K.D. Schmitt

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IMPACTS DETERMINATION
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CITY OF MESA NORTHWEST WATER RECLAMATION PLANT IMPACTS DETERMINATION REPORT

Prepared for:

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June 5, 1995

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1.0 EXECUTIVE SUMMARY

The City of Mesa (COM) through John Carollo Engineers (JCE), has contracted HydroSystems, Inc. (HSI) to determine the impacts, if any, from the operation of the COM's Northwest Water Reclamation Plant (NWWRP) Recharge project. Of particular concern are any possible negative impacts (pollutant migration) to the adjacent Indian Bend Wash-South (IBW-South) Superfund Site.

Historic impacts from the operation of the NWWRP were assessed from the start of plant operation in December of 1990 to December of 1994. This analysis is based on the actual annual volume of water recharged which is approximately 3,941 acre-ft versus the permitted volume of 8,963 acre-ft. Projected impacts are based on the worst case scenario of storing the full permitted volume of 8,963 acre-ft for the remaining 16 year life of the permit (1994 through 2010).

The results of the study clearly show that the overwhelming stress on the hydrologic system in the project site is caused by releases from Granite Reef Dam located approximately 12 miles upstream from the NWWRP recharge project. When the Salt River flows, water infiltrates into the vadose zone and causes water levels in wells to rise significantly (up to 30 feet) due to one season of flow, and causes the hydraulic gradient to change in the vicinity of the recharge project from west to west-southwest, south of the recharge project and north to north-west, north of the bed of the Salt River.

Any artificial groundwater recharge that occurs due to the operation of the NWWRP is totally overcome by these Salt River flows. Theoretical results versus actual responses in project monitor wells are representative of the river data and not of the mounding. The modeling results indicated that a 15 foot rise in water level directly beneath the percolation ponds would occur if there were no other stresses on the hydrologic system, and the aquifer was homogeneous, isotropic, and of infinite extent. This however, was not the case and water levels have risen a total of about 50 feet since the recharge project began operation. Only the releases from Granite Reef Dam can contribute that much water to the aquifer to cause such a rise in water levels, the effects of which is seen at the present time. Therefore, current recharge impacts do not presently affect the IBW-South Superfund Site.

In order to assess the impacts from the continued operation of the project a "worst case" scenario that incorporated the permitted volume of water over the existing life of the project was evaluated. This is an unrealistic assessment due to the fact that the existing percolation ponds cannot achieve the permitted recharge volume, only half that. Groundwater pumpage was not taken into consideration, nor projected river recharge. Under this "worst case" assessment, the projected rise in water level or mounding would extend approximately 12 miles in all directions away from the site. Also, a groundwater rise of about 36 feet would occur directly beneath the percolation ponds.

As stated above, the impacts due to the continued operation of the NWWRP recharge project are somewhat unrealistic in that the current percolation ponds are about half as efficient as what they were permitted for. If the COM is to fully utilize the permitted volume of water, then the project should be modified in such a way as to spread the recharge over a greater area thus reducing the long term impacts of recharging the groundwater system directly beneath the existing recharge ponds.

2.0 INTRODUCTION

In 1989 the COM applied for and received what is now termed a Constructed Underground Water Storage Facility Permit[1] and Associated Water Storage Permit to store 8,963 acre-ft of treated effluent per year at the COM's NWWRP recharge project. Copies of these new permits are provided in *Appendix A*. The COM has operated the NWWTP Underground Storage Facility (recharge project) since December of 1990. The COM stores approximately 3,941 acre-ft/yr of effluent with this project. As originally envisioned the project would store water essentially on an annual basis recovering the water from several recovery wells to be located in close proximity of the recharge project. This project was not envisioned as a long term storage project, rather the COM intended to recover the same amount of water that they had stored during the prior year.

The COM has been storing water and accumulating recharge credits since the project began. Although the impacts have been minimal due to the project operation, the COM has not operated the project pursuant to the conditions stated in the Arizona Department of Water Resources (ADWR) original and subsequent permits. The COM, with this report will provide the documentation needed to allay agency concerns regarding the mounding analysis and any impacts from historic and future project operation

2.1 Scope of Work

HSI was retained by the COM through JCE to determine the current impacts of operating the NWWRP recharge project and to determine if and how the operation of the project has affected the IBW-South Superfund Site. This work was accomplished by the following tasks:

[1]The COM originally received an Underground Storage and Recovery permit No. 64-518105. With a change in statute, these permits were converted on December 30, 1994 to the permit the COM currently holds, which is a Constructed Underground Water Storage Facility Permit and Water Storage Permit, permit No. 73-518105.

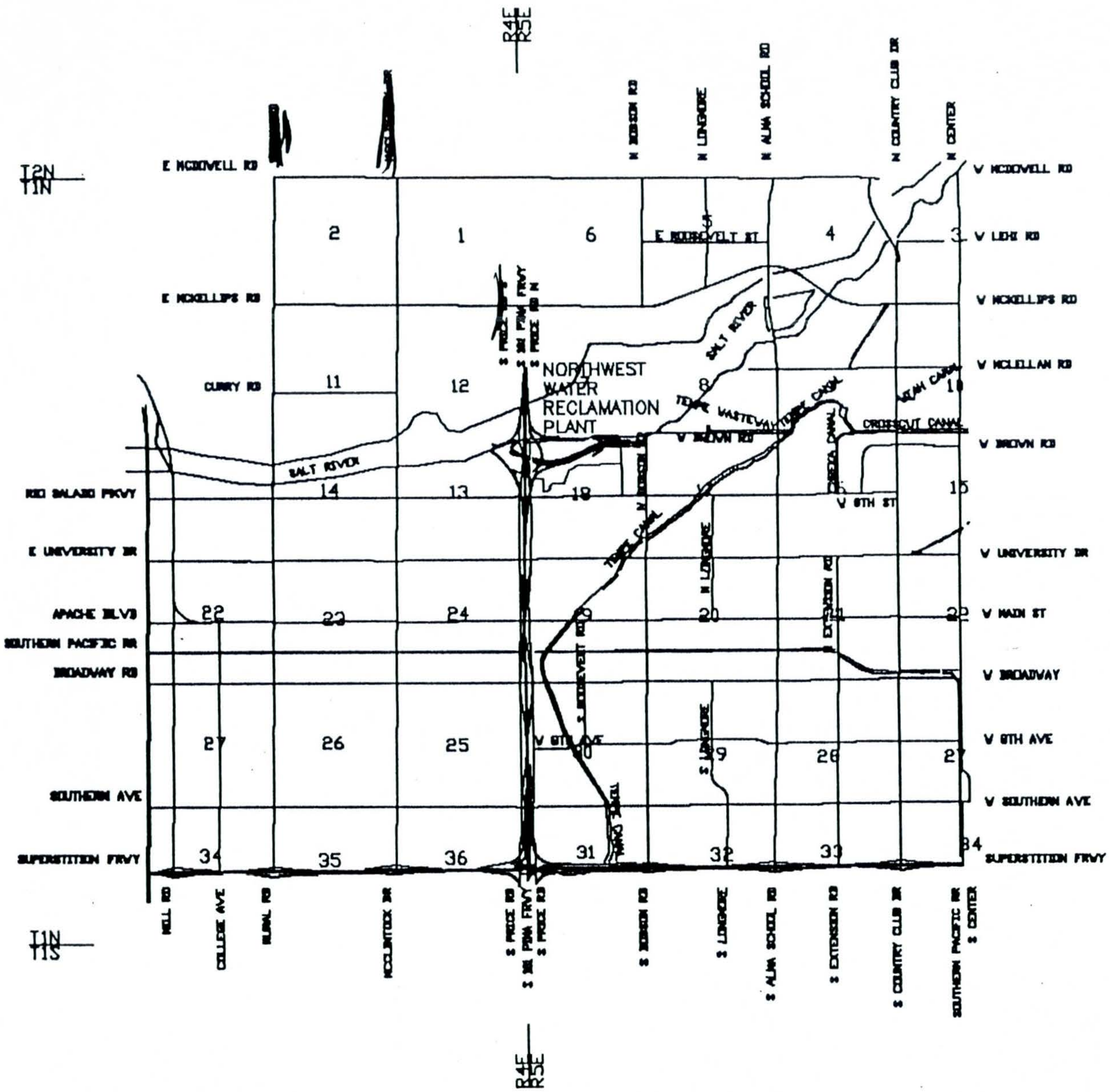
1. Review existing recharge site data and information. This included reviewing existing ADWR file data and COM water level and water quality data as collected pursuant to their existing ADWR permit.
2. Review existing project area hydrologic data from 1986 to the present. This included reviewing IBW-South data and evaluating historic mound impacts due to project operation.
3. Evaluate mounding data and information. This included projecting the mounding analysis for the remaining 16 years of project operation, evaluating the effects of river recharge, determining recharge site impacts on the IBW-South site, and determining any water quality changes as a result of project operation.
4. Final report to the COM.
5. Review of report with ADWR.

This report provides the results of the above mentioned tasks 1 through 4.

2.2 Site Description

The NWWRP is located in the COM northwest of the Riverview Golf Course and Park on 8th Street between Dobson Road and the Pima Freeway (Loop 101) (*Figure 1*). Directly north of the plant and recharge facility lies the normally dry Salt River bed. Directly to the west of the recharge facility, the Pima Freeway and Red Mountain Interchange are currently under construction (*Figure 2*). South of the recharge facility is the Riverview Golf Course and east are the buildings of the NWWRP site.

Figure 2 shows the monitor well locations for the project and the location of each of the percolation ponds. Cell No. 1 is directly in the path of the Pima and Red Mountain Freeway Interchange and will be destroyed due to this construction. Also, monitor well NW-1 has not been



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City of Mesa Northwest Water Reclamation Plant Location Map and Project Site Boundaries

Not to Scale

May 31, 1995
Figure 1

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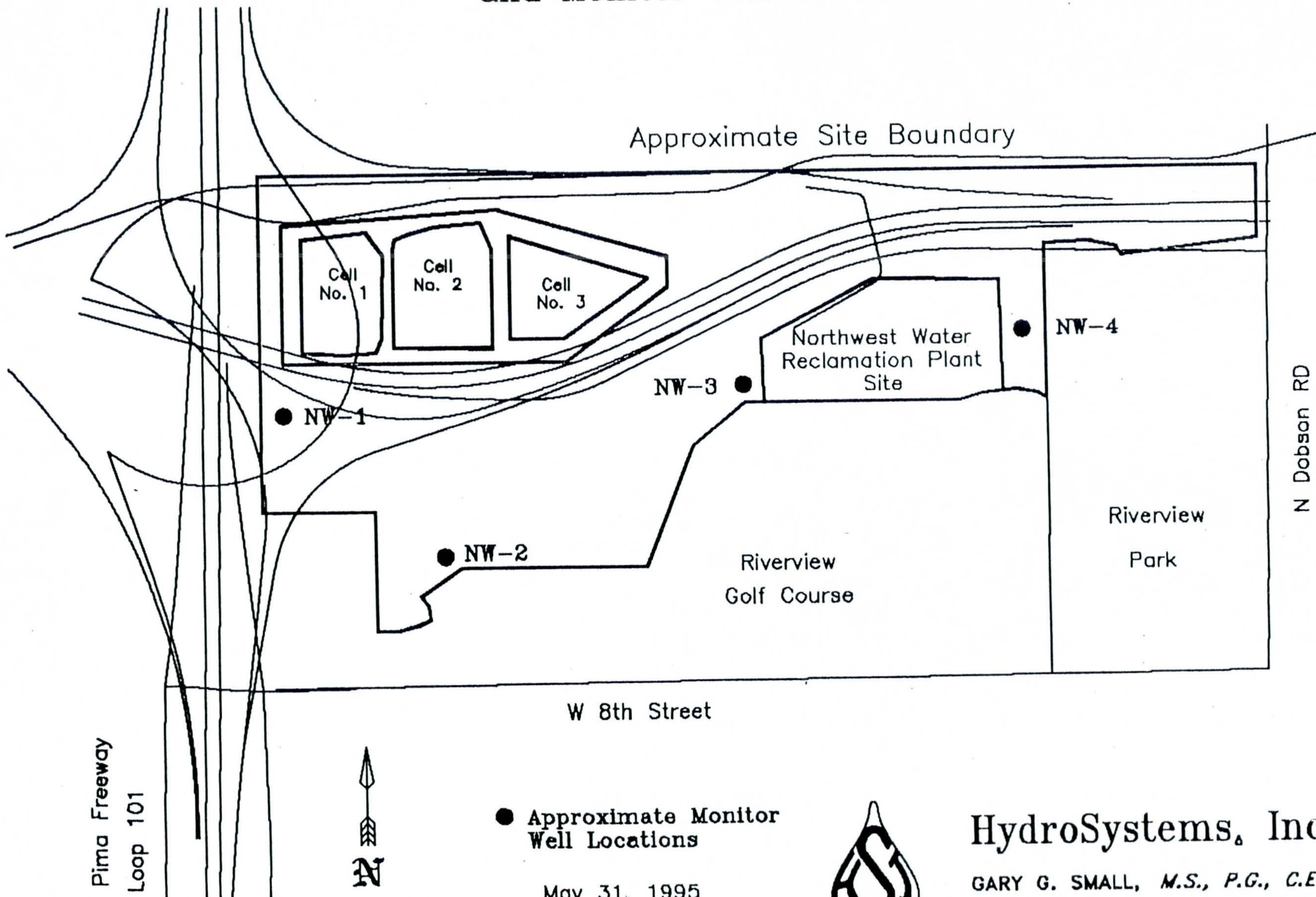
Northwest Water Reclamation Plant Site Map Showing Percolation Ponds and Monitor Well Locations



Not To Scale

May 31, 1995

Figure 2

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monitored since July 10, 1992 due to the construction process, however, once construction is completed, access will be provided to this well and it will again be monitored. The additional monitor well locations for wells NW-2, NW-3, and NW-4 are shown on *Figure 2*.

Three percolation ponds were constructed in the fall of 1990. Percolation pond cell 1 is furthest to the west, followed by cell 2, in the center, and cell 3 furthest to the east. Each pond varies in size due to the shape of the ponds that were constructed. Percolation pond cell 1 is the largest and covers an area of 424,710 ft^2, or 9.75 acres. Percolation pond cell 2 covers an area of 383,764 ft^2, or 8.81 acres, and cell 3 is the smallest covering as area of 367,211 ft^2, or 8.43 acres. Each of the pond cells were constructed to have a bottom elevation of 1,160 ft above mean sea level (m.s.l.). The percolation ponds are bermed to an elevation of 1,180 ft above m.s.l. around the perimeter of the ponds. This berm also acts as an access road. A much smaller north-south berm separates each of the percolation pond cells. These smaller berms are three feet higher than the bottom of the cells.

2.3 Hydrogeology

The site hydrogeology was characterized by Kenneth D. Schmidt and Associates (KSA, 1987a) in a report prepared for the COM provided with the original permit application. KSA (1987a) describes three major geologic units present within the project site. These units included the Upper Alluvial Unit (UAU), the Middle Alluvial Unit (MAU), and the Lower Alluvial Unit (LAU). The UAU is reported to be approximately 125 to 150 feet thick (KSA, 1987a) and is the uppermost unit consisting of boulders, cobbles, gravel, and sand deposited by the ancestral Salt River. The analysis conducted and presented in this report focus on the UAU.

The MAU underlies the UAU and is reported to be between 400 to 600 feet thick extending

550 to 750 feet below land surface (KSA, 1987a). The MAU is a finer-grained deposit consisting of clay, sandy clay and mixtures of fine sand, silt, and clay. The LAU is underlying the MAU extending to a depth exceeding 1,200 feet in the vicinity of the site (KSA, 1987a). The LAU consists of indurated sands and gravels.

The design capacity of the recharge facility was for 8 mgd with a vertical permeability of approximately 5.3 ft/d. KSA (1987a) stated that at the 23rd Avenue recharge site, the vertical permeability of the UAU was only about 2 percent of the horizontal permeability. At the Mesa site, KSA (1987a) reported that a horizontal permeability value of 2,000 gpd/ft^2 was used to evaluate the potential mound buildup. The KSA addendum (1987b) to the KSA (1987a) report for the COM, reported values for the infiltration rate that ranged from 1.0 ft/d to 2.5 ft/d (these data were based on reported information from the Flushing Meadows Project, 23rd Avenue site).

Infiltration rates reported by Dames & Moore (1994) ranged from 0.3 to 0.4 ft/d. These rates were based on several soil borings at the site and laboratory analysis of the soil samples from these borings. The average hydraulic conductivity values reported by Dames & Moore (1994) ranged from 10^{-3} cm/sec (2.8 ft/d) to 10^{-5} cm/sec (0.028 ft/d), with the average value estimated at 10^{-4} cm/sec (0.28 ft/d).

Aquifer parameter data were reported in the KSA (1987a) report and by Dames & Moore (1994) from work that was done on site for the COM. These data are presented in *Table 1*, below. The transimissivity (T) data were from SRP production well tests and Motorola Mesa monitor well aquifer tests, as reported by KSA (1987). Reported T-values from the SRP well tests ranged from 75,000 gpd/ft to 105,000 gpd/ft. UAU T-values averaged 133,000 gpd/ft, and LAU T-values averaged 77,000 gpd/ft. T-values for the Motorola monitor wells ranged from 70,000 to 220,000

Table 1. Aquifer Parameter Data for the Northwest Water Reclamation Plant Site						
Well ID	**Piezometer or Well Depth (ft)**	**Piezometer or Well Screened Interval (ft-ft)**	**Perforated Interval (ft)**	**Transmissivity Values (gpd/ft)**	**Range of Storage Coefficient Value (Dimensionless)**	**Specific Capacity (gpm/ft)**
MOW-1A MOW-2A	70	50-70		105,000- 815,000	2.7×10^{-2} - 2.3×10^{-1}	
MOW-1B MOW-2B	110	90-110		150,000- 430,000	1.4×10^{-3} - 5.4×10^{-3}	
MOW-1C MOW-2C	150	130-150		45,000- 75,000	1.9×10^{-4} - 3.0×10^{-4}	
MOW-1D MOW-2D	260	210-260		60,000- 65,000	4.3 x 10[illegible] - 5.0×10^{-4}	
23E-2.9N			150-457	165,000		119
24.3E-3N			145-720	80,000		24
24.5E-2.5N			160-685	76,000		45
25E-3.1N			170-682	75,000		37
25.5E-3.5N			150-585	128,000		85
26E-3.9N			80-438	107,000		63
MW-2				82,000		62
MW-9				115,000		225
MW-11				107,000		30
MW-12				217,000		36
MW-14				70,000		22

A blank space signifies missing data.

gpd/ft, and averaged 120,000 gpd/ft. KSA (1987a) also reported an estimated storage coefficient for the UAU to be 25 percent.

Dames & Moore (1994) constructed a reclaimed water production well and associated nested monitoring wells. Aquifer tests were performed on the newly constructed wells and the results are reproduced in *Table 1*. T-values ranged from 105,000 to 815,000 gpd/ft for upper UAU wells, 45,000 to 75,000 gpd/ft for lower UAU wells, and 60, 000 to 65,000 gpd/ft for MAU wells. Storage coefficient values ranged from 10^{-1} to 10^{-4}. Thess data are based on preliminary analysis for site specific tests.

2.4 NWWRP Recharge Project Operation

As stated previously, the NWWRP has been operating since December of 1990, pursuant to ADWR permit No. 74-518105 (*Appendix A*). Each percolation pond has been monitored separately in order to comply with the permit conditions and to determine the volume of water that has been recharged. *Figures 3* through *5* graphically represent the average volume of water recharged in million gallons per month (MG/month) (plotted on the left y-axis) and the infiltration rate in ft/d (plotted on the right y-axis), for each percolation pond 1, 2, and 3, respectively. The percolation pond performance data are provided in *Appendix B*. *Figure 6* is a graph of data from all three percolation ponds combined. This figure shows the average infiltration rates to be from 0.1 ft/d (January, 1992) to 0.6 ft/d (November, 1991). The four year average infiltration rate is 0.4 ft/d. This operational infiltration rate was confirmed by a study by Dames & Moore (1994) that determined the in-situ infiltration rates for the soil at the NWWRP ponds. Dames & Moore (1994) derived infiltration rates of between 0.3 to 0.4 ft/d. This only confirmed the operational rates that the COM was actually getting at the site. Very little surface maintenance is done within the percolation ponds, because it was assumed that the fine grained nature of the subsoils was the limiting factor and not surface plugging due to algae, siltation, or other such problems. [redacted]

[redacted]

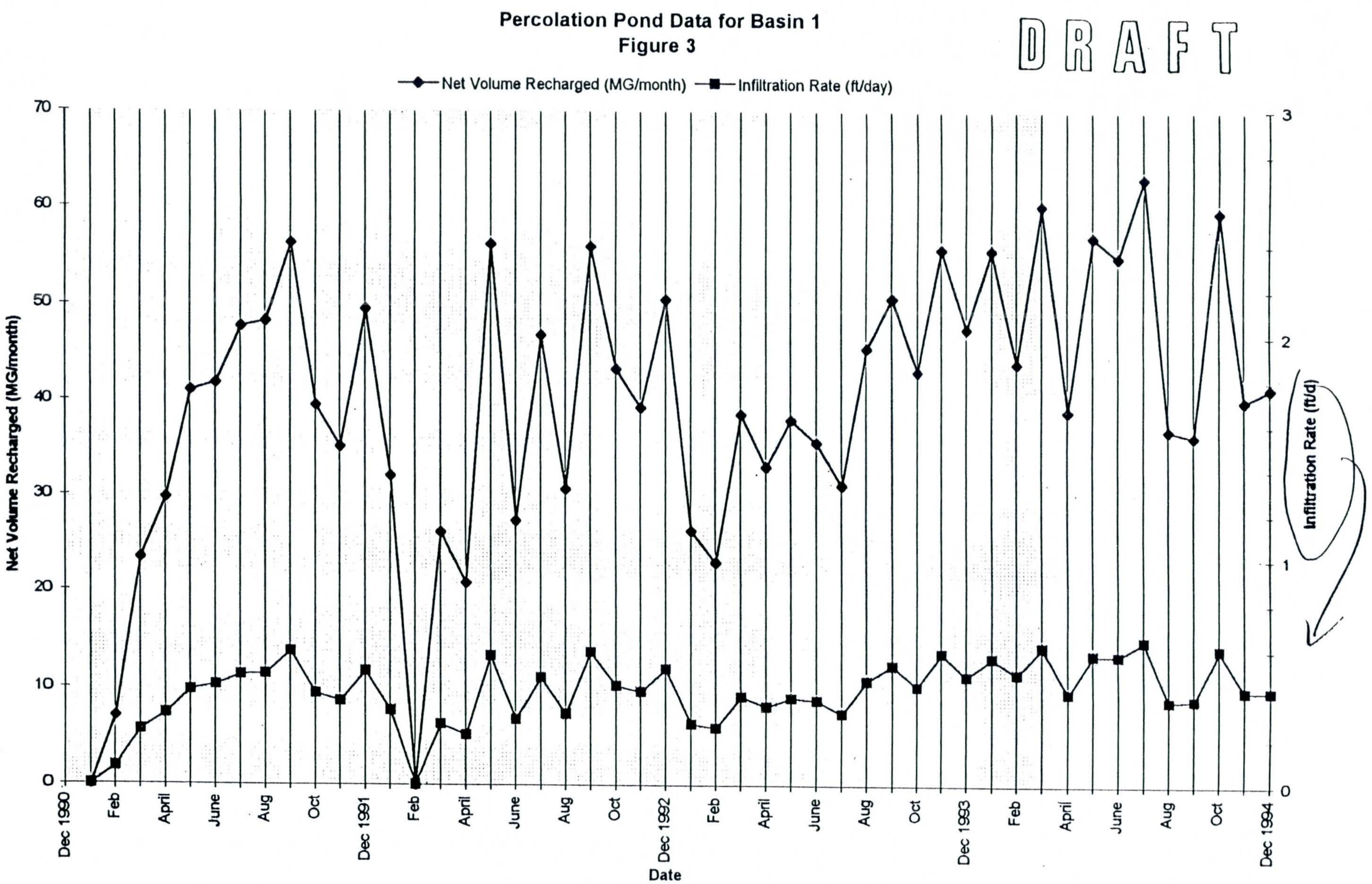
3.0 HISTORIC IMPACTS

Much data has been collected for the recharge project by the COM pursuant to their ADWR permit. These data include infiltration rates for each percolation pond (as shown in *Figures 3* through *5, Appendix B*), water level data for both the monitor wells and the percolation ponds, and water quality data from the monitor wells (*Appendix C*). There has been little if any maintenance done on the ponds to increase the infiltration and recharge capacity. However, it is unlikely that maintenance would have helped due to the lithology present at the site itself.

In addition to the data collected at the NWWRP recharge project, data were obtained from reports generated for the IBW-South Superfund Site, Motorola Mesa, and from ADWR file data, and Salt River Project (SRP). Information from the IBW-South Superfund Site is very useful in providing unit-specific water level information. These data allow evaluation of the upper aquifer in response to releases from Granite Reef Dam, from the impacts of recharge at the NWWRP, and other hydrologic stresses that may be occurring in the project area. Also, several years worth of unit-specific water level data have been collected at the Motorola Mesa Plant, located to the southeast of the project site (*Figure 1*). SRP provided flow release data for Granite Reef Dam. These data provided the foundation for the determination of historic impacts from project operation from December of 1990 to December 1994.

3.1 Stresses Within the Hydrologic System

There are several stresses within the hydrologic system near the project site that impact both the NWWRP recharge project and the IBW-South site. The most important and significant of these stresses include groundwater pumpage from the alluvial aquifers in the vicinity of the project and releases from Granite Reef Dam.



Percolation Pond Data for Basin 1
Figure 3
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Net Volume Recharged (MG/month)
Infiltration Rate (ft/day)
Net Volume Recharged (MG/month)
Infiltration Rate (ft/d)
Date
70
60
50
40
30
20
10
0
3
2
1
0
Dec 1990
Feb
April
June
Aug
Oct
Dec 1991
Feb
April
June
Aug
Oct
Dec 1992
Feb
April
June
Aug
Oct
Dec 1993
Feb
April
June
Aug
Oct
Dec 1994

Percolation Pond Data for Basin 2
Figure 4

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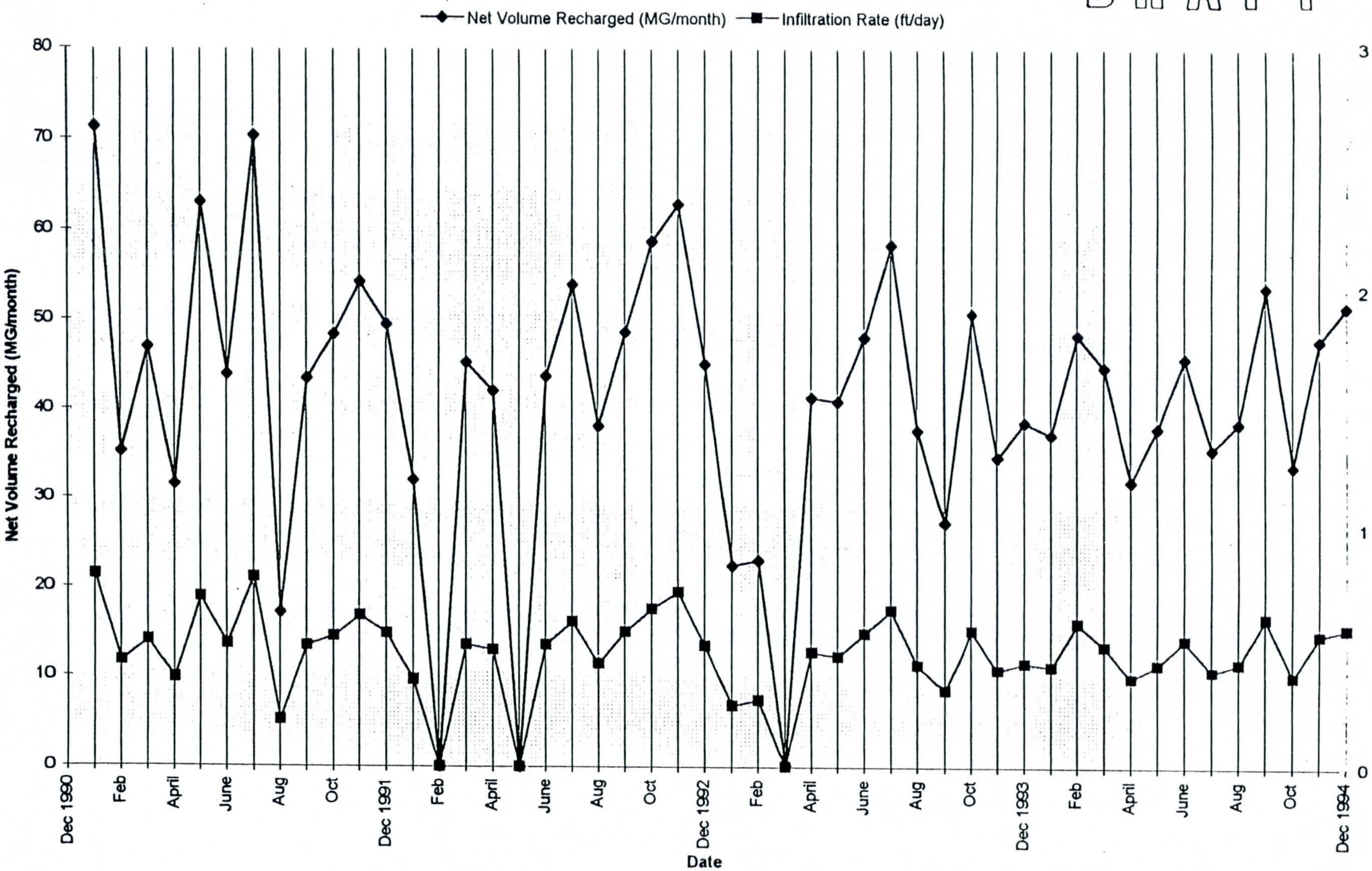

Percolation Pond Data for Basin 3
Figure 5

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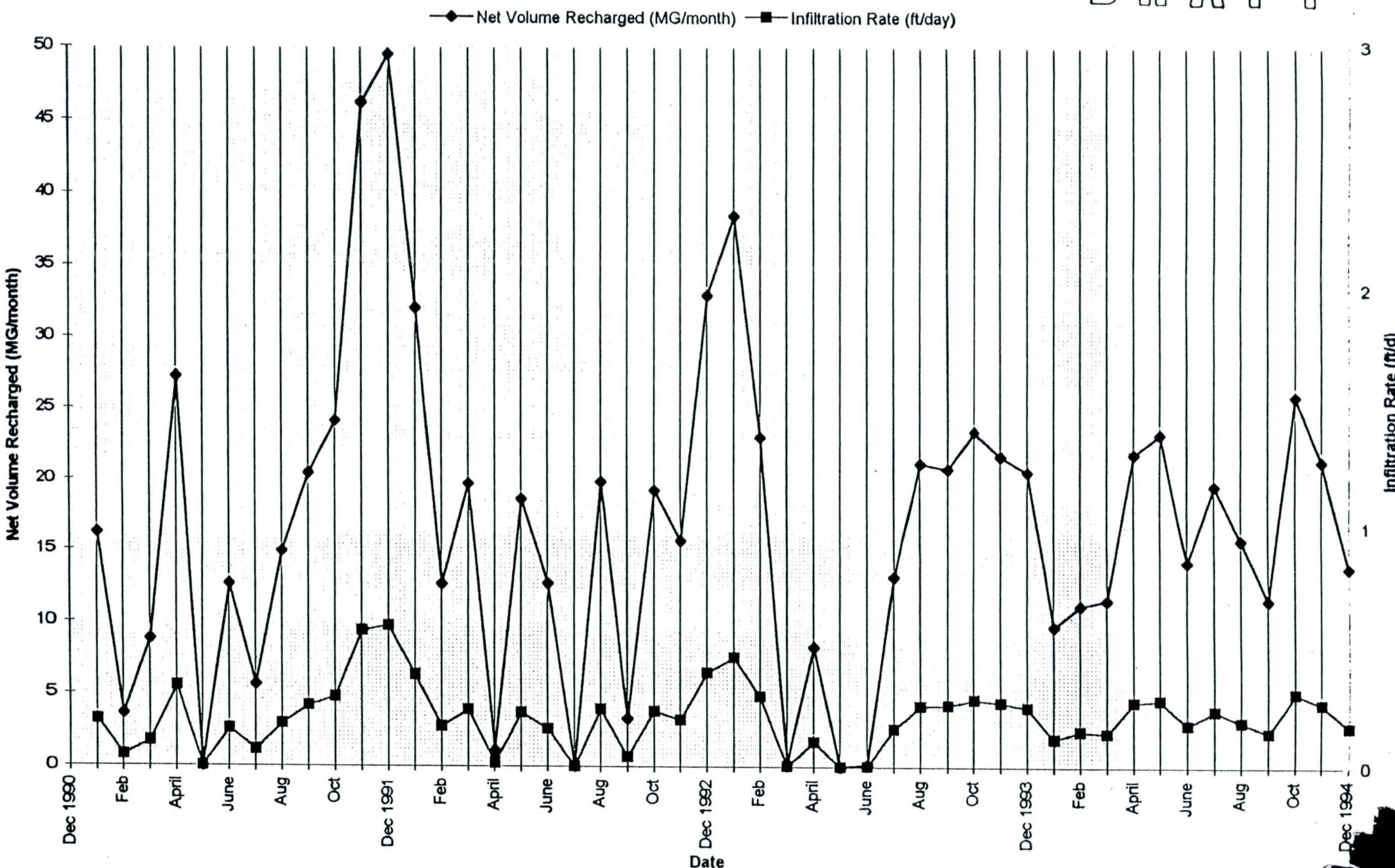

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Percolation Pond Performance for All Three Basins Combined
Figure 6

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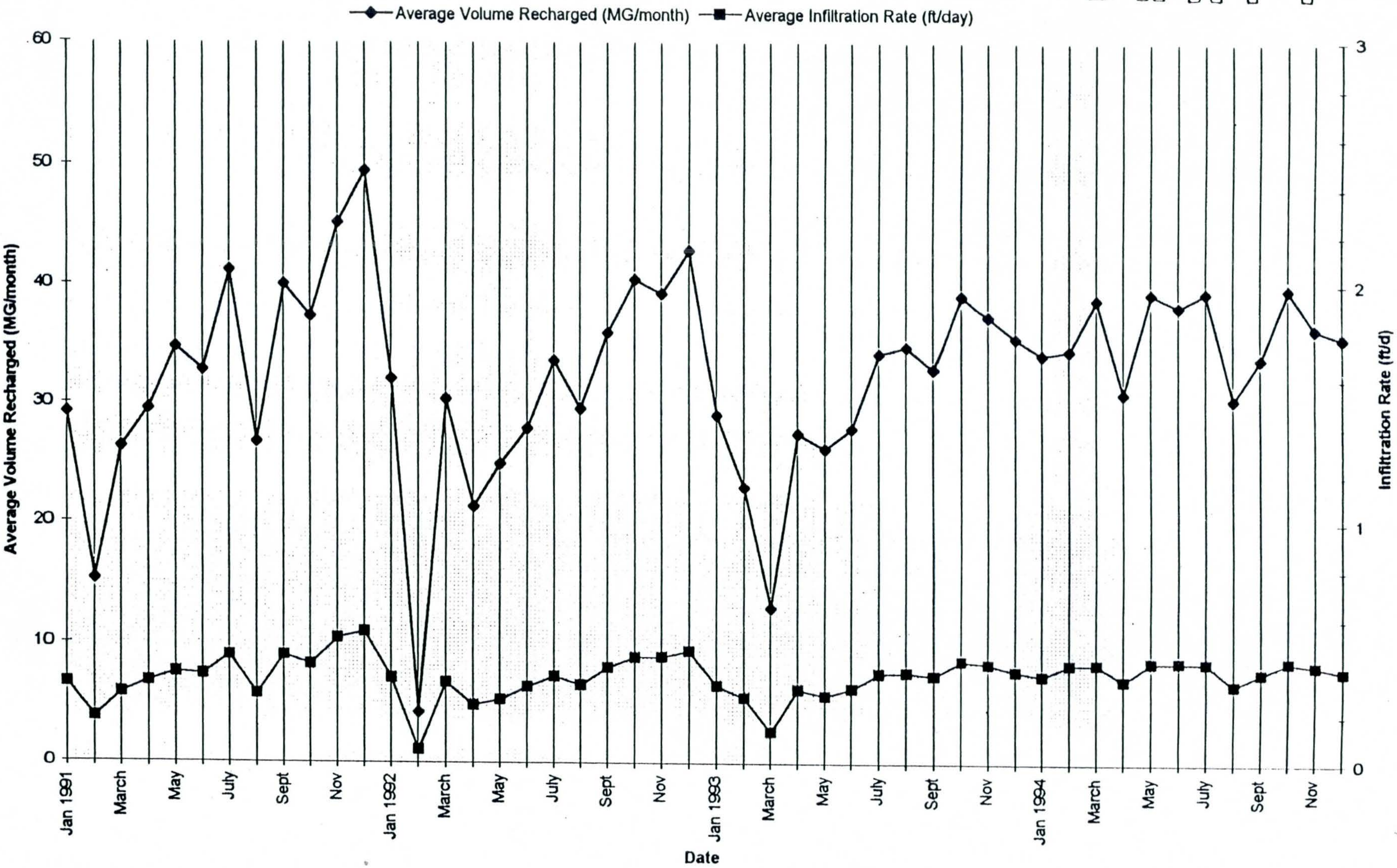

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3.1.1 Groundwater Pumpage

Groundwater pumpage comprised the major stress within the overall hydrologic system in the project site. Data obtained from the ADWR Registry of Grand-fathered Rights (ROGR) database (1994) was used to show yearly pumpage within the project site (*Figure 1*). These data are provided in *Appendix D*, for the period from 1984 through 1993. The data are also plotted by well owner/use and by total pumpage for the area. *Figure 7* graphically represents the data contained in *Appendix D*. The major groundwater users including Motorola, City of Tempe, COM, and Salt River Project are graphed separately. All "Other" groundwater pumpers are added together and graphed as one group. These groundwater users would include well owners that withdraw more than 35 gpm or 50 acre-ft/yr. Finally, the last bar graph in the figure (illustrated in blue) incorporates all of the well owners. Annual average pumpage within the project site over the ten year period is approximately 10,000 acre-ft (*Figure 7*). However, during times of drought groundwater withdrawals increase significantly to approximately 60,000 acre-ft. The majority of this pumpage is attributable to SRP (*Figure 7 and 8*). The majority of this pumpage is from the MAU and LAU (KSA, 1987a), only small domestic well users would have wells that are perforated in the UAU.

