beyond the northwest corner of the basin.

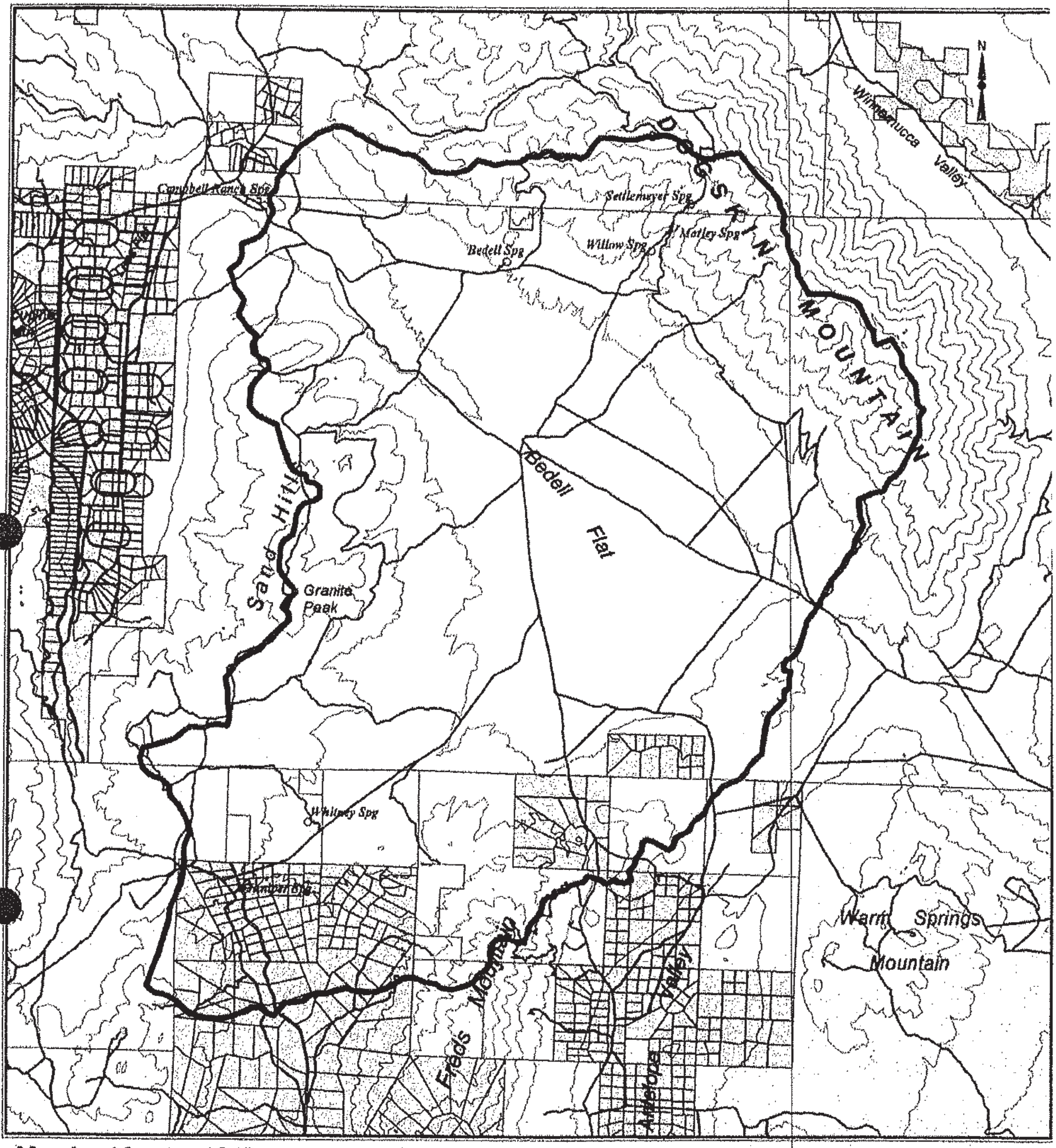
A majority of Bedell Flat is public lands, managed by the BLM. A portion of Red Rock Estates occupies the southern edge of the basin, with approximately 140 privately owned parcels ranging from approximately 10 to 50 acres in size (Figure 3). Many of these parcels are currently undeveloped; however, some have been built upon, with individual domestic wells and septic systems serving the residents. In total, over 90 percent of Bedell Flat is public land.

