

Impact of San Felipe Springs on the Rio Grande

for the *Rio Grande Regional Water Authority*



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A Division of Leggette, Brashears & Graham, Inc.

Photograph on cover from
<http://www.edwardsaquifer.net/sanfelip.html>
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Executive Summary

At the request of NRS Consulting Engineers on behalf of the Rio Grande Regional Water Authority, LBG-Guyton Associates has performed a preliminary study to evaluate San Felipe Springs in Val Verde County, Texas and their impact on flow downstream to the Rio Grande. An evaluation of the general hydrology, information on current and past flow conditions of San Felipe Springs and potential impact to inflows into the Rio Grande was made.

The City of Del Rio depends on the San Felipe Springs for their water supply. Del Rio has a surface water right to 11,416 acre-feet/year (ac-ft/yr), which is taken from the spring lake of the East Spring. For the West San Felipe Spring, pumps are installed into caverns that feed directly into the spring lake. Historically, the water produced from the West San Felipe Spring has been considered groundwater by the State of Texas because the pumps are installed into a cavern prior to becoming surface water. In recent years, the City's usage has been about 2.6 billion gallons per year or about 8,100 ac-ft/yr, which is distributed to both the City and Laughlin Air Force Base (AFB).

The City of Del Rio has recently constructed a microfiltration plant with a maximum capacity of about 18.2 million gallons per day. If the treatment plant is operated continuously, the maximum capacity is about 20,000 ac-ft/yr. Average discharge from San Felipe Springs is about 238 ac-ft/day and at full capacity the microfiltration plant can treat about 23 percent of that total springflow.

Downstream from the Springs prior to the confluence of the Rio Grande, water has historically been removed from San Felipe Creek for irrigation. San Felipe Manufacturing and Irrigation Company has a surface water right to remove up to 5,012 ac-ft/yr. Recent irrigation usage has only been a small portion of the total permitted amount, about 1,500 ac-ft/yr.

In recent years, the City of Del Rio has received funding to repair old infrastructure, which has greatly reduced their water losses. As a result, annual usage has declined by about 2 billion gallons or about 6,100 ac-ft/yr. Anticipated growth in Val Verde County over the next 50 years is to add about 5,000 ac-ft/yr to the existing demand of about 21,000 acre-feet of water per year. As a result, the additional demand over the next 50 years is anticipated to be less than the historic water usage prior to the new conservation efforts.



Historically, San Felipe Springs has accounted for a relatively small overall contribution of about 8 percent of the total volume of water in the Rio Grande near Del Rio. Discharge from San Felipe Springs may be impacted by increased groundwater production in areas that recharge the Springs. The impact of increased groundwater withdrawal from new wells to springflow is hard to predict but is dependent on the proximity of the withdrawal location to the Springs. If new wells are at or near the Springs, then the withdrawal ratio from the aquifer will be near one to one compared to springflow. If any new wells or additional pumpage are located some distance away from the Springs, then the withdrawal ratio will be less than one to one comparing quantities of new pumpage to lost springflow and available water to San Felipe Creek.



Introduction

At the request of NRS Consulting Engineers on behalf of the Rio Grande Regional Water Authority, LBG-Guyton Associates performed a “desktop” study to evaluate the San Felipe Springs system and the impact of groundwater withdrawals on flow to the Rio Grande. Water from San Felipe Springs eventually makes its way to the Rio Grande, as it passes from the Plateau Water Planning Region to the Rio Grande Water Planning Region (Figure 1). Currently, groundwater models have not been constructed and calibrated that accurately represent the groundwater system in this area and therefore were not considered in this study. This report includes evaluating hydrology, available information on current and past flow conditions of the Springs and potential impact to the Rio Grande inflows due to groundwater withdrawal from the San Felipe Springs area.

Most water that falls as rain either runs off into streams and lakes, evaporates or transpires before the water can percolate downward into an aquifer. Net lake evaporation is about 60 inches in western Val Verde County. Only a very small percentage of total rainfall ever enters an aquifer as recharge. The combination of high temperatures, high potential evapotranspiration and intermittent rainfall totals in the Del Rio area combine to produce a semiarid climate with drought conditions during all or parts of some years (Bomar, 1995). The rainfall in Val Verde County decreases from east to west, from about 22 inches per year in the northeastern end of the county to about 12 inches per year in the western part of the county near Del Rio. Most of the rainfall occurs as thunderstorms with the highest amounts falling in September and May (averaging up to 2.5 inches per month) and the driest winter months averaging a little over 0.5 inches per month (top graph in Figure 2). The average annual rainfall over the period of record (1951 - 2008) at the Del Rio International Airport is 18 inches and has ranged from less than 10 inches to 33.2 inches in 1969 (bottom graph in Figure 2). Generally, the drought during the mid-1950s is considered the most severe drought of record.



San Felipe Springs

San Felipe Springs is one of 48 springs in Val Verde County identified by Brune (1981) and is considered the fourth largest spring in Texas. San Felipe Springs is actually a combination of about 10 individual springs emanating from the Edwards limestone that form the headwaters of San Felipe Creek, which is a tributary to the Rio Grande (Figure 1). The recharge area for San Felipe Springs is not precisely known but is surmised to be a large area extending into northern Val Verde, Kinney and Edwards Counties (Reeves and Small, 1973). Long periods of below-normal rainfall lead to reduced recharge and to lower water levels in the aquifer. As aquifer levels fall, the volume of water discharging from San Felipe Springs into San Felipe Creek decrease.

San Felipe Springs has never ceased flowing through recorded history. The very location for the City of Del Rio was originally placed in proximity to this historic pristine water source. Spring discharge at San Felipe Springs (US Geological Survey Gage 08-4528.00), which has been maintained by the International Boundary and Water Commission (IBWC), is plotted with monthly rainfall in Figure 3. A 3-month running average of rainfall is also plotted in Figure 3 to show the correlation between precipitation trends and springflow. The reported value for San Felipe springflow includes the gaged flow downstream in San Felipe Creek, plus the City of Del Rio's withdrawals and an amount of water withdrawn for an irrigation canal located upstream of the gaged location.

For the period of record since 1961, low flow at San Felipe Springs occurred during 1963 at about 2,000 ac-ft/ month (Figure 3). An acre-foot of water equals 325,851 gallons. The yearly total flow for 1963 was 36,580 ac-ft or a little more than an average of 50 cubic feet per second (cfs). Miscellaneous measurements by the USGS during the drought of the 1950s indicate an instantaneous low flow of about 25 to 30 cfs for San Felipe Springs (Reeves and Small, 1973). Since Lake Amistad was filled in 1968, average discharge from San Felipe Springs has increased and has averaged 7,167 ac-ft/month. The lowest flow after the Lake was filled occurred in 1996 at a little less than 4,000 ac-ft/month (Figure 3).