[redacted]

3.1.2 Granite Reef Dam Releases

Historic records for releases, in cubic feet per second (cfs), from Granite Reef Diversion Dam for the past 20 years are presented in *Figure 9*. These data were used in several ways through out this report depending on the data set that the flow data are compared with. However, all of the data are derived from this original data set. For instance monthly flow data is compared with monitor well hydrographs, whereas, annual flow data is compared with pumpage data. In order to make these

Reported Pumpage Within Study Area
Figure 7

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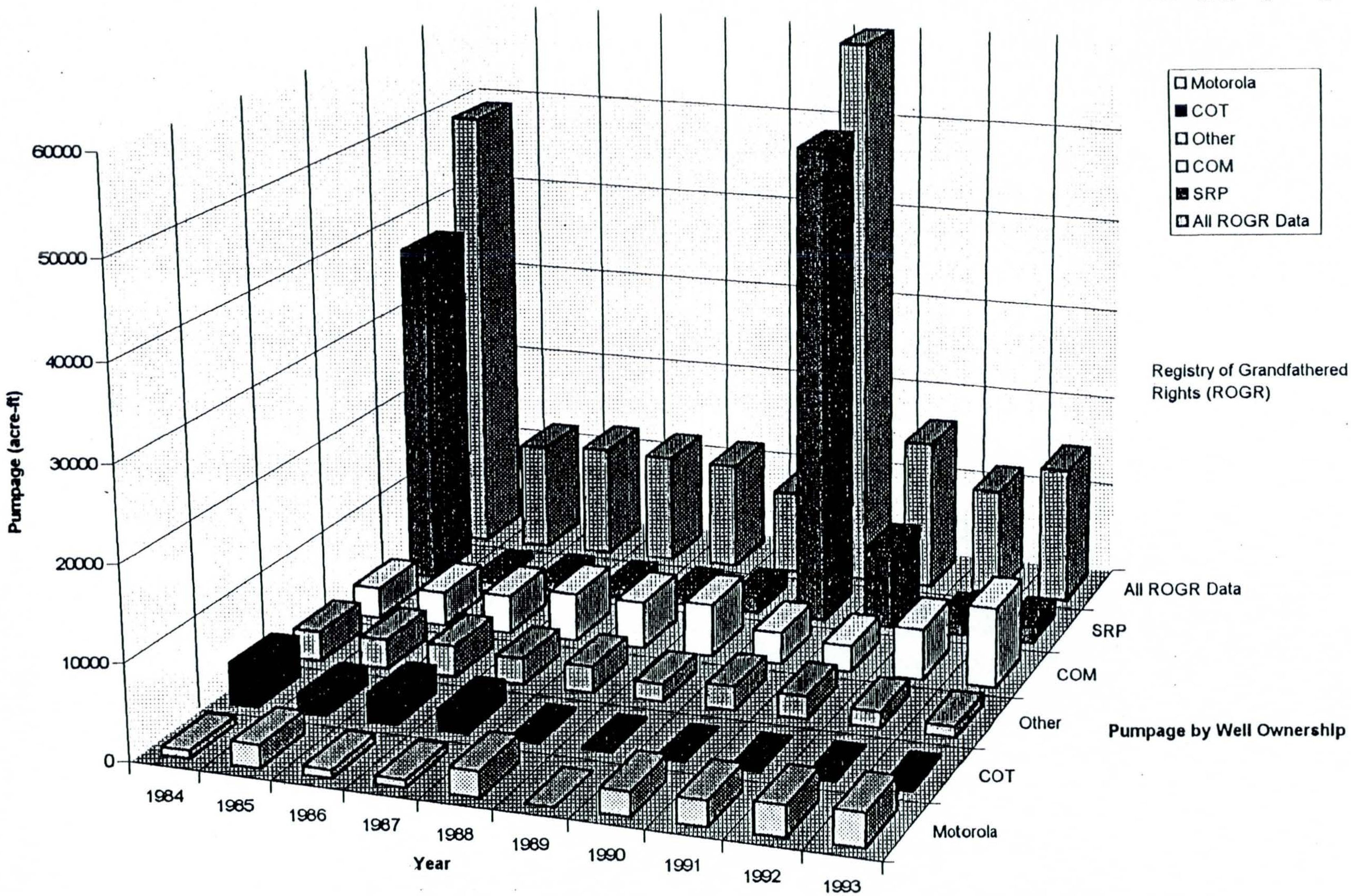

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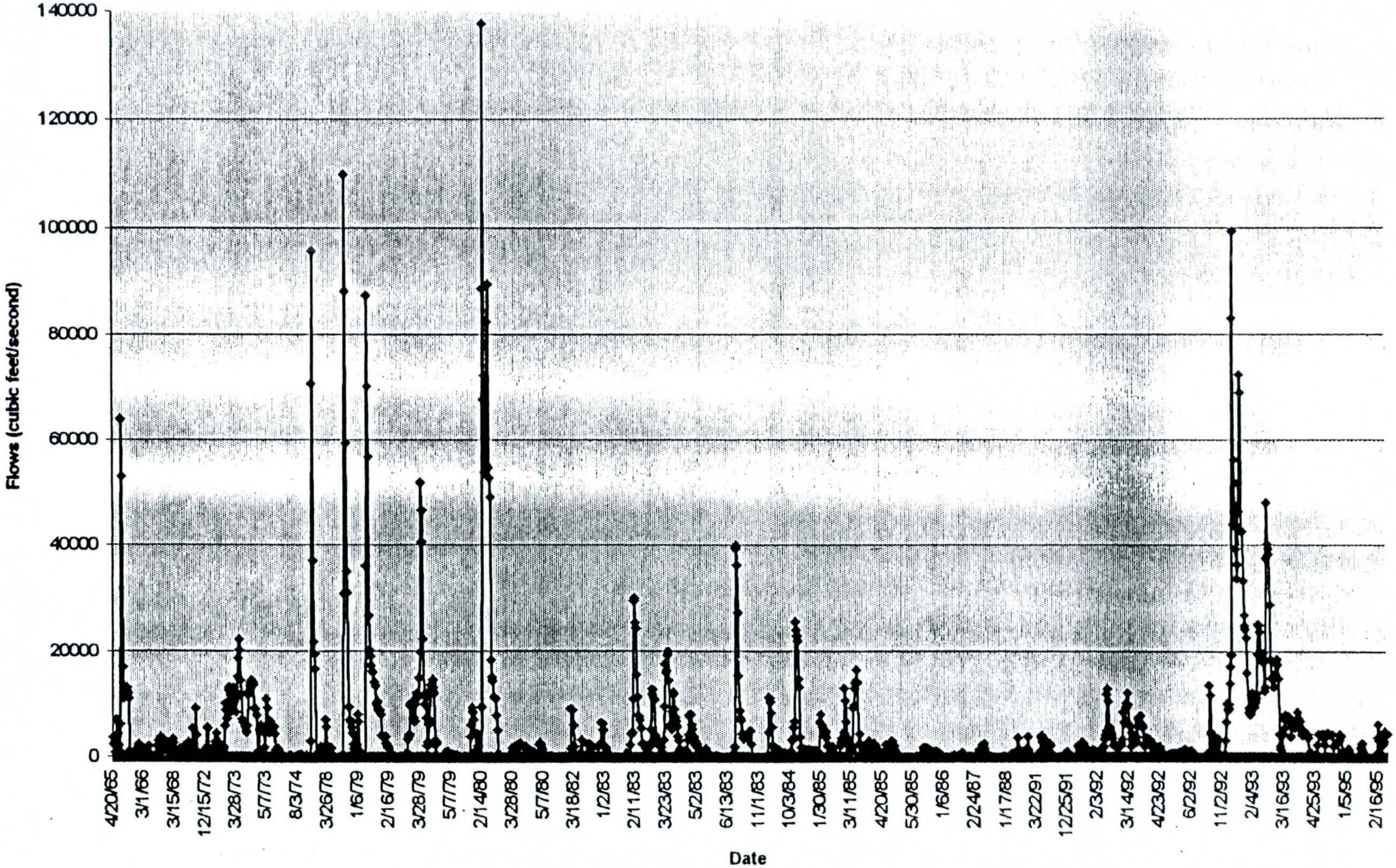
Granite Reef Releases 1965 - Present
Figure 9



Note: Plot Not to Scale

comparisons, it was necessary to convert the daily flow values from cubic feet per second (cfs) to acre-ft per day, and then depending on the values needed either total the data monthly or annually.

For this study, the period of record from the beginning of the project operation was analyzed due to it being the most critical. A detailed graph of the data from September 1990 through the February 1995 is presented in *Figure 10*. These data converted into acre-ft per month are shown in *Figure 11*. There are several significant flow events shown in *Figure 11*, occurring February-March of 1991, January through March of 1992, August 1992, January through May 1993, and most recently this past February of 1995. The data plotted in acre-ft per month clearly shows these flow events due to releases from Granite Reef Dam on the Salt River. This information was used in combination with several other types of data to evaluate the historic impacts to the project site.

The combined groundwater pumpage data from *Figure 7* (*Appendix D*) was plotted with annual release data from Granite Reef Dam as shown in *Figure 12* . Both data sets are plotted in acre-ft. This figure shows that typically groundwater withdrawals are limited to approximately 10,000 acre-ft/yr. However, when a drought condition exists, such as occurred in 1990, groundwater pumpage increased to approximately 60,000 acre-ft. When surface water again becomes available from the watershed, then SRP does not need to pump groundwater to meet customer demands, and pumpage again decreases to about 10,000 acre-ft. This is shown for years 1991 and 1992 where releases from Granite Reef Dam have been discharged to the Salt River bed.

When groundwater is withdrawn, it is mostly taken from the lower units and doesn't affect the UAU water levels significantly. However, when the Salt River flows, this does impact the hydrologic system in the UAU at the project site. These flows affect both the recharge project and IBW-South.

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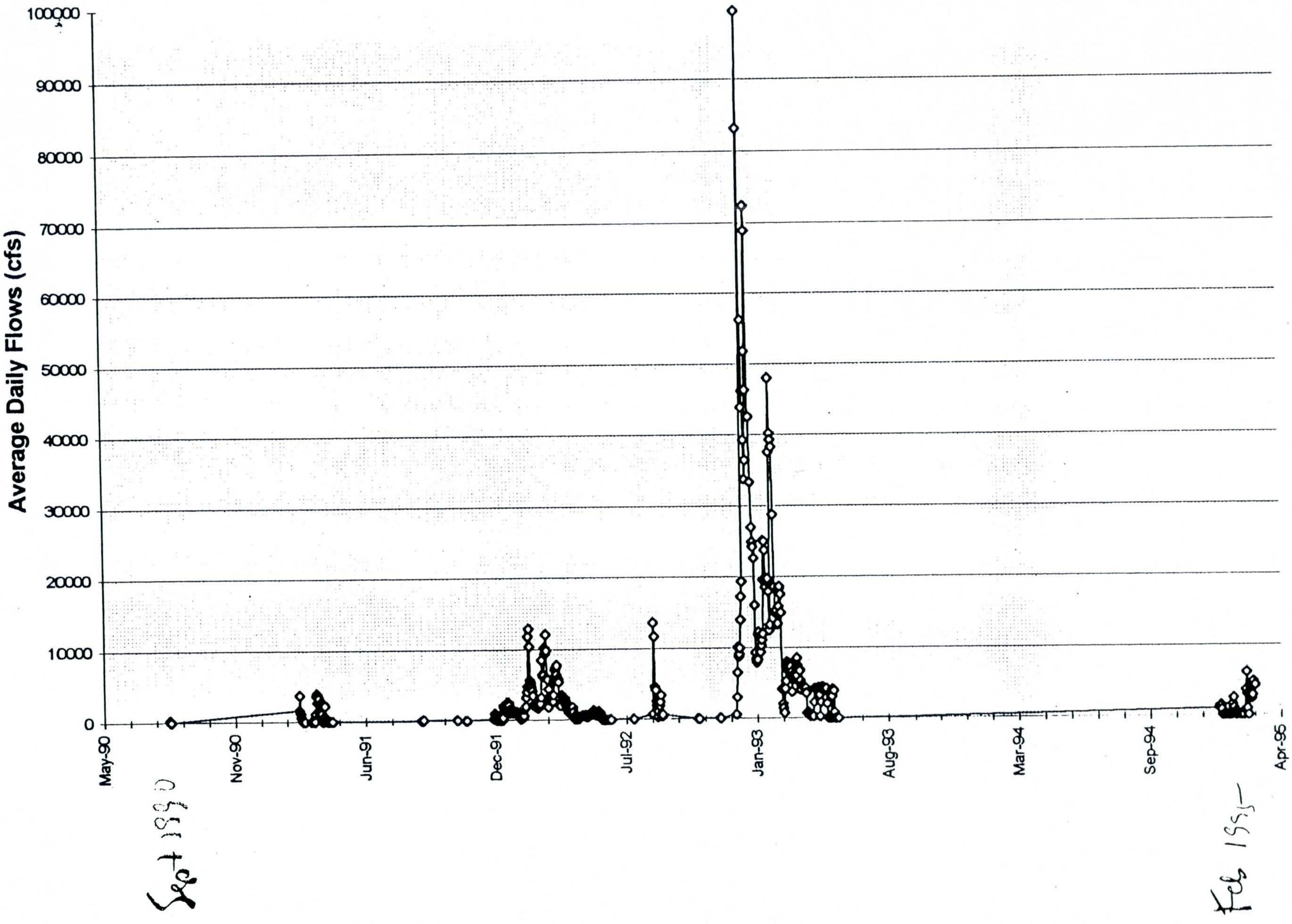
Granite Reef Releases 1990-Present (Average Daily Flows)
Figure 10



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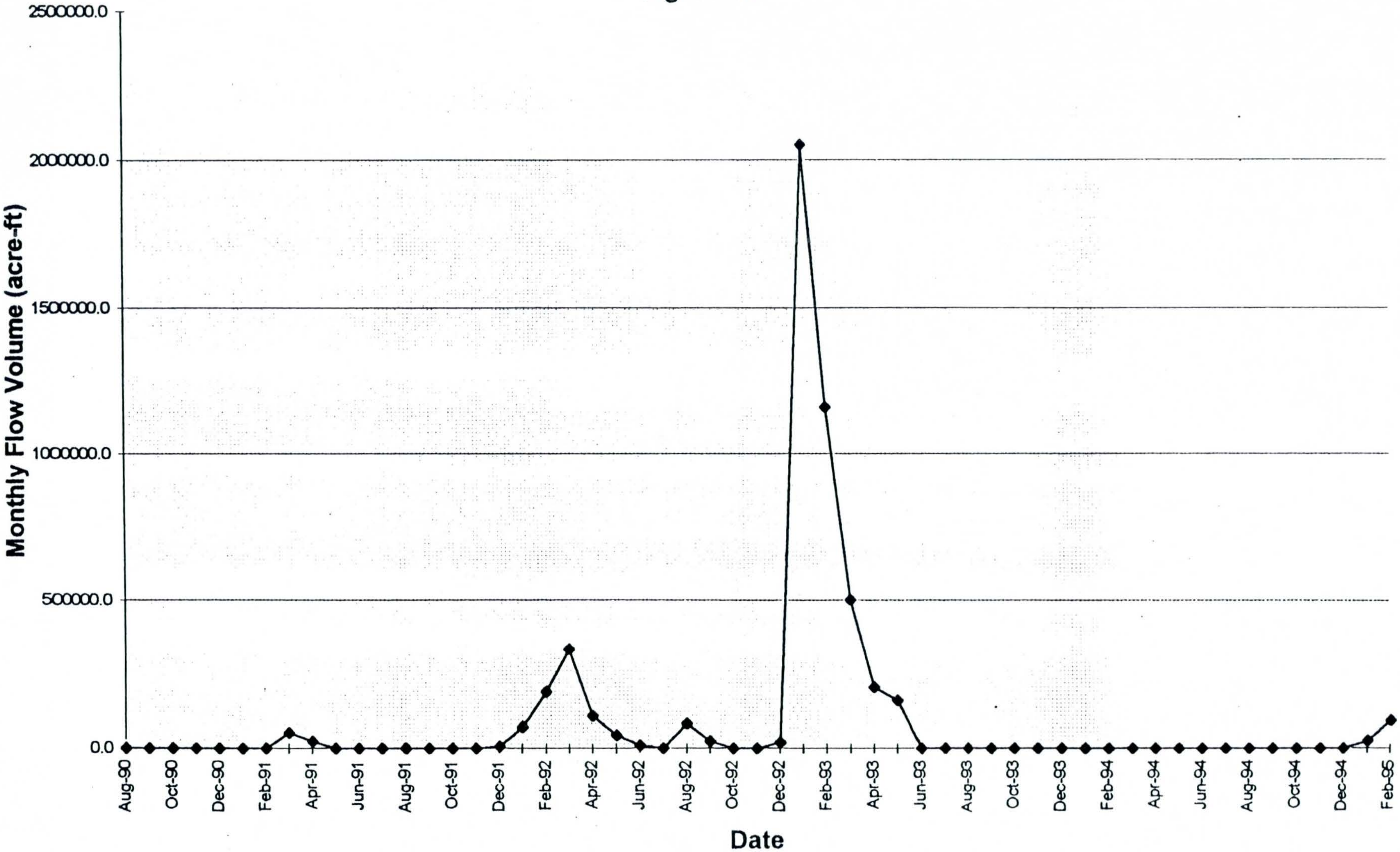
Granite Reef Releases 1990 - Present (Monthly Flow Volume)
Figure 11



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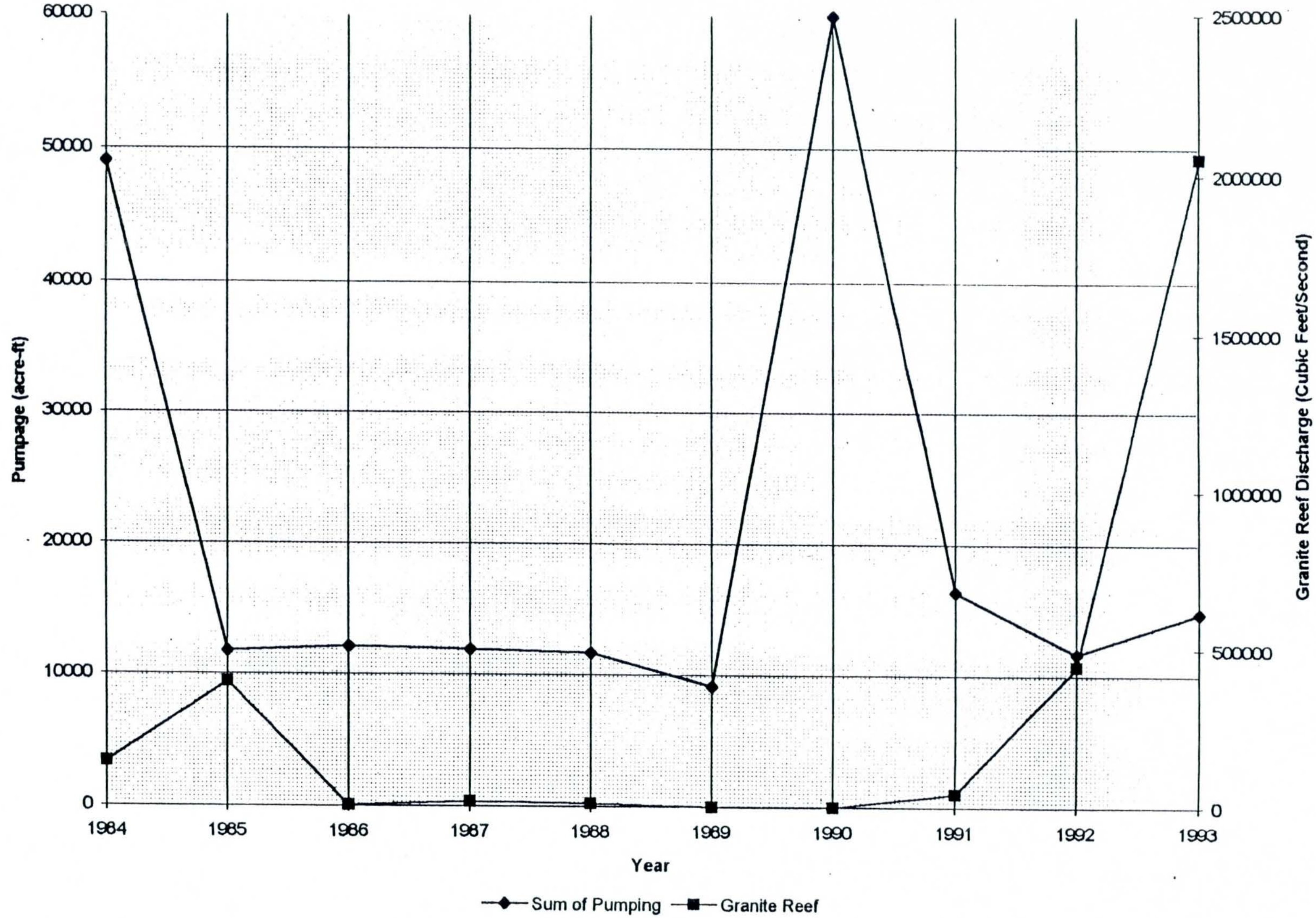
Granite Reef and Combined Pumping Wells
Figure 12



The releases from Granite Reef Dam have an impact on the percolation pond performance and are graphically represented in *Figure 13.* This graph shows the monthly flow volume of releases from Granite Reef Dam in acre-ft (plotted on the left y-axis) versus the average volume of water recharged in million gallons per month (MG/month), from all three of the percolation ponds combined (plotted on the right y-axis). These data show that when flows in the Salt River occur, percolation pond performance decreases significantly. This has occurred at a minimum of three times since the NWWRP recharge project became operational. The first time was during a flow event in February and March of 1991, where the volume of water recharged decreased to 15 MG/month. The next time the Salt River flowed extensively, was during January through May of 1992, where the volume of water recharged decreased to approximately 3 MG/month (from a high of about 50 MG/month). The last time this occurred was during the flow event from January through May of 1993, where water was being recharged at a rate of about 42 MG/month, and this decreased to about 12 MG/month. In addition to the data presented in *Figure 13*, Ronny Lopez, Water Reclamation Plants Supervisor for the COM (1995), stated that when the Salt River flows, discharge into the percolation ponds must be reduced or curtailed due to the fact that the percolation cells will not accept the additional water.

3.2 Changes to the Hydrologic System

Groundwater Site Inventory (GWSI) data were evaluated from 1980 to the present in order to develop a pre-project groundwater elevation map. These data are presented in *Appendix E.* Unfortunately, the existing unit specific data prior to the discovery of and potential for groundwater contamination at both the IBW-South and Motorola Mesa sites, was poor. Very little groundwater elevation data existed prior to the remedial investigation activities at these sites, and even fewer unit-specific water level data were available. Several attempts were made to contour water level data prior to 1994 were made, but professional judgement took precedence over the data poor contour maps. Therefore, more recent water level elevation data were used to construct an UAU water level

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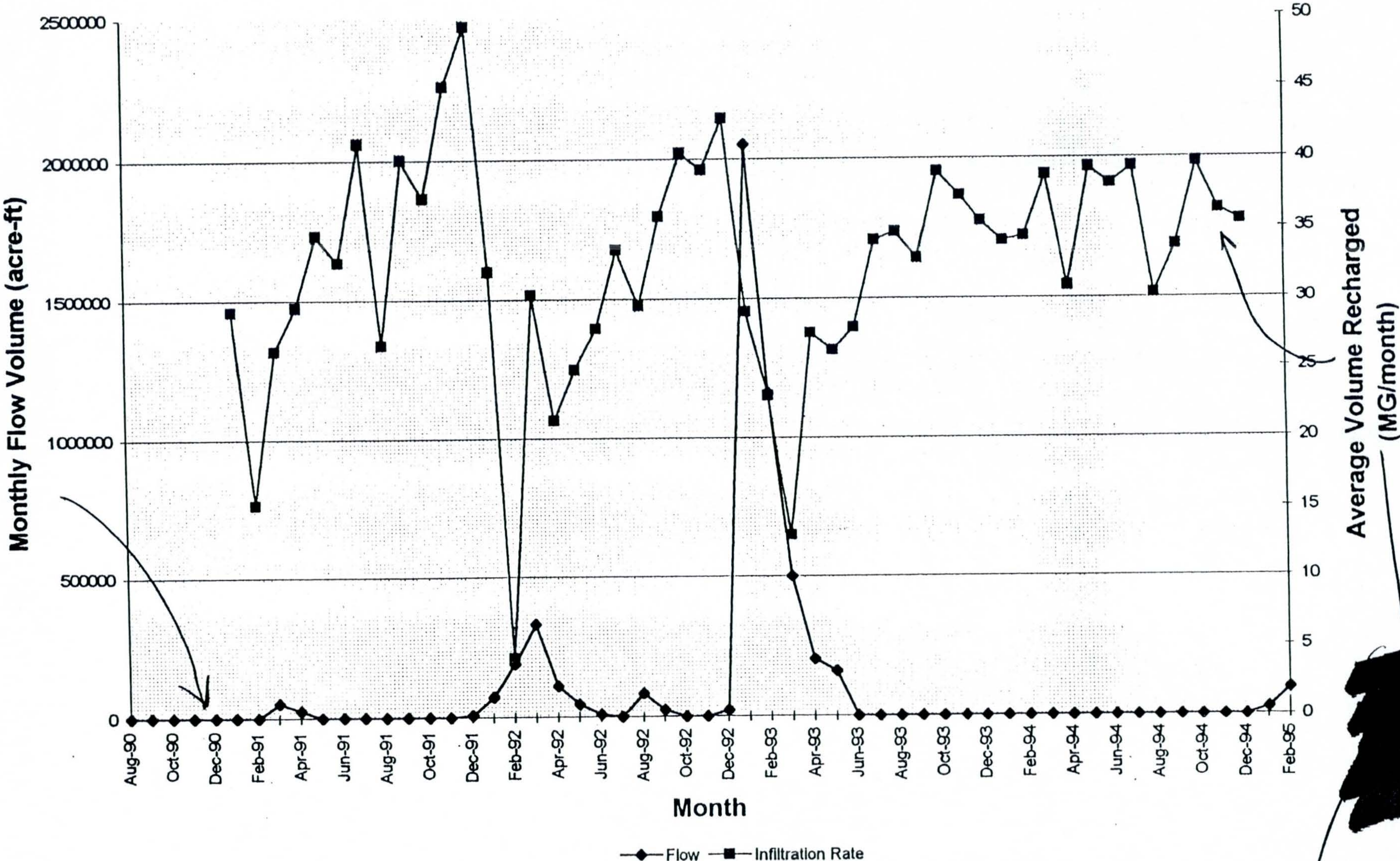
Granite Reef Releases Versus Average Volume Recharged
Figure 13



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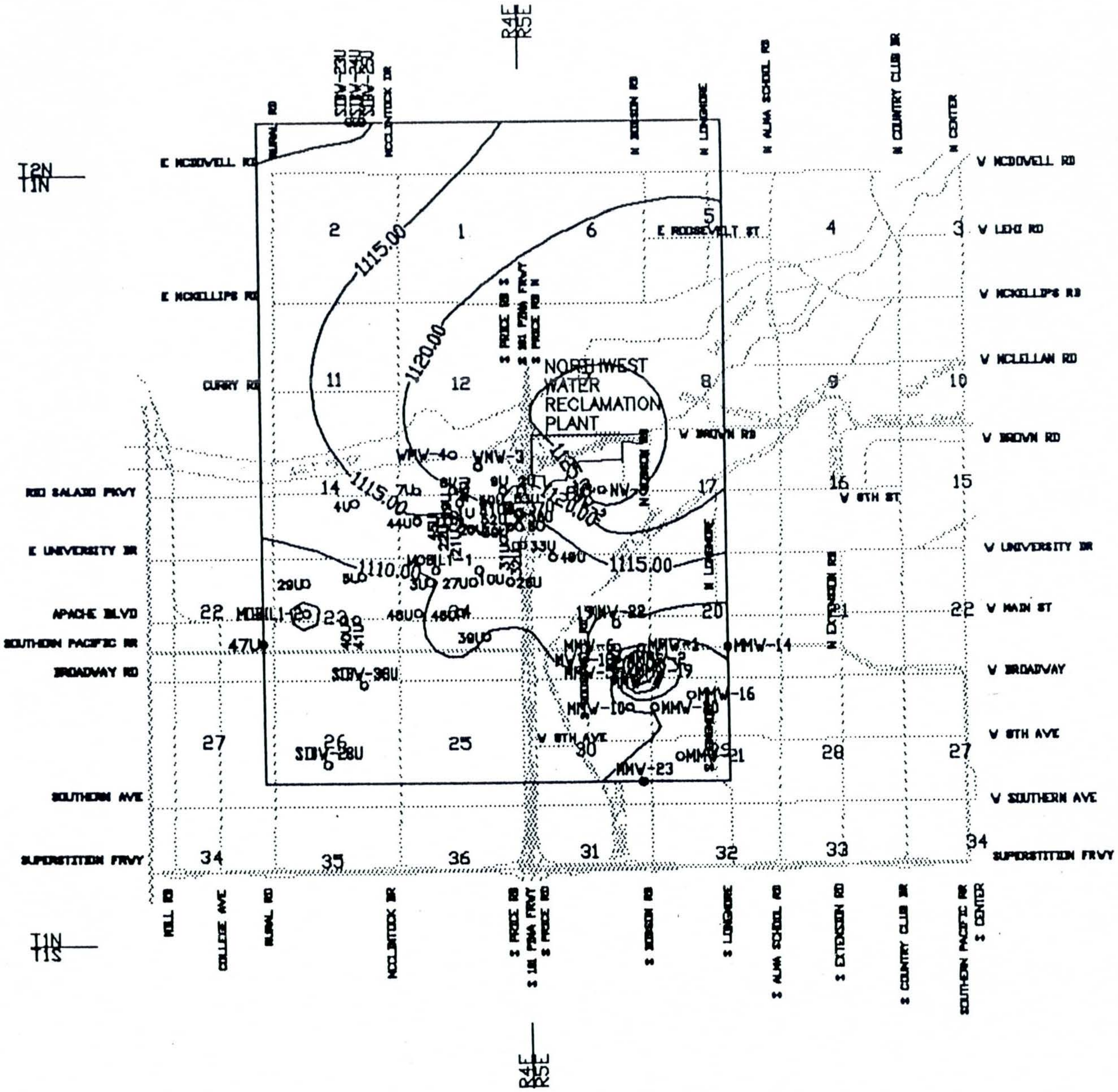
elevation map for the project site. This map is used to evaluate the projected impacts to the project site from the permitted volume of water recharged (discussed and presented in Section 4.4).

