APPENDIX E
SURFACE WATER ANALYSES
PERMIT 15000 FEASIBILITY STUDY

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The scope of the surface water analysis was to address the hydrologic possibilities for diverting water from the Santa Margarita River for use on Camp Pendleton and to construct streamflow quantities for use by the ground-water Model. Streamflow quantities were estimated at a point below the confluence of the Santa Margarita River and De Luz Creek for the purpose of determining the amount of available water in the model area. Results from the surface water analysis were used by the Model to simulate the amount of water that enters the Model's Northeast boundary, the amount of water available for diversion, the amount of water that by-passes the diversion point, and the amount of water that reaches Lake O'Neill. In addition to these calculations, the surface water analysis also estimated the amount of streamflow that flows into the modeled area from side tributaries within the lower Santa Margarita River basin.

E.1 STREAMFLOW AT THE MODEL BOUNDARY

The first step was to make a composite record of the historic streamflow data for water years 1925 to 1999. Daily historical mean streamflow data from the USGS gages listed in Table E-1 were used to develop a streamflow hydrograph for the 75 period of record.

TABLE E- 1: STREAM GAGING STATIONS IN THE SANTA MARGARITA RIVER BASIN

Station Name	STATION ID#	OPERATING AGENCY	PERIOD OF RECORD	DRAINAGE AREA (MI^2)
De Luz Creek near De Luz	11044800	USGS	10/92-Present	33.0
De Luz Creek near Fallbrook	11044900	USGS	10/51-9/67	47.5
Murrieta Creek at Temecula	11043000	USGS	10/25-Present	222.0
Sandia Creek near Fallbrook	11044350	USGS	10/89-Present	21.1
Santa Margarita River at FPUD Sump	11044300	USGS	10/89-Present	620.0
Santa Margarita River at Ysidora	11046000	USGS	3/23-Present	723.0
Santa Margarita River near Fallbrook	11044500	USGS	10/24-9/80	644.0
Santa Margarita River near Temecula (Gorge)	11044000	USGS	2/23-Present	588.0
Santa Margarita River Tributary near Fallbrook	11044600	USGS	10/61-9/65	0.5
Temecula Creek near Aguanga	11042400	USGS	8/57-Present	131.0

A schematic drawing of available USGS gages is shown in Figure E-1. There is no USGS gage at the established diversion structure, thus the development of a complete hydrograph at this point on the river required combining the flow data from different gages. Missing data for periods of broken record were calculated, simulated, and calibrated based on the available data.

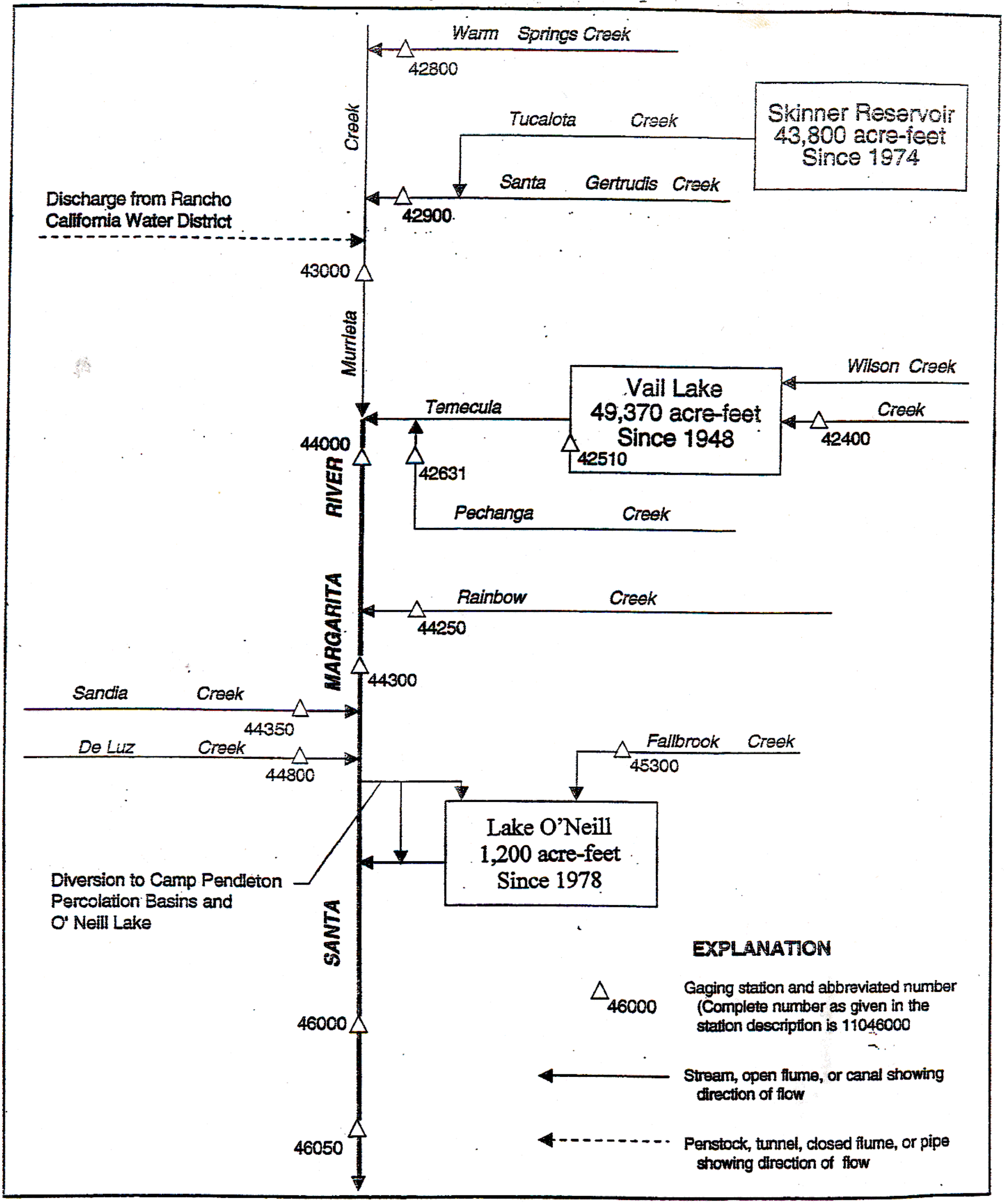
A spreadsheet model was used to reconstruct the surface flow at the Model boundary. The period of record was divided into 3 parts due to the non-continuous data set. For water years 1925 to 1980, the total streamflow at the Model boundary was calculated based on adding the observed streamflow from the Fallbrook gage to the simulated streamflow contribution from De Luz Creek. For water years 1981 to 1989, the peak flows during precipitation events were determined by the Soil Conservation Service method for calculating surface runoff, and the baseflow was simulated using the natural flow at the Gorge using USEPA's (1993) Hydrological Simulation Program-Fortran (HSPF). For water years 1990 to 1999, the observed streamflow values at the FPUD sump gage, Sandia Creek, and De Luz Creek were added together to approximate the flow at the Model boundary.

E.1.1 WATER YEARS 1925 TO 1980

For this early period of record, the Fallbrook gage (44500) historical streamflow data set was complete, representing the mean daily streamflow at a point below the confluence of Sandia Creek and the Santa Margarita River. The contribution from De Luz Creek to the Santa Margarita River was simulated using a proportionality constant based on drainage areas. The total streamflow at the Model boundary was calculated based on adding simulated streamflow from De Luz Creek with observed streamflow from the Fallbrook gage.

Between water years 1924 and 1930, the De Luz Creek contribution was based on the observed flow at the Gorge. Subtracting the historical streamflow at the Gorge gage (44000) from the Fallbrook gage (44500) gave the approximate contribution from the 56 mi^2 between the two gages. Based on available soil maps, it was assumed that the De Luz Creek Watershed has similar runoff characteristics to the watershed located between the Gorge and the Fallbrook gage, for the pre-development years before 1931. A proportionality constant (33 mi^2 /56 mi^2) was

Diversions and Storage in Santa Margarita River Basin



Hayes, P.D., Agajanian, J., and Rockwell, G.L., "Water Resources Data – California, Water Year 1997, Volume 1, Southern Great Basin from Mexican Borde to Mono Lake Basin, and Pacific Slope Basins from Tijuana River to Santa Maria River." U. S. Geological Survey, Water Resources Division, California District. 1997.

multiplied by the streamflow between the two gages to give an estimate of the flow from De Luz Creek.

Between water years 1931 and 1979, the De Luz Creek contribution was based on the natural flow at the Gorge; modeled in HSPF by Stetson. The natural flow model represents how the watershed would respond had no development occurred since 1930. Since the De Luz watershed remained relatively undeveloped over these years, the post 1930 natural flow conditions would more accurately reflect runoff characteristics and baseflow conditions.

A closer look at the hydrogeology of the Santa Margarita Watershed identifies the primary source of baseflow at the Gorge as derived from the ground water basins below Vail Lake. This is significant to the applied drainage area proportionality constants. Previously, the natural flow Gorge data was assumed to come from the entire upper watershed of the Santa Margarita River Watershed, a drainage area of 588 mi^2. The calibration to the observed data for the more recent years proved that a more accurate assessment uses the drainage area between Vail Lake Dam and the Gorge (268 mi^2) as the primary source of the natural baseflow at the Gorge. Thus, a proportionality constant (33 mi^2 / 268 mi^2) was multiplied by the natural streamflow simulated at the Gorge, to give a reasonable estimate of the flow from De Luz Creek.

The actual Fallbrook data, which included Sandia Creek, was then added to the calculated De Luz data to get the flow at the diversion structure.

E.1.2 WATER YEARS 1981 TO 1989

The only historical streamflow data set available for this period of record was from the Gorge gage (44000). The flow at this point is highly controlled by urban development in the Upper Basin, and is not necessarily representative of the factors that dictate the hydrology in the lower part of the watershed. Multiple methods of model simulation and calibration were explored to model the streamflow below the Gorge during this period.

The Soil Conservation Service (SCS, 1972) developed a method for computing abstractions from storm rainfall (Chow et. al., 1988). The basic equation for computing the depth of excess rainfall or direct runoff from a storm by the SCS method is:

$$P_e = \frac{(P - 0.2S)^2}{P - 0.8S}$$

The variables in the SCS method include: P_e = rainfall excess (direct runoff), P = total rainfall, and S = potential maximum water retention. To standardize this equation for different watersheds, a dimensionless curve number (CN) is defined, such that for impervious water surfaces CN=100, and for natural surfaces CN<100. Table 4-3 lists the curve numbers chosen for the streamflow model. The curve number and S are related by the equation:

$$S = 1000/CN - 10.$$

TABLE E- 2: CURVE NUMBERS FOR SANTA MARGARITA RIVER WATERSHED

CN	S	
87	1.49	**Normal**
93.9	0.65	**Wet**
73.8	3.56	**Dry**

* Antecedent Moisture Conditions

The SCS method was used to approximate flows after peak precipitation events for this period. Hourly and daily data from the Oceanside rainfall gage in southern California was used to calculate precipitation runoff. Data sets were obtained from the Desert Research Institute. Monthly and annual precipitation values at Oceanside are shown in Attachment E-1.

During the 1980 flood, the Fallbrook gage (44500) was washed out, and in 1989 a new gage was installed at the FPUD Sump on the Santa Margarita River (44300) upstream of the confluence with Sandia Creek. The contribution between the Gorge and the new Fallbrook gage (drainage area = 32 mi^2) during a peak event was calculated from the SCS Curve Number Method. When there was not a precipitation event, the baseflow was simulated using the natural flow at the Gorge as modeled by HSPF. Again, the proportionality constant for the drainage areas of Sandia Creek and De Luz Creek was multiplied by the natural streamflow simulated at the Gorge, to give a reasonable estimate of the relative flow in the adjacent tributary watersheds. The observed flow at the Gorge was combined with the modeled streamflow below the Gorge, to produce a simulated hydrograph at the point of diversion.

This method was applied to a period of observed flow, water years 1989 to 1996, to determine if the predicted streamflow provided a reasonable replication of the observed data. The modeled hydrograph for this period of comparison used daily Oceanside precipitation data (1989 to 1996) for the SCS method of calculating runoff during rain events and the HSPF model to simulate baseflows. The constructed hydrograph at the diversion point for this period was calculated as the sum of the observed data from the FPUD Sump gage (44300), Sandia Creek gage (44350), and the De Luz Creek gage (44800). The modeled data for Sandia Creek, De Luz Creek, and at the location of FPUD Sump were compared to the observed data at these USGS gages. The modeled data at the diversion point was compared to the constructed data at the diversion point. The calibration to the observed data for these later years proved that a more accurate assessment uses the drainage area between Vail Lake Dam and the Gorge (268 mi^2) as the primary source of the natural baseflow at the Gorge. The proportionality constants were modified to present a more accurate replication of the streamflow during the 1980 to 1989 period of missing streamflow data.

Two final refining calibration steps were performed on the simulated data set. The MODFLOW model output showed that the simulated historical flows from 1979, 1981, and 1989 were underestimating spring baseflows and overestimating summer baseflows. By applying the simulation method to the 1990 to 1996 period of known flow, it was clear that there was a discrepancy between modeled and observed flow. Due to the size and capacitance of the ground-water aquifer in the upper basin, base flows are overestimated in the winter. The base flow in De Luz and Sandia Creeks would proportionally be less during the summer due to the very low storage volume of the thin channel alluvium. Similarly the base flows in the winter would be proportionally greater due to the minimal ground-water storage available to capture rainfall-runoff events. A series of monthly multipliers, shown in Table E-3, were used to account for this error. These constants were multiplied by the HSPF natural flow contribution from between Vail Dam and the Gorge to account for inconsistencies in the simulations.

TABLE E- 3: MULTIPLIERS USED TO RECALIBRATED BASEFLOWS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.0	2.0	2.0	2.0	2.0	1.75	1.25	0.75	0.75	1.25	1.75	2.0

Specific monthly corrections to historical flow were made to assure that there was enough water in the Santa Margarita River to satisfy historical diversions. Table E-4 shows four months (out of 240 months) where the surface water analysis underestimated the flow at the diversion point and water was added to the analysis to meet historical diversions. This is most likely due to the low precipitation values from the Oceanside data set, or a function of the conservative baseflow approximation method.

TABLE E- 4: SPECIFIC MONTHLY ADDITIONS (CFS/DAY)

Date	Santa Margarita River Flow Increase
May-86	3
Mar-87	4
Jan-89	3
Feb-89	6

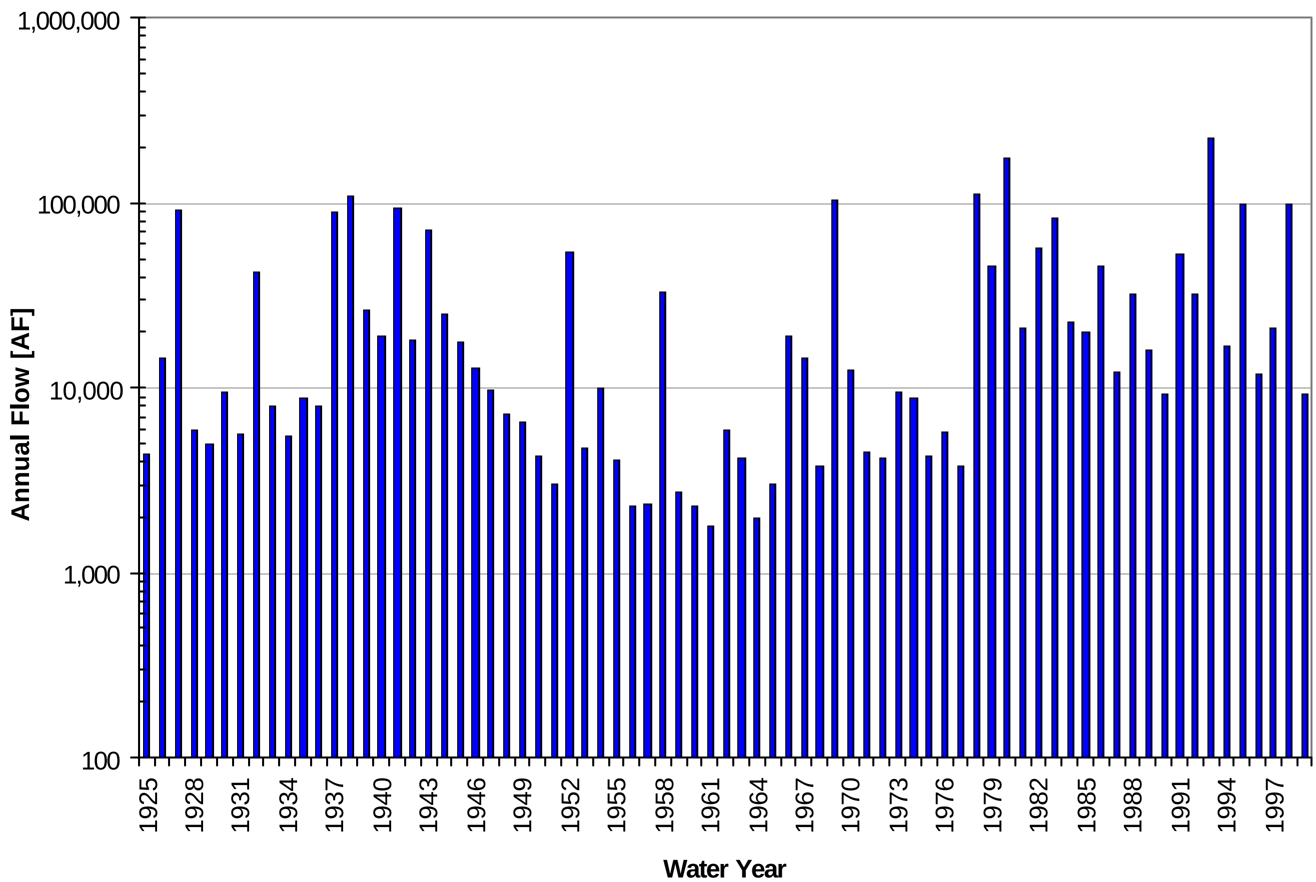
To summarize, the surface water flow for water years 1981 to 1989 were derived as follows. The peak flows, during precipitation events, were determined by the SCS method. The baseflow was determined by adding the observed Gorge flow to the calculated Sandia Creek and De Luz Creek streamflow (proportional to the natural flow at the Gorge modeled by HSPF) and the contribution between the Gorge and the Fallbrook FPUD Sump gage (also based on the HSPF natural flow). A monthly multiplier was used to account for the underestimation of spring flows and the overestimation of summer flows. A final refining step added 3 to 6 cfs of baseflow to particular months where the modeled flow in the Santa Margarita River was insufficient to satisfy historically diverted quantities.

E.1.3 WATER YEARS 1989 - 1999

For the most recent period of record there is an extensive set of historical streamflow data for the FPUD Sump gage (44300), Sandia Creek (44350), and De Luz Creek (44800). The streamflow from these three gages were added together to approximate the flow at the diversion structure. The only missing data were for De Luz creek from 10/1/89 to 10/1/92. The contribution from De Luz Creek, for this period, was simulated using a proportionality constant based on drainage areas. It was assumed that the De Luz Watershed has similar runoff characteristics to the Sandia Creek watershed. A proportionality constant (33 mi^2 /21.1 mi^2) was multiplied by the streamflow at Sandia Creek to give a reasonable estimate of the flow from De Luz Creek.

The Simulated Annual Flow at the Diversion Structure for water years 1925 to 1999 is represented by a bar graph in Figure E-2. A table of the simulated annual streamflow values for water years 1980 to 1999 is provided in the Reservoir Operations section of this appendix.

FIGURE E-2
Simulated Annual Flow at Diversion Structure
Water Years 1925 to 1999



E.2 MINOR TRIBUTARY DRAINAGE

The contribution of minor tributary drainage and runoff was computed using the Soil Conservation Service Curve Number Method described early in this appendix. The delineation of each of the minor tributary drainage areas on the east side and west side of the ground-water model area is visually represented in Appendix D. The West side drainage area includes sub-basins 11 through 19. The East side drainage area includes sub-basins 21 through 31. The drainage areas and percent contribution to the total minor tributary drainage is shown in Table E-5 below.