City of Del Rio Use

Two of the 10 springs that compose San Felipe Springs, referred to as the East Spring and West Spring, provide all the public water supply currently used by the City of Del Rio and Laughlin AFB. Pumps are installed in the San Felipe East Spring lake and into a cave that feeds into the San Felipe West Spring lake. Spring water is pumped through a microfiltration plant, treated with chlorine and then supplied to the City and Base.

The City of Del Rio has a water right authorizing it to divert up to 11,416 acre-feet per year (ac-ft/yr) from the surface-water portion of the Springs for municipal use. The City of Del Rio reports their usage to the State separately as surface water and groundwater. The water withdrawn from wells installed in the cave near the spring outlet at the West Spring is technically considered groundwater.

Monthly average and annual historic usage are shown in Figure 4. Much of the annual variation seen between surface water and groundwater usage on the bottom graph of Figure 4 is believed to be reporting inconsistencies by the City of Del Rio to the State. The monthly usage for groundwater peaks in July at a little more than 200 million gallons per month (over 600 ac-ft/month). The reported surface water use peaks in August at almost 300 million gallons per month (over 900 ac-ft/month) (top graph in Figure 4). The general trend in the annual usage shown in the bottom graph of Figure 4 is upward from a low of just over 1 billion gallons per year (over 3,000 ac-ft/yr) to a high of over 6 billion gallons per year (over 18,400 ac-ft/yr). In recent years, the City of Del Rio has received funding to repair old water lines and storage tanks and has greatly reduced the water losses in the water system. This is likely the cause for the recent decrease of about 2 billion gallons (6,100 ac-ft/yr) in annual usage down to the reported 2.6 billion gallons (about 8,100 ac-ft/yr) in the year 2007.

Maximum capacity of the City's microfiltration plant is 18.2 million gallons per day (55.8 ac-ft/day), which if operated at full capacity year round would give about 20,000 ac-ft/yr. San Felipe Springs averages about 238 ac-ft/day. At full capacity, Del Rio can extract and treat about 23 percent of the average daily flow from the Springs.



Irrigation and Other Surface Water Gaging

Irrigation water is also removed from San Felipe Creek downstream of the Springs prior to its confluence with the Rio Grande. Figure 5 is the irrigation survey for the year 2000 and shows that most of the irrigation in Val Verde County occurs downstream of San Felipe Springs. The historic estimate of irrigation in Val Verde County has ranged from 1,350 ac-ft/year to about 2,400 ac-ft/yr and is shown with the irrigated acreage in the graph of Figure 6. San Felipe Manufacturing and Irrigation Company has a water right authorizing it to divert 4,962 ac-ft/yr for irrigation use and 50 ac-ft/yr for industrial use from San Felipe Creek. The total authorized surface water amount withdrawn from San Felipe Creek is 16,428 ac-ft/yr with the other irrigation and industrial permitted uses; however, this does not include water that is considered groundwater that is removed from near the Springs by the City of Del Rio.

Several gaging stations with historical data are located along the Rio Grande and are shown on Figure 1. A graph showing the gaged stream discharge at these stations is given in Figure 7. The following table summarizes the range and average flow in cfs since 1961 at each station:

Station	Rio Grande below Amistad Dam	Rio Grande at Del Rio and Acuna	San Felipe Springs	San Felipe Creek	Maverick Canal Diversion near Mile 13	Rio Grande at Jimenez and Quemado	Rio Grande at Eagle Pass
Maximum	61,094	113,713	188	16,386	1,780	3,528	134,549
Minimum	42	3	52	7	0	3	173
Mean	2,215	1,583	124	108	1,200	1,002	2,742

All values in cubic feet per second

Four of the the above listed gaging sites are located on the Rio Grande staggered from just below Lake Amistad downstream to Eagle Pass. In general, flow increases downstream from Lake Amistad to Eagle Pass, except for the Rio Grande at Jimenez/Quemado (US Geological Survey Gage 08-4557.00). The Maverick Canal gaging station (US Geological Survey Gage 08-4539.00 seen on Figure 1) measures water withdrawn from the Rio Grande for hydro-electric generation and irrigation use and results in decreased flows in the Rio Grande at that point. The other two gaging stations are for San Felipe Springs (US Geological Survey



Gage 08-4528.00) and San Felipe Creek (US Geological Survey Gage 08-4530.00), which contribute flow into the Rio Grande downstream of the Del Rio gaging station (US Geological Survey Gage 08-4518.00 seen on Figure 1).

As mentioned above, the official San Felipe springflow discharge data includes water taken out by the City of Del Rio and for one irrigation canal. The location of the gaging station for San Felipe Creek is downstream of San Felipe Springs near its confluence with the Rio Grande (Figure 1). The baseflow of the Creek is generally less than the reported flow for San Felipe Springs (Figure 8). The Creek flow is affected not only by withdrawals by the City of Del Rio and for irrigation but by the storm water runoff that results in extreme high stream flow spikes (Figure 8). During high flow events on the Rio Grande, the flow from San Felipe Creek contributes a relatively small portion, sometimes less than 0.1 percent, of the total flow in the Rio Grande near Del Rio. However, when the flow in the Rio Grande is low the percent contribution from San Felipe Springs increases and may constitute a majority of the baseflow to the River. For the period of record since 1961, the composite volume of water contributed from San Felipe Springs is about 8 percent of the total cumulative volume of water in the Rio Grande at Del Rio.



Future Projections

According to the State Data Center and U.S. Census Bureau's census, population in Val Verde County has been on a steady incline throughout history (top graph in Figure 9). Projections of regional population (blue bars on the top graph in Figure 9) and water demand (bottom graph in Figure 9) were developed in cooperation with the Texas Water Development Board, other state agencies and the 2006 Plateau Region Water Plan. In general, the population of Laughlin AFB has been fairly constant and is currently projected to remain that way. However, depending on future military circumstances, the size of the Base could grow more than is currently projected.

Based on data from the Plateau Regional Water Planning Group, demand for water in Val Verde County is projected to increase about 5,000 ac-ft/decade from a little less than 21,000 ac-ft/yr in 2010 to about 26,000 ac-ft/yr by the year 2060 (bottom graph in Figure 9). This amount does not consider any possible groundwater development and transport out of the County to other destinations. Since surface water in the Rio Grande Basin is largely allocated, much of the additional water produced in the County is likely to come from groundwater. The City of Del Rio has three wells that can produce water north of town but the City is not currently utilizing any of those wells.



