

**DECLARATION OF RICH BURTELL ON THE
NON-NAVIGABILITY OF THE SANTA CRUZ RIVER
AT AND PRIOR TO STATEHOOD**

*In re Determination of Navigability of the Santa Cruz River
(Case No. 03-002-NAV)*

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I. INTRODUCTION AND SUMMARY OF OPINIONS

1. I am a Registered Geologist (AZ No. 33746) and Principal at Plateau Resources, LLC (Plateau) with degrees in hydrology and geology.

2. Before founding Plateau, I worked at the Arizona Department of Water Resources (ADWR) for twelve years. At ADWR I was manager of the Adjudications Section and, as manager of that section, was frequently involved in evaluating the nature and occurrence of surface water in Arizona streams.

3. My education, experience, and expertise are detailed in my *Curriculum Vitae*, included as **Attachment A**.

4. I have been asked by Freeport-McMoRan Corporation (Freeport) to evaluate the navigability of the Santa Cruz River at and prior to statehood. This declaration provides supplemental evidence in a case currently before the Arizona Navigable Stream Adjudication Commission (ANSAC). On October 22, 2012, ANSAC voted to reopen the record for receiving evidence on six remanded cases. These cases address the navigability of the Gila River, San Pedro River, Santa Cruz River, Lower Salt River, Upper Salt River and the Verde River.

5. In evaluating the navigability of the Santa Cruz River, I am mindful that ANSAC intends to receive, review, and consider evidence on two issues: (a) the navigability or non-navigability of the Santa Cruz River in its “ordinary and natural condition” prior to the State of Arizona’s admission to the United States on February 14, 1912, consistent with the Arizona Court of Appeals decision in *State v. Arizona Navigable Stream Adjudication Comm’n*, 224 Ariz. 230, 229 P.3d 242 (App. 2010); and (b) segmentation of the San Pedro River consistent with the United States Supreme Court’s decision in *PPL Montana, LLC v. Montana*, 556 U.S. ___, 132 S.Ct. 1215 (2012).

6. In preparing this declaration, I reviewed: (a) the evidence compiled for ANSAC’s first Santa Cruz hearing (Hearing No. 03-002-NAV); (b) ANSAC’s October 18, 2006 document *Report, Findings and Determination Regarding the Navigability of the Santa Cruz River from the Mexican Border to the Confluence with the Gila River*; (c) legal memoranda filed in 2012 by various parties regarding the Santa Cruz River and posted on ANSAC’s website (www.ansac.az.gov); and (d) authorities cited in those legal memoranda. If additional information becomes available, I reserve the right to revise or supplement my opinions.

7. Based on my review of existing information and the supplemental evidence presented here, it is my opinion that the Santa Cruz River was not susceptible to navigation in its ordinary and natural condition at and prior to statehood. It is also my opinion that if the San Pedro River was divided into segments, none of the segments would have been navigable at that time.

8. The remainder of this declaration is organized into five sections –

Segmentation (Section II), Upper Reach (Section III), Middle Reach (Section IV), Lower Reach (Section V) and Conclusions (Section VI). References cited herein follow the last section. A map showing the general location of the Santa Cruz River and important geographic and cultural features is presented in **Figure 1**.

II. SEGMENTATION

9. The Court in *PPL Montana* found that practical considerations support the segmentation of rivers when determining navigability:

Physical conditions that affect navigability often vary significantly over the length of a river. This is particularly true with longer rivers, which can transverse vastly different terrain and the flow of which can be affected by varying local climates...These shifts in physical conditions provide a means to determine appropriate start points and end points for the segment in question. Topographical and geographic indicators may assist.

10. In its June 2012 memorandum on the effects of *PPL Montana*, the Arizona State Land Department (ASLD) agreed with the Court's findings and recommended that ANSAC consider several segmentation factors including (a) whether the river is located in a canyon or runs through flats or wide river valleys; (b) the river's flow rate; (c) the classification of rapids by degree of difficulty; (d) whether the river is a gaining or losing stream; and (d) the river's slope or steepness (pp.2 and 7). Based on these factors, ASLD recommended that the Santa Cruz River be divided into three segments (p.7):

- Headwaters to Mexican Border – “The river is a relatively small stream flowing in broad alluvial valleys, and flows into Mexico. Very low flow rates. No record of historical or modern boating.”
- Mexican Border to Marana – “Normally dry river in broad alluvial river. Some possibility that some segments had very shallow perennial or intermittent flow. No record of historical or modern boating, except during floods or effluent discharges from wastewater treatment plants.”
- Marana to Gila River Confluence – “Historically dry river in broad alluvial valley with no historical or modern boating record.”

11. In their September 2012 memorandum on the navigability of the Santa Cruz River, the Arizona Center for Law in the Public Interest (ACLPI) indicated that “for purposes of a segment by segment analysis” the segments proposed by ASLD are “logical stretches to consider.” (p.11)

12. While my opinion is that no segment of the Santa Cruz was navigable or susceptible to navigation, I agree with ASLD that it is useful to divide the Santa Cruz River into three segments for purposes of addressing stream characteristics and evaluating navigability. I also agree with ASLD's recommended start and end points, with one exception. Rather than stopping the middle segment at Marana, I extend the middle Santa Cruz about 29 river miles downstream where the channel of the Santa Cruz River historically first became undefined and its streamflow spread

out across Santa Cruz Flats.¹ The Santa Cruz River passes about 2 miles southwest of Marana in Section 33 of Township 11 South (T11S), Range 11 East (R11E) while Santa Cruz Flats begins in about Section 29 of T8S, R8E. For reference, survey maps from the General Land Office (GLO) that cover this portion of the river are presented in **Appendix B** and show where the river channel historically ended. All of these GLO maps were surveyed on or before 1905 except for the map covering T11S, R10E, which was surveyed in 1911. Note that Greene's Canal, which caused much of the river's flow downstream of Marana to be diverted around Santa Cruz Flats, was completed in 1913 and later destroyed by flooding between 1914 and 1915. (Fuller, 2004a, Section 4, p.54) The GLO maps therefore predate this canal.

13. Northwest of Casa Grande, runoff from Santa Cruz Flats, Greene and Santa Rosa Washes, and other intervening tributaries collects and forms Santa Cruz Wash, a relatively poorly defined ephemeral stream with multiple channels. This wash becomes better defined about 10 miles upstream of its confluence with the Gila River (see **Figure 1**). This last reach of the Santa Cruz River is best addressed in combination with Santa Cruz Flats.

14. Based upon the foregoing, I have divided the Santa Cruz River into the following three segments and have organized the remainder of my declaration accordingly:

- Headwaters to Mexican Border (Upper Reach)
- Mexican Border to Santa Cruz Flats (Middle Reach)
- Santa Cruz Flats to Gila River Confluence (Lower Reach).

III. UPPER REACH

15. This section of my declaration describes the Upper Reach of the Santa Cruz River, which was not susceptible to navigation in its ordinary and natural condition at or prior to statehood. Two lines of evidence are presented – historic accounts and streamflow records. Historic accounts indicate that flow in the Upper Reach was discontinuous with both perennial and ephemeral sections (interrupted perennial). Streamflow records indicate that where flow was more regular, stream depths were typically too shallow for commercial boat travel.

16. My conclusion regarding the navigability of the Upper Reach is consistent with that recently reached by ACLPI. In their September 2012 memorandum, ACLPI urges ANSAC to find that sections of the middle segment of the Santa Cruz River were navigable. (p.16) However, ACLPI does not argue that the Upper Reach was navigable.

A. Historic Accounts

17. As shown in **Figure 2**, the Santa Cruz River begins in the Canelo Hills, crosses the San Rafael land grant, and then flows into Mexico at a point about 1.5 miles east of Lochiel. From its headwaters to the International Border, this segment of the Santa Cruz River covers approximately 14 stream miles.

ⁱ Stream miles presented in this reported were approximated by Plateau using digital planimetry of current 1:24,000 USGS topographic maps.

18. In 1880, the U.S. Surveyor General recorded the testimony of five residents of the town of Santa Cruz who had knowledge of the land grant during the 1830s and/or 1840s. Two of these residents discussed the occurrence of water in the Santa Cruz River (Hadley and Sheridan, 1995, pp.24-25).

19. Jose Maria Montoya, age 58, recounted that the ranch was well occupied with several thousand cattle in 1834 but, by 1843, this stock had been driven away or killed by Apaches. Ranchers were also killed by Apaches and, according to Mr. Montoya, “it was not safe at any time after 1834” for families to establish themselves in the area. Regarding the occurrence of water, he indicated that “water first rises in the river” near the center of the land grant. In response to the question of how much running water was available, he answered “the water rises and sinks in different places and more than half the distance in the aggregate there is no running water.”

20. Alejandro Apadaco, age 47, when asked by the U.S. Surveyor General how many leagues (a length of about 2.6 miles) of the land grant contained running water, answered “I cannot say. Perhaps the half more or less.”

B. Streamflow Records

21. **Table 1** lists median monthly streamflows measured at a gage on the Santa Cruz River near Lochiel from 1948 through 2012. The U.S Geological Survey (USGS) gage is located along the southern border of the land grant, about 1.7 miles upstream from the International Border (**Figure 2**). According to Fuller (2004b, p.7-9), “median (50%) flow rates are probably best representative of ‘typical’ flow conditions...floods with high peaks tend to skew the average...”

22. Also listed in **Table 1** are average stream depths estimated using the median monthly streamflows and a rating curve developed by Plateau. The rating curve is shown in **Figure 3** and was based on nearly 250 field measurements taken at the gage site by the USGS between 1977 and 2011.ⁱⁱ

23. Stream depths estimated at the gage near Lochiel were typically less than 1 foot for all months in the period of record. Such shallow water would have precluded commercial boat travel along this segment of the Santa Cruz River.

24. Although the Lochiel streamflow data were collected after statehood, they are useful in evaluating ordinary and natural streamflow conditions because of the relatively minor diversions noted above the gage.ⁱⁱⁱ Hadley and Sheridan (1995, pp.195) describe that there were less than 200 acres of irrigated lands in the San Rafael Valley during the 1920s and 1930s. In 1950, the USGS reported only “small diversions for irrigation above station” and, in 2012, they reported “small diversions for irrigation of 200 acres above station mostly by pumping ground water.” Even during the height of the growing season, irrigation of 200 acres would not be expected to deplete, on average, more than 1 to 2 cubic feet per second (cfs) from the stream. If these diversions are added to the median streamflows presented in **Table 1** and then compared to the rating curve in **Figure 3**, typical stream depths still remain below one foot.

ⁱⁱ Cross sections of desert streams are rarely uniform in shape and often exhibit high points (islands and point bars) and low points (pools). The average depth of such streams represents the mean of the varying water depths encountered across its width, including both high and low points.

ⁱⁱⁱ As described in *State v. ANSAC*, use of more recent evidence is not precluded when assessing a river’s navigability and may be informative and relevant.

IV. MIDDLE REACH

25. This section of my declaration describes the Middle Reach of the Santa Cruz River, from the International Border to Santa Cruz Flats, which also was not susceptible to navigation in its ordinary and natural condition prior to statehood. This segment of the river covers approximately 128 stream miles. Three lines of evidence are presented here – historic accounts, streamflow records, and past and present boat use. Historic accounts indicate that flow in the Middle Reach was discontinuous for extended sections that would have required long portages. Where flow was more regular, historic accounts indicate that it was too shallow for commercial boat travel. Streamflow records and past and recent boat use further support the conclusion that commercial boat travel along the Middle Reach of the Santa Cruz River was impractical.

A. Historic Accounts

26. It is well documented that irrigation has been practiced along the Middle Reach of the Santa Cruz River for centuries, if not millennia (Fuller, 2004b, Sections 2 and 3). Depending on the extent of irrigation and variations in climate, it is likely that diversions have at times impacted river flows. In fact, during the Spanish and Mexican occupation, water shortages were reported during the irrigation season at both Tubac and Tucson (Meyer, 1984, pp.55-57, 65; Officer, 1987, p.113). Water shortages become more common in the 1870s as more Americans settled in the area and the watershed was further developed.

27. For purposes of this discussion, however, it is important to determine whether these diversions were substantial enough to impact the stream's susceptibility to navigation.

28. **Table 2** presents historic accounts of the Middle Reach of the Santa Cruz River made before 1860. The accounts were taken from various sources listed in the table along with their location, date and associated comments. I specifically selected accounts when irrigation diversions were minor due to the time of year (during or after the autumn harvest or in the winter when irrigation was light and natural evapotranspiration low) and/or in years in which Apache unrest in the area had significantly reduced local populations.^{iv}

29. The historic accounts in **Table 2** indicate that, in its natural and ordinary condition, the Middle Santa Cruz River had regular flow from Calabasas to near Canoa and at least three reaches of regular flow from San Xavier to a few miles north of Tucson. Where flow was regular, the accounts indicate that it was typically shallow (1 foot or less) and was, in places, narrow. Based on these and other accounts, Bentacourt (1990, p.58) summarized streamflows in the Middle Santa Cruz River as follows:

^{iv} In his assessment of the high incident of malaria among Mexican farmers, Assistant Surgeon Smart noted in 1869 that fields in the Tucson area produced “yearly two crops, one of small grain, such as barley or wheat, sown in November and harvested in May, the other of corn, planted in June and harvested in October...The spring rains occurring in February fetch up the first or small grain crop of the farmers.” (U.S. Surgeon General's Office, 1870, p.462-463). Due to its cooler climate, the growing season is shorter in the Tubac area than in Tucson (Davison, 2000) and small grains would have been sown somewhat later (Ottman, 2004). According to Logan (2006, p.125), winter crops at that time “typically received only two irrigations, then relied on winter rain to mature the crops.”

All accounts agree that the flow of the Santa Cruz first disappeared not far north of Tubac, near the ford at La Canoa...The flows from the Punta de Agua and Agua de la Mision springs disappeared at San Xavier and the eastern base of Martinez Hill, respectively. Permanent water reappeared 3.5 km (about 2 miles) north of Martinez Hill, quitting again in less than 2 km. Another brief stretch of perennial flow existed half way to Tucson in the northern half of Section 2, T15S, R13E...The evidence for where the flow disappeared north of Tucson is less clear.^v

30. The historic accounts also indicate that, even if there was sufficient water to conduct commercial navigation from Calabasas to Canoa, which there is no evidence for, a portage of approximately 24 miles would have been required before reaching the springs above San Xavier Mission. From that point, based on the historic accounts described above, still more portages would have been required as the stream headed generally northwesterly towards the Marana area. The stream then went dry again near Marana.

31. **Table 3** summarizes available data on the major irrigated areas along the Middle Santa Cruz River and their crop production during the Spanish, Mexican and Early American periods. Agricultural activity was erratic during this time, apparently due both to Apache unrest and changes in water availability. The data do show that, prior to increased settlement by Americans in the late 1860s, there were likely no more than 300 to 400 acres being irrigated at any given time from the International Border to Canoa, and less than a total of 1,000 acres of irrigation combined in the San Xavier and Tucson area. At the height of the growing season, irrigation along both reaches would not have depleted, on average, a total of more than 10 to 20 cfs from the stream. In light of the water shortages that Spanish and Mexican officials periodically recorded, there were times when streamflows were insufficient even for this limited agricultural demand. Clearly it would have been impractical to conduct commercial navigation under such flow conditions, even if there were no diversions.

B. Streamflow Records

32. **Table 4** lists median monthly streamflows measured at a USGS gage on the Santa Cruz River near Nogales from 1913 to 1920 and from 1930 through 1939. The gage was located about 6 to 7 miles downstream of the International Border during the earlier period of record and about 1 mile downstream of the border since that time. (**Figure 2**)

33. **Table 4** also notes average stream depths during the period that were estimated using the median monthly streamflows and a rating curve developed by Plateau. The rating curve is shown in **Figure 4** and was based on 200 field measurements taken by the USGS at the upstream gage site between 1975 and 2011.

34. Stream depths estimated at the gages near Nogales were typically less than 1 foot in 165 of the 169 months with record. Such shallow water would have precluded

^v Upstream of these various points where flow disappeared, the river would have transitioned from a gaining to a losing reach. Along the losing reach, flows would have diminished until there was eventually no surface water left in the stream. The historic accounts do not mention whether this decline in flow was gradual or abrupt. Nevertheless, a portion of the losing reach would have had very shallow water and would not have supported commercial navigation, regardless of the river's depth along the gaining reach.

commercial boat travel along this portion of the Santa Cruz River. Four months had median flows greater than 100 cfs, two during the monsoon in August and two during the winter months of January and February. However, based on the rating curve in **Figure 4**, even during these months of higher flows, average stream depths would typically have been less than 2 feet.

35. Like the gage near Lochiel, the streamflow data presented in **Table 4** were collected after statehood. However, because there were only relatively minor diversions above the gage, these data are useful in evaluating ordinary and natural streamflow conditions. In 1913 and 1920, the USGS reported that about 140 acres of land were irrigated above the station plus a “small irrigation ditch” located a short distance above the gage was said to divert water. USGS reported “minor diversions for irrigation above station” in 1931 and in 1939 “several small diversions above station for irrigation” were noted. It was also noted in 1939 that “no water (had been) diverted around station by Buena Vista canal since April 1939.” Diversions by this ditch were measured during 1937 through 1939 and ranged from 0.11 to 1.6 cfs (USGS, 1977).

36. During the height of the growing season, irrigation of a few hundred acres upstream and diversion of a few cfs immediately above the gages would not, on average, deplete more than 5 cfs from the stream. If these potential diversions are added to the median streamflows presented in **Table 4** and compared again to the rating curve in **Figure 4**, typical stream depths still remain below 1 foot.

37. During the early 1880s, Tucson City Engineer J.P. Culver measured the discharge of several springs in the San Xavier-Tucson area to assess the supply of “visible waters...of greatest quantity and value” available from the Santa Cruz River. (Arizona Daily Star, 1884). His data are summarized in **Table 5** and measurement locations are shown in **Figure 5**.

38. Culver concluded that the springs, which directly supplied the perennial reaches of the Santa Cruz River in this area, could be relied on to provide “at least 1000 miner’s inches (25.0 cfs) of visible flowing water during the dryest (sic) of seasons.” He actually calculated a total of 1,403 miner’s inches (35.1 cfs) was available from the springs, but reduced his value to be safe. Even at the higher flow rate, and even if all of the springs discharged to the same point along the Santa Cruz River, which they did not, the combined flow would have been insufficient for commercial navigation.