TABLE E- 5: EAST AND WEST MINOR TRIBUTARY DRAINAGE AREAS

East Tributary Sub-Basins	Drainage Area (Acre)	% Contribution
21	334.35	7.0
22	148.17	3.1
23	153.67	3.2
24	185.92	3.9
25	539.75	11.4
26	617.06	13.0
27	786.06	16.6
28	435.05	9.2
29	783.19	16.5
30	438.72	9.2
31	327.2	6.9
Total East	**4749.14**	**100**

West Tributary Sub-Basins	Drainage Area (Acre)	% Contribution
11	1603.75	22.8
12	371.64	5.3
13	1719.65	24.4
14	1215.08	17.3
15	619.63	8.8
16	161.29	2.3
17	383.68	5.5
18	429.97	6.1
19	534.47	7.6
Total West	**7039.16**	**100**

The hourly Oceanside Precipitation gage data (obtained from the DRI) was used to simulate rainfall from October 1, 1979 to September 30, 1999. There were two substantial periods of missing data during wet years (8/1/93 to 4/24/94, and 12/16/97 to 10/2/98). The daily Oceanside Precipitation gage data (also obtained from the DRI) was used to simulate rainfall during these days. (See Attachment E.1 for monthly and annual values)

The calculation of the Curve Number (CN) for the West and East drainage areas was based on the soil classification information provided by SCS. The representative area for each soil type is shown in Attachment E-2. The USDA SCS Method was applied to determine the hydrologic soil group and associated CN for each land use. The land use for the areas of interest was assumed to be 100% pasture. The classification of native pasture or range was assumed to be fair. According to the Hydrology section of the SCS National Engineering Handbook, fair pasture is defined as not heavily grazed with plant cover on 1/2 to 3/4 of the area. A curve number-rating table for fair pasture is shown Table E-6.

TABLE E- 6: CURVE NUMBER FAIR PASTURE

Cover		Hydrologic Soil Group			
Land Use	**Hydrologic Condition**	**A**	**B**	**C**	**D**
Pasture or Range	**FAIR**	49	69	79	84

The Soil Conservation Service (Soil Classification Service) (SCS 1972) developed a method for computing abstractions from storm rainfall (Chow et. al., 1988). The method described in the streamflow at model boundary section of this appendix is also applied to the minor tributary runoff calculation. The normal curve number used to calculate wet, dry, and antecedent moisture conditions was derived from the hydrologic soil analysis (see Table E-7).

TABLE E- 7: CURVE NUMBERS FOR EAST AND WEST MINOR TRIBUTARY RUNOFF USED IN THE SCS METHOD

EAST TRIBUTARY			WEST TRIBUTARY		
CN	**S**		**CN**	**S**	
78.58	2.73	**Normal**	76.6	3.05	**Normal**
89.4	1.19	**Wet**	88.3	1.33	**Wet**
60.6	6.49	**Dry**	57.9	7.27	**Dry**

For minor tributary runoff, the SCS method was used to approximate flows after peak precipitation events. Monthly precipitation values at Oceanside are shown in Attachment E-1. The baseflow was assumed to be zero. The annual total runoff contribution from both the west side and east side minor tributaries is show in Table E-8 below. Appendix D discusses the calibration of these numbers for the ground-water model.

TABLE E-8: ANNUAL CONTRIBUTION FOR EAST AND WEST MINOR TRIBUTARY RUNOFF

Water Year	Total EAST Tributary Contribution Annual Runoff (AF)	Total WEST Tributary Contribution Annual Runoff (AF)	Total Minor Tributary Contribution Annual Runoff (AF)
1980	3,030	4,047	7,078
1981	199	227	426
1982	1,691	2,286	3,977
1983	1,348	1,713	3,061
1984	509	656	1,164
1985	367	463	831
1986	1,698	2,225	3,923
1987	293	386	679
1988	1,202	1,596	2,798
1989	481	607	1,088
1990	233	294	527
1991	852	1,098	1,950
1992	1,306	1,720	3,026
1993	2,077	2,805	4,882
1994	244	316	560
1995	1,791	2,454	4,246
1996	80	97	177
1997	1,011	1,328	2,338
1998	1,095	1,451	2,546
1999	185	231	416

Total	**19,691**	**26,001**	**45,692**
Mean	985	1,300	2,285
Median	931	1,213	2,144
Max	3,030	4,047	7,078
Min	80	97	177

E.3 RESERVOIR OPERATIONS

The scope of this analysis is to address multiple scenarios for diverting water from the Santa Margarita River for use on Camp Pendleton. The goal is to maximize the amount of water diverted from the Santa Margarita River under the permitted water rights. The surface water analysis is based on general principals of hydrology and hydraulics. This baseline data and format for simulating streamflow for each alternative is laid out at the beginning of this section. A more detailed description of each alternative and the monthly results follows.

There is an established point of diversion to Lake O'Neill and the five existing recharge ponds, below where the De Luz Creek tributary enters the Santa Margarita River. Currently, the system diverts water from the Santa Margarita River at an average flow of 60 cfs. Stetson Engineers is seeking to improve the diversion at this point by increasing the diversion capacity of the channel, enlarging the volume of the recharge ponds, and/or providing additional reservoirs for off-stream storage.

Stetson Engineers has explored four alternatives to improve Camp Pendleton's existing diversion capabilities. A MODFLOW ground-water model ran multiple simulations for each alternative to explore how different hydrologic factors would affect the ground-water system. A reservoir operations model was constructed to supply input for the ground-water model, while also providing a balanced water budget for Lake O'Neill and the recharge ponds.

The reservoir operations model was used to estimate the rate of diversion from the Santa Margarita River to both the recharge ponds and Lake O'Neill. The model used 1980 to 1999 hydrology in order to construct streamflow at a point below the confluence of De Luz Creek and the Santa Margarita River. Applying daily estimates of streamflow and historical measurements of precipitation and evaporation, the reservoir operations model was used to predict the daily diversion during the historical period.

E.3.1 LAKE O'NEILL

Lake O'Neill is a 1,200 acre-foot reservoir located on Fallbrook Creek, a minor tributary of the Santa Margarita River. Most of the water stored in the lake is diverted from the nearby Santa Margarita River. The dam creating Lake O'Neill and the diversion ditch from the Santa Margarita River were constructed in 1883 as part of the farm irrigation system. Since acquisition by the U.S. Government for Camp Pendleton, Lake O'Neill has been used for recreation, training purposes, and subsequent ground water recharge (Leedshill and Herkenhoff, 1988).

E.3.2 RECHARGE PONDS

There are five recharge ponds located off the diversion channel from the Santa Margarita River. These ponds permit water to recharge the ground-water system. The reservoir operations model calculates the daily flow of water into the recharge ponds, the net effect of precipitation and evaporation, the volume of water infiltrating into the ground, and finally the volume of water, which spills out of the last pond. These calculations provide input for MODFLOW, which then simulates the path of the recharged water once it infiltrates below the surface.

E.3.3 DIVERSION CAPACITY

The diversion capacity is defined by the amount of water that can be directed into the O'Neill ditch based on the available streamflow in the Santa Margarita River, defined bypass flow, and diversion capacity. The available streamflow is the calculated or calibrated values at the diversion structure for the period of record minus the defined bypass flow of 3 cfs. No water may be diverted from the Santa Margarita River if the flow in less than 3 cfs, and for all other flows at least 3 cfs must be bypassed around the diversion structure. There are two existing water diversion rights.

1) The Pre-1914 Water Right allows for 1,100 AFY of storage plus 100 AFY of dead storage and 400 AFY of evaporation and seepage from Lake O'Neill. The total diversion right is for 1,500 AFY at a maximum diversion rate of 20 cfs. The diversion period is between April 1st and October 31st although the Base and FPUD have an agreement that allows for diversion from November 1st through March 31st.

2) Permit 15000 License 10494 allows for 4000 AFY to be collected in the underground storage reservoir by way of the percolation ponds and the natural channel of the river. The existing system can divert a maximum of 60 cfs, but by improving the existing constrictions, this capacity could be greatly increased. The permitted diversion period is between October 1st and June 30th.

Since one of the goals of the study is to find the optimal scenario for diverting water from the Santa Margarita River year round, a range of capacities for the diversion channel were explored. At present, the bottleneck in the diversion system is the road crossing downstream of the headgate. It is feasible to redesign the road crossing to handle a higher flow capacity. Ten scenarios were investigated to simulate the quantity of water that could be diverted from the historical streamflow in the Santa Margarita River for water years 1925 to 1999 based on channel capacities equal to 25, 60, 100, 150, 200, 250, 350, 450, and 600 cfs. For each year the total annual flow was calculated, along with the total, median, and mean divertable flow for each scenario. It was also noted the number of days when the channel was running at full capacity. For the 75-year period of record, the total, minimum, maximum, mean and median flow were tabulated for each scenario. Table E-9 shows the summary for the 75-year period of record for each channel capacity.

TABLE E-9: SUMMARY OF ANNUAL DIVERSION POTENTIAL FOR VARIOUS DIVERSION CAPACITIES

Water Years 1925 - 1999			Diversion Capacity (cfs)								
Diversion Potential	**Unit**	**Santa Margarita River Flow**	**25 cfs**	**60 cfs**	**100 cfs**	**150 cfs**	**200 cfs**	**250 cfs**	**350 cfs**	**450 cfs**	**600 cfs**
75-yr Annual Average	(AF)	30,474	5,614	7,672	9,150	10,332	11,421	12,218	13,477	14,488	15,723
75-yr Annual Median	(AF)	12,246	4,845	5,511	6,110	6,451	6,667	6,920	7,552	7,588	7,886
# of Days Flow >= Diversion Capacity	(AF)	N/A	3,316	1,715	2,470	831	671	559	424	356	283

*** See Attachment E-3 for table of annual results**

Figure E-3 illustrates the annual diversion potential for the range of capacities studied. Based on the median of a 75-yr potential annual diversion analysis for the range of diversion

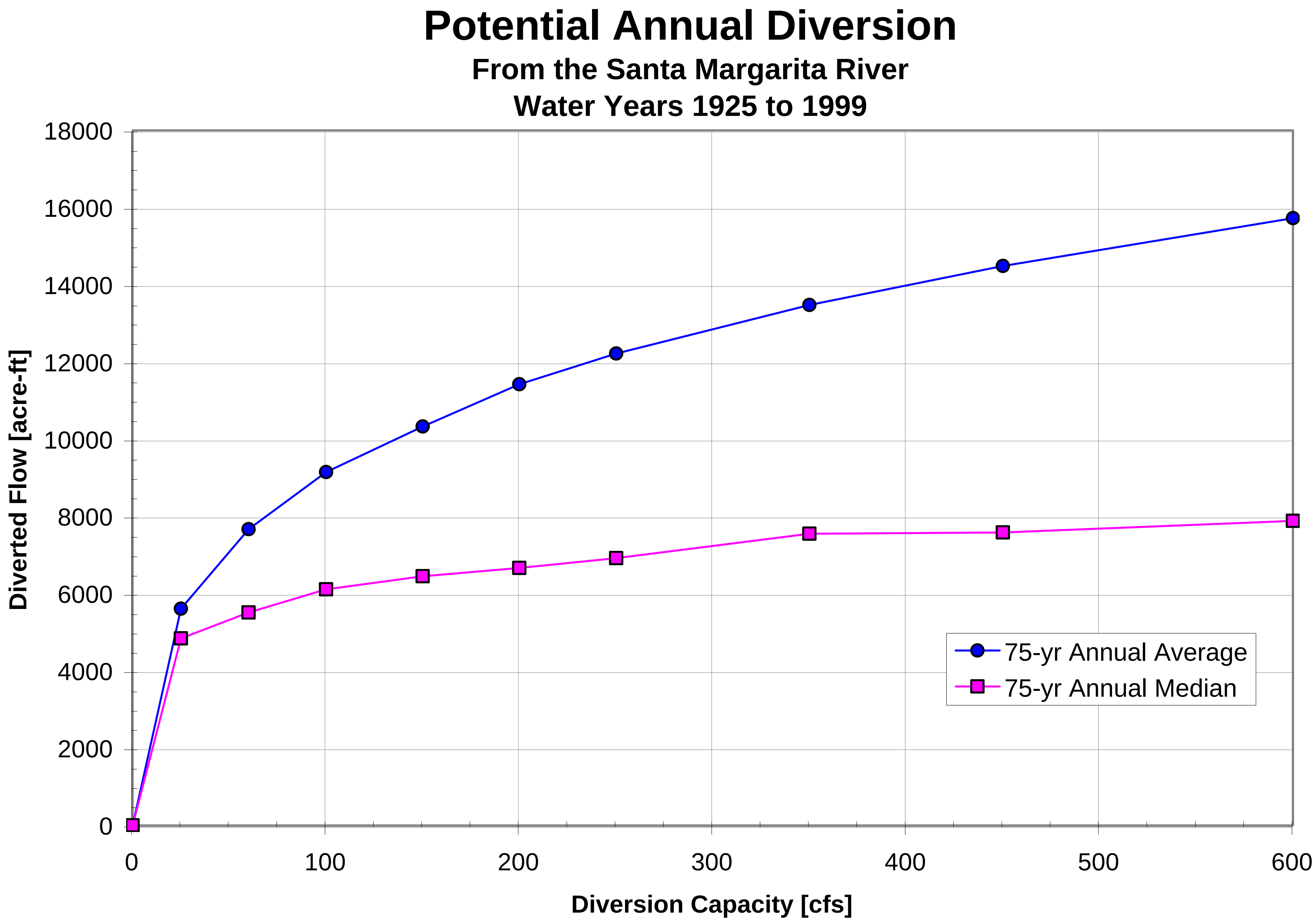

Potential Annual Diversion
From the Santa Margarita River
Water Years 1925 to 1999
Diverted Flow [acre-ft]
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
0
100
200
300
400
500
600
Diversion Capacity [cfs]
75-yr Annual Average
75-yr Annual Median

FIGURE E-3

capacities, it was found that 200 cfs represented the optimal diversion capacity. Furthermore, a 200 cfs canal capacity minimizes the spill from the last recharge pond, while maximizing the recharge to the ground-water basin.

A more detailed analysis was performed by dividing the 75 year period of record into wet and dry years. An annual frequency distribution diagram was created base on the USGS Gorge gage (44000) for water years 1925 to 1999. Wet years were defined as years where the total flow has <18% occurrence. Dry years were defined as years where the total flow has a >85% occurrence. The previously described procedures and statistics were replicated for wet and dry years to refine the optimization process. In essence, it would be advantageous to divert large amounts of water during wet years so that the subsequent dry years will be adequately compensated by the surplus storage.

Another pertinent question relates to the current capacity of the channel. This was explored using actual data from the Camp Pendleton gage. The actual channel flow was computed as the sum of the flow diverted to the recharge/spreading ponds plus the flow diverted to Lake O'Neill. Annual diversions to Lake O'Neill and the recharge ponds can be seen in Table E-10.

TABLE E- 10: HISTORICAL DIVERSIONS TO THE RECHARGE PONDS AND LAKE O'NEILL

WATER YEAR	HISTORICAL DIVERSION TO LAKE O'NEILL (AF)	HISTORICAL DIVERSION TO RECHARGE PONDS (AF)	TOTAL HISTORICAL DIVERSION FROM THE SANTA MARGARITA RIVER (AF)
1980	0	0	0
1981	0	0	0
1982	0	0	0
1983	221	7,624	7,845
1984	569	1,421	1,990
1985	643	2,618	3,261
1986	1,146	6,791	7,937
1987	1,336	1,035	2,371
1988	904	2,125	3,029
1989	1,295	2,346	3,641
1990	867	2,756	3,623
1991	958	5,178	6,136
1992	702	5,461	6,163
1993	68	629	697
1994	0	3,759	3,759
1995	798	804	1,602
1996	0	1,099	1,099
1997	0	3,633	3,633
1998	291	4,368	4,659
1999	0	2,955	2,955
Total	**9,798**	**54,602**	**64,400**
Average	490	2,730	3,220
Median	430	2,482	3,145
Min	0	0	0
Max	1,336	7,624	7,937

E.3.4 OBERMEYER DAM

One of the design options to improve the diversion capacity is to replace the current corrugated sheet-pile dam with an inflatable Obermeyer dam. The Obermeyer dam will be deflated during large storm events to allow sediment and large debris to flow downstream over the lowered dam. This will eliminate the need to dredge accumulated sand from behind the diversion structure. The previous diversion calculations discussed in this section assumed that the dam never deflated nor was it impeded by sediment and debris.

In order to assess the amount of flow that will be lost when the dam deflates, the peak flows for each storm event must be evaluated. Unfortunately, only the historical annual peak flows, not daily peak flows, are available through the USGS. Data simulation for peak flow events cannot be treated the same as for mean daily flow events. Gages can not be added together because the time of concentration for the peak pulse to pass through each watershed to a defined point will be very different.

Looking at the 15-minute hydrograph for recent storms in March 1991, March 1995, and January 1995 the known peaks and their corresponding daily means were used to calculate a peak:mean ratio. A mean flow value that will cause the dam to collapse can be determined based on this ratio. Since this method has the potential to both under-estimate and over-estimate the number of days when the dam will collapse, three ratios were evaluated for the period of record (Table E-11).

TABLE E- 11: RELATION OF INSTANTANEOUS PEAK TO DAILY MEAN

peak:mean (-)	Peak flow to deflate dam (10-year Storm) Q_{peak} (cfs)	Mean flow to deflate dam Q_{mean} (cfs)	
5:1	18,000	3,600	Most Conservative
3.5:1	18,000	5,143	
2.5:1	18,000	7,200	Least Conservative

It was assumed that the Obermeyer dam would be deflated to let the 10-yr flow, with an instantaneous peak of 18,000 cfs, pass over the structure. A peak to mean ratio of 5:1 was used to be conservative. Thus, on any day when the flow in the Santa Margarita River was greater than 3,600 cfs, the Obermeyer dam would deflate and do water would be diverted. This condition was applied to Alternatives 2, 3, and 4 to represent the most conservative case.

E.3.5 PRECIPITATION

The daily precipitation values used in the SCS-Curve Number method for streamflow and runoff were also used in the reservoir operations analysis. Hourly data from the Oceanside rainfall gage in southern California was used as the primary source of data. Data sets were obtained from the Desert Research Institute (DRI). There was missing data for random months in 1984, 1989, 1993, 1994, and 1998. For these days, daily rainfall, also from Oceanside (DRI), was used. Monthly precipitation values at Oceanside are shown in Attachment E-1.

E.3.6 EVAPORATION

Evaporation removes water from the surface area of an open body of water. These monthly values were applied on a daily basis to the surface area of Lake O'Neill and the recharge ponds. The consumptive use rates (Table E-12), for water surface evaporation, were taken from 'Addendum to DRAFT Technical Memorandum dated April 11, 1995' 4/25/95 (Stetson Engineers).