Vegetation on the valley floor consists of a desert shrub assemblage, and a recent wildfire has burned the eastern side. Pinyon and juniper exist above approximately 5,100 feet in altitude on western Dogskin Mountain and above 5,400 in altitude on the eastern side of Dogskin Mountain. The southeast flanks of the Sand Hills support pinyon and juniper assemblages above 5,100 feet, as does the northern portion of Fred's Mountain above 5,250 feet.

Whiskey, Bird and Juniper Springs are situated near the southwestern edge of the basin, in the vicinity of Red Rock Ranch Road, and support small areas of riparian vegetation. On the intermediate southern flanks of Dogskin Mountain are several springs, including Bedell, Willow, Matley, and Settlemeyer. These springs produce small flows that have historically been used for livestock water sources.

Existing Water Rights

Few water rights have been granted in Bedell Flat; however, the basin has been designated for preferred uses by the State Engineer. A review of the basin abstract from NDWR database (January 2003) indicates 9 active permits, as summarized in Table 1. The BLM holds 22.4 acre-feet of underground rights for stockwatering associated with an existing well in the central portion of the valley. Two permits have been granted for quasi-municipal and wildlife/commercial use in the extreme southern part of the valley, to the International Church of Christ and Animal Ark Wildlife Center. Total duty for Permit 53338 owned by the church in Bedell Flat is combined with Permit 50399 located in Antelope Valley. Together these permits are not to exceed 17.14 million gallons annually (mya), or 52.60 acre-feet per year (af/yr). Water use reported to the State Engineer for 2001 was 16.280 mya (49.96 af/yr) pumped from the Antelope Valley permit, with no development in Bedell Flat. Water use reported in year 2002 was reported at 17.144 million gallons, the full combined duty of both permits, pumped entirely from Antelope Valley. Because the full permitted duty of Permits 50399 and 53338 is currently being pumped in Antelope Valley, we assume most water under these permits will continue to be pumped from Antelope Valley in the future. The wildlife center has a permit allowing 2.03 af/yr of pumping. Total existing underground rights permitted in Bedell Flat is determined to be approximately 25 af/yr, subject to proof of beneficial use of the full permitted duties.



Legend

- Springs
- 100m Contour intervals
- Streams
- Roads and Trails
- Bedell Hydrographic Area Boundary, State
- Private parcels
- Public parcels

Project Site NEVADA

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InterFlow Hydrology, Inc.

Intermountain Pipeline, LTD
Reno, Nevada

Topography & Parcel Map

FIGURE 3

Table 1 - Summary of Existing Water Rights in Bedell Flat (NDWR Basin 94)

Permit / Application No.	Cert. No.	Filing Date (Year)	Source	Point of Diversion (Section-Township - Range)	Manner of Use	Diversion Rate (CFS)	Duty (AFA)	Owner of Record	Notes
7106	1604	1924	Juniper or Bird Spring	Sec. 6, T22N, R19E	Stockwater	--	0.92	Red Rock Ranch, LTD	
7713	1613	1926	Spring	Sec. 5, T22N, R19E	Stockwater	--	1.87	Red Rock Ranch	
7860	1763	1926	Willow Spring	Sec. 2, T23N, R19E	Stockwater	0.02	15.68	Settlemeyer, E.A.	
8105	1765	1927	Settlemeyer Spring	Sec. 35, T24N, R19E	Stockwater	0.02	15.68	Settlemeyer, E.A.	
46705	11969	1983	Underground	Sec. 22, T23N, R19E	Stockwater	0.03	22.43	BLM	
53338	--	1989	Underground	Sec. 35, T23N, R19E	Quasi-Municipal	0.07	52.60*	International Community of Christ Church	*Combined Duty with Permit 50399 in Antelope Valley
54998	13901	1990	Whitney Spring	Sec. 31, T23N, R19E	Stockwater	0.01	6.41	Feather River Ranch	
55384	13774	1990	Bedell Spring	Sec. 4, T23N, R19E	Stockwater	0.01	9.05	BLM	
65118	--	1999	Underground	Sec. 8, T22N, R19E	Wildlife	--	2.03	Animal Ark Wildlife Center	
Application 56541	--	1991	Underground Well BF-1	Sec. 9, T23N, R19E	Quasi-Municipal	2.50	--	Red Rock Estates, Inc.	Protested, no action to date
Application 66873	--	2000	Underground Well BF-2	Sec. 5, T23N, R19E	Municipal	1.50	--	Intermountain Pipeline, LTD	Protested