39. Culver’s measurements are useful in assessing the ordinary and natural condition of the Santa Cruz River in this area because he evaluated the water sources above potential diversion points. He may have even overstated the natural surface flow in the river. Several of the springs he measured had already been developed to enhance their groundwater discharge. Moreover, he considered the springs located downstream of the uppermost spring (Punta de Agua) to be separate and distinct water sources. Water from Punta de Agua may have contributed flow to one or more of the lower springs. Culver indicated “only a moderate, or a partial use (was) being made of (this spring) for the cultivation of small tracts of land (on the reservation) and some minor domestic uses.” Any unused water from Punta de Agua may have contributed to the discharges measured downstream. Culver measured a discharge of 17.5 cfs from Punta de Agua during 1881-1883 and, in 1888, the GLO mapped about 800 acres of agricultural lands on the San Xavier Reservation.

40. Since Culver’s measurements were made during the dry season, it is possible that spring discharges along this portion of the Santa Cruz River were higher during other

times of the year. Culver did not provide discharge measurements for the other seasons. However, at least one earlier observation of the Santa Cruz River suggests that the difference between dry and wet season spring discharges may not have been substantial. As noted in **Table 2**, Lieutenant Park camped along the Santa Cruz River in late February 1854 at a point about 2.5 miles south of Tucson. As shown in **Figure 5**, this would have placed him along the perennial reach of the river that would later feed Lee's Mill. Park indicated that the river "flows past our camp with a depth of one foot and width of six feet." Assuming a reasonable flow rate of between 1 to 3 feet per second, Park would have observed a discharge of from 6 to 18 cfs at his camp site. By comparison, Culver reported the flow in this area at 12.5 to 17.5 cfs.

C. Past and Recent Boating

41. The Santa Cruz River Valley has been a center for travel, commerce, settlement, and agricultural activities for thousands of year. However, no archeological evidence has been found to suggest that early inhabitants used boats on the river. (Fuller, 2004a, Section 2, p.43 and Section 3, p.4)

42. From the early 1690's through 1700, Father Kino made numerous expeditions along the Santa Cruz River, beginning south of the current International Border and ending near Santa Cruz Flats (**Figure 6**).^{vi} During these trips, he visited Indian villages and established missions along the river. His memoirs from the period make no mention of boating along the Santa Cruz River, regardless of the season. He does, however, describe two crossings he made of the Colorado River in November 1701. The first was in a basket being towed behind a raft and the second used the same raft to recross the river (Bolton, 1919, pp.316-317 and pp.319-320).

43. None of the numerous accounts that I have identified made by 49ers travelling along the Santa Cruz River on their way to the California gold fields ever mention using the stream as a means of transportation. They passed through the area at all times of the year and during a period when Apache raids had caused towns along the river to be abandoned or their populations significantly reduced. Any impacts on the river from diversions would have been minimal during this period.

44. Prior to the Civil War, American soldiers stationed at Fort Buchanan, located east of Calabasas along Sonoita Creek, were supplied via wagon trains from the port at Guaymas, Mexico (Frazer, 1983, Chapters 6 and 8). Mines developed in the nearby Patagonia Mountains during and after the war were also supplied via Guaymas (Mowry, 1864, pp.74 and 92-94; Allyn, 1974, pp.190-191). **Figure 7** shows the location of the historic ports of Guaymas and Yuma which both received supplies from San Francisco. I found no evidence that the Santa Cruz River was ever used as a 'highway for commerce' to transport equipment, supplies or people to military camps and mines at this time even though the need certainly existed.

45. The need for commercial transportation grew in the region after the Civil War, as reported in the July 3, 1869 edition of *The Weekly Arizonian*:

Another great draw-back and one which is felt everywhere throughout the (Arizona) territory is the enormous prices which all classes of merchandise command. Fort Yuma which, by the route traveled is

^{vi} North of Santa Cruz Flats, he proceeded in a north-northwest direction and reached the Gila River about 20 to 30 miles upstream of its confluence with the Santa Cruz River.

nearly three hundred miles distant from Tucson, is the nearest point to which merchandise can be conveyed by water, and the prices paid for transportation thence to Tucson, in almost every instance, amount to more than the original cost of goods as purchased in San Francisco. This is, certainly, a very unwholesome state of affairs, and to those who expect to accumulate fortune with little labor, a very mountain in the pathway. But this condition of affairs can continue, at most, only a few years. The Southern Pacific railroad, running south of the Gila, will place us in almost direct communication with California and the East, while the Gulf trade via Guaymas will give additional importance to our position. It will be strange indeed if all these advantages in store for Southern Arizona fail to lend importance to its principal business point...

46. In their September 2012 memorandum regarding the navigability of the Santa Cruz River, ACLPI presents the following evidence from Fuller (2004a) of boating on the Middle Santa Cruz during the late 1800s and early 1900's (p.14):

There are numerous documented instances of navigation on the middle segment of the Santa Cruz River. During the 1880's, people were boating, fishing and swimming on Silver Lake as well as upstream...Describing the Silver Lake resort, the 1881 City of Tucson Directory advised that the resort offered "several boats for sailing and rowing up the river beyond the lake...Similarly, flat bottomed boats launched on Warner's Lake for recreation both on the lake and "up the river."...Several years later, there were a few attempts at boating in 1914 during flood conditions, but those were unsuccessful.

47. As described in detail by Bentacourt (1990), both Silver and Warner lakes were man-made water features. Silver Lake was formed in 1857 after a low earthen dam was constructed across the Santa Cruz River about 1 mile south of Sentinel Peak and downstream of a spring (p.52). By 1881, this earthen dam had been replaced by a masonry one and resort facilities were added (p.88). Warner Lake was formed in 1883 at the foot of Sentinel Peak. It collected runoff from the base of the peak and runoff from the West Branch of the Santa Cruz River behind a large earthen dam that was wide enough on its top for a roadway (pp.91-92). The effects from Warner Lake on downstream flows in the Santa Cruz River were litigated in 1884 (pp.94-95).

48. Clearly, Silver and Warner lakes were not natural water bodies and any boating on them should not be considered when determining the navigability of the Santa Cruz River in its ordinary and natural condition. No mention of lakes in this area was made prior to their construction (see Section A of this declaration) and, after intense flooding in February 1890 washed out their dams, "neither the dams nor the lakes were rebuilt." (Fuller, 2004a, Section 3, p.44).

49. ACLPI also cites modern boating on the Santa Cruz River in its September 2012 memorandum in support of a navigability determination (p.14):

There are also several accounts of boating using canoes in the middle segment during modern times...Although some of these trips have been during high water, not all. Wayne Van Vorhees and his wife traveled the river during the winter of 1989-90 and again in the summer.

50. Review of the source for ACLPI's statements does not, however, support a finding of navigability. As stated by Fuller (2004a, Section 3, p.63-64):

The Tucson Weekly featured a canoer traveling the effluent-dominated stretch in July 1990, a trip which he repeated during flood time for the Tucson Weekly photographer (Malusa 1990). The Citizen reported travelers in canoers (sic) on the Rillito during the 1990 flood (Tucson Citizen, July 25, 1990). The same canoers have also traveled on the Santa Cruz (River) and Agua Caliente (Wash) at various times in the 1990s. These canoers, Wayne Van Vorhees and his wife, stated that when they also traveled the river during the winter of 1989-90 it was "a reasonable canoeing river" but when they made the trip in the summer, it was "more like the Grand Canyon" in terms of difficulty. They are deeply involved with local boating groups, but are unaware of any attempts to boat the upper Santa Cruz River, although they state that it is certainly feasible. Mr. Malusa believes that the Santa Cruz can just barely be navigated by canoe with 4" of water, but that the channel topography is a limiting factor as sand bars are frequent. (Jim Malusa and Wayne Van Vorhees, personal communications, 1996).

51. It cannot be determined from the Fuller quotation precisely where Mr. Van Vorhees and his wife floated the Santa Cruz River, but they do indicate that it was not the "upper Santa Cruz River". Since they reportedly floated both the Santa Cruz River and Agua Caliente Wash in the 1990s, it is likely that they traveled the section of the Santa Cruz River through Tucson.^{vii} Streamflow records from a USGS gage located on the Santa Cruz River in north Tucson show several floods during the summer of 1990 that likely caused the Grand Canyon-like difficulties that they mention (**Figure 8**). The gage is located downstream of the Ina Road and Pima Road sewage treatment plants and, according to USGS (2013b); baseflow along this section of the Santa Cruz River is from effluent discharged from the plants. The Van Vorhees likely floated down this effluent-dominated reach of the Santa Cruz River during the winter as Mr. Malusa did later that summer. The stream was neither in its "ordinary" condition nor in its "natural" condition during these isolated events.

52. Copies of the 1990 Tucson Citizen and Tucson Weekly articles cited above are presented in **Attachment C**. The Tucson Citizen article shows three people in an inflatable raft floating down the Santa Cruz River during a summer flood. Two of the raft's occupants may be the Van Vorhees. The Tucson Weekly article shows Mr. Malusa and his wife floating the effluent-dominated reach of the Santa Cruz in Tucson, also using an inflatable raft. Neither effluent nor flood flows are characteristic of the ordinary and natural condition of the Santa Cruz River. Therefore, these modern accounts of boating the Middle Reach of the Santa Cruz River should not be considered when determining its navigability.

V. LOWER REACH

53. This section of my declaration describes the Lower Reach of the Santa Cruz River, from Santa Cruz Flats to the confluence with the Gila River, which also was not susceptible to navigation in its ordinary and natural condition prior to statehood. Three lines of evidence are presented here – historic accounts, impediments to navigation, and

^{vii} Agua Caliente Wash is a tributary to Tanque Verde Creek in northeastern Tucson. Tanque Verde Creek flows into Rillito Creek which then joins then the Santa Cruz River in northwestern Tucson.

past boating. Historic accounts indicate that flow in the Lower Reach of the Santa Cruz River was ephemeral except for a section immediately above its confluence with the Gila River where a relatively large cienega was located. Other impediments and no record of past boating further support the conclusion that commercial boat travel was not feasible along this reach of the river.

54. As with the Upper Reach, my conclusion regarding the navigability of the Lower Reach of the Santa Cruz River is consistent with the conclusion recently reached by ACLPI. In its September 2012 memorandum, ACLPI urges ANSAC to find that several reaches in the middle segment of the Santa Cruz River were navigable. (p.16) However, ACLPI makes no argument to support navigability of either the Upper or Lower reaches. In fact, referencing Fuller (2004a), ACLPI states that “The lower Santa Cruz river in Pinal County never supported perennial flows...It is only during flood times that the river flows continuously to the Gila River...There are no reported instances of boating at any time on the lower Santa Cruz, although during one high flood event, Tucsonan Sam Hughes opined that the river was ‘big enough to float a steamboat all the way to the sea.’” (p.15).

A. Historic Accounts

55. Father Kino’s numerous expeditions along the Santa Cruz River during the 1690s ended north of Picacho Peak where Santa Cruz Flats began. From that point, he and his associates proceeded in a north-northwest direction and reached the Gila River about 20 to 30 miles upstream of its confluence with the Santa Cruz River near the present day ruins of Casa Grande (**Figure 6**). In light of the numerous Indian villages he visited and the missions that he established along the Middle Reach, the Lower Reach of the Santa Cruz River probably did not support a large Native American population at that time, most likely due to a lack of permanent water.^{viii} The lack of regular flow along this reach would have precluded its use for commercial navigation.

56. The diaries of Captain Anza and Father Font indicate that they followed a similar route as Kino along the Santa Cruz River in late October 1775. Their accounts are summarized in **Table 6** and indicate a general lack of water along the Lower Reach during the fall harvest period. Also listed in this table is an account made by Captain Manje in November 1697 when he accompanied Father Kino along this route. Manje recognized that flow in the Santa Cruz River disappeared in this area and reappeared near its confluence with the Gila River.

B. Impediments

57. The lack of perennial flow described along much of the Lower Reach of the Santa Cruz River would itself pose a significant impediment to commercial navigation. In addition, when flood waters periodically did reach Santa Cruz Flats, they divided into numerous smaller channels and spread out over a large plain. It would not have been possible to navigate a commercial vessel in such an environment.

58. The channel of the Santa Cruz River becomes reestablished about 10 miles upstream of its confluence with the Gila River. Bryan (1922, pp. 3 and 427) identified a cienega here which he described as “a swampy area of salt grass and mesquite on the

^{viii} Father Kino noted Indian villages along the Gila River downstream of the Casa Grande ruins and below the Santa Cruz-Gila confluence. He also noted ruins at the confluence, but no villages further upstream from the mouth of the Santa Cruz River.

Santa Cruz between Maricopa and Gila Crossing.” The cienega was located west of the former town of Maricopa Wells and is depicted on an historic USGS topographic map. **(Attachment C)**

59. Father Sedelmayr (1955, pp. 4, 23-24) described the area in September 1743:

Leaving behind these Pima settlements and trekking down stream (along the Gila River) we come upon broad savannas of reed grass and clumps of willow and a beautiful spring with good land for pasture. We named the place Santa Teresa (near Maricopa Wells). Passing on down river another five or six leagues and keeping it always in view with its willows and cottonwoods, we come to its confluence with the Río de la Asunción, which in its turn is formed by the Salado and the Verde (rivers)...A very pleasant county surrounds this fork of the rivers. Here the eye is regaled with creeks, marshes, fields of reed grass and an abundant growth of alders and cottonwoods.

Along this route Father Sedelmayr would have directly passed the confluence of the Santa Cruz and Gila rivers. However, unlike the confluence with the Salt River, he makes no mention of it. This suggests that the Santa Cruz River at its mouth was not easily observed, presumably due to thick vegetation.

60. The occurrence of marsh-like conditions and heavy vegetation along this last portion of the Santa Cruz River would have posed still another impediment to navigation along the Lower Reach.

C. Past Boat Use

61. As stated above in paragraph 41, there is no archeological evidence of boat use along any segments of the Santa Cruz River.

62. There is also no record that Father Kino attempted to float any of these segments, including the Lower Reach. As noted above, Kino visited Indian villages along the Gila River both upstream and downstream of the Santa Cruz confluence and Captain Manje, who accompanied Kino, noted where the rivers joined (see **Figure 6** and **Table 6**, respectively).

63. Finally, there is no record that Americans used the Lower Reach of the Santa Cruz River to supply military posts or mines either prior to or after 1860 when increased development in the region began and affordable supply routes were in demand.

VI. CONCLUSIONS

64. It is my opinion that, in its ordinary and natural condition, the Santa Cruz River was not navigable or susceptible to navigation at and prior to statehood.

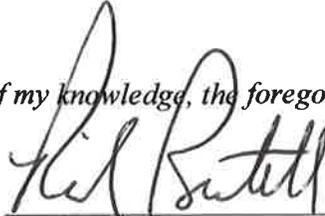
65. It is also my opinion that if the Santa Cruz River is divided into segments, no segment would have been navigable in its ordinary and natural condition.

66. I base these opinions on my review of existing and supplemental evidence

presented in this declaration including, but not limited to: (a) historic accounts; (b) streamflow records; (c) past and present boating; and (d) impediments to boat travel.

I declare under penalty of perjury that, to the best of my knowledge, the foregoing is true and correct.

Executed on this 18th date of October, 2013


RICHARD T. BURTELL

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TABLES

TABLE 1 - UPPER SANTA CRUZ RIVER STREAMFLOWS NEAR LOCHIEL

WATER YEARS/ MONTH	1948-2012	
	Median Q (cfs) ^{1,2}	D (ft) ³
Jan	0.61	<1.0
Feb	0.64	
Mar	0.51	
Apr	0.36	
May	0.19	
Jun	0.04	
Jul	0.12	
Aug	0.71	
Sep	0.68	
Oct	0.5	
Nov	0.6	
Dec	0.66	

Notes:

¹ Median monthly discharge (Q) in cubic feet per second (cfs) measured at USGS Gage 09480000, located about 1.7 miles upstream from the International Border (see **Figure 2**). Data from USGS (2013a).

² USGS Water-Supply Paper 1313 reported "small diversions for irrigation above station" in 1950 and USGS Water-Data Report 2012 reported "small diversions for irrigation of 200 acres above station, mostly by pumping from groundwater" in 2012. During the 1920s and 1930s, Hadley and Sheridan (1995, pp. 195 and 211) reported less than 200 acres of irrigation in the San Rafael Valley.

³ Average stream depth (D) in feet (ft) at Q based on rating curve presented in **Figure 3**.