TABLE E- 12: EVAPORATION RATES

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
In/month	2.31	2.92	4.06	4.94	5.87	6.37	6.99	6.75	5.62	4.03	2.70	2.15	**54.71**
in/day	0.07	0.10	0.13	0.16	0.19	0.21	0.23	0.22	0.19	0.13	0.09	0.07	**1.80**

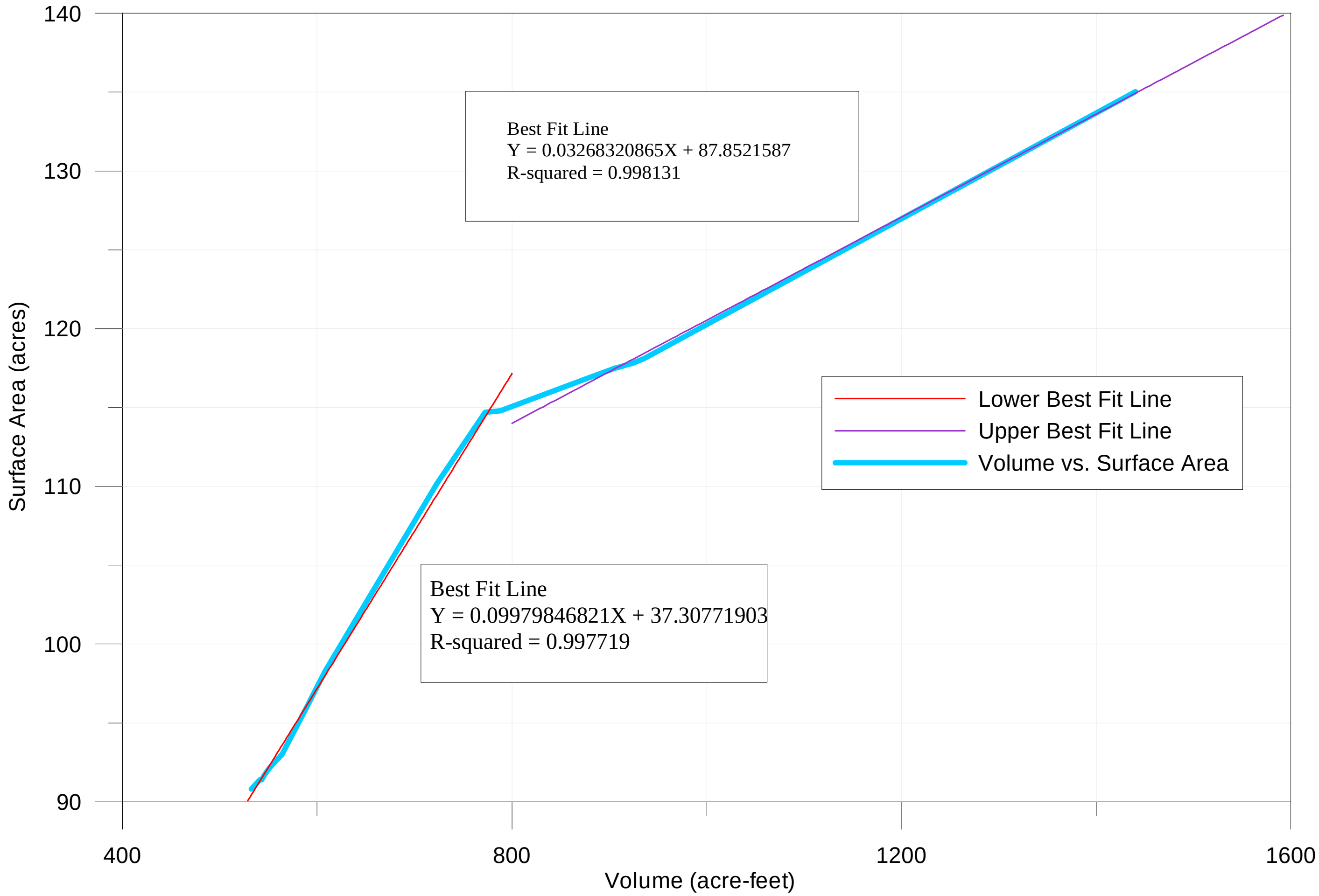
The evaporation rate for each month was applied to the surface area of each pond. The ponds are assumed to be rectangular in shape, such that at any depth the surface area is constant. The evaporative loss for the ponds was calculated on a daily basis based on the availability of water in the ponds and the precipitation falling on that day.

The surface area of Lake O'Neill changes with the daily depth of water. Actual data from the Public Works Survey Department at Camp Pendleton (Drawing # 10601), following a 1977 Dredging Survey, was used to construct a graph of Volume vs. Surface Area (Figure E-4). A trendline for this graph was used to calculate the volume of loss from evaporation each day, based on the daily changes in the volume of Lake O'Neill.

E.3.7 INFILTRATION RATES

The most important attribute of the recharge ponds is the ability of water to infiltrate below the surface to recharge ground water. The reservoir operation model used infiltration rates ranging seasonally from 0.2 to 1.8 feet/day. The infiltration rates for January and June for ponds 1 and 2 are based on the results of an infiltration study conducted by Stetson Engineers. The rates were interpolated between January and June (Table E-13) to reflect the decrease in infiltration rates on spreading systems during periods of continual wetting. After June, no water is diverted to the recharge ponds; thus, the simulated rates remain constant until maintenance in the fall rejuvenates the original infiltration rates. Ponds 3, 4, and 5 were assumed to have slightly higher infiltration rates than ponds 1 and 2, because most of the fine sediment would have already

Volume vs. Surface Area[1] of Lake O'Neill and Best Fit Lines



1. Data based upon maximum surface area and capacity, and values of surface area and capacity from December through May, 2000. Actual data froma Public Works Survey Department at Camp Pendelton (Drawing # 10601), following a 1977 Dredging Survey

FIGURE E-4

settled out in the first two ponds, reducing the risk of clogging in the later ponds. Proposed ponds 6 and 7 were assumed to be as efficient as ponds 3, 4 and 5 by the same reasoning. The ground-water model simulated the conditions below ground surface, to estimate if there would be enough room to store the percolating water. An optimal conjunctive-use-pumping rate was determined such that the storage could handle the influx of water from the recharge ponds.

TABLE E- 13: INFILTRATION RATES (FEET/DAY)

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Pond 1	**1.4**	1.40	1.1	0.8	0.5	**0.2**	0.2	0.2	0.2	0.2	1.4	1.4	**9.00**
Pond 2	**1.5**	1.5	1.4	1.2	1.1	**0.9**	0.9	0.9	0.9	0.9	1.5	1.5	**14.10**
Pond 3	1.6	1.6	1.6	1.2	1.1	0.9	0.9	0.9	0.9	0.9	1.5	1.5	**14.55**
Pond 4	1.8	1.8	1.8	1.2	1.1	0.9	0.9	0.9	0.9	0.9	1.5	1.5	**15.15**
Pond 5	1.8	1.8	1.8	1.2	1.1	0.9	0.9	0.9	0.9	0.9	1.5	1.5	**15.15**
TOTAL	**8.1**	**8.1**	**7.7**	**5.6**	**4.7**	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**	**7.4**	**7.4**	**68.0**
Pond 6	1.8	1.8	1.8	1.2	1.1	0.9	0.9	0.9	0.9	0.9	1.5	1.5	**15.15**
Pond 7	1.8	1.8	1.8	1.2	1.1	0.9	0.9	0.9	0.9	0.9	1.5	1.5	**15.15**
TOTAL	**11.7**	**11.7**	**11.3**	**8.0**	**6.8**	**5.6**	**5.6**	**5.6**	**5.6**	**5.6**	**10.4**	**10.4**	**93.8**

E.4 DEVELOPMENT OF ALTERNATIVES

A reservoir operations model was performed for each of the four project alternatives, including a no project alternative. The results are presented below.

E.4.1 ALTERNATIVE 1: NO PROJECT ALTERNATIVE

The reservoir operations model used for Alternative 1 estimated the rate of diversion from the Santa Margarita River to both the recharge ponds and Lake O'Neill. The model used 1980 to 1999 hydrology and future streamflow augmentation in order to construct streamflow at a point below the confluence of De Luz Creek and the Santa Margarita River. Applying daily estimates of streamflow and historical measurements of precipitation and evaporation, the reservoir operations model was used to predict the daily diversion during the historical period. The same model was also used to estimate daily diversion rates in Alternatives 2 through 4, based on improvements and expansion of the existing diversion facilities.

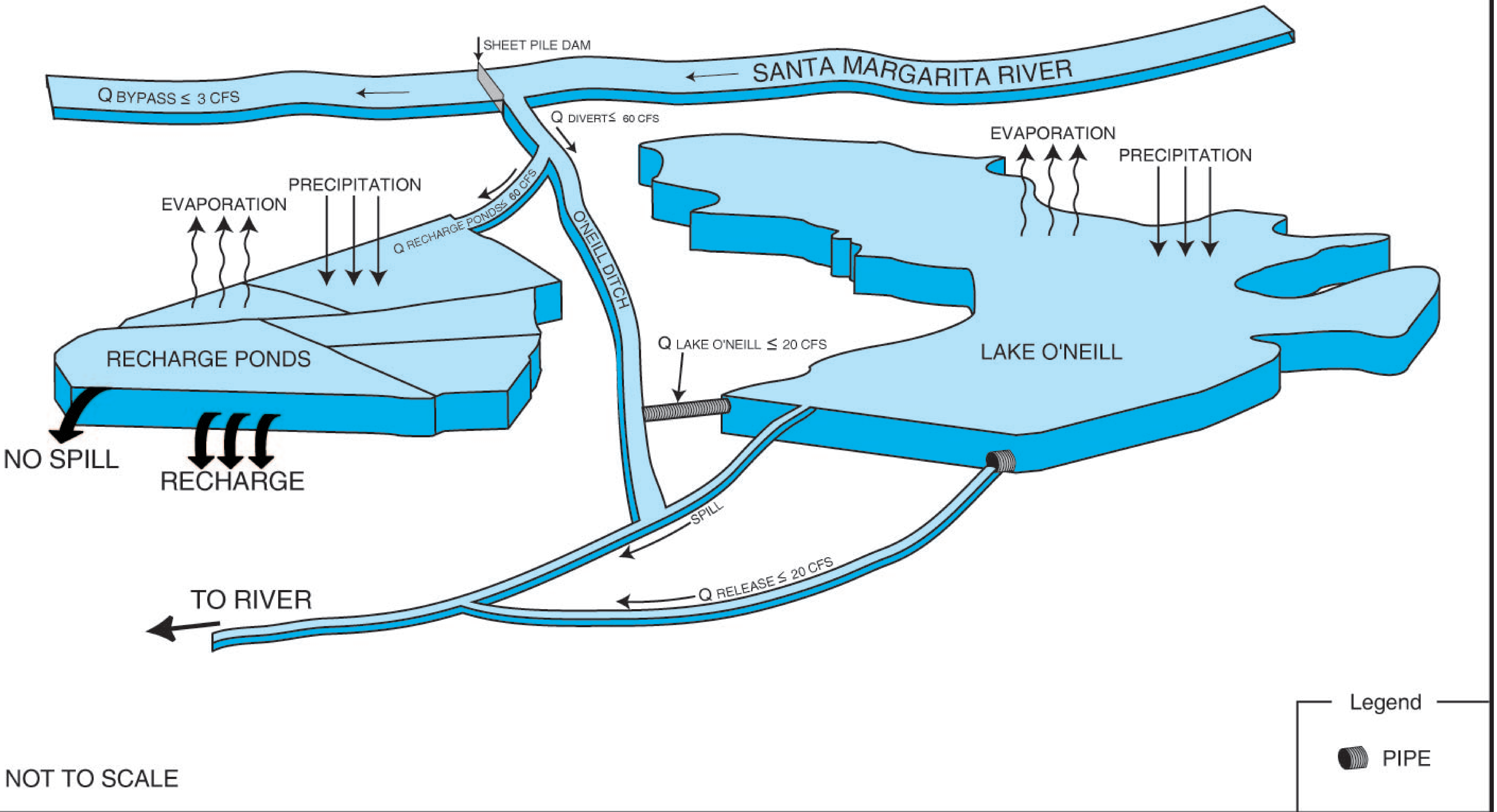
Limitations to the diversion rate from the Santa Margarita River accounted for in the reservoir operations model included not only the available water supply and physical limitations of the diversion facilities, but also such factors as available water rights, recharge pond infiltration rates, rainfall, evaporation, and spill from both the ponds and the lake. The Alternative 1 reservoir operations model also accounted for augmented surface flows and increased diversion efficiencies due to the maintenance and repair projects recommended in Chapter 6. Results from the model analysis were used by the ground-water model to estimate recharge at the ponds, streamflow past the diversion point, and releases from Lake O'Neill.

Diversions to Lake O'Neill and the recharge ponds were simulated in the reservoir operations model in order to establish baseline conditions. Simulated diversions to Lake O'Neill and the recharge ponds were estimated based on the limitations of the existing 1,500 AFY water right for diverting to Lake O'Neill and the 4,000 AFY license for diverting to the recharge ponds, complimented by the increased efficiency from the maintenance and repair of the relocated headwall and headgate. The diversion channel was assumed to divert a maximum of 60 cfs, based on the size of the culverts in the upper road crossing that impose flow restrictions.

A schematic diagram of the reservoir operations model is shown in Figure E-5. During periods of diversion, three cfs remains in the Santa Margarita River while the remaining surface flow may be diverted to either Lake O'Neill or to the recharge ponds. The simulated diversion to Lake O'Neill is limited to 20 cfs or less, while the maximum simulated diversion to the recharge ponds is 60 cfs.

The timing and quantity of diversions in the Alternative 1 reservoir operations model obeys certain constraints with respect to the filling and draining of Lake O'Neill.

- Beginning November 1st of every year, the lake is drained at a rate of 20 cfs. The drained flow leaves the lake through a pipe and into a channel flowing towards the Santa Margarita River. The water drained from the lake is recaptured by ground-water recovery wells located down-gradient of the release point. Draining terminates once the volume of Lake O'Neill approaches 100 AF.



STETSON ENGINEERS INC.

Surface Water Analysis
Resevoir Operations Model

Alternative 1
No Project

FIGURE E-5

1828-324LakeGraph1.ILL

- Water is diverted to Lake O'Neill between December 1st and March 31st. Between April and October, precipitation and evaporation act to raise and lower the water levels in the lake during this period.

- The reservoir operations model commences the use of the Pre-1914 water right from December 1st to March 31st. The Pre-1914 water right allows for 1,500 AFY to be diverted from the Santa Margarita River to Lake O'Neill, at a maximum diversion rate of 20 cfs. During this time, Lake O'Neill may approach its capacity of 1,200 AF, and on occasion will spill out of the lake via a spillway located on its western side. The effects of precipitation and evaporation are applied such that in dry years it may take slightly over 1,200 AF to fill the lake, while in wet years it may take less than 1,200 AF.

Alternative 1 operations model allows for the filling of Lake O'Neill exclusively from water diverted from the Santa Margarita River. Fallbrook Creek is allowed to bypass Lake O'Neill completely, helping to recharge the ground-water basin below the percolation ponds. The Pre-1914 water right is fully maximized every year and is only dependent upon the winter baseflow of the Santa Margarita River. Once Lake O'Neill has completed filling, water in O'Neill Ditch is then directed to the recharge ponds. The diversion schedule to the recharge ponds and Lake O'Neill, as dictated by the existing license and vested water right, is described in Table E-14.

TABLE E-14: ALTERNATIVE 1 - DIVERSION SCHEDULE TO THE RECHARGE PONDS

Month	Activity	Rate	Limit	Water Right
Diversions to Lake O'Neill				
Nov	Drain	$Q_{release}$ <= 20 cfs	Min Volume = 100 AF	N/A
Dec to March	Fill	$Q_{Lake\ O'Neill}$ <= 20 cfs	1,500 AF	Pre-1914 Water Right
April to Oct	Precip-Evap	Q_{spill} = f(precip-evap)	N/A	N/A
Diversions to Recharge Ponds				
Nov	Fill w/ 100% Q_{divert}	$Q_{recharge\ ponds}$ <= 60 cfs	No Spill	License 21471 A
Dec to March	Fill w/ $Q_{divert} - Q_{Lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 60 cfs	No Spill	License 21471 A
May to June	Fill w/ Q_{divert}	$Q_{recharge\ ponds}$ <= 60 cfs	No Spill	License 21471 A
July to Sept	No Diversion	$Q_{recharge\ ponds}$ = 0 cfs	N/A	N/A
Oct	Fill w/ Q_{divert}	$Q_{recharge\ ponds}$ <= 60 cfs	No Spill	License 21471 A

Applying these constraints to the augmented streamflow, the reservoir operations model estimated that 4,000 AFY could have been diverted to the recharge ponds every year during the historical calibration period, and 1,500 AFY could have been diverted to Lake O'Neill every year. The simulated annual diversion to Lake O'Neill and the recharge ponds is shown in Table E-15. Once the recharge ponds are full, diversion from the Santa Margarita River is limited to a prescribed flow rate, as a function of infiltration, for each of the five ponds so no spilling from the ponds occurs. The daily infiltration rates vary with each pond for each month.

TABLE E- 15: ALTERNATIVE 1 - DIVERSIONS TO THE RECHARGE PONDS AND LAKE O'NEILL (AFY)

Model Year	Pre-1914 Water Diverted to Lake O'Neill from Dec 1st-Mar 31st (AFY)	Alternative 1 Diversions to Recharge Ponds (AFY)	Total Diversions from the Santa Margarita River (AFY)
1	1,500	4,000	5,500
2	1,500	4,000	5,500
3	1,500	4,000	5,500
4	1,500	4,000	5,500
5	1,500	4,000	5,500
6	1,500	4,000	5,500
7	1,500	4,000	5,500
8	1,500	4,000	5,500
9	1,500	4,000	5,500
10	1,500	4,000	5,500
11	1,500	4,000	5,500
12	1,500	4,000	5,500
13	1,500	4,000	5,500
14	1,500	4,000	5,500
15	1,500	4,000	5,500
16	1,500	4,000	5,500
17	1,500	4,000	5,500
18	1,500	4,000	5,500
19	1,500	4,000	5,500
20	1,500	4,000	5,500
Total	**30,000**	**80,000**	**110,000**
Average	1,500	4,000	5,500
Median	1,500	4,000	5,500
Min	1,500	4,000	5,500
Max	1,500	4,000	5,500

A post-1978 Camp Pendleton Public Works Survey Department (1978) provided a surface area to volume curve used to calculate the change in storage (Figure E-4). Fluctuations in the storage volume for Lake O'Neill, due to the effective evaporation and precipitation, may provide more room for the pre-1914 water in dry years, or may cause spilling during wet years when rain is falling on the already full lake. Figure E-6 shows a graphical example of the reservoir operations model output for Lake O'Neill for modeled water years 9-11.

The sizing of the five existing recharge ponds once repaired is shown in Table E-16.

TABLE E- 16: SURFACE AREA AND VOLUME OF RECHARGE PONDS 1-5

POND #	1	2	3	4	5	Sub Total
Surface Area (Acre)	13.9	7.0	7.0	16.5	4.66	**49.10**
Depth (Feet)	5	7.5	6.5	6.5	8	**33.50**
Water Volume (AF)	**69.5**	**52.5**	**45.5**	**107.3**	**37.6**	**312.35**

The recharge pond simulation is calculated as the mass balance equation shown below.

$$DS = Q_{in} + \text{Precipitation} - \text{Evaporation} - \text{Recharge} - \text{Spill}$$

The flow into Pond 1 is the total diversion to the recharge pond. The flow into Pond 2 is the spill from Pond 1. The spill from Pond 2 flows into Pond 3, the spill from Pond 3 flows into Pond 4, and the spill from Pond 4 flows into Pond 5. There is no spill from Pond 5 in Alternative 1 because once the recharge ponds are full, diversion from the Santa Margarita River is limited to a prescribed flow rate, as a function of infiltration. The daily infiltration rates vary with each pond for each month (Table E-13). The flow required to keep the recharge ponds full without spilling can be calculated by multiplying this rate by the total surface area of each pond and the converting to cfs (Table E-17).