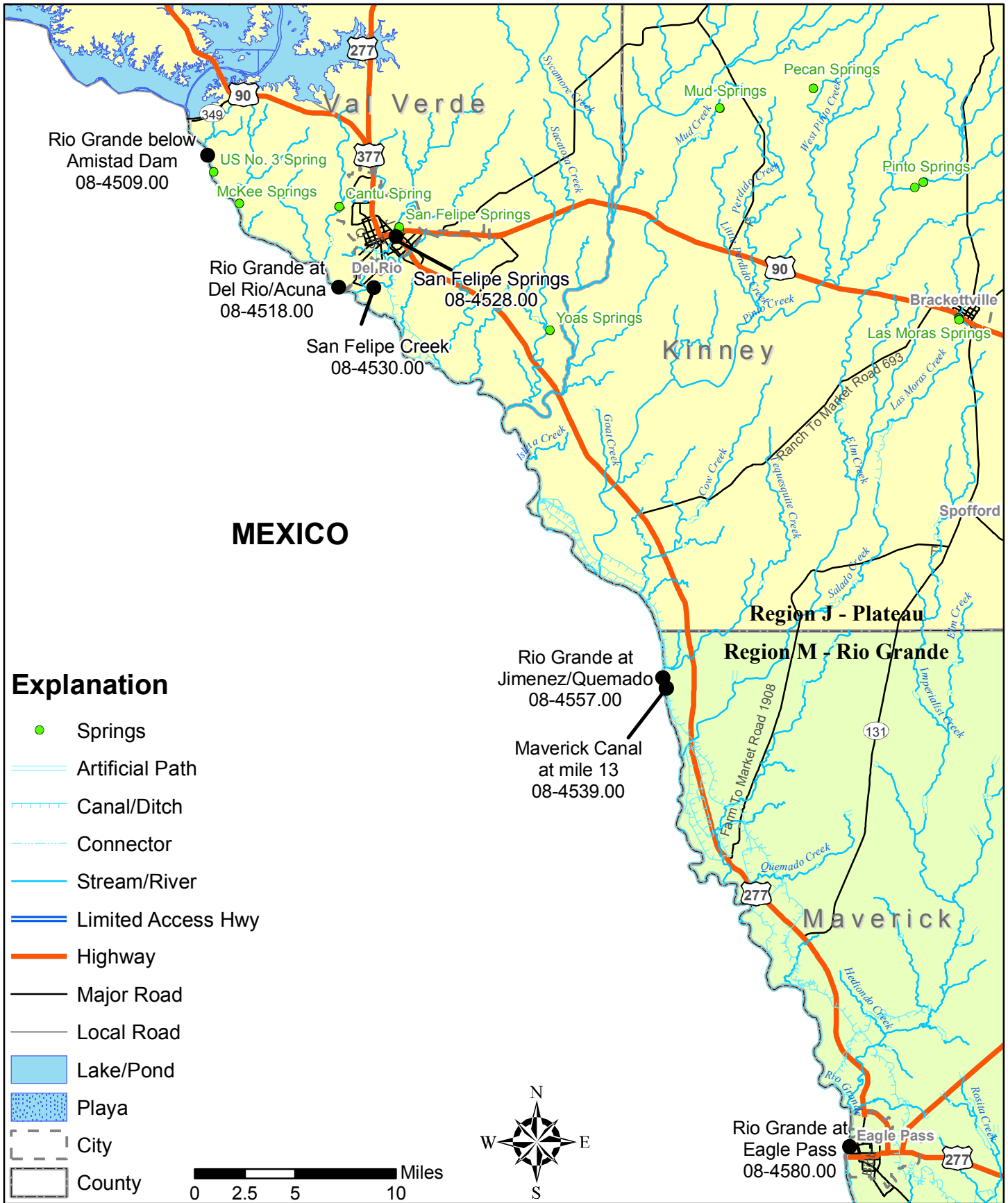
Conclusions

Historically, the San Felipe Springs system has accounted for a relatively small overall contribution (8 percent) of the total volume of water to the Rio Grande near Del Rio. Water withdrawn from the Springs by the City of Del Rio has declined in recent years as a result of improvements in their infrastructure. Projections for future use in the next 50 years are not anticipated to be any greater than the historic usage prior to the infrastructure improvements. Discharge from San Felipe Springs can be impacted by increased groundwater production in areas that recharge the Springs. The impact of increased groundwater production from wells to decreased springflow is hard to predict but is dependent on the proximity of the pumping location to the Springs. If new wells are at or near the Springs, then the withdrawal ratio from the aquifer will be near one to one in the amount decreased from springflow. If new wells are located some distance away from the Springs, then the withdrawal ratio will be less than one to one comparing groundwater pumpage to decreased springflow. In order to track future impacts to springflow, the location and amount of groundwater produced needs to be recorded and measurements of accurate spring and creek discharge need to be continued.