TABLE 2 - HISTORIC ACCOUNTS OF STREAMFLOW CONDITIONS ALONG THE MIDDLE SANTA CRUZ RIVER^{1,2}

LOCATION	DATE	DESCRIPTION	SOURCE	REFERENCE	COMMENTS
Santa Cruz to San Xavier	1804	<i>Our river is the Santa Cruz, which takes its name from the Santa Cruz presidio at its headwaters, forty miles to the southeast of us. Only in the rainy seasons does it enjoy a steady flow. During the rest of the year, it sinks into the sand in many places. Another, which we call Sonoita River, takes its name from the abandoned Pima mission of the same name. It flows steadily for the first fifteen miles of its westward course, but sinks beneath the sand seven to eight miles before joining the Santa Cruz. This confluence provides water for Tumacacori and Tubac and collects in the marsh lands around San Xavier del Bac in great abundance.</i>	Leon	McCarty (1976, p.83)	Discontinuous flow observed during all but the rainy season
		<i>Our major river...is the Santa Maria Suamca (Santa Cruz River) which arises ninety-five miles to the southeast from a spring near the presidio of Santa Cruz. From its origin it flows past the Santa Cruz presidio, the abandoned ranches of Divisaderos, Santa Barbara, San Luis, and Buenavista, as well as the abandoned missions of Guevavi and Calabazas, the Pima mission of Tumacacori, and the Tubac presidio. When rainfall is only average or below, it flows above ground to a point some five miles north of Tubac and goes underground all the way to San Xavier del Bac. Only during years of exceptionally heavy rainfall does it water the flat land between Tubac and San Xavier.</i>	Zuniga	McCarty (1976, pp.86-87)	Discontinuous flow observed during all but very wet years
Calabasas	February 1857	<i>"If you will portray in your imagination a bottom covered with tall, golden colored grass, hedged by mountains whose sands glitter like metal, divided by a meandering stream (Santa Cruz River) a dozen yards wide and as many inches deep, this shaded by cottonwoods, willows and musquites, then a few hundred yards higher up another stream (Sonoita Creek), a creek with less volume pouring in from the right, and in the fork an elevated rolling surface, you will have a view of Calabasas."</i>	Reid	(1935, p.187)	Shallow water observed during period of potential light irrigation for winter wheat/barley
Tumacacori to near Canoa	May 1849	<i>"We camped eight miles (north) from this last ranch (Tumacacori)...Just below this point the river sinks into the sand and appears again only at intervals for many miles."</i>	Durivage	Beiber (1937, p.209)	Discontinuous flow observed during period of Apache hostilities; ranches upstream along the Santa Cruz were found abandoned.
Tumacacori to San Xavier	late November 1697	<i>"On the 26th, after having heard mass and saying goodbye to the Indians (at San Xavier), we continued south over plains, passing along the river bed which submerges here. After going 20 leagues, we arrived at nightfall at (Tumacacori) where 150 souls live...The lands here are fertile and irrigated like those at del Bac."</i>	Manje	Karnes (1954, pp.93-94).	Discontinuous flow observed at end of fall harvest period; planting of winter wheat/barley may have begun
Tubac to near Canoa	early October 1849	<i>"(about 9.5 miles north of Tubac)...we crossed the river to left bank...three or four hundred yards below where we crossed the river sinks into the sand, and where it rises again we do not know. It sinks into the bend northeast of the point of the double peak mountains."</i>	Powell	(1931, p.143)	Discontinuous flow observed during fall harvest and period of Apache hostilities; ranches upstream along the Santa Cruz were found abandoned.
Canoa to San Xavier	late October 1775	<i>"it was necessary to divide the march from here (Canoa) to San Xavier del Bac, since there was no water on the way."</i>	Anza	Bolton (1930, vol.3, p.7)	Discontinuous flow observed during harvest; Apache hostilities noted in area.
near Green Valley to San Xavier	late July 1852	<i>"After a hard journey (south from San Xavier) of eighteen miles, we stopped at the banks of the (Santa Cruz) river; and strange as it may appear, notwithstanding all the rain that had fallen, the river, such is the uncertainty of the streams in this country, was quite dry."</i>	Bartlett	(1854, pp. 302 and 305).	Discontinuous flow observed during a period of Apache hostilities; ranches upstream along the Santa Cruz River were found abandoned.
Sahuarita to San Xavier	late October 1775	<i>"At the (Sahuarita) campsite and in the plains which follow there is grass but no water...arrived at the mission of San Xavier del Bac (the next day)...its waters are very turgid and salty..."</i>	Font	Bolton (1930, vol.4, p.27)	Discontinuous flow observed during fall harvest period; Apache hostilities noted in area.
San Xavier to Tucson	early October 1849	<i>The road from San Xavier to camp, 1 mile short of Tucson, was very level, running throughout mesquite, etc. We encamped in a grassy bottom, much covered with saline efflorescence. The river has divided to a mere brook, the grassy banks of which are not more than 2 yards apart."</i>	Powell	(1931, p.145)	Narrow channel observed during fall harvest and period of Apache hostilities.
Tucson	late February 1854	<i>"The party then moved through the town (of Tucson), and encamped about two and a half miles beyond on the bank of a clear running brook (Santa Cruz River) with an abundance of grass and wood...Remained in camp...Tucson...is a one-storied flat-roofed adobe town of about six hundred inhabitants, whose sole pursuit is agriculture; the much dreaded Apaches have interfered greatly with their pastoral occupation. They raise chiefly corn and wheat, cultivating about three hundred acres of rich soil by irrigation from a stream which has its source near the mission of San Xavier del Bac, 9.5 miles to the south; and although it flows past our camp with a depth of one foot and width of six feet, its waters nevertheless disappear a short distance below the town, either consumed by irrigation or absorbed by the sands."</i>	Parke	(1855, pp.6-7)	Shallow water observed during period of potential light irrigation for winter wheat/barley; period of Apache hostilities.
Tucson to Marana	December 1846	<i>"To my surprise, I found water seven miles (north) from town (Tucson) and plenty of it, instead of an insufficiency for miles reported by Weaver, whom I sent yesterday to examine...The next three miles down the dry creek of Tucson were excessively difficult, with deep sand and other obstacles. There our beautiful level prairie road was much obstructed by mesquite."</i>	Cooke	(1938, p.161)	Discontinuous flow observed after fall harvest period; planting of winter wheat/barley may have begun with potential light irrigation
near Tucson to near Picacho Peak	late November 1697	<i>"...we camped for the night at a settlement which we called Santa Catarina de Cuituabagu (also spelled Catalina). On November 23, after mass, traveling nine leagues south down the river...we came to the settlement of Valle de Correa, where the Indians obtain their drinking water from a well made by hand in the bed of the river. These lands are seasonable...we continued to the south; and after going six leagues, we came to the settlement of San Agustin de Oiaur...here the river runs a full flow of water, though the horse forded it without difficulty. There are good pasture and agricultural lands with a canal for irrigation."</i>	Manje	Karnes (1954, pp.91-92).	Discontinuous flow observed at end of fall harvest period; planting of winter wheat/barley may have begun
near Rillito to near Picacho Peak	late October 1775	<i>"October 28...We set out from the plain of the Puerto del Azotado (near Rillito)...having traveled six long leagues west-northwest and at times almost west...we halted at some lagoons of rain water which the Indians call Oytaparts, site of a village of Papago Pimas which the Apaches destroyed...October 29...We set out from the lagoons of Oytaparts at one in the afternoon...and halted a little beyond a picacho or peak which the Indians call Tacca, having traveled some five leagues, two to the northwest and the rest to the north-northwest...This is a place with little pasturage and no water, and all the route is just like it; but it is very level and open county, the same as yesterday. Half a league beyond the place whence we set out there is an abandoned pueblo of Papagos...and a little further on there is a lagoon which is the seepage or rising of the river of El Tuquison (Tucson) and San Xavier, which disappears and ends in these plains."</i>	Font	Bolton (1930, vol.4, pp.29-32)	Discontinuous flow observed during fall harvest

Notes:

¹ See Figures 1, 5 and 6 for maps showing account locations.

² This table does not include accounts of Santa Cruz River streamflows in the Tucson area during and since 1857. In that year, a low earthen dam was completed across the river near Sentinel Peak. The reservoir that formed, later known as Silver Lake, supported a mill and irrigation of downstream fields. (Bentacourt, 1990, p.52).

TABLE 3 - MAJOR IRRIGATED AREAS AND CROP PRODUCTION ALONG THE MIDDLE SANTA CRUZ RIVER DURING THE SPANISH, MEXICAN AND EARLY AMERICAN PERIODS

LOCATION ¹	YEAR	CROP PRODUCTION (bushels)			IRRIGATED AREA (acres)	SOURCE	REFERENCE	NOTES
		Wheat	Corn	Vegetables				
Calabasas	1867	3,448 ²		---	200	Bell	(1870, p.316)	Estimates from "intelligent residents"; Bell's Tucson data indicates estimates may be high.
Tumacacori	1867	862 ²		---	50			
Tumacacori and upstream villages	1843	NA			Minor (see notes)	Quiroga	Officer (1987, p.167)	Original account from the Tubac justice of the peace. According to Officer, "the mission fields were overgrown with mesquite trees and other scrubby vegetation and the one lying most distant from the village was visited only occasionally by a few Indians...who went there to irrigate small plots. None of the fields were being rented to outsiders and none had been sold. The Calabasas pastures and fields were abandoned, as was the case with those at Guevavi and Sonoita."
	1868				"hundreds" (see notes)	Pioneer	The Miner (1868)	"Above (Tubac), on the Rio Santa Cruz, we meet the Ranches of Col. Lewis, Mr. Chambers and others with their hundreds of acres of good corn"
Tumacacori and Tubac	1804	1,600 ³	960 ³	---	102 to 256 ⁴	Leon	McCarty (1976, pp.82-85)	Crop production from a census prepared by the Tubac presidio second ensign; upstream ranches and missions were reported as abandoned but the Santa Cruz presidio was active.
Tubac	1767	NA			60 ⁵	Urrutia	Arizona State Parks (2013)	Acreage from a survey map. According to Officer (1987, p.47), the Spanish population of southern Arizona was almost entirely concentrated in Tubac at this time with a total population probably close to 500, "the largest it would ever be during the Spanish and Mexican periods."
	1777	960 ³		---	38 to 96 ⁴	Barragua, Castro and Romero	McCarty (1976, pp.31-34)	Crop production reported by three Tubac settlers; "We have enough water for cultivation of wheat, but not enough to grow the corn we need. If Tubac shares Tumacacori water, dammed up by the mission at that place, there is enough water for all. Captain Juan Bautista de Anza set up a schedule whereby Tubac used the Tumacacori water for a week, then the Tumacacori Pimas used it for a week and so on. We were overjoyed to hear recently that you (Captain Saavedra) have approved the continuance of this arrangement...the Tubac settlers are raising over 600 bushels (fanegas) of wheat and corn annually, and we are farming only two-thirds of our land ...Calabasas has been burned to the ground (by Apaches)." (emphasis added)
	1856	None			Area abandoned	Poston	Officer (1987, p.290)	
	1867	8,620 ²		---	500	Bell	(1870, p.316)	Estimates from "intelligent residents"; Bell's Tucson data indicates estimates may be high.
	1868	NA			"hundreds" (see notes)	Pioneer	The Miner (1868)	"Above this we meet Tubac, with its hundreds of acres of wheat and barley, already secured, and its greater number of acres of corn now well nigh ready for harvesting."
San Xavier	1843	NA			Minor (see notes)	Quiroga	Officer (1987, p.167)	Original account from Tucson justice of the peace. According to Officer, "the San Xavier governor was cultivating a part of the garden and about one-eighth of the acreage previously devoted to growing crops for the support of the priest and their project";
	1852					Bartlett	(1854, p.300)	"Near by is a fertile valley, a very small portion of which is now tilled: although from appearances, it was all formerly irrigated and under cultivation."
	1867	862 ²		---	100	Bell	(1870, p.316)	Estimates from "intelligent residents"; Bell's Tucson data indicates estimates may be high.
San Xavier and Tucson	1804	2,800 ³	600 ³	300 ³	148 to 370 ⁴	Zuniga	McCarty (1976, pp.86-92)	Crop production from a census prepared by the Tucson presidio captain.
Tucson	1854	NA			300	Parke	(1855, pp.6-7)	Period of Apache unrest.
	1862				841 ⁵	Ferguson	Sheridan (1992, p.62)	Acreage from survey map. Irrigated area downstream of Silver Lake which was completed in 1857 and may have increased water availability.
	1867	25,862 ²		---	2,000	Bell	(1870, p.316)	Estimates from "intelligent residents"; comparison to 1862 and 1871 survey maps and the 1868 account indicates estimates are probably high.
	1868	NA			500 (see notes)	Pioneer	The Miner (1868)	"Immediately about Tucson there are perhaps 500 acres under cultivation, dependent upon irrigation. The finest vegetables are produced here - grown in open air through the entire winter, save potatoes of which we have none. Wheat and barley are sure crops; corn and beans are sure upon the same ground, thus securing two crops a year.
	1871				1,394 ⁵	Foreman	Logan (2006, p.129)	Acreage from survey map; Logan (p.126) indicates that a wet cycle may explain this increase in acreage from prior years.

"---" indicates not reported and "NA" indicates data not available.

Notes:

- ¹ See Figure 1 for general location of irrigated areas along the Middle San Pedro River.
- ² Production originally reported in pounds and converted by Plateau to bushels using a conversion factor of 58 pounds of corn and wheat per bushel (Murphy, 1993).
- ³ Production originally reported in fanegas and converted by Plateau to bushels using the standard conversion factor of 1.6 bushels per fanega (Officer, 1987).
- ⁴ Estimated by Plateau based on historic crop yields. From 1866 to 1870, average wheat yields in the United States ranged from 11.0 to 13.7 bushels per acre and average corn yields ranged from 21.8 to 29.3 bushels per acre (USDA, 2013). In 1887, the Governor of the Arizona Territory reported that wheat and corn fields in the state yielded from 25 to 50 bushels per acre (Zulick, 1887). For purposes of this study, Plateau used a yield of 10 to 25 bushels of corn and wheat per acre and assumed no double cropping. The latter would have increased yields and decreased estimated irrigated acreage.
- ⁵ Acreage calculated by Plateau using digital planimetry of historic survey maps.

TABLE 4 - MIDDLE SANTA CRUZ RIVER STREAMFLOWS NEAR NOGALES (in cfs)^{1,2}

YEAR/ MONTH	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922		
Gage located about 6 to 7 miles downstream of International Border³												
Jan	0	0.5	130	ND	15	10	2	63	ND	ND ⁶		
Feb	12.5	0	180		11.5	14	10	23				
Mar	9.4	0	ND ⁶		5	4	2	9				
Apr	3.1	0			3	2	1	5				
May	0	0			2	0	0	1				
Jun	0	0			1	0	0	0				
Jul	0	0			1	0	45	ND	ND ⁶			
Aug	0.2	27			53	7	61					
Sep	0	34	28.5		0	26						
Oct	0	2	2		7	0	10					
Nov	0	4	2		11	0	11					
Dec	2.8	ND	11		8	0	31					
YEAR/ MONTH	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939		
Gage located about 1 mile downstream of International Border^{4,5}												
Jan	ND	5	46	16	ND	ND	12	19	6	7		
Feb		59	42	18			12	9	5	8.5		
Mar		20	23	10			6	6	2	2		
Apr		7	8	6			3	2	0.2	0.3		
May		1	1	2			2	0.5	0.4	0.5	0.1	
Jun		0	0	0			0.5	0.1	0	0	0	
Jul		8	2	13			0	0.4	1	1	0	5
Aug		15	166	56			0	69	22	75	14	115
Sep		1.5	80.5	8			2.5	28.5	6	25	10.5	29
Oct		1	25	5			2	10	0.6	10	0.9	12
Nov		2	22.5	9			1	12	3	7	0.7	8
Dec		6	27	16			1	18	6	7	2	8

Notes:

- ¹ Median discharge in cubic feet per second (cfs) measured at USGS Gage 09480500; "ND" indicates no data were collected during month. Data from USGS (2013a). See **Figure 2** for the gage locations.
- ² Discharges in **red** indicate that the average stream depth was greater than 1.0 feet based on the rating curve presented in **Figure 4**. Average stream depths for other discharges were less than 1.0 feet based on the rating curve.
- ³ USGS Water-Supply Papers 359 and 509 reported that about 140 acres of land were irrigated above the station in 1913 and 1920, respectively. In addition, "a small irrigation ditch" was noted to divert water a short distance above the gage in 1918.
- ⁴ USGS Water-Supply Paper 719 reported "minor diversions for irrigation above station" in 1931. USGS Water-Supply Paper 899 reported "several small diversions above station for irrigation" with "no water diverted around station by Buena Vista Canal since April 1939."
- ⁵ From November 1937 through May 1939, diversions by the Buena Vista Canal were measured 16 times and ranged from 0.11 to 1.6 cfs (USGS, 1977).
- ⁶ From March 13 to December 4, 1915 and from April 28, 1921 to June 30, 1922, the gage was located 1/2 mile downstream at the Nogales pumping plant. Due to potential impacts from the plant on streamflows, data collected during these months are not included in this table.

TABLE 5 - EARLY 1880s SANTA CRUZ RIVER DISCHARGE MEASUREMENTS IN THE SAN XAVIER-TUCSON AREA¹

LOCATION	MAP NUMBER ²	WATER SOURCE	DISCHARGE ³		COMMENTS
			Miner's Inches	Cubic Feet/Second	
Punta de Agua	1	Undeveloped spring	700	17.5	Spring supplied fields on the San Xavier Reservation. GLO mapping shows about 800 acres were irrigated there in 1888 while Culver indicated "only a moderate, or a partial use (was) being made of it for the cultivation of small tracts of land and some minor domestic uses." Any unused water may have contributed to the spring discharges measured downstream.
Valencia Road head cut	2	Developed spring	170	4.3	Water was developed from the spring during this period and piped to Tucson for municipal use.
Unnamed spring ~1 mile below head cut	3	Undeveloped spring	23	0.6	All or a portion of this water may have contributed to the spring discharges measured downstream.
Lee's Mill above Silver Lake	4	Developed spring	500 to 700	12.5 to 17.5	According to Bentacourt (1990, p.54), water from the spring fed Lee's Mill via a ditch. Culver indicates he measured the discharge in the mill's "waste flume" or tail race which fed Silver Lake.
Warner's Mill below Warner's Lake	5	Silver and Warner's Lakes plus developed springs	500 to 700	12.5 to 17.5	When calculating available water supplies for the town, Culver assumed that flow to Warner's Mill originated from the upstream flume that fed Silver Lake, so he only used this quantity once and did not count it twice. However, as indicated by Bentacourt (1990, pp.89-91), Warner's Mill was also supplied by Warner's Lake which captured runoff from the West Branch of the Santa Cruz River and the discharge from springs along the base of Sentinel Peak. It is unknown how much water from Warner's Lake supplied Warner's Mill at this time.
"Lower settlement about 4 miles from Tucson"	---	Irrigation ditch	10	0.25	Culver does not state whether this flow is spring discharge or tail water from upstream irrigation in Tucson.

Notes:

¹ Reported by Tucson City Engineer J.P. Culver in the Arizona Daily Star (February 12, 1884) when assessing the supply of "visible waters...of greatest quantity and value" "afforded by the Santa Cruz River".

² Locations shown in **Figure 4**.

³ Culver indicated that his discharge measurements were during made the driest seasons over a three year period from 1881-1883.

