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July 17, 2015

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LEGAL
DEPT OF WATER RESOURCES

Sharon Scantlebury
Docket Supervisor
Arizona Department of Water Resources
3550 North Central Avenue
Phoenix, AZ 85012

Re: Designating a Subsequent Irrigation Non-Expansion Area for the San Simon Valley Sub-Basin

Dear Ms. Scantlebury:

This firm represents Farmers Investment Co. ("FICO"). These comments are being submitted on FICO's behalf and supplement the comments that FICO submitted to the Arizona Department of Water Resources ("ADWR") on May 16, 2015. FICO is a family farm with pecan growing and processing operations located in the Santa Cruz River Valley south of Tucson and the San Simon Valley. In the San Simon Valley, FICO has over 3,000 acres in production and employs the best available technologies in order to conserve water, such as laser leveling, GPS-guided tractors, and highly efficient micro sprayer irrigation systems, which allows FICO to use less water per acre on its San Simon Valley farm than was used to irrigate the crops previously grown on the land. Nevertheless, groundwater pumping throughout the San Simon Valley and the recent expansion of irrigated acreage in the area is depleting the accessible irrigation water in the aquifer and causing significant groundwater level declines.

In order to protect the water supply for farms and residents and the agricultural economy of the region, existing farmers in the San Simon Valley, including FICO, submitted a petition to ADWR to designate an Irrigation Non-Expansion Area ("INA") for the San Simon Valley Sub-basin ("Sub-basin"). As discussed below, the Director of ADWR may designate an INA for the Sub-basin, and should elect to do so, because the Sub-basin does not have sufficient groundwater to provide a reasonably safe supply for the irrigation of currently cultivated lands. According to the data prepared by ADWR, groundwater pumping at the current level exceeds the annual rate of recharge, which is depleting the supply in the aquifer. In addition, due to historic groundwater pumping and the increased demand caused by recent expansions in the amount of irrigated acreage, the depth to groundwater beneath the areas that contain most of the cultivated lands in the Sub-basin is rapidly increasing. Finally, although the quantity of groundwater stored in the

Sub-basin has been estimated to be as high as 25,000,000 acre-feet, the attached analysis of the groundwater conditions of the San Simon Valley indicates that current demands on the aquifer will lower groundwater levels to an average depth of 370 feet by 2075, at which point the costs of lifting groundwater will be too great for farmers to withdraw water to irrigate crops economically. *See* Evaluation of the San Simon Sub-basin as an Irrigation Non-expansion Area, Leonard Rice Engineers, Inc., at 22 (July 14, 2015) [hereinafter San Simon Sub-basin Report]. Therefore, FICO respectfully requests that the Director designate an INA for the San Simon Valley Sub-basin.

THE SAN SIMON VALLEY SUB-BASIN DOES NOT HAVE SUFFICIENT GROUNDWATER TO PROVIDE A REASONABLY SAFE SUPPLY FOR THE IRRIGATION OF CULTIVATED LANDS IN THE AREA

The Director may designate an INA if the Director determines that there is insufficient groundwater to provide a reasonably safe supply for irrigation of the cultivated lands at current rates of withdrawal and regulation as an active management area ("AMA") is not necessary. A.R.S. § 45-432(A). The Sub-basin lacks sufficient groundwater to provide a reasonably safe supply for irrigation of currently cultivated acres, and thus an INA is appropriate for the Sub-basin, because recent increases in the amount of irrigated acreage and the growing water requirements of significant new orchard acres are depleting the groundwater in storage, groundwater levels are declining substantially in cultivated areas, and there are less than 100 years of economically recoverable irrigation water remaining with existing irrigation demands.

A. Recently Increased Amounts of Irrigated Acreage and the Extent of Pumping in the Sub-basin will Deplete the Aquifer.

Intensive agricultural development and groundwater withdrawals began occurring in the Sub-basin in the 1950s and steadily increased until the early 1980s. During the period of peak agricultural activity in the Sub-basin, which lasted from the 1970s through the early 1980s, approximately 35,000 acres were farmed and annual groundwater withdrawals ranged from 105,000 acre-feet to 139,000 acre-feet. Groundwater Flow Model of the San Simon Valley Sub-basin Technical Memorandum, Arizona Department of Water Resources, at 17-19 (June 17, 2015) [hereinafter ADWR Model]. Beginning in the early 1980s, the amount of irrigated acreage in the Sub-basin decreased and annual groundwater withdrawals have consistently ranged from around 45,000 acre-feet to 55,000 acre-feet until the present day. ADWR estimates that the groundwater in storage has already been depleted by more than 3.5 million acre-feet. ADWR Model at 30.

Although the amount of irrigated acreage in the Sub-basin declined from the peak levels of the 1970s and remained relatively stable for nearly 30 years, fallowed and raw desert lands have been rapidly brought into agriculture since 2010 and irrigated acreage in the Sub-basin has increased by 6,500 acres—or roughly 50%—to around 20,000 acres. San Simon Sub-basin Report at 9-10. Moreover, according to a 2014 USGS Crop Survey Summary, 63% of the agricultural lands in the Sub-basin are used to grow permanent orchard crops. *See* Hydrology and Water Use Data of the San Simon Valley Sub-Basin, Frank Corkhill, at 16 (May 16, 2015) [hereinafter ADWR Presentation]. Notably, about half of the orchard acres accounted for in the

USGS crop survey, which equates to more than 6,000 acres, were planted in the last five years. San Simon Sub-basin Report at 11.

As illustrated in the San Simon Sub-basin Report, the water requirements of newly planted orchards are low relative to those of mature orchards and other crops grown in the Sub-basin. However, by the time orchards reach maturity, their corresponding water requirements may more than double. San Simon Sub-basin Report at 11. Consequently, the pumping estimates relied upon in the ADWR Model, which suggest that pumping in the Sub-basin has remained stable despite the significant and sudden increase in irrigated acreage after 2010, do not reflect the true water demands of the cultivated lands in the Sub-basin. Rather, as the orchards planted since 2010 mature over the next 5 to 10 years, the amount of groundwater pumped in the Sub-basin for irrigation is projected to rise to around 66,500 acre-feet per year. San Simon Sub-basin Report at 9-11. Assuming that natural recharge in the Sub-basin is around 30,000 acre-feet per year as estimated in the ADWR Model and recharge from agricultural irrigation remains modest due to highly efficient modern irrigation practices, pumping groundwater to meet the irrigation demands of the cultivated lands in the Sub-basin will result in a sizable overdraft and continue to deplete the practicably usable quantity of water stored in the aquifer even if no new lands are cultivated in the future.

B. Groundwater Levels have Declined Significantly Throughout the Agricultural Areas of the Sub-basin.

ADWR's GWSI water level change data suggests that water levels are now declining in the Sub-basin overall by an average of 1.1 feet per year. GWSI Water Level Change Data for the San Simon Valley Sub-basin, ADWR Hydrology Division at 4 (June 1, 2015) [hereinafter GWSI Data]. However, the data also indicates that substantial water level declines are occurring in wells near the agricultural areas surrounding Bowie and San Simon. Indeed, according to the water level change data from 2007 to 2015, many individual wells located within the concentrated areas of cultivated lands south and east of San Simon, South of Olga, and surrounding Bowie have seen 20 to 111 foot water level declines in less than ten years. GWSI Data at 3-4. Therefore, the average rate of water level declines throughout the entire Sub-basin is not truly illustrative of the types of declines seen in the intensively irrigated portions of the Sub-basin, which are more relevant for purposes of determining whether the Sub-basin has enough groundwater to provide a reasonably safe supply for irrigation of the cultivated lands in the area.

In addition, ADWR's water level data and hydrographs demonstrate that water levels in the cultivated areas of the Sub-basin have declined by more than 150 feet, and in some cases more than 200 feet, since intensive agricultural development began in the 1950s. *See* ADWR Presentation at 24-32; Final Water Level Data for the San Simon Valley Sub-Basin. Because pumping activity in the Sub-basin will increase during the next 5 to 10 years to meet the irrigation demands of recently planted orchards and is likely to remain at higher levels due to the permanent nature of orchard crops, water levels probably will continue to decline in the cultivated areas at relatively high rates. The increased withdrawals that will be required to irrigate the newer orchards once they mature, coupled with the effects of increased pumping on the cones of depression that have already developed beneath the agricultural areas, will exacerbate the steep declines in the water table beneath the heavily cultivated portions of the Sub-basin. Therefore, with the extent of irrigated agriculture now existing in the Sub-basin, the depth to water already approaches levels that will jeopardize the ability of many growers to pump irrigation water.

C. Irrigated Agriculture will Become Uneconomic at Current Rates of Withdrawal due to Rising Pumping Costs Long Before Depletion of the Lower Aquifer.

No matter how much groundwater remains stored in an aquifer, it cannot constitute a reasonably safe supply for the irrigation of cultivated lands if it is too costly for farmers to withdraw. According to the San Simon Sub-basin Report, the average depth to water below the agricultural pumping areas of the Sub-basin will drop to 290 feet by 2030, 340 feet by 2060, 390 feet by 2090, and 430 feet by 2115 at rates of withdrawal associated with the current irrigation demand of cultivated lands. San Simon Sub-basin Report at 13, Table 3. The analysis further projects that expenses for most farms in the Sub-basin—due primarily to increased groundwater lifting costs—will exceed revenues when the depth to water reaches approximately 370 feet below the surface, at which point irrigated agriculture will no longer be economically viable. With the currently irrigated acreage in the Sub-basin, the analysis estimates that groundwater levels will drop to the uneconomic level for most farms around 2075. San Simon Sub-basin Report at 22. Moreover, if pumping increases by 25% from the current irrigation demand rate, farms in the Sub-basin are projected to become uneconomic by 2055. San Simon Sub-basin Report at 23.

The costs of obtaining a proposed water supply are central to the determination of whether the supply is reasonably safe. Thus, even if water theoretically can be accessed from 1,200 or more feet underground, the costs of bringing the water to the surface will eventually foreclose its viability as a reasonably safe irrigation supply. Examining the probable costs of lifting groundwater from increasing depths reveals that existing irrigation needs in the Sub-basin will exhaust the economically viable irrigation supply in the next 60 years. Accordingly, the groundwater in the Sub-basin is insufficient to provide a reasonably safe supply for the irrigation of some of the more recently planted nut orchards throughout their projected lifespans.

In sum, the irrigation supply for existing farms is already imperiled at current levels of demand, let alone under circumstances of further agricultural development. Thus, the Sub-basin does not have sufficient groundwater to provide a reasonably safe irrigation supply for existing cultivated lands. As a result, FICO requests that the Director designate an INA for the San Simon Valley Sub-basin.

Very truly yours,

Salmon, Lewis & Weldon, P.L.C.

By
Scott M. Deeny

LeonardRice
ENGINEERS, INC.

Evaluation of the San Simon Sub-basin as an Irrigation Non-expansion Area

Prepared For

Farmers Investment Co.

July 2015

Project No.: 1477FIC01

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LeonardRice ENGINEERS, INC.

Integrated Water Resources Engineering
Innovative Solutions for Water and Land

Evaluation of the San Simon Sub-basin as an Irrigation Non-expansion Area

Prepared for:

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July 14, 2015

1477FIC01

The technical material in this report was prepared by or under the supervision and direction of the undersigned, whose seal as a Professional Engineer and a Certified Professional Geologist are affixed below.