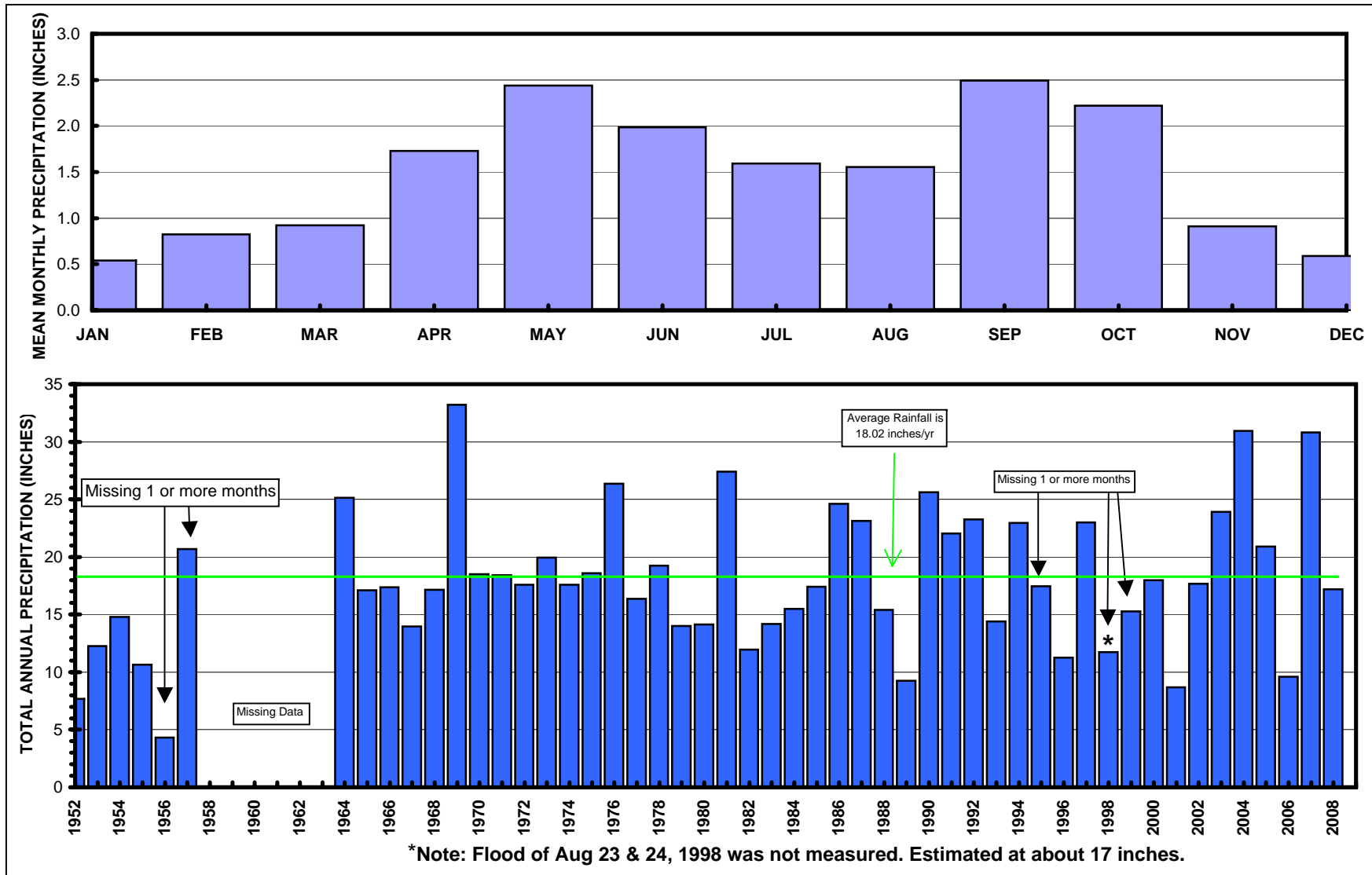
FIGURES





SITE MAP SHOWING STREAM GAGING STATIONS FROM AMISTAD TO EAGLE PASS





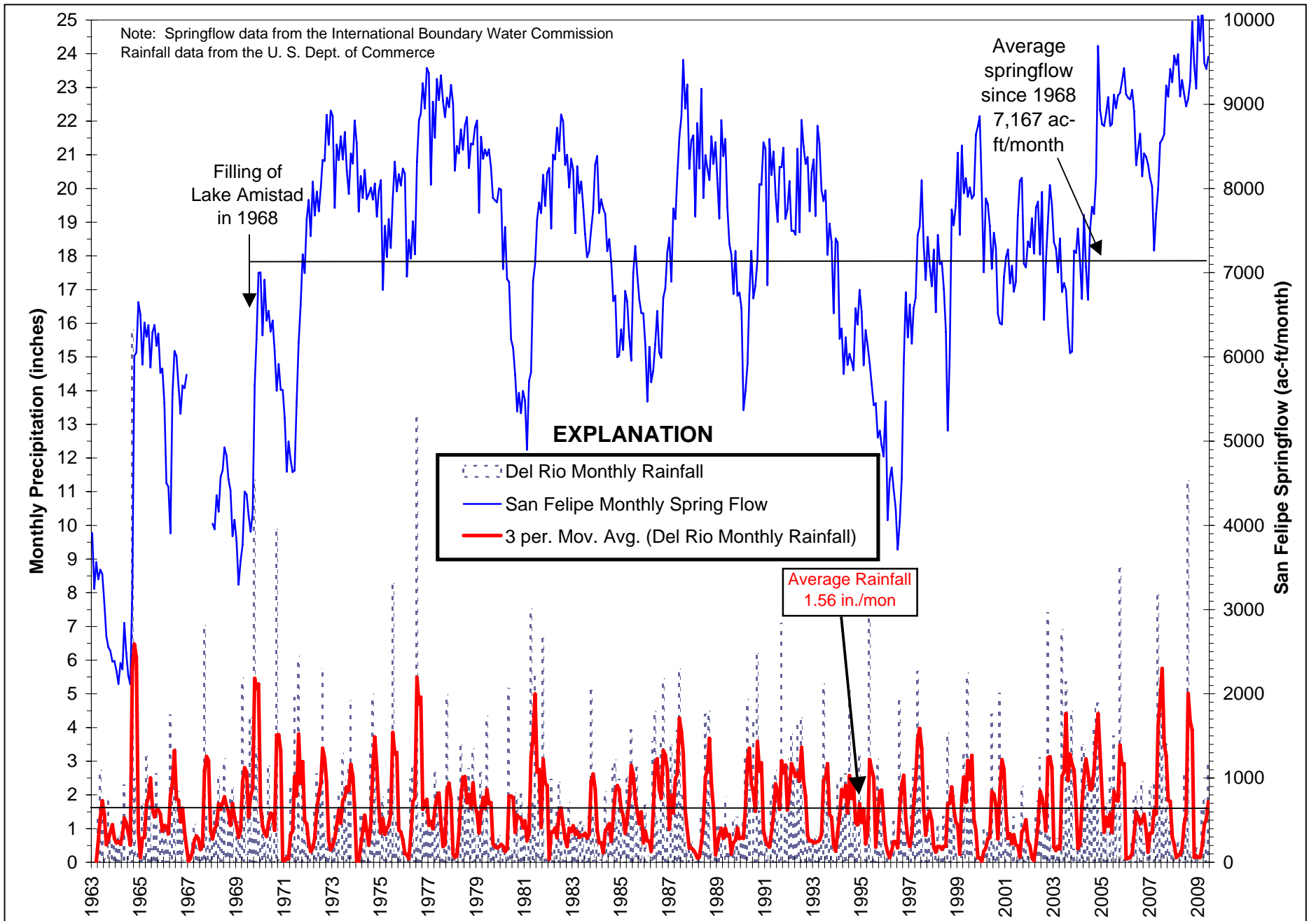
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