A 1994 project area water level contour map is presented in *Figure 14*. This map shows that the hydraulic gradient north of the river is in the west-northwest direction and south of the river is in a southwest direction. Water level contours range from 1100 feet above mean sea level (m.s.l.) in the northwest corner of the map and to the southwest of the plant, to 1125 feet m.s.l. at the project site. The 1125 feet contour interval beneath the site is most likely due to a combination of recharge from the project and the result of releases from Granite Reef Dam. The drawdown cone to the south of the project site represents the ongoing remedial activities associated with the groundwater contamination at Motorola Mesa.

There is a significant seasonal variation in flow directions within the project site. CH2MHill evaluated these seasonal changes in the hydraulic gradients in the UAU for the IBW-South site. This information showed that when the river flowed there was a strong inflection of the gradient to the southwest away from the river, however when the river was dry the flow direction was more westerly (Environmental Protection Agency, EPA, 1993).

Water level elevation data for each of the four monitor wells, NW-1, NW-2, NW-3 and NW-4 are presented in *Figures 15* through *18*, respectively. *Figure 2* shows the approximately monitor well locations. These data were used to prepare the water level elevation contour map presented in *Figure 14*. Water levels have increased significantly during the time period that the project has been in operation. At the monitor well closest to the percolation ponds (*Figure 2*), an overall water level change of about 55 feet has occurred in NW-1, since the project began in 1990 (*Figure 15*). Monitor wells NW-2 and NW-3, show a change of approximately 50 feet (*Figure 16 and 17*).



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City of Mesa Northwest Water Reclamation Plant 1994 Water Level Map

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Not To Scale

May 31, 1995

Figure 14

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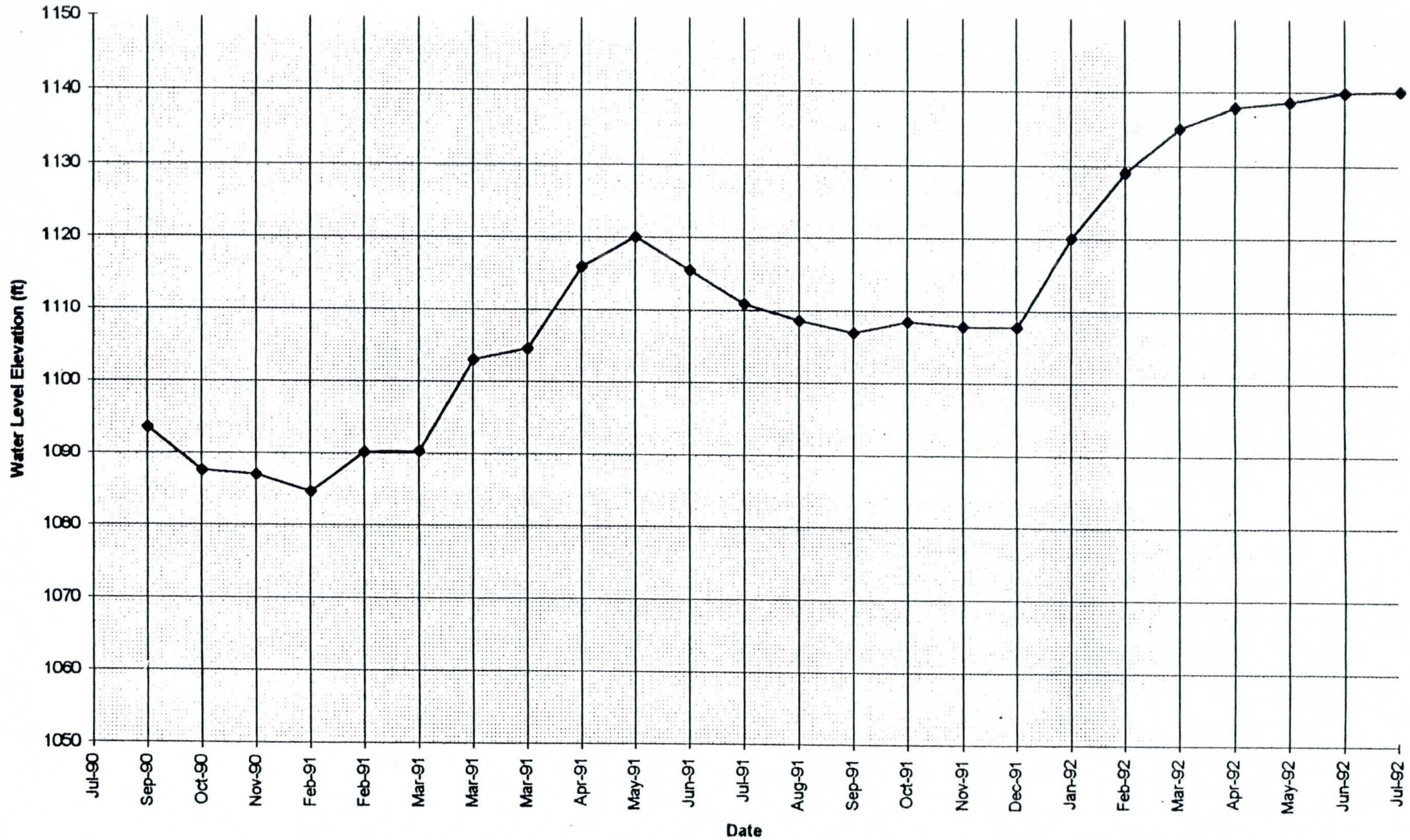
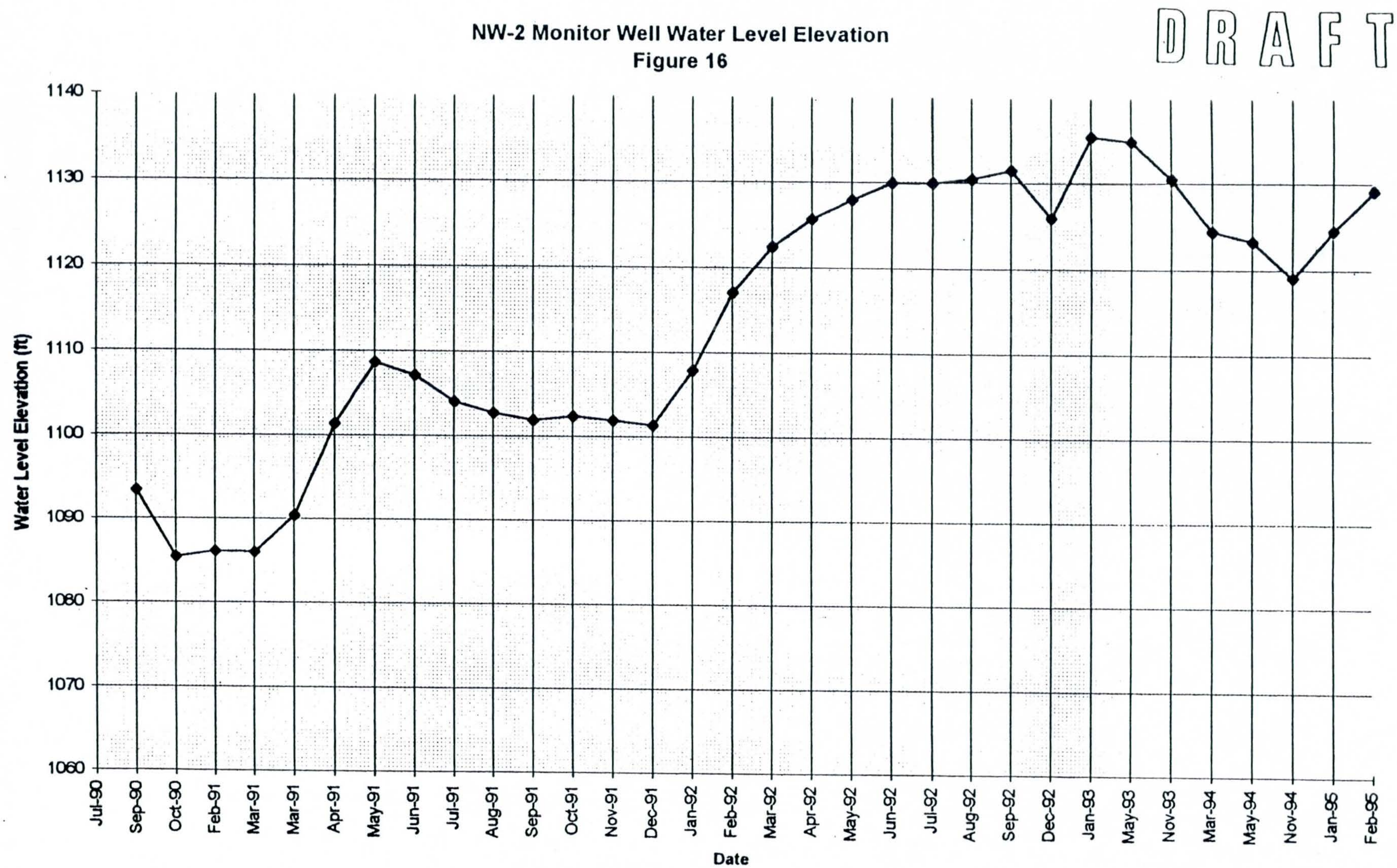
NW-1 Monitor Well Water Level Elevation
Figure 15

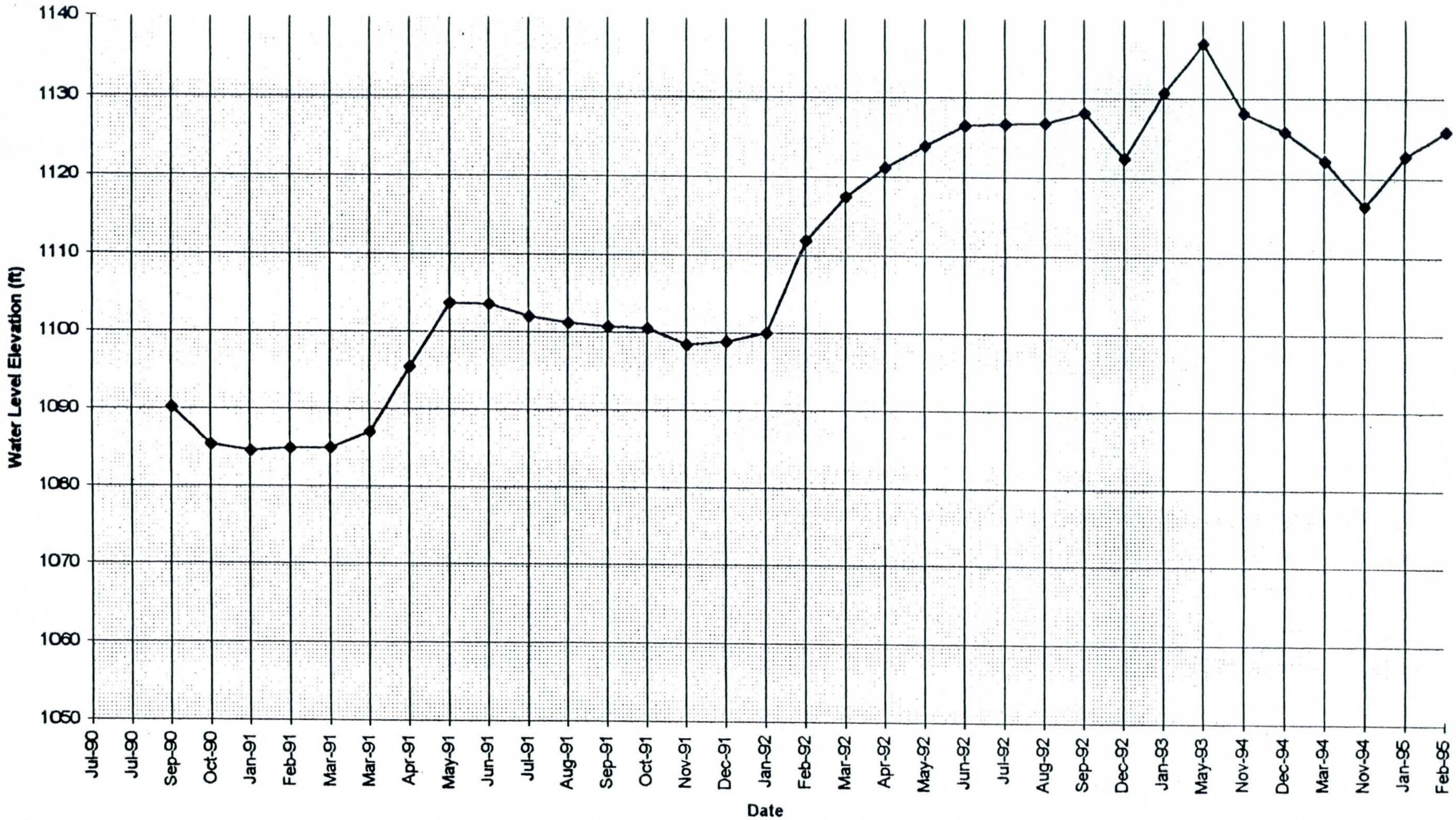




DRAFT
NW-2 Monitor Well Water Level Elevation
Figure 16
Water Level Elevation (ft)
1140
1130
1120
1110
1100
1090
1080
1070
1060
Jul-90
Sep-90
Oct-90
Feb-91
Mar-91
Mar-91
Apr-91
May-91
Jun-91
Jul-91
Aug-91
Sep-91
Oct-91
Nov-91
Dec-91
Jan-92
Feb-92
Mar-92
Apr-92
May-92
Jun-92
Jul-92
Aug-92
Sep-92
Dec-92
Jan-93
May-93
Nov-93
Mar-94
May-94
Nov-94
Jan-95
Feb-95
Date

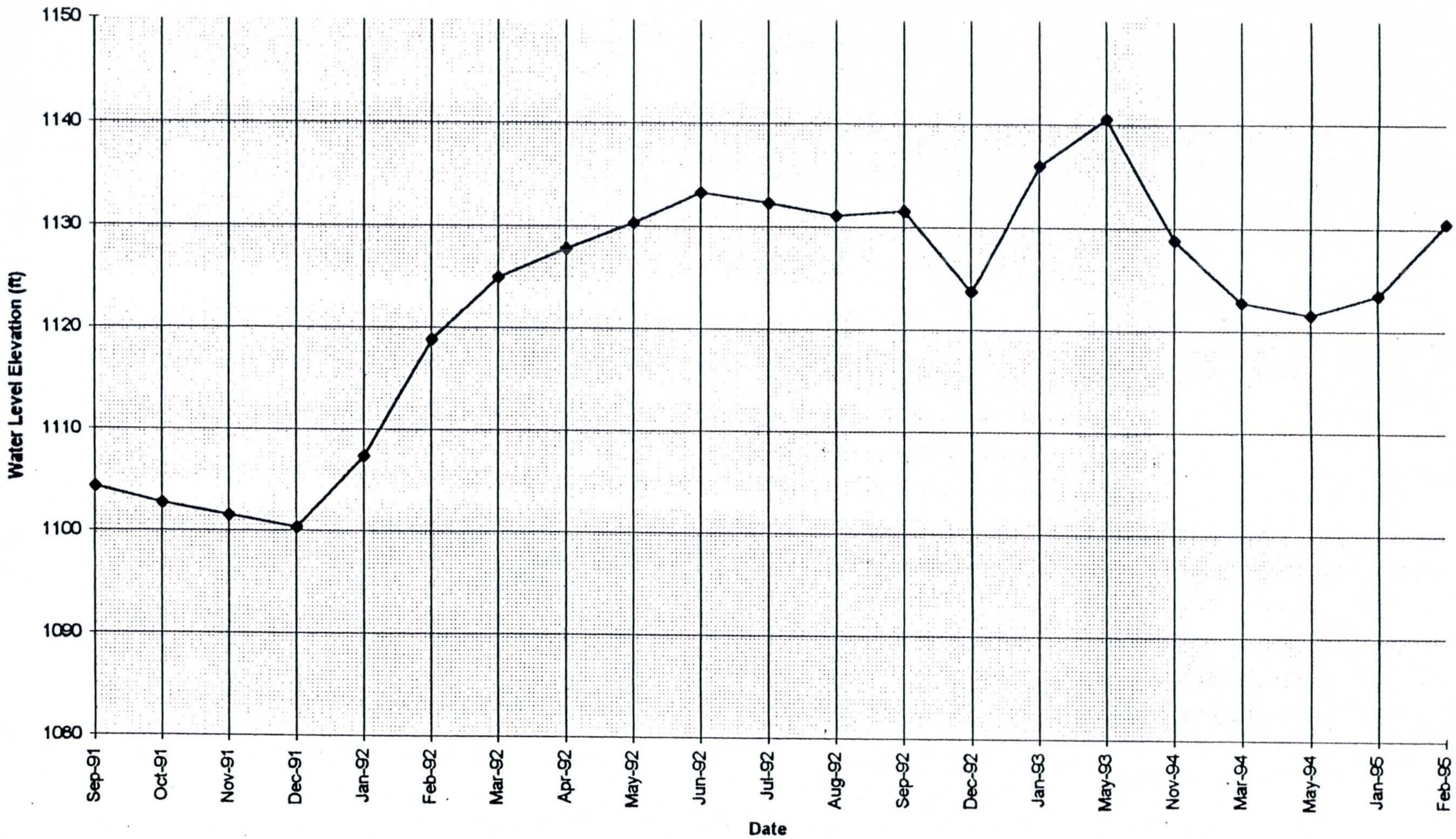
DRAFT

NW-3 Monitor Well Water Level Elevation
Figure 17



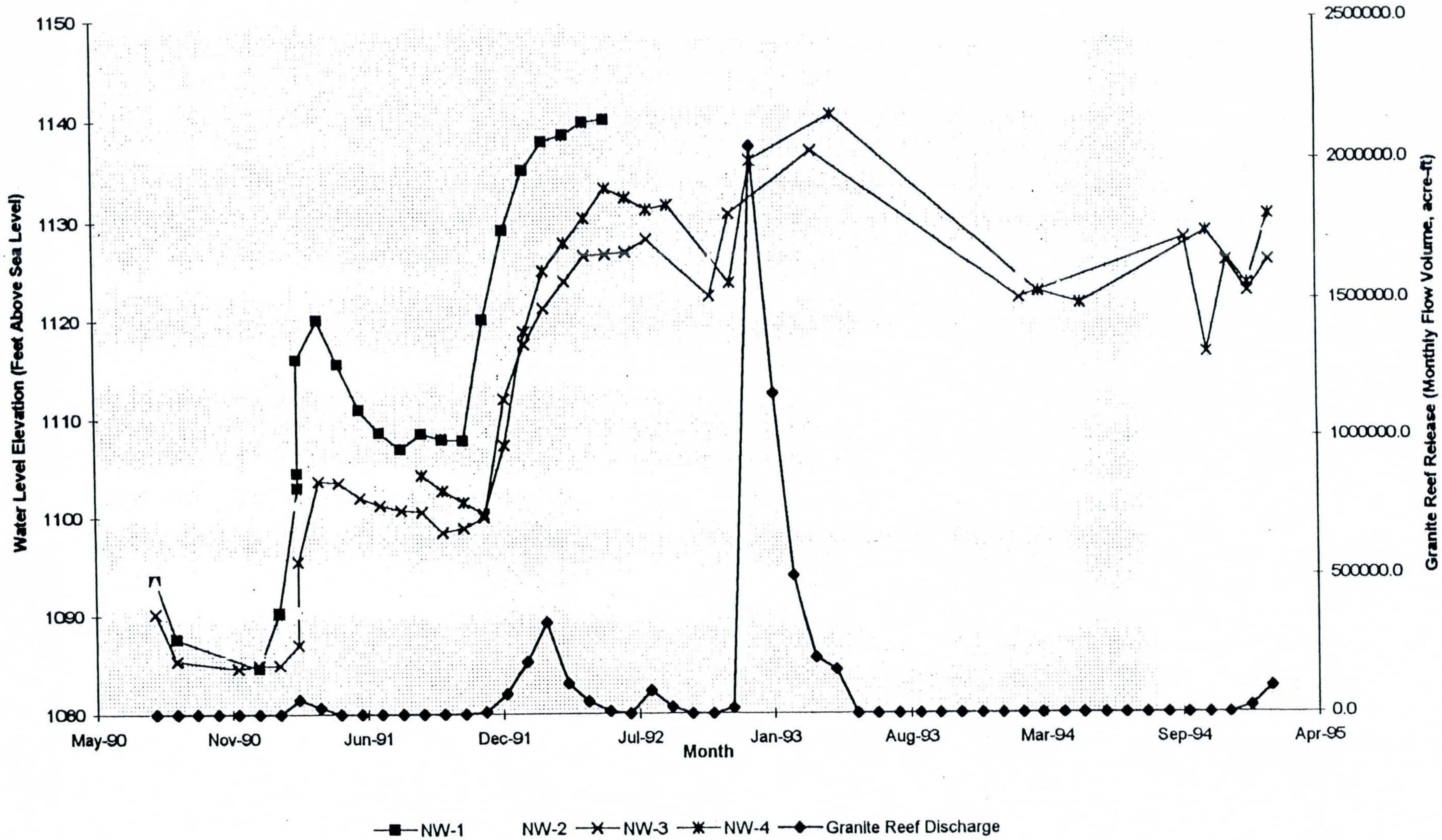
DRAFT

NW-4 Monitor Well Water Level Elevation
Figure 18



DRAFT

Granite Reef Releases Versus Water Level Hydrographs
Figure 19



Water Level Data Interpolated Where Fewer Than Two Points Exist

Figure 19 shows the monthly flow volume (in acre-feet) versus the water level elevation rise from the monitor wells. With this information it can be shown that when the Salt River flows, water levels increase dramatically. This occurred during the January 1991 flow event, where water levels in the monitor wells responded with a 35 feet rise in water level. It also occurred again during the January through May flow event of 1992 where water levels increased approximately 30 feet, after ~~recovering~~ only 10 feet. Water levels also showed a slight increase in elevation during the December 1992 through April 1993 flow event. It is hypothesized that water levels only responded slightly due to the already saturated conditions of the aquifer material in the vicinity of the recharge project. Water levels increased about 10 feet during this event. Total change in water level elevation was from 1085 feet m.s.l. to 1140 feet m.s.l. This groundwater level ~~rise~~ is approximately 20 feet below the bottom elevation of the percolation ponds (1160 feet m.s.l.). Most of the change in water level can be attributable to the flows in the Salt River and not recharge from the project operation. This will be presented and discussed in more detail in Section 4.0 below.

[redacted]

4.0 PROJECTED IMPACTS

In order to assess the impacts from both the historic operation of the NWWRP recharge project and the projected impacts due to the continued operation of the project, the U.S. Geological Survey MODFLOW computer code was used. This groundwater flow model was developed by McDonald and Harbaugh (1988) to model advective groundwater flow through porous media. It was developed in such a way that as the science advanced additional "packages" could be added to the basic computer code that would allow for the evaluation of such occurrences as subsidence, streamflow routing, and flow through the vadose zone. The "Block Centered Flow 2" package allows for the resaturation of model cells that have gone "dry" or that were never before saturated. This package is documented and described in U.S. Geological Survey Open File Report No.91-536, by McDonald et.al. (1992).

The complex MODFLOW model was used in a simplified fashion. The problem was also simplified so that a timely solution could be obtained resulting in a reasonable answer. This was accomplished by using the site-specific data that the COM had already collected both through the continued operation of the project and through other consultant's work. Without the site specific data, there would be no way of knowing whether the modeling analyses were within an order of magnitude in determining the impacts.

Hydrologic data previously been presented has shown that the hydrologic system in the project area is very complex. The modeling results only incorporates the historic and projected impacts and does not incorporate all of the hydrologic stresses within the system. It does, however, provide an analysis of the impacts that would be expected from the operation of the recharge project only. Therefore, only the recharge itself was modeled. The results from the historic operation of the recharge project were provided as a comparison between what had occurred and what was shown by the monitor well water level hydrographs. The results from the projected continued operation of

[redacted]

the project were superimposed onto the 1994 water level contour map to provide a "worst case scenario" of project operation.

[redacted]

4.1 Model Parameters

Figure 20 shows how the model was setup and used. An arbitrary grid size of 32 rows by 32 columns by 5 layers was constructed. This area represents 1/4 of the overall grid area, or approximately 35 square miles. The total area that was modeled was approximately 140 square miles. The grid was extended significantly to mitigate the affects of boundary conditions. Each layer was 20 feet thick (again an arbitrary decision) and a reference head of 50 feet was chosen (*Figure 20*). The reference head was chosen in the center of the model layers and is used to evaluate changes to the groundwater table. The model results are presented as an addition to (recharge) or subtraction from (pumpage) this reference elevation. The results were then added to the water level contour map to show the impact from the recharge project. The model was run both in steady state (no storage properties) conditions and in transient conditions (represent changes over time).

300 x 7.48 = 2240 gpd/ft² UAY only

The data input parameters for transmissivity and hydraulic conductivity are 100,000 gpd/ft and 300 ft/d, respectively. These parameters are specific to the NWWRP recharge project site and were presented previously in Section 2.3. Specific yield and storage coefficient used in the model are 25 percent (0.25), and .001, respectively. *Appendix F* provides a printout of the model Data sets used to run MODFLOW for this project.

[redacted]

4.2 Model Setup

As shown in *Figure 20*, the model was constructed to represent only a quarter of the totaled model area. This is possible due to the fact that both the west and north model boundaries are flow

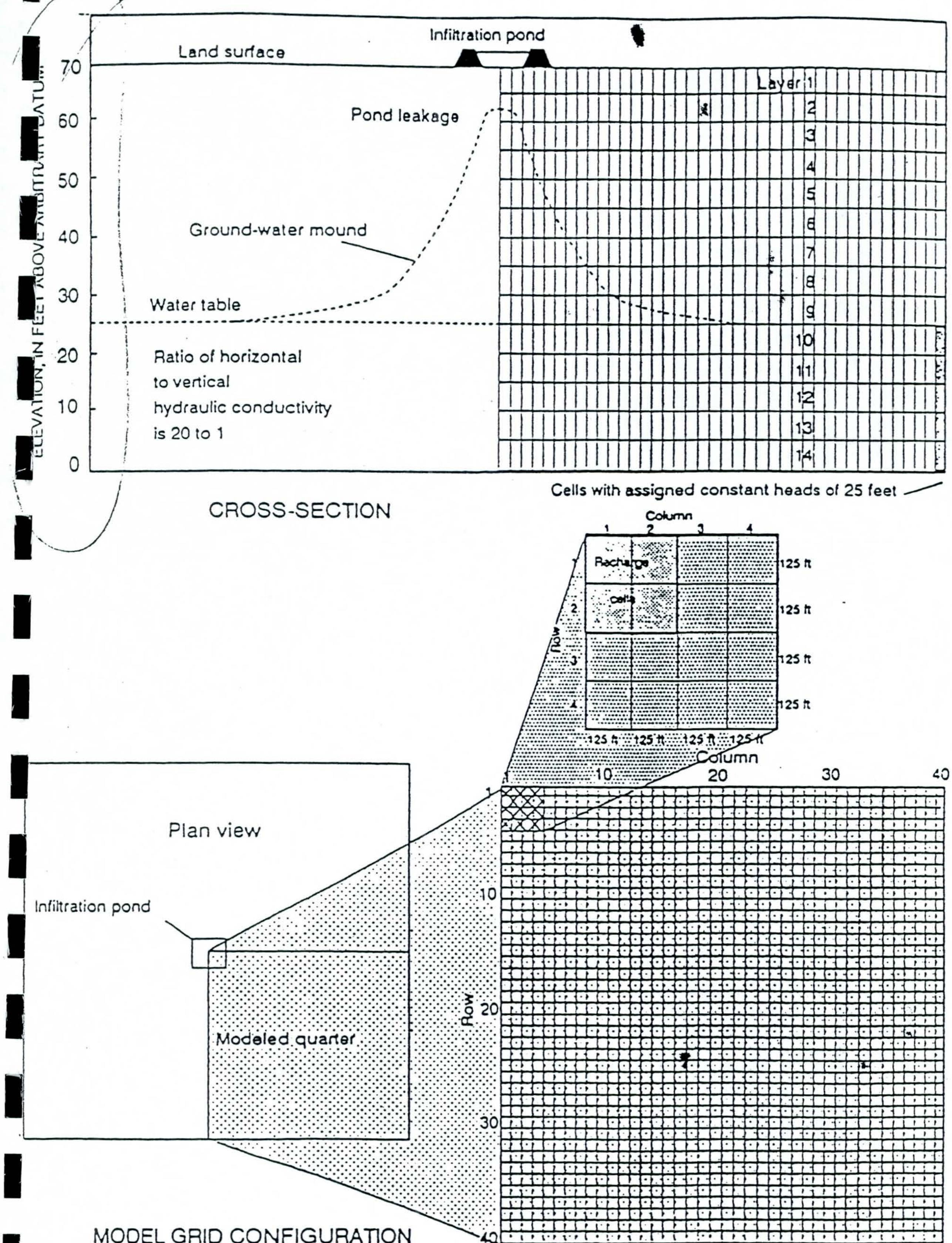


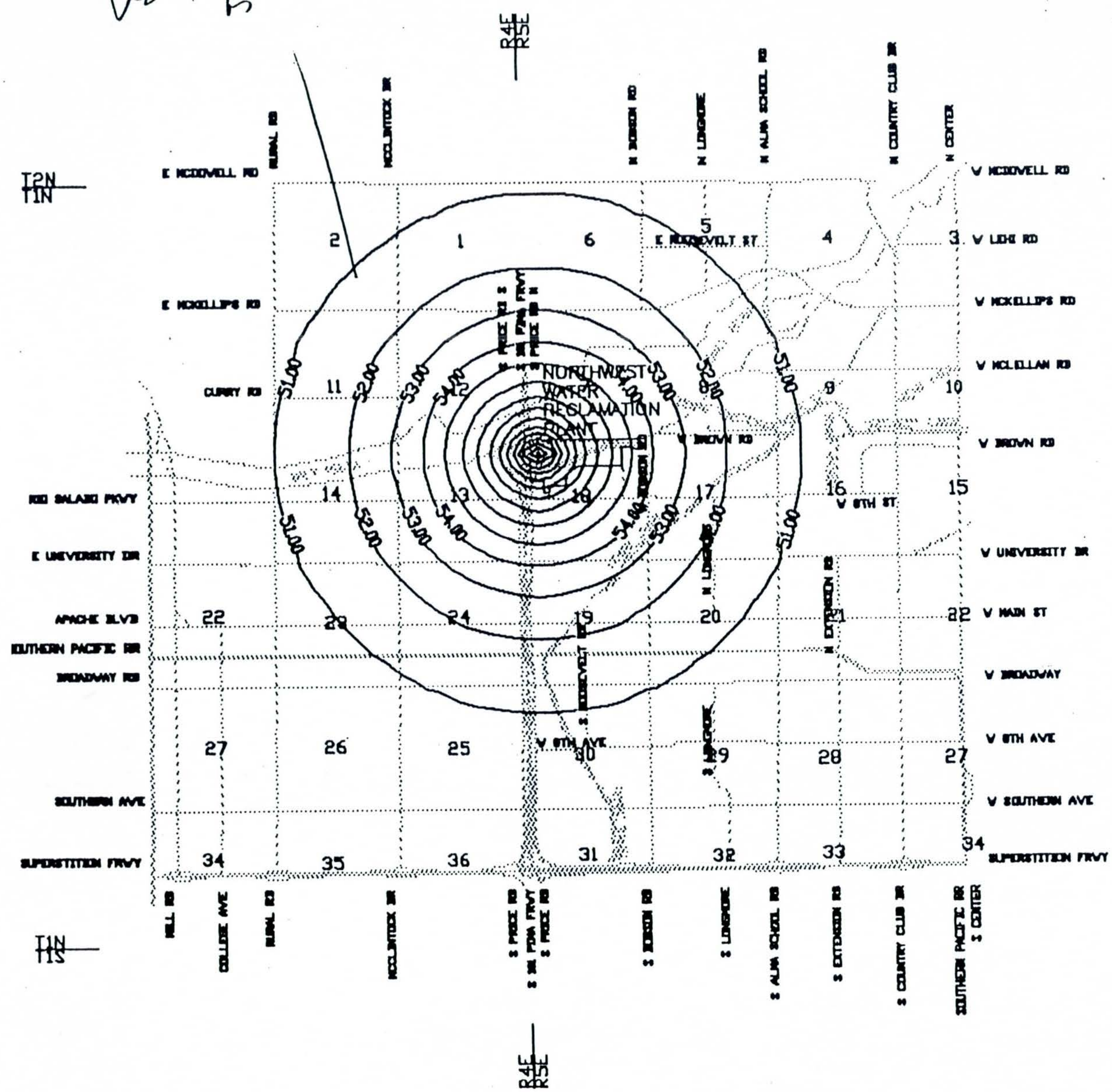
Figure 20–Hydrogeology, Model Grid, and Model Boundary Conditions
Source: USGS Open-File Report 91-536

boundaries. That is, the ~~hydraulic gradients~~ are along flow lines, perpendicular to the groundwater elevation contours. These flow lines are in a north-south direction for the west boundary and are in an east-west direction for the northern boundary (*Figure 20*). The recharge ponds are represented by eight cells that are located in the northwestern most corner of the model domain (*Figure 20*). Each cell has a recharge rate of 0.4 ft/d attributed to it, and the recharge from these cells will be attributable to the first layer that contains the water level, or in the case of this model, layer three. A general head boundary condition was used for the south and east boundaries of the model domain. The conductance value was set at 6000 ft/d (*Appendix F*). This value was chosen through trial and error through the calibration process to provide a constant head at the model boundaries, but allowing water to pass across the boundary and not impact the mounding projections.

In order to contour and evaluate the results from the model, a contour map was made using the krigging option in the **SURFER® for Windows** program. This contour map was then imported into AutoCAD and using the mirror command and by virtue of symmetry, a copy of the contour map was inverted and flipped over to make half the total contour map. This same process was repeated for the top half of the map until the entire contour map was created. The result of this was overlayed using AutoCAD onto the base map to create the completed impact map (*Figures 21* and *22*). The overlays were also added to the 1994 water level elevation contour map to provide a "projected impacts" water level contour map.

For the four year historic impact period, the actual recharge value of 0.4 ft/d, was used in the model to determine the mounding due to the actual operation of the project. There were no additional impacts from the system for that time period. At the end of the four years, the recharge value was adjusted in the model to 0.89 ft/d. This rate reflects the volume of water the COM is permitted to recharge (8,963 acre-ft). The model was run for an additional 16 years at that rate. This would reflect the "worst case" scenario as presented in *Figure 22*, of the historic impacts along with

Use 50 WLE to base



DRAFT

City of Mesa
Northwest Water Reclamation Plant
Historical Impacts 1990–1994

N

Not To Scale

May 31, 1995

Figure 21

HydroSystems, Inc.