Jon R. Ford, P.E. and C.P.G., Senior Project Manager

The following members of the Leonard Rice Engineers, Inc. staff contributed to the preparation of this report.

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Staff Hydrogeologist	William Loopesko
Data Processor	Joli A. Sajban

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Tables

Figures

1 EXECUTIVE SUMMARY

Without any control on the magnitude of irrigation in the San Simon Sub-basin, as would be provided by an Irrigation Non-expansion Area (INA), groundwater levels will continue to fall to the point that lifting costs will become so great that irrigated farming is unprofitable. At that point, farming will cease and the economy of the area will contract as it did in 1980 when irrigated acreage declined from 139,000 acre feet per year (af/yr) to 42,000 af/yr over a three year period. This time the irrigated agriculture economy will not ever recover.

How long irrigated agriculture is profitable in the sub-basin depends upon the annual volume of irrigation pumped from the Lower Aquifer and is independent of the volume of groundwater stored in the Lower Aquifer. The unprofitable point will be reached long before the storage in the Lower Aquifer is depleted. Thus, irrigated agriculture will not extend for centuries into the future as those who consider only the volume of groundwater in storage believe; rather it will extend only 100 years or less from now, depending upon the rate of expansion of irrigation in the sub-basin.

As water levels continue to decline, farmers will further improve their irrigation systems to reduce waste, switch to crops with a lower water demand, or switch to a more profitable crop. Unfortunately, these strategies have a limited ability to significantly reduce the water demand. Ultimately, water demand reduction will only delay the time until the uneconomic point is reached.

To forecast when irrigation will become uneconomic, we relied upon ADWR's compilation of USGS estimated irrigated acres and annual pumping, ADWR's GWSI depth to water measurements, the ADWR Groundwater Flow Model of the San Simon Valley Sub-basin, information provided by Farmers Investment Co. (FICO) and the University of Arizona Extension Service crop budgets. From our analysis as described in this report, we conclude that the currently irrigated farms in the San Simon Sub-basin will become uneconomic in 50 to 60 years (2075) when groundwater lifting costs increase to the point that they consume all profits.

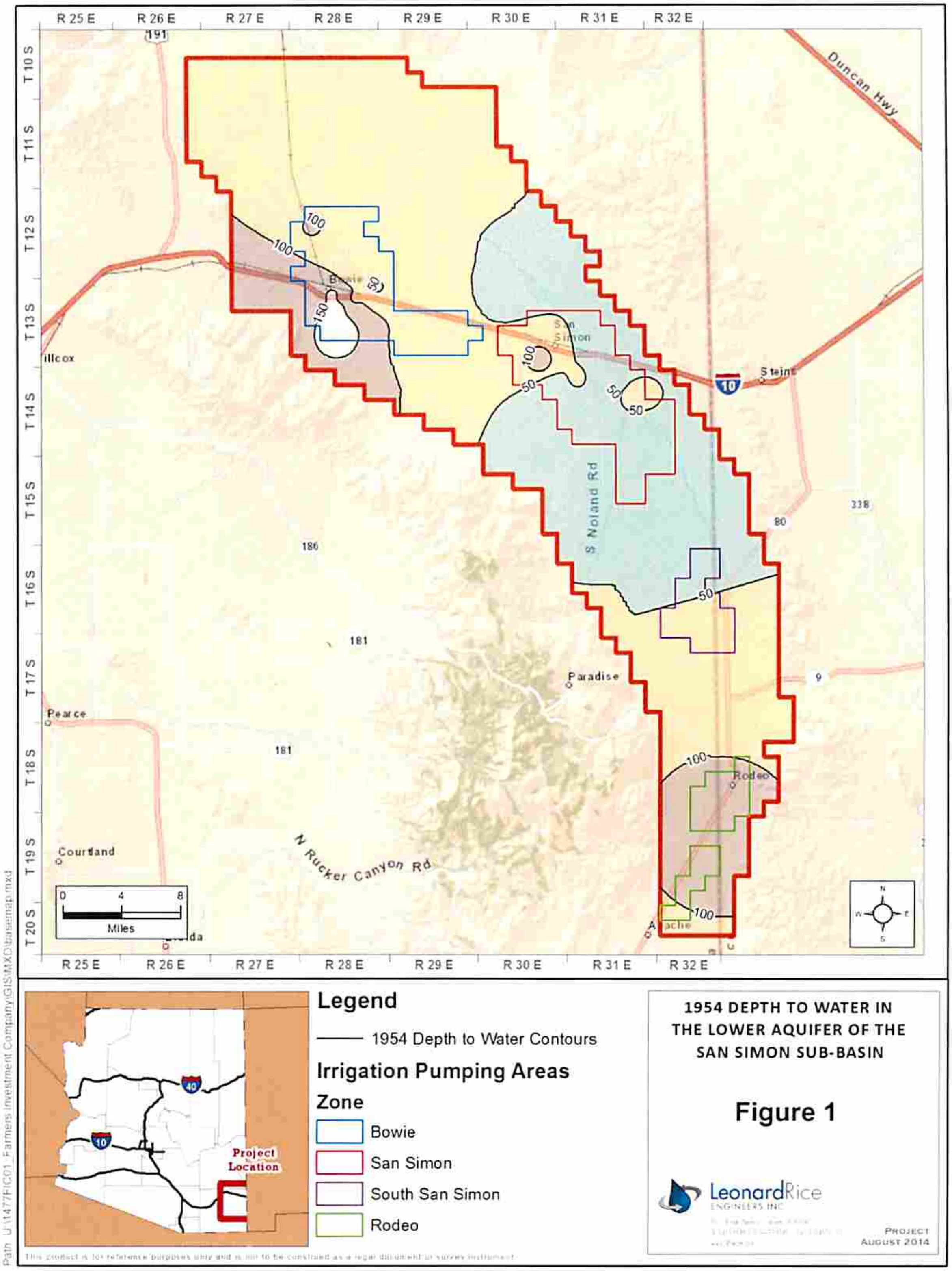
In our opinion, there is not a reasonably safe supply for irrigation of the currently irrigated lands in the area. Therefore, an INA is necessary to provide a measure of safety for the existing irrigated agriculture and to preserve the San Simon Sub-basin economy.

2 HISTORIC COST TO PUMP GROUNDWATER FROM THE LOWER AQUIFER

Our economic analysis is based upon estimating groundwater pumping costs, which in turn are based upon forecasting the future depth to groundwater in the Lower Aquifer. We used the ADWR GWSI San Simon Sub-basin depth to water data to prepare depth to groundwater maps for the years 1954, 1980, 1983, 1987, and 2015 as shown in Figures 1 – 5. For each of the depth to water maps, we calculated the average depth to water in the sub-basin and the average for each of the irrigation pumping centers shown on ADWR (2015) Figure 9. We then calculated the weighted average depth to water for the irrigated acreage for each of the five time periods. This information is shown in Table 1.

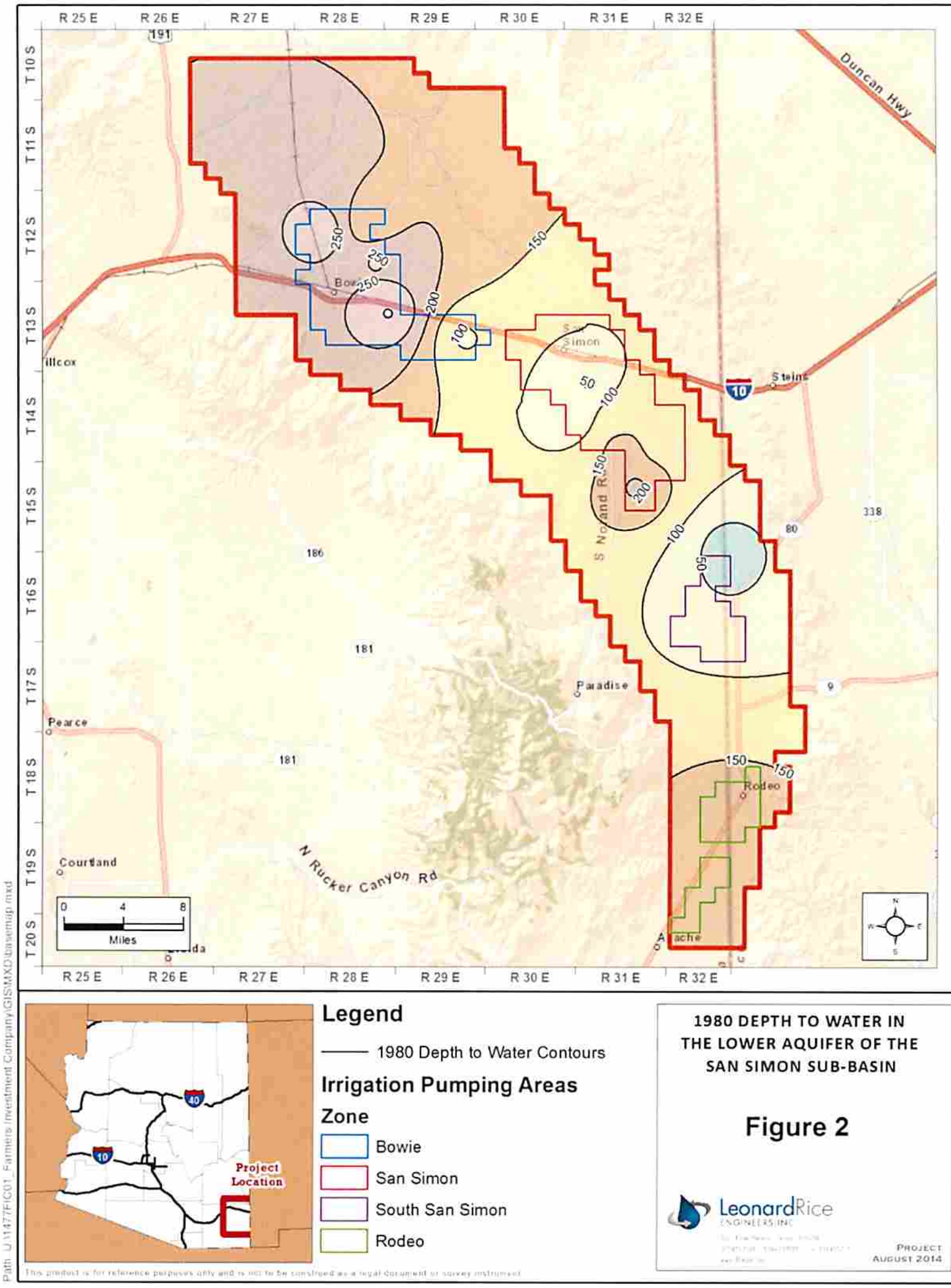
Table 1 - Historic Depth (Feet) to Groundwater Below Ground Surface in the Lower Aquifer

Year	Model Extent Average	Irrigation Pumping Center Average				Pumping Center Weighted Average
		Bowie	San Simon	South San Simon	Rodeo	
1954	60	100	50	50	110	70
1980	140	220	110	70	170	150
1983	170	230	120	160	190	170
1987	180	300	110	150	180	190
2015	230	340	200	180	240	250