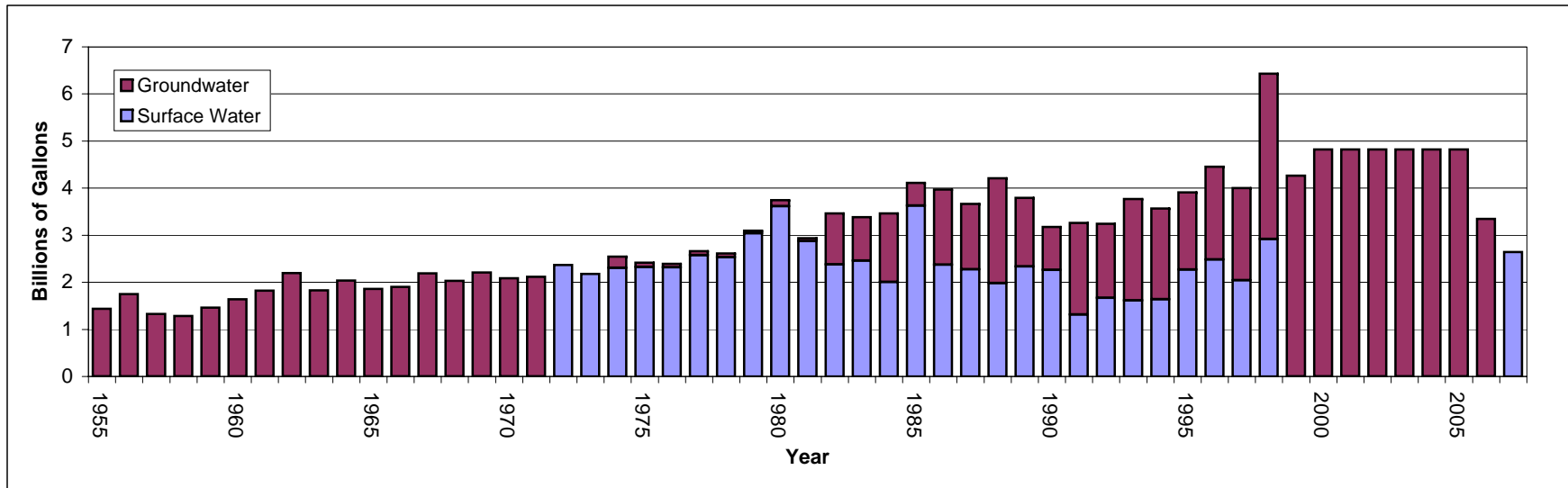
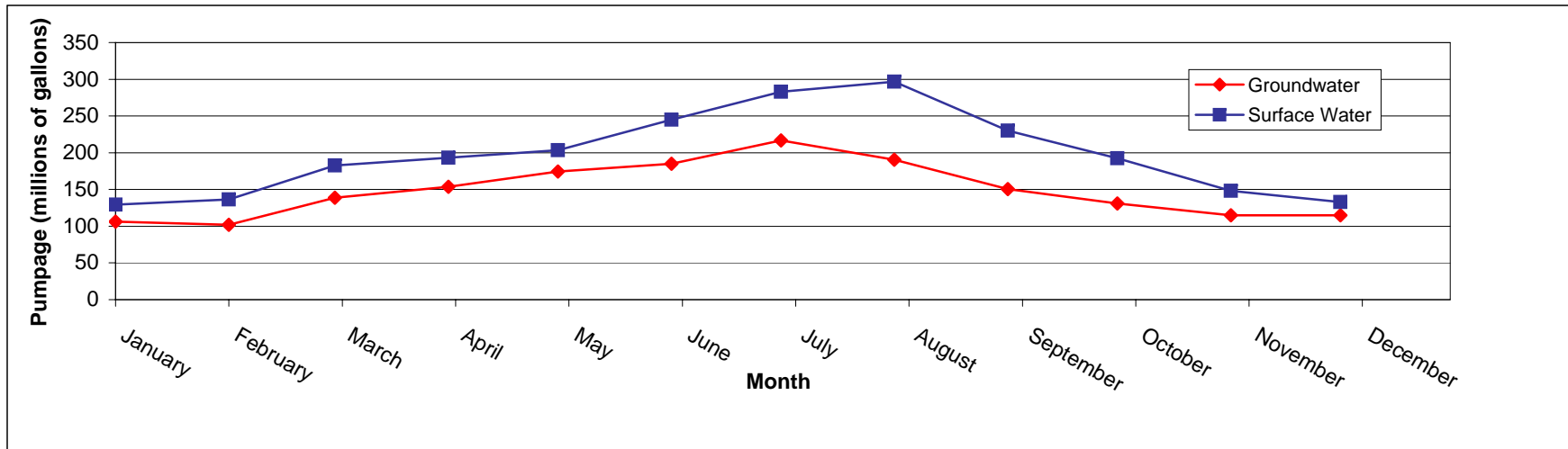
**MEAN MONTHLY AND HISTORIC TOTAL ANNUAL PRECIPITATION AT
DEL RIO INTERNATIONAL AIRPORT, VAL VERDE COUNTY, TEXAS
1951 - 2008**