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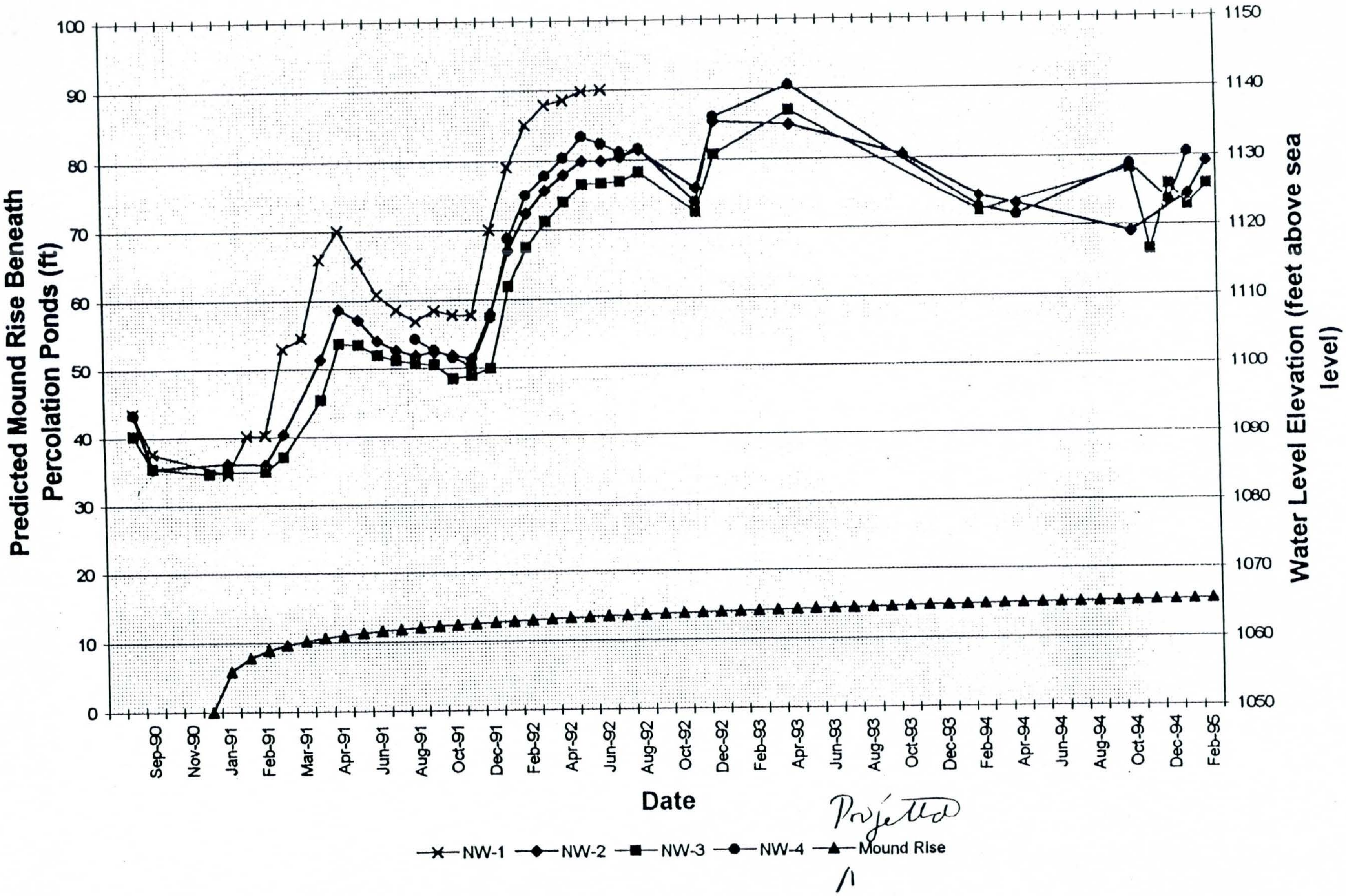
TELEPHONE: 602-730-0486 FAX: 602-730-0432

DRAFT

Monitor Well Hydrographs versus Predicted Water Level Rise Beneath Percolation Ponds
Figure 23



the projected impacts of the maximum volume of water recharged over the remaining life of the permit, without any recovery or other pumping.

[redacted]

4.3 Model Results

The model results of the historic impacts are presented in *Figure 21*. This figure represents the projected increase in water level due to the recharge only from the NWWRP recharge project. A recharge rate of 0.4 ft/d (this represents approximately 3.5 mgd) was used to represent the impacts that have occurred since the project became operational. The one-foot rise in water level is represented by the 51 foot contour interval (50 foot reference head elevation plus one-foot water level rise). For this four year model analysis, a water level rise of about 15 feet occurred directly beneath the percolation ponds. The extent of the one-foot water level rise was approximately 2 miles in all directions away from the site (*Figure 21*). This mounding would be attributable only to the project operation, and not to other stresses such as flows in the Salt River. Also, there are no groundwater withdrawals modeled. All things considered equal for a homogeneous, isotropic aquifer with a flat water table, the projected mound is what should occur beneath the project site, given the site-specific parameters noted. This however, is not what was depicted in the water level hydrographs. The theoretical mound rise was plotted with the water level hydrographs from the monitor wells onsite (*Figure 23*). This graph illustrates what should have occurred in the hydrologic system beneath the site (projected mound rise) versus what actually occurred. Water levels have increased significantly over time, however, they do not represent the theoretical mound rise. Water levels within the project site have responded significantly to changes Salt River flows due to releases from Granite Reef Dam. [redacted]

A 16 year projection was made that begins from the last stress period that represents the historic impacts. The projection is for the time period from 1994 through the year 2010 (which is the [redacted]

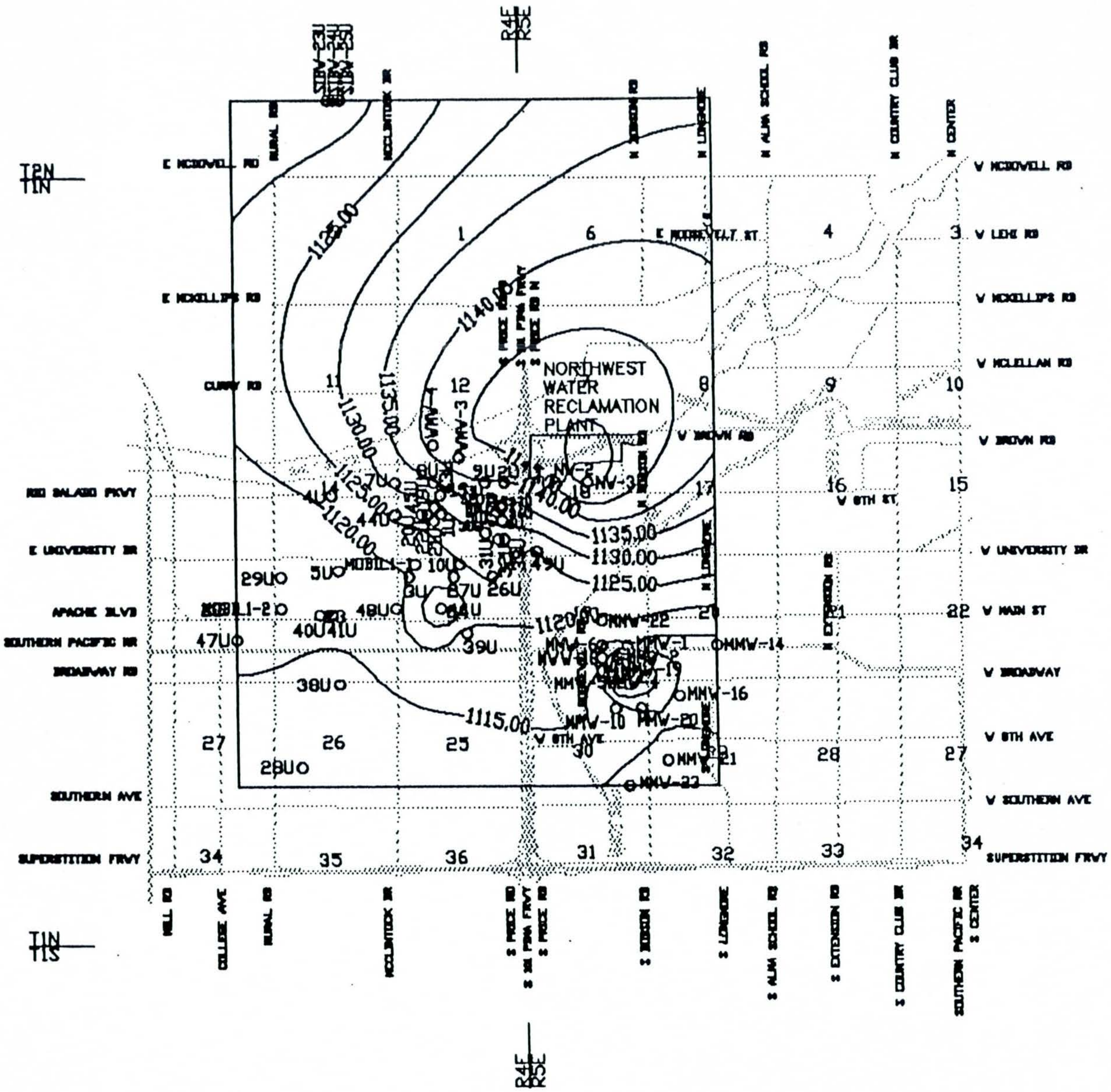
[redacted]

where is this?

remaining permit duration). A "worst case" scenario was developed to provide the agencies with an analysis that was not conducted for the original permit. Usually, the "worst case" scenario is used for public noticing purposes and is a very hypothetical analysis used to evaluate the potential impacts from the operation of the project for the permitted life of the project. For the COM, this scenario assumed that an infiltration rate of 0.89 ft/d was possible for the percolation ponds, although it has been shown that the actual infiltration rate is approximately half that. The 0.89 ft/d rate translates into 8.0 mgd, which is the permitted volume of 8,963 acre-ft/yr.

The results of this mounding analysis are presented in *Figure 22*. This map shows the one-foot contour interval as represented by the 51 foot contour interval. The effects of the mounding extend away from the site approximately 12 miles. Again, this is under homogeneous, isotropic conditions on a flat water table. There are no stresses modeled for this scenario either. The red hatched areas on the map represent hard-rock areas that recharge from this analysis would not flow through. A water level rise of approximately 36 feet is projected to occur directly beneath the percolation ponds by the end of project operation. *Figure 24* represents a water level contour map that incorporates the mounding results from the modeling. As can be seen from this map, the effects of this recharge at the 8.0 mgd rate are showing up as a mound beneath the percolation ponds (note the 1145 contour interval).

The results of these model analyses when compared to water level hydrographs from project monitoring wells indicate a significant difference between actual site water levels and modeled water levels (*Figure 23*). It is also evident from modeling only the impacts of the recharge project, that the threat to contaminant migration at the IBW-South Superfund Site is minimal. The model results indicate that the most significant impacts, especially from the historic operation of the project occur beneath the percolation ponds and although a water level rise is seen within the IBW-South Superfund Site, it is unlikely that the increase head and gradient would cause significant changes in the contamination seen at IBW-South (*Figures 21 and 22*). The most significant changes seen are directly beneath the percolation ponds as shown on *Figures 21 and 22.*



DRAFT

City of Mesa
Northwest Water Reclamation Plant
1994 Water Level Map With Project Impacts

N

Not To Scale

May 31, 1995

Figure 24

HydroSystems, Inc.

GARY G. SMALL, *M.S., P.G., C.E.I.*

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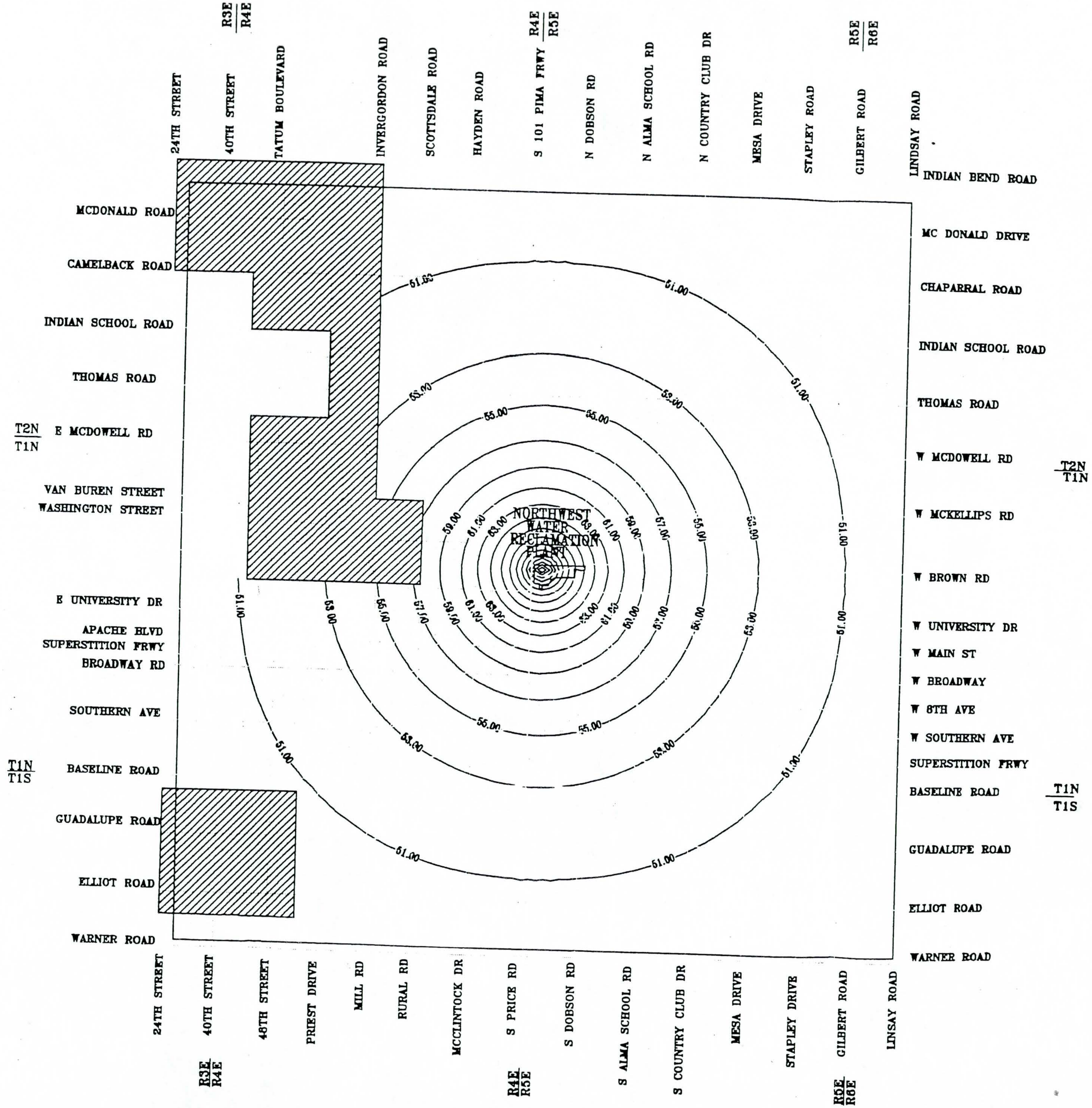

Theoretical Mounding Analysis 1994–2010

Explanation

Rock Outcrops

Water Level Contour

Figure 22

N

Not to Scale

HydroSystems, Inc.
GARY G. SMALL, M.S., P.G., C.E.I.
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TELEPHONE: 602-730-0466 FAX: 602-730-8432

5.0 IMPACTS TO INDIAN BEND WASH - SOUTH SUPERFUND SITE

As provided by the data developed for the COM for this project and the model analyses discussed previously, the impacts from the NWWRP recharge facility are minimal. The overwhelming hydrologic influence on the UAU where the NWWRP recharge facility is concerned are releases from Granite Reef Dam. These releases also significantly affect the IBW-South Superfund Site to such and extent to cause significant changes in head and gradient in the UAU aquifer. This information was presented previously in Section 3.0 Historic Impacts, in this report. Independent of the data presented in this report, the U.S. Environmental Protection Agency (EPA), through their consultant CH2MHILL, arrived at the same conclusions. The following excerpts are taken directly out of the IBW-South Interim RI Report, published in June of 1993. The Water Budget section of the IBW-South Interim RI Report is provided in *Appendix G*. The following excerpt is from page 6-2of *Appendix G:*

> "No pumping centers or recharge areas outside of the study area significantly affect the horizontal groundwater flow in the UAU within the study area, including the City of Mesa's wastewater recharge facility."

The EPA report further goes on to analyze the water budget components of the IBW-South Superfund Site. In regards to the NWWRP recharge facility, the EPA further states (page 6-18, *Appendix G*):

> "If the operations of the City of Mesa wastewater recharge facility affect the groundwater flow patterns in the UAU within the IBW-South study area, then the lateral inflow component of the water budget would be affected. The hydraulic gradient would increase as a result of the mounding of groundwater. The limited water level data available for the area surrounding

the recharge facility ... indicates that the operations at the facility do not significantly affect the groundwater flow direction within the IBW-South study area.

Sergent, Hauskins & Beckwith (SH&B) evaluated the effect of the recharge facility operations on groundwater levels in the UAU (SH&B, 1990). Even though the data presented in their report cannot be reduced to a form that defines the rise in water level caused by recharge at the facility, it appears that the radius of influence of the recharge facility is less than 0.5 mile."

The independent studies presented in the EPA's Interim report, provide additional substantiation that the NWWRP recharge facility has little or no actual impact to the IBW-South Superfund Site.

[redacted]

6.0 CONCLUSIONS

The following preliminary conclusions can be made:

1. Actual infiltration rates are approximately half of the design infiltration rates. This is supported by work that the COM contracted to Dames & Moore where soil samples from borings were analyzed for their ability to transmit water and in-situ infiltration tests were conducted (Dames & Moore, 1994). The results of these analyses indicated that the actual infiltration rates at the project site was closer to 0.3 or 0.4 ft/d. In addition, through the project operation, it appears that the maximum infiltration rate achieved was about 0.4 ft/d.

2. Groundwater pumpage within the study area is approximately 10,000 acre-ft per year under normal conditions and has historically been as high as 60,000 acre-ft in a year during drought conditions. The additional pumpage is due to SRP. According to well construction details, almost all of the groundwater withdrawals in the study area are from the middle and lower units. The groundwater that is pumped from the upper unit is from wells that are perforated in multiple units or small diameter shallow wells.

3. Releases from Granite Reef Dam are intermittent and depend on conditions on the watershed and storage capacities within the Salt River Project reservoir system. Usually when releases occur they are great in magnitude but relatively short in duration.

4. When the Salt River flows, infiltration rates decrease significantly at the COM percolation ponds. Water levels start rising within the percolation ponds due to the Salt River flows; discharges to the percolation ponds must be curtailed or sharply reduced during these flow events.

5. Water levels recorded from project monitor wells reflect changes in the hydrologic system due to Salt River flows.

6. Historic (pre-1990) unit specific water level data in the study area are poor, however, more recent data are good. This reflects the ongoing monitoring efforts at sites where water quality is at issue. This includes the IBW-South and Motorola Mesa sites. At these sites, unit specific water levels are monitored.

7. The theoretical historic impacts due to the project operation are approximately 15 feet at the percolation ponds. This means that water levels beneath the ponds were estimated to rise 15 feet above the existing water table from the start of project operation through December of 1994. The mounding from this recharge is estimated to have extended approximately two miles laterally from the infiltration ponds.

8. The actual infiltration rates at the site are less than half the design infiltration rates, 0.4 ft/d versus 1.0 ft/d.

9. Water levels in the monitor wells at the NWWRP recharge site reflect Salt River flows. The monitor wells do not directly reflect recharge from the basins. This is due to the overwhelming nature of the flow releases and the magnitude of impacts these releases have on the hydrologic system within the project site.

10. Projected impacts from the continued project operation at a rate of 8 mgd is predicted to be approximately 36 feet beneath the percolation ponds. The extent of the one-foot rise in water level is approximately five miles.

11. Mounding impacts at the current recharge rate of 0.4 ft/d is insignificant compared to Salt River flows and has not impacted the IBW-South Superfund Site.

12. The City of Mesa NWWRP recharge facility has only minor impacts to the IBW-South Superfund Site.

7.0 RECOMMENDATIONS

After careful consideration of the existing hydrogeologic data, HSI makes the following recommendations:

1. The COM will need to further evaluate and select another method of recharge either using the recharge dry-wells, or deep well injection, but not an additional spreading basin at this site. It is evident that the COM will not be able to fully utilize the 8mgd of treated effluent that is or will become available from the NWWRP to recharge using the current percolation ponds.

2. The COM should select a recharge method that will spread the recharge over a greater area thereby reducing the groundwater mounding impacts. It is also evident from this study that the impacts of the recharge are concentrated in the vicinity of the percolation ponds. This is effective when the Salt River is not flowing, however, as shown by the available data, when the river flows, the percolation rates decrease significantly, so much so that the COM cannot discharge to the percolation ponds.

3. The COM should secure access to monitoring well NW-1 in order to continue collecting water level and water quality data for the project. This monitoring well is the closest to the percolation ponds and would be the first to reflect changes in water levels, and water quality.

9.0 REFERENCES

Arizona Department of Water Resources, 1994, Registry of Grand-Fathered Rights Database.

Dames & Moore, 1994, City of Northwest Water Reclamation Plant Percolation ponds Performance and Alternatives Evaluation Summary Report: report prepared for City of Mesa, Mesa, Arizona, 24p.

Kenneth D. Schmidt and Associates, 1987a, Hydrogeologic Conditions at the Northwest Water Reclamation Plant Recharge Site: report prepared for Black & Veatch, Phoenix, Arizona, 62p.

______ , 1987b, Addendum to Hydrogeologic Conditions at the Northwest Water Reclamation Plant Recharge Site: report prepared for Black & Veatch, Phoenix, Arizona.

Lopez, Ronny, 1995, Water Reclamation Plants Supervisor, City of Mesa, Personal Communication, March 7.

McDonald, M.G., Harbaugh, A.W., Orr, B.R., and Ackerman, D.J., 1992, A Method of Converting No-Flow Cells to Variable-Head Cells for the US Geological Survey Modular Finite-Difference Ground-Water Flow Model: US Geological Survey Open-File Report 91-536, 99p.

McDonald, M.G. and Harbaugh, A.W., 1988, A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: US Geological Survey Techniques of Water Resources Investigations, Book 6, Chapter A1, 586p.

U.S. Environmental Protection Agency, 1993, Indian Bend Wash-South Interim RI Report: report prepared by CH2MHILL, June.

FIGURES

APPENDICES

APPENDIX A

[LTS No. 70-441127]

ARIZONA DEPARTMENT OF WATER RESOURCES

WATER STORAGE PERMIT

PERMIT NO. 73-518105

STATE OF ARIZONA)ss.
)
COUNTY OF MARICOPA)

Pursuant to 1994 Ariz. Sess. Laws, Chapter 291, § 62, the Director hereby grants authority to the Permittee to store water, subject to the following limitations and conditions:

<u>Permit Limitations</u>

Permittee:	City of Mesa P.O. Box 1466 Mesa, Arizona 85201
Storage Facility Permit Number:	No. 71-518105
Management Area: Phoenix	Subbasin: East Salt River Valley
Water To Be Stored:	Effluent
Legal Basis for Acquiring Water To Be Stored:	Right to control and use municipally treated effluent, in accordance with *Arizona Public Service*

Company v. Long, 160 Ariz. 429, 773 P.2d 988 (1989)

Maximum Permitted Storage: 8963 acre-feet per annum

Duration of Permit: January 1, 1995 to March 31, 2008

Permit Conditions

1. Applicant shall not proceed to construct or operate the project prior to receipt of all water quality permit(s) required by the Arizona Department of Environmental Quality. Water quality permits or renewals must be kept current throughout the life of the project.

2. The annual report shall be submitted no later than March 31 following the end of each completed annual reporting period. The first annual reporting period shall be from the date of this permit through December 31, 1995. Subsequent annual reporting periods shall be January 1 through December 31.

3. The Permittee shall continue to meet the requirements of A.R.S. § 45-831.01 during water storage.

4. Recovery of stored water is prohibited unless the Permittee receives a recovery well permit pursuant to A.R.S. § 45-834.01 (previously A.R.S. § 45-807).

5. The Permittee shall not recover water in excess of the amount allowed by Title 45, Chapter 3.1, Article 4, Arizona Revised Statutes.

6. The Permittee shall report all assignments of long-term storage credits accrued pursuant to this permit to the Arizona Department of Water Resources in accordance with A.R.S. § 45-854.01.

7. Water may be stored pursuant to this permit only at Constructed Underground Storage Facility, Permit No. 71-518105.

Witness my hand and seal of office this 30 day of December, 1994.

Herb Dishlip

Herb Dishlip, Deputy Director

ARIZONA DEPARTMENT OF WATER RESOURCES

UNDERGROUND STORAGE FACILITY PERMIT

[CONSTRUCTED]

PERMIT NO. 71-518105

STATE OF ARIZONA)ss.
)
COUNTY OF MARICOPA)

Pursuant to 1994 Ariz. Sess. Laws, Chapter 291, § 62, the Director hereby grants authority to the Permittee to operate a constructed underground storage facility, subject to the following limitations and conditions:

<u>Permit Limitations</u>

Permittee:	City of Mesa P.O. Box 1466 Mesa, Arizona 85201
Management Area: Phoenix	Subbasin: East Salt River Valley
Location of Facility:	Section 18, Township 1 North, Range 5 East
Maximum Storage at Facility:	8,963 acre-feet per annum
Duration of Permit:	January 1, 1995 to March 31, 2008

Permit Conditions

1. Except as provided in Condition No. 2 of this Permit, the facility shall be constructed and operated pursuant to the approved Project construction plan, Project plan of operation and monitoring plan as shown in the report entitled Hydrologic Conditions at the Northwest Reclamation Plant Recharge Site (May, 1987) and Supplemental Addendum (September, 1987) (hereinafter referred to as "hydrologic report"), which are incorporated in and made a part of this permit.

2. Monitoring of the facility is required only at the following wells and locations:

Wells Registration Number	Cadastral Location
55-522678	A(1-5)18bbc
55-522679	A(1-5)18bcd
55-522680	A(1-5)18bdd
55-629617	A(1-5)18aac

3. The facility will utilize infiltration basins with a total infiltration area of not more than 35 acres.

4. The volume of water discharged in to each infiltration basin will be measured with a totalizing flow meter or other approved water measurement device. The volumes discharged to each basin and extracted from each recovery well shall be recorded on a monthly basis at minimum.

5. Monitor wells shall be installed so that the water table falls within the screened or perforated interval throughout project operation, with the exception of extreme water level fluctuation following Salt River flood events. [redacted]

6. Monitoring well pumps shall be installed approximately ~~ten feet below the water table~~. Pump level shall be adjusted for the purpose of maintaining this separation interval during periods of water table fluctuation caused by project operation.

7. Water level measurement shall be conducted in each monitor well prior to the start of recharge operation and monthly thereafter.

8. All monitoring data collected shall be reported to the Operations Division, Arizona Department of Water Resources, 500 North 3rd Street, Phoenix, Arizona 85004, in the form of quarterly data reports. The reports shall include a minimum of, but are not limited to, the following:

    a. Effluent quality and ambient groundwater quality sampling results as required by the water quality permit issued by ADEQ.

    b. Monthly static water levels for monitor wells in feet above mean sea level and feet below land surface. Difference in water levels for each monitor well between current and preceding data reports shall also be reported.

c. Average rate of flow and total volume of water discharged into each infiltration basin recorded on a monthly basis.

d. Average rate of discharge and total pumpage volume for each extraction well recorded on a monthly basis.

9. The facility shall continue to meet the requirements of A.R.S. § 45-811.01 during operation of the facility.

10. In accordance with A.R.S. § 45-814.01(G), the monitoring requirements of this permit may be modified as the Arizona Department of Water Resources finds necessary, depending upon the water storage permits that become affiliated with this storage facility permit and upon other circumstances.

Witness my hand and seal of office this 30 *day of* December*, 1994.*

Herb Dishlip

Herb Dishlip, Deputy Director

APPENDIX B

Appendix B
Northwest Water Reclamation Plant Infiltation Basins
Performance Data

Basin 1

Area: 424710 ft^2

Year	Month	Volume (MG)	Evap. (MG)	Net Volume Recharged (M.G./month)	Infiltration Rate (ft/day)
1990	Dec 1990	48.31			
1991	Jan 1991	0	0	0	0
	Feb	7.1	0.14	6.96	0.078
	March	23.85	0.48	23.37	0.237
	April	30.34	0.61	29.73	0.312
	May	41.82	0.84	40.98	0.416
	June	42.62	0.85	41.77	0.438
	July	48.62	0.97	47.65	0.484
	Aug	49.16	0.98	48.18	0.489
	Sept	57.35	1.15	56.2	0.590
	Oct	40.21	0.8	39.41	0.400
	Nov	35.77	0.72	35.05	0.368
	Dec 1991	50.45	1.01	49.44	0.502
1992	Jan 1992	32.67	0.65	32.02	0.325
	Feb	0	0	0	0
	March	26.58	0.53	26.05	0.264
	April	21.18	0.42	20.76	0.218
	May	57.26	1.15	56.11	0.570
	June	27.84	0.56	27.28	0.286
	July	47.69	0.95	46.74	0.475
	Aug	31.24	0.62	30.62	0.311
	Sept	57.02	1.14	55.88	0.586
	Oct	44.13	0.88	43.25	0.439
	Nov	40.01	0.8	39.21	0.411
	Dec 1992	51.52	1.03	50.49	0.513
1993	Jan 1993	26.78	0.54	26.24	0.266
	Feb	23.48	0.47	23.01	0.250
	March	39.3	0.79	38.51	0.391
	April	33.7	0.67	33.03	0.347
	May	38.7	0.77	37.93	0.385
	June	36.3	0.73	35.57	0.373
	July	31.69	0.63	31.06	0.315
	Aug	46.4	0.93	45.47	0.462
	Sept	51.65	1.03	50.62	0.531
	Oct	43.91	0.88	43.03	0.437
	Nov	56.79	1.14	55.65	0.584
	Dec 1993	48.46	0.97	47.49	0.482
1994	Jan 1994	56.65	1.13	55.52	0.564
	Feb	44.8	0.9	43.9	0.493
	March	61.38	1.23	60.15	0.611
	April	39.67	0.79	38.88	0.408
	May	58.05	1.16	56.89	0.578
	June	55.91	1.12	54.79	0.575
	July	64.31	1.29	63.02	0.640
	Aug	37.64	0.75	36.89	0.375
	Sept	36.97	0.74	36.23	0.380
	Oct	60.68	1.21	59.47	0.604
	Nov	40.8	0.82	39.98	0.419
	Dec 1994	42.13	0.84	41.29	0.419

Appendix B
Northwest Water Reclamation Plant Infiltation Basins
Performance Data

Basin 2

Area: 383764 ft^2

Year	Month	Volume (MG)	Evap (MG)	Net Volume Recharged (M.G./month)	Infiltration Rate (ft/day)
1990	Dec 1990	2.52			
1991	Jan 1991	72.73	1.45	71.28	0.801
	Feb	35.93	0.72	35.21	0.438
	March	47.84	0.96	46.88	0.527
	April	32.13	0.64	31.49	0.366
	May	64.31	1.29	63.02	0.708
	June	44.69	0.89	43.8	0.509
	July	71.67	1.43	70.24	0.789
	Aug	17.5	0.35	17.15	0.193
	Sept	44.28	0.89	43.39	0.504
	Oct	49.29	0.99	48.3	0.543
	Nov	55.33	1.11	54.22	0.630
	Dec 1991	50.45	1.01	49.44	0.556
1992	Jan 1992	32.67	0.65	32.02	0.360
	Feb	0	0	0	0
	March	46.15	0.92	45.23	0.508
	April	42.83	0.86	41.97	0.487
	May	0	0	0	0
	June	44.52	0.89	43.63	0.507
	July	55.02	1.1	53.92	0.606
	Aug	38.84	0.78	38.06	0.428
	Sept	49.59	0.99	48.6	0.564
	Oct	59.95	1.2	58.75	0.660
	Nov	64.16	1.28	62.88	0.730
	Dec 1992	45.95	0.92	45.03	0.506
1993	Jan 1993	22.88	0.46	22.42	0.252
	Feb	23.48	0.47	23.01	0.276
	March	20.41	0.41	0.2	0.002
	April	42.08	0.84	41.24	0.479
	May	41.65	0.83	40.82	0.459
	June	49.01	0.98	48.03	0.558
	July	59.54	1.19	58.35	0.656
	Aug	38.42	0.77	37.65	0.423
	Sept	27.85	0.56	27.29	0.317
	Oct	51.82	1.04	50.78	0.571
	Nov	35.34	0.71	34.63	0.402
	Dec 1993	39.32	0.79	38.53	0.433
1994	Jan 1994	37.91	0.76	37.15	0.417
	Feb	49.3	0.99	48.31	0.601
	March	45.63	0.91	44.72	0.503
	April	32.55	0.65	31.9	0.370
	May	38.6	0.77	37.83	0.425
	June	46.63	0.93	45.7	0.531
	July	36.18	0.72	35.46	0.398
	Aug	39.17	0.78	38.39	0.431
	Sept	54.79	1.1	53.69	0.623
	Oct	34.32	0.69	33.63	0.378
	Nov	48.68	0.97	47.71	0.554
	Dec 1994	52.61	1.05	51.56	0.579

Appendix B
Northwest Water Reclamation Plant Infiltation Basins
Performance Data

Basin 3

Area: 367211 ft^2

Year	Month	Volume (MG)	Evap (MG)	Net Volume Recharged (M.G./month)	Infiltration Rate (ft/day)
1990	Dec 1990	16.42			
1991	Jan 1991	16.56	0.33	16.23	0.191
	Feb	3.67	0.07	3.6	0.047
	March	8.95	0.18	8.77	0.103
	April	27.76	0.56	27.2	0.330
	May	0	0	0	0
	June	12.87	0.26	12.61	0.153
	July	5.72	0.11	5.61	0.066
	Aug	15.14	0.3	14.84	0.174
	Sept	20.86	0.42	20.44	0.248
	Oct	24.61	0.49	24.12	0.283
	Nov	47.04	0.94	46.1	0.559
	Dec 1991	50.45	1.01	49.44	0.581
1992	Jan 1992	32.67	0.65	32.02	0.376
	Feb	12.85	0.26	12.59	0.164
	March	20.08	0.4	19.68	0.231
	April	1.11	0.02	1.09	0.013
	May	18.96	0.38	18.58	0.218
	June	12.89	0.26	12.63	0.153
	July	0	0	0	0
	Aug	20.24	0.4	19.84	0.233
	Sept	3.35	0.07	3.28	0.040
	Oct	19.64	0.39	19.25	0.226
	Nov	15.98	0.32	15.66	0.190
	Dec 1992	33.59	0.67	32.92	0.387
1993	Jan 1993	39.21	0.78	38.43	0.451
	Feb	23.48	0.47	23.01	0.289
	March	20.41	0.41	0.2	0.002
	April	8.41	0.17	8.24	0.100
	May	0	0	0	0
	June	13.27	0.27	0.13	0.002
	July	13.39	0.27	13.12	0.154
	Aug	21.59	0.43	21.16	0.248
	Sept	21.18	0.42	20.76	0.252
	Oct	23.88	0.48	23.4	0.275
	Nov	22.13	0.44	21.69	0.263
	Dec 1993	20.99	0.42	20.57	0.242
1994	Jan 1994	9.86	0.2	9.66	0.113
	Feb	11.37	0.23	11.14	0.145
	March	11.75	0.24	11.52	0.135
	April	22.24	0.44	21.8	0.265
	May	23.67	0.47	23.2	0.272
	June	14.44	0.29	14.15	0.172
	July	19.99	0.4	19.59	0.230
	Aug	16.04	0.32	15.72	0.185
	Sept	11.74	0.23	11.51	0.140
	Oct	26.37	0.53	25.84	0.303
	Nov	21.77	0.44	21.33	0.259
	Dec 1994	14.07	0.28	13.79	0.162

APPENDIX C

Water Level and Water Quality Data for the Northwest Water Reclamation Plant Monitoring Wells

NW-1 Monitor Well T1N R5E 18bbc
Water Level Data

Top of Vault: 1183.09 ft
Measuring Pt.: 1180.59 ft

Date	Depth to Water (ft bls)	Water Level Elevation (ft)
7/30/90		
9/12/90	87	1093.59
10/26/90	93	1087.59
11/7/90		1087
2/1/91	96.08	1084.59
2/27/91	90.42	1090.19
3/6/91	90.33	1090.29
3/25/91	77.58	1103.01
3/28/91	76.08	1104.51
4/12/91	64.58	1116.01
5/16/91	60.5	1120.09
6/13/91	65.08	1115.58
7/17/91	69.67	1110.92
8/14/91	72	1108.59
9/6/91	73.67	1106.92
10/15/91	72.08	1108.49
11/13/91	72.75	1107.84
12/11/91	72.83	1107.76
1/16/92	60.5	1120.09
2/12/92	51.5	1129.09
3/12/92	45.5	1135.09
4/9/92	42.67	1137.92
5/14/92	42	1138.59
6/12/92	40.75	1139.84
7/10/92	41.5	1140.09

NW-1Monitor Well TIN R5E 18bbc
Water Quality Data

Sample Date	TDS (mg/l)	Sodium Na (mg/l)	Calcium Ca (mg/l)	Magnesium Mg (mg/l)	Cloride Cl-2 (mg/l)	Sulfate H2SO4 (mg/l)
4/12/91	570					
3/25/91		133	41	14.8	140	65
5/16/91	600	136	50.9	18.2	160	76
6/13/91	666					
7/17/91	670					
8/14/91	714	147	63	22.1	210	87
9/6/91	718					
10/15/91	719					
11/13/91	783	154	68.8	.24.2	240	98
12/11/91	809					
1/16/92	867					
2/12/92	881	172	80.5	28	300	120
3/12/92	881					

testing waived by ADEQ

? Where is nitrate?