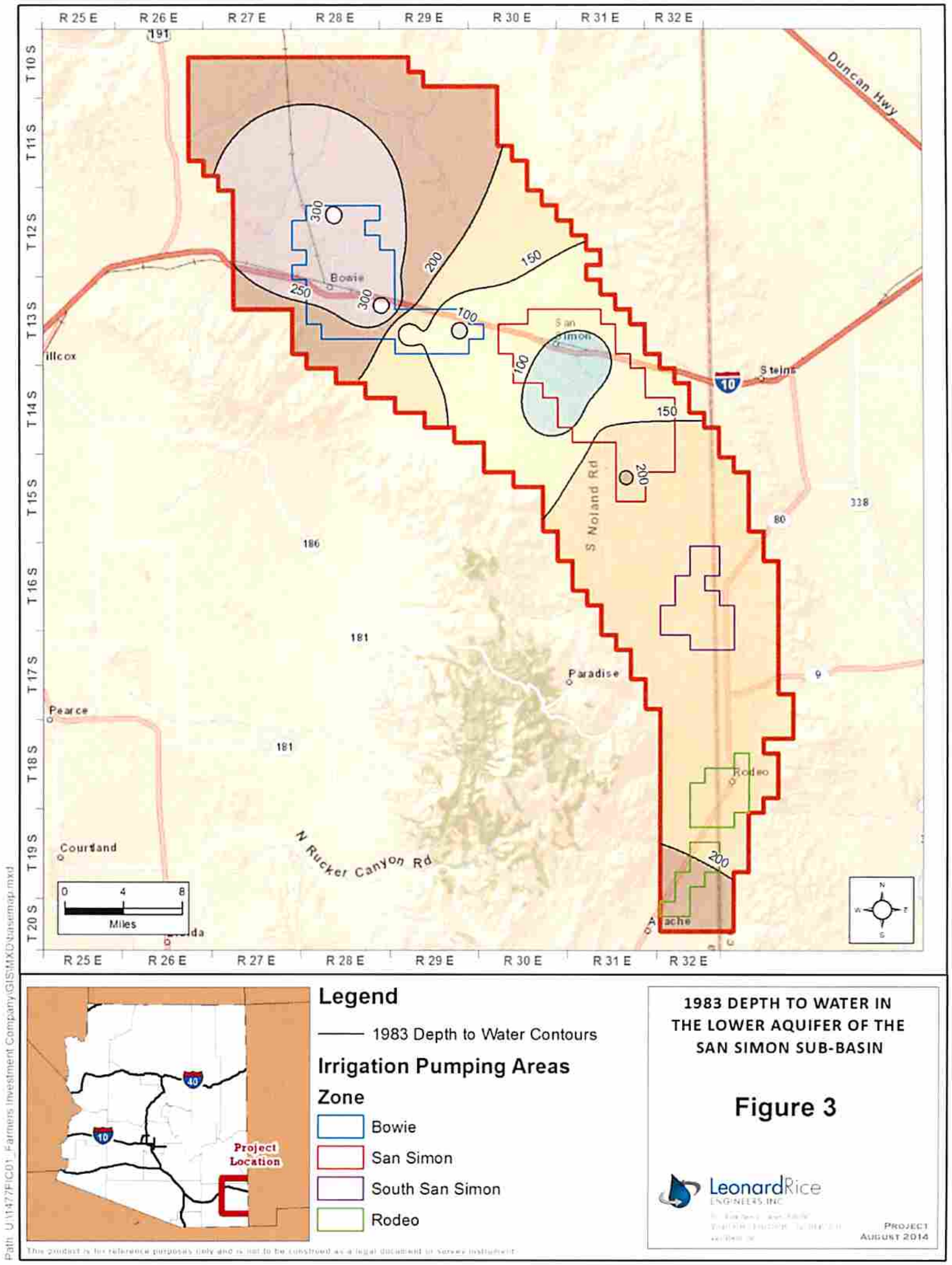
1954 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN

Figure 1



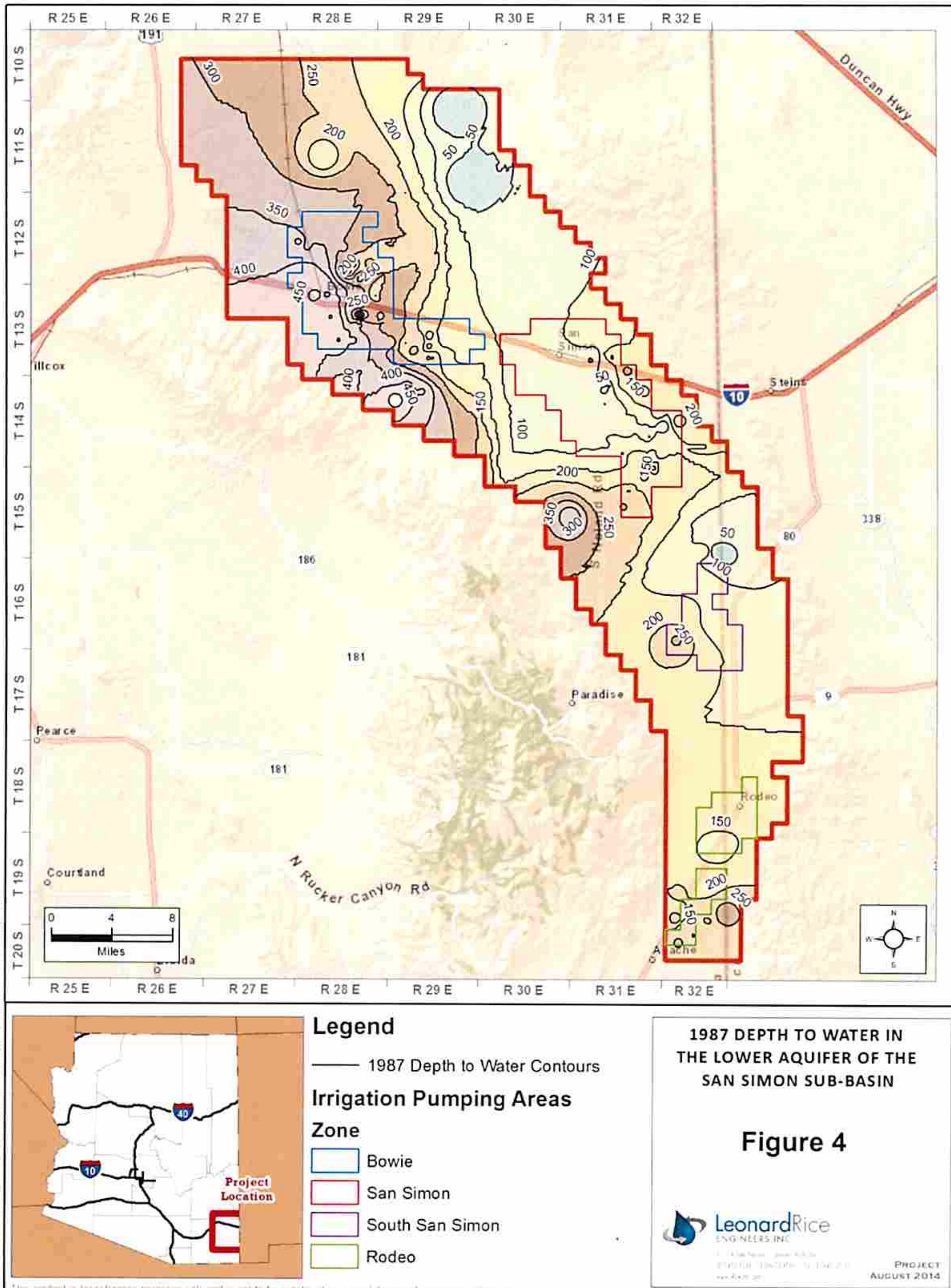
1980 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN

Figure 2



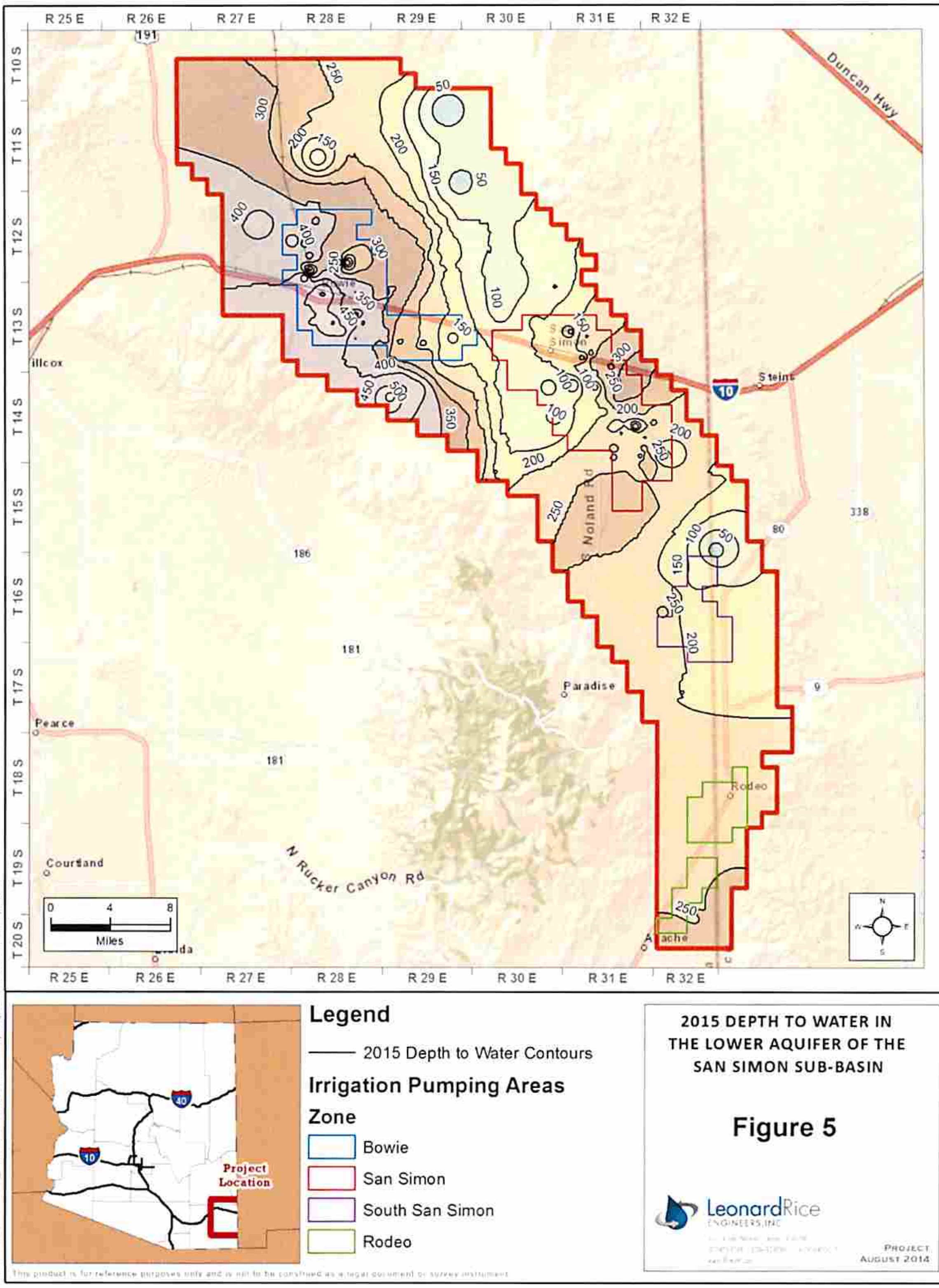
1983 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN

Figure 3



1987 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN

Figure 4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Duncan Hwy
Willcox
Steins
Paradise
Pearce
Courtland
Rodeo
N Rucker Canyon Rd
S Noland Rd
0 4 8
Miles
Legend
2015 Depth to Water Contours
Irrigation Pumping Areas
Zone
Bowie
San Simon
South San Simon
Rodeo
Project Location
2015 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN
Figure 5
LeonardRice ENGINEERS, INC
PROJECT
AUGUST 2014
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The weighted average depth to water for the irrigated area is also shown in Table 2. For other years, we interpolated the depth to water as shown in column 5 of Table 2. The ADWR estimates of historically irrigated acres and annual pumping are shown in columns 2 and 3 of Table 2. The irrigated acres and annual pumping were used to estimate the annual irrigation application rate shown in column 4.