LBG-GUYTON ASSOCIATES

FIGURE 2



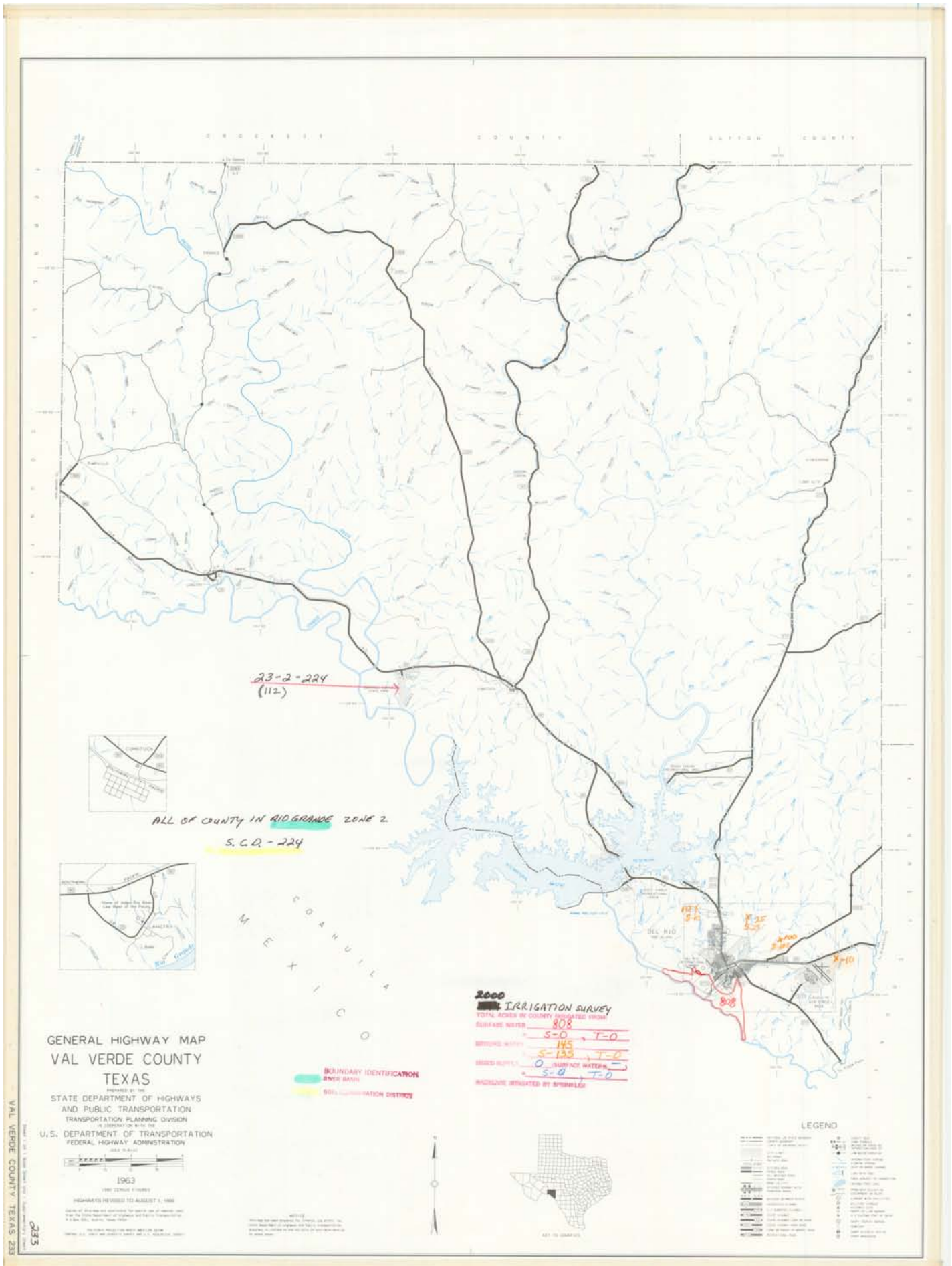


MEAN MONTHLY AND HISTORIC TOTAL WATER USE BY THE CITY OF DEL RIO, VAL VERDE COUNTY, TEXAS



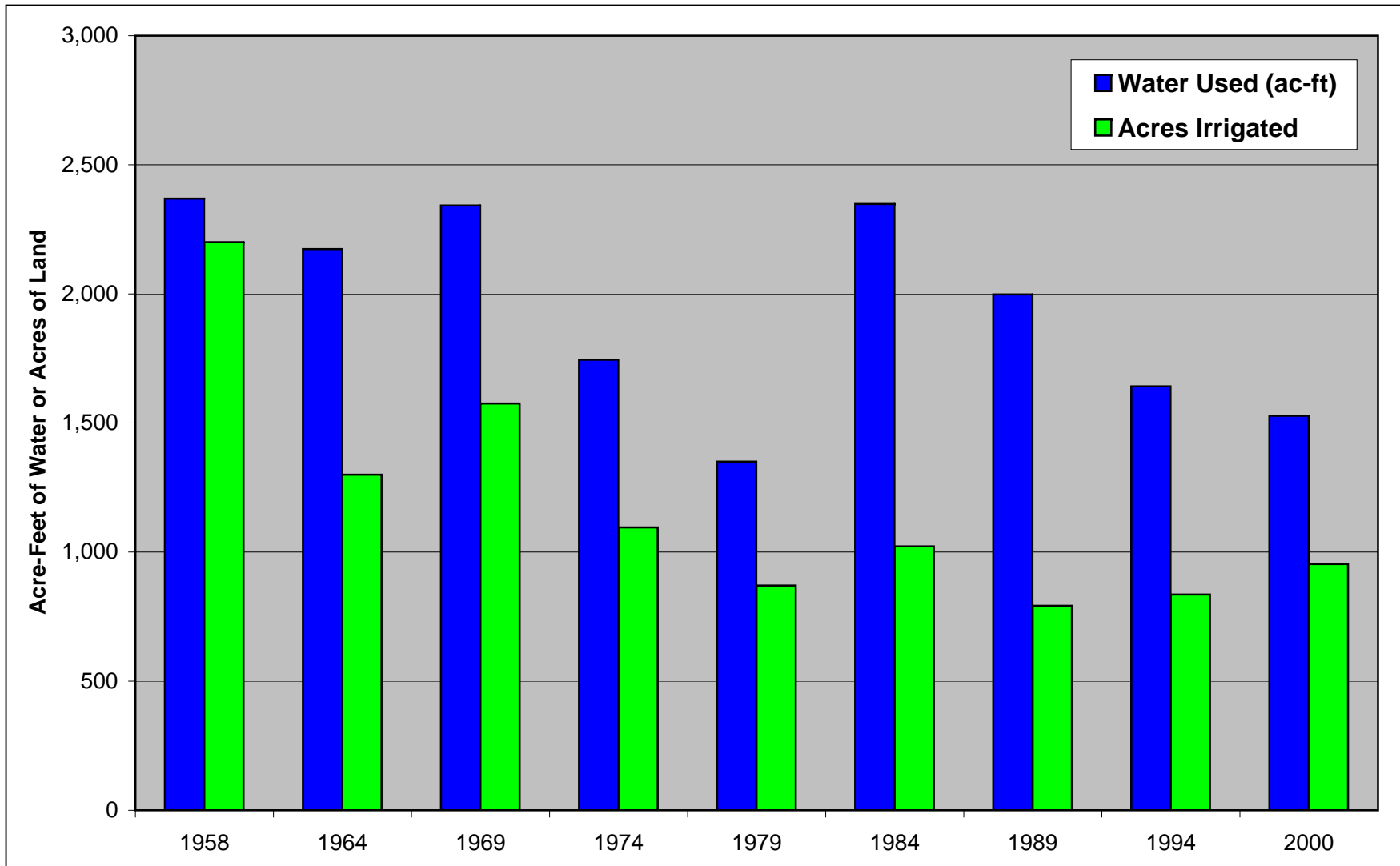
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FIGURE 4