NW-2 Monitor Well T1N R5E 18bcd
Water Level Data

Top of Vault:	1182.9 ft
Measuring pt.:	1180.4 ft

Date	Depth to Water (ft bls)	Water Level Elevation (ft)
Jul-90		
Sep-90	87	1093.4
Oct-90	95	1085.4
Feb-91	94.3	1086.1
Mar-91	94.4	1086
Mar-91	90	1090.4
Apr-91	79.01	1101.39
May-91	71.71	1108.69
Jun-91	73.25	1107.15
Jul-91	76.33	1104.07
Aug-91	77.67	1102.73
Sep-91	78.5	1101.9
Oct-91	78	1102.4
Nov-91	78.5	1101.9
Dec-91	79	1101.4
Jan-92	72.5	1107.9
Feb-92	63.33	1117.07
Mar-92	58	1122.4
Apr-92	54.75	1125.65
May-92	52.5	1127.9
Jun-92	50.5	1129.9
Jul-92	50.5	1129.9
Aug-92	50	1130.4
Sep-92	49	1131.4
Dec-92	54.5	1125.9
Jan-93	45	1135.4
May-93	45.5	1134.9
Nov-93	49.92	1130.48
Mar-94	56	1124.4
May-94	57.17	1123.23
Nov-94	61.33	1119.07
Jan-95	55.92	1124.48
Feb-95	51.25	1129.15

NW-2 Monitor Well TIN 18bcd
Water Quality Data

Sample Date	TDS (mg/l)	Sodium Na (mg/l)	Calcium Ca (mg/l)	Magnesium Mg (mg/l)	Cloride Cl-2 (mg/l)	Sulfate H2S04(mg/l)
3/22/91	486	130	34.8	12.2	134	53
4/12/91	495					
5/16/91	618	146	45.7	15.9	170	76
6/13/91	684					
7/19/91	737					
8/14/91	753	164	62.1	21	220	100
9/6/91	783					
10/15/91	789					
11/13/91	873	174	72.4	24.9	290	105
12/11/91	913					
1/16/92	962					
2/14/92	971	195	85.2	28.8	350	120
3/12/92	956					
5/28/93	845	184	70.8	23.9	270	100
11/4/93	828	180	66.6	23	280	110
3/23/94	784	177	61.9	22.5	280	120
11/17/94	795	170	68	21	250	120

NW-3 Monitor Well T1N R5E 18bdd
Water Level Data

Top of Vault:	1185.7 ft
Measuring pt.:	1183.2 ft

Date	Depth to Water (ft bls)	Water Level Elevations (ft)
Jul-90		
Jul-90		
Sep-90	93	1090.2
Oct-90	97.8	1085.4
Jan-91	98.6	1084.6
Feb-91	98.3	1084.9
Mar-91	98.25	1084.95
Mar-91	96.16	1087.04
Apr-91	87.75	1095.45
May-91	79.5	1103.7
Jun-91	79.67	1103.53
Jul-91	81.25	1101.95
Aug-91	82	1101.2
Sep-91	82.5	1100.7
Oct-91	82.67	1100.53
Nov-91	84.75	1098.45
Dec-91	84.33	1098.87
Jan-92	83.25	1099.95
Feb-92	71.25	1111.95
Mar-92	65.67	1117.53
Apr-92	62	1121.2
May-92	59.25	1123.95
Jun-92	56.67	1126.53
Jul-92	56.5	1126.7
Aug-92	56.33	1126.87
Sep-92	55	1128.2
Dec-92	60.75	1122.45
Jan-93	52.5	1130.7
May-93	46.3	1136.9
Nov-94	55	1128.2
Dec-94	57.33	1125.87
Mar-94	61	1122.2
Nov-94	66.67	1116.53
Jan-95	60.42	1122.78
Feb-95	57.3	1125.9

NW-3 Monitor Well TIN R5E 18bdd
Water Quality Data

Sample Date	TDS (mg/l)	Sodium Na (mg/l)	Calcium Ca (mg/l)	Magnesium Mg (mg/l)	Cloride Cl-2 (mg/l)	Sulfate H2S04(mg/l)
3/6/91	480					
3/22/91	509	132	38	13.2	147	54
4/12/91	600					
5/16/91	606	142	44.5	15.4	160	66
6/13/91	618					
7/17/91	609					
8/14/91	640	145	49.6	16.7	170	81
9/6/91	667					
10/15/91	679					
11/12/91	690	152	55.9	19.2	200	87
12/11/91	709					
1/16/92	743					
2/14/92	794	171	66.1	22.2	260	99
3/12/92	835					
5/28/93	704	158	58	19.6	230	81
3/23/94	710	156	56.1	20.3	240	96
12/13/93	682	145	52.4	18.1	200	90
11/17/94	772	160	72	22	250	110

NW-4 Monitor Well T1N R5E 18aac
Water Level Data

Top of Vault: 1192.81 ft
Measuring pt.: 1187.81 ft

Date	Depth to Water (ft bls)	Water Level Elevation (ft)
9/6/91	83.5	1104.31
10/15/91	85.1	1102.71
11/12/91	86.3	1101.51
12/11/91	87.5	1100.31
1/16/92	80.5	1107.31
2/13/92	69	1118.81
3/12/92	62.8	1125.01
4/10/92	60	1127.81
5/14/92	57.5	1130.31
6/12/92	54.5	1133.31
7/10/92	55.5	1132.31
8/19/92	56.7	1131.11
9/29/92	56.2	1131.61
12/10/92	64	1123.81
1/20/93	51.8	1136.01
5/28/93	47.3	1140.51
11/4/94	59	1128.81
3/23/94	65	1122.81
5/25/94	66.2	1121.61
1/24/95	64.25	1123.56
2/27/95	57.33	1130.48

Choline

NW-4 Monitor Well TIN R5E 18aac
Water Quality Data

Sample Date	TDS (mg/l)	Sodium Na (mg/l)	Calcium Ca (mg/l)	Magnesium Mg (mg/l)	Chloride Cl-2 (mg/l)	Sulfate H_2SO_4 (mg/l)
8/22/91	581	128	42.1	14.7	160	61
10/15/91	491					
11/12/91	602	127	43.5	15.4	160	58
12/11/91	641					
1/16/92	629					
2/13/92	698	151	57.4	19.8	210	77
3/12/92	688					
5/28/93	500	116	34.7	12	140	52
3/23/94	554	127	39.5	14.7	180	74
11/4/93	499	119	35	12.5	140	60
11/17/94	590	130	46	15	170	80

APPENDIX D

Arizona Department of Water Resoures

Registery of Grand-Fathered Rights

Pumpage Data

cadastral	pump84	pump85	pump86	pump87	pump88	pump89	pump90	pump91	pump92	pump93
A-01-04 01ABA	377.9	12.5	6.18	59.83	11.58	5.47	1.2	0	0	0
A-01-04 01CDA	239.81	34.06	17.43	8.58	79.85	8.39	861.78	377.05	9.45	12.51
A-01-04 02ABB	0	0	0	0	0.03	0	0	0	0	0
A-01-04 02DAA	0	0	0	0	0.03	0	0	0	0	0
A-01-04 02DBB	577.86	7.09	12.55	13.88	15.73	8.88	30.71	0	0	0
A-01-04 02DBD	0	0	0	0	0.03	0	0	0	0	0
A-01-04 02DDA	281.8	337.91	397.82	626.04	459.92	1358.65	951.58	800	612.32	0
A-01-04 05BAB	0	0	0	0	0	0	0	0	0	35
A-01-04 05BAB	0	0	0	0	0	0	0	0	0	11.2
A-01-04 05BAB	0	0	0	0	0	0	0	0	15.9	0
A-01-04 05BAB	0	0	0	0	0	0	0	0	29.1	0
A-01-04 05BAB	0	0	0	0	0	0	0	0	14.2	0
A-01-04 05BAB	0	0	0	0	0	0	0	0	4.5	0
A-01-04 05BAC	0	0	0	0	0	0	0	0	0	7.5
A-01-04 05BAC	0	0	0	0	0	0	0	0	0	5.1
A-01-04 06AAB	0	0	0	0	0	0	0	0	28.4	31.2
A-01-04 06AAB	0	0	0	0	0	0	0	0	31.3	32
A-01-04 06AAB	0	0	0	0	0	0	0	0	40.5	104
A-01-04 06AAC	0	0	0	0	0	0	0	0	54.9	65.7
A-01-04 06AAC	0	0	0	0	0	0	0	0	61.4	68
A-01-04 06ADB	0	0	0	0	0	0	0	0	67.01	79
A-01-04 06ADB	0	0	0	0	0	0	0	0	34.1	32.6
A-01-04 06ADC	0	0	0	0	0	0	0	0	13.9	10
A-01-04 06ADC	0	0	0	0	0	0	0	0	4.4	0.6
A-01-04 11ABA	1797.03	396.1	2179.2	1025.56	31.37	8.32	0	0.47	5.12	0
A-01-04 11BDB	0	33.48	37.18	35.95	33.63	45.49	22.96	25.09	4.46	5.6
A-01-04 11DBA	0	0	0	0	0	0	0	0	0	202.06
A-01-04 11DBA	0	0	0	0	0	0	0	214.77	181.79	0
A-01-04 13ADB	151	207.65	249.98	334	248	252	63.47	42.41	0	0
A-01-04 13ADD	51.78	52.99	72.74	48.6	38.36	27.48	24.32	28.84	55.87	0
A-01-04 13BAC	192	18.26	97	0	1.04	0.08	0.41	0.03	3.63	2.29

cadastral	pump84	pump85	pump86	pump87	pump88	pump89	pump90	pump91	pump92	pump93
A-01-04 13BCC	0	0	0	0	0	0	0	0.02	0	0
A-01-04 13CAB	0	0	0	0	0	0	0	0.1	0	0
A-01-04 13CAC	0	0	0	0	0	0	0	0	0.15	0
A-01-04 13CBA	0	0	0	0	0	0	0	0.02	0	0
A-01-04 13CCA	0	0	0	0	0	0	0	0	0.15	0
A-01-04 13CDB	0	0	0	0	0	0	0	0.02	0	0
A-01-04 13CDB	0	0	0	0	0	0	0	0.18	0	0
A-01-04 13CDB	0	0	0	0	0	0	0	0	0.15	0
A-01-04 13DDB	0	0	0	0	0	0	0	0.02	0	0
A-01-04 14DAA	0	0	719.08	223.67	0	0	0	0	0	0
A-01-04 14DAA	0	862.1	0	0	0	0	0	0	0	0
A-01-04 14DAB	0	0	0	0	251	0	488.6	481.7	652.6	587.2
A-01-04 14DBC	0	0	0	0	0	0	0	0.02	0	0
A-01-04 15DCC	1055.6	1301.52	388.73	858.72	21.9	11.23	0	0.15	3.54	0
A-01-04 18CBD	0	0	0	0	0	0	0	1.7	0	0
A-01-04 18CCA	0	1	1	1	1	0	1	1	1	1
A-01-04 19ACC	201.38	3.25	1.08	5.7	5.68	4.79	18.38	0.05	3.68	5.22
A-01-04 22DBC	136.8	113.53	70.36	75.89	23.01	8.95	0	0	2.02	0
A-01-04 23ABC	0	0	0	0	0	0	0	0.01	0	0
A-01-04 23ABC	0	0	0	0	0	0	0	0.02	0	0
A-01-04 23BCC	0	0	0	0	0	0	0	0	0	12
A-01-04 23BCC	59.4	61.66	48.9	95.21	30.29	16.89	0	0.23	2.73	0
A-01-04 24ABC	397.9	38.48	27.06	43.8	25.76	15.24	0	0.28	7.37	0
A-01-04 24BAA	0	0	0	0	0	0	0	0.02	0	0
A-01-04 24BBC	0	0	0	0	0	0	0	0.03	0	0
A-01-04 24BBC	0	0	0	0	0	0	0	0.15	0	0
A-01-04 24BBC	0	0	0	0	3	0	0	0	0	0
A-01-04 24BBC	153.6	16.15	69.32	17.04	12.7	160.25	16.82	0	0	0
A-01-04 25DDC	629.98	57.64	188.95	109.29	20.96	17.6	0	0.41	11.51	0
A-01-04 27AAA	89.47	9.89	8.85	115.02	9.17	3.93	84.11	8.71	7.1	23.07
A-01-04 30BB	0	7	7	0	0	7	0	0	0	7
A-01-04 30C	17	15.33	15.8	0	0	0	0	0	0	0
A-01-05 01BDD	1705.09	18.62	17.44	22.81	14.26	10	2356.93	472.31	17.28	23.27
A-01-05 02AAA	1241.04	13.69	13.35	12.15	96.88	96.48	2149.57	515.58	8.65	15.91
A-01-05 02BBB	1401.13	12.86	15.11	16	21.28	51.61	2646.77	831.47	19.02	17.53

cadastral	pump84	pump85	pump86	pump87	pump88	pump89	pump90	pump91	pump92	pump93
A-01-05 02CDD	1397.98	16.74	22.31	23.15	16.01	28.32	3090.48	862.35	108.14	81.69
A-01-05 02CDD	1070.85	12.36	14.23	8.53	30.33	15.24	499.63	0	0	264.43
A-01-05 02DBB	1733.83	14.38	16.35	14.57	29.36	32.06	609.32	0.29	14.02	15.9
A-01-05 03ACC	0	0	500	772.68	531.55	0	221.25	54.17	26.45	59.48
A-01-05 03ACC	604.52	649.3	265	0	0	0	0	0	0	0
A-01-05 03ACC	0	0	88.5	0	0	0	0	0	0	0
A-01-05 03DDD	1157.79	14.23	0	40.15	23.29	50.84	2245.77	579.89	14.57	40.39
A-01-05 04DCD	0	0	0	0	43.43	0	89.45	80.88	85.44	163.85
A-01-05 04DDD	1648.03	16.39	16.53	14.54	34.04	31.19	1634.43	312.62	19.39	39.8
A-01-05 06	469	18	220	99	79	0	0	0	0	0
A-01-05 09BBB	1.5	0.5	2.58	0	0	0	0	0	0	0
A-01-05 09BBB	0	0	0	3.32	28.2	0	24.1	32.08	0	0
A-01-05 09BBB	995	963.5	652.83	0	0	0	0	0	0	0
A-01-05 09BBB	0	0	0	665.64	823.4	0	590.25	585.15	0	0
A-01-05 09DBC	1930.05	0	43.33	40.66	56.06	92.2	2065.27	722.83	29.8	106.17
A-01-05 09DCD	0	10.91	22.47	11.57	29.79	124.79	2649.76	579.05	33.43	27.71
A-01-05 10CCD	1768.12	12.4	11.99	14.07	13.14	0	0	26.1	9.82	13.93
A-01-05 11CAD	721.73	17.44	16.98	3.44	7.43	65.36	1557.35	466.86	7.4	61.85
A-01-05 12BBA	0	0	0	0	0	0	0	831.93	485.79	737.35
A-01-05 13BBC	1749.87	12.78	12.02	20.07	11.87	22.03	2389.04	46.58	5.97	54.38
A-01-05 13CAA	1436.53	17.68	11.39	0	15.52	24.14	352.41	588.14	14.89	27.29
A-01-05 14BAA	1396.12	30.82	25.78	49.32	15.52	19.88	868.22	0	0	3.18
A-01-05 14BCC	453	519	497.92	495	578	506	555	282.41	866.3	918.8
A-01-05 15DBC	467	498	527.92	547	621	537	538	218.6	919.56	131.67
A-01-05 15DBD	184	279	273.81	315	285	245	215	125.54	400.64	29.47
A-01-05 16CCD	188.76	13.55	21.19	25.8	9.22	2.23	360.9	6.76	3.07	0.94
A-01-05 17AAA	1226.66	11	10.1	28.46	45.76	136.18	325.91	29.52	57.22	86.71
A-01-05 17CAA	272.63	46.63	21.01	18.16	22.86	26.03	2175.57	547.93	35.39	26.21
A-01-05 18AAC	8	6	0	0	1	2	0	0	0	0
A-01-05 18BCA	0	0	0	0	0	0	0	0.77	0	0
A-01-05 18CBB	435.35	0	0	0	0	0	0	0	0	0
A-01-05 18CCA	0	0	0	0	288	121	0	0	0	0
A-01-05 18CDC	853.95	11.27	37.74	18.36	25.92	31.77	1125.82	83.04	36.67	25
A-01-05 18DDD	735.43	8.41	10.23	20.25	9.77	99.7	1312.61	299.65	75.56	171.79
A-01-05 19BCD	326.17	0	0	0	0	0	0	0	0	0

cadastral	pump84	pump85	pump86	pump87	pump88	pump89	pump90	pump91	pump92	pump93
A-01-05 19BDD	1786.21	24.05	20.05	14.94	15.9	55.38	1150.27	0	0	0
A-01-05 19DCA	0	0	0	0	0	0	0	0	110	132
A-01-05 19DCA	0	0	0	0	1226	1697	0	0	0	0
A-01-05 19DCA	0	0	0	0	0	0	2008	0	1881	1985
A-01-05 19DCA	766.4	2161	626.8	576.4	2454	0	0	0	0	0
A-01-05 19DCC	1550	1520	1187.6	1133	0	0	0	0	0	0
A-01-05 19DCC	12	29.6	18.5	0.6	0	0	0	0	0	0
A-01-05 19DCD	0	0	0	0	0	0	13	59	0	0
A-01-05 19DCD	0	0	0	0	0	0	91	0	0	0
A-01-05 19DCD	11.8	45.1	55	91.6	84	0	0	0	0	0
A-01-05 19DCD	0	0	0	0	0	0	21	77	0	0
A-01-05 19DCD	0	0	0	0	0	0	53	0	0	0
A-01-05 19DCD	10.7	84.9	100.7	70.1	46.1	0	0	0	0	0
A-01-05 19DCD	0	0	0	0	0	0	0	0	88	45
A-01-05 19DCD	0	0	0	0	0	0	0	0	130	144
A-01-05 19DDC	0	0	0	0	0	0	13	66	0	0
A-01-05 19DDC	0	0	0	0	0	0	77	0	0	0
A-01-05 19DDC	0	0	0	62.3	56.8	0	0	0	0	0
A-01-05 19DDC	0	0	0	0	0	0	0	0	112	135
A-01-05 19DDD	0	0	0	0	0	0	30	165	65	0
A-01-05 19DDD	0	0	0	0	0	0	42	1977	0	0
A-01-05 21ABB	318.34	11.83	11.23	11.75	29.23	0	1307.61	24.68	10.12	138.8
A-01-05 21DCB	0	0	1.14	0	0	83	0	0	0	0
A-01-05 22AAA	0	297	279.31	317	246	339	248	215.68	614.88	1045.53
A-01-05 22BBB	323	351	393.57	617	394	626	394	279.66	567.11	697.68
A-01-05 22CDC	0	0	0	0	310	323	294	251.19	262.87	112.28
A-01-05 22DDD	348	171	652.38	455	564	503	454	206.5	635.08	2214.43
A-01-05 24AAD	0	0	12.36	9.66	15.93	44.57	2670.73	127.33	12.62	56.33
A-01-05 24DAA	0	0	0	898	439	456	429	193.64	338.2	1669.11
A-01-05 26BAA	0	0	261.72	304	363	271	255	212.33	380.47	1008.09
A-01-05 26DDD	405.08	5.17	5.11	4.88	0	6.8	1506.84	6.88	7.32	16.73
A-01-05 27DCC	646.01	13.41	12.15	11.21	29.62	29.82	1546.52	5.71	3.53	0
A-01-05 29CBB	0	0	0	0	0	0	5	17	35	94
A-01-05 29CBB	0	0	0	0	0	0	85	0	0	0
A-01-05 29CBC	0	0	0	0	0	0	0	81	79	100

cadastral	pump84	pump85	pump86	pump87	pump88	pump89	pump90	pump91	pump92	pump93
A-01-05 29CCC	0	0	0	0	0	0	0	0	0	51
A-01-05 30AAD	0	0	0	0	0	0	19	155	154	153
A-01-05 30AAD	0	0	0	0	0	0	81	0	0	0
A-01-05 30BBA	865.92	10.66	0	17.16	13.53	17.11	2364.28	407.95	48.05	12.62
A-01-05 30BDD	868.62	36.51	261.01	27.5	23.35	5.67	2336.42	20.17	20.84	8.22
A-01-05 30DCC	2050.94	13.14	28.03	0	40.81	28.25	3184.31	449.92	30.38	17.01
A-01-05 30DDA	0	0	0	0	0	0	20	92	130	112
A-01-05 31CBC	0	0	0	0	0	0	0	0	0	7.87
A-01-05 32CDD	1058.19	36.35	52.34	38.56	43.97	36.78	1881.31	38.86	37.3	41.72
A-01-05 33CDD	688.96	9.4	10.72	8.96	20.41	20.75	1387.99	4.32	6.42	10.22
A-01-05 34DDD	790.82	14.87	15.8	137.95	38.81	123.85	0	0	0	0
A-01-05 35ADC	2077.73	11.38	65.6	14.18	16.52	108.42	679.05	29.26	613.78	14.1
A-01-05 35BAA	498.21	10.27	15.71	61.83	22.72	4.62	10.09	3.1	0.48	233.79
A-01-05 36CDC	0	0	28	28	28.93	28.63	0	30	29.27	31.45
A-01-05 36CDC	26	36	0	0	0	0	0	0	0	0
Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Sum of Pumping	49092.4	11725.69	12119	11909.1	11653.6	9140.34	59871.57	16362.18	11661.44	14771.53

APPENDIX E

Arizona Department of Water Resources
Groundwater Site Inventory Data 1980-1993
(By Year)

1993 Data

Local_id	Well_alt	Perf_top	Perf_bot	M_mea	D_me	Yr_mea	Cwl_depth	Wl_elev
A-01-04 01BDA2	1209.00	85	125	1	11	1993	87.40	1121.60
A-01-04 01BDA2	1209.00	85	125	2	9	1993	86.20	1122.80
A-01-04 01BDA2	1209.00	85	125	5	14	1993	78.30	1130.70
A-01-04 01BDA2	1209.00	85	125	8	17	1993	73.30	1135.70
A-01-04 01BDA2	1209.00	85	125	11	17	1993	78.30	1130.70
A-01-04 02DBB	1200.00	520	610	4	19	1993	131.70	1068.30
A-01-04 02DBB	1200.00	210	505	4	19	1993	131.70	1068.30
A-01-04 02DBB	1200.00	210	505	5	18	1993	129.20	1070.80
A-01-04 02DBB	1200.00	520	610	5	18	1993	129.20	1070.80
A-01-04 11BDB2	1185.00	155	430	1	15	1993	82.20	1102.80
A-01-04 11BDB2	1185.00	155	430	2	9	1993	97.40	1087.60
A-01-04 11BDB2	1185.00	155	430	3	9	1993	94.90	1090.10
A-01-04 11BDB2	1185.00	155	430	4	13	1993	92.60	1092.40
A-01-04 11BDB2	1185.00	155	430	5	17	1993	93.70	1091.30
A-01-04 24ABC	1182.00	200	675	1	15	1993	79.90	1102.10
A-01-04 24ABC	1182.00	688	690	1	15	1993	79.90	1102.10
A-01-04 24ABC	1182.00	200	675	2	9	1993	75.70	1106.30
A-01-04 24ABC	1182.00	688	690	2	9	1993	75.70	1106.30
A-01-04 24ABC	1182.00	200	675	3	9	1993	71.80	1110.20
A-01-04 24ABC	1182.00	688	690	3	9	1993	71.80	1110.20
A-01-04 24ABC	1182.00	200	675	4	14	1993	72.50	1109.50
A-01-04 24ABC	1182.00	688	690	4	14	1993	72.50	1109.50
A-01-04 24ABC	1182.00	688	690	5	17	1993	72.90	1109.10
A-01-04 24ABC	1182.00	200	675	5	17	1993	72.90	1109.10
A-01-04 27AAA2	1172.00	150	475	1	12	1993	68.80	1103.20
A-01-04 27AAA2	1172.00	490	500	1	12	1993	68.80	1103.20
A-01-04 27AAA2	1172.00	150	475	2	10	1993	122.70	1049.30
A-01-04 27AAA2	1172.00	490	500	2	10	1993	122.70	1049.30
A-01-04 27AAA2	1172.00	490	500	3	17	1993	62.50	1109.50
A-01-04 27AAA2	1172.00	150	475	3	17	1993	62.50	1109.50
A-01-04 27AAA2	1172.00	150	475	4	19	1993	58.60	1113.40
A-01-04 27AAA2	1172.00	490	500	4	19	1993	58.60	1113.40
A-01-04 27AAA2	1172.00	490	500	5	18	1993	60.20	1111.80
A-01-04 27AAA2	1172.00	150	475	5	18	1993	60.20	1111.80
A-01-05 03DDC	1220.00	200	480	1	12	1993	152.80	1067.20
A-01-05 03DDC	1220.00	496	500	1	12	1993	152.80	1067.20
A-01-05 03DDC	1220.00	496	500	2	10	1993	145.70	1074.30
A-01-05 03DDC	1220.00	200	480	2	10	1993	145.70	1074.30
A-01-05 03DDC	1220.00	496	500	3	17	1993	138.60	1081.40
A-01-05 03DDC	1220.00	200	480	3	17	1993	138.60	1081.40
A-01-05 03DDC	1220.00	496	500	4	19	1993	131.00	1089.00
A-01-05 03DDC	1220.00	200	480	4	19	1993	131.00	1089.00
A-01-05 03DDC	1220.00	200	480	5	18	1993	126.00	1094.00
A-01-05 03DDC	1220.00	496	500	5	18	1993	126.00	1094.00
A-01-05 06CAA	1196.00	590	596	1	11	1993	115.80	1080.20
A-01-05 06CAA	1196.00	250	580	1	11	1993	115.80	1080.20
A-01-05 06CAA	1196.00	120	180	1	11	1993	115.80	1080.20
A-01-05 06CAA	1196.00	590	596	3	9	1993	109.50	1086.50
A-01-05 06CAA	1196.00	250	580	3	9	1993	109.50	1086.50
A-01-05 06CAA	1196.00	120	180	3	9	1993	109.50	1086.50
A-01-05 06CAA	1196.00	120	180	4	14	1993	101.80	1094.20
A-01-05 06CAA	1196.00	590	596	4	14	1993	101.80	1094.20
A-01-05 06CAA	1196.00	250	580	4	14	1993	101.80	1094.20
A-01-05 06CAA	1196.00	590	596	5	17	1993	97.90	1098.10
A-01-05 06CAA	1196.00	250	580	5	17	1993	97.90	1098.10

Local_id	Well_alt	Perf_top	Perf_bot	M_mea	D_me	Yr_mea	Cwl_depth	Wl_elev
A-01-05 06CAA	1196.00	120	180	5	17	1993	97.90	1098.10
A-01-05 06CAA	1196.00	590	596	11	16	1993	104.50	1091.50
A-01-05 06CAA	1196.00	250	580	11	16	1993	104.50	1091.50
A-01-05 06CAA	1196.00	120	180	11	16	1993	104.50	1091.50
A-01-05 16ABB	1246.00	300	685	1	12	1993	194.90	1051.10
A-01-05 16ABB	1246.00	300	685	3	17	1993	171.80	1074.20
A-01-05 16ABB	1246.00	300	685	4	19	1993	162.30	1083.70
A-01-05 16ABB	1246.00	300	685	5	18	1993	159.40	1086.60
A-01-05 16ABB	1246.00	300	685	12	2	1993	165.20	1080.80
A-01-05 22AAA	1243.00	374	680	1	12	1993	182.20	1060.80
A-01-05 22AAA	1243.00	374	680	2	9	1993	178.90	1064.10
A-01-05 22AAA	1243.00	374	680	5	18	1993	173.70	1069.30
A-01-05 30BDD	1199.00	90	430	12	2	1993	97.50	1101.50
A-01-05 33CDD	1206.00	160	408	1	12	1993	131.80	1074.20
A-01-05 33CDD	1206.00	160	408	2	10	1993	130.60	1075.40
A-01-05 33CDD	1206.00	160	408	3	17	1993	140.50	1065.50
A-01-05 33CDD	1206.00	160	408	4	19	1993	129.30	1076.70
A-01-05 33CDD	1206.00	160	408	5	18	1993	134.70	1071.30

1992 Data

Local_id	Well_alt	Perf_top	Perf_bot	M_mea	D_me	Yr_mea	Cwl_depth	Wl_elev
A-01-04 01BDA2	1209.00	85	125	2	18	1992	105.90	1103.10
A-01-04 01BDA2	1209.00	85	125	5	12	1992	97.04	1111.96
A-01-04 01BDA2	1209.00	85	125	8	10	1992	85.10	1123.90
A-01-04 01BDA2	1209.00	85	125	11	13	1992	83.75	1125.25
A-01-05 06CAA	1196.00	590	596	11	18	1992	122.60	1073.40
A-01-05 06CAA	1196.00	120	180	11	18	1992	122.60	1073.40
A-01-05 06CAA	1196.00	250	580	11	18	1992	122.60	1073.40
A-01-05 16ABB	1246.00	300	685	12	1	1992	206.60	1039.40
A-01-05 30BDD	1199.00	90	430	12	1	1992	112.60	1086.40