Table 2 - Estimated **Historic** Groundwater Pumping Costs San Simon Sub-basin

1	2	3	4	5	6	7	8	9
Year	Estimated Irrigated Acres	Estimated Annual Pumping (af)	Irrigation Application Rate (af/ac)	Depth to Non-Pumping Water Level (ft)	Drawdown Due to Well Pumping (ft)	Total Dynamic Head (TDH) (ft)	Pumping Cost per Acre-Foot at Current Energy Cost ($/af)	Pumping Cost per Acre at Current Energy Cost ($/ac)
1917	1900	11000	5.8	20	0	20	$0	$0
1918	700	4000	5.7	10	0	10	$0	$0
1945	1200	7000	5.8	-20	-50	146	$27	$156
1950	1200	7000	5.8	-30	-70	179	$33	$191
1951	2000	6000	3.0	-50	-70	201	$37	$111
1954	10000	32000	3.2	**-70**	-70	223	$41	$131
1961	20000	65000	3.3	-95	-100	284	$52	$169
1969	24000	78000	3.3	-125	-100	317	$58	$189
1973	34800	115000	3.3	-140	-100	333	$61	$202
1980	42000	139000	3.3	**-150**	-100	344	$63	$209
1981	39000	127000	3.3	-160	-100	355	$65	$212
1983	13000	42000	3.2	**-170**	-100	366	$67	$217
1987	13000	45500	3.5	**-190**	-100	388	$71	$249
1991	12500	46000	3.7	-195	-100	394	$72	$265
2010	13000	49500	3.8	-225	-100	427	$78	$298
2011	14625	50000	3.4	-230	-100	432	$79	$271
2012	16250	50000	3.1	-235	-100	438	$80	$247
2013	17875	50000	2.8	-240	-100	443	$81	$227
2014	19500	44000	2.3	-245	-100	449	$82	$186
2015	19500	55000	2.8	**-250**	-100	454	$83	$235

We estimated the 2015 irrigation pumping (55,000 acre feet) using the 2013 annual irrigation application rate and the 2014 estimated irrigated acres. We did not use the 2014 irrigation application rate because Mr. Saeid Tadayon of the USGS (personal communication) informed us that 2014 was an unusually wet year in the San Simon sub-basin, so it was not representative.

Table 2, column 6 includes our estimate of the well irrigation season drawdown, which is the difference between the non-irrigation season pseudo static depth to water and the well pumping depth during the irrigation season. There are no readily available data on well drawdown, so it was estimated using the difference between FICO San Simon Wells non-pumping depth to water measurements and depth to water during pumping for its San Simon wells for the years 2007 to 2015. Over that period, the average FICO well drawdown was 113 feet. We used 100 feet as the well drawdown in Table 2 because we believe that the FICO wells likely have a higher than average drawdown.

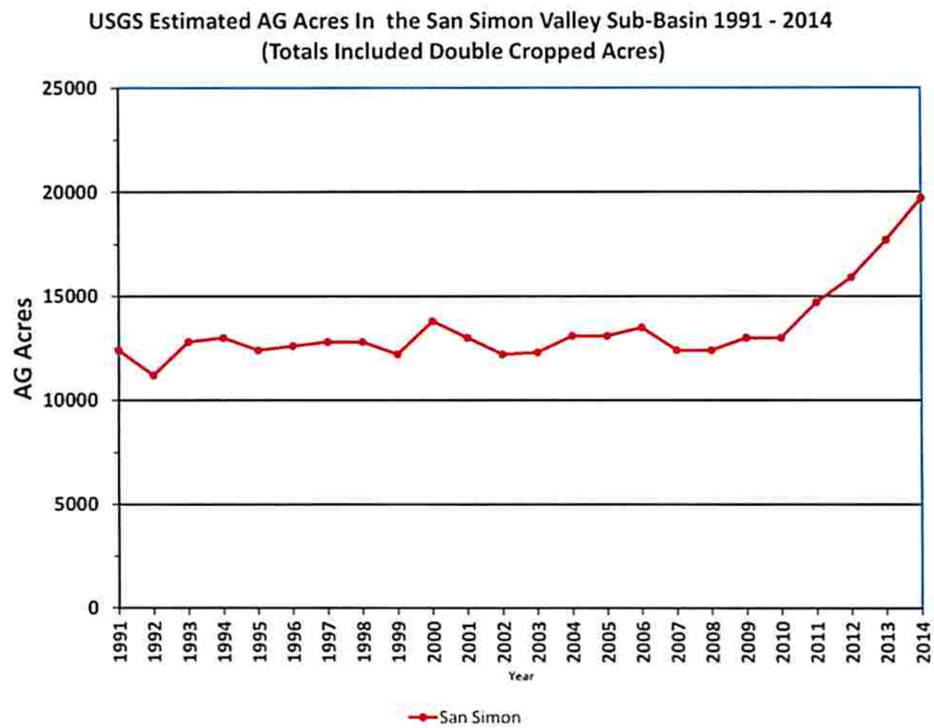
The total dynamic head (TDH) shown in Table 2, column 7 is the sum of the depth to water, the well drawdown, friction loss in the piping system, and the surface discharge pressure necessary to operate the irrigation system. Friction loss was assumed to be ten percent of pumping depth to water. The discharge pressure was assumed to be 69 feet based upon information supplied by Mr. Brian Driscoll, FICO San Simon Farm Manager (personal communication).

The cost to pump groundwater per acre-foot (column 8) was calculated using the TDH, a pump efficiency of 70 percent, and an estimate of the electrical power cost. Data on electrical power cost are not readily available; however, FICO's cost is $85 per acre-foot (Brian Driscoll, personal communication). From this information we estimate that the effective electrical power cost is approximately $0.125 per kilowatt hour. The pumping cost per acre (column 9) was calculated as the product of the pumping cost per acre-foot times the irrigation application rate (column 4). Table 2 shows the cost to pump groundwater per irrigated acre (column 8) has steadily increased over the years as the depth to water has increased.

3 ESTIMATE OF FUTURE IRRIGATION DEMAND FOR THE CURRENTLY IRRIGATED ACRES

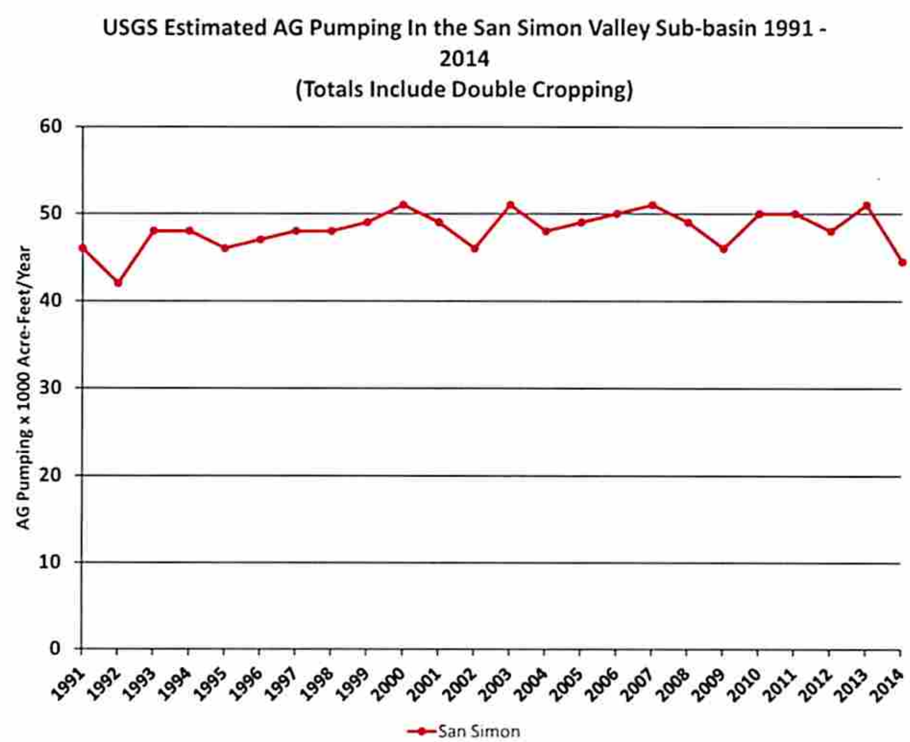
We estimate that the future average annual groundwater demand for the 19,500 currently irrigated acres will be approximately 66,500 af/yr. This estimate was derived by assuming the demand for non-orchard crops remains constant and that over the next 5 to 10 years the orchard demand will increase as the orchards planted subsequent to 2010 continue to mature.

Figures 6 and 7 show the irrigated acres and the annual pumping estimated by the USGS. Since 2010, Figure 6 shows that the irrigated acres have increased approximately 6,500 acres. This is a significant increase (50%). However, Figure 7 shows that the pumping since 2010 has essentially remained constant. The explanation for this anomaly is that juvenile pistachio and pecan orchards have been planted since 2010 and require much less water than other crops, including mature orchards (Saeid Tadayon, USGS and Brian Driscoll, FICO, personal communication).



1: Saeid Tadayon, USGS, Personal Communication and Brian Driscoll, FICO San Simon Farm Manager, personal communication.