TABLE 6 - HISTORIC ACCOUNTS OF STREAMFLOW CONDITIONS ALONG THE LOWER SANTA CRUZ RIVER¹

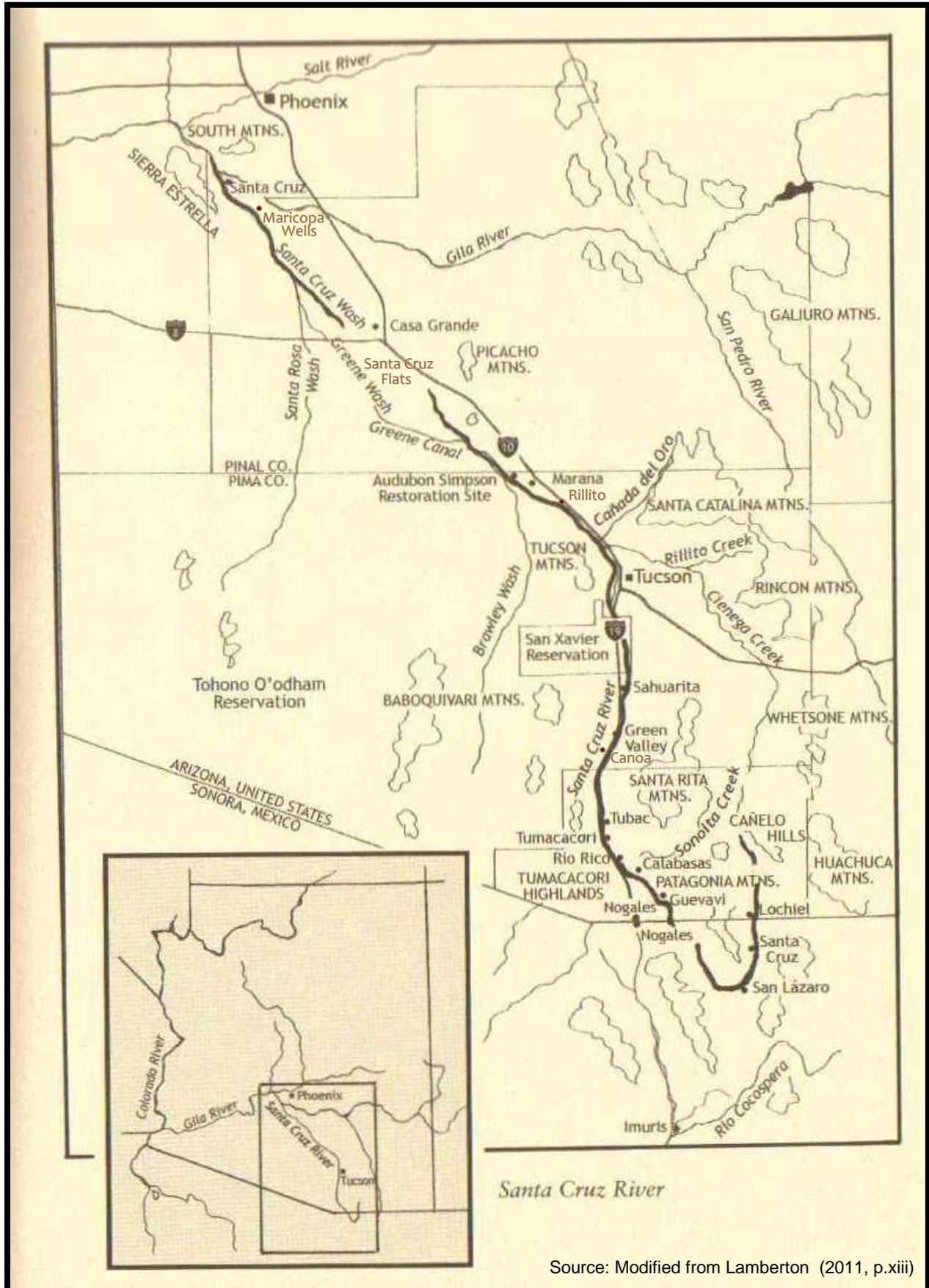
LOCATION	DATE	DESCRIPTION	SOURCE	REFERENCE	COMMENTS
near Picacho Peak to Gila River	late November 1697	<i>...the (Santa Cruz) river...which submerges some distance, coming out again and then flowing to join the Jila River to the west and near the last settlement we came from (Tusonimo)</i>	Manje	Karnes (1954, p92)	Discontinuous flow observed at end of harvest period; planting of winter wheat/barley may have begun
	late October 1775	<i>"...a halt was made for the night in this same valley at the place where the pasturage ends, at a site known as the flat of El Aquituni (near Picacho Peak)...Monday, October 30...At half past seven we set forth along the same valley, which from here forward is entirely without pasturage, and traveled through it for about two leagues to the west-northwest to go around a thicket. Turning afterward to the northwest for five leagues and then three more to the north, we arrived at the Gila River at a site with abundant pasturage and water...From what has already been said one can see how difficult this journey must have been, but it was necessary to make it, for lack of water, any of which is found only by rare accident."</i>	Anza	Bolton (1930, vol. 3, pp.13-14)	Discontinuous flow observed during harvest period
		<i>"Monday, October 30...We set out from the Picacho de Tacca at eight o'clock in the morning, and at half past five in the afternoon, having traveled some twelve leagues, about six northwest, three north-northwest, and finally some three almost due north, we reached the vicinity of the Gila River and halted some distance from it at a lagoon...the road from El Tuquison (Tucson) to the Gila River is through open and level county in the main, but it has scanty pasturage and very little water, for this is found only when it rains, and in pools in the flats where the Papago Indians make something like canals for collecting it."</i>	Font	Bolton (1930, vol. 4, pp.32)	

Notes:

¹ See **Figures 1** and **6** for maps showing account locations.

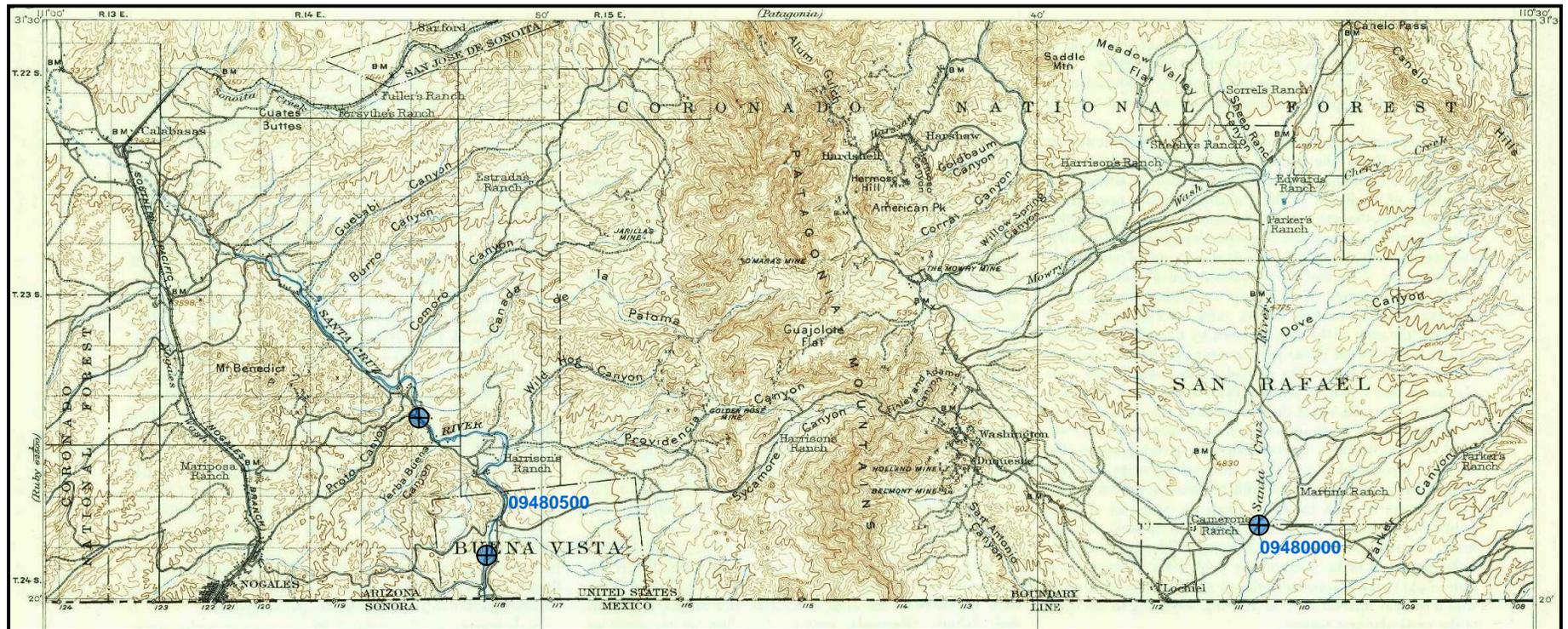
FIGURES

FIGURE 1 – GENERAL LOCATION MAP

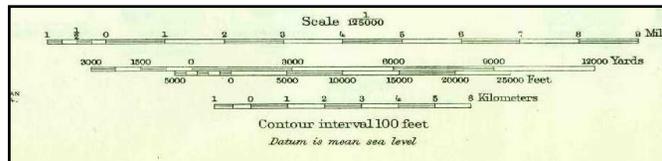


Source: Modified from Lamberton (2011, p.xiii)

FIGURE 2 – SANTA CRUZ RIVER ADJACENT TO THE INTERNATIONAL BORDER

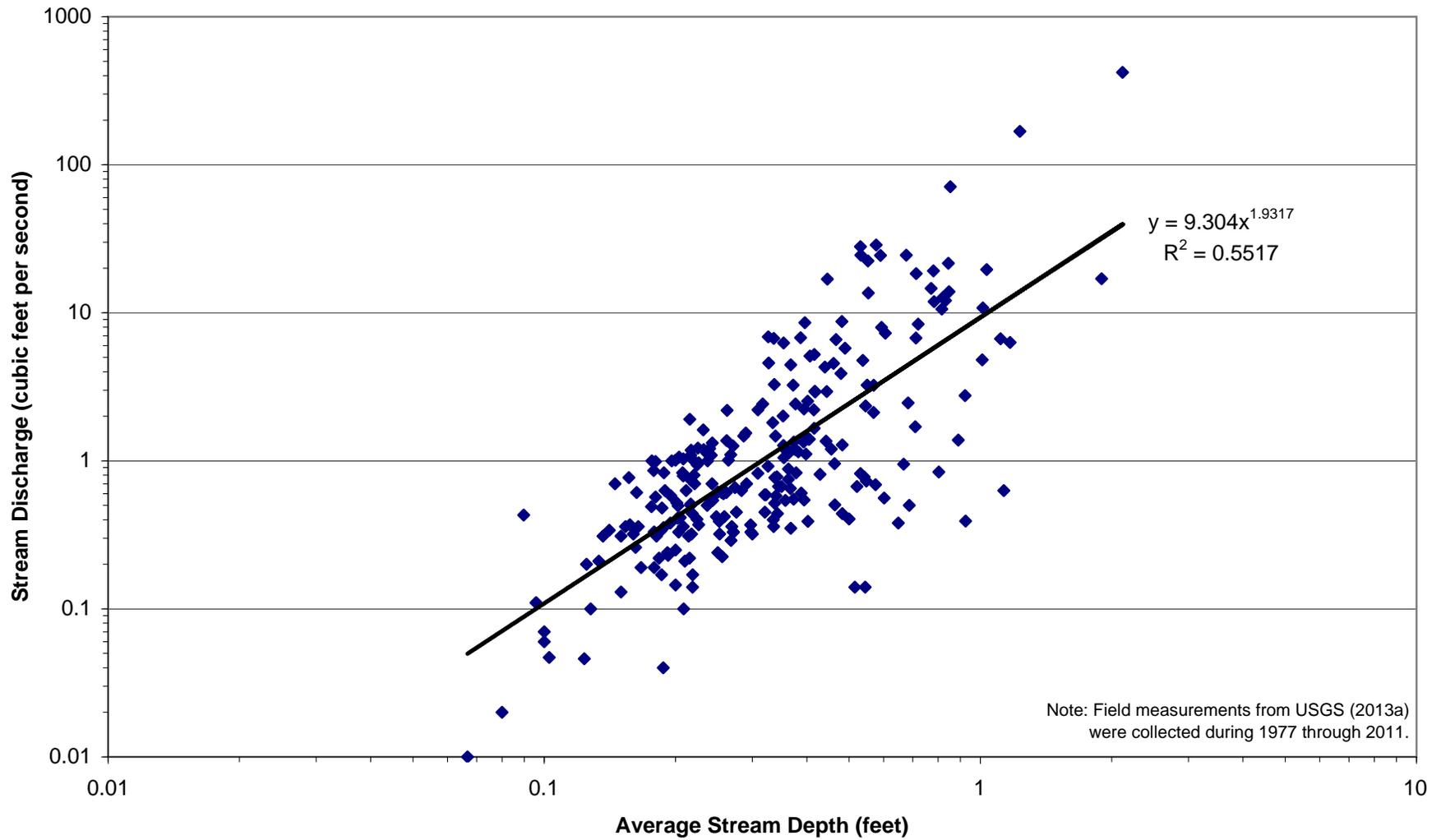


 USGS Gaging Station



Source: Modified from USGS (1904).

**FIGURE 3 - AVERAGE DEPTH VS. DISCHARGE OF THE SANTA CRUZ RIVER NEAR LOCHIEL
BASED ON FIELD MEASUREMENTS (USGS Gage 09480000)**



**FIGURE 4 - AVERAGE DEPTH VS. DISCHARGE OF THE SANTA CRUZ RIVER NEAR NOGALES
BASED ON FIELD MEASUREMENTS (USGS Gage 09480500)**

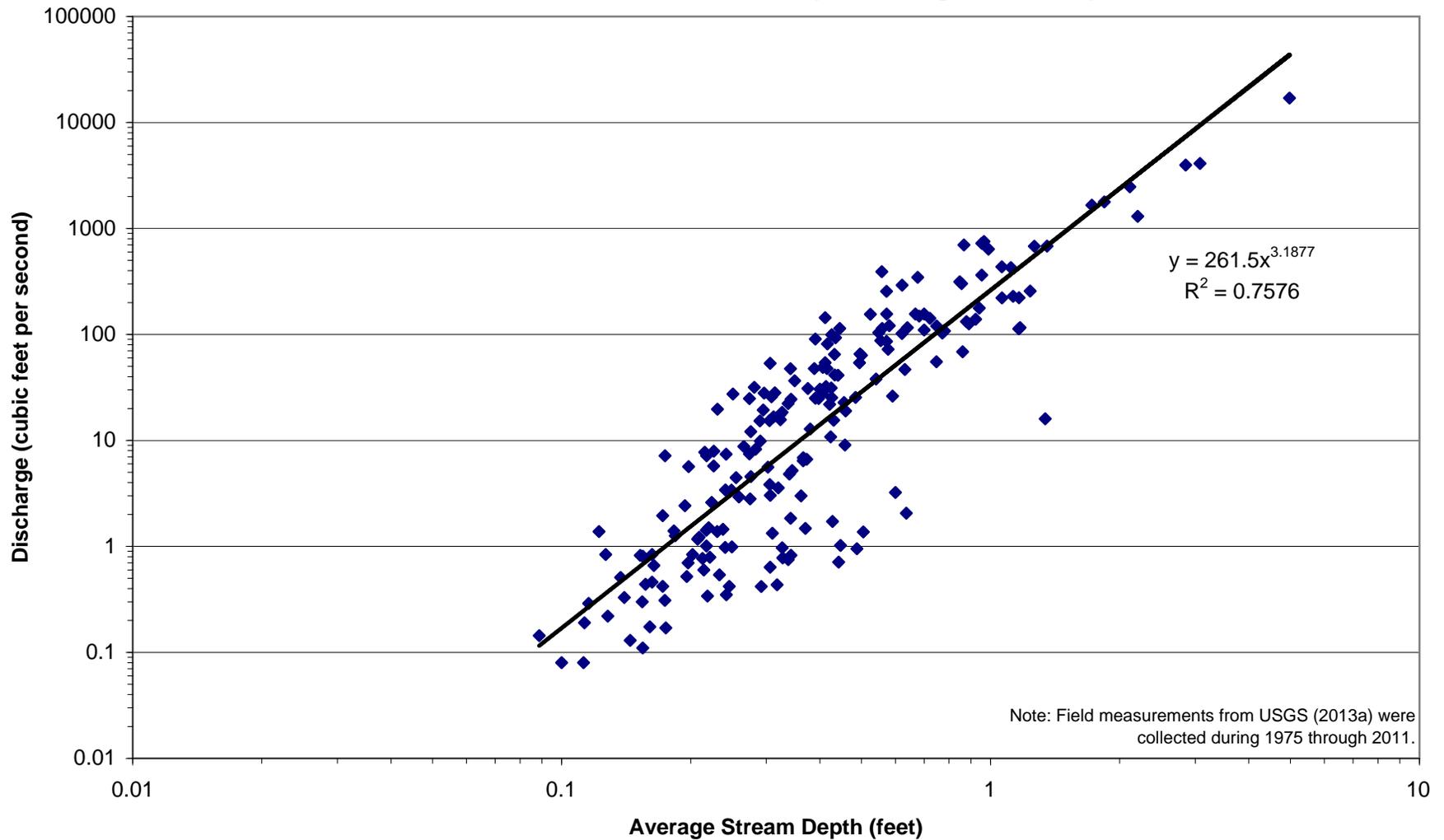
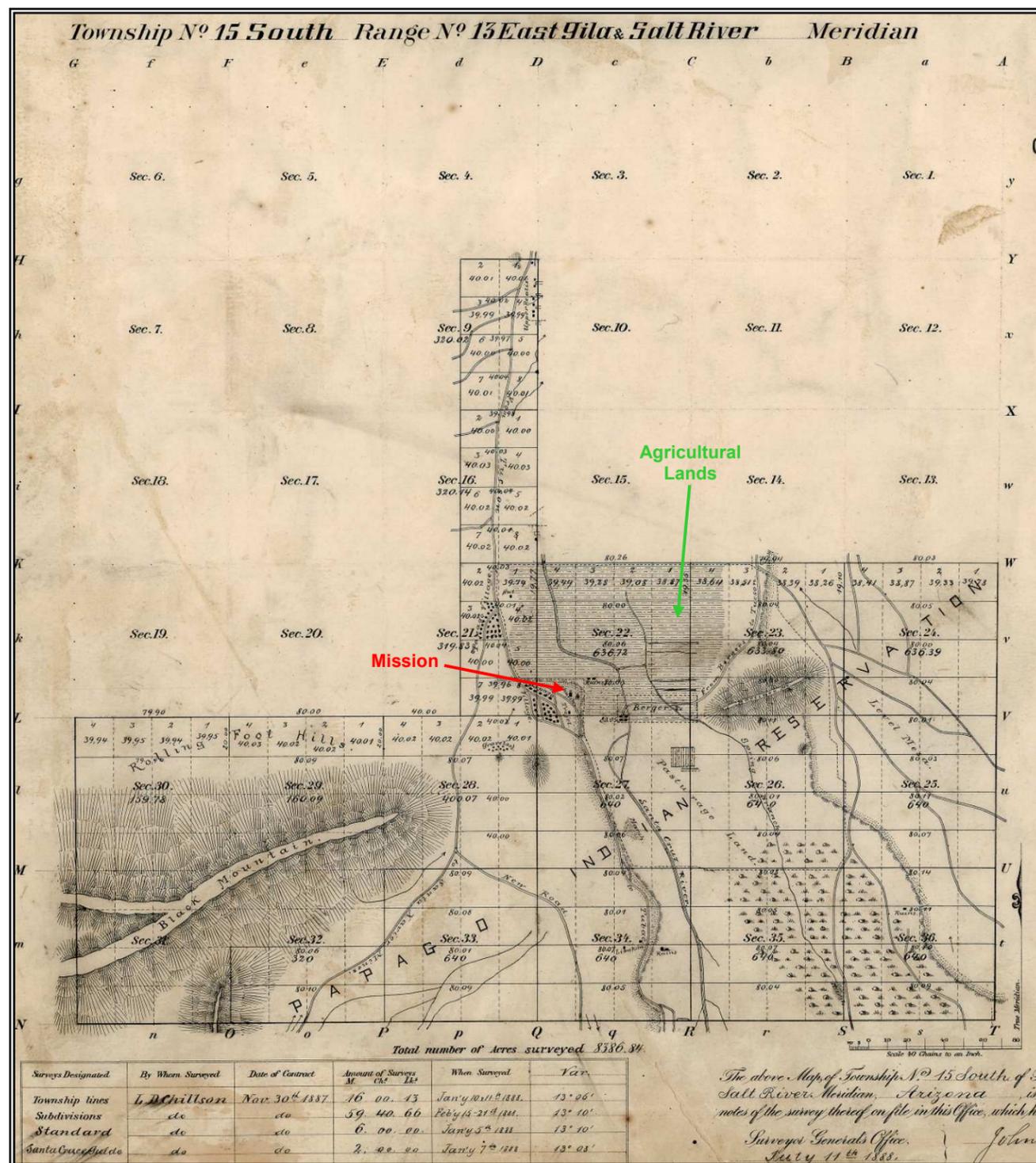
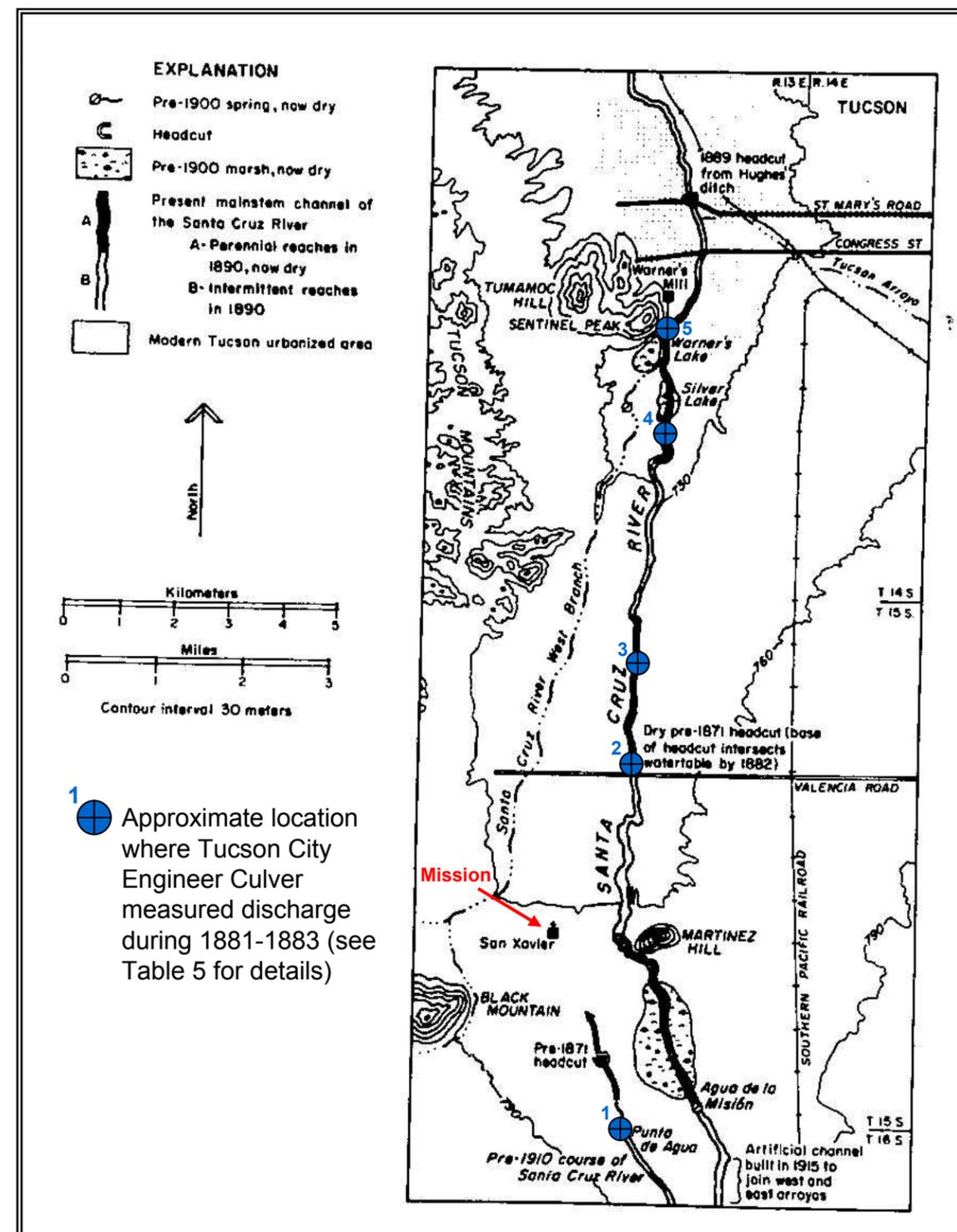