Local_Id	Well_alt	Perf_top	Perf_bot	M_mea	D_me	Yr_mea	Cwl_depth	Wl_elev
A-01-04 01ABA1	1209.00	482	493	11	11	1991	182.90	1026.10
A-01-04 01ABA1	1209.00	90	465	11	11	1991	182.90	1026.10
A-01-04 01BDA2	1209.00	85	125	2	12	1991	110.10	1098.90
A-01-04 01BDA2	1209.00	85	125	5	16	1991	110.00	1099.00
A-01-04 01BDA2	1209.00	85	125	8	14	1991	104.40	1104.60
A-01-04 01BDA2	1209.00	85	125	11	15	1991	103.90	1105.10
A-01-04 01CDA2	1197.00	840	850	11	11	1991	179.60	1017.40
A-01-04 01CDA2	1197.00	300	820	11	11	1991	179.60	1017.40
A-01-04 02DBB	1200.00	210	505	11	11	1991	182.60	1017.40
A-01-04 02DBB	1200.00	520	610	11	11	1991	182.60	1017.40
A-01-04 11ABA	1185.00	205	1038	11	18	1991	153.40	1031.60
A-01-04 11BDB2	1185.00	155	430	11	18	1991	145.70	1039.30
A-01-04 13ADD	1180.00	160	380	11	7	1991	82.00	1098.00
A-01-04 13ADD	1180.00	100	115	11	7	1991	82.00	1098.00
A-01-04 13BAC	1179.00	401	497	11	7	1991	131.30	1047.70
A-01-04 23BCC	1170.00	496	500	11	18	1991	86.70	1083.30
A-01-04 23BCC	1170.00	80	481	11	18	1991	86.70	1083.30
A-01-04 24ABC	1182.00	688	690	11	18	1991	110.90	1071.10
A-01-04 24ABC	1182.00	200	675	11	18	1991	110.90	1071.10
A-01-04 24BBC2	1178.00	150	457	11	12	1991	117.80	1060.20
A-01-04 25DDC	1190.00	270	520	11	18	1991	139.80	1050.20
A-01-04 27AAA2	1172.00	490	500	11	11	1991	95.90	1076.10
A-01-04 27AAA2	1172.00	150	475	11	11	1991	95.90	1076.10
A-01-05 03DDC	1220.00	496	500	11	13	1991	193.10	1026.90
A-01-05 03DDC	1220.00	200	480	11	13	1991	193.10	1026.90
A-01-05 06BDA1	1201.00	90	0	11	12	1991	100.40	1100.60
A-01-05 08AAA2	1202.00	150	0	11	15	1991	174.30	1027.70
A-01-05 09DCB	1220.00	754	900	11	13	1991	184.50	1035.50
A-01-05 09DCB	1220.00	300	734	11	13	1991	184.50	1035.50
A-01-05 10CCC	1253.00	300	685	11	13	1991	230.70	1022.30
A-01-05 15DBD	1245.00	400	776	10	29	1991	261.50	983.50
A-01-05 15DBD	1245.00	796	870	10	29	1991	261.50	983.50
A-01-05 15DBD	1245.00	796	870	12	3	1991	255.30	989.70
A-01-05 15DBD	1245.00	400	776	12	3	1991	255.30	989.70
A-01-05 16ABB	1246.00	300	685	1	23	1991	289.60	956.40
A-01-05 16ABB	1246.00	300	685	11	13	1991	239.30	1006.70
A-01-05 16CDC	1239.00	860	960	11	13	1991	214.80	1024.20
A-01-05 16CDC	1239.00	300	846	11	13	1991	214.80	1024.20
A-01-05 17AAA	1205.00	80	438	11	13	1991	169.40	1035.60
A-01-05 17CAA	1221.00	150	585	11	12	1991	182.80	1038.20
A-01-05 17CAA	1221.00	598	600	11	12	1991	182.80	1038.20
A-01-05 18CDC	1188.00	145	720	11	12	1991	132.80	1055.20
A-01-05 18CDC	1188.00	734	770	11	12	1991	132.80	1055.20
A-01-05 19BDD	1202.00	160	685	11	12	1991	128.00	1074.00
A-01-05 19DCA	1208.00	1187	1205	11	13	1991	172.60	1035.40
A-01-05 19DCA	1208.00	387	1187	11	13	1991	172.60	1035.40
A-01-05 19DCC1	1203.00	995	1195	11	13	1991	157.80	1045.20
A-01-05 19DCC1	1203.00	615	655	11	13	1991	157.80	1045.20
A-01-05 19DCC1	1203.00	290	535	11	13	1991	157.80	1045.20
A-01-05 19DCC1	1203.00	855	975	11	13	1991	157.80	1045.20
A-01-05 19DCC1	1203.00	735	835	11	13	1991	157.80	1045.20
A-01-05 21DCC	1230.00	1010	1013	12	4	1991	199.60	1030.40
A-01-05 21DCC	1230.00	500	1000	12	4	1991	199.60	1030.40
A-01-05 22AAA	1243.00	374	680	12	3	1991	214.40	1028.60
A-01-05 22ABB	1244.00	350	985	10	28	1991	255.80	988.20
A-01-05 22ABB	1244.00	350	985	12	3	1991	216.50	1027.50
A-01-05 22CCD	1234.00	910	1180	12	3	1991	206.10	1027.90
A-01-05 22CCD	1234.00	350	880	12	3	1991	206.10	1027.90
A-01-05 22DDD	1234.00	660	980	10	28	1991	286.20	947.80
A-01-05 22DDD	1234.00	655	660	10	28	1991	286.20	947.80

Local_id	Well_alt	Perf_top	Perf_bot	M_mea	D_me	Yr_mea	Cwl_depth	Wl_elev
A-01-05 22DDD	1234.00	515	645	10	28	1991	286.20	947.80
A-01-05 22DDD	1234.00	655	660	12	3	1991	213.00	1021.00
A-01-05 22DDD	1234.00	660	980	12	3	1991	213.00	1021.00
A-01-05 22DDD	1234.00	515	645	12	3	1991	213.00	1021.00
A-01-05 27DCC	1219.00	685	775	11	7	1991	191.50	1027.50
A-01-05 27DCC	1219.00	200	670	11	7	1991	191.50	1027.50
A-01-05 29DDA	1218.00	480	490	11	13	1991	161.90	1056.10
A-01-05 29DDA	1218.00	210	465	11	13	1991	161.90	1056.10
A-01-05 30BBA	1198.00	684	900	11	12	1991	152.20	1045.80
A-01-05 30BBA	1198.00	680	684	11	12	1991	152.20	1045.80
A-01-05 30BBA	1198.00	300	670	11	12	1991	152.20	1045.80
A-01-05 30BDD	1199.00	90	430	1	23	1991	222.30	976.70
A-01-05 30BDD	1199.00	90	430	11	12	1991	143.40	1055.60
A-01-05 30DCD	1197.00	660	893	11	12	1991	158.30	1038.70
A-01-05 30DCD	1197.00	300	676	11	12	1991	158.30	1038.70
A-01-05 32DCC	1205.00	450	992	11	7	1991	185.00	1020.00
A-01-05 32DCC	1205.00	1007	1015	11	7	1991	185.00	1020.00
A-01-05 33CDD	1206.00	160	408	11	14	1991	164.30	1041.70

1990 Data

Local_id	Well_alt	Perf_top	Perf_bot	M_mea	D_me	Yr_mea	Cwl_depth	Wl_elev
A-01-04 01BDA2	1209.00	85	125	2	27	1990	107.10	1101.90
A-01-04 01BDA2	1209.00	85	125	5	22	1990	107.60	1101.40
A-01-04 01BDA2	1209.00	85	125	8	21	1990	107.00	1102.00
A-01-04 01BDA2	1209.00	85	125	11	16	1990	107.00	1102.00
A-01-04 02DDB	1189.00	350	480	5	21	1990	174.60	1014.40
A-01-04 02DDB	1189.00	484	700	5	21	1990	174.60	1014.40
A-01-04 11ABA	1185.00	205	1038	5	24	1990	159.10	1025.90
A-01-04 11BDB1	1185.00	60	160	4	12	1990	105.20	1079.80
A-01-04 11BDB2	1185.00	155	430	4	12	1990	143.00	1042.00
A-01-04 13ADB	1181.00	250	300	4	13	1990	94.40	1086.60
A-01-04 13BAC	1179.00	401	497	4	13	1990	143.50	1035.50
A-01-04 23BCC	1170.00	496	500	5	2	1990	92.30	1077.70
A-01-04 23BCC	1170.00	80	481	5	2	1990	92.30	1077.70
A-01-04 24ABC	1182.00	200	675	5	24	1990	136.70	1045.30
A-01-04 24ABC	1182.00	688	690	5	24	1990	136.70	1045.30
A-01-04 25DDC	1190.00	270	520	5	24	1990	189.80	1000.20
A-01-05 06CAA	1196.00	120	180	12	3	1990	165.40	1030.60
A-01-05 06CAA	1196.00	590	596	12	3	1990	165.40	1030.60
A-01-05 06CAA	1196.00	250	580	12	3	1990	165.40	1030.60

1989 Data

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01ABA1	8	1	1989	90	465	202.20	1006.80
A-01-04 01ABA1	8	1	1989	482	493	202.20	1006.80
A-01-04 01BDA2	1	25	1989	85	125	101.70	1107.30
A-01-04 01BDA2	4	19	1989	85	125	103.30	1105.70
A-01-04 01BDA2	7	28	1989	85	125	101.30	1107.70
A-01-04 01BDA2	11	1	1989	85	125	102.20	1106.80
A-01-04 27AAA2	7	28	1989	150	475	158.30	1013.70
A-01-04 27AAA2	7	28	1989	490	500	158.30	1013.70
A-01-05 19BDD	7	31	1989	160	685	159.90	1042.10

1988 Data

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01BDA2	1	6	1988	85	125	99.32	1109.68
A-01-04 01BDA2	2	4	1988	85	125	100.89	1108.11
A-01-04 01BDA2	3	7	1988	85	125	100.52	1108.48
A-01-04 01BDA2	4	12	1988	85	125	100.33	1108.67
A-01-04 01BDA2	5	10	1988	85	125	101.30	1107.70
A-01-04 01BDA2	6	14	1988	85	125	100.35	1108.65
A-01-04 01BDA2	7	25	1988	85	125	98.14	1110.86
A-01-04 01BDA2	8	29	1988	85	125	96.70	1112.30
A-01-04 02BBB	1	7	1988	65	161	0.00	0.00
A-01-04 02BBB	1	7	1988	170	187	0.00	0.00
A-01-04 13ADD	1	29	1988	100	115	79.80	1100.20
A-01-04 13ADD	1	29	1988	160	380	79.80	1100.20
A-01-04 24ABC	1	7	1988	200	675	103.80	1078.20
A-01-04 24ABC	1	7	1988	688	690	103.80	1078.20
A-01-04 25DDC	1	28	1988	270	520	120.80	1069.20
A-01-04 27AAA2	1	28	1988	150	475	143.50	1028.50
A-01-04 27AAA2	1	28	1988	490	500	143.50	1028.50
A-01-05 15DBD	2	3	1988	400	776	203.90	1041.10
A-01-05 15DBD	2	3	1988	796	870	203.90	1041.10
A-01-05 16ABB	6	8	1988	300	685	205.40	1040.60
A-01-05 16ABB	12	6	1988	300	685	205.00	1041.00
A-01-05 19DCC2	2	23	1988	149	160	108.90	1096.10
A-01-05 21DCC	2	3	1988	500	1000	174.90	1055.10
A-01-05 21DCC	2	3	1988	1010	1013	174.90	1055.10
A-01-05 22AAA	2	3	1988	374	680	191.30	1051.70
A-01-05 22ABB	2	3	1988	350	985	194.20	1049.80
A-01-05 22CCD	2	3	1988	350	880	182.50	1051.50
A-01-05 22CCD	2	3	1988	910	1180	182.50	1051.50
A-01-05 22DDD	2	3	1988	515	645	190.40	1043.60
A-01-05 22DDD	2	3	1988	655	660	190.40	1043.60
A-01-05 22DDD	2	3	1988	660	980	190.40	1043.60
A-01-05 27DCC	1	29	1988	200	670	161.00	1058.00
A-01-05 27DCC	1	29	1988	685	775	161.00	1058.00
A-01-05 29DDA	1	29	1988	210	465	139.30	1078.70
A-01-05 29DDA	1	29	1988	480	490	139.30	1078.70
A-01-05 30BDD	6	9	1988	90	430	131.10	1067.90
A-01-05 30BDD	12	6	1988	90	430	123.10	1075.90
A-01-05 32DCC	1	29	1988	450	992	140.30	1064.70
A-01-05 32DCC	1	29	1988	1007	1015	140.30	1064.70

1987 Data

Local_Id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01BDA2	1	29	1987	85	125	100.04	1108.96
A-01-04 01BDA2	2	27	1987	85	125	99.98	1109.02
A-01-04 01BDA2	3	27	1987	85	125	99.45	1109.55
A-01-04 01BDA2	4	24	1987	85	125	97.46	1111.54
A-01-04 01BDA2	6	5	1987	85	125	90.53	1118.47
A-01-04 01BDA2	7	8	1987	85	125	90.22	1118.78
A-01-04 01BDA2	8	7	1987	85	125	90.10	1118.90
A-01-04 01BDA2	9	4	1987	85	125	90.16	1118.84
A-01-04 01BDA2	10	6	1987	85	125	91.97	1117.03
A-01-04 01BDA2	11	5	1987	85	125	95.21	1113.79
A-01-04 01BDA2	12	4	1987	85	125	97.24	1111.76
A-01-05 16ABB	6	1	1987	300	685	201.50	1044.50
A-01-05 16ABB	12	18	1987	300	685	200.30	1045.70
A-01-05 30BDD	11	11	1987	90	430	117.60	1081.40
A-01-05 30BDD	12	29	1987	90	430	112.10	1086.90

1986 Data

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01BDA2	1	24	1986	85	125	92.60	1116.40
A-01-04 01BDA2	2	21	1986	85	125	92.57	1116.43
A-01-04 01BDA2	3	24	1986	85	125	92.80	1116.20
A-01-04 01BDA2	4	23	1986	85	125	92.35	1116.65
A-01-04 01BDA2	5	22	1986	85	125	90.83	1118.17
A-01-04 01BDA2	6	20	1986	85	125	91.19	1117.81
A-01-04 01BDA2	7	11	1986	85	125	92.07	1116.93
A-01-04 01BDA2	8	11	1986	85	125	91.17	1117.83
A-01-04 01BDA2	9	29	1986	85	125	93.04	1115.96
A-01-04 01BDA2	9	11	1986	85	125	91.17	1117.83
A-01-04 01BDA2	10	28	1986	85	125	95.80	1113.20
A-01-04 01BDA2	12	29	1986	85	125	99.82	1109.18
A-01-04 01CDA2	7	28	1986	300	820	259.20	937.80
A-01-04 01CDA2	7	28	1986	840	850	259.20	937.80
A-01-04 02DCC	7	9	1986	50	145	88.03	1102.97
A-01-04 24BBC2	8	7	1986	150	457	142.30	1035.70
A-01-04 27AAA2	8	6	1986	150	475	152.40	1019.60
A-01-04 27AAA2	8	6	1986	490	500	152.40	1019.60
A-01-05 16ABB	6	6	1986	300	685	191.70	1054.30
A-01-05 16ABB	12	1	1986	300	685	198.40	1047.60
A-01-05 30DCD	7	9	1986	300	676	223.50	973.50
A-01-05 30DCD	7	9	1986	660	893	223.50	973.50
A-01-05 33CDD	7	10	1986	160	408	236.30	969.70

1985 Data

Local_Id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01BDA2	3	8	1985	85	125	98.19	1110.81
A-01-04 01BDA2	5	22	1985	85	125	89.00	1120.00
A-01-04 01BDA2	5	16	1985	85	125	89.81	1119.19
A-01-04 01BDA2	6	19	1985	85	125	86.60	1122.40
A-01-04 01BDA2	7	24	1985	85	125	85.75	1123.25
A-01-04 01BDA2	8	26	1985	85	125	84.09	1124.91
A-01-04 01BDA2	9	27	1985	85	125	82.83	1126.17
A-01-04 01BDA2	11	5	1985	85	125	86.96	1122.04
A-01-04 01BDA2	12	4	1985	85	125	90.55	1118.45
A-01-04 01BDA2	12	31	1985	85	125	92.70	1116.30
A-01-04 02DBB	7	28	1985	210	505	233.00	967.00
A-01-04 02DBB	7	28	1985	520	610	233.00	967.00
A-01-05 16ABB	6	18	1985	300	685	221.00	1025.00
A-01-05 16ABB	12	10	1985	300	685	195.40	1050.60

1984 Data

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01ABA1	11	20	1984	90	465	162.50	1046.50
A-01-04 01ABA1	11	20	1984	482	493	162.50	1046.50
A-01-04 01BDA2	8	20	1984	85	125	92.78	1116.22
A-01-04 01CDA2	11	30	1984	300	820	199.80	997.20
A-01-04 01CDA2	11	30	1984	840	850	199.80	997.20
A-01-04 02DBB	11	30	1984	210	505	202.90	997.10
A-01-04 02DBB	11	30	1984	520	610	202.90	997.10
A-01-04 02DCC	11	30	1984	50	145	98.30	1092.70
A-01-04 11BDB1	11	30	1984	60	160	101.10	1083.90
A-01-04 24BBC2	12	3	1984	150	457	114.30	1063.70
A-01-04 27AAA2	11	30	1984	150	475	93.30	1078.70
A-01-04 27AAA2	11	30	1984	490	500	93.30	1078.70
A-01-05 15DCB	11	30	1984	450	990	224.00	1021.00
A-01-05 16ABB	11	28	1984	300	685	222.80	1023.20
A-01-05 16CDC	12	7	1984	300	846	210.50	1028.50
A-01-05 16CDC	12	7	1984	860	960	210.50	1028.50
A-01-05 18CBB	11	30	1984	400	790	152.20	1026.80
A-01-05 18DDD2	11	28	1984	170	682	159.90	1051.10
A-01-05 18DDD2	11	28	1984	702	704	159.90	1051.10
A-01-05 19DCC1	11	30	1984	290	535	156.50	1046.50
A-01-05 19DCC1	11	30	1984	615	655	156.50	1046.50
A-01-05 19DCC1	11	30	1984	735	835	156.50	1046.50
A-01-05 19DCC1	11	30	1984	855	975	156.50	1046.50
A-01-05 19DCC1	11	30	1984	995	1195	156.50	1046.50
A-01-05 22AAA	11	30	1984	374	680	225.10	1017.90
A-01-05 22ABB	11	28	1984	350	985	228.10	1015.90
A-01-05 22CCD	11	30	1984	350	880	215.90	1018.10
A-01-05 22CCD	11	30	1984	910	1180	215.90	1018.10
A-01-05 30BDD	11	30	1984	90	430	134.00	1065.00
A-01-05 34AAA	11	27	1984	80	210	165.60	1054.40
A-01-05 34AAA	11	27	1984	210	224	165.60	1054.40

1983 Data

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 11ABA	1	13	1983	205	1038	190.30	994.70
A-01-04 11BDB1	2	18	1983	60	160	107.23	1077.77
A-01-04 11BDB1	2	14	1983	60	160	108.09	1076.91
A-01-04 11BDB1	2	20	1983	60	160	106.74	1078.26
A-01-04 11BDB1	2	19	1983	60	160	106.98	1078.02
A-01-04 11BDB1	2	13	1983	60	160	108.18	1076.82
A-01-04 11BDB1	2	21	1983	60	160	106.45	1078.55
A-01-04 11BDB1	2	11	1983	60	160	108.49	1076.51
A-01-04 11BDB1	2	12	1983	60	160	108.37	1076.63
A-01-04 11BDB1	2	22	1983	60	160	106.12	1078.88
A-01-04 11BDB1	2	10	1983	60	160	108.55	1076.45
A-01-04 11BDB1	2	23	1983	60	160	105.78	1079.22
A-01-04 11BDB1	2	25	1983	60	160	105.19	1079.81
A-01-04 11BDB1	2	24	1983	60	160	105.47	1079.53
A-01-04 11BDB1	2	26	1983	60	160	104.87	1080.13
A-01-04 11BDB1	2	28	1983	60	160	104.13	1080.87
A-01-04 11BDB1	2	27	1983	60	160	104.51	1080.49
A-01-04 11BDB1	3	21	1983	60	160	95.63	1089.37
A-01-04 11BDB1	3	20	1983	60	160	96.09	1088.91
A-01-04 11BDB1	3	23	1983	60	160	94.97	1090.03
A-01-04 11BDB1	3	22	1983	60	160	95.33	1089.67
A-01-04 11BDB1	3	24	1983	60	160	94.54	1090.46
A-01-04 11BDB1	3	19	1983	60	160	96.46	1088.54
A-01-04 11BDB1	3	15	1983	60	160	98.06	1086.94
A-01-04 11BDB1	3	14	1983	60	160	98.47	1086.53
A-01-04 11BDB1	3	13	1983	60	160	98.91	1086.09
A-01-04 11BDB1	3	16	1983	60	160	97.69	1087.31
A-01-04 11BDB1	3	25	1983	60	160	94.23	1090.77
A-01-04 11BDB1	3	18	1983	60	160	96.80	1088.20
A-01-04 11BDB1	3	17	1983	60	160	97.21	1087.79
A-01-04 11BDB1	3	29	1983	60	160	92.89	1092.11
A-01-04 11BDB1	3	26	1983	60	160	93.96	1091.04
A-01-04 11BDB1	3	12	1983	60	160	99.33	1085.67
A-01-04 11BDB1	3	28	1983	60	160	93.20	1091.80
A-01-04 11BDB1	3	31	1983	60	160	92.15	1092.85
A-01-04 11BDB1	3	30	1983	60	160	92.54	1092.46
A-01-04 11BDB1	3	27	1983	60	160	93.57	1091.43
A-01-04 11BDB1	3	8	1983	60	160	100.99	1084.01
A-01-04 11BDB1	3	11	1983	60	160	99.74	1085.26
A-01-04 11BDB1	3	5	1983	60	160	102.11	1082.89
A-01-04 11BDB1	3	4	1983	60	160	102.45	1082.55
A-01-04 11BDB1	3	7	1983	60	160	101.38	1083.62
A-01-04 11BDB1	3	6	1983	60	160	101.77	1083.23
A-01-04 11BDB1	3	3	1983	60	160	102.74	1082.26
A-01-04 11BDB1	3	9	1983	60	160	100.55	1084.45
A-01-04 11BDB1	3	2	1983	60	160	103.19	1081.81
A-01-04 11BDB1	3	10	1983	60	160	100.14	1084.86
A-01-04 11BDB1	3	1	1983	60	160	103.66	1081.34
A-01-04 11BDB1	4	6	1983	60	160	90.23	1094.77
A-01-04 11BDB1	4	5	1983	60	160	90.50	1094.50
A-01-04 11BDB1	4	7	1983	60	160	89.91	1095.09
A-01-04 11BDB1	4	4	1983	60	160	90.88	1094.12
A-01-04 11BDB1	4	2	1983	60	160	91.45	1093.55
A-01-04 11BDB1	4	3	1983	60	160	91.04	1093.96
A-01-04 11BDB1	4	1	1983	60	160	91.86	1093.14
A-01-04 11BDB1	12	23	1983	60	160	96.13	1088.87
A-01-04 23BCC	1	13	1983	80	481	112.60	1057.40
A-01-04 23BCC	1	13	1983	496	500	112.60	1057.40
A-01-04 25DDC	1	13	1983	270	520	155.10	1034.90
A-01-05 17CAA	1	0	1983	150	585	205.00	1016.00

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-05 17CAA	1	0	1983	598	600	205.00	1016.00
A-01-05 18CBB	6	3	1983	400	790	144.65	1034.35
A-01-05 18DDD1	9	28	1983	45	177	0.00	0.00
A-01-05 21DCC	1	11	1983	500	1000	233.30	996.70
A-01-05 21DCC	1	11	1983	1010	1013	233.30	996.70
A-01-05 22AAA	1	11	1983	374	680	247.60	995.40
A-01-05 22ABB	1	11	1983	350	985	249.10	994.90
A-01-05 22CCD	1	11	1983	350	880	236.60	997.40
A-01-05 22CCD	1	11	1983	910	1180	236.60	997.40

1982 Data

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01ABA1	12	1	1982	90	465	128.90	1080.10
A-01-04 01ABA1	12	1	1982	482	493	128.90	1080.10
A-01-04 01CDA2	12	1	1982	300	820	227.80	969.20
A-01-04 01CDA2	12	1	1982	840	850	227.80	969.20
A-01-04 02DBB	1	22	1982	210	505	233.40	966.60
A-01-04 02DBB	1	22	1982	520	610	233.40	966.60
A-01-04 02DBB	12	1	1982	210	505	220.30	979.70
A-01-04 02DBB	12	1	1982	520	610	220.30	979.70
A-01-04 02DCC	9	9	1982	50	145	113.10	1077.90
A-01-04 02DCC	11	29	1982	50	145	114.10	1076.90
A-01-04 11ACD	9	9	1982	100	420	0.00	0.00
A-01-04 11ACD	9	9	1982	436	545	0.00	0.00
A-01-04 11BDB1	11	29	1982	60	160	116.60	1068.40
A-01-04 11DCB	9	9	1982	70	137	0.00	0.00
A-01-04 13CDB	9	8	1982	60	90	0.00	0.00
A-01-04 24BBC1	9	8	1982	48	140	0.00	0.00
A-01-04 24BBC2	12	10	1982	150	457	131.00	1047.00
A-01-04 27AAA1	9	8	1982	48	132	0.00	0.00
A-01-04 27AAA2	12	2	1982	150	475	110.60	1061.40
A-01-04 27AAA2	12	2	1982	490	500	110.60	1061.40
A-01-04 27CCC	9	8	1982	46	130	0.00	0.00
A-01-04 27DDD	9	8	1982	48	115	0.00	0.00
A-01-05 16ABB	11	29	1982	300	685	274.20	971.80
A-01-05 16CDC	11	29	1982	300	846	253.00	986.00
A-01-05 16CDC	11	29	1982	860	960	253.00	986.00
A-01-05 18CBB	12	10	1982	400	790	171.00	1008.00
A-01-05 19DCA	12	2	1982	387	1187	201.70	1006.30
A-01-05 19DCA	12	2	1982	1187	1205	201.70	1006.30
A-01-05 30BDD	12	1	1982	90	430	129.30	1069.70
A-01-05 33CDD	11	29	1982	160	408	181.10	1024.90
A-01-05 34AAA	11	29	1982	80	210	171.70	1048.30
A-01-05 34AAA	11	29	1982	210	224	171.70	1048.30

1981 Data

Local_Id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01ABA1	1	1	1981	90	465	186.00	1023.00
A-01-04 01ABA1	1	1	1981	482	493	186.00	1023.00
A-01-04 01CDA2	1	1	1981	300	820	210.00	987.00
A-01-04 01CDA2	1	1	1981	840	850	210.00	987.00
A-01-04 02DBB	1	1	1981	210	505	202.00	998.00
A-01-04 02DBB	1	1	1981	520	610	202.00	998.00
A-01-04 02DBB	2	11	1981	210	505	196.40	1003.60
A-01-04 02DBB	2	11	1981	520	610	196.40	1003.60
A-01-04 11BDB1	5	27	1981	60	160	105.00	1080.00
A-01-04 24BBC2	1	1	1981	150	457	110.00	1068.00
A-01-04 27AAA2	1	1	1981	150	475	91.00	1081.00
A-01-04 27AAA2	1	1	1981	490	500	91.00	1081.00
A-01-05 16ABB	1	1	1981	300	685	237.00	1009.00
A-01-05 16CDC	1	1	1981	300	846	212.00	1027.00
A-01-05 16CDC	1	1	1981	860	960	212.00	1027.00
A-01-05 17AAA	1	1	1981	80	438	163.00	1042.00
A-01-05 17CAA	1	1	1981	150	585	171.00	1050.00
A-01-05 17CAA	1	1	1981	598	600	171.00	1050.00
A-01-05 18CDC	1	1	1981	145	720	129.00	1059.00
A-01-05 18CDC	1	1	1981	734	770	129.00	1059.00
A-01-05 18DDD2	1	1	1981	170	682	133.00	1078.00
A-01-05 18DDD2	1	1	1981	702	704	133.00	1078.00
A-01-05 19BDD	1	1	1981	160	685	114.00	1088.00
A-01-05 27DCC	1	1	1981	200	670	204.00	1015.00
A-01-05 27DCC	1	1	1981	685	775	204.00	1015.00
A-01-05 30BBA	1	1	1981	300	670	143.00	1055.00
A-01-05 30BBA	1	1	1981	680	684	143.00	1055.00
A-01-05 30BBA	1	1	1981	684	900	143.00	1055.00
A-01-05 30BDD	1	1	1981	90	430	119.00	1080.00
A-01-05 30DCD	1	1	1981	300	676	148.00	1049.00
A-01-05 30DCD	1	1	1981	660	893	148.00	1049.00
A-01-05 32DCC	1	1	1981	450	992	157.00	1048.00
A-01-05 32DCC	1	1	1981	1007	1015	157.00	1048.00
A-01-05 33CDD	1	1	1981	160	408	173.00	1033.00

1980 Data

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-04 01ABA1	5	12	1980	90	465	199.00	1010.00
A-01-04 01ABA1	5	12	1980	482	493	199.00	1010.00
A-01-04 01CDA2	5	12	1980	300	820	210.00	987.00
A-01-04 01CDA2	5	12	1980	840	850	210.00	987.00
A-01-04 02DBB	3	7	1980	210	505	203.30	996.70
A-01-04 02DBB	3	7	1980	520	610	203.30	996.70
A-01-04 02DBB	5	12	1980	210	505	195.00	1005.00
A-01-04 02DBB	5	12	1980	520	610	195.00	1005.00
A-01-04 11BDB1	1	30	1980	60	160	102.82	1082.18
A-01-04 11BDB1	4	4	1980	60	160	101.80	1083.20
A-01-04 24BBC2	5	12	1980	150	457	110.00	1068.00
A-01-04 27AAA2	5	12	1980	150	475	81.00	1091.00
A-01-04 27AAA2	5	12	1980	490	500	81.00	1091.00
A-01-05 16ABB	5	12	1980	300	685	263.00	983.00
A-01-05 16CDC	5	12	1980	300	846	226.00	1013.00
A-01-05 16CDC	5	12	1980	860	960	226.00	1013.00
A-01-05 17AAA	1	30	1980	80	438	188.00	1017.00
A-01-05 17AAA	2	19	1980	80	438	184.00	1021.00
A-01-05 17AAA	2	6	1980	80	438	185.00	1020.00
A-01-05 17AAA	2	26	1980	80	438	183.00	1022.00
A-01-05 17AAA	2	13	1980	80	438	185.00	1020.00
A-01-05 17AAA	3	7	1980	80	438	183.00	1022.00
A-01-05 17AAA	3	11	1980	80	438	180.00	1025.00
A-01-05 17AAA	3	19	1980	80	438	177.00	1028.00
A-01-05 17AAA	4	30	1980	80	438	170.00	1035.00
A-01-05 17AAA	4	23	1980	80	438	171.00	1034.00
A-01-05 17AAA	4	16	1980	80	438	172.00	1033.00
A-01-05 17AAA	4	9	1980	80	438	173.00	1032.00
A-01-05 17AAA	4	2	1980	80	438	175.00	1030.00
A-01-05 17AAA	5	7	1980	80	438	169.00	1036.00
A-01-05 17AAA	5	12	1980	80	438	168.00	1037.00
A-01-05 17AAA	5	21	1980	80	438	167.00	1038.00
A-01-05 17AAA	5	28	1980	80	438	168.00	1037.00
A-01-05 17AAA	5	14	1980	80	438	168.00	1037.00
A-01-05 17CAA	5	12	1980	150	585	180.00	1041.00
A-01-05 17CAA	5	12	1980	598	600	180.00	1041.00
A-01-05 18CDC	5	12	1980	145	720	129.00	1059.00
A-01-05 18CDC	5	12	1980	734	770	129.00	1059.00
A-01-05 18DDD2	1	30	1980	170	682	160.00	1051.00
A-01-05 18DDD2	1	30	1980	702	704	160.00	1051.00
A-01-05 18DDD2	2	6	1980	170	682	159.00	1052.00
A-01-05 18DDD2	2	13	1980	170	682	158.00	1053.00
A-01-05 18DDD2	2	19	1980	170	682	157.00	1054.00
A-01-05 18DDD2	2	26	1980	170	682	155.00	1056.00
A-01-05 18DDD2	2	6	1980	702	704	159.00	1052.00
A-01-05 18DDD2	2	19	1980	702	704	157.00	1054.00
A-01-05 18DDD2	2	26	1980	702	704	155.00	1056.00
A-01-05 18DDD2	2	13	1980	702	704	158.00	1053.00
A-01-05 18DDD2	3	19	1980	170	682	145.00	1066.00
A-01-05 18DDD2	3	11	1980	170	682	149.00	1062.00
A-01-05 18DDD2	3	7	1980	170	682	150.00	1061.00
A-01-05 18DDD2	3	7	1980	702	704	150.00	1061.00
A-01-05 18DDD2	3	11	1980	702	704	149.00	1062.00
A-01-05 18DDD2	3	19	1980	702	704	145.00	1066.00
A-01-05 18DDD2	4	16	1980	170	682	138.00	1073.00
A-01-05 18DDD2	4	23	1980	170	682	137.00	1074.00
A-01-05 18DDD2	4	9	1980	170	682	140.00	1071.00
A-01-05 18DDD2	4	2	1980	170	682	142.00	1069.00
A-01-05 18DDD2	4	30	1980	170	682	136.00	1075.00
A-01-05 18DDD2	4	9	1980	702	704	140.00	1071.00

Local_id	M_mea	D_me	Yr_mea	Perf_top	Perf_bot	Cwl_depth	Wl_elev
A-01-05 18DDD2	4	30	1980	702	704	136.00	1075.00
A-01-05 18DDD2	4	2	1980	702	704	142.00	1069.00
A-01-05 18DDD2	4	16	1980	702	704	138.00	1073.00
A-01-05 18DDD2	4	23	1980	702	704	137.00	1074.00
A-01-05 18DDD2	5	28	1980	170	682	133.00	1078.00
A-01-05 18DDD2	5	21	1980	170	682	133.00	1078.00
A-01-05 18DDD2	5	7	1980	170	682	135.00	1076.00
A-01-05 18DDD2	5	12	1980	170	682	134.00	1077.00
A-01-05 18DDD2	5	14	1980	170	682	134.00	1077.00
A-01-05 18DDD2	5	12	1980	702	704	134.00	1077.00
A-01-05 18DDD2	5	28	1980	702	704	133.00	1078.00
A-01-05 18DDD2	5	21	1980	702	704	133.00	1078.00
A-01-05 18DDD2	5	14	1980	702	704	134.00	1077.00
A-01-05 18DDD2	5	7	1980	702	704	135.00	1076.00
A-01-05 19BDD	5	12	1980	160	685	114.00	1088.00
A-01-05 27DCC	5	12	1980	200	670	208.00	1011.00
A-01-05 27DCC	5	12	1980	685	775	208.00	1011.00
A-01-05 30BBA	5	12	1980	300	670	147.00	1051.00
A-01-05 30BBA	5	12	1980	680	684	147.00	1051.00
A-01-05 30BBA	5	12	1980	684	900	147.00	1051.00
A-01-05 30BDD	5	12	1980	90	430	130.00	1069.00
A-01-05 30DCD	5	12	1980	300	676	125.00	1072.00
A-01-05 30DCD	5	12	1980	660	893	125.00	1072.00
A-01-05 32DCC	5	12	1980	450	992	160.00	1045.00
A-01-05 32DCC	5	12	1980	1007	1015	160.00	1045.00
A-01-05 33CDD	5	12	1980	160	408	181.00	1025.00