TABLE E- 17: FLOW RATE TO MAINTAIN FULL RECHARGE PONDS (CFS)

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Pond 1	9.81	9.81	7.71	5.61	3.50	1.40	1.40	1.40	1.40	1.40	9.81	9.81	**63.07**
Pond 2	5.29	5.29	4.76	4.24	3.71	3.18	3.18	3.18	3.18	3.18	5.29	5.29	**49.76**
Pond 3	5.65	5.65	5.65	4.24	3.71	3.18	3.18	3.18	3.18	3.18	5.29	5.29	**51.35**
Pond 4	14.97	14.97	14.97	9.98	8.73	7.49	7.49	7.49	7.49	7.49	12.48	12.48	**126.03**
Pond 5	4.27	4.27	4.27	2.84	2.49	2.13	2.13	2.13	2.13	2.13	3.55	3.55	**35.90**
Total	**40.0**	**40.0**	**37.4**	**26.9**	**22.1**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**36.4**	**36.4**	**326.1**

Alternative 1: Operation of Lake O'Neil
Model Years 9, 10, & 11

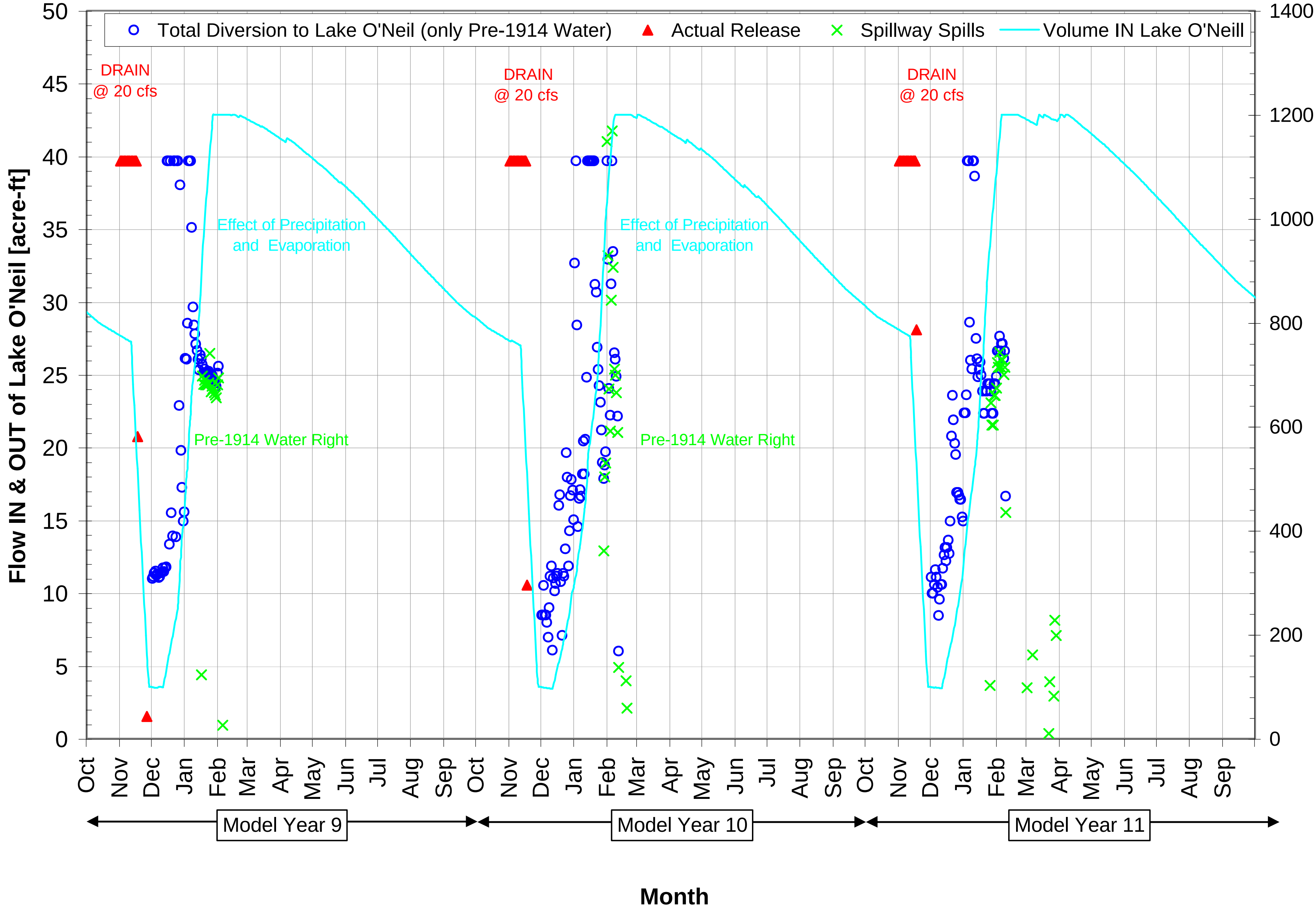


FIGURE E-6

As the flow enters each pond, the effective evaporation-precipitation acts over the surface area of each pond.

Effective Evap-Precip = Surface Area (Acre)* (Precip (inch) – Potential Evap (inch)/12 (inch)/(feet)

The model then assesses how much water is available to be stored or to infiltrate once the effects of evaporation and precipitation have occurred.

Water Available = Qin + Effective Evap-Precip + Water Standing (previous day)

The starting volumes for each pond on the first day of the model is zero. The potential infiltration rate will act on all available water in the pond to recharge the ground water. If there is more water available than the maximum potential infiltration volume (rate x time x surface area of the pond), the ponds will begin to accumulate water as storage. Once the capacity of each pond is reached, spilling occurs.

Table E-18 summarizes the results of the Alternative 1 reservoir operations model based on simulated diversions to Lake O'Neill with diversions to the recharge ponds being a function of the 4,000 acre-foot water right license 21471A. The simulated time period is based on historical data from water years 1980-1999. These values serve as the input to the MODFLOW ground-water model. Results from the streamflow analysis described earlier in this appendix, and the Alternative 1 reservoir operations model indicate that the average flow of the Santa Margarita River was approximately 55,860 AFY while the average diversion to the recharge ponds and Lake O'Neill was about 5,500 AFY. Although not used in this analysis, the actual historical diversion to Lake O'Neill and the percolation ponds, averaged around 500 AFY and 2,800 AFY respectively, due to the poor design and placement of the headwall and headgate structures.

TABLE E- 18: ALTERNATIVE 1 – SUMMARY OF AUGMENTED BASELINE CONDITIONS

20-year Simulated Period	Augmented Flow Santa Margarita River (AF)	Total Diversion Max 60 cfs (AF)	Diversion to Lake O'Neill (AF)	Diversion to Recharge Ponds (AF)	Ground Water at Recharge Ponds (AF)	Net Precip (+) Evap (-)[1] (AF)
20-yr Total	**1,117,110**	**110,000**	**30,000**	**80,000**	**80,203**	**-8,750**
Average	55,860	5,500	1,500	4,000	4,010	-440
Median	30,740	5,500	1,500	4,000	4,010	-450
Min	10,730	5,500	1,500	4,000	3,970	-480
Max	226,230	5,500	1,500	4,000	4,060	-340

[1] Includes both lake and pond surfaces
*** See Attachment E-5 for table of annual results**

Augmentation to the streamflow due to the RCWD agreement added an average annual surface flow of 2,500 AF, allowing 4,000 AFY to be diverted to the recharge ponds during the entire period of record. The median flow in the river increased by over 3,000 AFY, also providing the necessary water supply for diversion to the recharge ponds.

E.4.2 ALTERNATIVE 2: NEW DIVERSION DAM, NEW HEADGATE, AND IMPROVED CHANNEL

A reservoir operations model was used to estimate the rate of diversion from the Santa Margarita River to both the recharge ponds and Lake O'Neill for Alternative 2 projects. The model used 1980 to 1999 hydrology in order to construct streamflow at a point located below the confluence of De Luz Creek and the Santa Margarita River. Applying daily estimates of streamflow and historical measurements of precipitation and evaporation, the reservoir operations model was used to predict the daily diversion during the historical period.

The Alternative 2 reservoir operations model was altered to reflect the effects of three major improvements to the system:

- New Obermeyer spillway gate system,
- Expanded headgate diversion structure from 100 cfs to 200 cfs,
- Expanded canal capacity from 60 cfs to 200 cfs.

Alternative 2 simulates the augmented flow diversion potential to Lake O'Neill and the recharge ponds. A schematic of the reservoir operations model shows simulated Alternative 2 diversion to Lake O'Neill and the recharge ponds (Figure E-7).

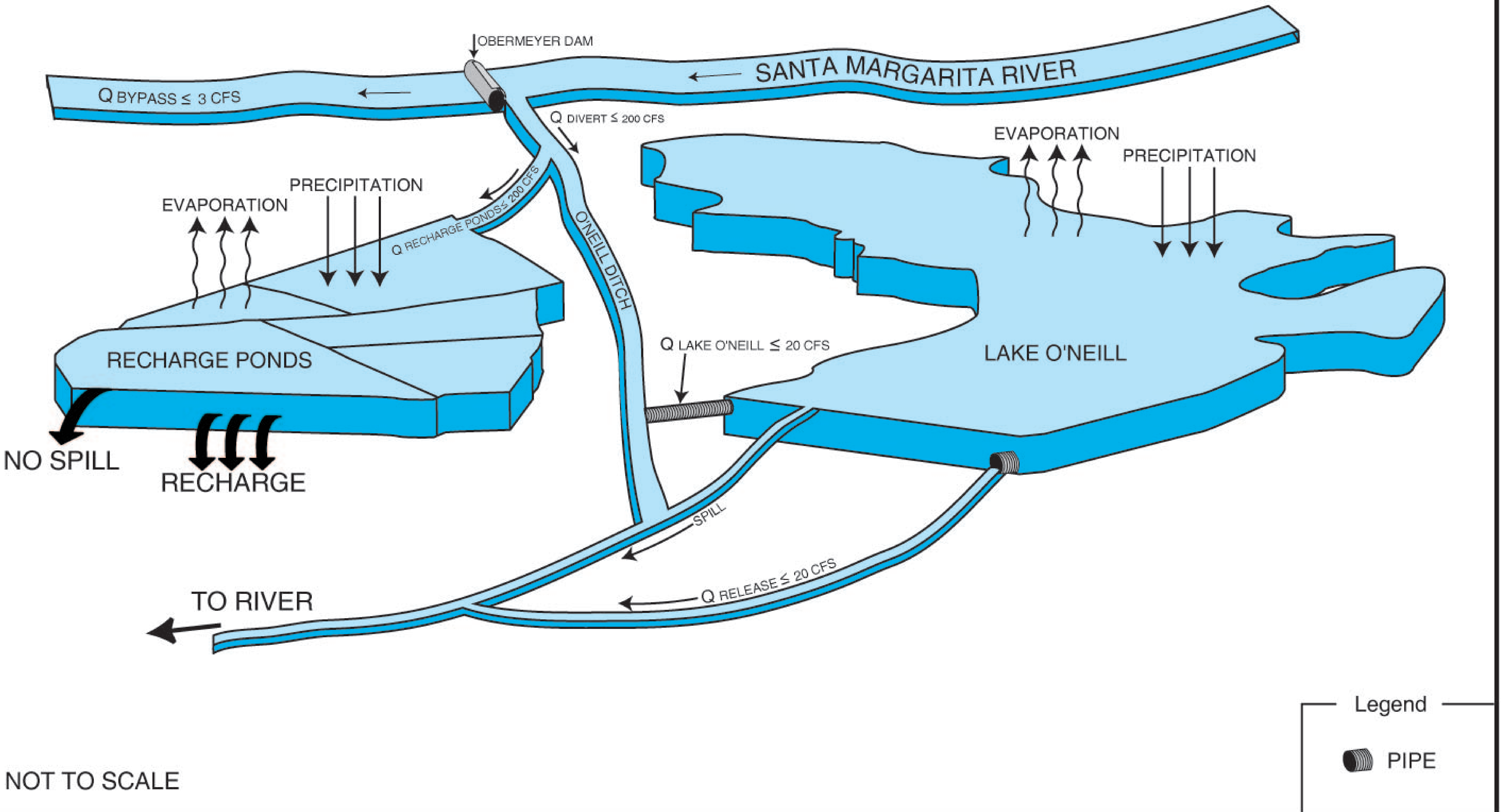
The timing of and quantity of diversions to Lake O'Neill in the Alternative 2 reservoir operations model is similar to the Alternative 1 Reservoir Operations model. An additional permit allows for winter diversions from the Santa Margarita River to Lake O'Neill, which were not previously permitted. The Lake O'Neill diversion schedule for Alternative 2 is outlined below.

- Beginning November 1st of every year, the lake is drained at a rate of 20 cfs. The lake water leaves the lake through a pipe and into a channel flowing towards the Santa Margarita River. Draining terminates once the volume of Lake O'Neill approaches 100 AF.

- December 1st marks the filling of Lake O'Neill with water from the Permit 15000 (License 21471B) water right. Flow is diverted from the Santa Margarita River into Lake O'Neill, at a rate of 20 cfs, until it fills to the current capacity of 1,200 AF. The effects of precipitation and evapotranspiration are applied such that in dry years it may take slightly over 1,200 AF to fill the lake, while in wet years it may take less than 1,200 AF.

- No water is diverted to Lake O'Neill between February 1st to May 30th. Precipitation and evaporation continue to lower and raise the water levels in the lake during this period. Flows from Fallbrook Creek are by-passed through the outlet.

- The reservoir operations model commences the use of the Pre-1914 water right from June 1st to October 31st, a time period that would optimize this water right given the last 20 years of streamflow records. The Pre-1914 water right allows for the diversion of 1,500 AFY to be diverted from the Santa Margarita River, to Lake O'Neill, at a maximum diversion rate of 20



STETSON ENGINEERS INC.

Surface Water Analysis
Resevoir Operations Model

Alternative 2

New Diversion Dam
Expanded Headgate
Improved Canal

FIGURE E-7

1828-324LakeGraph2.ILL

cfs. (This right is valid from April 1st to October 31st). During this time, Lake O'Neill may approach its capacity of 1,200 AF, and on occasion, spill water out of the lake via a spillway located on its northern side.

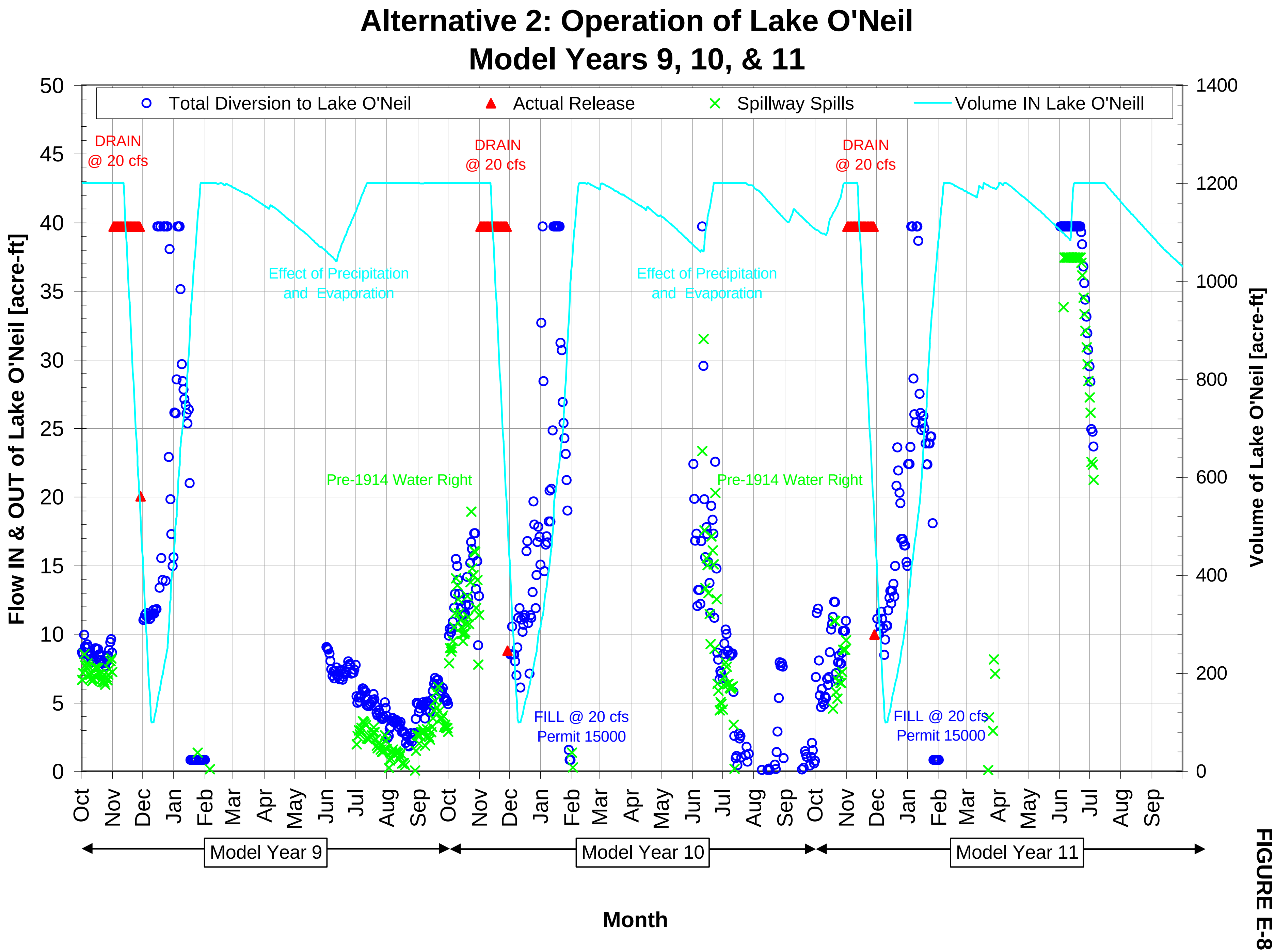
Alternative 2 operations model allows for the filling of Lake O'Neill exclusively from water diverted from the Santa Margarita River. Fallbrook Creek is allowed to bypass Lake O'Neill completely, helping to recharge the ground-water basin below the percolation ponds. The Pre-1914 water right is fully maximized and is only dependent upon the non-winter baseflow of the Santa Margarita River. Permit 15000 water diverted to Lake O'Neill during the winter is allowed to recharge the ground-water basin as it is released from Lake O'Neill in the summer depending on the availability of pre-1914 water.

A post-1978 Pendleton Public Works Survey Department drawing (1978) was used to construct a surface area to volume curve, which was used to calculate the change in Lake O'Neill storage (Figure E-4). Fluctuations in the storage volume for Lake O'Neill, due to the effective evaporation and precipitation, may provide more room for the pre-1914 water in dry years, or may cause spilling during wet years when rain is falling on the already full lake. Table E-19 below describes the diversion schedule, rates, and limitations to Lake O'Neill. Figure E-8 shows a graphical example of the reservoir operations model output for Lake O'Neill for model years 9 through 11.

TABLE E- 19: ALTERNATIVE 2 - DIVERSION SCHEDULE TO THE LAKE O'NEILL

Month	Activity	Rate	Limit	Permit
Nov	Drain	$Q_{release}$ <= 20 cfs	Min Volume = 100 AF	
Dec to Jan	Fill	$Q_{Lake\ O'Neill}$ <= 20 cfs	Max Volume = 1,200 AF	Permit 15000
Feb to May	Precip/Evap	Q_{spill} = f(precip/evap)	N/A	
June to Oct	Fill	$Q_{Lake\ O'Neill}$ <= 20 cfs	No spill of Pre 1914 water	Pre 1914 Water Right

The capacity of the recharge ponds remains the same as in Alternative 1 (Table E-16), but the diversion schedule to the recharge ponds has two notable changes (Table E-20). First, the increased canal capacity allows 200 cfs to be diverted from the Santa Margarita River into the



Alternative 2: Operation of Lake O'Neil
Model Years 9, 10, & 11
Total Diversion to Lake O'Neil
Actual Release
Spillway Spills
Volume IN Lake O'Neill
DRAIN @ 20 cfs
DRAIN @ 20 cfs
DRAIN @ 20 cfs
Effect of Precipitation and Evaporation
Effect of Precipitation and Evaporation
Pre-1914 Water Right
Pre-1914 Water Right
FILL @ 20 cfs Permit 15000
FILL @ 20 cfs Permit 15000
Flow IN & OUT of Lake O'Neil [acre-ft]
Volume of Lake O'Neil [acre-ft]
Model Year 9
Model Year 10
Model Year 11
Month

FIGURE E-8

recharge ponds. Second, part B of Permit 15000 will allow for a greater amount of water to be diverted from the Santa Margarita River for use in the recharge ponds. The total volume diverted to the ponds is limited by the maximum infiltration potential. Once the ponds are full, the flow into the ponds equals the total infiltration rate so that there is no spilling from the final pond.

TABLE E- 20: ALTERNATIVE 2 - DIVERSION SCHEDULE TO RECHARGE PONDS

Month	Activity	Rate	Limit	Water Right[1]
Nov	Fill w/ 100% Q_{divert}	$Q_{recharge\ ponds}$ <= 200 cfs	No Spill	Permit 15000
Dec to Jan	Fill w/ $Q_{divert} - Q_{Lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs	No Spill	Permit 15000
Feb to May	Fill w/ 100% Q_{divert}	$Q_{recharge\ ponds}$ <= 200 cfs	No Spill	Permit 15000
Jun	Fill w/ $Q_{divert} - Q_{Lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs	No Spill	Permit 15000
Jul to Sept	No Diversion	$Q_{recharge\ ponds}$ = 0 cfs	N/A	N/A
Oct	Fill w/ $Q_{divert} - Q_{Lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs s	No Spill	Permit 15000

[1] Note: The first 4,000 AFY is attributed to Permit 15000, License 10494 while the remaining diversion to the recharge ponds would be developed under Permit 15000, Application 21571B.