FIGURE 5 – HISTORIC MAPS OF THE SANTA CRUZ VALLEY IN THE SAN XAVIER-TUCSON AREA

1888 General Land Office Survey

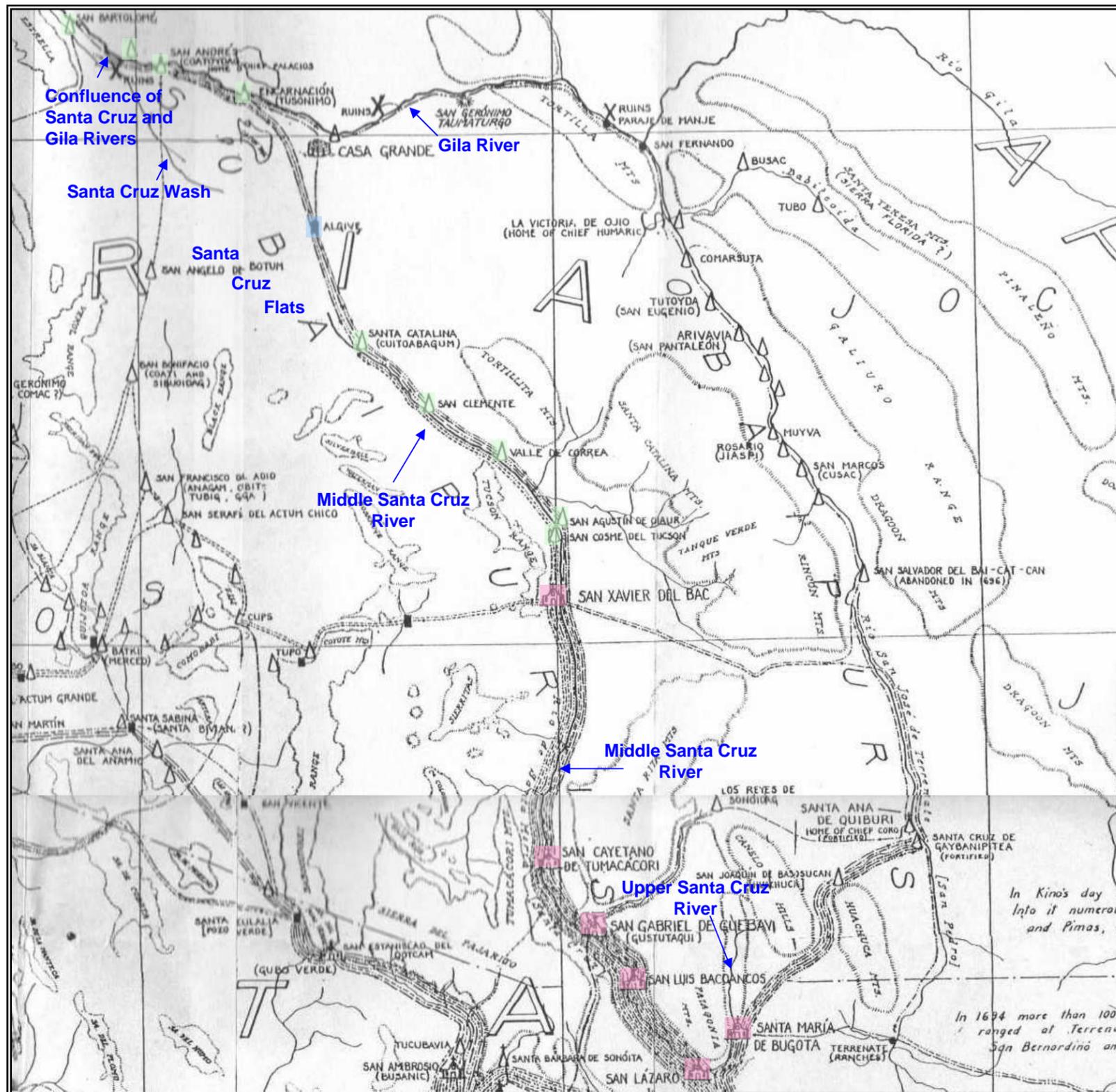


Circa 1890



Source: Modified from Bentacourt (1990).

**FIGURE 6 - PRINCIPAL EXPEDITIONS BY FATHER KINO AND ASSOCIATES
ALONG THE SANTA CRUZ RIVER**



LEGEND	
	SPANISH SETTLEMENT
	MISSION
	PRESIDIO
	INDIAN VILLAGE
	VISITA
	WATERING PLACE
	RUINS
	PLACE

PRINCIPAL EXPEDITIONS OF FATHER KINO AND ASSOCIATES:	
1	Kino, journey to Dolores, March, 1687 (with González, Burgos, and Aguilar)
2	Kino and Aguilar, to Imuris and Remedios, March, 1687 (repeated in April)
3	Kino, to Bacanuche, May, 1687
4	Kino and González, to Cocóspera, 1689
5	Kino and Salvatierra, to Tubutama and Tumacacori, 1691
6	Kino, to Bac and Bai-cat-con, 1692
7	Kino, Campos, and Romero, to Caborca and El Nazareno, Dec, 1693
8	Kino, Kapus, and Manje, to Caborca and the coast, Feb, 1694
9	Kino and Manje, to Bapía, Caborca, and the coast, March, 1694
10	Kino, to Caborca, and Manje, to Cups, Moicahui, and Caborca, June, 1694
11	Kino and Saeta, to Caborca, Oct., 1694
12	Kino, to Casa Grande and Costoydag (San Andrés), Nov., 1694
13	Jiranza and Manje, to Tubutama and Caborca, April, 1695
14	Kino, to Caborca, Aug., 1695
15	Kino, from Mexico, April-May, 1696
16	Kino, to Quiburi and Bac, Dec. 1696 - Jan., 1697
17	Kino, to Quiburi and Tumacacori, March, 1697 (repeated in April)
18	Kino, to Bazeraca, with Pima Chiefs, Sept.-Oct., 1697
19	Kino, Bernal, and Manje, down Río de Terrenate [San Pedro], Nov., 1697
20	Kino, Manje, and Ramos Sarmiento, to Tucubavia and Caborca, Feb. 1698
21	Kino and Manje, to Quiburi, April, 1698
22	Kino and Carrasco, to Río Gila and Sierra de Santa Clara, Sept.-Oct., 1698
23	Kino, Gilg, and Manje, to Río Gila, via Sonoita, Feb.-Mar., 1699
24	Kino, Leal, González and Manje, to Bac, Santa Catalina and Sonoita, Oct.-Nov., 1699
25	Kino, to Bac, April, 1700 (Church foundations begun April 28)
26	Kino, to Gila-Colorado junction, via Batki, Sept.-Oct., 1700
27	Kino, Salvatierra, and Manje, to Puerto de Santa Clara, Feb.-April, 1701
28	Kino, to lower Río Colorado, Nov.-Dec., 1701
29	Kino and González, to lower Río Colorado and sand dunes, Feb.-Mar., 1702
30	Kino and Minutili, to Tubutama, 1704
31	Kino, to Guaymas, 1704
32	Kino and Minutili, to Tepaca coast, Jan. (?), 1706
33	Kino, to Caborca, Feb., 1706
34	Kino, to Santa María, April, 1706 (repeated in June)
35	Kino, Oyuela, Ramírez, and Durán, to Sierra de Santa Clara, Nov., 1706

NOTE: Names of mountains are mainly those on modern maps.

Source – Modified from Bolton (1919); Plateau added stream labels and colored highlights.

FIGURE 7 – LOCATION OF HISTORIC PORTS AT GUAYMAS AND YUMA

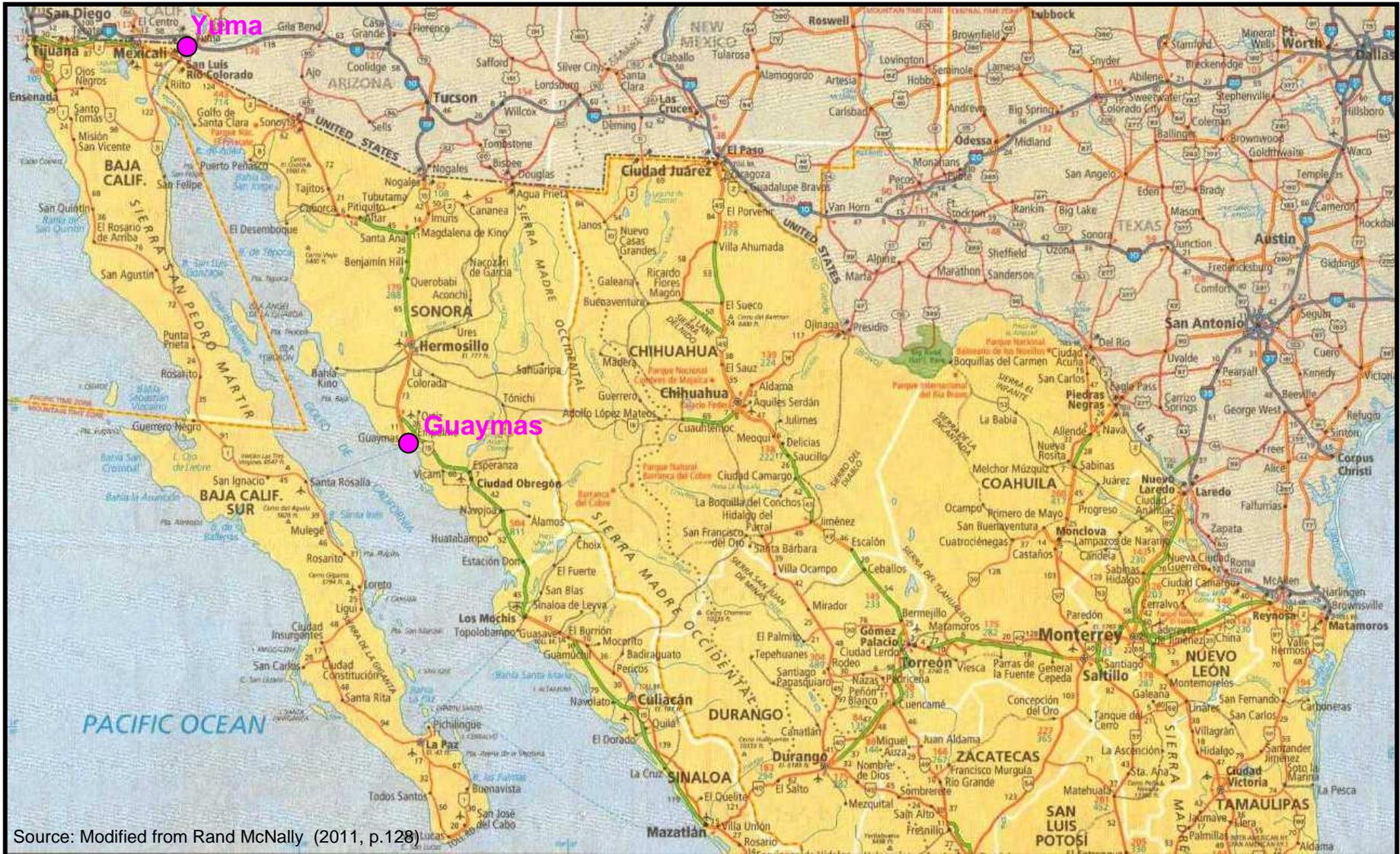
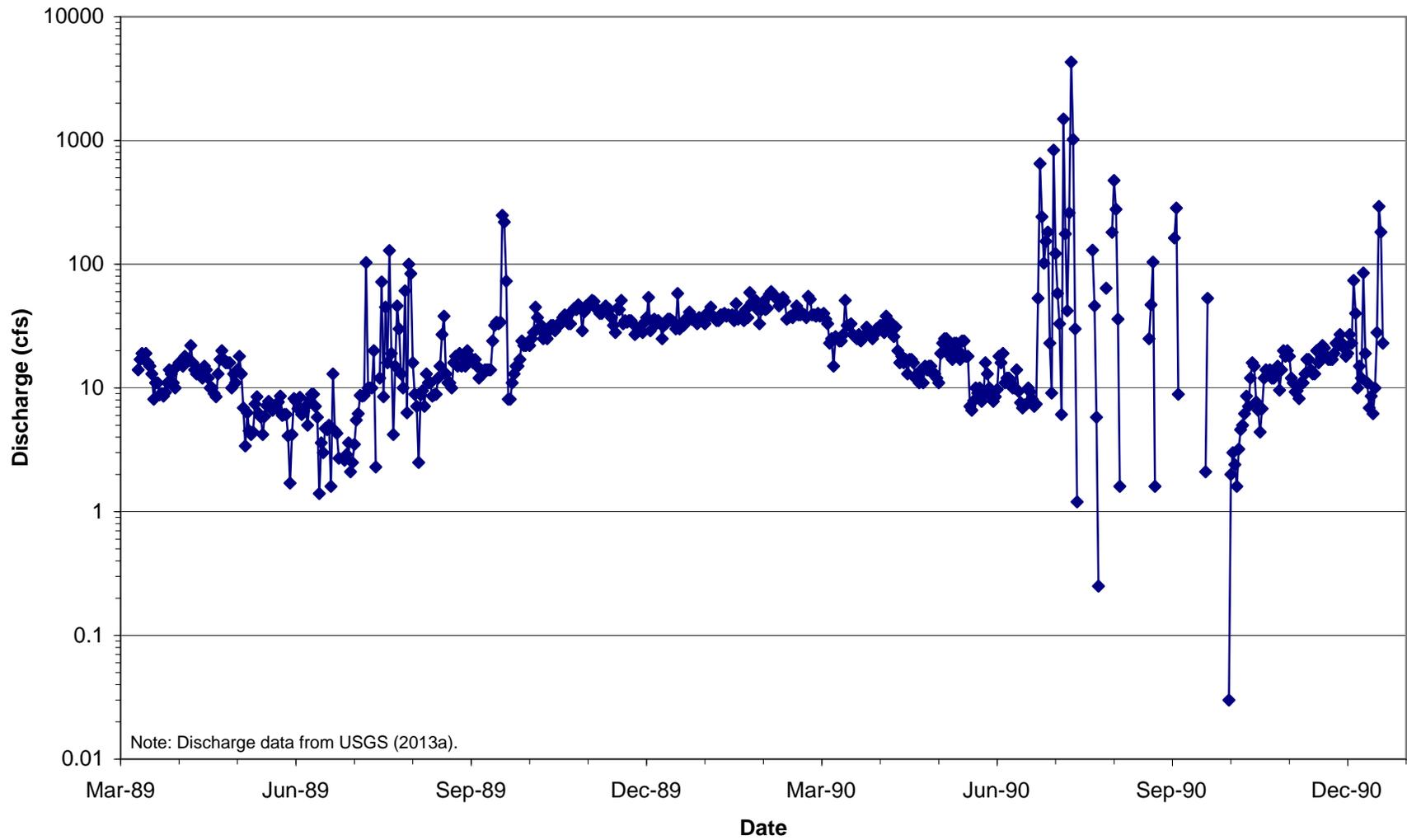


FIGURE 8 - MEAN DAILY FLOWS IN THE SANTA CRUZ RIVER NEAR MARANA DURING 1989 AND 1990 (USGS Gage 09486520)



ATTACHMENTS

ATTACHMENT A

Curriculum Vitae for Rich Burtell

RICHARD THOMAS BURTELL

4016 East Jojoba Road
Phoenix, Arizona 85044
602-327-7486
plateauresources@gmail.com

EDUCATION

- M.S. Hydrology, University of Arizona (1989)
- B.S. Geology, University of Pittsburgh (1986)

CERTIFICATION/TRAINING

- Registered Geologist, Arizona (No. 33746)
- Mine Geochemistry , Hydrology and Water Treatment Workshops (EPA, 2013)
- Section 404 Permitting and Groundwater Plume Analysis Workshops (AHS, 2012)
- Stream Restoration Course (WMG, 2011)

SUMMARY

Mr. Burtell is an environmental scientist with 25 years of project and management experience. Areas of expertise include water rights and demand analyses; evaluation of ground and surface water resources; remote sensing; land ownership assessments; environmental compliance; investigation of mine, fuel and waste storage facilities; contaminant hydrology; and, collection and analysis of environmental data. Management duties have included supervision of staff and consultants, project planning and coordination, report preparation, and litigation support.