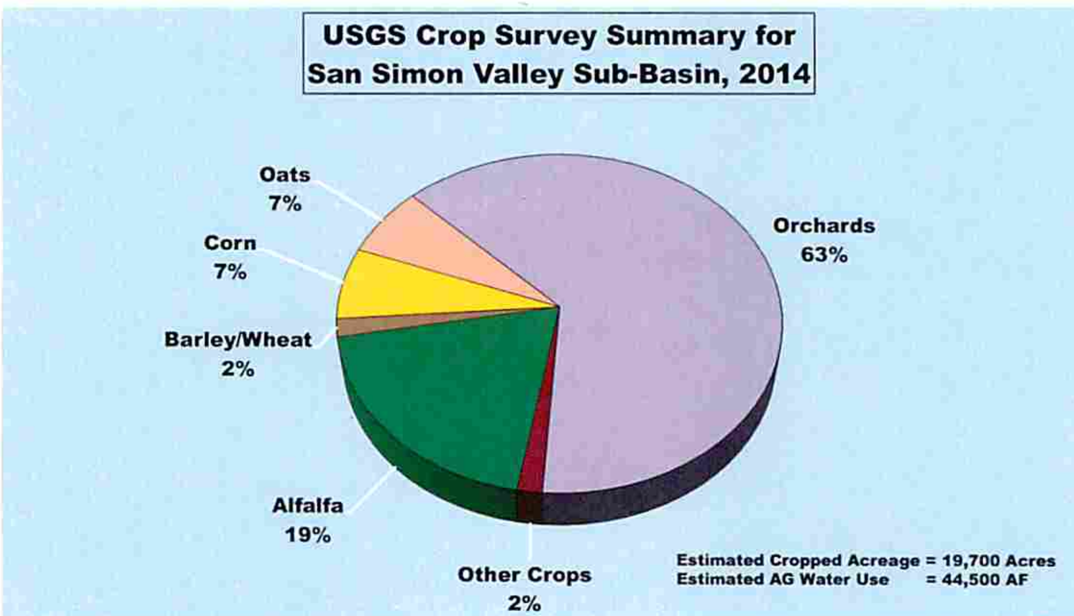
Figure 6



1: Saeid Tadayon, USGS, Personal Communication.

Figure 7

Figure 8 shows the USGS estimated crop distribution for 2014. Saeid Tadayon informed us that approximately half of the orchard acres shown on Figure 8 have been planted since 2010. The newly planted orchards require approximately 2 acre feet per acre (af/ac) of irrigation compared to the mature orchard irrigation demand of 4 to 5 af/ac (Brian Driscoll, FICO personal communication). Using this information, we conclude that the annual irrigation application rate will increase from 2.8 af/ac (2013 and 2015) to 3.4 af/ac as the newly planted orchards mature over the next 5 to 10 years. This means the average annual irrigation application rate for the currently irrigated area will increase from 55,000 acre feet in 2015 to approximately 66,500 acre feet.



Source: Presentation Slide 16, Hydrology and Water Use Data of the San Simon Valley Sub-basin, Frank Corkhill, ADWR (May 16, 2015).
1: Saeid Tadayon, USGS, Personal Communication.

Figure 8

From a technical perspective, the phrase in the statute "...the cultivated levels in the area at the current rates of withdrawal" is problematic. It is not a problem for most crops because they are harvested every year and they have a nearly constant irrigation demand each year. The problem occurs for crops like orchards that have an increasing demand over 5 to 10 years until the trees reach maturity. For orchards, the cultivated land remains constant and the demand increases beyond "the current rates of withdrawal." For the INA evaluation, does this mean that the full future irrigation demand must be considered? In our opinion it does because the demand obligation exists for land already irrigated. Another related dilemma exists if the INA is designated. In that case, should the full future irrigation demand be considered as an irrigation expansion? In that case, our opinion is that it should not because the future demand obligation existed at the time the INA was designated.

4 REVIEW OF ADWR GROUNDWATER FLOW MODEL

We completed a limited review of the ADWR Groundwater Flow Model of the San Simon Valley Sub-basin. Our review included an evaluation of the calibration and calibration statistics, the modeled water budget, and model parameters including hydraulic conductivity, specific storage and specific yield. Based on this review we have the following comments/suggestions regarding its construction and performance:

1. Calibration:

    a. Overall the model head calibration appears reasonable in the San Simon and Bowie areas with a relatively even split between positive and negative residuals. We note that the calibration residuals histogram for the un-weighted transient is approximately centered around a mean residual of approximately 10 feet; however, the distribution is somewhat flatter than would be expected with many residuals with an absolute value greater than 100 ft. This distribution suggests that the model could benefit from further calibration. Some of the error may be due to localized pumping effects that the model cannot capture, but it does appear that there is room for improvement in the model calibration.

    b. In the southern region of the model (near Rodeo) the simulated water levels for layer 2 in 2015 are universally lower than the observed values by 100 to 200 feet. The fact that the simulated water levels are too low suggests that the hydraulic conductivity in this region may be too high. This region corresponds to the highest hydraulic conductivity in the model domain, so we suggest that ADWR review the calibration for this area to determine if any adjustments need to be made.

2. Parameters: In general, the model parameters appear reasonable for what would be expected for alluvial and basin-fill deposits. We question whether or not the hydraulic conductivity in the southern region is too high in layer 2 as discussed above.

3. Model Geometry: We compared the elevation in the USGS National Elevation Dataset Digital Elevation Model (DEM) to the top of layer 1 in the ADWR Groundwater Model. Overall there was good agreement, however in southern regions and along the perimeter of San Simon Valley, the elevation of the top of layer 1 was significantly higher than the DEM elevation by up to 1,000 feet or more. This may have caused some issues with the correct elevation for the top of layer 2 when it was calculated based on the depth to bedrock map, which presumably would place the top of layer 2 too high.

4. Mass balance error / Solver Parameters: Overall, the model mass balance error was less than generally accepted criteria. However, the HCLOSE parameter used by the solver was set to an unusually high value of 110 feet. Generally, this parameter is set much lower to achieve the lowest possible mass balance error. We attempted to set it lower and the mass balance error increased unexpectedly. This issue likely stems from the numerical instability

at the model edges and instability induced by cell dewatering. It is possible that some of these instabilities could be addressed by correcting the model elevations as discussed in the model geometry section.

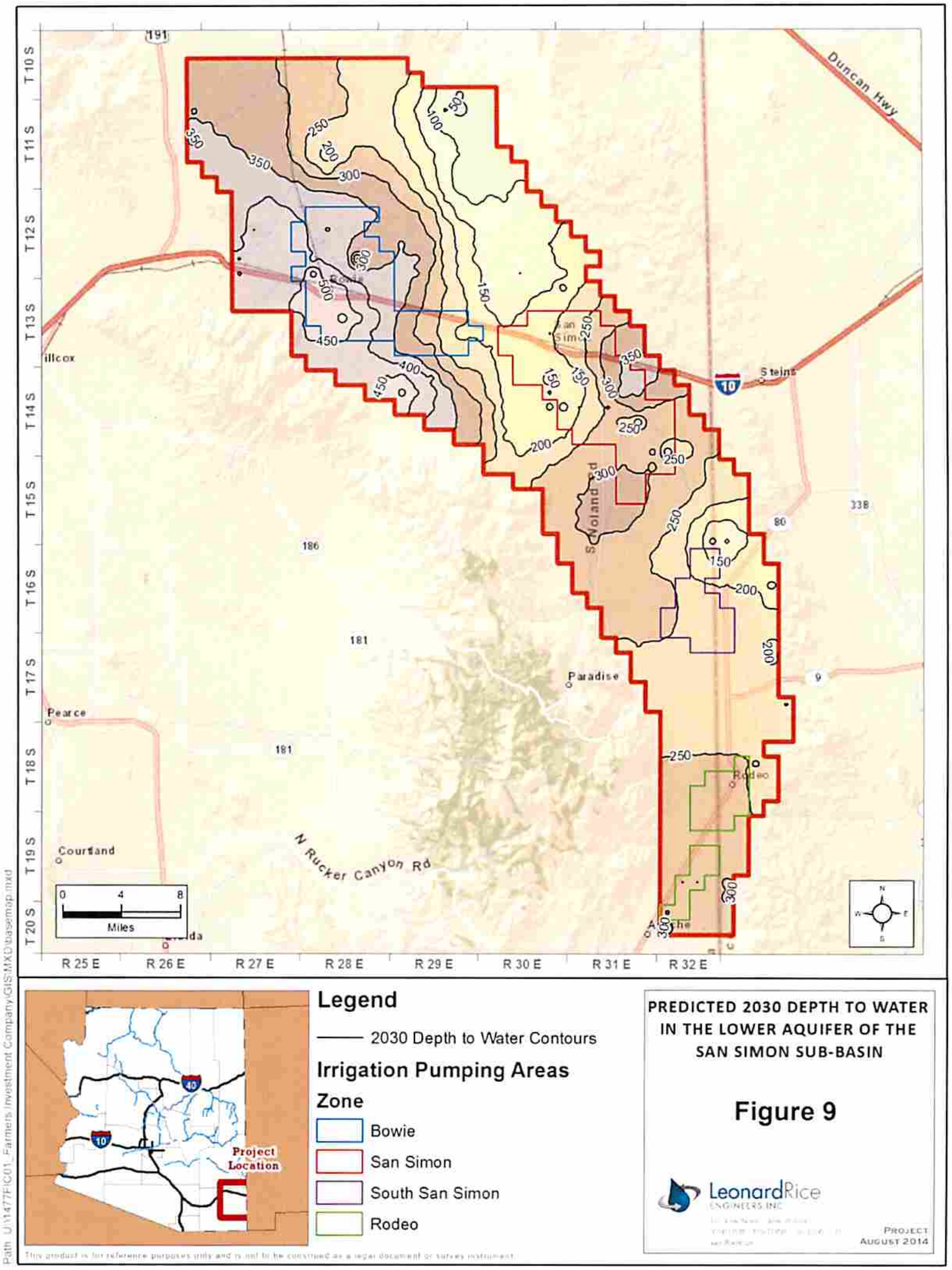
Overall, the model is the best tool available to assess regional-scale drawdown in the San Simon Sub-basin and we believe it is suitable for this purpose. Finally, we agree with ADWR's approach to projecting water levels in the future using the existing 2015 measured depth-to-water and simulated drawdown. This approach reduces or eliminates local model bias in the simulated head and is likely to significantly improve on the model-simulated future water level elevations.

5 FORECAST OF FUTURE DEPTH TO GROUNDWATER IN THE LOWER AQUIFER

To forecast the future depth to water for the currently irrigated 19,500 acres, we used the ADWR Groundwater Flow Model of the San Simon Valley Sub-basin (2015). The only changes we made to the model were to increase the annual pumping for approximately 50,000 acre feet after beginning in 2015 to approximately 66,5000 af/yr in 2020 and to proportionately increase recharge to layer 1 to represent irrigation return flow. From this simulation we extracted the model cell heads at various time increments (2030, 2060, 2090, and 2115) and calculated the drawdown between 2015 and the various time increments. We then added them to the 2015 depth to water map (Figure 5) to yield the future depth to water forecasts. See Figures 9 – 12. For each of the time increments we calculated the sub-basin average depth to water, the average depth to water for each of the farm irrigation pumping centers and the weighted average depth to water for the irrigated acres. The results are shown in Table 3.