The simulated performance of the reservoir operations model for Alternative 2 with augmented flows is shown in Tables E-21.

TABLE E- 21: ALTERNATIVE 2 - AUGMENTED FLOW OBERMEYER DAM, NEW HEADGATE, AND IMPROVED CHANNEL

Model Years 1-20	Augmented Flow Santa Margarita River (AF)	Total Diversion Max 200 cfs (AF)	Diversion to Lake O'Neill (AF)	Diversion to Recharge Ponds (AF)	Recharge to Ground Water (AF)	Net Precip (+) Evap (-) [1] (AF)
Total	**1,117,110**	**210,430**	**50,520**	**159,910**	**159,020**	**-7,910**
Average	55,860	10,520	2,530	8,000	7,950	-400
Median	30,740	10,880	2,610	8,270	8,220	-400
Min	10,730	6,420	2,000	4,420	4,400	-270
Max	226,230	14,120	2,640	11,500	11,470	-480

[1] Includes both lake and pond surfaces
*** See Attachment E-5 for table of annual results**

The benefit of the new diversion dam and increased channel capacity allows for an average annual diversion that is 5,020 AFY greater than Alternative 1. Approximately 10,500 AFY of water can be diverted annually from the Santa Margarita River with an average of almost 8,000 AFY of this water going to the recharge ponds each year.

Total diversions to Lake O'Neill, under the Pre-1914 water right, change from the Alternative 1 baseline conditions due to summer-time diversions to Lake O'Neill. The Alternative 2 facilities and augmented flows do allow for a higher diversion potential during most years, because of Permit 15000's diversion license. Table E-22 below highlights the maximum potential water available for diversion and the amount of water that was actually diverted under the Alternative 2 conditions. Note that during model years 8 to 11, the total diversion potential equals the actual Pre-1914 water diverted. During these dry years it is imperative to effectively divert the maximum potential in order to fully utilize the Pre-1914 water right. All diversions are based on a maximum rate of 20 cfs.

TABLE E- 22: ALTERNATIVE 2 - DIVERSIONS TO THE RECHARGE PONDS AND LAKE O'NEILL (AFY)

Model Year	Maximum Divertable Water Potential from June 1st –Oct. 31st.	Pre-1914 Water Diverted to Lake O'Neill from June 1st-Oct. 31st	Permit 15000 Water Diverted to Lake O'Neill from Dec.1st-Jan.31st	Total Diversion to Lake O'Neill
1	5,590	1,500	1,130	2,630
2	3,340	1,500	1,130	2,630
3	3,580	1,500	1,120	2,620
4	4,720	1,500	1,120	2,620
5	3,350	1,500	1,110	2,610
6	3,150	1,500	1,100	2,600
7	1,840	1,500	1,130	2,630
8	1,090	1,090	1,130	2,220
9	1,490	1,490	1,100	2,600
10	890	890	1,110	2,000
11	1,040	1,040	1,120	2,160
12	3,520	1,500	1,130	2,630
13	3,900	1,500	1,090	2,590
14	4,080	1,500	1,080	2,580
15	2,020	1,500	1,140	2,640
16	3,790	1,500	1,060	2,560
17	1,200	1,202	1,130	2,340
18	1,580	1,500	1,110	2,610
19	4,200	1,500	1,130	2,630
20	1,790	1,500	1,140	2,640
Total	**56,160**	**28,220**	**22,300**	**50,520**
Average	2,810	1,410	1,120	2,530
Median	3,240	1,500	1,120	2,610
Min	890	890	1,060	2,000
Max	5,590	1,500	1,140	2,640

E.4.3 ALTERNATIVE 3: NEW DIVERSION DAM, NEW HEADGATE, IMPROVED CHANNEL, AND NEW RECHARGE PONDS

A reservoir operations model was used to estimate the rate and amount of surface diversion from the Santa Margarita River to both the recharge ponds and Lake O'Neill for Alternative 3 projects. The model used 1980 to 1999 hydrology in order to construct streamflow at a point below the confluence of De Luz Creek and the Santa Margarita River. Applying daily estimates of streamflow and historical measurements of precipitation and evaporation, the reservoir operations model was used to predict the daily diversion during the historical period.

The Alternative 3 reservoir operations model was altered to reflect the effects of adding four major improvements to the system:

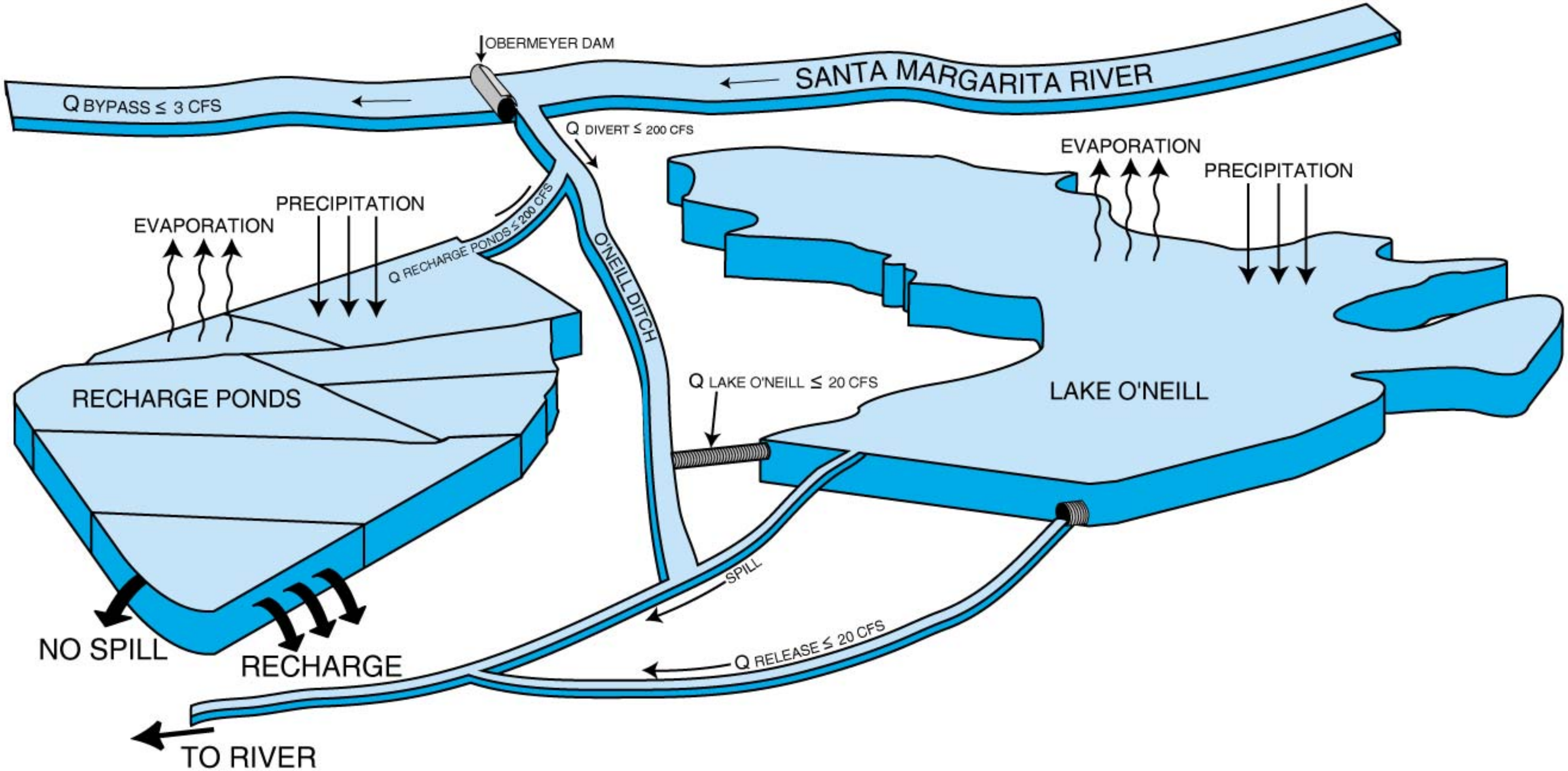
- new Obermeyer spillway gate system,
- expanded headgate diversion structure from 100 cfs to 200 cfs,
- expanded canal capacity from 60 cfs to 200 cfs.
- two new additional ground-water recharge ponds.

The reservoir operations model for Alternative 3 is similar to Alternative 2 except for the addition of two recharge ponds. The proposed ponds increase the total storage capacity of all recharge ponds by more than 240 AF and increase the area of infiltration by 46 acres (Table E-23).

TABLE E- 23: VOLUME OF RECHARGE PONDS 1-7

POND #	1	2	3	4	5	6	7	Sub Total
Surface Area (Acre)	13.9	7.0	7.0	16.5	4.66	33.3	12.6	**95.00**
Depth (Feet)	5	7.5	6.5	6.5	8	5.0	6.0	**-**
Water Volume (AF)	**69.5**	**52.5**	**45.5**	**107.3**	**37.6**	**166.5**	**75.6**	**554.45**

The diversion schedule to the recharge ponds is the same as in Alternative 2 (see Table E-20). A schematic of the reservoir operations model can be seen in Figure E-9.



Legend

PIPE

NOT TO SCALE

STETSON ENGINEERS INC.

Surface Water Analysis
Resevoir Operations Model

Alternative 3

New Diversion Dam
Expanded Headgate
Improved Canal
New Recharge Ponds

FIGURE E-9

1828-324LakeGraph3.ILL

The addition of ponds 6 and 7 allows the Base to divert a greater quantity of water from the Santa Margarita River for use in the recharge ponds, due to the increase storage capacity and infiltration rate. Once the ponds have been filled from the initial storm event, the total volume diverted to the ponds is limited by the maximum infiltration potential. Due to the increase in wetted area and storage capacity, the existing and future ponds will be able to infiltrate a sustained inflow of 80 cfs, during the months of January and February, without spilling (Table E-24). The maximum sustained infiltration rate without the construction of the new ponds would be limited to 40 cfs.

TABLE E-24: FLOW RATE TO MAINTAIN FULL RECHARGE PONDS (CFS)

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
Pond 1	9.81	9.81	7.71	5.61	3.50	1.40	1.40	1.40	1.40	1.40	9.81	9.81	**63.07**
Pond 2	5.29	5.29	4.76	4.24	3.71	3.18	3.18	3.18	3.18	3.18	5.29	5.29	**49.76**
Pond 3	5.65	5.65	5.65	4.24	3.71	3.18	3.18	3.18	3.18	3.18	5.29	5.29	**51.35**
Pond 4	14.97	14.97	14.97	9.98	8.73	7.49	7.49	7.49	7.49	7.49	12.48	12.48	**126.03**
Pond 5	4.27	4.27	4.27	2.84	2.49	2.13	2.13	2.13	2.13	2.13	3.55	3.55	**35.90**
Total (Ponds 1-5)	**40.0**	**40.0**	**37.4**	**26.9**	**22.1**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**36.4**	**36.4**	**326.1**
Pond 6	30.2	30.2	30.2	20.1	17.6	15.1	15.1	15.1	15.1	15.1	25.2	25.2	**254.35**
Pond 7	11.4	11.4	11.4	7.6	6.7	5.7	5.7	5.7	5.7	5.7	9.5	9.5	**96.24**
Total (Ponds 1-7)	**81.6**	**81.6**	**79.0**	**54.7**	**46.4**	**38.2**	**38.2**	**38.2**	**38.2**	**38.2**	**71.1**	**71.1**	**676.7**

The simulated performance of the reservoir operations model for Alternative 3 with augmented flows is shown in Table E-25. The proposed recharge ponds make available an average of almost 7,000 AF of additional recharge to ground water as compared to the average augmented baseline condition. The incremental increase in the average water diverted to the recharge ponds is approximately 4,000 AFY greater than Alternative 1. The average annual diversions to Lake O'Neill increase by approximately 1,000 AFY compared with Alternative 1.

TABLE E- 25: ALTERNATIVE 3 AUGMENTED FLOW
OBERMEYER DAM, NEW HEADGATE, IMPROVED CHANNEL, NEW RECHARGE PONDS

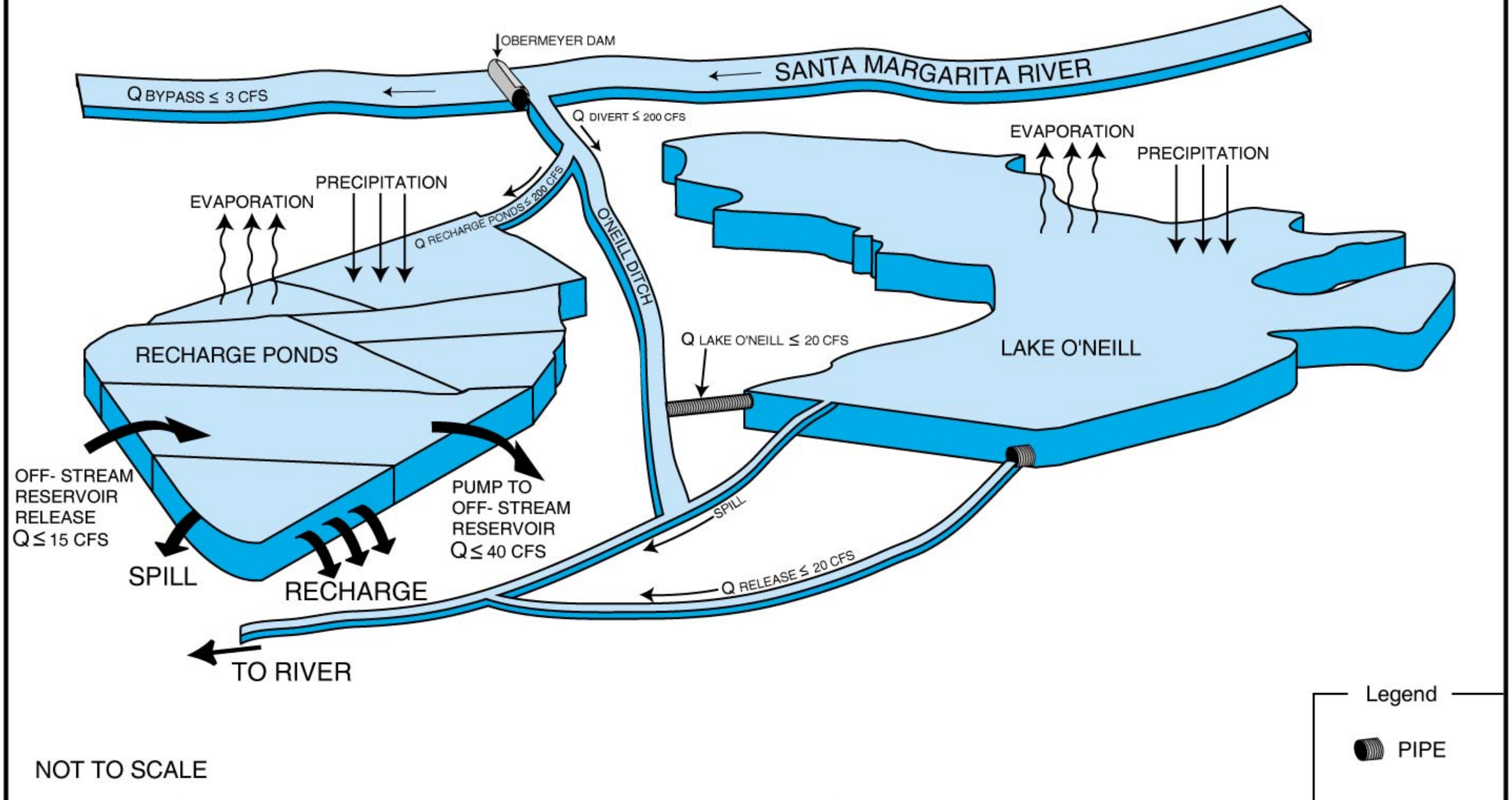
Model Years 1-20	Augmented Flow Santa Margarita River (AF)	Total Diversion Max 200 cfs (AF)	Diversion to Lake O'Neill (AF)	Diversion to Recharge Ponds (AF)	Recharge to Ground Water (AF)	Net Precip (+) Evap (-)[1] (AF)
20-yr Total	**1,117,110**	**269,920**	**50,520**	**219,400**	**218,720**	**-8,120**
Average	55,860	13,500	2,530	10,970	10,940	-410
Median	30,740	13,270	2,610	10,650	10,590	-420
Min	10,730	6,540	2,000	4,540	4,540	-290
Max	226,230	21,840	2,640	19,220	19,190	-490

[1] includes lake and pond surface
* See Attachment E-6 for table of annual results

E.4.4 ALTERNATIVE 4: NEW DIVERSION DAM, NEW HEADGATE, IMPROVED CHANNEL, NEW RECHARGE PONDS WITH 4,800 AF OF OFF STREAM STORAGE

The reservoir operations model for Alternative 4 is the same as for Alternative 3 with a maximized diversion scheme to allow the final recharge pond to overflow and spill. This spilled water will be pumped out of pond No. 6 to be made available for off-stream storage. This alternative maximizes the amount of water diverted from the Santa Margarita River to fill Lake O'Neill and the recharge ponds while sending any excess water to a 4,800 AF of off stream storage site for use during drought periods. A schematic of the reservoir operations model can be seen in Figure E-10.

The diversion schedule and total diversion to Lake O'Neill remains the same as in Alternative 2 and 3 (Table E-19). The percolation pond volumes and infiltration rates remain the same as in Alternative 3. Diversions to the recharge ponds are maximized such that excess water may be pumped to the reservoir at a rate up to 162-cfs (channel capacity minus the minimum infiltration flow rate). The diversion schedule to the recharge ponds is shown in Table E-26.



STETSON ENGINEERS INC.