EMPLOYMENT

- Plateau Resources LLC
Principal and Owner
Phoenix, AZ (2011-Present)
- Arizona Department of Water Resources
Manager, Adjudications and Tech Support
Phoenix, Arizona (1999-2011)
- Golden Environmental Management
Senior Project Manager
Tempe, Arizona (1998-1999)
- Montgomery Watson
Supervising Hydrologist/ Geochemist
Arizona and Colorado (1992-1998)
- Golder Associates Inc.
Project Hydrologist/Geochemist
Denver, Colorado (1990-1992)
- U.S. Geological Survey
Staff Hydrologist/Geochemist
Orlando, Florida (1989-1990)
- Phelps Dodge Inc.
Hydrogeologist – Summer Intern
Morenci, Arizona (1987)

EXPERIENCE

Project

- Evaluation of ground and surface water resources including aquifer testing, model development and review and GW/SW interactions
- Water rights analysis and legal review
- Stormwater, Section 404 , and mine exploration permits
- Preparation of Environmental Impact Statements and Aquifer Protection Permits
- Water demand determinations for agricultural, municipal, industrial, and riparian uses
- Phase I/II Environmental Site Assessments
- Remote sensing and surface mapping
- Contaminant hydrology and transport/ geochemical modeling
- Characterization of fuel and solid/ hazardous waste facilities
- Collection and analysis of hydrologic, geologic and water quality data

Management

- Supervision of enviro. staff (up to 15 geologists, hydrologists, GIS analysts and administrative assistants) and consultants
- Project planning and scheduling
- Proposal and report preparation including document publication
- Coordination with interdisciplinary teams, stakeholders and regulators
- Litigation support (expert testimony, technical advisor to court, and settlement negotiations)
- Third party and peer review
- Budget development and control

COMMITTEES

- Water Resources Development Commission (served on Water Supply and Demand Committee)
- Western Navajo-Hopi Water Supply (Kyl) Study
- Upper San Pedro Partnership (served on Technical Advisory Committee)

AWARDS/HONORS

- Arizona Department of Water Resources
 - Supervisor of the year
 - Section of the year
 - Team and individual special achievement
- University of Arizona
 - Meritorious performance as teaching assistant
- University of Pittsburgh
 - Representative of graduating class
 - Tarr Award, Sigma Gamma Epsilon
 - Summa cum laude

PROFESSIONAL ORGANIZATIONS

- Arizona Hydrological Society
- Arizona Geological Society
- Arizona Water Well Association
- Arizona Riparian Council
- SME (Maricopa Section)

RECENT PUBLICATIONS/REPORTS

- *Estimated Water Demand and Conservation Potential of Domestic Wells in the Sierra Vista Subwatershed, Arizona* (2012)
- *Water Supply Options and Potential at the Fancher Mill Site* (2011)
- *Assessing Water Supply Vulnerability in a Water Scarce State: The Arizona Water Sustainability Evaluation* (prepared with Kelly Lacroix and Linda Stitzer and presented at the XIV World Water Congress, 2011)
- *Multi-Sector General Stormwater Permit Applications for the Ajo, Carlota, Fancher and Zonia Mines, Arizona* (2011)
- *Response to Comments and Objections Filed on ADWR's June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed* (2011)
- *Land Ownership Within the San Pedro Riparian National Conservation Area* (2010)
- *Mapping of Holocene River Alluvium along the Verde River, Central Arizona* (prepared in cooperation with the Arizona Geological Survey, 2010)
- *Arizona Water Atlas, Volumes 1 through 8* (2006-2010)
- *Catalog of Non-Exempt Registered Wells, Zuni Indian Water Rights Settlement* (2009)
- *Subflow Zone Delineation Report for the San Pedro River Watershed* (2009)
- *Preliminary Hydrographic Survey Report for the Hopi Indian Reservation* (2008)
- *Identification of Irrigated Lands in the Gila River Maintenance Area* (2008)
- *Review of the Settlement of Public Water Reserve No. 107 Claims in the San Pedro River Watershed* (2007)
- *Technical Assessment of the Tohono O'odham Nation, Gila River Indian Community, and Zuni Indian Tribe Water Rights Settlements* (2006)

RECENT AND CURRENT PROJECTS

- Analysis of federal reserved right claims and subflow-related issues, AZ (confidential client)
- Aquifer Protection Permit for a marble quarry near Dragoon, AZ (Alpha Calcit Arizona Ltd.)
- Aquifer testing, well siting, and ground-water quality assessment for the proposed Fancher gold mill near Salome, AZ (Luxcor Gold)
- Analysis of Clean Water Act issues, southwestern United States (confidential client)
- Exploration permit for the Idaho Placer Claim near Prescott Valley, AZ (various investors)
- Geochemical characterization of impacted waters and stormwater and 404 permitting for the Zonia copper mine near Prescott, AZ (Redstone Resources Corporation)
- Hydrogeologic and well permitting support for reclamation of the St. Anthony uranium mine, NM (Pueblo of Laguna)
- Litigation of Bonita Creek water rights issues near Payson, AZ (various plaintiffs)
- Navigability assessment for major instate streams, AZ (confidential client)
- Water supply evaluation of the Arctic Ice and Water company (various investors)
- Water use and conservation potential of domestic wells in the Sierra Vista Subwatershed, AZ (City of Sierra Vista and Western Resource Advocates)
- Water use evaluation for the town of Camp Verde, AZ (Western Resource Advocates)

ATTACHMENT B

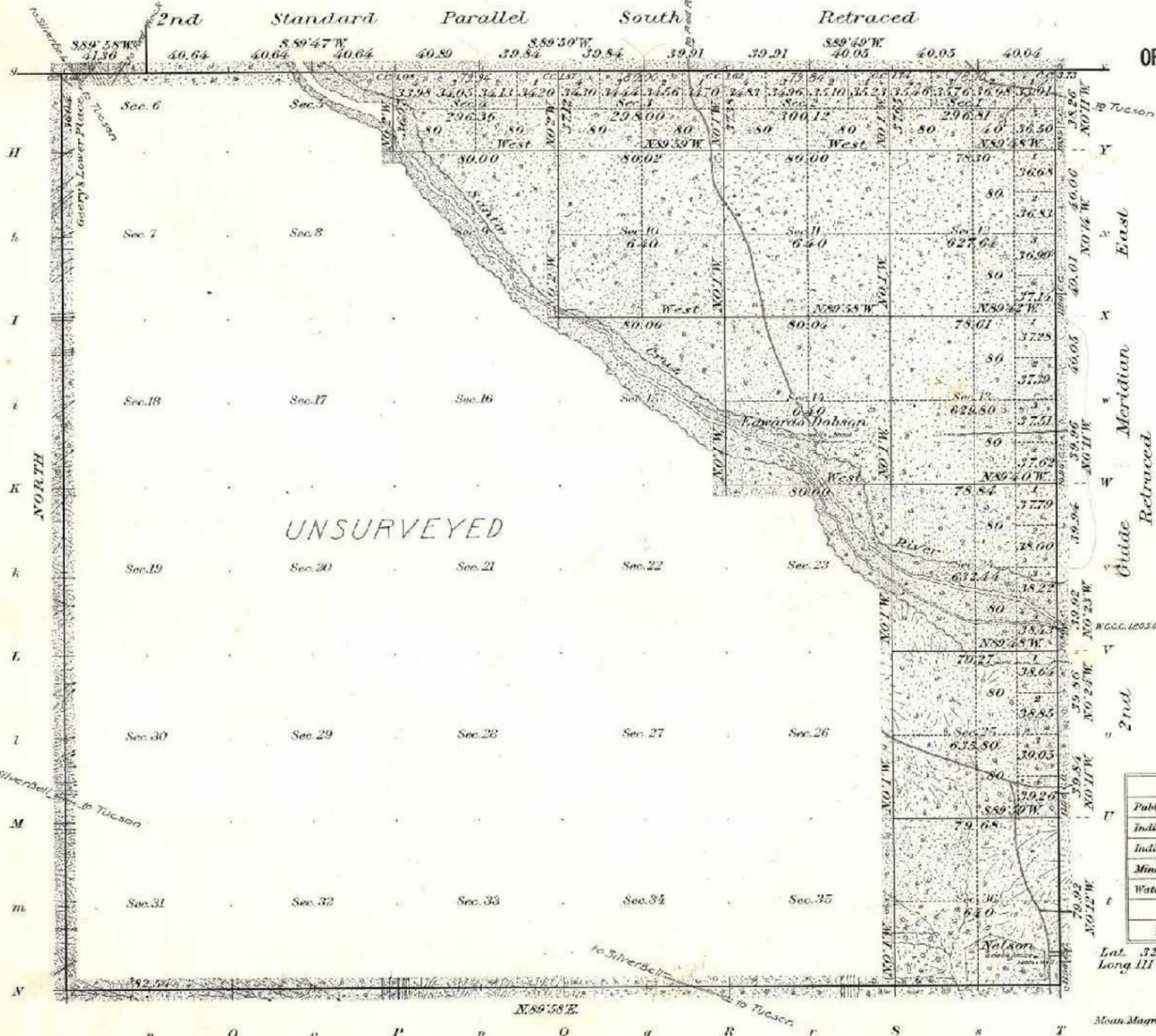
General Land Office Survey Maps

Township No. 11 South Range No. 10 East, Gila and Salt River Meridian, Arizona.

G I F E E d D o U b B a A

1907

Sec. 36 Sec. 31 Sec. 32 Sec. 33 Sec. 34 Sec. 35 Sec. 36



OFFICIALLY FILED 4-15-1913

Areas in Acres	
Public Land	6,276.97
Indian Reservation	
Indian Allotments	
Mineral Claims	
Water Surfaces	
Total Area	6,276.97

Lat. 32° 25' 39" N.
 Long. 111° 17' 16" W.
 Scale 40 Chains to an inch.
 Mean Magnetic Declination 15° 30' E.

Surveys Designated	By Whom Surveyed	Group No.	Date	Amount of Surveys			When Surveyed	
				Mls.	chs.	fms.	Began	Completed
St. Lines Retraced	Fred W. Rodolf	11	Aug 22, 1911	11	41	63	Oct 16-17, 1911	
S & W Boundaries	" " "	"	" " "	11	35	55	" 11-15 "	
Subdivisions	" " "	"	" " "	20	63	88	" 18-21 "	
Connections	" " "	"	" " "		11	07		

The above map of Township No. 11 South Range No. 10 East of the Gila and Salt River Meridian Arizona is strictly conformable to the field notes of the survey thereof on file in this office, which have been examined and approved

U. S. Surveyor General's Office.
 Phoenix, Ariz. June 12, 1912.
Frank D. Ogden
 Surveyor General.

ATTACHMENT C

1990 Newspaper Articles Showing Rafts on Santa Cruz River

ministrative Coast Guard judge was held to determine whether Hazelwood could keep his captain's license and continue his seagoing career. That hearing continued, with the judge to decide on sanctions for the no-contest pleas.

However, the Coast Guard dismissed a charge that Hazelwood was drunk by Coast Guard standards while he commanded the 987-foot tanker.

It also dismissed a charge that he was negligent in leaving a third mate who was not properly licensed in charge of the Exxon Valdez as it passed through the Valdez Narrows of Alaska into Prince William Sound.

Diggers uncover first 'golden calf'

NEW YORK — Archaeologists in Israel have discovered an ancient "golden calf" figurine, a pagan idol frequently mentioned in the Bible.

The hand-sized, mixed-metal figurine, about 3,500 years old, is the first of its kind to be unearthed. The New York Times reported today.

Harvard University archaeologists excavating Canaanite ruins near the ancient port city of Ashkelon found the figurine on June 26, the Times reported.

The figurine was found in the rubble of a temple destroyed by Egyptian conquerors in about 1550 B.C., during the Bronze Age.

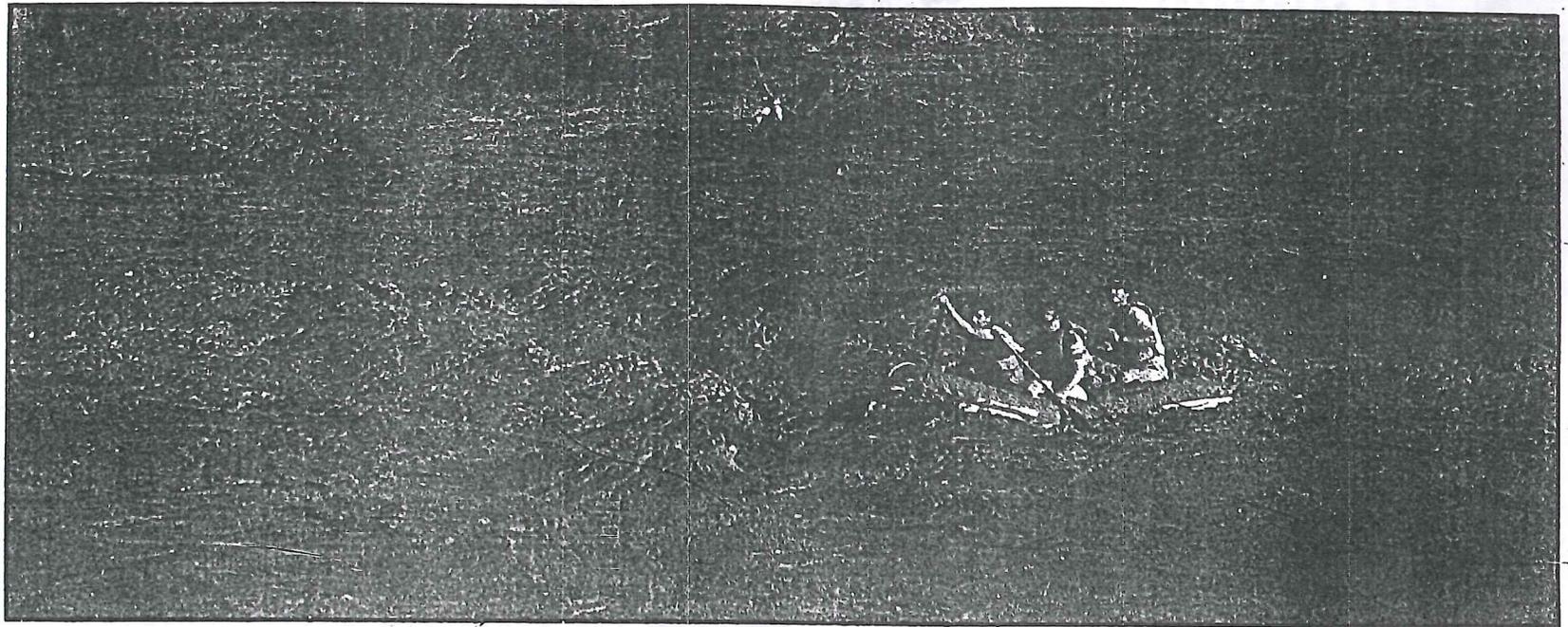
The calf is 4¼ inches tall, 4½ inches long and weighs just under one pound.

Compiled by Karen Saunders from wire services

Thursday

She lost everything to a psychic con

In a whirlwind of false hope and intimidation, a lonely Tucson woman gave her life savings to a "psychic" who promised her success in love. Read her story in tomorrow's Citizen.



Three adventuresome people, who said they have whitewater rafting experience in the Grand Canyon, braved the Santa Cruz yesterday. GARY GAYNOR/Tucson Citizen

A very wet July

If the last week of this month is as wet as the first three, Tucson could record its rainiest July ever.

Through yesterday, 5.20 inches of rain have fallen this month at the official National Weather Service station at Tucson International Airport.

The wettest July was in 1981, with 6.17 inches of rain at the airport. The wettest month in Tucson's history was August 1955, with 7.93 inches of rain.

So far this year, the airport has received 8.05 inches of rain — about 3½ inches more than normal and about 4 inches more than at the same time last year.