Table 3 - Projected Future Depth (Feet) to Groundwater Below Ground Surface in the Lower Aquifer

Year	Model Extent Average	Irrigation Pumping Center Average				Pumping Center Weighted Average
		Bowie	San Simon	South San Simon	Rodeo	
2015	230	340	200	180	240	250
2030	260	370	240	220	270	290
2060	310	410	300	300	330	340
2090	350	440	360	360	390	390
2115	390	470	390	420	440	430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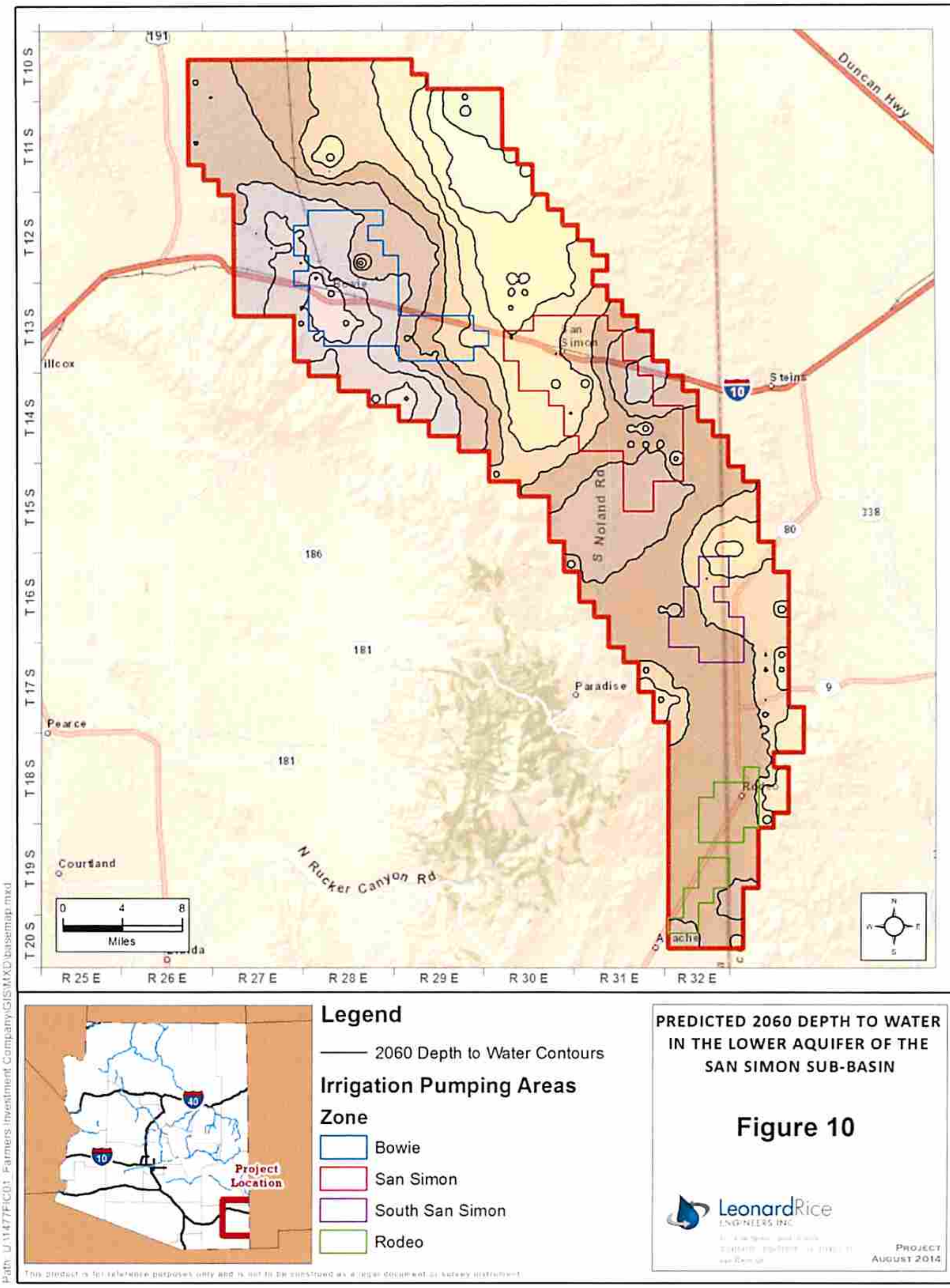
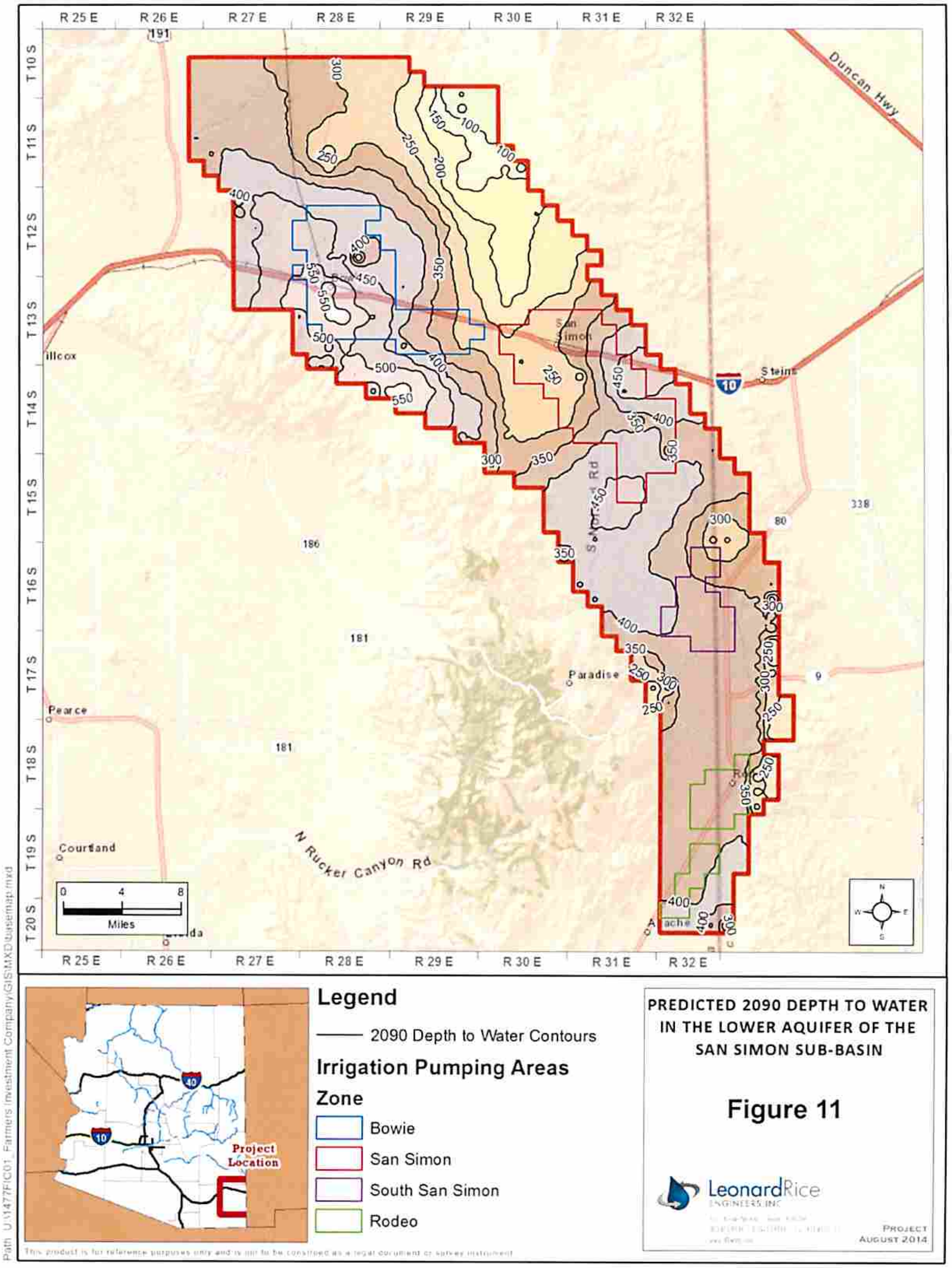
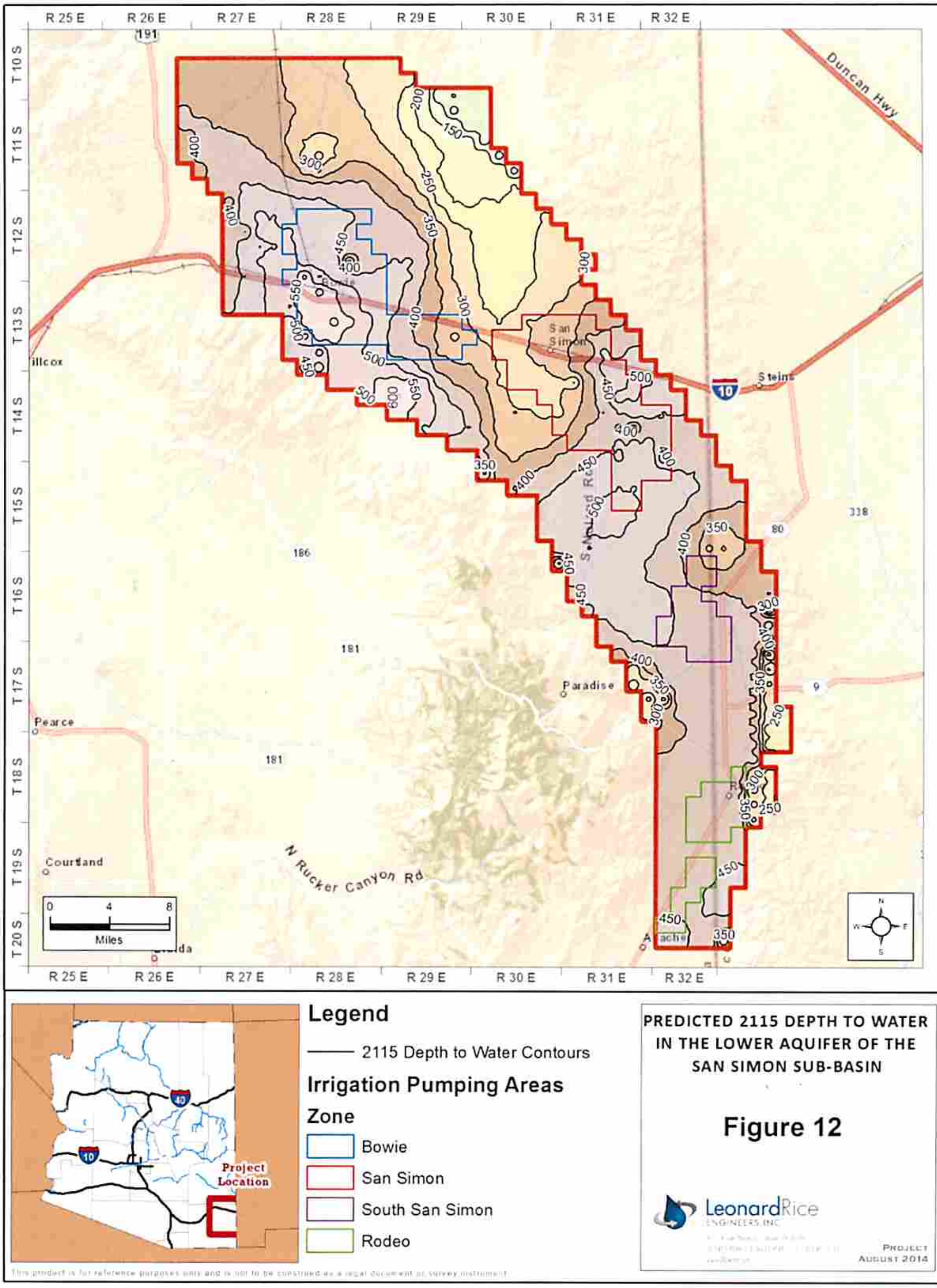
R 28 E
R 29 E
R 30 E
R 31 E
R 32 E
Duncan Hwy
Willcox
Steins
Paradise
Pearce
Courtland
Rodeo
N Rucker Canyon Rd
Miles
Legend
2030 Depth to Water Contours
Irrigation Pumping Areas
Zone
Bowie
San Simon
South San Simon
Rodeo
Project Location
PREDICTED 2030 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN
Figure 9
LeonardRice
PROJECT
AUGUST 2014



PREDICTED 2060 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN

Figure 10


Legend
2090 Depth to Water Contours
Irrigation Pumping Areas
Zone
Bowie
San Simon
South San Simon
Rodeo
PREDICTED 2090 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN
Figure 11
Project
August 2014



PREDICTED 2115 DEPTH TO WATER IN THE LOWER AQUIFER OF THE SAN SIMON SUB-BASIN

Figure 12

6 FUTURE COST TO PUMP GROUNDWATER FROM THE LOWER AQUIFER

The Table 3 information was used to forecast the future cost to pump groundwater for the existing irrigated acres using the approach presented in Section 2. Table 4 shows these results. This table also includes the multiplier of the cost compared to 2015. For example, the cost per acre in 2115 is 1.74 times the 2015 cost.