-- Indicates not reported in NDWR database

Six permits with certificates have been granted at springs in Bedell Flat, for stockwater purposes, totaling 49.62 af/yr. These permits are located at the southern edge of the valley at Whitney, Juniper and Bird Springs, and at the Settlemeyer Spring, Willow, and Bedell Springs, emanating from south side of Dogskin Mountain.

During the past 3 decades, permits have been granted for development of underground water for municipal uses in Lemmon Valley. However, the applicant failed to carry forth with perfecting the rights, and the permits were subsequently cancelled by the State Engineer due to lack of due diligence. Permits granted in the 1970s (26771, 26772, 30255, 30256, 30274 and 30275) had a combined duty not to exceed 589.77 mya (1,809.94 af/yr).

Existing Wells

A review of the NDWR well log database (January 2003) indicates 51 domestic wells have been drilled in Bedell Flat, all of which are in the southern-most portion of the valley. Occasionally, designated locations are incorrect on driller's logs, and subsequently some well logs are mis-located. Thirty-three well logs were confirmed to be correctly located in the Bedell Flat basin based on physical addresses on the well log. Nevertheless, there are a substantial number of domestic wells that have been drilled in past 10 years in the southern portion of Bedell Flat, along Red Rock Ranch Road, as part of the Red Rock Estates subdivision. Typical domestic well diameter is 6-inches and depths range from 150 feet to 844 feet, with reported depths to ground water ranging from 35 feet to 678 feet. These domestic wells have been completed in a fractured bedrock environment.

Other non-domestic wells in Bedell Flat include the Animal Ark Wildlife Center well on the southern edge of basin and a BLM stockwater well in the central portion of the basin (Section 22, T23N, R19E). The BLM well is reported to have been completed in 1959 to a depth of 224 feet, with a static water level of 207 feet. Predominantly clay was encountered with interbedded thin layers of gravel and sand. Depth to water in this well was measured in August 2002 at 180 feet below ground surface, and the ground surface elevation was surveyed at 5,088.43 feet above mean sea level (msl) by Tri State Surveying in January 2003 (top of casing at 5,089.28 feet msl).

Two production wells were drilled in the 1970s in the northwestern portion of the basin, in pursuit of developing ground water for proposed municipal use in Lemmon Valley. These wells were drilled by the Red Rock Ranch developers and were the subject of geologic evaluation and aquifer test analyses by SEA, Incorporated (Arden and Peterson, 1978). Well BF-1 was drilled in 1972 to a depth of 950 feet, encountering granite bedrock at 944 feet. The well was completed with 16-inch diameter mill-slot perforated casing, and a 3/8-inch pea gravel filter pack. The well was pump tested in 1978 at rates ranging from 180 to 690 gallons per minute (gpm). Static water level was reported at 53.2 feet below ground surface.

Ground surface at well BF-1 (Section 9, T23N, R19E) was surveyed by Tri State Surveying at 4,949.83 feet msl (top of casing at 4,950.47 feet msl). Depth to water in January 2003 was measured at 46.4 feet below ground surface (oil was noted on the water surface in the well).