More on flood inside

- A man remains missing after falling into the raging Santa Cruz. 1C
- Work done since the flood of 1983 prevented serious damage yesterday. 2C
- A complete look at yesterday's problems. 2C

Neighborhoods survive, watch flooding recede

By TOM SHIELDS and K.J. SCOTTA
Citizen Staff Writers

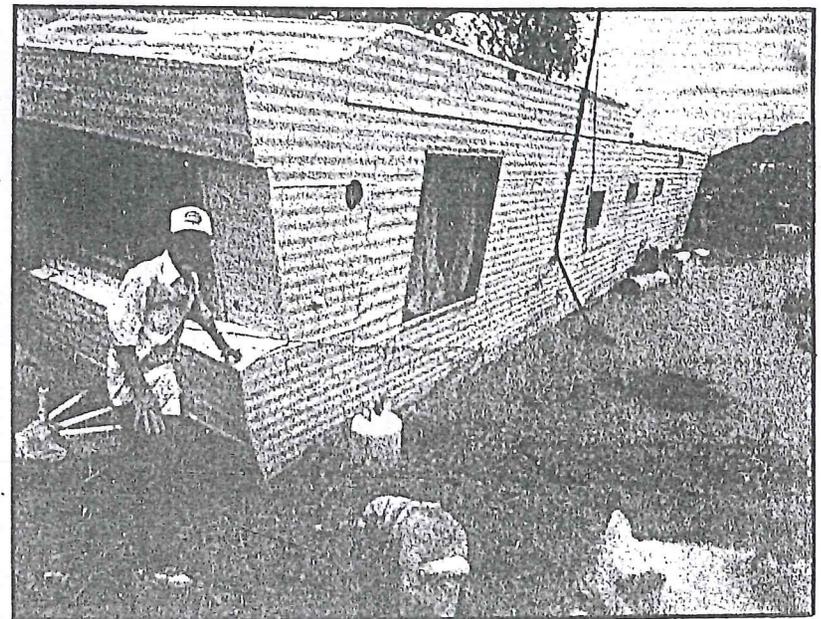
As the sun broke out of the clouds yesterday afternoon, people on Camino Tierra in the Drexel Heights area of southwest Tucson came out of their homes to survey the damage and watch the foot-deep water swirling down the road.

Most of the people were quiet, amazed that so much water had flooded their neighborhood so quickly. Frogs croaked, roosters crowed, dogs in a kennel barked.

But the water was receding and everyone had survived. There had been close calls, but no one had been hurt in this neighborhood.

On the other end of the Tucson valley, 25 miles to the northeast, residents of 49ers Country Club were having the same problems at their posh homes.

Early yesterday morning, about 100 families were evacuated from the country club as rains pounded



Harry Huggitt examines his mobile home after it was washed off its foundation on the Southwest Side and swept 150 feet away. XAVIER GALLEGOS/Tucson Citizen

TUCSONANS, continued/2A

Family-leave bill is dead

\$167,000 spent

mer New Hampshire governor's role was one of direct advocacy for the man he placed on his state Su-

bench. Bush for the time being seems to be having it both ways with the

But was Sununu in the doghouse? Not on your life. His words were designed to provide a reassuring

taxes' pledge. On abortion Bush has softened some edges of his position even as

the mother there isn't involved, he



LINDA SEEGÉR/Tucson Citizen

A parked car was washed about 150 feet when water swept along West Camino Tierra yesterday.

Tucsonans watch floods recede

Continued from 1A

into the lowlands Rincon Valley. By 10 a.m. water from Tanque Verde Wash had covered all but three of the 18 holes on the 49ers golf course. Families sandbagged their homes.

Yesterday's torrential storm, dumping up to 4 1/2 inches of rain in two hours, covered the entire Tucson valley with water and mud.

Until then, the residents of the country club homes and of the Southwest Side mobile homes had little in common.

As the torrent from the hills and desert to the east poured over South Mark Road and crossed Camino Tierra, climbing around cars and mobile homes, Karen Costanten, 14, went out to rescue her dog. But she got caught in the water, grabbed onto a small tree and clung there until a neighbor pulled her to safety.

Up the street, Harry Huggitt, 65, and a friend had been sitting in a car, waiting for the downpour to let up so Huggitt could run inside his mobile home.

As they watched the water rise on the mobile home, Huggitt said, half in jest, that he hoped it wouldn't be washed away.

"All of a sudden it started floating off, like a ship, just as smooth," he said later, standing next to his mobile home about 150 feet downstream from where it had been.

Huggitt's dog, Piggy, who was in the mobile home, was rescued unhurt by Ernie Trujillo, 42, a neighbor who crawled in through a window.

Francisco Rodriguez saved his two horses but lost about 100 roosters as their pens were swept away by the sudden flooding.

Near the intersection of Mark



XAVIER GALLEGOS/Tucson Citizen

High water came within inches of washing inside Frances Salazar's mobile home near West Valencia and South Mark roads.

Road and Camino Tierra, Jesus Metzler looked at the debris, broken fences and mud and declared he had never seen so much water in the neighborhood. And it had been scary for his wife and three children.

A neighbor's car had been swept out of his driveway, down the street and jammed off the side of the road by the force of the water.

Soon, electric and gas company workers began arriving to help. American Red Cross workers arrived and told people they would be opening Lawrence School, 6855 S. Mark Road, so they could provide food and other assistance.

Far away, at 49ers, the residents had this kind of experience before.

In the floods of October 1983, the neighborhood was one of the hardest-hit areas in the county due to its position in the flood plain along Tanque Verde Wash.

Yesterday, children emerged from their homes barefooted and ready to make use of all the mud and makeshift swimming holes dotting the neighborhood.

Matt Rieck, 16, and a group of his buddies spent the morning tubing in the temporary river behind his home on Barbary Coast Road.

"The water was up to the garage," Rieck said. "It wasn't as bad as in 1983 when the wash was flowing down my street here, but if we get any more rain, it could get that bad."

One of Rieck's neighbors, Orrin Biesterfeld, said he did not evacuate his home yesterday morning.

"We were pretty high up. I've seen pictures of the 1983 flood, and today wasn't nearly as bad. I can't help but wonder if it rains again tonight what will happen, though," Biesterfeld said.

Karen Russell said she had Pima County to thank for the fact that no water got into her new home on Gold Rush Place.

"They made us put down an extra 900 yards of fill dirt to the pad the house sits on. We weren't very happy at the time, but now I'm glad they made us build up more. We would have had a lot of water in the house," she said.

Bill would r

Continued from 1A

senior level of government," said the report by the commission. The goal "can best be achieved by centralizing the current widely dispersed government structure for handling immigration and refugee affairs in a single agency whose head reports directly to the president."

The legislation embraces a chief recommendation of the bipartisan commission that was set up as part of the landmark 1986 Immigration Reform Act. That chief recommendation called for radical restructuring of the U.S. immigration policy, which Cranston is proposing.

The 1986 immigration reform act

also allow workers to, posed sanct the hiring o

The fede rent divisio lities amo means little on immigra licies, such developm

The study talks betwe Mexico tow between the trade zone U.S.-Canad

It said su followed by cord to all

Grass not yet g

Continued from

In fact, the engineering department decided November completion date came too late for sowing a permanent lawn, so money was withheld from contractor with a plan to return in early sum and put in the lawn.

But when an undisclosed board member or members heard of the plan, there was concern about looks of the field, Dixon said. "Since so much money was spent to improve the fields, they did want a barren school yard all winter."

And who would? O'Toole asked. Certainly public would prefer to having winter grass for 1 months.

But when temperatures suitable for planting stand of summer Bermuda came around six months later, there was no seed for the sowing, Dixon said.

So sowing summer seed was delayed, O'Toole said.

But one of the first items for order on the fiscal 1990-91 budget was Bermuda grass seed, Dixon said.

And seed sowing is to get under way next week, even this week if grounds crews have time, O'Toole said. "We have a certain size groundskeeping for and we've had a lot to do this summer."

Meanwhile, board president Sylvia Campoy wondering who asked for the fall sowing. She asked Assistant Superintendent Roger Pfeuffer for an explanation.

Pfeuffer's response summed up the reasons for the barren playground at Roskrige, but never mentioned who directed the sowing in the fall.

Nevertheless, Pfeuffer said, the lawn will be planted in plenty of time to gain a foothold before children resume classes Aug. 20, less than four weeks away.

Nursery workers contacted by the Tucson Citizen said he might be right, but that's cutting it a little close.

Under ideal conditions, Bermuda germinates eight to 12 days and should be closed to traffic until after at least the first cutting.

Gene linked to Alzheimer's

Continued from 1A

linked to an abnormality on chromosome 19, one of the 23 pairs of human chromosomes.

Previous studies found a defect on chromosome 21 linked to an early-onset form of Alzheimer's in which memory loss and other

frustrated in efforts to publish his findings in a scientific journal.

Other researchers are now rapidly trying to determine whether their genetic samples from Alzheimer's victims also reveal an abnormality on chromosome 19, said Dr. Peter St. George-Hyslop of Massachusetts General Hospital in Boston. He is one of the discoverers of

tion for the disease die of something else before they develop it, Roses said.

"There are a lot of people in the field who have doubts about whether late-onset Alzheimer's can even be approached by genetic techniques," Roses said.

Researchers differ in their view of the disease. Roses believes that

House sustains B veto of family-lea

Continued from 1A

"We're going to have this kind of legislation enacted — if not this year in this session, next year or the year after. It's inevitable," Foley said.

But Rep. Texas, prais "courageous v opponents c would have in fits-all benefit and employ

Cruising The Effluent

...Or, Up Shit Creek
With Two Paddles

With an inflatable boat and explorers' spirits, author Jim Malusa and his wife Sonya Norman floated the 10-mile stretch of treated sewage in the Santa Cruz.

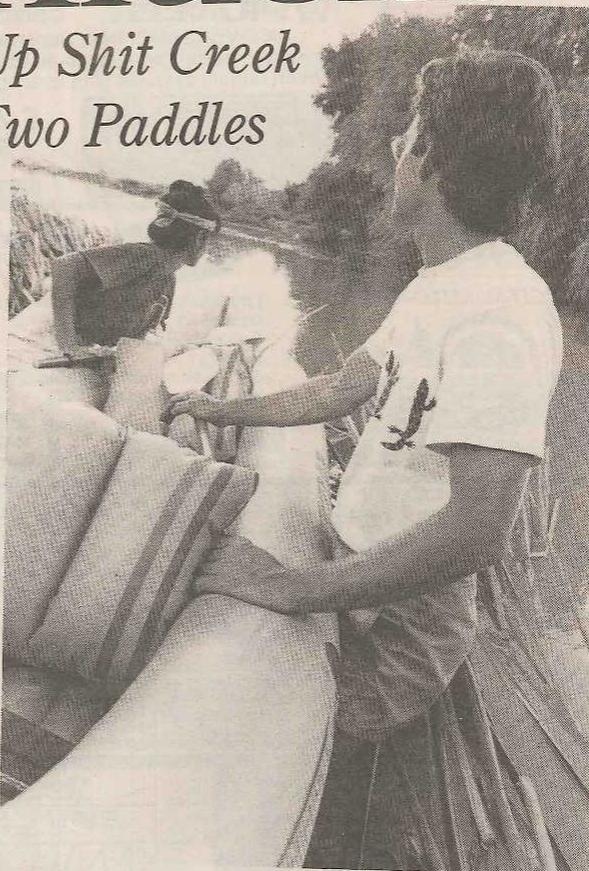


Photo by Tim Acubuhadi

FEW RIVERS LOOK more desperate than the Santa Cruz near downtown Tucson.

Squeezed between freeway and power lines, straightened by blueprint and bulldozer, it is more canal than river. To add insult, most of the time it's an empty canal. There's no water.

Yet only 10 miles downstream, as the Santa Cruz winds north toward Marana and beyond, the river runs year round. From this perennial water life flows: from algae to bug to bird. Very big birds, big enough to provide shade if they would only stay still. They're all here because of millions of gallons of water that pours into the streambed each day between Roger and Ina roads—treated effluent, courtesy of Pima County Wastewater Management. You say sewage, I say Santa Cruz.

This is where the water goes after it spirals down the sink and shower, tub and toilet. Even though the water's been treated, its origins are reason enough for most people to keep their distance.

But I had a little inflatable boat and a powerful interest in what lay north of the Ina Road bridge. So we went, my wife Sonya and I, wastewater rafting down the river some 10 miles to Avra Valley Road.

A few days later, having failed to die from infectious diseases, I called the Pima County Wastewater Treatment Plant at Roger Road (there's a second plant nearby at Ina Road) to find out if rafting the effluent was a good idea or a bad idea. Plant Superintendent Don Armstrong said

BY JIM MALUSA

we shouldn't have any problems, so long as we didn't drink the stuff.

On the other hand, the river of effluent may soon be no more. Soon, the only free-flowing stretch of the Santa Cruz near Tucson may be shut off like a garden hose, before most locals knew it existed.

The problem is straightforward: the county says the effluent is clean enough to be discharged into the Santa Cruz, while state and federal agencies say it isn't. Meeting tougher discharge standards could cost the county up to \$200 million, and no county employee has dared say it's worth it. Because standards for agricultural use of effluent are less stringent than for aquatics and wildlife, Pima County is pushing hard to send the Santa Cruz effluent flow—all of it—in a canal or pipe to Marana area farms.

Unfortunately, the river and its inhabitants are utterly dependent on the effluent flow. If Pima County diverts the water there will be nothing but sand left in this stretch of the Santa Cruz, an ironic consequence of state and federal efforts to clean up the flow.

SONYA AND I are cheerfully ignorant of all this the morning we slip our inflatable kayak into the Santa Cruz. We fancy ourselves a hardy breed of pioneer wastewater rafters, tight-lipped, with eyes peeled for potentially offensive floating matter. It's a warm morning in late April, with torn clouds drifting above, and a south wind carrying the cotton puff seeds of the riverbank willows. The

stream is quick and turbid, about eight feet wide and eight inches deep.

"We are ready to start on our way down the Great Unknown," wrote John Wesley Powell in 1869, before rowing off into the Grand Canyon of the Colorado River.

"It doesn't stink!" says Sonya—and the current takes us away.

Into a jungle of overarching willows, salt cedars topped with purple blooms, cattails crowding the stream's edge. We paddle for fun, then stop and drift. We hear the whistles and trills and shrieks of birds strange and fantastic. Birds with needle beaks and insanely thin, red legs bent like soda straws: the black-necked stilt. We round a bend to see mallards, with webbed feet and iridescent green heads, springing out of the water, stretching into the wind. Dozens of red-winged blackbirds swoop and yak, looking like compact ravens streaked with red fingerpaint.

Whitewater ahead. We hope for something dangerous—a rapid, or a waterfall—but the boat just grinds to a halt on the shallow bottom. We drag it through the midjet waves of what we christen Redworm Rapid for the little creatures we see clinging to the grains of sand and small cobbles.

Later I learn they are not worms, but the larvae of chironomid flies. They're red because their blood contains hemoglobin, the same molecule that human blood uses to grab oxygen molecules. Chironomid larvae are common here, and other species are absent, because the stream is low in dissolved oxygen, much of which has been consumed by organic wastes in the effluent. Also, the water is warm—my little thermometer shows 80 degrees—and a warm stream, like warm beer, holds less dissolved gas than a cold stream. Active fish like trout live in cold, high oxygen streams. The Santa Cruz is not a trout stream.

But it could be. Raw sewage can be treated to any standard, even sterilized for infant formula—for a price. But it's far cheaper to simply eliminate solids and reduce organic wastes from sewage and get drinking water from wells. Pima County treats sewage through mechanical filtration and settling tanks, then a host of hungry bacteria get to eat the biological wastes. Finally, disinfection with chlorine.

Some 20 percent of the effluent is reused, mainly for irrigation, and the rest goes into this usually dry channel of the Santa Cruz. When the flow is high the river runs 30 miles to Red Rock, near Picacho Peak. Along the way the water is used by wildlife, evaporates, or seeps through the sands back down into the aquifer from which it came.

BOAT TRAFFIC IS minimal; we see nobody else. In fact, we see almost nothing but the sky and the crest of the Tucson Mountains, all else hidden behind parallel walls of water-loving plants. There's not much trash: an occasional tire embedded in the sand and on the bank, an old stove perforated with bullet holes like Bonnie and Clyde's car.

We glide on, Sonya paddling while I play naturalist, peering through my binoculars at mildly peeved waterfowl, flipping through my bird book. I drop everything when something feathered and bigger than my head bursts out of one thicket and disappears into another without a sound. There's only one bird that big, that quiet and with talons that

long: the great horned owl, a predator capable of deflating our flimsy boat in five seconds.

We stop in the shade under a bridge and break out the survival gear: a Tucson road map and a can of Milwaukee's Best. We open both, and determine our location to be the Cortaro Road Bridge.

This is where the Arizona Department of Environmental Quality (ADEQ) monitors the water quality, retrieving samples every other month for lab analysis. Every three years the ADEQ evaluates water quality standards. A 1987 amendment to the federal Clean Water Act requires that states adopt specific criteria for toxic pollutants that will protect the "designated use" of a stream

We fancy ourselves a hardy breed of pioneer wastewater rafters, tight-lipped, with eyes peeled for potentially offensive floating matter.

or lake. The ADEQ, prompted by the U.S. Fish and Wildlife Service, has set the designated use of the Santa Cruz as "Aquatic and Wildlife."

Among their primary interests are the levels of chlorine and ammonia, a nitrogenous endproduct of humans digesting protein. Standards for chlorine and ammonia are determined by a variety of methods, including studies of typical warm stream inhabitants, such as minnows. Where the effluent enters the Santa Cruz, and for some distance downstream, the levels of ammonia and chlorine are usually at levels that would kill many aquatic organisms.

Also monitored is the less common but more ominous mercury. A heavy metal which can kill or cause deformities in exceedingly small doses, mercury has the unfortunate tendency to bioaccumulate: organisms ingest it while feeding, unwittingly store it in body tissues, then pass it on in an intensified dose to whatever eats them. Mercury occasionally appears at high levels in the effluent. So do phenols, organic acids common in cleaning products like Lysol. They impart an evil taste to fish, and in some instances are also toxic. With the exception of chlorine, which is intentionally added to the effluent, none of these pollutants is removed by the current wastewater facilities.

And why would we bother? "I love wildlife," asserts Superintendent Armstrong, "and I bring the Boy Scouts down for their soil and water conservation merit badge." He's aware that chlorine is toxic to some aquatics, but the whole point of a disinfectant is to kill potentially infectious bacteria and microbes. Ammonia is toxic too, but both ammonia and chlorine are reduced to non-toxic levels by sunlight and plants once the Santa Cruz reaches Marana, about 15 miles downstream.