VAL VERDE COUNTY IRRIGATION SURVEY

FIGURE 5

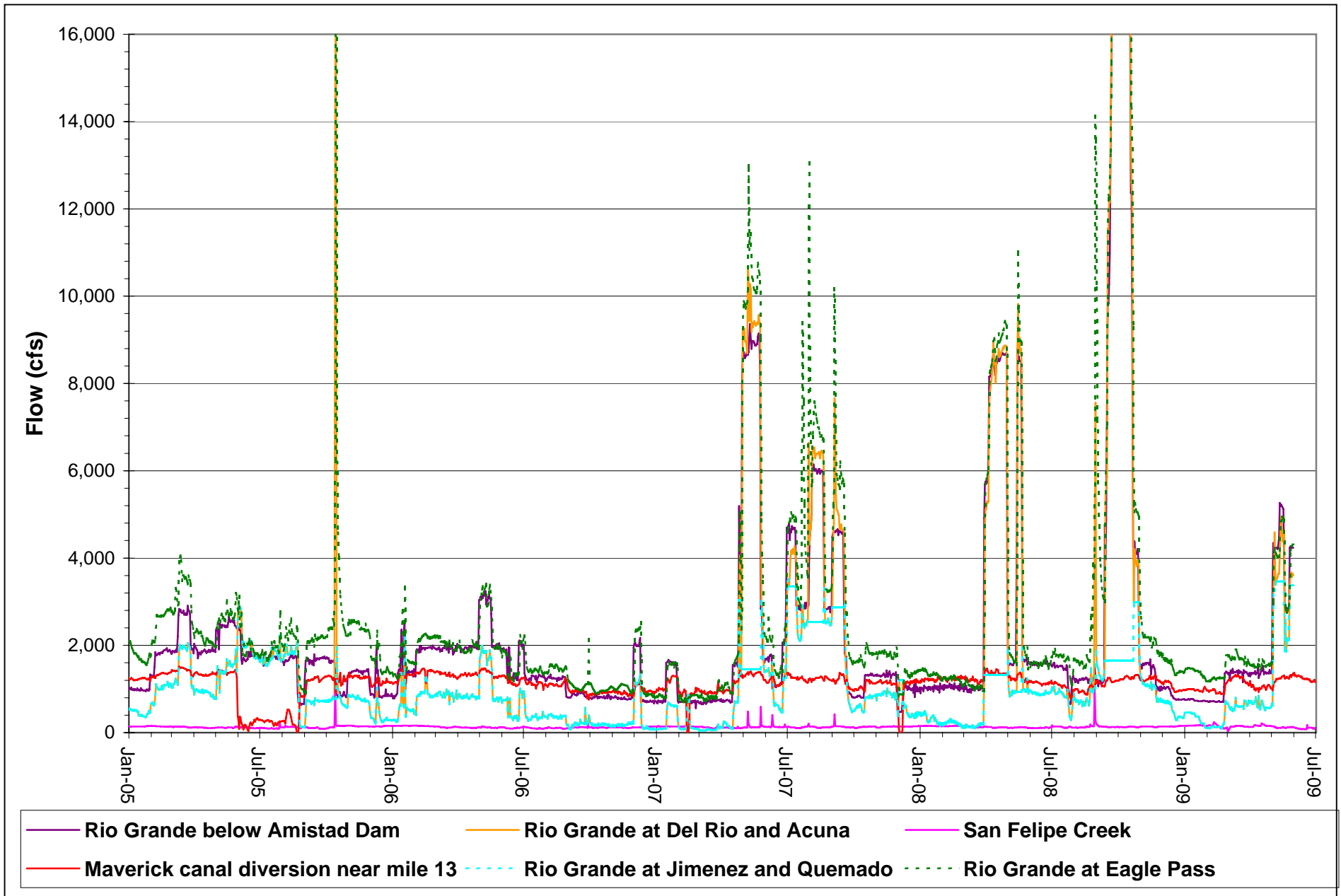


HISTORIC IRRIGATION IN VAL VERDE COUNTY



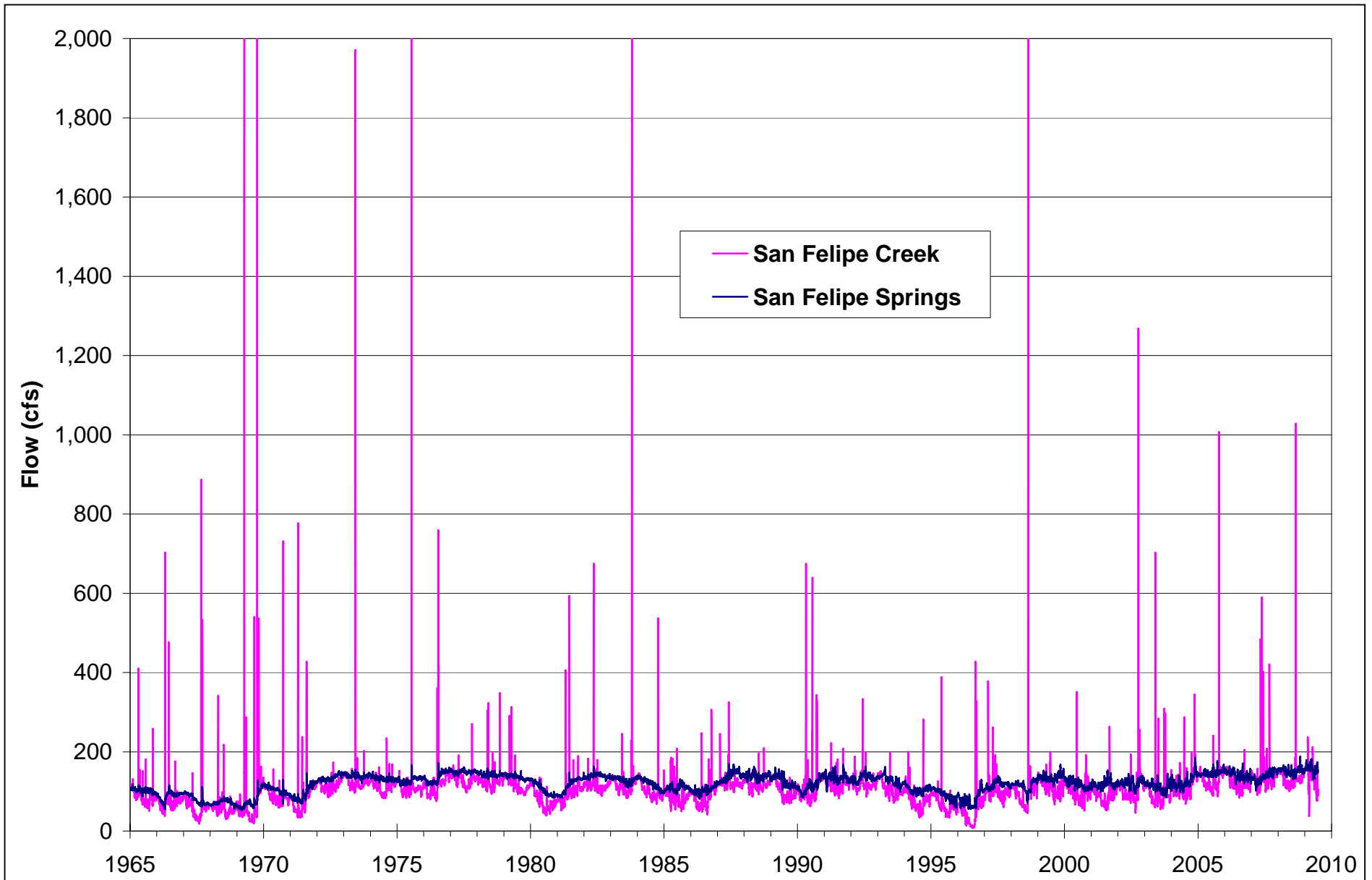
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FIGURE 6