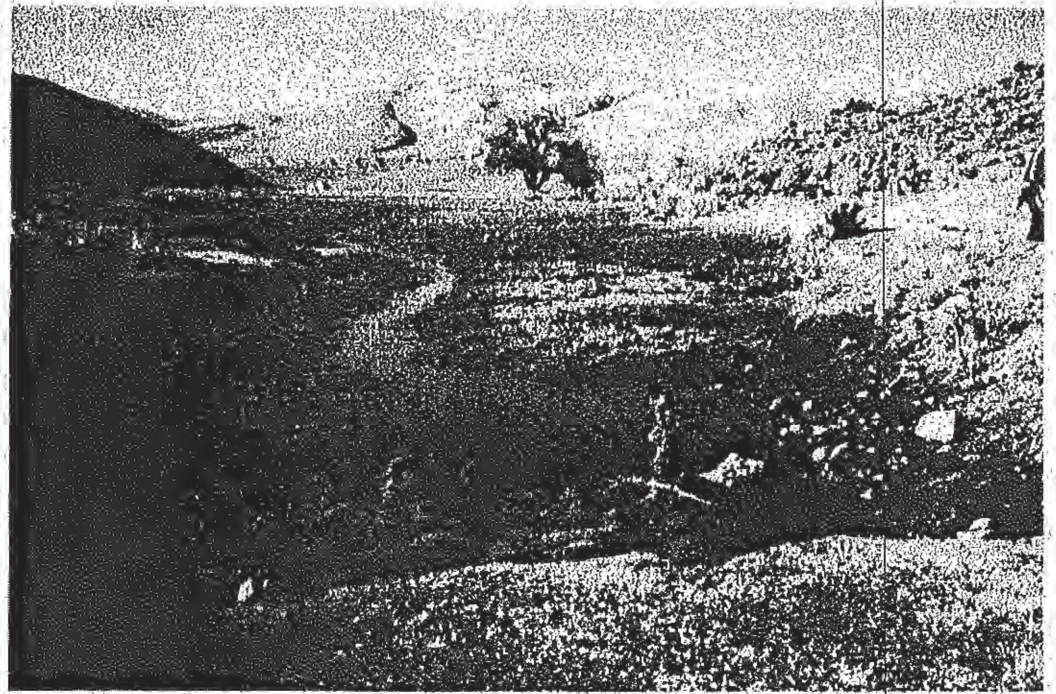
Well BF-2 was completed in 1978 to a depth of 400 feet and is located 5,017.5 feet northwest of Well BF-1. The well was built with 12-inch diameter casing, using 160 feet of Johnson wire-wrap screen and Monterey as a sand filter pack (Figure 4). Well BF-2 was test pumped at rates ranging from 200 to 450 gpm. Static water level was reported at 63 feet below ground surface. The well head elevation at BF-2 (Section 5, T23N, R19E) was surveyed by Tri State Surveying at 4,941.94 feet msl at ground surface and 4,944.23 feet msl at the top of casing. The well cap has been removed and debris plugs the well

Well BF-1 facing south, with central Bedell Flat and Fred's Mountain in the background.

Well BF-2, facing north with western Dogskin Mountain in the background.

InterFlow Hydrology, Inc. Hydrogeology and Water Resources Consulting	Intermountain Pipeline, LTD	IFH Report No. 2003-03
	Figure 4a – Photographs from Bedell Flat	

BLM stockwater well in central part of Bedell Flat, facing east.



Campbell Ranch spring facing west toward Seven Lakes Mountain and Red Rock Valley.

InterFlow Hydrology, Inc.

Hydrogeology and Water Resource Consulting

Intermountain Pipeline, LTD

IFH Report No. 2003-03

Figure 4b – Photographs from Bedell Flat

casing at approximately 60 below ground surface, precluding any current depth to water measurements.

The production wells BF-1 and BF-2 are shown in Figure 4a and will be discussed in more detail later in this report, including discussion of pumping tests results, aquifer transmissivity calculations, and water chemistry analyses.