Table 4 - Estimated **Future** Groundwater Pumping Costs San Simon Sub-basin

1	2	3	4	5	6	7	8	9	10
Year	Estimated Irrigated Acres	Estimated Annual Pumping (af)	Irrigation Application Rate (af/ac)	Depth to Non-Pumping Water Level (ft)	Drawdown Due to Well Pumping (ft)	Total Dynamic Head (TDH) (ft)	Pumping Cost per Acre-Foot at Current Energy Cost ($/af)	Pumping Cost per Acre at Current Energy Cost ($/ac)	Water Cost Multiplier
2015	19500	55000	2.8	**-250**	-100	454	$83	$235	1.00
2030	19500	66500	3.4	**-290**	-100	498	$91	$311	1.33
2060	19500	66500	3.4	**-340**	-100	553	$101	$346	1.47
2090	19500	66500	3.4	**-390**	-100	608	$111	$380	1.62
2115	19500	66500	3.4	**-430**	-100	652	$120	$408	1.74

7 FORECAST OF WHEN IRRIGATION IN THE SAN SIMON SUB-BASIN WILL BECOME UNECONOMIC

Each farm in the sub-basin has a unique profit and cost situation that not only includes the value of the crop and the lifting costs of groundwater but a myriad of other things like taxes, debt, labor costs, equipment costs, and fertilizer costs. Although farm income and expenses vary year-to-year it is reasonable to assume that they are nearly a constant percentage year to year. Therefore, the most significant variable that affects profitability is the groundwater lifting cost, which increases every year.

Using the future cost to pump groundwater multipliers shown in Table 4, we evaluated nine profit-loss scenarios where current profit was either is 15, 10, or 5 percent and the current cost of water was either 10, 20, or 30 percent of farm expenses. For the years 2030, 2060, 2090, and 2115 the cost of water increased for each scenario based upon the multiplier. The range in current cost of water as a percent of farm expenses was determined by reviewing University of Arizona Extension Service Crop Budgets for Pinal and Cochise Counties. That range was 12 to more than 30 percent. Three example budgets are included in Tables 5 – 7.

Table 5 - Pinal County Corn Crop Budget

Table 7A. Income and Cash Operating Summary; Corn (Spring), 1998

COUNTY: Pinal FARM: Pinal County 98 WATER SOURCE: Maricopa-Stanfield Irrig. TILLAGE: Conventional
CROP: Corn Grain ACRES: 1.0 IRRIGATION SYSTEM: Flood Furrow SOIL: Sandy-Loam
AREA: Maricopa YIELD: 8,400.0 Lb / Acre PREVIOUS CROP: Cotton, Upland DATE: 2/18/99

Item	Unit	Quantity	Price/ Unit	Budgeted /Acre	Total /Acre	Your Farm Budget
INCOME Þ Grain	Pound	8,400.00	$0.05	$445.20	$445.20	
CASH LAND PREPARATION AND GROWING EXPENSES (including sales tax)						
Paid Labor (including benefits)					37.90	
Tractor/Self Propelled				20.41		
Hand				4.33		
Irrigation				13.16		
Chemicals and Custom Applications					192.29	
Fertilizer				107.76		
Insecticide				68.74		
Herbicide				15.79		
Farm Machinery and Vehicles					28.51	
Diesel Fuel				10.78		
Repairs and Maintenance				17.73		
Irrigation Water (excluding labor)					120.04	
Water Assessment (See Note Below) **						
Other Purchased Inputs &					27.90	
Seed/Transplants				27.90		
TOTAL CASH LAND PREPARATION AND GROWING EXPENSES					406.65	
CASH HARVEST AND POST HARVEST EXPENSES						
Paid Labor (including benefits)					2.33	
Tractor/Self Propelled				2.15		
Irrigation				0.18		
Farm Machinery and Vehicles					3.66	
Diesel Fuel				1.32		
Repairs and Maintenance				2.34		
Custom Harvest/Post Harvest					84.50	
TOTAL HARVEST AND POST HARVEST EXPENSE					90.49	
OPERATING OVERHEAD Þ PICKUP USE					7.71	
OPERATING INTEREST AT 10.0%					14.62	
TOTAL CASH OPERATING EXPENSES					$519.46	
RETURNS OVER CASH OPERATING EXPENSES					($74.26)	

Table 7B. Allocations of Ownership Costs; Corn (Spring), 1998

COUNTY: Pinal FARM: Pinal County 98 WATER SOURCE: Maricopa-Stanfield Irrig. TILLAGE: Conventional
CROP: Corn Grain ACRES: 1.0 IRRIGATION SYSTEM: Flood Furrow SOIL: Sandy-Loam
AREA: Maricopa YIELD: 8,400.0 Lb / Acre PREVIOUS CROP: Cotton, Upland DATE: 2/18/99

Item	-- CASH COST BASIS ($/ACRE) -- Income and Costs	Net Returns	-- TOTAL COST BASIS ($/ACRE) -- Income and Costs	Net Returns
TOTAL INCOME at $0.05 / Lb	$445.20		$445.20	
TOTAL OPERATING EXPENSES	$519.46		$519.46	
RETURN OVER CASH OPERATING EXPENSES		($74.26)		($74.26)
CASH OVERHEAD EXPENSES				
Taxes, Housing and Insurance, Farm Machinery	3.40		3.40	
General and Office Overhead (5.0% of Total Operating Exp.)	25.97		25.97	
General Farm Maintenance (3.0% of Total Operating Exp.)	15.58		15.58	
Total Cash Overhead Expenses	44.95		44.95	
Total Cash Operating and Overhead Cost	564.41		564.41	
RETURNS OVER CASH OPER. AND OVER. EXPENSES		($119.21)		($119.21)
CAPITAL ALLOCATIONS (100% Equity)				
Capital Replacement, Machinery and Vehicles			19.15	
Interest on Equity, Machinery and Vehicles			7.65	
Total Capital Allocations			26.80	
RETURNS TO LAND, CAPITAL, MANAGEMENT AND RISK ------>		($119.21)		
RETURNS TO LAND, MANAGEMENT AND RISK ------>				($146.01)
Land Cost / Ownership (100% Equity)				
Property Taxes ($447.00 X 16.0% X 0.169)	12.15		12.15	
Opportunity Interest on Land (100% X 6.0 X $447.00)			26.82	
Water Assessment	25.00		25.00	
Total Land Costs	37.15		63.97	
RETURNS TO CAPITAL, MANAGEMENT AND RISK ------>		($156.36)		
RETURNS TO MANAGEMENT AND RISK ------>				($209.98)
Management Services (8% of Total Operation Expenses)			41.56	
TOTAL OWNERSHIP COST	82.10		177.28	
TOTAL COST	$601.56		$696.74	
RETURNS TO CAPITAL, MANAGEMENT AND RISK ------>		($156.36)		
RETURNS TO RISK (PROFITS) ------>				($251.54)
BREAK-EVEN PRICE TO COVER OPERATING COST (PER Lb)		$0.06		$0.06
BREAK-EVEN PRICE TO COVER OWNERSHIP COST		$0.01		$0.02
BREAK-EVEN PRICE TO COVER TOTAL COST		$0.07		$0.08

Water Cost % - $120.04/$696.74 = 17%

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Table 6 - Coshise County Corn Crop Budget

Table 5A. Income and Cash Operating Summary; Corn, 1998

COUNTY: Cochise	FARM: Cochise County 98	WATER SOURCE: Ks Settlement, NG	TILLAGE: Conventional
CROP: Corn Grain	ACRES: 1.0	IRRIGATION SYSTEM: Flood Furrow	SOIL: Sandy-Loam
AREA: Kansas Settlement	YIELD: 10,100.0 Lb / Acre	PREVIOUS CROP: Watermelons	DATE: 2/4/99

Item	Unit	Quantity	Price/ Unit	Budgeted /Acre	Total /Acre	Your Farm Budget
INCOME Þ Grain	Pound	10,100.00	$0.06	$616.10	$616.10	________
CASH LAND PREPARATION AND GROWING EXPENSES (including sales tax)						
Paid Labor (including benefits)					43.28	________
Tractor/Self Propelled				19.16		________
Irrigation				22.25		________
Other/ Contract				1.88		________
Chemicals and Custom Applications					145.99	________
Fertilizer				80.25		________
Insecticide				45.34		________
Herbicide				20.41		________
Farm Machinery and Vehicles					27.41	________
Diesel Fuel				9.96		________
Repairs and Maintenance				17.45		________
Irrigation Water (excluding labor)					168.38	________
Natural Gas/Pumping				143.86		________
Repairs and Maintenance				24.51		________
Other Purchased Inputs &					29.75	________
Seed/Transplants				29.75		________
TOTAL CASH LAND PREPARATION AND GROWING EXPENSES					414.82	________
CASH HARVEST AND POST HARVEST EXPENSES						
Paid Labor (including benefits)					4.30	________
Tractor/Self Propelled				4.30		________
Farm Machinery and Vehicles					4.37	________
Diesel Fuel				1.85		________
Repairs and Maintenance				2.51		________
Custom Harvest/Post Harvest					125.70	________
TOTAL HARVEST AND POST HARVEST EXPENSE					134.37	________
OPERATING OVERHEAD Þ PICKUP USE					12.88	________
OPERATING INTEREST AT 10.0%					21.18	________
TOTAL CASH OPERATING EXPENSES					$583.24	________
RETURNS OVER CASH OPERATING EXPENSES					$32.86	________

Table 5B. Allocations of Ownership Costs; Corn, 1998

COUNTY: Cochise	FARM: Cochise County 98	WATER SOURCE: Ks Settlement, NG	TILLAGE: Conventional
CROP: Corn Grain	ACRES: 1.0	IRRIGATION SYSTEM: Flood Furrow	SOIL: Sandy-Loam
AREA: Kansas Settlement	YIELD: 10,100.0 Lb / Acre	PREVIOUS CROP: Watermelons	DATE: 2/4/99