Surface Water Analysis
Resevoir Operations Model

Alternative 4

New Diversion Dam
Expanded Headgate
Improved Canal
New Recharge Ponds
Off Stream Storage

FIGURE E-10

TABLE E- 26: DIVERSION SCHEDULE TO RECHARGE PONDS AND OFF-STREAM STORAGE

Month	Activity	Rate	Reservoir Diversion	Water Right[1]
Nov	Fill w/ 100% Q_{divert}	$Q_{recharge\ ponds}$ <= 200 cfs	RSVR <= 162 cfs	Permit 15000
Dec to Jan	Fill w/ $Q_{divert} - Q_{Lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs	RSVR <= 162 cfs	Permit 15000
Feb to May	Fill w/ 100% Q_{divert}	$Q_{recharge\ ponds}$ <= 200 cfs	RSVR <= 162 cfs	Permit 15000
Jun	Fill w/ $Q_{divert} - Q_{Lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs	RSVR <= 162 cfs	Permit 15000
Jul to Sept	No Diversion	$Q_{recharge\ ponds}$ = 0 cfs	N/A	N/A
Oct	Fill w/ $Q_{divert} - Q_{Lake\ O'Neill}$	$Q_{recharge\ ponds}$ <= 200 cfs s	RSVR <= 162 cfs	Permit 15000

[1] **Note: The first 4,000 AFY is attributed to Permit 15000, License 10494 while the remaining diversion to the recharge ponds would be developed under Permit 15000, Application 21571B.**

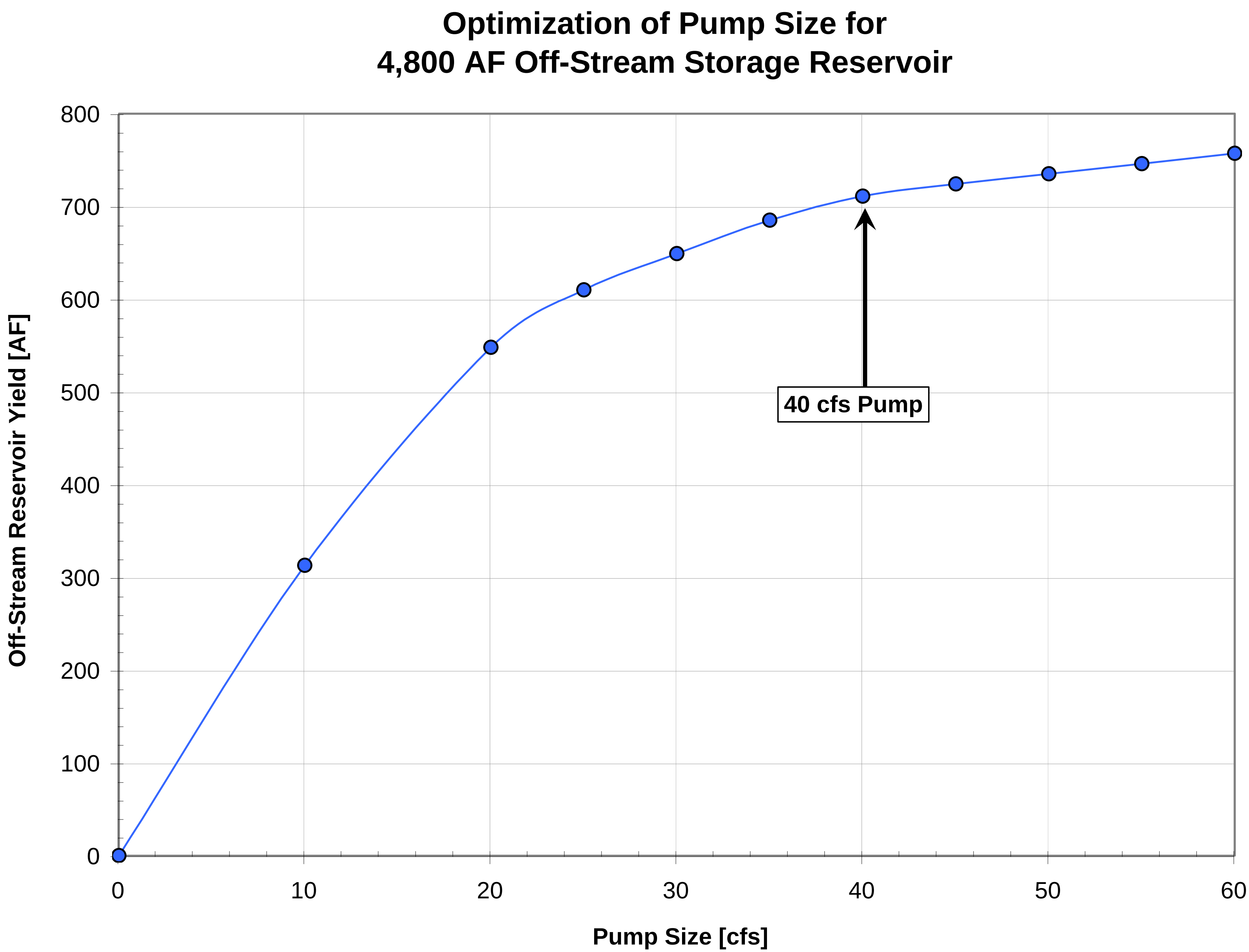
The off-stream storage operations model described below will articulate the diversion limitations for alternative 4.

E.4.4.1 Off-Stream Storage Operations Model

An off-stream storage operations model was developed for alternative four to evaluate the potential yield of the off-stream storage reservoir as it pertained to the three different pumping scenarios; F2, F3, and 90%F3 (see Appendix D).

The off-stream storage operations model accounts for the pumping of water from the recharge ponds up to the reservoir when the ponds reach a maximum capacity. A 40 cfs pump relieves the recharge ponds of their excess water, and may pump water to the reservoir until it fills its 4,800 AF capacity. The pump size was chosen based on an optimization curve (shown in Figure E-11) derived from running multiple scenarios of the off-stream storage operations model. The reservoir is not annually drained. Water is allowed to accumulate through out wet years so that is may be available during periods of drought. Water from the reservoir is released to the recharge pons when the ground-water table is low.

The release of water from the reservoir back into the recharge ponds (reservoir yield) is governed by the ground-water model's simulation of ground-water levels. If the water surface elevation in the target well falls below 80 feet mean sea level (msl) (12 feet below ground surface) in any month; the reservoir will release 10 cfs (19.8 AF/day) to Recharge Pond 6 during that month. If the water surface elevation in the ground water well falls below 75 feet msl (17



Optimization of Pump Size for
4,800 AF Off-Stream Storage Reservoir
800
700
600
500
400
300
200
100
0
Off-Stream Reservoir Yield [AF]
40 cfs Pump
0
10
20
30
40
50
60
Pump Size [cfs]

FIGURE E-11

feet below ground surface) in any month, the reservoir will release 15 cfs (29.8 AF/day) to Recharge Pond 6 during that month. Water will be released from the reservoir to ease the depleted ground-water levels as long as water is available in the reservoir.

The reservoir yield that is released into pond 6 experiences minimal loses. Since the minimum infiltration rate of pond 6 is 15.1 cfs (Table E-24), the pond will be able to exercise its maximum infiltration flow rate to allow for complete recharge of all reservoir releases. At no time does Pond 6 reach a maximum capacity at the same time as the reservoir release fills it. Therefore, there is always room for the reservoir releases to recharge to the ground water. The allowable flow from the recharge ponds is limited to the ability of the pump to transfer water to the off-stream storage reservoir as well as the capability of the reservoir to store the excess water. The GIS contours of the reservoir design provided a surface area to volume curve used to calculate the change in storage (Figure E-12). Fluctuations in the storage volume for the reservoir, due to the effective evaporation and precipitation, may provide more room for the pumped water from the recharge ponds, or cause a limited amount of spill due to rain falling on the already full reservoir.

Tables E-27, E-28, and E-29 show the summary of results for each of the three pumping scenarios. The augmented flow in the Santa Margarita River and the diversions to Lake O'Neill remain the same as Alternative 3 (Table E-25) for each of the pumping scenarios. The actual diversion from the Santa Margarita River to fulfill the pumping requirements, the effect of precipitation and evaporation on the reservoir, and the reservoir releases to Pond 6 change for each scenario.

TABLE E- 27: ALTERNATIVE 4 AUGMENTED FLOW ANNUAL SUMMARY OF OFF STREAM STORAGE FOR PUMPING SCENARIO F2

Model Years 1-20	Actual Diversion from Santa Margarita River to Recharge Ponds (AF)	Diversion to Off-Stream Storage Reservoir (AF)	Precip Falling on Reservoir (AF)	Loss to Evaporation on Reservoir (AF)	Volume IN Reservoir on Oct. 1st of every year (AF)	Release from Reservoir to Recharge Pond 6 (YIELD) (AF)
Total	**248,120**	**28,170**	**680**	**5,750**	**N/A**	**22,910**
Average	12,410	1,410	30	290	1,770	1,150
Median	11,110	350	30	330	970	830
Min	4,540	0	0	0	0	0
Max	23,880	4,850	90	630	4,500	3,590

*** See Attachment E-7 for table of annual results**

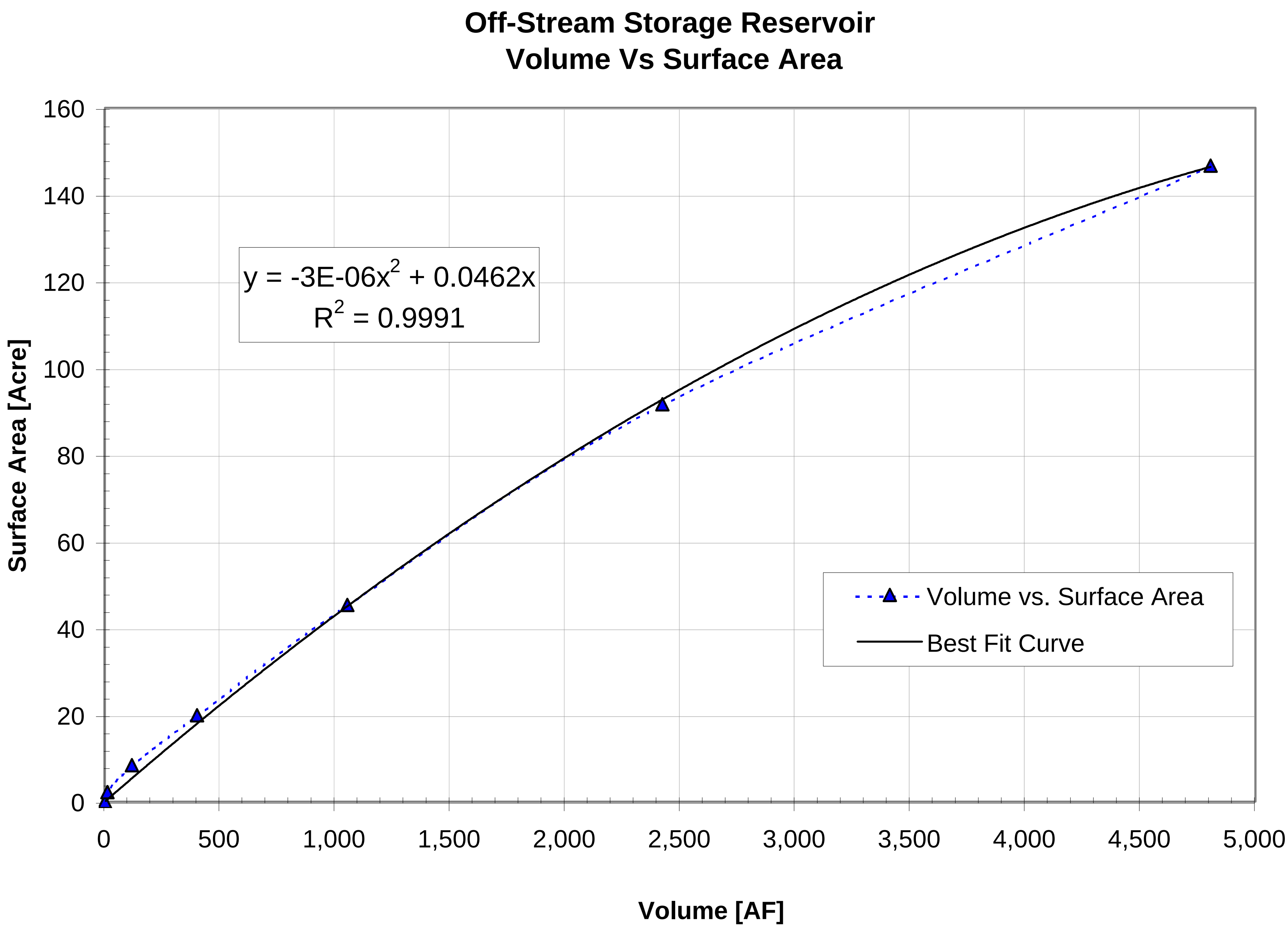

Off-Stream Storage Reservoir
Volume Vs Surface Area
Surface Area [Acre]
160
140
120
100
80
60
40
20
0
y = -3E-06x2 + 0.0462x
R2 = 0.9991
Volume vs. Surface Area
Best Fit Curve
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
Volume [AF]

FIGURE E-12

TABLE E- 28: ALTERNATIVE 4 AUGMENTED FLOW ANNUAL Summary of Off Stream Storage for Pumping Scenario F3

Model Years 1-20	Actual Diversion from Santa Margarita River to Recharge Ponds (AF)	Diversion to Off-Stream Storage Reservoir (AF)	Precip Falling on Reservoir (AF)	Loss to Evaporation on Reservoir (AF)	Volume IN Reservoir on Oct. 1st of every year (AF)	Release from Reservoir to Recharge Pond 6 (YIELD) (AF)
Total	**248,120**	**28,170**	**680**	**5,810**	**N/A**	**22,890**
Average	12,410	1,410	30	290	1,790	1,140
Median	11,110	350	30	330	1,040	900
Min	4,540	0	0	0	0	0
Max	23,880	4,850	90	630	4,500	3,590

*** See Attachment E-8 for table of annual results**

TABLE E- 29: ALTERNATIVE 4 AUGMENTED FLOW ANNUAL SUMMARY OF OFF STREAM STORAGE FOR PUMPING SCENARIO 90%F3

Model Years 1-20	Actual Diversion from Santa Margarita River to Recharge Ponds (AF)	Diversion to Off-Stream Storage Reservoir (AF)	Precip Falling on Reservoir (AF)	Loss to Evaporation on Reservoir (AF)	Volume IN Reservoir on Oct. 1st of every year (AF)	Release from Reservoir to Recharge Pond 6 (YIELD) (AF)
Total	**243,920**	**23,780**	**1,330**	**8,160**	**N/A**	**14,230**
Average	12,200	1,190	70	410	2,430	710
Median	11,110	350	40	520	3,090	30
Min	4,540	0	0	0	0	0
Max	23,510	4,850	280	680	4,500	3,050

*** See Attachment E-9 for table of annual results**

The Alternative 4 with the F3 pumping scenario was compared to the baseline condition to assess the added benefits of the proposed off-stream storage reservoir. The simulated performance of the reservoir operations model for the Alternative 4 with the F3 pumping scenario is shown in Table E-30. The average annual diversions from the Santa Margarita River increased 9,200 AFY from the augmented baseline conditions. The total diversion to Lake O'Neill remains the same as in Alternatives 2 to 3. The proposed recharge ponds and off-stream storage operations make available an average of approximately 8,000 AFY of additional recharge to ground water as compared to the average augmented baseline condition. Based on the added diversions, there is the potential to store and average annual volume of 1,440AFY in off-stream storage. Note that the diversion and spill from the recharge ponds is presented in the Table E-30 as potential diversion and spill.

TABLE E- 30: ALTERNATIVE 4 AUGMENTED FLOW
OBERMEYER DAM, NEW HEADGATE, IMPROVED CHANNEL, NEW RECHARGE PONDS, AND OFF STREAM STORAGE W/ F3 PUMPING

Model Years 1-20	Augmented Flow Santa Margarita River (AF)	Total Potential Diversion Max 200 cfs (AF)	Diversion to Lake O'Neill (AF)	Diversion to Recharge Ponds (AF)	Diversion to Reservoir (AF)	Release from Reservoir to Pond 6 (AF)	Recharge to Ground Water[1] (AF)	Net Precip (+) Evap (-)[2] (AF)
20-yr Total	**117,110**	**298,640**	**50,520**	**219,950**	**28,170**	**22,890**	**241,600**	**-14,590**
Average	55,860	14,930	2,530	11,000	1,410	1,140	12,080	-730
Median	30,740	13,730	2,610	10,650	350	900	11,760	-720
Min	10,730	6,540	2,000	4,540	0	0	4,540	-430
Max	226,230	26,500	2,640	19,220	4,850	3,590	19,810	-1,090

[1] Includes Reservoir release to Pond 6
[2] Includes lake, pond, and reservoir surfaces

APPENDIX E
ATTACHMENTS

ATTACHMENT E-1

Recorded Precipitation from

Oceanside Rainfall Gage in Southern California

Provided by the Desert Research Institute: Hourly and Daily Data Sets

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TOTAL
1980	0.80	0.90	0.40	10.10	7.50	5.10	0.90	0.10	-	-	0.10	-	**25.90**
1981	0.50	-	1.20	1.70	1.90	3.00	0.60	-	-	-	-	-	**8.90**
1982	0.10	2.20	0.90	4.20	1.20	5.30	0.90	0.10	0.10	-	-	1.10	**16.10**
1983	0.10	2.30	2.10	3.00	3.10	7.20	2.80	0.30	-	-	0.30	1.60	**22.80**
1984	1.10	2.90	3.30	-	0.20	-	0.30	-	0.10	-	-	-	**7.90**
1985	0.50	1.50	4.50	0.90	1.30	0.40	0.20	-	-	-	-	0.10	**9.40**
1986	0.20	5.00	1.60	1.00	3.70	3.50	1.00	-	-	-	-	2.30	**18.30**
1987	0.70	1.50	-	1.00	0.10	-	-	-	-	0.20	0.10	-	**3.60**
1988	2.80	0.70	3.00	1.70	1.40	-	2.90	0.10	-	-	0.40	-	**13.00**
1989	-	1.90	4.10	0.50	0.90	1.10	-	0.30	-	-	-	0.31	**9.11**
1990	0.35	0.20	-	1.80	1.80	0.40	1.30	0.60	0.60	-	-	-	**7.05**
1991	-	0.30	0.10	1.00	2.40	6.20	-	-	-	0.10	-	-	**10.10**
1992	0.40	-	2.40	2.80	4.40	3.20	0.10	0.20	-	0.10	-	-	**13.60**
1993	0.20	-	2.40	11.30	2.10	1.40	-	-	0.50	-	-	-	**17.90**
1994	-	-	0.39	0.42	2.90	-	0.50	0.10	-	-	0.10	-	**4.41**
1995	-	-	0.20	10.40	0.50	2.50	1.80	0.10	0.40	0.10	-	-	**16.00**
1996	-	-	0.40	1.70	1.90	0.80	0.20	-	-	-	-	-	**5.00**
1997	0.90	2.60	2.70	5.40	0.40	-	0.20	-	-	-	-	0.80	**13.00**
1998	-	1.90	1.60	-	8.50	-	-	0.20	-	0.10	-	-	**12.30**
1999	0.30	1.20	0.60	-	0.80	-	1.20	-	0.40	1.40	-	-	**5.90**
Total	**8.95**	**25.10**	**31.89**	**58.92**	**47.00**	**40.10**	**14.90**	**2.10**	**2.10**	**2.00**	**1.00**	**6.21**	**240.27**
Average	0.45	1.26	1.59	2.95	2.35	2.01	0.75	0.11	0.11	0.10	0.05	0.31	**12.01**
Median	0.25	1.05	1.40	1.70	1.85	0.95	0.40	0.05	-	-	-	-	**11.20**
Min	-	-	-	-	0.10	-	-	-	-	-	-	-	**3.60**
Max	2.80	5.00	4.50	11.30	8.50	7.20	2.90	0.60	0.60	1.40	0.40	2.30	**25.90**

EASTERN Minor Tributary Sub-Basin
Soil Types, Hydrologic Group, and Curve Number

Cover		Hydrologic Soil Group			
Land Use	Hydrologic Condition	A	B	C	D
Pasture or Range	FAIR	49	69	79	84

(1) GROUP	(2) SOIL	(3) Hydrologic Soil Group	(4) CN	(5) ACRES	(6) % OF TOTAL	(7) Fraction of TOTAL CN
EAST	C1G2	C	79	112.22	2.36%	1.87
EAST	DAD	D	84	59.74	1.26%	1.06
EAST	DAE	D	84	72.33	1.52%	1.28
EAST	FAC2	B	69	23.60	0.50%	0.34
EAST	FAD2	B	69	46.45	0.98%	0.67
EAST	FAE2	B	69	39.45	0.83%	0.57
EAST	FEE2	B	69	14.58	0.31%	0.21
EAST	GAE	D	84	139.09	2.93%	2.46
EAST	GAF	D	84	969.34	20.41%	17.15
EAST	GRA	B	69	5.96	0.13%	0.09
EAST	GRB	B	69	14.08	0.30%	0.20
EAST	LEC	D	84	13.90	0.29%	0.25
EAST	LEC2	D	84	12.58	0.26%	0.22
EAST	LED	D	84	119.09	2.51%	2.11
EAST	LED2	D	84	93.19	1.96%	1.65
EAST	LEE	D	84	84.20	1.77%	1.49
EAST	LEE2	D	84	428.96	9.03%	7.59
EAST	LSE	C	79	21.58	0.45%	0.36
EAST	LSF	C	79	1323.64	27.87%	22.02
EAST	OHC	D	84	114.98	2.42%	2.03
EAST	OHF	D	84	2.01	0.04%	0.04
EAST	RCE	B	69	25.28	0.53%	0.37
EAST	RM	A	49	2.95	0.06%	0.03
EAST	SBA	B	69	14.31	0.30%	0.21
EAST	SBC	B	69	132.75	2.80%	1.93
EAST	SCB	B	69	44.17	0.93%	0.64
EAST	STG	C	79	58.20	1.23%	0.97
EAST	TEF	B	69	356.87	7.51%	5.18
EAST	TUB	A	49	62.09	1.31%	0.64
EAST	VAA	B	69	38.93	0.82%	0.57
EAST	VAB	B	69	119.08	2.51%	1.73
EAST	VAC	B	69	24.02	0.51%	0.35
EAST	VAD	B	69	52.36	1.10%	0.76
EAST	VBC	B	69	42.10	0.89%	0.61
EAST	VSE	B	69	65.07	1.37%	0.95
EAST	**TOTAL**			**4749.15**	**100.00%**	**78.58**