Other wells reported in the literature and databases include:

1. A Red Rock Ranch well in southwest corner of the basin (Section 31, T23N, R19E, possibly near Whitney Spring) drilled in 1944 to 69 feet with a static water level of 12 feet (cited by Maxey, and others, 1966, and Rush and Glancy, 1967).
2. A BLM well in the far southern portion of the basin Section 4, T22N, R19E) drilled to 390 feet with a depth to water of 300 feet (Rush and Glancy, 1967).
3. A domestic well drilled in 1954 approximately 1-mile to the east-northeast of the BLM well (in Section 23, T23N, R19E) to a depth of 60 feet with a reported depth to water of 44 feet (Rush and Glancy, 1967).
4. A reported 6-inch diameter well in the north-central portion of the valley (Section 15, T23N, R19E) at the point of diversion for Permit 30274, completed to 182-feet in depth, as cited in the Proof of Completion of Work filed at the State Engineers office for Permit 30274.

Wells listed as 3 and 4 above would prove valuable for data collection, if their existence could be confirmed. Our field reconnaissance included a search for these wells, without avail. We believe the well cited by Rush and Glancy (1967) probably has an incorrect location designation on the well log. No private property exists (or existed in the mid-1960s) in the center of the valley and no evidence of an abandoned residence could be found. In regards to the other reported well, no well log was on file at NDWR, and no well could be located in the vicinity of the specified point of diversion. We did however note that an exploration borehole was drilled at the point of diversion (TH-1) as reported by Arden and Peterson (1978). The exploration hole was drilled to 850 feet in depth, encountering predominantly clay below 200 feet in depth. No casing is reported to have been installed during exploration drilling.

Table 2 presents a summary of existing well data for Bedell Flat. Only domestic well logs that have physical addresses in Bedell Flat are listed (confirmed to be correctly located within the basin), and are representative of domestic wells on the southern edge of the basin.

Table 2 - Summary of Wells in Bedell Flat (NDWR Basin 94)