Is it worth an estimated \$200 million dollars to reduce the ammonia and chlorine in the effluent to increase the number of aquatic species in a historically dry section of the Santa Cruz?

"For that money we could buy a 747 and fly everyone to San Diego to see

The amount of water in the Santa Cruz varies greatly. The river level pictured is after recent monsoons. At the time of the rafting trip described there was only effluent in the riverbed and the water level was much lower. For more information on the effluent flow call the Roger Road treatment plant at 888-4801.

some aquatics," jokes Armstrong.

Heavy metals and phenols can only be controlled by keeping them out of the sewers. Pima County currently spends about a million dollars a year to keep out various pollutants, with inspections and "sewer cops" to trace the source of violations. The proposed standards for the effluent would require even stronger limits on what goes down the drain.

Dentists, for example, may need to install systems to filter out the tiny bits of amalgam that their patients spit out. This "silver filling" contains mercury. The county and the Arizona State Dental Association claim it's inert mercury, harmless, and not bioaccumulative.

The EPA disagrees. They point out that waterfowl, including game birds, are dependent on the effluent. Why shouldn't the county and the dentists be required to protect the birds the effluent attracts?

Because, says Engineer John Davis of Pima County Wastewater, "The cost of more stringent controls is unknown. When the industry types come moaning to us, all we can say is, 'Look, we tried to keep things reasonable.'"

LUNCHTIME ON THE river. We deserve it after surviving Blind Man Rapid, so named because it's impossible to scout, especially if you happen to be looking the wrong way, which we were. Suddenly we had to make a hard left, between a marooned tumbleweed and a willow hanging into the stream. We hit the willow, sending up a cloud of tufted seeds and delicate lacewings, insects with translucent green wings.

On a shady sandbar we eat peanut butter and jelly sandwiches, slice Willcox apples, munch on carrots: a lunch Mom would be proud of. The riverbank is lined with mint bushes and tree tobacco, each waving flowers, each vying for the attention of pollinators. Out of the bushes struts a noisy, long-legged bird with two black rings around its neck. The book says it's a killdeer, so named for its call, which to me sounds nothing at all like "killdeer." I was never a Scout.

AND PIMA COUNTY needs more than a merit badge to discharge effluent into the Santa Cruz riverbed. Without a federal permit from the Environmental Protection Agency, it faces heavy fines. Meeting the proposed standards would likely cause sewer fees to double or triple and, says Pima County's Davis, "People presumably do not want to pay a penny more in user fees—or at least that's the Board of Supervisors' view."

No permit would be needed if there

were no discharge into the Santa Cruz (which, being connected to the Gila and Colorado rivers, is considered a "waterway of the United States"). So the Board has "acted aggressively to get the water out of the Santa Cruz," Armstrong says.

Board member Ed Moore would have a fine view of the Santa Cruz from his 11th story office window, but when I visit the shades are drawn. It is an office of strong opinions and stronger smells, the predominant odor being cigar, an Hoyo de Monterrey Largo Elegante. "Do you mind?" he asks politely.

Moore doesn't conceal his disdain for those who don't see the advantages of taking the effluent out of the Santa Cruz. "In Israel, they'd hang people for throwing that water away."

But isn't there considerable recharge to the aquifer?

"Much of that goes to Pinal County," asserts Moore, implying that it might as well go to Jupiter. "When we remove the water from the riverbed," he continues, "we remove the Aquatic and Wildlife designation. My theory is let's give the effluent to the farmers; then they won't have to pump so much ground water. The delivery system would cost two or three million, but the alternative is \$500 to \$600 million to save some water bugs."

It's not that he has anything against water bugs, against nature, however. "I can identify birds in the field," he says. "Any one of my kids can identify Southwestern animals. The real environmental issue here is conserving water."

Moore is convincing in a good 'ol boy sort of way, and the trail of cigar ash down the front of his oxford cloth shirt only magnifies this impression.

"It makes business sense," he continues. "One of the ways to strangle growth in this community is to force the community to spend \$600 million to waste a valuable commodity. The no-growthers would like that."

And what of the river?
"Before the treatment plant, that riparian area was never there. Let's put in a 500-acre lake, plant 5,000 to 50,000 trees in a linear park."

ONE MIGHT THINK the county would have little trouble in finding takers for effluent. But the problem is finding a way to use *all* the effluent *all* the time. Without a EPA permit, there can be no discharge into any "waterway." Tucson and Pima County agreed in May to spend \$200,000 on developing effluent reuse programs, a process which is bound to take longer than the EPA will wait. For the interim, Moore and Pima County

continued on next page



Photo by Tom Archibald

A riparian catch-22: Birds, mice, grasses and trees have returned to the river since Pima County began discharging effluent there. But now state and federal environmental officials say the water has too much ammonia, chlorine and heavy metal to be safe for wildlife.

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RIVER

continued from previous page

Wastewater are looking north, downhill to Marana.

The Cortaro-Marana Irrigation District pumps and delivers water to farms. If you must farm cotton in the desert, this seems a good place to do it: the water table has not dropped since the Santa Cruz effluent began recharging the aquifer, and cropland near the interstate may soon fetch a very fair price for real estate development. Now the county wants to give Marana farmers more water, cheap water loaded with nitrogen (from the ammonia), which is the stuff of fertilizer.

It sounds good, but Bob Condit, manager of the district, says there's a problem: "Farmers don't always need nitrogen. We'll take advantage of it, but cotton needs to be stressed to fruit, and to be defoliated, to get rid of the leaves before picking. The chemical defoliant's ability to work depends on low nitrogen." When the farmers don't want the effluent, it would have to be stored in very large retention basins.

Condit also worries about heavy metals. "Some people are concerned that if you want to sell your land, and somebody does a soil test, there might be environmental problems. You might think your 320 acres is your retirement—but maybe it isn't."

THE SANTA CRUZ flows, the channel narrowing, the current accelerating as we near Big Rapid. It is a big rapid only relative to the rest of the river, but the wind is picking up, roaring through the trees, adding dramatic effect. We run the 10-inch drop smoothly, then, celebrating prematurely, crash into a wall of cattails. Redwing blackbirds erupt, mad and scolding, the black feathers on their shoulders spreading like venetian blinds to expose the red feathers beneath.

After Big Rapid the channel broadens, the stream spreading into braided channels, none carrying enough water to float our boat. I get out, grab the bowline, and drag us along, thinking of Bogart pulling the African Queen.

Big cottonwoods now rise 40 to 50 feet on either side. The rustling of their leaves in the wind sounds exactly right, like water flowing, perfect for a river tree. And the shade beneath seems to improve the prospects of life in general. The idea that someone would want to turn the water off seems impossible.

But it's happened before. When the City of Prescott, Arizona, said it would rather cut the effluent supply to Walker Lake than spend the money to meet the EPA standards, some conservationists thought it was a ploy to win an exemption. Now the lake is gone, the effluent instead going to evaporating ponds. From the dried mud flats of former Walker Lake it can be convincingly argued that an effluent-supplied stream or lake is better than nothing.

It's the sort of unhappy ending that Andy Laurenzi, of the Arizona Riparian Council, hopes to avoid for the birds and trees of the Santa Cruz. "The EPA and ADEQ need to recognize that if it wasn't for the effluent there wouldn't be any wildlife there," says Laurenzi. "Our position is that because the riparian system is dependent on effluent, we should try to maintain at least some of the

Jim Malusa is a biologist and writer who likes traveling by foot and bicycle, savors beans, tortillas and Herdez salsa, and hopes to stay in Tucson, his home for the last 18 years. His last story for The Weekly was "Helicopters."

effluent flow."

This stance has placed environmentalists like Laurenzi in the uncomfortable position of tacitly endorsing effluent standards for the Santa Cruz that are less stringent than those proposed by the State Department of Environmental Quality—if that's what it takes to save the habitat.

Pima County is, in fact, lobbying the ADEQ to relax the proposed standards during "roundtable discussions," public meetings attended largely by toxicologists, engineers and lawyers, the hired guns of municipalities, business and industry.

But if the county succeeds, it will probably be only buying time. Much of the Santa Cruz effluent reaches the underground aquifer. If the effluent quality is not soon improved, the ADEQ will likely require Pima County Wastewater to get an Aquifer Protection Permit.

High on the hit list of potential aquifer contaminants are chlorine and ammonia. Chlorine can form trihalomethanes (THMs), which can cause cancers. Ammonia forms nitrates, which are linked with "blue-baby," a heart-lung circulation defect in newborns. Nobody wants THMs and nitrates sneaking into the ground water. At the same time, nobody wants to spend the money to prevent it unless the risks are large enough to inflame the public ire. Until that day, money talks: "Whatever is done will be the most cost-effective thing to do," says Armstrong.

"What is the worth of the Santa Cruz?" asks Laurenzi. "It's a matter of values—cost, health, beauty. Certainly from the perspective of wildlife it's worth it. I just want to make sure people know what they might lose."

WE LEAVE THE river at Avra Valley Road, dragging the boat up a muddy bank to the edge of the asphalt. The plan is to hitchhike back, with the still-inflated boat as a device to slow the curious. It works: the first car to see us and our boat hits his brakes and stops in a cloud of dust. We trot over as he rolls down his window to ask, "Did you come down the river in that thing?"

Yessir, we sure did.
"Holy smokes, don't you know where that water comes from?"
Yessir, sure do. □



Wastewater rafters may find their chances have dried up if county efforts to send the effluent to Marana farms are successful.

Photo by Tim Archibald

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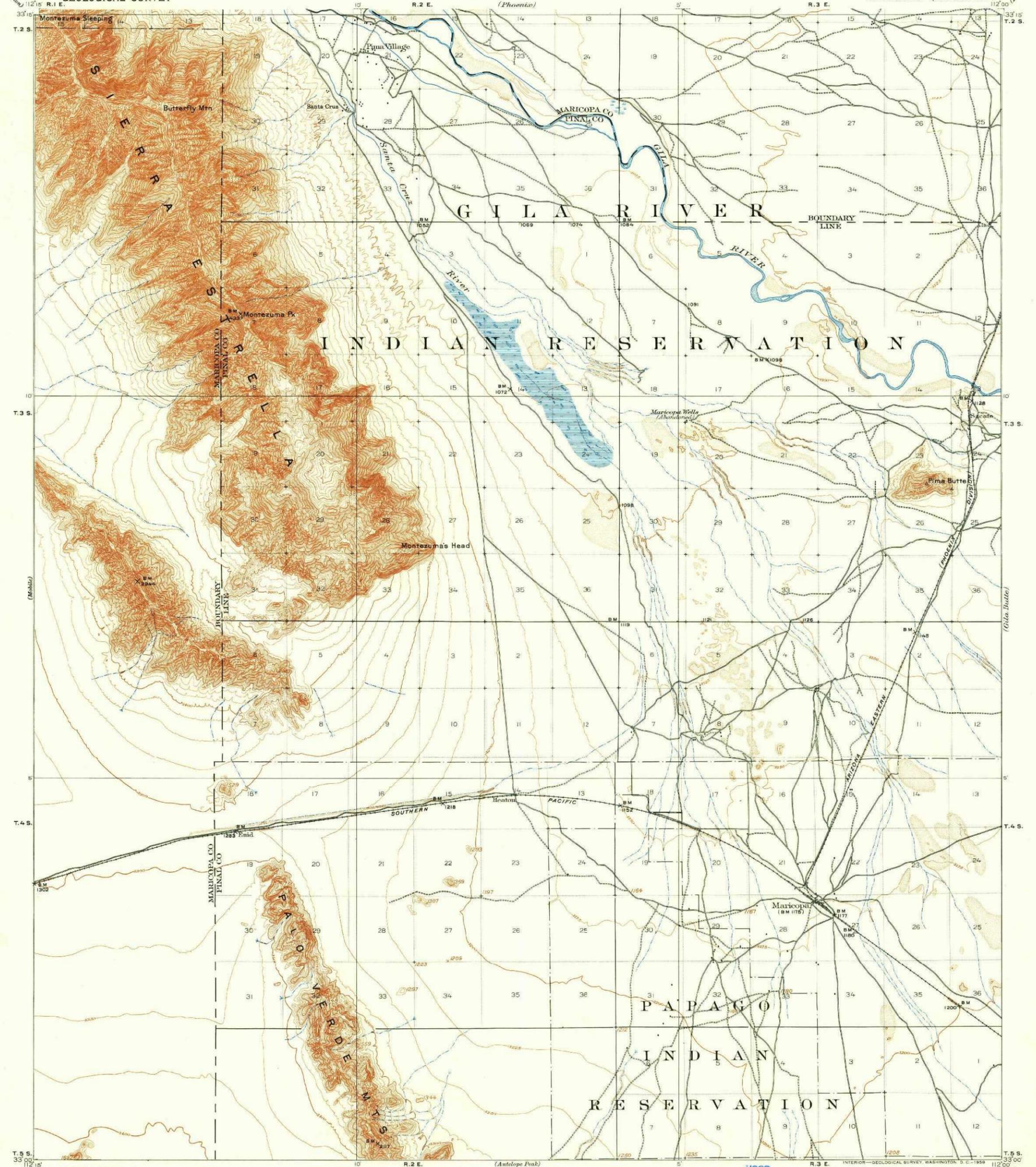
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ATTACHMENT D

Historic USGS Topographic Maps



R. B. Marshall, Chief Geographer,
Geo. R. Davis, Geographer in charge,
Topography by U.S. Reclamation Service,
T. P. Pendleton, and D. H. Watson.
Control by Coast and Geodetic Survey,
General Land Office, U.S. Reclamation Service,
A. H. Thompson, T. M. Barron, and M. S. Bright.
Surveyed in 1903-1904 and 1913.

APPROXIMATE MEAN
DECLINATION, 1913



USGS
Historical File
Topographic Division

This area also covered by 1:24,000 scale
maps of Pima Butte, Montezuma Peak,
Gila, and Maricopa 7.5 minute quadrangles,
surveyed in 1952.

Polyconic projection. To place on 1927 North American datum
move projection lines 40 feet north and 100 feet west.
Note: In joining Phoenix sheet use black dotted
projection corners. Maricopa sheet is
projected from later date.

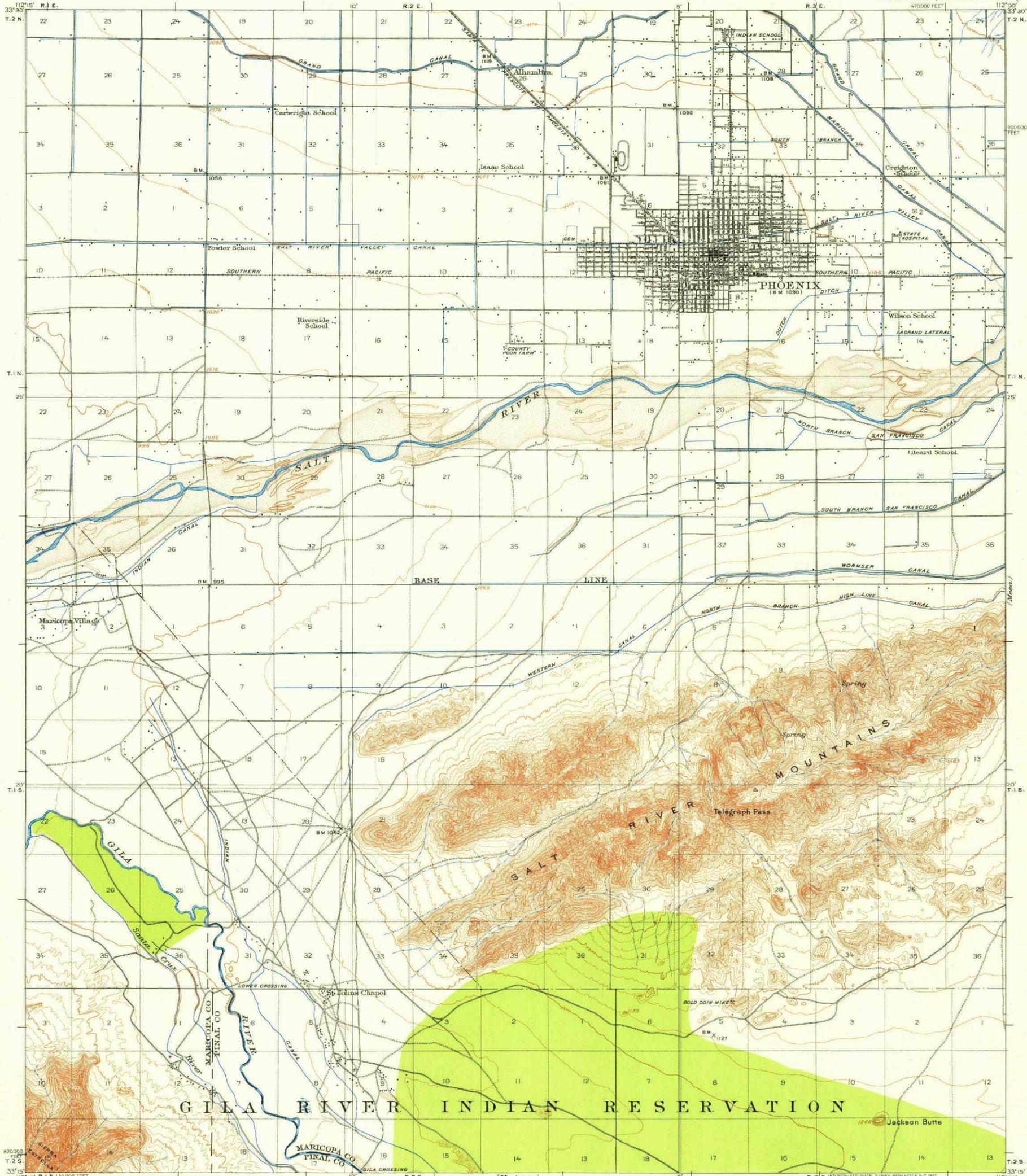
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R. B. Marshall, Chief Geographer.
T. C. Gardine, Geographer in charge.
Topography by T. P. Fendleton and Reclamation Service.
Control by A. H. Thompson, J. T. Stewart, and Reclamation Service.
Surveyed in 1903-1904 and 1912.

APPROXIMATE MEAN
DECLINATION 1912

SCALE 1:62500
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 5 0 1 2 3 4 5 KILOMETERS
CONTOUR INTERVAL 25 FEET
DATUM IS MEAN SEA LEVEL

Polycenic projection. To place on 1927 North American datum
move projection lines 460 feet south and 350 feet west
10000 foot grid based on Arizona (Central)
rectangular coordinate system

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