Column Legend

(1) Eastern Sub-Basins draining into the Santa Margarita River (Sub-Basins 11-19)
(2) SCS Soil Classification
(3) Hydrologic Soil Group as defined by the National Engineering Handbook (USDA SCS)
(4) Runoff Curve Numbers for hydrologic soil-cover complexes
(5) Acres of each soil type found on the Eastern Drainage Area
(6) Acres of each soil type / Acres of the entire Eastern Drainage Area * 100
(7) Defined CN * % of Total Acreage

ATTACHMENT E-2

WESTERN Minor Tributary Sub-Basin
Soil Types, Hydrologic Group, and Curve Number

Cover		Hydrologic Soil Group			
Land Use	Hydrologic Condition	A	B	C	D
Pasture or Range	FAIR	49	69	79	84

GROUP	SOIL	Hydrologic Soil Group	CN	ACRES	% OF TOTAL	Fraction of TOTAL CN
WEST	C1G2	C	79	133.22	1.89%	1.50
WEST	CME2	C	79	19.29	0.27%	0.22
WEST	CMRG	C	79	833.19	11.84%	9.35
WEST	CNG2	C/B	74	73.69	1.05%	0.77
WEST	DAC	D	84	172.76	2.45%	2.06
WEST	DAD	D	84	499.31	7.09%	5.96
WEST	DAE	D	84	615.32	8.74%	7.34
WEST	DAE2	D	84	44.75	0.64%	0.53
WEST	DAF	D	84	173.22	2.46%	2.07
WEST	FAC	B	69	49.99	0.71%	0.49
WEST	FAC2	B	69	125.47	1.78%	1.23
WEST	FAD2	B	69	405.12	5.76%	3.97
WEST	FAE2	B	69	293.68	4.17%	2.88
WEST	FEE2	B	69	646.96	9.19%	6.34
WEST	GAF	D	84	471.53	6.70%	5.63
WEST	GRB	B	69	19.83	0.28%	0.19
WEST	GRC	B	69	8.38	0.12%	0.08
WEST	HRC	C	79	76.82	1.09%	0.86
WEST	HRD	C	79	20.83	0.30%	0.23
WEST	HRE2	C	79	37.55	0.53%	0.42
WEST	LEC	D	84	147.89	2.10%	1.76
WEST	LED	D	84	144.42	2.05%	1.72
WEST	LED2	D	84	132.41	1.88%	1.58
WEST	LEE	D	84	8.04	0.11%	0.10
WEST	LEE2	D	84	47.35	0.67%	0.57
WEST	LEE3	D	84	317.68	4.51%	3.79
WEST	M1C	C	79	105.57	1.50%	1.18
WEST	RAC2	B	69	59.10	0.84%	0.58
WEST	RM	A	49	8.33	0.12%	0.06
WEST	SCB	B	69	13.81	0.20%	0.14
WEST	TEF	B	69	718.83	10.21%	7.05
WEST	TUB	A	49	31.03	0.44%	0.22
WEST	VAB	B	69	27.88	0.40%	0.27
WEST	VAC	B	69	81.04	1.15%	0.79
WEST	VAD	B	69	0.19	0.00%	0.00
WEST	VSC	B	69	178.62	2.54%	1.75
WEST	VSE	B	69	200.42	2.85%	1.96
WEST	VSE2	B	69	95.66	1.36%	0.94
WEST	**TOTAL**			**7039.18**	**100.00%**	**76.60**

Column Legend
(1) Western Sub-Basins draining into the Santa Margarita River (Sub-Basins 21-31)
(2) SCS Soil Classification
(3) Hydrologic Soil Group as defined by the National Engineering Handbook (USDA SCS)
(4) Runoff Curve Numbers for hydrologic soil-cover complexes: Land Cover
(5) Acres of each soil type found on the Western Drainage Area
(6) Acres of each soil type / Acres of the entire Western Drainage Area * 100
(7) Defined CN * % of Total Acreage

Potential Diversion from the Santa Margarita River
Water Years 1925 to 1999

		Diversion Goal [cfs] 25				Diversion Goal [cfs] 60				Diversion Goal [cfs] 100				Diversion Goal [cfs] 150				Diversion Goal [cfs] 200				Diversion Goal [cfs] 250				Diversion Goal [cfs] 350				Diversion Goal [cfs] 450				Diversion Goal [cfs] 600			
Water Year	Annual Historical Flow [acre-ft]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]	Total Diversion [acre-ft]	Median Flow [cfs]	Average Flow [cfs]	Flow >= Goal [days]
1925	4,434	2,420	1	3	2	2,496	1	3	1	2,575	1	4	2	2,582	1	4	0	2,582	1	4	0	2,582	1	4	0	2,582	1	4	0	2,582	1	4	0	2,582	1	4	0
1926	14,513	3,897	5	5	17	4,764	5	7	9	5,348	5	7	17	5,928	5	8	5	6,424	5	9	5	6,920	5	10	5	7,809	5	11	3	8,404	5	12	3	9,297	5	13	3
1927	92,717	6,562	7	9	63	9,445	7	13	26	10,988	7	15	63	12,265	7	17	11	13,169	7	18	8	13,945	7	19	7	15,293	7	21	6	16,317	7	23	5	17,618	7	24	4
1928	6,014	4,166	3	6	5	4,231	3	6	0	4,231	3	6	5	4,231	3	6	0	4,231	3	6	0	4,231	3	6	0	4,231	3	6	0	4,231	3	6	0	4,231	3	6	0
1929	5,071	3,338	4	5	3	3,345	4	5	0	3,345	4	5	3	3,345	4	5	0	3,345	4	5	0	3,345	4	5	0	3,345	4	5	0	3,345	4	5	0	3,345	4	5	0
1930	9,596	4,231	2	6	27	5,503	2	8	11	6,110	2	8	27	6,451	2	9	3	6,667	2	9	2	6,866	2	9	2	7,195	2	10	1	7,393	2	10	1	7,486	2	10	0
1931	5,699	3,012	3	4	5	3,269	3	5	3	3,382	3	5	5	3,482	3	5	1	3,581	3	5	1	3,642	3	5	0	3,642	3	5	0	3,642	3	5	0	3,642	3	5	0
1932	42,921	7,070	6	10	59	10,230	6	14	34	12,668	6	17	59	14,938	6	21	19	16,660	6	23	17	18,015	6	25	12	19,913	6	27	8	21,499	6	30	8	23,638	6	33	6
1933	8,108	5,069	6	7	12	5,450	6	8	3	5,688	6	8	12	5,921	6	8	1	5,936	6	8	0	5,936	6	8	0	5,936	6	8	0	5,936	6	8	0	5,936	6	8	0
1934	5,506	3,031	3	4	5	3,237	3	4	2	3,328	3	5	5	3,382	3	5	0	3,382	3	5	0	3,382	3	5	0	3,382	3	5	0	3,382	3	5	0	3,382	3	5	0
1935	8,845	4,879	5	7	25	5,778	5	8	9	6,287	5	9	25	6,600	5	9	2	6,718	5	9	1	6,723	5	9	0	6,723	5	9	0	6,723	5	9	0	6,723	5	9	0
1936	8,042	3,523	3	5	19	4,160	3	6	6	4,469	3	6	19	4,767	3	7	3	5,053	3	7	2	5,252	3	7	2	5,467	3	8	1	5,665	3	8	1	5,963	3	8	1
1937	90,418	10,397	12	14	138	17,941	12	25	87	23,929	12	33	138	29,760	12	41	52	34,465	12	48	43	38,347	12	53	36	44,483	12	61	26	48,710	12	67	18	53,103	12	73	12
1938	109,744	10,865	12	15	98	15,792	12	22	51	19,247	12	27	98	22,325	12	31	26	24,599	12	34	22	26,697	12	37	21	30,355	12	42	16	33,165	12	46	13	36,125	12	50	9
1939	26,642	10,719	12	15	102	14,105	12	19	27	15,773	12	22	102	16,911	12	23	9	17,801	12	25	8	18,455	12	25	5	19,423	12	27	4	20,217	12	28	4	21,113	12	29	3
1940	19,149	8,806	11	12	48	10,392	11	14	12	11,216	11	15	48	12,001	11	17	6	12,596	11	17	6	13,091	11	18	4	13,885	11	19	4	14,678	11	20	4	15,227	11	21	1
1941	94,700	12,799	18	18	143	20,749	18	29	98	27,744	18	38	143	35,296	18	49	66	41,053	18	57	52	45,764	18	63	45	53,182	18	73	32	58,945	18	81	25	65,029	18	90	19
1942	18,434	12,102	19	17	119	14,968	19	21	18	15,763	19	22	119	16,086	19	22	2	16,262	19	22	0	16,262	19	22	0	16,262	19	22	0	16,262	19	22	0	16,262	19	22	0
1943	72,588	9,991	11	14	98	15,574	11	22	62	19,503	11	27	98	22,469	11	31	23	24,548	11	34	19	26,255	11	36	16	28,963	11	40	13	31,254	11	43	10	33,846	11	47	6
1944	25,135	10,438	12	14	70	13,170	12	18	24	14,789	12	20	70	16,046	12	22	7	16,685	12	23	6	17,280	12	24	6	18,470	12	25	6	19,340	12	27	3	20,232	12	28	3
1945	17,862	9,477	12	13	54	11,818	12	16	24	13,068	12	18	54	13,790	12	19	6	14,288	12	20	3	14,585	12	20	3	15,014	12	21	1	15,212	12	21	1	15,510	12	21	1
1946	12,996	6,611	9	9	22	7,403	9	10	7	7,920	9	11	22	8,334	9	12	4	8,638	9	12	3	8,935	9	12	3	9,530	9	13	3	10,125	9	14	3	10,661	9	15	1
1947	9,712	6,505	8	9	17	7,112	8	10	7	7,452	8	10	17	7,552	8	10	0	7,552	8	10	0	7,552	8	10	0	7,552	8	10	0	7,552	8	10	0	7,552	8	10	0
1948	7,342	4,903	6	7	5	5,123	6	7	3	5,165	6	7	5	5,165	6	7	0	5,165	6	7	0	5,165	6	7	0	5,165	6	7	0	5,165	6	7	0	5,165	6	7	0
1949	6,537	4,331	4	6	2	4,366	4	6	0	4,366	4	6	2	4,366	4	6	0	4,366	4	6	0	4,366	4	6	0	4,366	4	6	0	4,366	4	6	0	4,366	4	6	0
1950	4,330	2,349	3	3	0	2,349	3	3	0	2,349	3	3	0	2,349	3	3	0	2,349	3	3	0	2,349	3	3	0	2,349	3	3	0	2,349	3	3	0	2,349	3	3	0
1951	3,052	1,340	1	2	0	1,340	1	2	0	1,340	1	2	0	1,340	1	2	0	1,340	1	2	0	1,340	1	2	0	1,340	1	2	0	1,340	1	2	0	1,340	1	2	0
1952	54,694	5,642	3	8	59	8,642	3	12	35	10,973	3	15	59	13,025	3	18	18	14,730	3	20	16	16,316	3	22	16	18,846	3	26	10	20,763	3	29	9	23,441	3	32	9
1953	4,764	2,520	1	3	9	2,880	1	4	3	3,061	1	4	9	3,074	1	4	0	3,074	1	4	0	3,074	1	4	0	3,074	1	4	0	3,074	1	4	0	3,074	1	4	0
1954	10,013	3,333	0	5	23	4,447	0	6	12	5,175	0	7	23	5,727	0	8	5	6,146	0	8	4	6,543	0	9	4	7,209	0	10	2	7,588	0	10	1	7,886	0	11	1
1955	4,128	2,171	0	3	4	2,304	0	3	1	2,383	0	3	4	2,482	0	3	1	2,580	0	4	0	2,580	0	4	0	2,580	0	4	0	2,580	0	4	0	2,580	0	4	0
1956	2,291	676	0	1	3	865	0	1	1	944	0	1	3	1,044	0	1	1	1,143	0	2	1	1,155	0	2	0	1,155	0	2	0	1,155	0	2	0	1,155	0	2	0
1957	2,389	1,131	0	2	6	1,420	0	2	2	1,535	0	2	6	1,583	0	2	0	1,583	0	2	0	1,583	0	2	0	1,583	0	2	0	1,583	0	2	0	1,583	0	2	0
1958	33,417	3,579	0	5	46	5,946	0	8	27	7,777	0	11	46	9,633	0	13	17	11,319	0	16	17	12,807	0	18	14	15,158	0	21	11	17,120	0	24	9	19,688	0	27	8
1959	2,725	1,268	0	2	2	1,349	0	2	1	1,356	0	2	2	1,356	0	2	0	1,356	0	2	0	1,356	0	2	0	1,356	0	2	0	1,356	0	2	0	1,356	0	2	0
1960	2,330	1,150	0	2	0	1,150	0	2	0	1,150	0	2	0	1,150	0	2	0	1,150	0	2	0	1,150	0	2	0	1,150	0	2	0	1,150	0	2	0	1,150	0	2	0
1961	1,823	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0
1962	5,990	2,398	1	3	15	3,094	1	4	7	3,500	1	5	15	3,897	1	5	4	4,198	1	6	2	4,397	1	6	2	4,412	1	6	0	4,412	1	6	0	4,412	1	6	0
1963	4,244	834	0	1	4	1,058	0	1	3	1,221	0	2	4	1,419	0	2	2	1,558	0	2	1	1,658	0	2	1	1,856	0	3	1	2,054	0	3	1	2,352	0	3	1
1964	2,008	640	0	1	0	640	0	1	0	640	0	1	0	640	0	1	0	640	0	1	0	640	0	1	0	640	0	1	0	640	0	1	0	640	0	1	0
1965	3,015	806	0	1	7	1,127	0	2	3	1,291	0	2	7	1,477	0	2	1	1,499	0	2	0	1,499	0	2	0	1,499	0	2	0	1,499	0	2	0	1,499	0	2	0
1966	19,063	3,526	0	5	22	4,626	0	6	13	5,313	0	7	22	6,007	0	8	6	6,602	0	9	6	7,184	0	10	5	8,157	0	11	4	8,951	0	12	4	10,141	0	14	4
1967	14,755	4,845	5	7	26	5,924	5	8	11	6,678	5	9	26	7,363	5	10	4	7,760	5	11	4	8,157	5	11	4	8,950	5	12	4	9,743	5	13	4	10,753	5	15	2
1968	3,832	1,483	0	2	8	1,773	0	2	2	1,873	0	3	8	1,973	0	3	1	1,975	0	3	0	1,975	0	3	0	1,975	0	3	0	1,975	0	3	0	1,975	0	3	0
1969	103,952	6,245	2	9	80	10,311	2	14	49	13,612	2	19	80	16,759	2	23	25	19,173	2	26	24	21,381	2	30	21	24,990	2	35	17	28,362	2	39	17	32,805	2	45	13
1970	12,443	2,213	2	3	7	2,691	2	4	6	3,167	2	4	7	3,727	2	5	5	4,223	2	6	5	4,711	2	7	4	5,363	2	7	3	5,958	2	8	3	6,851	2	9	3
1971	4,590	1,927	1	3	7	2,279	1	3	4	2,564	1	4	7	2,701	1	4	1	2,738	1	4	0	2,738	1	4	0	2,738	1	4	0	2,738	1	4	0	2,738	1	4	0
1972	4,211	1,550	0	2	8	1,919	0	3	5	2,202	0	3	8	2,438	0	3	2	2,543	0	4	0	2,543	0	4	0	2,543	0	4	0	2,543	0	4	0	2,543	0	4	0
1973	9,475	3,554	3	5	22	4,725	3	7	12	5,380	3	7	22	5,762	3	8	3	6,060	3	8	3	6,357	3	9	3	6,866	3	9	2	7,262	3	10	2	7,684	3	11	0
1974	8,860	1,837	1	3	10	2,401	1	3	7	2,812	1	4	10	3,116	1	4	3	3,395	1	5	2	3,593	1	5	2	3,990	1	6	2	4,386	1	6	2	4,981	1	7	2
1975	4,297	1,841	1	3	12	2,389	1	3	2	2,522	1	3	12	2,550	1	4	0	2,550	1	4	0	2,550	1	4	0	2,550	1	4	0	2,550	1	4	0	2,550	1	4	0
1976	5,762	1,516	0	2	8	1,934	0	3	4	2,252	0	3	8	2,564	0	4	3	2,827	0	4	2	3,026	0	4	2	3,245	0	4	1	3,419	0	5	0	3,419	0	5	0
1977	3,848	1,295	0	2	7	1,616	0	2	4	1,897	0	3	7	2,031	0	3	1	2,130	0	3	1	2,164	0	3	0	2,164	0	3	0	2,164	0	3	0	2,164	0	3	0
1978	113,070	9,668	10	13	149	17,362	10	24	91	23,017	10	32	149	27,570	10	38	41	31,550	10	44	38	34,962	10	48	31	40,376	10	56	24	44,573	10	62	21	50,574	10	70	20
1979	45,716	10,583	9	15	144	16,742	9	23	57	20,050	9	28	144	22,951	9	32	24	24,942	9	34	16	26,327	9	36	12	28,213	9	39	9	29,748	9	41	7	31,638	9	44	6
1980	175,417	11,953	14	16	134	20,262	14	28	108	28,542	14	39	134	37,423	14	52	68	43,055	14	59	50	47,566	14	66	39	53,829	14	74	27	58,550	14	81	22	64,766	14	89	20
1981	21,149	11,599	15	16	66	13,064	15	18	13	14,022	15	19	12	15,036	15	21	9	15,898	15	22	8	16,387	15	23	4	17,180	15	24	4	17,973	15	25	4	18,583	15	26	1
1982	57,715	10,742	15	15	92	13,733	15	19	29	15,541	15	21	18	17,178	15	24	15	18,631	15	26	13	19,920	15	28	13	22,499	15	31	13	24,980	15	35	12	28,315	15	39	11
1983	82,811	12,817	20	18	145	20,463	20	28	90	26,230	20	36	57	30,863	20	43	41	34,345	20	47	32	37,133	20	51	25	40,863	20	56	16	44,036	20	61	16	48,150	20	67	12
1984	22,888	9,922	16	14	23	10,707	16	15	6	11,183	16	15	6	11,717	16	16	5	12,213	16	17	5	12,709	16	18	5	13,700	16	19	5	14,692	16	20	5	16,180	16	22	5
1985	20,450	8,603	11	12	42	9,933	11	14	11	10,669	11	15	7	11,363	11	16	7	12,023	11	17	6	12,618	11	17	6	13,703	11	19	5	14,667	11	20	4	15,302	11	21	2
1986	46,545	7,227	9	10	39	9,263	9	13	26	11,074	9	15	17	12,648	9	17	14	13,964	9	19	13	15,207	9	21	12	17,512	9	24	11	19,694	9	27	11	22,666	9	31	9
1987	12,246	4,269	5	6	11	4,711	5	7	4	4,976	5	7	3	5,216	5	7	2	5,414	5	7	2	5,612	5	8	2	6,009	5	8	2	6,406	5	9	2	7,001	5	10	2
1988	32,493	4,647	5	6	23	5,992	5	8	16	7,092	5	10	12	8,144	5	11	9	9,037	5	12	9	9,929	5	14	9	11,660	5	16	8	13,247	5	18	8	15,627	5	22	8
1989	16,267	3,657	3	5	12	4,376	3	6	9	5,047	3	7	7	5,671	3	8	6	6,266	3	9	6	6,861	3	9	6	8,051	3	11	6	9,241	3	13	6	11,026	3	15	6
1990	9,256	4,875	6	7	15	5,511	6	8	6	5,928	6	8	4	6,201	6	9	3	6,551	6	9	2	6,744	6	9	1	6,943	6	10	1	7,141	6	10	1	7,241	6	10	0
1991	53,443	8,062	6	11	69	11,136	6	15	29	12,878	6	18	17	13,358	6	18	13	15,604	6	22	12	16,628	6	23	10	18,424	6	25	8	19,839	6	27	6	21,460	6	30	5
1992	32,767	9,345	10	13	92	12,813	10	18	34	14,746	10	20	21	15,102	8	21	14	17,764	10	25	11	18,854	10	26	10	20,751	10	29	9	22,142	10	31	5	23,630	10	33	5
1993	224,666	11,949	19	17	174	23,082	19	32	149	33,120	19	46	103	39,579	17	55	70	47,649	19	66	55	52,627	19	73	47	60,787	19	84	37	67,069	19	93	29	74,795	19	103	23
1994	16,866	8,275	9	11	46	10,029	9	14	16	10,983	9	15	10	11,424	9	16	7	12,486	9	17	3	12,726	9	18	2	13,123	9	18	2	13,519	9	19	2	14,115	9	19	2
1995	99,762	10,846	16	15	158	19,903	16	27	116	27,912	16	39	85	33,101	8	46	56	39,287	16	54	45	43,258	16	60	36	49,086	16	68	24	53,271	16	74	19	58,162	16	80	14
1996	11,910	6,497	9	9	28	7,541	9	10	11	8,253	9	11	8	8,662	9	12	4	9,094	9	13	3	9,265	9	13	1	9,463	9	13	1	9,661	9	13	1	9,743	9	13	0
1997	21,060	7,260	6	10	137	10,291	6	14	50	11,753	6	16	26	12,622	6	17	22	13,841	6	19	14	14,494	6	20	12	15,384	6	21	8	15,987	6	22	6	16,818	6	23	4
1998	100,677	10,848	14	15	146	19,577	14	27	102	26,451	14	37	77	30,878	9	43	52	37,128	14	51	42	40,688	14	56	31	45,843	14	63	23	49,870	14	69	18	54,858	14	76	16
1999	9,365	6,345	8	9	18	7,006	8	10	4	7,178	8	10	0	6,707	7	9	0	7,178	8	10	0	7,178	8	10	0	7,178	8	10	0	7,178	8	10	0	7,178	8	10	0
TOTAL	2,285,565	421,078	455	581	3,316	575,390	455	794	1,715	686,239	455	947	2,470	774,865	438	1,070	831	856,606	455	1,183	671	916,384	455	1,265	559	1,010,754	455	1,395	424	1,086,585	455	1,500	356	1,179,243	455	1,628	283
Min	1,823	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0	275	0	0	0
Max	224,666	12,817	20	18	174	23,082	20	32	149	33,120	20	46	149	39,579	20	55	70	47,649	20	66	55	52,627	20	73	47	60,787	20	84	37	67,069	20	93	29	74,795	20	103	23
Average	30,474	5,614	6	8	44	7,672	6	11	23	9,150	6	13	33	10,332	6	14	11	11,421	6	16	9	12,218	6	17	7	13,477	6	19	6	14,488	6	20	5	15,723	6	22	4
Median	12,246	4,845	5	7	22	5,511	5	8	9	6,110	5	8	12	6,451	5	9	4	6,667	5	9	3	6,920	5	10	2	7,552	5	10	2	7,588	5	10	2	7,886	5	11	1