Owner (As indicated on NDWR Well Log)	Physical Location	Year Drilled	Legal Location Township (N), Range (E), Section, 1/4, 1/4				Ground Surface Elevation at Well (ft)	Total Depth of Well (ft)	Depth to Water (ft)	Elevation of Water Table (ft)	Diameter of Well (inches)	Well Type	Permit or Log No.
Red Rock Ranch Inc.	BF-1	1972	23	19	9	NW NE	4949.83	950	53.2 (46.4)	4896.63 (4903.43)	16	Municipal	P26274
Red Rock Ranch Inc.	BF-2	1978	23	19	5	SE SE	4941.94	400	63 (+60)	4878.94 (-4881.94)	12.75	Municipal	P30275
Bureau of Land Management	BLM	1959	23	19	22	SE SW	5089.28	224	180	4909.28	6	Livestock	4830
Nolan	15085 Gooding	2000	22	19	5	SE SW	5580	165	48	5530	6.625	Domestic	81069
Campana	15110 Gooding	1998	22	19	5	SE SW	5580	245	185	5393	6.625	Domestic	71904
Parmenter	Gooding Drive	1998	22	19	5	SE SW	5580	150	35	5543	6.625	Domestic	71896
Lienhard	Gooding Drive	1997	22	19	7	NE NE	5580	516	130	5448	6 5/8, 5	Domestic	67871
Lampman	Gooding Drive	1995	22	19	8	NW NW	5580	200	57	5521	6.625	Domestic	49391
Schlarb	100 Desert Sun	1997	23	19	7	NE SW	5580	140	59	5519	6.625	Domestic	7812
Poe	445 Desert Sun	1998	23	19	7	NW NW	5580	395	130	5448	6.625	Domestic	71877
Poe	446 Desert Sun	1998	23	19	7	NW NW	5580	295	75	5503	6.625	Domestic	71877B
Leach	Desert Sun	2000	23	19	6	SW SE	5580	150	53	5525	6.625	Domestic	82625
Leach	Desert Sun	2000	23	19	6	SW SE	5580	150	50	5528	6.625	Domestic	82619
Mackin	100 Britt Rd.	2001	22	19	7	NW NW	5740	275	67	5675	6.625	Domestic	88293
Raatz	200 Britt Rd.	1990	22	19	7	NE NW	5740	280	62	5680	6	Domestic	35012
Etcheverry	300 Britt Rd.	1994	22	19	6	NE SW	5740	225	61	5681	6.625	Domestic	46652
Beaumont	400 Britt Rd.	2001	22	19	7	NW NW	5740	300	48	5694	6.625	Domestic	84920
Red Rock Ranch Inc.	1200 Bedell	1989	22	19	7	NE NW	5740	310	454	5288	6	Domestic	32900
Red Rock Ranches, Ltd	--	1967	22	19	7	SE SW	5820	317	140	5684	6.625	Domestic	9789
Bouchard	1205 Bedell Rd.	1995	22	19	7	NE SE	5740	200	55	5687	6.625	Domestic	49837
Garza	1215 Bedell Rd.	2001	22	19	7	NW SE	5740	240	67	5675	6.625	Domestic	83820
Richards	1230 Bedell Rd.	1995	22	19	7	SE NE	5740	185	47	5695	6.625	Domestic	49390
Giles	Bedell Rd.	2001	22	19	7	NE SE	5740	200	61	5681	8.625	Domestic	83818
Nelson	Graham Lane	1994	22	19	7	SW SE	5820	275	155	5669	6.625	Domestic	46297
Brimhall	1260 Deerlodge	1992	22	19	8	SE NW	5740	455	302	5440	6	Domestic	39225
Animal Ark Wildlife Center	1265 Deerlodge	1999	22	19	8	SE SE	5740	973	650	5092	6.625	Domestic	78393
Warner	1285 Deerlodge	1988	22	19	8	NE NE	5740	600	298	5444	6.625	Domestic	30542
Cary	1290 Deerlodge	1993	22	19	8	NE NW	5740	880	470	5272	6.625	Domestic	42754
Reslock	Deerlodge Rd	1991	22	19	8	NE NW	5740	615	275	5467	6	Domestic	37903
Saunders	Deerlodge Rd	1996	22	19	8	NE SW	5740	710	315	5427	6.625	Domestic	64885
Singley and Anderson	106 Cobalt Lane	1994	22	18	12	SE SE	5820	300	183	5641	6.625	Domestic	45900
Red Rock Estates Inc.	SE Corner of Red Rock & Bedell Rd.	1985	22	19	7	NW SE	5820	350	65	5759	6.625	Domestic	26374
Brannon	1500 Dixie Lane	1990	24	18	36	NE NE	4840	162	30	4809	6	Domestic	33017
Sharpe	1705 Dixie Lane	1998	24	18	36	NW SE	4840	398	88.5	4751	6.625	Domestic	74762
Bloom	Ruby Hill Rd	2000	23	19	35	SE SE	5410	650	505	4909	6.625	Domestic	79562
Gailson	Ruby Hill Rd	2000	23	19	35	NE SE	5410	650	430	4984	6.625	Domestic	79561

Previous Studies and On-going Work

Works of direct significance to the hydrogeology of Bedell Flat are summarized in the following paragraphs.

Maxey, Mifflin, Domenico and McLane, 1966, Geology and Water Resources of Red Rock Ranch, 48 pages.

George B. Maxey, as lead scientist, conducted a reconnaissance-level evaluation of the water resources of Red Rock Ranch, which included Bedell Flat. Most current private property in Bedell Flat was once part of the Red Rock Ranch, and the public lands were used for livestock grazing. Work by Maxey, and others, included an appraisal of existing water development on the ranch, an estimate of recharge to Bedell Flat, data on springs throughout the ranch, an estimate of the magnitude of agriculture that might be sustainable in Bedell Flat, and general summary of the geology and hydrology of the region.

Rush and Glancy, 1967, Water-Resources Appraisal of the Warm Springs-Lemmon Valley Area, Washoe County, Nevada, 70 pages with 2 plates.

In November of 1967, the USGS published this reconnaissance appraisal of 11 valleys north of Reno, Nevada, covering an area of approximately 900 square miles. Bedell Flat and all neighboring valleys were part of the study. This study provided estimates of ground water recharge and discharge for each valley, and provided "preliminary estimates" of perennial yield. It is important to recognize that this work, while comprehensive, was very reconnaissance in nature. A total of 10 days of field work spread over the entire 11 basin study area form the basis for field observations. Bedell Flat, being undeveloped and relatively small in size, undoubtedly received a proportionate level of attention. At the time of this study, only one well was known to exist in Bedell Flat. Nonetheless, this reconnaissance-level work represents a good first-order approximation of the water resources for each basin in the study area.