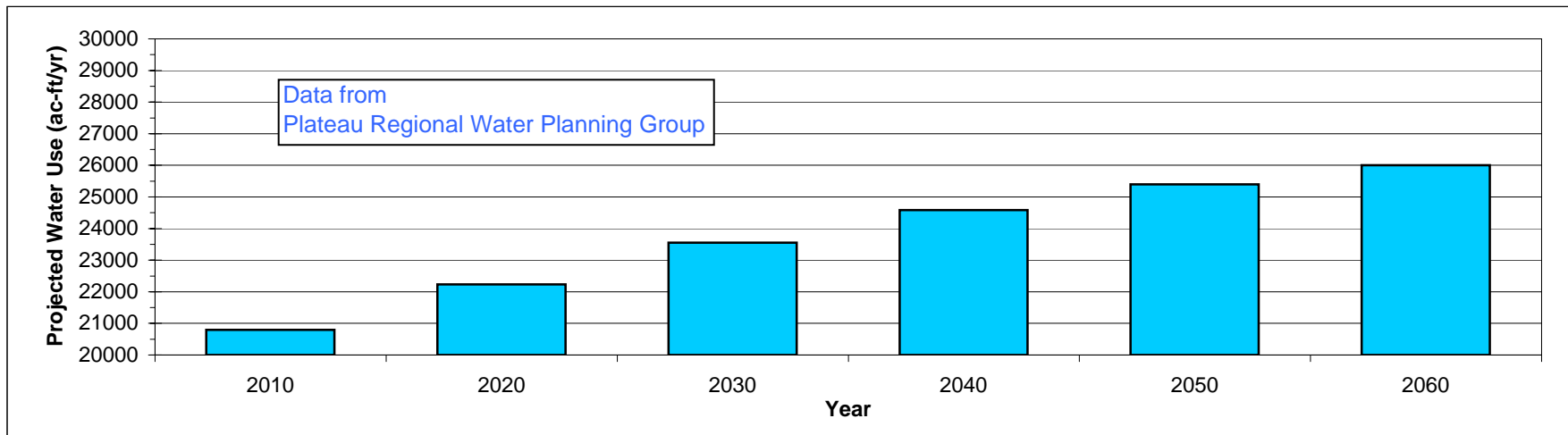
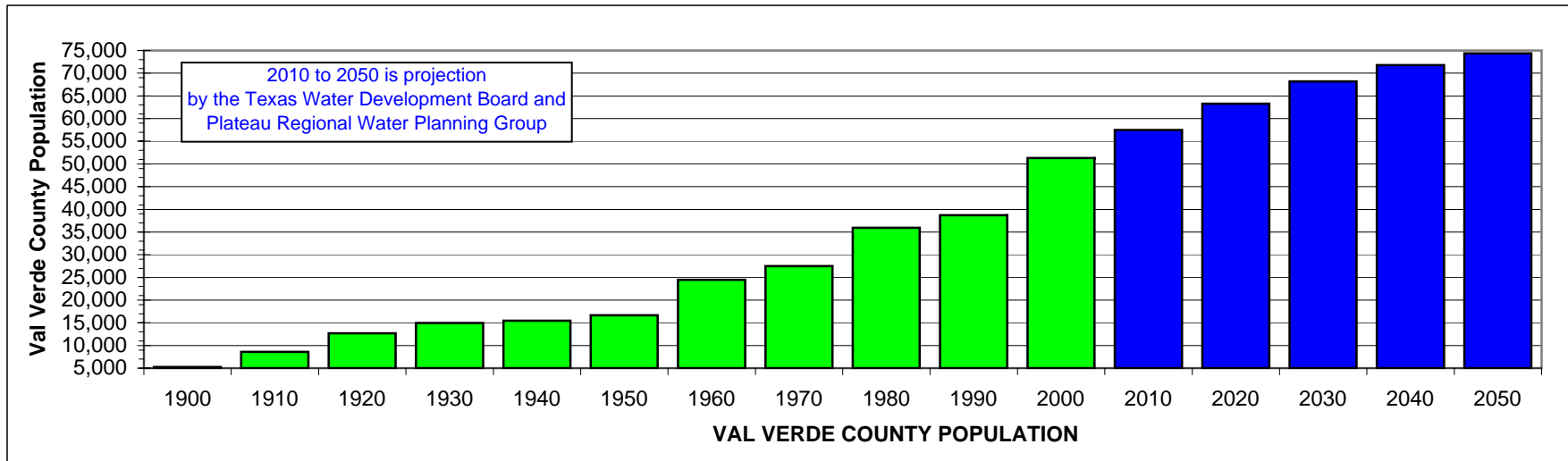
**FLOW HYDROGRAPH OF RIO GRANDE AND
OTHER RELEVANT SURFACE WATER
FROM 2005-2009**





HYDROGRAPH OF FLOW FOR SAN FELIPE SPRINGS AND CREEK





**HISTORIC AND PROJECTED POPULATION AND
WATER USE FOR VAL VERDE COUNTY, TEXAS**