Item	-- CASH COST BASIS ($/ACRE) -- Income and Costs	Net Returns	-- TOTAL COST BASIS ($/ACRE) -- Income and Costs	Net Returns
TOTAL INCOME at $0.06 / Lb	$616.10		$616.10	
TOTAL OPERATING EXPENSES	$583.24		$583.24	
RETURN OVER CASH OPERATING EXPENSES		$32.86		$32.86
CASH OVERHEAD EXPENSES				
Taxes, Housing and Insurance, Farm Machinery	3.30		3.30	
Wells and Irrigation System	14.45		14.45	
General and Office Overhead (5.0% of Total Operating Exp.)	29.16		29.16	
General Farm Maintenance (3.0% of Total Operating Exp.)	17.50		17.50	
Total Cash Overhead Expenses	64.41		64.41	
Total Cash Operating and Overhead Cost	647.64		647.64	
RETURNS OVER CASH OPER. AND OVER. EXPENSES		($31.54)		($31.54)
CAPITAL ALLOCATIONS (100% Equity)				
Capital Replacement, Machinery and Vehicles			18.83	
Wells and Irrigation System			53.80	
Interest on Equity, Machinery and Vehicles			9.11	
Wells and Irrigation System			27.43	
Total Capital Allocations			109.17	
RETURNS TO LAND, CAPITAL, MANAGEMENT AND RISK ---------->		($31.54)		
RETURNS TO LAND, MANAGEMENT AND RISK ---------->				($140.72)
Land Cost / Ownership (100% Equity)				
Property Taxes ($368.00 X 16.0% X 0.144)	8.54		8.54	
Opportunity Interest on Land (100% X 6.0 X $368.00)			22.08	
Total Land Costs	8.54		30.62	
RETURNS TO CAPITAL, MANAGEMENT AND RISK ---------->		($40.08)		
RETURNS TO MANAGEMENT AND RISK ---------->				($171.33)
Management Services (8% of Total Operation Expenses)			46.66	
TOTAL OWNERSHIP COST	72.94		250.85	
TOTAL COST	$656.18		$834.09	
RETURNS TO CAPITAL, MANAGEMENT AND RISK ---------->		($40.08)		
RETURNS TO RISK (PROFITS) ---------->				($217.99)
BREAK-EVEN PRICE TO COVER OPERATING COST (PER Lb)		$0.06		$0.06
BREAK-EVEN PRICE TO COVER OWNERSHIP COST		$0.01		$0.02
BREAK-EVEN PRICE TO COVER TOTAL COST		$0.06		$0.08

Water Cost % - $168.38/$834.09 = 20%

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Table 7 - Cochise County Alfalfa Crop Budget

Table 4A. Income and Cash Operating Summary; Alfalfa Hay, 1998

COUNTY: Cochise — FARM: Cochise County 98 — WATER SOURCE: Ks Settlement, NG — TILLAGE: Conventional
CROP: Alfalfa Hay — ACRES: 1.0 — IRRIGATION SYSTEM: Flood Basin — SOIL: Sandy-Loam
AREA: Kansas Settlement — YIELD: 5.9 Tn / Acre — PREVIOUS CROP: Cotton, Upland — DATE: 2/4/99

Item	Unit	Quantity	Price/ Unit	Budgeted /Acre	Total /Acre	Your Farm Budget
INCOME Þ Hay	Ton	5.90	$96.70	$570.53	$570.53	________
CASH LAND PREPARATION AND GROWING EXPENSES (including sales tax)						
Paid Labor (including benefits)					32.52	________
Irrigation				32.52		________
Irrigation Water (excluding labor)					238.54	________
Natural Gas/Pumping				203.81		________
Repairs and Maintenance				34.73		________
TOTAL CASH LAND PREPARATION AND GROWING EXPENSES					271.05	________
CASH HARVEST AND POST HARVEST EXPENSES						
Paid Labor (including benefits)					23.10	________
Tractor/Self Propelled				12.69		________
Other/Contract				10.41		________
Farm Machinery and Vehicles					66.44	________
Diesel Fuel				9.29		________
Repairs and Maintenance				57.15		________
Other Materials					16.98	________
TOTAL HARVEST AND POST HARVEST EXPENSE					106.53	________
OPERATING OVERHEAD Þ PICKUP USE					10.30	________
OPERATING INTEREST AT 10.0%					23.93	________
TOTAL CASH OPERATING EXPENSES					$411.81	________
RETURNS OVER CASH OPERATING EXPENSES					$158.72	________

Table 4B. Allocations of Ownership Costs; Alfalfa Hay, 1998

COUNTY: Cochise — FARM: Cochise County 98 — WATER SOURCE: Ks Settlement, NG — TILLAGE: Conventional
CROP: Alfalfa Hay — ACRES: 1.0 — IRRIGATION SYSTEM: Flood Basin — SOIL: Sandy-Loam
AREA: Kansas Settlement — YIELD: 5.9 Tn / Acre — PREVIOUS CROP: Cotton, Upland — DATE: 2/4/99

Item	-- CASH COST BASIS ($/ACRE) -- Income and Costs	Net Returns	-- TOTAL COST BASIS ($/ACRE) -- Income and Costs	Net Returns
TOTAL INCOME at $96.70 / Tn	$570.53		$570.53	
TOTAL OPERATING EXPENSES	$411.81		$411.81	
RETURN OVER CASH OPERATING EXPENSES		$158.72		$158.72
CASH OVERHEAD EXPENSES				
Taxes, Housing and Insurance, Farm Machinery	5.82		5.82	
Wells and Irrigation System	20.47		20.47	
General and Office Overhead (5.0% of Total Operating Exp.)	20.59		20.59	
General Farm Maintenance (3.0% of Total Operating Exp.)	12.35		12.35	
Total Cash Overhead Expenses	59.24		59.24	
Total Cash Operating and Overhead Cost	471.05		471.05	
RETURNS OVER CASH OPER. AND OVER. EXPENSES		$99.48		$99.48
CAPITAL ALLOCATIONS (100% Equity)				
Capital Replacement, Machinery and Vehicles			38.23	
Wells and Irrigation System			76.22	
Interest on Equity, Machinery and Vehicles			3.49	
Wells and Irrigation System			38.86	
Stand Establishment (3 year crop)	103.96		103.96	
Total Capital Allocations	103.96		260.77	
RETURNS TO LAND, CAPITAL, MANAGEMENT AND RISK ------>		($4.48)		
RETURNS TO LAND, MANAGEMENT AND RISK ------>				($161.29)
Land Cost / Ownership (100% Equity)				
Property Taxes ($368.00 X 16.0% X 0.144)	8.54		8.54	
Opportunity Interest on Land (100% X 6.0 X $368.00)			22.08	
Total Land Costs	8.54		30.62	
RETURNS TO CAPITAL, MANAGEMENT AND RISK ------>		($13.02)		
RETURNS TO MANAGEMENT AND RISK ------>				($191.91)
Management Services (8% of Total Operation Expenses)			32.94	
TOTAL OWNERSHIP COST	171.74		383.57	
TOTAL COST	$583.55		$795.38	
RETURNS TO CAPITAL, MANAGEMENT AND RISK ------>		($13.02)		
RETURNS TO RISK (PROFITS) ------>				($224.85)
BREAK-EVEN PRICE TO COVER OPERATING COST (PER Lb)		$69.80		$69.80
BREAK-EVEN PRICE TO COVER OWNERSHIP COST		$29.11		$65.01
BREAK-EVEN PRICE TO COVER TOTAL COST		$98.91		$134.81

Water Cost % - $238.54/$795.38 = 30%

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Our economic analysis assumes that the following all remain a nearly constant percent relative to one another:

1. Annual farm revenue
2. All farm costs except water
3. Energy cost

These assumptions allow the impact of increasing water costs to be easily evaluated.

The results of the economic analyses are summarized in Table 8 by scenario and by time period. Table 8 also includes the average profit or loss for each time period. From this table, we conclude that irrigation becomes uneconomic in approximately 2075 for most farms at an approximate depth to water in the Lower Aquifer of 370 feet. This is only 50 to 60 years into the future, and not thousands of years as presented by Mr. Mason Bolitho during the May 16, 2015 Public Hearing. He considered only groundwater in storage and did not consider the cost to pump groundwater and its impact on the economy of the sub-basin.

Table 8 - Impact of Increasing Depth to Groundwater on Farm Profit

		Current Annual Farm Profit									
		15%	15%	15%	10%	10%	10%	5%	5%	5%	
		Water Cost as a Percent of Total Farm Expenses									
Year	Water Cost Multiplier	10%	20%	30%	10%	20%	30%	10%	20%	30%	Scenario Average Profit
2015	1.00	15%	15%	15%	10%	10%	10%	5%	5%	5%	10%
2030	1.33	12%	9%	7%	7%	4%	1%	2%	**-1%**	**-4%**	4%
2060	1.47	11%	7%	3%	6%	1%	**-3%**	**1%**	**-4%**	**-8%**	1%
2090	1.62	10%	4%	**-1%**	4%	**-1%**	**-7%**	**-1%**	**-7%**	**-13%**	**-1%**
2115	1.74	9%	2%	**-4%**	3%	**-3%**	**-10%**	**-2%**	**-9%**	**-16%**	**-3%**

For comparison, the ADWR model results for 2115 show an average depth to water of about 350 feet in the irrigation pumping centers compared to 430 feet for our analysis. The difference occurs because ADWR did not include the full future irrigation demand for lands currently irrigated as explained in Section 5. Even though ADWR's analysis did not include the full future irrigation demand, it is useful because it confirms that the uneconomic point for irrigated agriculture is far less than thousands of years.

The ADWR 2115 non-pumping depth to water of 350 feet occurs in our analysis in 2060, which as shown in Table 8 is approximately the pumping depth (370 feet) that irrigation becomes uneconomic. So, the ADWR forecast nearly reaches the uneconomic depth to water in 2115. This demonstrates that inevitably, an uneconomic result occurs in no more than 100-120 years regardless of the withdrawal rate.

The economic limit is reached sooner than 2075 if the irrigated land increases beyond current limits. To demonstrate this, we increased the pumping 25 percent from 66,500 af/yr to 83,000 af/yr in the groundwater flow model. The simulation predicts that the depth to water reaches 370 feet in the irrigated areas in 2055. This shortens the remaining time when irrigation is profitable to approximately 40 years.

8 CONCLUSIONS

Based upon our analysis, we conclude that "There is insufficient groundwater to provide a reasonably safe supply for irrigation of the cultivated levels in the area at the current rates of withdrawal." Therefore, the director of ADWR should designate the San Simon Sub-basin as an irrigation non-expansion area (INA) because the economic life of the currently irrigated farms is on the order of 50 to 60 years and not thousands of years as was suggested by several at the May 16, 2015 Public Hearing. If the INA is not designated and additional acreage becomes irrigated, the rate of water level decline in the basin will accelerate and shorten the remaining economic life to significantly less than 50 to 60 years and negatively impact the economy of the sub-basin. In either case, the relatively short remaining economic life of the aquifer is inconsistent with the reasonably safe language in the INA statute.

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