Bonham, 1969, Geology and Mineral Deposits of Washoe and Storey Counties, Nevada, 140 pages.

The Nevada Bureau of Mines and Geology published a geologic map for the region at 1:250,000 scale. This geologic mapping includes basic rock types in the mountain blocks surrounding Bedell Flat, and shows major faults in the valley. Mineral resources of the region are discussed.

Arden and Peterson (SEA, Incorporated), 1978, Groundwater Investigations, Bedell Flat, Washoe County, Nevada, 18 pages with appendices.

This work provides a summary of exploration drilling (2 holes), production well construction (1 new well), and pumping tests for wells BF-1 and BF-2 completed in the northwest portion of Bedell Flat. This work defined the depth to bedrock and hydraulic characteristics in the northwestern portion of the valley, provides basic ground water chemistry data, presented an estimate of perennial yield, and made recommends for production well pumping.

Berger, Ponce, and Ross, 2001, Hydrogeologic Framework of Antelope Valley and Bedell Flat, Washoe County, West-Central Nevada, 11 pages with 1 plate.

This USGS study, prepared in cooperation with WCDWR, evaluated the hydrogeologic structure of Bedell Flat, including thickness of basin-fill materials using gravimetric and seismic-refraction geophysical methods.

WCDWR – ongoing data collection.

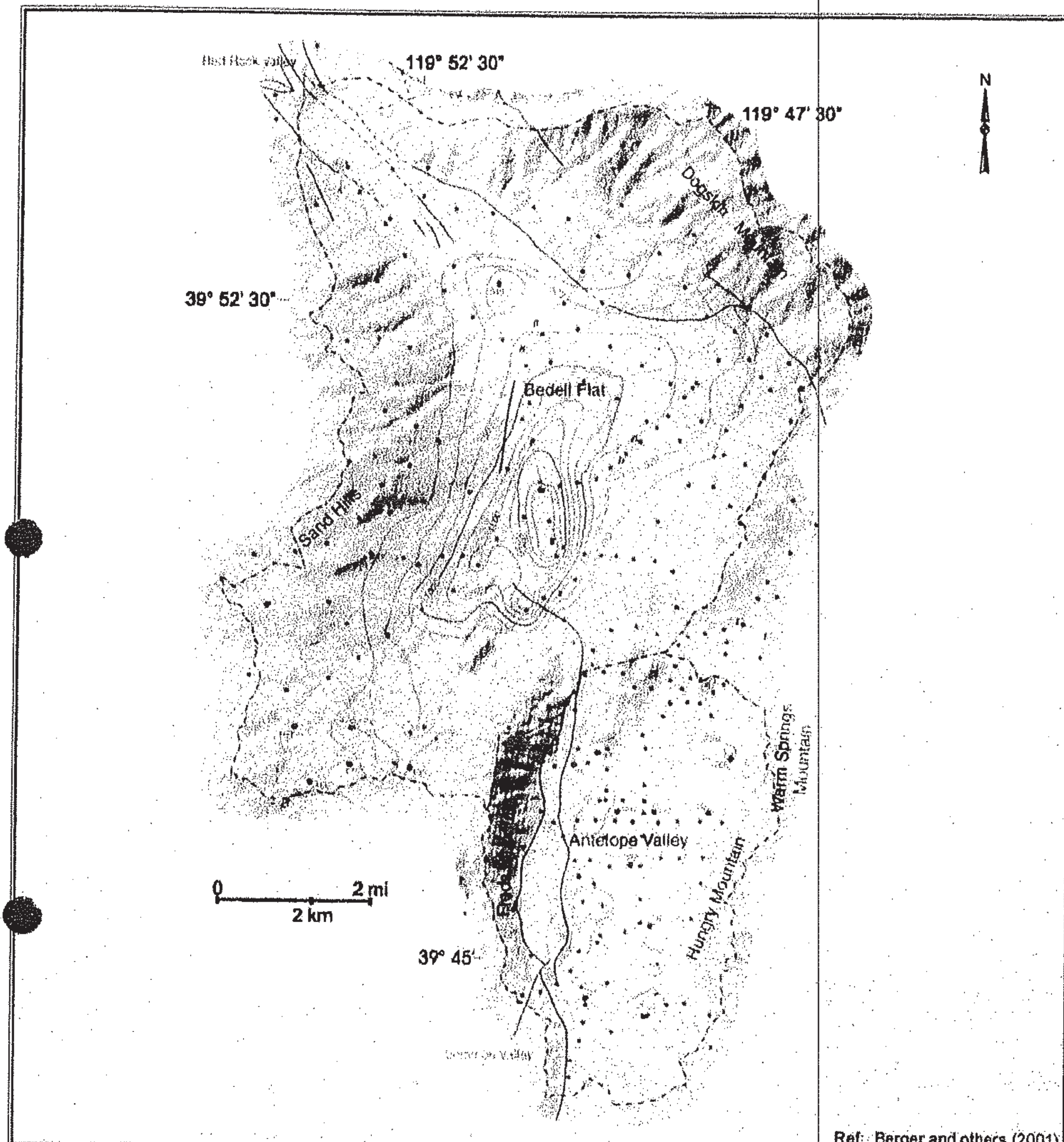
Washoe County Department of Water Resources is currently collecting precipitation data from 8 stations installed in Bedell Flat late in 1999. Data collection is on-going and is planned to continue for two more years. Water chemistry testing from springs on the southern flanks of Dogskin Mountain has also been conducted by WCDWR. This data collection and the 2001 study completed by the USGS (Berger, and others, 2001) is part of an on-going WCDWR program to assess water resources in basins in southern Washoe County.