APPENDIX F

```
..03.dat_Transient Analysis_General Head Boundary_CR=6,000ft2/d
echarge Rates: .4ft/d (4yrs), .89ft/d (16yrs)_Expanded Grid_5miles
         5         32         32          5          4  NLAY,NROW,NCOL,NPER,ITMUNI
   0  0  0  0  0 17 18  0  0  0 22 23  0  0  0  0  0  0  0  0  0 11  0
         0          1  IAPART,ISTRT
         0          1                                  IBOUND layer  1
         0          1                                  IBOUND layer  2
         0          1                                  IBOUND layer  3
         0          1                                  IBOUND layer  4
         0          1                                  IBOUND layer  5
    999.99  HNOFLO
         0 0.000E+00                                   SHEAD layer  1
         0 0.000E+00                                   SHEAD layer  2
         0 5.000E+01                                   SHEAD layer  3
         0 5.000E+01                                   SHEAD layer  4
         0 5.000E+01                                   SHEAD layer  5
 .461E+03          9 1.200E+00  PERLEN,NSTP,TSMULT
1.431E+03          9 1.200E+00  PERLEN,NSTP,TSMULT
 .461E+03          9 1.200E+00  PERLEN,NSTP,TSMULT
 .461E+03          9 1.200E+00  PERLEN,NSTP,TSMULT
1.461E+03          9 1.200E+00  PERLEN,NSTP,TSMULT
```

Block-Centered Flow 2 Package

```
    0         0  1.00E+30          1  5.00E-01         1         0  ISS,IBCFCB,HDRY,IWDFLG,WETFCT,IWETIT,IHDWET
3 3 3 3
         0 1.000E+00                              TRPY
        11 1.000E+00        (10F10.0)          0  DELR
.000E+02 2.000E+02 2.000E+02 2.000E+02 3.000E+02 3.000E+02 3.000E+02 3.000E+02 4.000E+02 4.000E+02
0E+02 5.000E+02 1.000E+03 1.000E+03 1.000E+03 1.000E+03 1.000E+03 1.000E+03 1.000E+03 1.000E+03
0E+03 1.000E+03 1.500E+03 1.500E+03 1.500E+03 2.000E+03 2.000E+03 2.000E+03 2.500E+03 2.500E+03
.500E+03 3.500E+03
        11 1.000E+00        (10F10.0)          0  DELC
0E+02 2.000E+02 2.000E+02 2.000E+02 3.000E+02 3.000E+02 3.000E+02 3.000E+02 4.000E+02 4.000E+02
.000E+02 5.000E+02 1.000E+03 1.000E+03 1.000E+03 1.000E+03 1.000E+03 1.000E+03 1.000E+03 1.000E+03
.000E+03 1.000E+03 1.500E+03 1.500E+03 1.500E+03 2.000E+03 2.000E+03 2.500E+03 2.500E+03 3.500E+03
0E+03 3.500E+03
         0 2.500E-01                              SF1 layer  1
         0 3.000E+02                              HY layer  1
         0 8.000E+01                              BOT layer  1
         0 1.000E+00                              VCONT layer  1
         0 1.000E-03                              SF2 layer  1
         0 1.000E+02                              TOP layer  1
         0-5.000E-01                              WETDRY layer  1
         0 2.500E-01                              SF1 layer  2
         0 3.000E+02                              HY layer  2
         0 6.000E+01                              BOT layer  2
         0 1.000E+00                              VCONT layer  2
         0 1.000E-03                              SF2 layer  2
         0 8.000E+01                              TOP layer  2
         0-5.000E-01                              WETDRY layer  2
         0 2.500E-01                              SF1 layer  3
         0 3.000E+02                              HY layer  3
         0 4.000E+01                              BOT layer  3
         0 1.000E+00                              VCONT layer  3
         0 1.000E-03                              SF2 layer  3
         0 6.000E+01                              TOP layer  3
         0-5.000E-01                              WETDRY layer  3
         0 2.500E-01                              SF1 layer  4
         0 3.000E+02                              HY layer  4
         0 2.000E+01                              BOT layer  4
         0 1.000E+00                              VCONT layer  4
         0 1.000E-03                              SF2 layer  4
         0 4.000E+01                              TOP layer  4
         0-5.000E-01                              WETDRY layer  4
         0 2.500E-01                              SF1 layer  5
         0 3.000E+02                              HY layer  5
         0 0.000E+00                              BOT layer  5
         0 1.000E-03                              SF2 layer  5
         0 2.000E+01                              TOP layer  5
         0-5.000E-01                              WETDRY layer  5
```

Recharge Package

```
   3         0 NRCHOP IRCHCB
   0         0  INRECH INIRCH
  18 1.000E+00 (10F10.0)                 0  RECH
[illegible] 4.000E-01 4.000E-01 4.000E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
[illegible] 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
[illegible] 0.000E+00
4.000E-01 4.000E-01 4.000E-01 4.000E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
[illegible] 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
[illegible] 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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0.000E+00 0.000E+00
        -1         0  INRECH INIRCH
        -1         0  INRECH INIRCH
        -1         0  INRECH INIRCH
```

General Head Boundary Package

```
64         0 MXBND IGHBCB
64           ITMP, Stress Period   1
 3         1         32 5.000E+01 6.000E+03
 3         2         32 5.000E+01 6.000E+03
 3         3         32 5.000E+01 6.000E+03
 3         4         32 5.000E+01 6.000E+03
 3         5         32 5.000E+01 6.000E+03
 3         6         32 5.000E+01 6.000E+03
 3         7         32 5.000E+01 6.000E+03
 3         8         32 5.000E+01 6.000E+03
 3         9         32 5.000E+01 6.000E+03
 3        10         32 5.000E+01 6.000E+03
 3        11         32 5.000E+01 6.000E+03
 3        12         32 5.000E+01 6.000E+03
 3        13         32 5.000E+01 6.000E+03
 3        14         32 5.000E+01 6.000E+03
 3        15         32 5.000E+01 6.000E+03
 3        16         32 5.000E+01 6.000E+03
 3        17         32 5.000E+01 6.000E+03
 3        18         32 5.000E+01 6.000E+03
 3        19         32 5.000E+01 6.000E+03
 3        20         32 5.000E+01 6.000E+03
 3        21         32 5.000E+01 6.000E+03
 3        22         32 5.000E+01 6.000E+03
 3        23         32 5.000E+01 6.000E+03
 3        24         32 5.000E+01 6.000E+03
 3        25         32 5.000E+01 6.000E+03
 3        26         32 5.000E+01 6.000E+03
 3        27         32 5.000E+01 6.000E+03
 3        28         32 5.000E+01 6.000E+03
 3        29         32 5.000E+01 6.000E+03
 3        30         32 5.000E+01 6.000E+03
 3        31         32 5.000E+01 6.000E+03
 3        32         32 5.000E+01 6.000E+03
 3        32          1 5.000E+01 6.000E+03
 3        32          2 5.000E+01 6.000E+03
 3        32          3 5.000E+01 6.000E+03
 3        32          4 5.000E+01 6.000E+03
 3        32          5 5.000E+01 6.000E+03
 3        32          6 5.000E+01 6.000E+03
 3        32          7 5.000E+01 6.000E+03
 3        32          8 5.000E+01 6.000E+03
 3        32          9 5.000E+01 6.000E+03
 3        32         10 5.000E+01 6.000E+03
 3        32         11 5.000E+01 6.000E+03
 3        32         12 5.000E+01 6.000E+03
 3        32         13 5.000E+01 6.000E+03
 3        32         14 5.000E+01 6.000E+03
 3        32         15 5.000E+01 6.000E+03
 3        32         16 5.000E+01 6.000E+03
 3        32         17 5.000E+01 6.000E+03
 3        32         18 5.000E+01 6.000E+03
 3        32         19 5.000E+01 6.000E+03
 3        32         20 5.000E+01 6.000E+03
 3        32         21 5.000E+01 6.000E+03
 3        32         22 5.000E+01 6.000E+03
 3        32         23 5.000E+01 6.000E+03
 3        32         24 5.000E+01 6.000E+03
 3        32         25 5.000E+01 6.000E+03
 3        32         26 5.000E+01 6.000E+03
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3        32        27 5.000E+01 6.000E+03
3        32        28 5.000E+01 6.000E+03
3        32        29 5.000E+01 6.000E+03
3        32        30 5.000E+01 6.000E+03
3        32        31 5.000E+01 6.000E+03
3        32        32 5.000E+01 6.000E+03
-1          ITMP, Stress Period   2
-1          ITMP, Stress Period   3
-1          ITMP, Stress Period   4
-1          ITMP, Stress Period   5
```

Preconditioned Conjugate Gradient Package

```
   15       20        1   MXITER  ITER1  NPCOND
1.00E-03  1.00E+03  1.00E+00        2        1        1        0  HCLOSE RCLOSE RELAX NPBOL IPRPCG MUTPCG IPCGCD
```