ATTACHMENT E-4

ALTERNATIVE 1
Annual Summary Table

NO PROJECT

Diversion Capacity (To Recharge Ponds) =	60	(cfs)	
Diversion To Lake O'Neill =	20	(cfs)	
Release Rate from Lake O'Neill =	20	(cfs)	
Lake O'Neilll Water Right Limitation =	1500	(Acre-Feet)	Pre-1914 Water Right
Recharge Ponds Water Right Limitation =	4000	(Acre-Feet)	Permit 15000

1980-1999 Period of Record Water Years	Augmented Flow Santa Margarita River (Acre-Feet)	Total Diversion Max 60 cfs (Acre-Feet)	Diversion to Lake O'Neill HISTORICAL (Acre-Feet)	Diversion to Recharge Ponds NO SPILL (Acre-Feet)	Precip Gain ON recharge ponds (Acre-Feet)	Recharge to Ground Water FROM Recharge Ponds (Acre-Feet)	Spill from Recharge Ponds NO SPILL (Acre-Feet)	Loss to Evaporation FROM Recharge Ponds (Acre-Feet)
1980	178,619	5,500	1,500	4,000	106	4,063	0	43
1981	23,681	5,500	1,500	4,000	36	3,995	0	41
1982	60,142	5,500	1,500	4,000	66	4,026	0	40
1983	85,762	5,500	1,500	4,000	93	4,043	0	50
1984	26,903	5,500	1,500	4,000	32	3,999	0	34
1985	23,418	5,500	1,500	4,000	38	4,002	0	36
1986	49,250	5,500	1,500	4,000	75	4,036	0	39
1987	14,680	5,500	1,500	4,000	15	3,974	0	40
1988	34,578	5,500	1,500	4,000	53	4,010	0	43
1989	18,417	5,500	1,500	4,000	37	3,990	0	47
1990	10,725	5,500	1,500	4,000	29	3,978	0	51
1991	56,515	5,500	1,500	4,000	41	4,002	0	40
1992	35,748	5,500	1,500	4,000	56	4,017	0	39
1993	226,232	5,500	1,500	4,000	73	4,041	0	32
1994	18,604	5,500	1,500	4,000	18	3,985	0	33
1995	101,364	5,500	1,500	4,000	65	4,031	0	34
1996	14,371	5,500	1,500	4,000	20	3,985	0	35
1997	23,035	5,500	1,500	4,000	53	4,022	0	31
1998	103,149	5,500	1,500	4,000	50	4,019	0	31
1999	11,922	5,500	1,500	4,000	24	3,984	0	40

Water Year	Augmented Flow Santa Margarita River (Acre-Feet)	Total Diversion Max 60 cfs (Acre-Feet)	Diversion to Lake O'Neill HISTORICAL (Acre-Feet)	Diversion to Recharge Ponds NO SPILL (Acre-Feet)	Precip Gain ON recharge ponds (Acre-Feet)	Recharge to Ground Water FROM Recharge Ponds (Acre-Feet)	Spill from Recharge Ponds NO SPILL (Acre-Feet)	Loss to Evaporation FROM Recharge Ponds (Acre-Feet)
Total	**1,117,114**	**110,000**	**30,000**	**80,000**	**983**	**80,203**	**0**	**780**
Average	55,856	5,500	1,500	4,000	49	4,010	0	39
Median	30,741	5,500	1,500	4,000	46	4,006	0	39
Min	10,725	5,500	1,500	4,000	15	3,974	0	31
Max	226,232	5,500	1,500	4,000	106	4,063	0	51

ATTACHMENT E-5

ALTERNATIVE 2
Annual Summary Table

OBERMEYER DAM
Augmented Flow Conditions

Diversion Capacity (To Recharge Ponds) =	**200**	**(cfs)**	
Diversion To Lake O'Neill =	**20**	**(cfs)**	
Release Rate from Lake O'Neill =	**20**	**(cfs)**	
Lake O'Neill Water Right Limitation =	**1500**	**(Acre-Feet)**	**Pre-1914 Water Right**
Recharge Ponds Water Right Limitation =	***optimize***	**(Acre-Feet)**	**Permit 15000**

20-year Period of Record	Augmented Flow	Total Diversion	Diversion to Lake O'Neill	Diversion to Recharge Ponds	Precip Gain	Recharge to Ground Water	Spill from Recharge Ponds	Loss to Evaporation
Model Year	Santa Margarita River	Max 200 cfs	Optimize Pre-1914 Water Right	NO SPILL	ON recharge ponds	FROM Recharge Ponds	NO SPILL	FROM Recharge Ponds
	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)
1	178,619	13,024	2,626	10,398	106	10,383	0	121
2	23,681	12,786	2,632	10,154	36	10,078	0	113
3	60,142	11,890	2,618	9,272	66	9,227	0	110
4	85,762	14,119	2,618	11,501	93	11,465	0	129
5	26,903	12,711	2,613	10,098	32	10,008	0	123
6	23,418	10,580	2,601	7,979	38	7,920	0	98
7	49,250	11,045	2,630	8,415	75	8,404	0	86
8	14,680	7,173	2,220	4,952	15	4,906	0	61
9	34,578	7,736	2,596	5,140	53	5,125	0	68
10	18,417	6,418	2,000	4,418	37	4,398	0	58
11	10,725	6,682	2,158	4,524	29	4,489	0	64
12	56,515	9,657	2,625	7,032	41	6,982	0	91
13	35,748	11,008	2,589	8,419	56	8,375	0	100
14	226,232	12,429	2,583	9,846	73	9,803	0	117
15	18,604	10,758	2,636	8,122	18	8,054	0	85
16	101,364	11,580	2,559	9,022	65	8,976	0	111
17	14,371	9,879	2,336	7,543	20	7,490	0	74
18	23,035	9,703	2,614	7,090	53	7,069	0	73
19	103,149	12,406	2,630	9,776	50	9,711	0	116
20	11,922	8,842	2,638	6,204	24	6,159	0	69

20-year Period of Record	Augmented Flow	Total Diversion	Diversion to Lake O'Neill	Diversion to Recharge Ponds	Precip Gain	Recharge to Ground Water	Spill from Recharge Ponds	Loss to Evaporation
Model Year	Santa Margarita River	Max 200 cfs	Optimize Pre-1914 Water Right	NO SPILL	ON recharge ponds	FROM Recharge Ponds	NO SPILL	FROM Recharge Ponds
	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)	(Acre-Feet)
Total	**1,117,114**	**210,426**	**50,521**	**159,905**	**983**	**159,021**	**0**	**1,868**
Average	55,856	10,521	2,526	7,995	49	7,951	0	93
Median	30,741	11,687	2,613	9,074	46	8,215	0	94
Min	10,725	6,474	2,000	4,474	15	4,398	0	58
Max	226,232	13,036	2,638	10,398	106	11,465	0	129

ATTACHMENT E-6

ALTERNATIVE 3
Annual Summary Table

NEW RECHARGE PONDS
Augmented Flow Conditions

Diversion Capacity (To Recharge Ponds) =	**200**	**(cfs)**	
Diversion To Lake O'Neill =	**20**	**(cfs)**	
Release Rate from Lake O'Neill =	**20**	**(cfs)**	
Lake O'Neill Water Right Limitation =	**1500**	**(Acre-Feet)**	**Pre-1914 Water Right**
Recharge Ponds Water Right Limitation =	***optimize***	**(Acre-Feet)**	**Permit 15000**

20-year Period of Record Model Year	Augmented Flow Santa Margarita River (Acre-Feet)	Total Diversion Max 200 cfs (Acre-Feet)	Diversion to Lake O'Neill Optimize Pre-1914 Water Right (Acre-Feet)	Diversion to Recharge Ponds NO SPILL (Acre-Feet)	Precip Gain ON recharge ponds (Acre-Feet)	Recharge to Ground Water FROM Recharge Ponds (1-7) (Acre-Feet)	Spill from Recharge Ponds NO SPILL (Acre-Feet)	Loss to Evaporation FROM Recharge Ponds (Acre-Feet)
1	178,619	19,855	2,626	17,229	205	17,241	0	192
2	23,681	14,333	2,632	11,701	70	11,631	0	140
3	60,142	14,961	2,618	12,343	127	12,310	0	161
4	85,762	21,839	2,618	19,222	181	19,193	0	210
5	26,903	13,222	2,613	10,609	63	10,540	0	132
6	23,418	10,803	2,601	8,202	74	8,167	0	110
7	49,250	13,619	2,630	10,989	145	11,023	0	110
8	14,680	7,239	2,220	5,019	29	4,983	0	65
9	34,578	8,381	2,596	5,785	103	5,803	0	85
10	18,417	6,540	2,000	4,540	72	4,544	0	68
11	10,725	7,098	2,158	4,940	56	4,920	0	76
12	56,515	13,325	2,625	10,700	80	10,641	0	138
13	35,748	14,881	2,589	12,292	108	12,251	0	149
14	226,232	21,115	2,583	18,533	142	18,470	0	204
15	18,604	12,656	2,636	10,019	35	9,953	0	101
16	101,364	19,055	2,559	16,497	127	16,440	0	183
17	14,371	11,225	2,336	8,889	40	8,840	0	88
18	23,035	10,186	2,614	7,572	103	7,587	0	88
19	103,149	20,624	2,630	17,994	97	17,892	0	199
20	11,922	8,961	2,638	6,323	47	6,287	0	82

20-year Period of Record Model Year	Augmented Flow Santa Margarita River (Acre-Feet)	Total Diversion Max 200 cfs (Acre-Feet)	Diversion to Lake O'Neill Optimize Pre-1914 Water Right (Acre-Feet)	Diversion to Recharge Ponds NO SPILL (Acre-Feet)	Precip Gain ON recharge ponds (Acre-Feet)	Recharge to Ground Water FROM Recharge Ponds (Acre-Feet)	Spill from Recharge Ponds NO SPILL (Acre-Feet)	Loss to Evaporation FROM Recharge Ponds (Acre-Feet)
Total	**1,117,114**	**269,918**	**50,521**	**219,397**	**1,902**	**218,718**	**0**	**2,581**
Average	55,856	13,496	2,526	10,970	95	10,936	0	129
Median	30,741	13,273	2,613	10,654	89	10,591	0	121
Min	10,725	6,540	2,000	4,540	29	4,544	0	65
Max	226,232	21,839	2,638	19,222	205	19,193	0	210

ALTERNATIVE 4
PUMPING SCENARIO F2
Annual Summary Table

OFF STREAM STORAGE OPERATION MODEL

Pumping Rate to Off-Stream Storage = 40 (cfs)
Reservroir Capacicty = 4800 (Acre-Feet)

20-year Period of Record Model Year	Actual Diversion from SMR to Recharge Ponds (Acre-Feet)	Actual Diversion to Off-Stream Storage (Acre-Feet)	Precip Falling on Reservoir (Acre-Feet)	Loss to Evaporation on Reservoir (Acre-Feet)	Volume IN Reservoir on Oct. 1st of every year (Acre-Feet)	Release from Reservoir to Recharge Pond 6 (YIELD) (Acre-Feet)
1	22,112	4,758	38	476	0	0
2	12,018	317	80	494	4,445	1,825
3	13,025	681	29	150	2,505	2,440
4	23,882	4,660	85	463	624	615
5	10,609	0	94	632	4,313	0
6	8,202	0	64	280	3,755	2,440
7	11,602	614	48	184	1,099	615
8	5,019	0	2	11	961	953
9	5,865	79	0	6	0	53
10	4,540	0	0	0	0	0
11	4,958	18	0	0	0	0
12	11,997	1,298	3	120	0	314
13	13,287	995	9	140	826	819
14	23,506	4,758	29	510	851	843
15	10,407	388	35	466	4,500	2,727
16	21,367	4,759	41	504	1,700	1,679
17	8,890	1	41	435	4,429	3,035
18	7,572	0	1	8	971	964
19	22,940	4,845	26	497	0	0
20	6,323	0	50	378	4,476	3,590

20-year Period of Record Model Year	Actual Diversion from SMR to Recharge Ponds (Acre-Feet)	Actual Diversion to Off-Stream Storage (Acre-Feet)	Precip Falling on Reservoir (Acre-Feet)	Loss to Evaporation on Reservoir (Acre-Feet)	Volume IN Reservoir on Oct. 1st of every year (Acre-Feet)	Release from Reservoir to Recharge Pond 6 (YIELD) (Acre-Feet)
Total	248,122	28,171	675	5,754	n/a	22,911
Average	12,406	1,409	34	288	1,773	1,146
Median	11,106	353	32	329	966	831
Min	4,540	0	0	0	0	0
Max	23,882	4,845	94	632	4,500	3,590

ALTERNATIVE 4
PUMPING SCENARIO F3
Annual Summary Table

OFF STREAM STORAGE OPERATION MODEL

Pumping Rate to Off-Stream Storage = 40 (cfs)
Reservroir Capacicty = 4800 (Acre-Feet)

20-year Period of Record Model Year	Actual Diversion from SMR to Recharge Ponds (Acre-Feet)	Actual Diversion to Off-Stream Storage (Acre-Feet)	Precip Falling on Reservoir (Acre-Feet)	Loss to Evaporation on Reservoir (Acre-Feet)	Volume IN Reservoir on Oct. 1st of every year (Acre-Feet)	Release from Reservoir to Recharge Pond 6 (YIELD) (Acre-Feet)
1	22,112	4,758	38	476	0	0
2	12,018	317	80	494	4,445	1,825
3	13,025	681	29	150	2,505	2,440
4	23,882	4,660	85	463	624	615
5	10,609	0	94	632	4,313	0
6	8,202	0	64	280	3,755	2,440
7	11,602	614	48	184	1,099	615
8	5,019	0	2	11	961	953
9	5,865	79	0	8	0	52
10	4,540	0	0	0	0	0
11	4,958	18	0	3	0	0
12	11,997	1,298	7	161	0	0
13	13,287	995	9	146	1,124	1,110
14	23,506	4,758	29	510	851	843
15	10,407	388	35	466	4,500	2,727
16	21,367	4,759	41	504	1,700	1,679
17	8,890	1	41	435	4,429	3,035
18	7,572	0	1	8	971	964
19	22,940	4,845	26	497	0	0
20	6,323	0	50	378	4,476	3,590

20-year Period of Record Model Year	Actual Diversion from SMR to Recharge Ponds (Acre-Feet)	Actual Diversion to Off-Stream Storage (Acre-Feet)	Precip Falling on Reservoir (Acre-Feet)	Loss to Evaporation on Reservoir (Acre-Feet)	Volume IN Reservoir on Oct. 1st of every year (Acre-Feet)	Release from Reservoir to Recharge Pond 6 (YIELD) (Acre-Feet)
Total	248,122	28,171	680	5,805	n/a	22,887
Average	12,406	1,409	34	290	1,788	1,144
Median	11,106	353	32	329	1,035	898
Min	4,540	0	0	0	0	0
Max	23,882	4,845	94	632	4,500	3,590

ALTERNATIVE 4
PUMPING SCENARIO 90% F3
Annual Summary Table

OFF STREAM STORAGE OPERATION MODEL

Pumping Rate to Off-Stream Storage = 40 (cfs)
Reservroir Capacicty = 4800 (Acre-Feet)

20-year Period of Record Model Year	Actual Diversion from SMR to Recharge Ponds (Acre-Feet)	Actual Diversion to Off-Stream Storage (Acre-Feet)	Precip Falling on Reservoir (Acre-Feet)	Loss to Evaporation on Reservoir (Acre-Feet)	Volume IN Reservoir on Oct. 1st of every year (Acre-Feet)	Release from Reservoir to Recharge Pond 6 (YIELD) (Acre-Feet)
1	22,112	4,758	38	476	0	0
2	12,018	317	109	665	4,445	0
3	12,985	558	190	666	4,207	0
4	19,718	391	283	680	4,373	0
5	10,609	0	96	647	4,472	0
6	8,202	0	105	592	3,921	0
7	11,602	614	169	529	3,414	615
8	5,019	0	30	250	3,073	2,833
9	5,865	79	0	10	0	0
10	4,540	0	0	0	50	50
11	4,958	18	0	3	0	0
12	11,997	1,298	7	161	16	0
13	13,287	995	10	158	1,144	1,099
14	23,506	4,758	30	520	871	834
15	10,407	388	44	568	4,500	1,230
16	21,367	4,759	55	547	3,114	3,054
17	8,890	1	49	522	4,429	1,825
18	7,572	0	15	34	2,102	2,093
19	22,940	4,845	26	497	0	0
20	6,323	0	70	639	4,476	595

20-year Period of Record Model Year	Actual Diversion from SMR to Recharge Ponds (Acre-Feet)	Actual Diversion to Off-Stream Storage (Acre-Feet)	Precip Falling on Reservoir (Acre-Feet)	Loss to Evaporation on Reservoir (Acre-Feet)	Volume IN Reservoir on Oct. 1st of every year (Acre-Feet)	Release from Reservoir to Recharge Pond 6 (YIELD) (Acre-Feet)
Total	**243,917**	**23,778**	**1,326**	**8,161**	**n/a**	**14,229**
Average	12,196	1,189	66	408	2,430	711
Median	11,106	353	41	521	3,094	25
Min	4,540	0	0	0	0	0
Max	23,506	4,845	283	680	4,500	3,054