Geologic Setting

Bedell Flat is within both the Great Basin and the Basin and Range Province as defined by Fenneman (1931). The valley is generally oriented in a north-south direction, as is typical of Great Basin valleys. However, the valley floor exhibits a northwest orientation in the northern portion, with a perpendicular northeast orientation in the south (Figures 2 and 5). Basins in the vicinity (including Warm Springs Valley and Dry Valley) also exhibit a northwest orientation, resultant of the northwest trending Walker Lane Shear (fault) Zone. Berger and others (2001) described the valley as lying in a transitional zone between the Sierra Frontal Fault Zone and the Walker Lane Shear Zone, citing interpretations of Bell (1981).

The oldest rock outcrops in the basin occur near the southeastern basin boundary in a part of Fred's Mountain, and are Triassic and Jurassic age (248 to 144 million years ago-mya) metamorphic rocks of volcanic origin (Peavine Sequence as described by Bonham, 1969). The majority of the mountain blocks bounding the basin are granitic intrusive rocks of Createous age (144 to 65 mya). The Sand Hills, Dogskin Mountain, much of Fred's Mountain and the unnamed hills on the eastern side of the basin are composed of this granite. Younger volcanic rocks can be found overlying the granitic rocks on the western part of Dogskin Mountain, and a small part of Fred's Mountain. These volcanic rocks are part of the Hartford Hill Rhyolite, which is composed primarily of ash-flow tuffs (Bonham, 1969).

Alluvial valley fill covers bedrock in the central portion of the valley, and was derived by erosion of the surrounding mountains. The alluvium has been divided into an older



Legend

Younger basin-fill deposits (Quaternary)

Older basin-fill deposits (Quaternary and Tertiary)

Volcanic rocks (Tertiary)

Plutonic rocks (Jurassic/early Tertiary?)

Metamorphic rocks (Triassic and Jurassic)

Line of equal combined thickness of basin-fill deposits and volcanic rocks

Intermittent Stream

Boundary of topographic area

Fault

Well that penetrates to the base of the basin-fill deposits and volcanic rocks

Gravity Station

Project Site

www.digitalmappingsolutions.com

InterFlow Hydrology, Inc.

Intermountain Pipeline, LTD
Reno, Nevada

Geology Map

FIGURE 5