Output Control Option

```
0    0    30   31  IHEDFM,IDDNFM,IHEDUN,IDDNUN
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  1
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  2
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  3
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  4
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  5
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  6
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  7
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  8
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
1    1    1    0   1,1,IBUDFL,ICBCFL: PER.  1  STEP  9
1    1    1    1   Hdpr,Ddpr,Hdsv,Ddsv
1    1    1    1   Hdpr,Ddpr,Hdsv,Ddsv
1    1    1    1   Hdpr,Ddpr,Hdsv,Ddsv
1    1    1    1   Hdpr,Ddpr,Hdsv,Ddsv
1    1    1    1   Hdpr,Ddpr,Hdsv,Ddsv
1    1    0    0   1,1,IBUDFL,ICBCFL: PER.  2  STEP  1
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
0    0    0    0   Hdpr,Ddpr,Hdsv,Ddsv
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0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	2	STEP	2
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	2	STEP	3
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	2	STEP	4
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	2	STEP	5
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	2	STEP	6
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	2	STEP	7
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	2	STEP	8
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	1	0	1,1,IBUDFL,ICBCFL: PER.	2	STEP	9
1	1	1	1	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	1	1	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	1	1	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	1	1	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	1	1	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	3	STEP	1
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
1	1	0	0	1,1,IBUDFL,ICBCFL: PER.	3	STEP	2
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
0	0	0	0	Hdpr,Ddpr,Hdsv,Ddsv			
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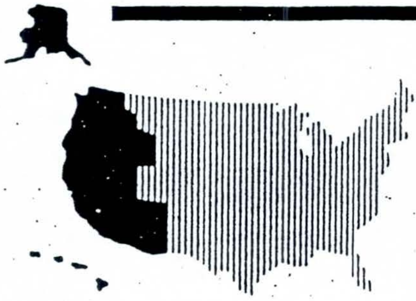
APPENDIX G

ARCS WEST



Remedial Activities at Selected Uncontrolled Hazardous Waste Sites in the Zone of Regions IX and X

INDIAN BEND WASH-SOUTH
INTERIM RI

Volume 2 of 5

June 1993

EPA Work Assignment No. 31-020-9LG6
Project No. PHX69124.DE.U1

Environmental Protection Agency
Contract No. 68-W9-0031

CH2M HILL

Section 6
Water Budget

Introduction

This section contains the results of the water budget subtask of the regional groundwater investigation. The objective of the water budget subtask is to quantify the major avenues of groundwater movement in the Indian Bend Wash-South (IBW-South) Study Area and to determine the groundwater recharge and discharge zones and groundwater flux rates. The following data have been obtained and compiled to evaluate the water budget:

- Pumping records for water supply wells in the study area
- Salt River flow data
- Hayden Canal flow data
- Available water level data from all wells within and near the study area

The conceptual hydrogeologic conditions are based on geologic interpretations presented in Section 4. Well construction and pumpage data are presented in Section 3, and water level data are presented in Section 5.

Regional Recharge and Discharge

To select the appropriate boundary for the water budget analysis, regional hydrogeologic conditions were reviewed. Geologic cross sections were presented in Section 4 and will not be presented here. In general, the vertical distance to the bedrock contact increases from west to east and ranges from zero at bedrock outcrops near the site's western boundary to more than 1,000 feet at the eastern boundary. Figure 6-1 shows the locations of the bedrock outcrops that are present to the west of the IBW-South study area. No hydraulic testing data of these rocks in the subsurface have been found for the IBW-South study area. As reported in Section 4, these crystalline rocks would be expected to allow some flow of groundwater, particularly where they are fractured or weathered extensively.

Significant regional surface-water features are also shown in Figure 6-1. The riverbeds of the Salt River and Indian Bend Wash are outlined. These rivers flow infrequently, but have the potential to recharge large volumes of water to the underlying aquifer when they are flowing. The Hayden Canal is a concrete-lined canal that is part of the Salt River Project (SRP) distribution system. The City of Mesa operates a wastewater recharge facility east of the IBW-South study area. Approximately 8 million gallons of water are recharged to the subsurface per day. Most urban irrigation (landscape watering) occurs in the southern part of the study area as shown in Figure 6-1. Irrigation is

Not True

applied to agricultural lands owned by the Salt River Pima-Maricopa Indian Community (SRPMIC) northeast of the study area.

Pumping data were collected and reviewed to identify regional pumping zones within and surrounding the study area. Table 6-1 summarizes the pumpage data that were presented in Appendix 3A. Typical annual pumping rates were calculated for each well by dividing total pumpage by appropriate number of years. Figure 6-2 presents wells that pumped more than 1,000 acre-feet per year, between 500 and 1,000 acre-feet per year, between 200 and 500 acre-feet per year, and less than 200 acre-feet per year between 1980 and 1990.

The regional groundwater flow patterns in the Upper Alluvial Unit (UAU) were evaluated to aid in the selection of the boundary for the water budget. Sufficient water level data are not available to characterize the groundwater flow patterns in the Middle Alluvial Unit (MAU) and Lower Alluvial Unit (LAU) units and therefore were not used to select the water budget boundary. After reviewing all water level data collected at UAU wells, the time period December 1990 to January 1991 was selected to represent typical conditions when flow in the Salt River is not affecting groundwater flow patterns. The selection of this time period was limited by the lack of water level data available for the area.

Figure 5-5 (Section 5) presents the groundwater flow conditions in the UAU during this time period. The boundary of the IBW-South study area was used as the boundary for the water budget analysis after reviewing the information presented in Figures 6-1, 6-2, and 5-5. No pumping centers or recharge areas outside of the study area significantly affect the horizontal groundwater flow in the UAU within the study area, including the City of Mesa's wastewater recharge facility. The effect of pumping centers outside of the study area on groundwater movement in the lower alluvial units is a data deficiency that will be investigated in future phases of the Remedial Investigation (RI).

Figure 6-3 presents a conceptual diagram of the hydrogeologic units that underlie the IBW-South study area. This conceptualization is based on geologic data summarized in Section 4. Two distinct areas have been identified: the basin fill area and the pediment area. The hydraulic communication between all the hydrogeologic units in each area is not fully understood at present. However, several components of the hydraulic connections have been identified, and hydrologic inputs and outputs were identified for the UAU and MAU. The corresponding calculations are discussed below.

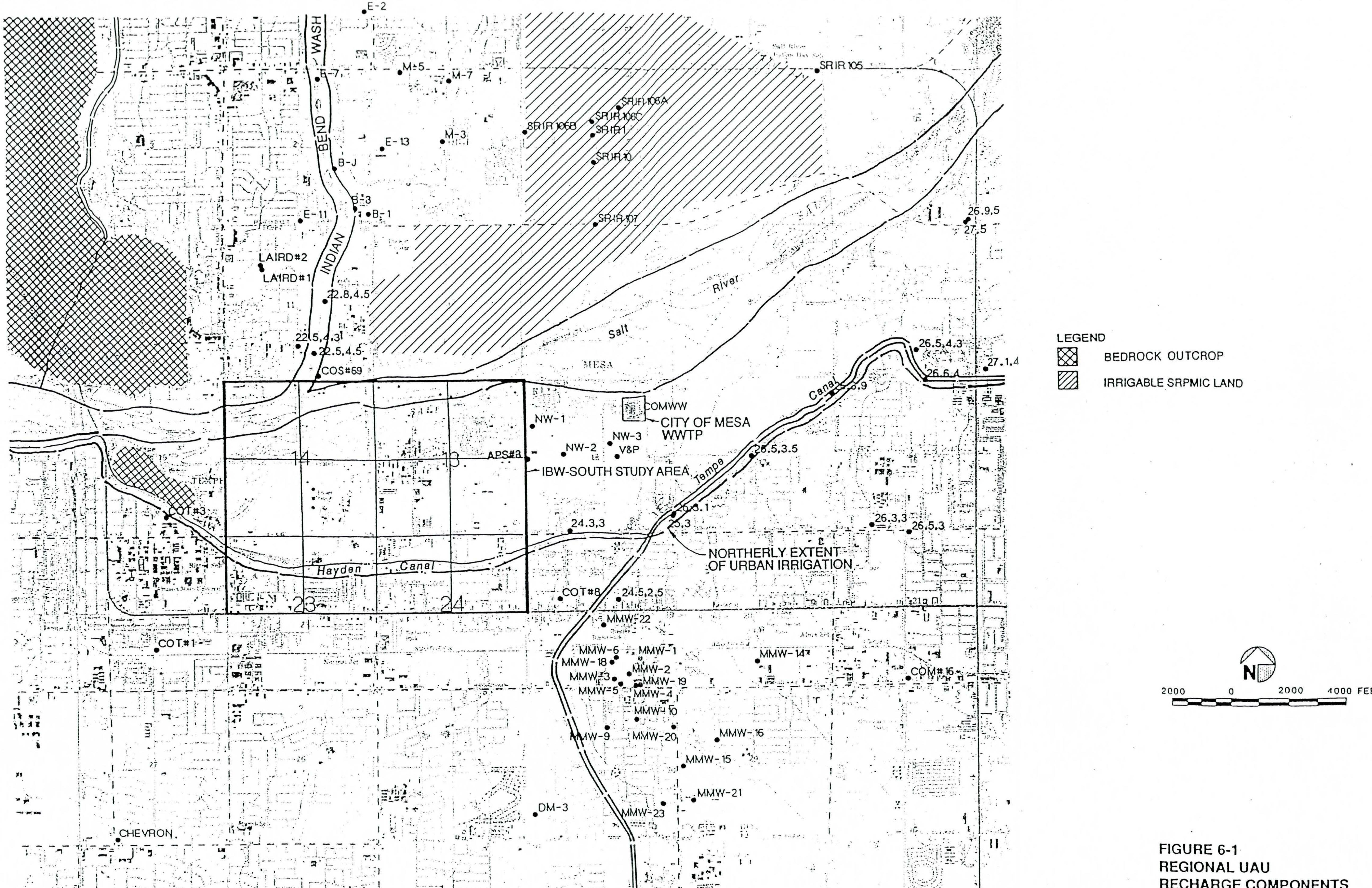


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FIGURE 6-1
REGIONAL UAU RECHARGE COMPONENTS
SOUTH INDIAN BEND WASH INTERIM RI

Table 6-1
Summary of Pumpage Data

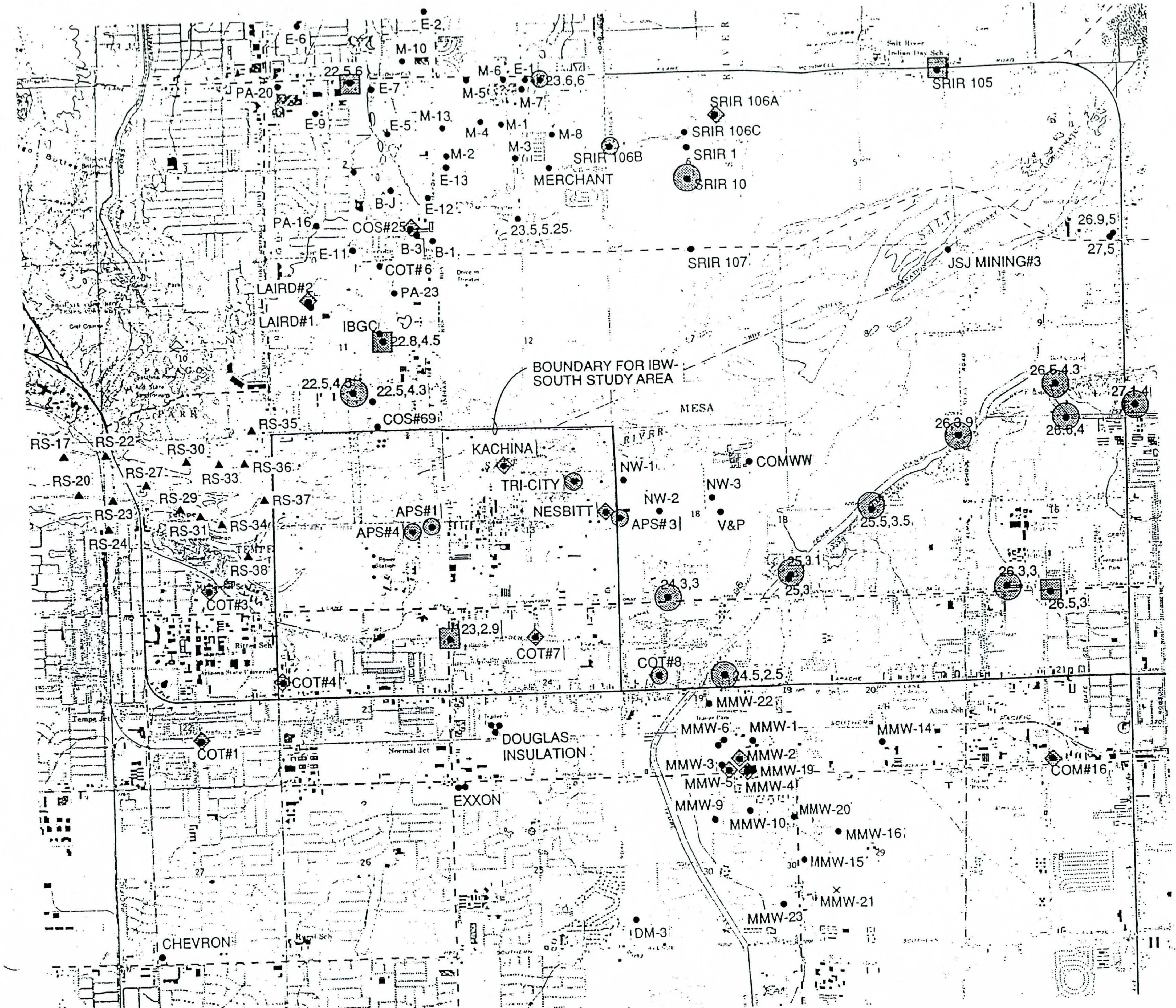
Well	Total Pumpage (acre-feet)							Number of Typical Pumpage Years	Typical Annual Pumpage (acre-feet)
	1957-66	1967-77	1978-85	1986	1987	1988	1989		
22.5.4.5[a]	12.916	0	0					10	1.292
22.5.5.5[a]	17.493	8.386	1.307	13	14	13		32	851
22.5.6[a]	16.154	7.005	2.310	28	0	0		30	850
22.8.4.5[a]	12.893	5.137	0					21	859
23.2.9 (MAU)	17.191	10.034	1.004	70	17	9	1.235	33	896
23.5.2.5[a]	24.225	11.443	2.743	18	9			31	1.240
23.6.6[a]	4.825	3.238	798	6	16			31	286
24.3.3[a]	19.317	11.640	3.539	38	18	22		32	1.081
24.5.2.5[a]	22.749	11.652	1.865					29	1.251
25.3.1[a]	24.009	12.893	866			100		30	1.262
25.5.3.5[a]	30.219	14.879	439			26		30	1.519
26.3.9[a]	20.057	12.667	1.267			136		30	1.138
26.3.3[a]	26.458	9.501	1.166					29	1.280
26.5.3[a]	11.627	4.155	350			1964		30	603
26.5.4.3[a]	41.683	36.348	2.029					29	2.761
26.6.4[a]	36.024	33.698	262					29	2.413
26.9.5[a]	26.835	24.130	1.926					29	1.824
27.1.4[a]	31.157	18.319	1.905					29	1.772
APS No. 1 (LAU)			2.209	719				9	325
APS No. 3 (MAU)			435					1	435
APS No. 4 (Red)				666	463	46	0	4	294
COM No. 16[a]			461					8	58
COS No. 25[a]			1.017	398				9	157
COT No. 1[a]	780	1.126	511					29	83
COT No. 3[a]	20	31	2.457					29	87
COT No. 4 (MAU/LAU)	1.200	1.781	372	49	95	30	17	33	107
COT No. 6[a]	1.752	3.954	3.886	2.054				30	388
COT No. 7 (MAU/LAU)	570	895	468	27	5	26	15	33	61
COT No. 8[a]	2.370	3.516	833					29	232
KACHINA (MAU)			210					2	105
LAIRD No. 2[a]			107	37				4	36
MMW-2[a]			57					1	57
MMW-4[a]			96					1	96
MMW-5[a]			42					1	42

This is an interim report, and all data, analysis, and conclusions are preliminary.
For more detail on the limitations of this report, see Section 1.

Table 6-1 Summary of Pumpage Data									
Well	Total Pumpage (acre-feet)							Number of Typical Pumpage Years	Typical Annual Pumpage (acre-feet)
	1957-66	1967-77	1978-85	1986	1987	1988	1989		
NESBITT (UAU/MAU)			155	73				4	57
SRIR 10[a]	23.710	2.047						21	1.227
SRIR 105[a]	3.627	11.997	724					29	564
SRIR 106A[a]			506	18				4	131
SRIR 106B[a]			1.158	11				4	292
Tri-City (UU/MAU)			558	250	334	248	252	7	235

[a]Located outside of IBW-South study area.

This is an interim report, and all data, analysis, and conclusions are preliminary. For more detail on the limitations of this report, see Section 1.



LEGEND

- 0-200 AF/YR
- 200-500 AF/YR
- 500-1000 AF/YR
- >1000 AF/YR

NOTE: REFER TO TABLE 6-1 FOR PUMPAGE DATA.

N

2000 0 2000 4000 FEET

FIGURE 6-2
REGIONAL GROUNDWATER PUMPING ZONES
SOUTH INDIAN BEND WASH INTERIM RI

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Calculations presented in this water budget show that different components affect groundwater flow patterns when the Salt River flows near the IBW-South site compared to when the river does not flow. Table 6-5 categorizes the components considered in this water budget as either significant or insignificant factors that affect the groundwater flow direction and/or gradient for two conditions: (1) periods when the Salt River flows and (2) when the Salt River does not flow. The factors that are listed as significant have the greatest effect on groundwater flow patterns within the study area.

The strong vertical gradients and different flow directions in each alluvial unit result in complex paths in which contaminants move.

Table 6-5
Significance of Water Budget Components

Water Budget Component	No Salt River Flow		Salt River Flow	
	Significant	Insignificant	Significant	Insignificant
UAU				
Salt River		x	x	
Urban Irrigation		x		x
Lateral Inflow	x			x
Hayden Canal		x		x
Pumping		x		x
Lateral Outflow	x		x	
Cascading Wells	x		x	
Leakage to MAU	x		x	
MAU				
Leakage from UAU	x		x	
Cascading Wells	x		x	
Lateral Inflow	x		?	
Pumping	x		?	
Lateral Outflow	x		x	

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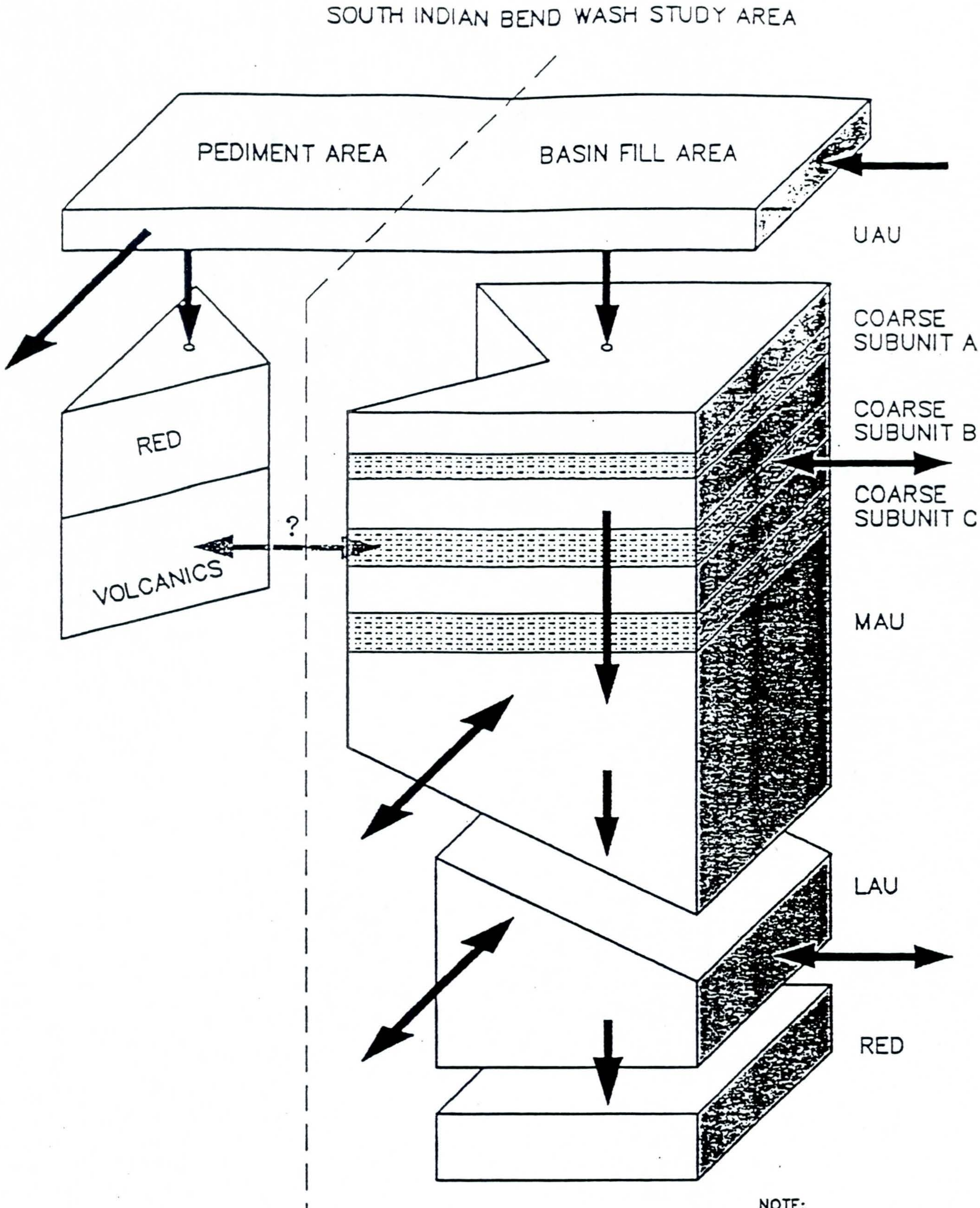


FIGURE 6-3
CONCEPTUAL DIAGRAM OF HYDROGEOLOGIC UNITS FOR WATER BUDGET
SOUTH INDIAN BEND WASH INTERIM RI

Upper Alluvial Unit

Several hydrologic inputs and outputs were identified for the UAU and are illustrated in Figure 6-4. Estimates of the magnitude of each input and output were calculated. These calculations are discussed below. These order-of-magnitude estimates may be used to identify components that warrant a more detailed analysis.

Inputs

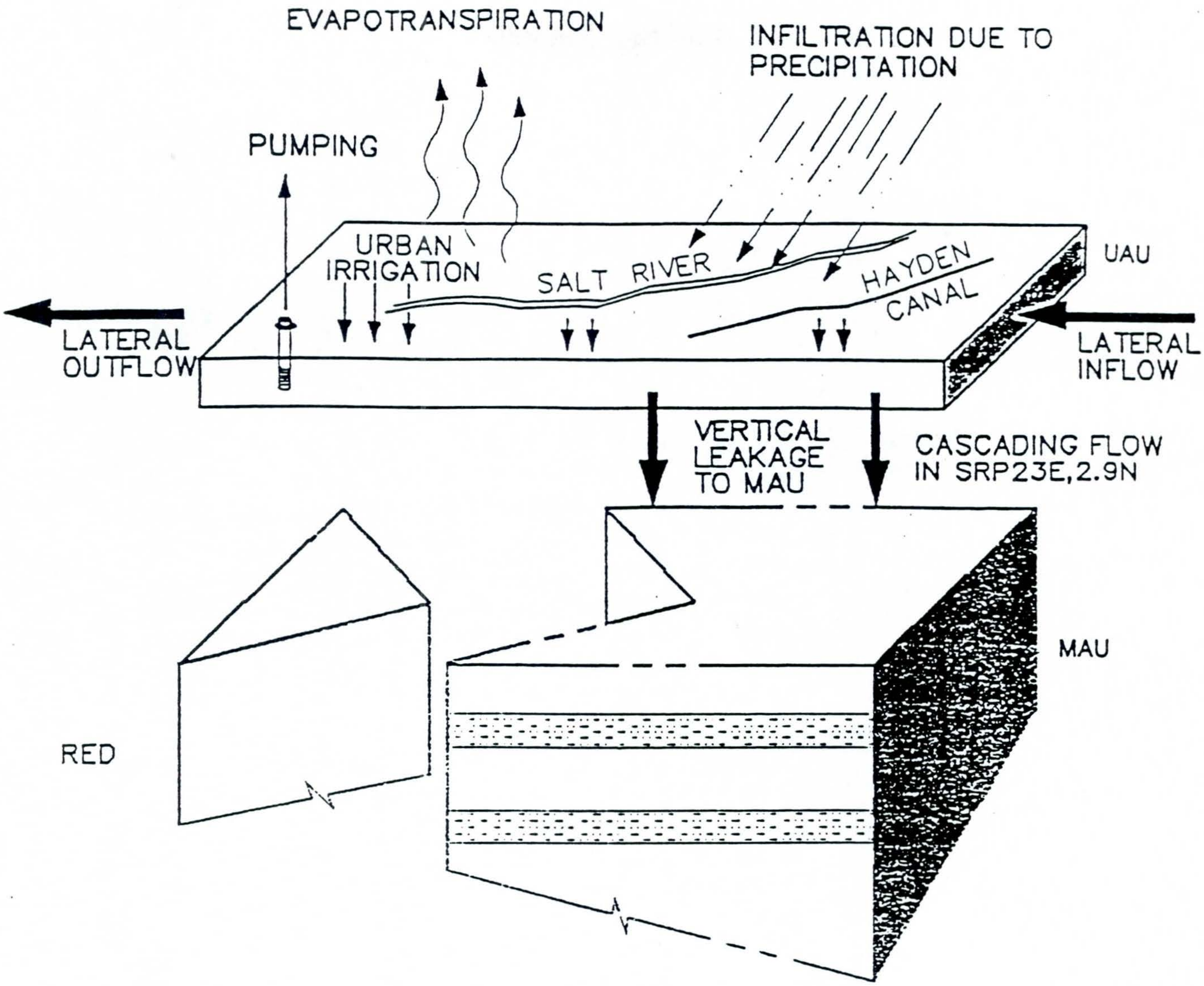
Salt River

Leakage rates through the bed of the Salt River have been estimated to range from 0.9 foot/day (Mann and Rohne, 1983) to 2.5 feet/day (Briggs and Werho, 1966) in the section of river between Granite Reef Dam and 48th Street. The variation in the leakage rate may be related to preexisting moisture conditions in the riverbed prior to each flow event, clogging of the streambed by fine-grained sediments or algae, different channel widths, a difference in the extent of gravel pit operations in the riverbed during each flow event, and/or different flow volumes.

An analysis was performed to estimate the leakage rate in the reach of the Salt River that lies within the IBW-South study area for two flow events that were estimated to occur between March 27 and April 10, 1991 and January to June 1992. The FORTRAN program WELSIM (CH2M HILL, 1987) was used to simulate the rise in water levels at UAU monitoring wells caused by recharge through the Salt River bed. The WELSIM program is a FORTRAN translation of commonly used analytical solutions for groundwater flow.

The nonsteady-state water table solution was used for this analysis. The analytical solution is based on the Jacob water table drawdown correction to the Theis artesian solution. Drawdowns are calculated using the superposition of the analytical solutions for a two-dimensional system. The model assumes that the aquifer transmissivity is homogeneous and isotropic and that the change in saturated thickness is less than approximately 10 percent of the total aquifer thickness. The aquifer in the UAU is actually heterogeneous, anisotropic, and the change in saturated thickness caused by the recent Salt River flow event was greater than 10 percent of the total aquifer thickness.

The Salt River was represented by 28 injection wells spaced 400 feet apart along the centerline of the riverbed. The injection rate at each well was assumed to be the same for each of the 28 wells and constant with time during the flow event. This injection rate was adjusted until the simulated rise in water levels closely approximated the actual rise in water levels as measured in the 10 EPA UAU monitoring wells. Simulated water levels were compared to actual water levels at 34, 64, and 94 days after flow began for the 1991 flow event.



NOTE:
DIAGRAM IS NOT TO SCALE

FIGURE 6-4
COMPONENTS OF UAU WATER BUDGET
SOUTH INDIAN BEND WASH INTERIM RI

Simulations were performed using a storage coefficient ranging from 0.08 to 0.1, and a transmissivity ranging from 100,000 gpd/ft to 300,000 gpd/ft. The simulation results indicate that an injection rate of 8,000 to 9,000 gpm per well best represents the flow event that occurred between March 27 and April 10, 1991. The length of the river that transverses the study area was approximated to be 10,800 feet (27 intervals of 400 feet). The river width was assumed to be 1,500 feet based on historical flood events (EPA, 1989). Using this river length and width results in a leakage rate of 2.89 ft/day for an injection rate of 9,000 gpm per well. The rate of 2.89 ft/day is higher than the range estimated by USGS for the river reach between Granite Reef Dam and 48th Street (0.9 to 2.5 ft/day).

In a conceptual water budget analysis for the North Indian Bend Wash (IBW-North) site, ADWR used the following guideline to determine how many days per year there is flow in the Salt River in the vicinity of the IBW-South study area (Kurtz, 1987); if flow released at Granite Reef Dam exceeds 1,000 cubic feet per second (cfs), then the flow reaches the IBW-South study area. Table 6-2 presents the number of days Granite Reef releases have exceeded 1,000 cfs since 1983. The number of days the river flows each year in the reach bordering the study area varies from 0 to more than 100.

Table 6-2
Estimated Frequency of Salt River Flow Near IBW-South Study Area

Year	Number of days flow >1,000 cfs
1983	117
1984	17
1985	122
1986	0
1987	7
1988	3
1989	0
1990	0
1991	16
1992	113

Using the range of leakage rates 0.9 to 2.89 ft/day, the recharge to the UAU from the riverflow is estimated for two cases: one in which the river flows 10 days per year, and one in which the river flows 100 days per year. This calculation neglects recharge that occurs through the sides of the river channel. The approximate length of river across the IBW-South study area is 10,600 feet. An approximate flow width of 1,500 feet is also assumed, based on historical flood events (EPA, 1989).

Approximately half the volume recharged to the UAU through the river channel will initially flow to the north side of the river, and half will recharge the UAU to the south of the riverbed. However, after the riverflow ceases, the regional groundwater gradient may cause the recharged water to flow from the north side of the river to the south. For this analysis, it is assumed that 50 percent of the recharge through the riverbed recharges the UAU to the south of the river. The equation used to estimate the recharge caused by flow in the river is:

$$Q = \frac{(length\ of\ river) \times (width\ of\ river) \times (leakage\ rate) \times (number\ of\ days\ river\ flows/year)}{2}$$

Riverflow 10 Days/Year

Leakage rate = 0.9 foot/day

$$Q = \frac{(10{,}600\,feet) \times (1{,}500\,feet) \times (0.9\,foot/day) \times (10\,days/year)}{2} = 1{,}700\,ac\text{-}ft/yr$$

Leakage rate = 2.89 feet/day

$$Q = \frac{(10{,}600\,feet) \times (1{,}500\,feet) \times (2.89\,feet/day) \times (10\,days/year)}{2} = 5{,}000\,ac\text{-}ft/yr$$

Riverflow 100 Days/Year

Leakage rate = 0.9 foot/day

$$Q = \frac{(10{,}600\,feet) \times (1{,}500\,feet) \times (0.9\,foot/day) \times (100\,days/year)}{2} = 16{,}000\,ac\text{-}ft/yr$$

Leakage rate = 2.89 feet/day

$$Q = \frac{(10{,}600\,feet) \times (1{,}500\,feet) \times (2.89\,feet/day) \times (100\,days/year)}{2} = 53{,}000\,ac\text{-}ft/yr$$

Figure 6-5 illustrates the potential effect the riverflow can have on groundwater movement in the UAU. The flow vectors represent approximate distances and directions a contaminant would move if retardation and decay were negligible. The distances were calculated using the following equation:

$x = vt$

where:

x	=	distance (feet)
t	=	time (days)
v	=	velocity (ft/day) = -(k/n)i

k	=	hydraulic conductivity (ft/day)
n	=	effective porosity
i	=	horizontal gradient (ft/ft)

The river did not flow between September 1988 and February 1991, and the horizontal gradient in the southern part of the study area was assumed to be similar to the gradient during February 1991, approximately 0.001. Assuming a hydraulic conductivity of 300 ft/day, an effective porosity of 0.25, and a gradient of 0.001, a groundwater molecule would have moved 1,095 feet to the southwest. Aquifer test data for UAU wells SIBW-1U to SIBW-4U and SIBW 6U to SIBW-10U presented in Table 4-4 in Section 4 show that the hydraulic conductivity ranges from 30 ft/day to 980 ft/day (220 to 7,300 gpd/ft^2). The value of 300 ft/day is the average hydraulic conductivity using the nine values presented in Table 4-4, which were derived by the Cooper Jacob method using the total aquifer thickness. Similar calculations for travel distance of a water molecule were made for three more consecutive time intervals that represent periods of riverflow versus no riverflow. Since the resulting flow line is sensitive to the value used for hydraulic conductivity, an additional flow line is shown corresponding to a hydraulic conductivity of 100 ft/day, which may be more representative of localized groundwater flow distances in areas with lower hydraulic conductivities. The range of 100 to 300 ft/day represents the expected hydraulic conductivity range at the site. The hydraulic conductivity has a large impact on the transport distance of a groundwater contaminant.

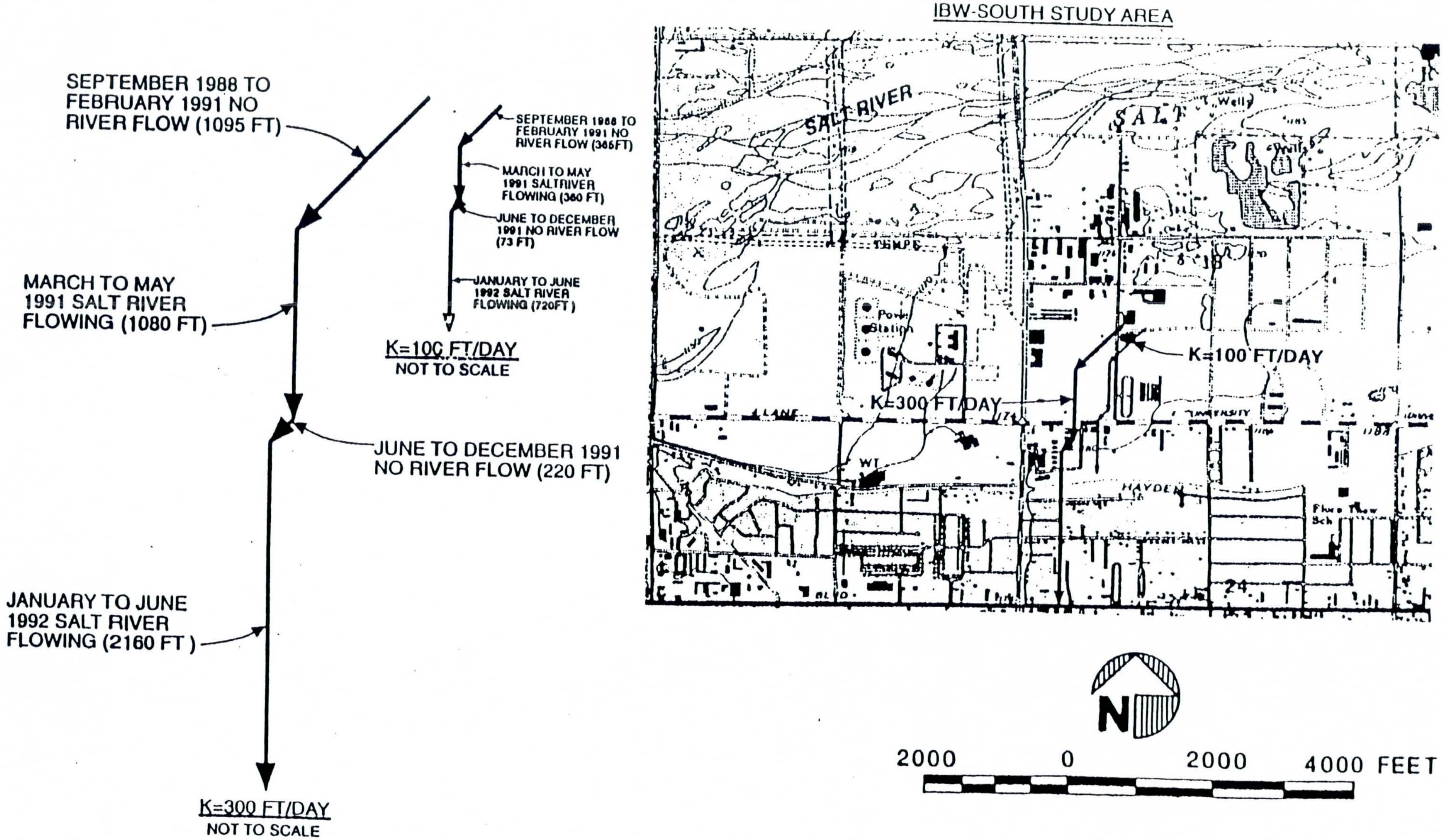


FIGURE 6-5
INFLUENCE OF SALT RIVER FLOW ON CONTAMINANT TRANSPORT
SOUTH INDIAN BEND WASH INTERIM RI

Hayden Canal Leakage

The Hayden Canal is a concrete-lined canal used to distribute water by the SRP. It is assumed the canal is in good condition. Canal leakage was estimated using a leakage rate of 0.0118 foot/day, which was the leakage rate used in ADWR's conceptual water budget analysis as part of its groundwater modeling study of IBW-North (Kurtz, 1987). Assuming the canal is approximately 11,000 feet in length across the study area and that the width of the canal is 10 feet, the canal leakage may be calculated as follows:

$$Q = (length) \times (width) \times (leakage rate)$$

$$= (11{,}000 feet) \times (10 ft) \times (0.0118 ft/day)$$

$$= 10 ac\text{-}ft/yr$$

Infiltration of Precipitation

Recharge caused by infiltrating precipitation was not considered in this analysis. It was assumed that the volume of water that is not lost to evapotranspiration would be very small. This assumption is not applicable to lands that drain to dry wells.

Urban Irrigation

Potential recharge to the UAU caused by urban irrigation in the Scottsdale area was evaluated by CH2M HILL as part of the IBW-North project and was reported in a memorandum to file dated June 18, 1990 (CH2M HILL, 1990). The potential recharge to the UAU caused by residential landscape watering in the IBW-South study area is estimated below, using data presented in the 1990 CH2M HILL memorandum.

Most of the southern portion of the IBW-South study area is residential. It was assumed that the lower third of the study area, approximately 1 square mile, is residential and applies water to landscaped areas. For this analysis, it is assumed that all residential areas are flood irrigated to estimate a maximum potential recharge caused by urban irrigation.

It is assumed that 24 percent of the applied water becomes deep percolation and recharges the UAU. For flood-irrigated turf areas, typical application rates have been estimated to be 4.76 ac-ft/ac/yr (CH2M HILL, 1990). The amount of deep percolation would then be 24 percent of 4.76 ac-ft/ac/yr, which is equal to 1.1 ac-ft/ac/yr.

It was assumed that approximately 12,000 square feet (0.28 acre) per acre of residential area is available for landscaping with plants (CH2M HILL, 1990). This estimate was calculated based on inspection of aerial photography for the IBW-North study area. The aerial photos were used to provide an average lot size and number of lots per quarter-section. The areas of a typical driveway, pool, and home were subtracted from the available area for landscaping.

Approximately 640 acres (1 square mile) of residential land overlies the UAU in the IBW-South study area. Multiplying 0.28 acre times 640 acres results in an estimate of 180 acres being available for landscaping with plants. If it is assumed that this entire area is flood irrigated (a conservatively large assumption), then the potential recharge can be estimated as:

$$180\,acres \times 1.1\,ac\text{-}ft/ac/yr = 200\,ac\text{-}ft/yr$$

Pond Leakage

Areas with ponded water were not identified in this analysis.

Lateral Inflow

Lateral inflow was estimated using two methods. The first method calculated lateral inflow using the groundwater flow conditions presented in Figure 5-5 and the following equation:

$$Q = TiL$$

where:

Q	=	Lateral inflow
T	=	Transmissivity
i	=	Horizontal gradient = change in hydraulic head/distance
L	=	Flow width

Aquifer tests were performed at each of the 10 shallow wells installed by EPA. The data analysis is presented in Section 4. The transmissivity at Wells SIBW-2U and SIBW-7U was estimated to be 33,000 and 137,000 gpd/ft, respectively. These wells are located in the northern portion of the study area where most lateral inflow is assumed to occur. The average of the two transmissivities is 85,000 gpd/ft. The horizontal gradient in the northern portion of the study area is approximately 5 feet/1,400 feet, or 0.0036. The flow width is approximately 8,000 feet.

Using the values presented above, the volume of lateral inflow during periods when the Salt River is not a hydraulic influence is estimated to be:

$$Q = TiL$$

$$= (85{,}000)\ (0.0036)\ (8{,}000 ft)$$

$$= 2{,}700\, ac\text{-}ft/yr$$

If the operations at the City of Mesa wastewater recharge facility affect the groundwater flow patterns in the UAU within the IBW-South study area, then the lateral inflow component of the water budget would be affected. The hydraulic gradient would increase as a result of the mounding of groundwater. The limited water level data available for the area surrounding the recharge facility (see Figure 5-5) indicates that the operations at the facility do not significantly affect the groundwater flow direction within the IBW-South study area.

Sergent, Hauskins & Beckwith (SH&B) evaluated the effect of the recharge facility operations on groundwater levels in the UAU (SH&B, 1990). Even though the data presented in their report cannot be reduced to a form that defines the rise in water level caused by recharge at the facility, it appears that the radius of influence of the recharge facility is less than 0.5 mile.

Long-term water level data are not sufficient to determine if irrigation on the SRPMIC land on the north side of the Salt River affects groundwater levels in IBW-South. Thus, the effect of the SRPMIC irrigation on the lateral inflow component of the UAU water budget cannot be determined at this time. The present UAU water level monitoring network is sufficient to monitor this effect.

The second method used to estimate lateral inflow incorporated the steady-state finite element model MircoFem (Hemker et al., 1988) in the analysis. This numerical model was used to estimate UAU lateral inflow and lateral outflow for two conditions: (1) when the Salt River is a hydraulic influence and (2) when the river is not a hydraulic influence. Simulation results also provided an estimate of vertical flow to the MAU for both conditions. The MicroFem model allows up to four layers and can incorporate heterogeneous transmissivities. A vertical resistance between each layer must be specified. A three-layer rectangular grid was used to represent the UAU, MAU-B, and MAU-C within the IBW-South study area. The MAU-B and MAU-C units were specified to underlie the UAU throughout the study area. As discussed in Section 4, the MAU is not present throughout the entire study area.

Using aquifer test data reported in Section 3, the transmissivity distribution for the UAU was generated by inputting these values at Wells SIBW-1U through SIBW-10U. (A transmissivity value was not specified at Well SIBW-5U because an aquifer test was not performed at that well.) MicroFem then interpolates between these values at all other locations within the model grid. The transmissivity of Layer 2 (MAU-B) was input in a similar way, using transmissivities presented in Section 4. The MAU-B transmissivities ranged from 7,000 to 180,000 gpd/ft. The transmissivity of Layer 3 (MAU-C) was specified to be constant at 60,000 gpd/ft based on aquifer test results presented in Section 4.

The hydraulic heads were specified for each boundary node in each unit. The heads specified for the UAU ranged from 1,072 to 1,092 feet, corresponding to the water levels measured in December 1990 and January 1991 and presented in Figure 5-5. A constant value of 1,065 feet was specified for all boundary nodes for Layer 2 (MAU-B) after reviewing water levels measured at Wells SIBW-15MB through SIBW-18MB in the fall of 1992. A constant value of 1,049 feet was specified for all boundary nodes for Layer 3 (MAU-C) based on water levels measured at the three MAU-C wells in the fall of 1992.

Simulation results indicate that lateral inflow to the UAU occurs along the north and east sides of the study area. MicroFem simulations indicate that approximately 2,100 ac-ft/yr flows laterally into the UAU from outside the study area during years when the Salt River is not a hydraulic influence. For comparison, the lateral inflow estimate using the first method was 2,700 ac-ft/yr.

Outputs

Pumping

Not true Not in mere for

Existing well information and records filed with the ADWR indicate that no wells pump solely from the UAU. Records filed with the ADWR are limited to wells with pumps installed that can pump more than 35 gallons per minute. Several wells are screened in the UAU that also withdraw water from deeper alluvial units. On the basis of the annual volumes pumped from these wells, it was estimated that less than 100 ac-ft/yr of water is pumped from the UAU.

Highly erroneous

Evapotranspiration

The amount of water that evaporates or transpires from the UAU is assumed to be zero because of the depth to the water table.

Lateral Outflow

Lateral outflow was calculated using two methods. The first method calculated lateral outflow using the groundwater flow conditions presented in Figure 5-5, and the same equation presented in the calculation of lateral inflow:

$$Q = TiL$$

where:

Q	=	Lateral outflow
T	=	Transmissivity = hydraulic conductivity (K) x aquifer thickness (b)
i	=	Horizontal gradient = change in hydraulic head/distance
L	=	Flow width

Wells SIBW-3U and SIBW-10U are located in the southern portion of the study area where most lateral outflow is expected to occur during periods when the Salt River is not a hydraulic influence. The transmissivity at Wells SIBW-3U and SIBW-10U was estimated to be 198,000 and 189,000 gpd/ft, respectively, based on results of aquifer tests. The average transmissivity, 193,500 gpd/ft, was used to estimate lateral outflow. An aquifer test has not been performed at SIBW-5U to date; therefore, the hydraulic conductivity is not available at this location to estimate lateral outflow.

The horizontal gradient in the southern portion of the study area is approximately 5 feet/4,600 feet, or 0.001. The flow width is approximately 8,000 feet.

Using the values presented above, the volume of lateral outflow during periods when the Salt River is not a hydraulic influence is estimated to be:

$$Q = TiL$$

$$= (193{,}500\ gpd/ft)\ (0.001)\ (8{,}000 ft)$$

$$= 1{,}700 ac\text{-}ft/yr$$

The second method used to estimate lateral outflow incorporated the steady-state finite element model MicroFem in the analysis, as described in the discussion for Lateral Inflow to the UAU above. Simulation results indicate that lateral outflow occurs mainly across the southern boundary of the study area. According to the MicroFem simulations, approximately 400 ac-ft/yr flows laterally out of the UAU to outside the study area during years when the Salt River is not a hydraulic influence. For comparison, the lateral outflow estimate using the first method was 1,700 ac-ft/yr. Up to 2,000 ac-ft/yr flows laterally out of the UAU during years when the Salt River is a hydraulic influence.

Leakage to MAU

The amount of vertical leakage to the MAU is dependent on the vertical hydraulic gradient and the vertical conductivity of the subsurface. One thin, extensive, low-permeability layer of fine-grained soils would limit the vertical downward flow. Two methods were used to estimate the amount of vertical leakage to the MAU. One method used a simple calculation, and the second method used results from a steady-state numerical model.

The first method uses the equation below to estimate a minimum and maximum vertical flow to the MAU.

$$Q = KiA$$

where:

K	=	Vertical conductivity
i	=	Vertical gradient
A	=	Area in which MAU underlies UAU

Should

not thin

As of June 31, 1992, the available water level data for the MAU were limited to three well groupings. Hydrographs for these wells are included in Section 5. As discussed in Section 5, the vertical gradient between the UAU and MAU-B appears to vary from 0.13 to 0.27 foot/foot downward. For comparison, the vertical gradient between the UAU and MAU in the IBW-North area has been estimated to range between 0.1 and 0.9 foot/foot downward (EPA, 1991). The vertical conductivity of the subsurface is unknown. A range of 0.01 to 0.1 ft/day is used for this calculation based on data collected at the IBW-North site (EPA, 1991). The hydrogeologic interpretation presented in Figure 6-4 indicate that the MAU does not underlie the UAU in the western portion of the site, identified as the pediment area. The calculation below assumes that the MAU underlies the UAU in two-thirds of the IBW-South study area, or 2 square miles (1,280 acres).

$$Q = KiA$$

13 ft/100 ft
27 ft/100 ft

where:

K	=	Vertical conductivity = 0.01 to 0.1 ft/day
i	=	Vertical gradient = 0.13 to 0.27 ft/ft

This is an interim report, and all data, analysis, and conclusions are preliminary. For more detail on the limitations of this report, see Section 1.

A = Area in which MAU underlies UAU = 1.280 acres

This equation is used to estimate a minimum and maximum vertical flow to the MAU.

$$Q(low) = (0.01 ft/day)\ (0.13 ft/ft)\ (1{,}280 acres)$$
$$= 600 ac\text{-}ft/year$$

$$Q(high) = (0.1 ft/day)\ (0.27 ft/ft)\ (1{,}280 acres)$$
$$= 13{,}000 ac\text{-}ft/year$$

The second method used to estimate vertical leakage to the MAU incorporated the steady-state finite element model MicroFem in the analysis, as described in the discussion on Lateral Inflow to the UAU. On the basis of the MicroFem simulations, approximately 700 ac-ft/yr flows to the MAU during years when the Salt River is not a hydraulic influence using a value of 15,000 for the vertical resistance between the first and second layers. This value varies significantly if the vertical leakance between the UAU and MAU is changed. If the vertical resistance is decreased to 3,000, the resulting leakage to the MAU is 3,100 ac-ft/yr. Approximately 1,200 ac-ft/yr flows to the MAU during years when the Salt River is a hydraulic influence using a resistance of 15,000. The MicroFem results indicate that the actual vertical conductivity of materials between the UAU and the MAU-B is closer to 0.01 than 0.1 ft/day.

Cascading Flow in Well SRP 23E,2.9N

Significant downward flow has been observed in the 23E,2.9N well as reported in a technical memorandum summarizing the hydrologic testing performed at this well (EPA, 1989). Downward velocities were estimated to average 20 feet per minute, which corresponds to a volumetric flow rate of 326 gallons per minute for the 20-inch-diameter well. These velocities were observed at a depth interval of 145 to 300 feet below ground surface. The well acts as a conduit for flow from the UAU to the MAU. Assuming the flow rate is constant, approximately 500 acre-feet per year may discharge to the MAU at this well. TCE has been detected at concentrations of 10 to 15 $\mu g/l$ in six collected between 1986 and 1988. This well has not been sampled since March 1988.

Summary of UAU Water Budget Calculations

Table 6-3 summarizes the UAU water budget calculations. These preliminary calculations indicate that the greatest volumetric input to the UAU is recharge from the Salt River when it flows. The storage in the aquifer is increased rapidly during a flow event. Vertical flow to the MAU increases because of the larger hydraulic gradient downward.

Table 6-3
Summary of UAU Water Budget Calculations

Inputs (acre-feet/year)		Outputs (acre-feet/year)	
Salt River (sporadic)	0 to 50.000	Pumping	100
Hayden Canal Leakage	10	Lateral Outflow	400 to 2,000
Lateral Inflow	600 to 1,900	Cascading Flow at 23E,2.9N	500
Urban Irrigation	200	Leakage to MAU	600 to 13,000
Total	800 to 52,100	Total	1,600 to 15,600

When the river is not a hydraulic influence, lateral inflow is the greatest volumetric input to the UAU. The most significant pathways for water to leave the UAU are via vertical flow to the MAU, or cascading flow at Well SRP 23E,2.9N.

Middle Alluvial Unit

The hydrologic inputs and outputs considered for the MAU water budget are illustrated in Figure 6-6. There is not sufficient information to quantify each of these components.

Inputs

Leakage from UAU

The vertical flow of water from the UAU was calculated as part of the UAU water budget. Approximately 600 to 13,000 acre-feet per year flow downward to the MAU.

Subsurface Lateral Inflow

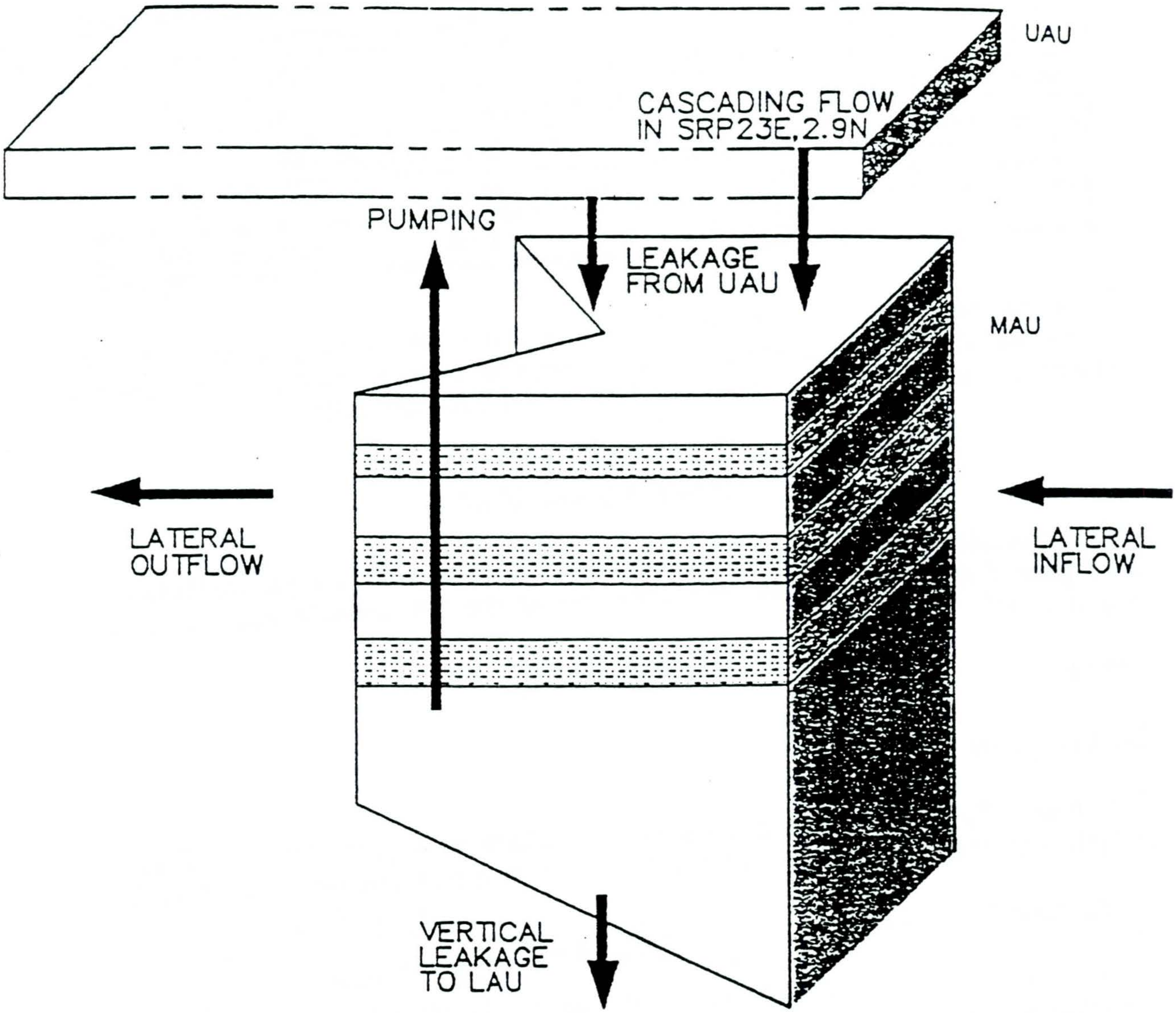
As of June 31, 1992, available water level data are insufficient to characterize the groundwater flow patterns in the MAU-B. However, the horizontal gradient appears to be so flat that lateral components of groundwater flow are small (less than 100 ac-ft/yr). The approximate horizontal gradient in the MAU-C is 0.003 and a representative transmissivity is 50,000 gpd/ft. A maximum flow length is 6,400 feet. Using these values, the volume of lateral flow in the MAU-B is estimated to be:

$$Q = TiL$$

$$= (50{,}000\ gpd/ft)\ (0.003)\ (6{,}400 ft)$$

$$= 1{,}100\, af/yr$$

This is an interim report, and all data, analysis, and conclusions are preliminary.
For more detail on the limitations of this report, see Section 1.



NOTE:
DIAGRAM IS NOT TO SCALE

FIGURE 6-6
COMPONENTS OF
MAU WATER BUDGET

Cascading Flow in Well SRP 23E,2.9N

As discussed in the UAU water budget, approximately 500 ac-ft/yr may discharge to the MAU at this well.

Outputs

Pumping

Pumpage data have been obtained from the ADWR and the SRP and were presented in Section 3 and summarized in Table 6-1. The average annual pumping from the MAU is approximately 500 to 2,000 acre-feet. Historically, wells within the IBW-South area pumped up to 3,000 ac-ft/yr total. Total pumpage has decreased since the early 1970s in the region and within IBW-South.

Past pumping patterns could have caused contaminants to move in different directions than present pumping. There was more stress on the aquifer, and contaminants could have moved more quickly.

Lateral Outflow

As mentioned in the lateral inflow discussion above, the horizontal gradient in the MAU-B appears to be very small, so lateral outflow may be less than 100 ac-ft/yr. The lateral outflow in the MAU-C is assumed to be the same as lateral inflow (1,100 ac-ft/yr). The lateral outflow may have changed in magnitude and direction because of changes in regional pumping patterns.

Leakage to LAU

An estimate of potential vertical leakage to the LAU is provided below. This estimate is based on vertical gradients measured at Wells SIBW-16MB and SIBW-12L (Section 5) and the vertical conductivity that is representative of hydrogeologic conditions in the IBW-North site. The estimate is extremely preliminary and is provided to aid with preliminary interpretations.

The vertical leakage may be estimated using the following equation:

$$Q = KiA$$

where:

K = Vertical conductivity = 0.002 ft/day (EPA, 1991)

i = Vertical gradient = 0.02 ft/ft

A = Area in which LAU underlies MAU = 1,280 acres

$$Q = (0.002 ft/day)\ (0.02 ft/ft)\ (1{,}280 acres)$$

$$= 20 ac\text{-}ft/year$$

Summary of MAU Water Budget Calculations

A summary of the MAU water budget calculations is provided in Table 6-4.

Table 6-4
Summary of MAU Water Budget Calculations

Inputs (ac-ft/yr)		Outputs (ac-ft/yr)	
Cascading Flow from SRP23E,2.9N	500	Pumping	500 to 2,000
Leakage from UAU	600 to 13,000	Lateral Outflow	MAU-B: <100 MAU-C: 1,100
Lateral Inflow	MAU-B: <100 MAU-C: 1,100	Leakage to LAU	<100
Total	2,300 to 14,700	Total	1,800 to 3,300

The most significant inputs to the MAU-B are leakage from the UAU and cascading flow from Well SRP 23E,2.9N. Lateral inflow may be a significant input to the MAU-C. Significant outputs from both the MAU-B and the MAU-C are pumping and lateral outflow (MAU-C).

Lower Alluvial and Red Units

A water budget was not attempted for these hydrogeologic units because of the limited geologic and water level data. Components of a water budget for these units include lateral inflows and outflows, pumping, and vertical leakages to and from other units.

Conclusions

This water budget evaluation disclosed significant clues regarding past directions of groundwater movement that could potentially be used to explain the contaminant distribution pattern. The effect of the riverflow on contaminant movement was illustrated. Well SRP 23E,2.9N may continue to provide a conduit for contaminated groundwater to plow from the UAU to the MAU. This well should be decommissioned.

Calculations presented in this water budget show that different components affect groundwater flow patterns when the Salt River flows near the IBW-South site compared to when the river does not flow. Table 6-5 categorizes the components considered in this water budget as either significant or insignificant factors that affect the groundwater flow direction and/or gradient for two conditions: (1) periods when the Salt River flows and (2) when the Salt River does not flow. The factors that are listed as significant have the greatest effect on groundwater flow patterns within the study area.

The strong vertical gradients and different flow directions in each alluvial unit result in complex paths in which contaminants move.

Table 6-5
Significance of Water Budget Components

Water Budget Component	No Salt River Flow		Salt River Flow	
	Significant	Insignificant	Significant	Insignificant
UAU				
Salt River		x	x	
Urban Irrigation		x		x
Lateral Inflow	x			x
Hayden Canal		x		x
Pumping		x		x
Lateral Outflow	x		x	
Cascading Wells	x		x	
Leakage to MAU	x		x	
MAU				
Leakage from UAU	x		x	
Cascading Wells	x		x	
Lateral Inflow	x		?	
Pumping	x		?	
Lateral Outflow	x		x	

This is an interim report, and all data, analysis, and conclusions are preliminary.
For more detail on the limitations of this report, see Section 1.

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