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DEPT OF WATER RESOURCES

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR THE COUNTY OF MARICOPA

IN RE: THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE GILA RIVER SYSTEM AND SOURCE

No. W-1 (Salt)
No. W-2 (Verde)
No. W-3 (Upper Gila)
No. W-4 (San Pedro)

Contested Case No. W1-103

SALT RIVER PROJECT'S OBJECTIONS TO ARIZONA DEPARTMENT OF WATER RESOURCES' SAN PEDRO RIVER SUBFLOW ZONE DELINEATION REPORT

(Assigned to the Hon. Eddward P. Ballinger)

(Oral Argument Requested)

Descriptive Summary: The Salt River Project files its objections to the Arizona Department of Water Resources' June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed.

Statement of Claimant Nos.: 39-07-1040, -1041, -1998, -1206, -1207; 39-0550053, -50054, -50055; 39-68-35212 and -35213.

Date of Filing: December 28, 2009.

Number of Pages: 33 + 140 (attachments) = 173 (total).

Pursuant to the Court's September 28, 2005 Order ("2005 Order") and the June 30, 2009 Notice of Publication and Filing of Report by the Arizona Department of Water Resources ("ADWR"), the Salt River Valley Water Users' Association and the Salt River Project Agricultural Improvement and Power District (collectively, "SRP") submit their objections to the June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed ("2009 ADWR Report"). These objections are supported by the attached maps and figures, including the affidavit of Jon R. Ford (*Attachment 1*). At the end of this document is a listing of all attachments, which are incorporated herein by this reference. In order to distinguish them from "exhibits" in the ADWR report, references herein to attachments to these objections are shown in italics.

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I. **Introduction**

For over twenty years, SRP has actively participated in the proceedings relating to the definition and delineation of appropriable subflow in this Adjudication, including efforts leading up to the 2009 ADWR Report. Those past activities have included field work and numerous rounds of expert testimony. As SRP has repeatedly stated, determination of the subflow zone is of critical importance to those Arizona water users who, like SRP, hold senior vested prior appropriative water rights. Moreover, since 2002, SRP has acquired land and water rights along the lower San Pedro River and Aravaipa Creek to be managed in perpetuity as riparian habitat for endangered species.[1] This riparian habitat is absolutely dependent on the maintenance of subflow.

The subflow zone delineation process made progress with ADWR's 2002 Technical Report, the Special Master's 2004 Report, and Court's 2005 Order. However, while SRP supports many aspects of ADWR's 2009 analysis, which are discussed below (*inter alia*, hydrologic criteria, predevelopment flows and water levels, sources of information, and mapping methods), ADWR has made a critical error that essentially turns back the subflow clock to 1993 or earlier by creating a new concept of "tributary Holocene alluvium." See 2009 ADWR Report, at 4-11 through 4-13; Section V, infra.

The most significant problem with ADWR's report is in its treatment of thin alluvial fans that come from side tributaries and lie across portions of the mainstem Holocene alluvium. ADWR's approach focused solely on surficial geology, so it excluded these areas, even though it is beyond dispute that they are underlain by saturated floodplain Holocene alluvium. See Section V.I, infra. Worse yet, ADWR applied 200-foot setbacks in those

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[1] The acquisition and maintenance of these riparian lands and water rights is required by the Roosevelt Habitat Conservation Plan, which supports an Incidental Take Permit issued by the U.S. Fish & Wildlife Service for continued operation of Roosevelt Dam and Lake. In addition to lands along the San Pedro, hundreds of acres of additional riparian habitat have been acquired and will be managed in perpetuity along the Gila and Verde rivers for the same purpose. See SRP, Roosevelt Habitat Conservation Plan, Gila and Maricopa Counties (2002), available at http://www.fws.gov/southwest/es/arizona/HCPs.htm.

locations, from the toe of the tributary alluvial fans, thereby making its subflow zone even more narrow. See Section V.E, infra. In some instances, the setbacks even overlap each other, so there is no subflow zone, even though no one could reasonably contend that the saturated floodplain Holocene alluvium is less than several hundred feet in width in those areas. See Section V.H, infra.

ADWR recognized the inherent problem with this approach in its Appendix D-4, where it tried to arbitrarily account for its wrongful exclusion of tributary alluvial fans based upon a ratio of the perimeter to the length of the deposit. See Section V.J, infra. That attempt to artificially cure the fundamental defects in ADWR's treatment of the tributary alluvial fans is of little avail. Because it incorrectly excluded these fans, the subflow zone delineated by ADWR is not a stable geologic unit; is subject to the temporal whims of floods and other high water flows; is substantially more narrow than the area of phreatophytes along the river in many places; and is demonstrably inconsistent with the prior decisions by the Arizona Supreme Court, this Court, and the Special Master. See Sections IV through VI, infra.

II. The Entire Saturated Floodplain Holocene Alluvium is the Subflow Zone.

Efforts by this Court to delineate the subflow zone are a continuation of the work undertaken by Judge Goodfarb that began in 1987 and resulted in his adoption of the "50%/90-day" test in 1988. That test was rejected in Gila II, the Arizona Supreme Court's first decision on Interlocutory Issue 2. In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, 175 Ariz. 382, 857 P.2d 1236 (1993). In rejecting that test, the Gila II Court remanded the issue to Judge Goodfarb. Judge Goodfarb subsequently held extensive evidentiary hearings, conducted a field trip to the San Pedro River, and determined that the saturated floodplain Holocene alluvium constitutes the subflow zone. See Judge Goodfarb's Order (June 30, 1994) ("1994 Order"). The Supreme Court upheld that determination "in all respects" in Gila IV. In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, 198 Ariz. 330, 344, 9 P.3d 1060, 1083 (2000).

A. **General principles**

Judge Goodfarb (in his 1994 Order) and the Supreme Court (in Gila II and Gila IV) each discussed various "principles," "factors," or "criteria" that are helpful in determining the location and extent of the subflow zone. See, e.g., 1994 Order, at 1-2 (reiterating the Gila II court's discussion of various "factors" such as "stable geologic formations, available hydrological information, and/or organic characteristics of the area"); see also Gila IV, 198 Ariz. at 341-42, 9 P.3d at 1080-81. ADWR's March 29, 2002 technical report regarding subflow in the San Pedro River Watershed ("2002 Technical Report"),[2] Special Master Schade's July 16, 2004 Report and Recommendations on the Technical Report ("2004 Master's Report"),[3] and this Court's 2005 Order each reaffirm that the saturated floodplain Holocene alluvium satisfies those principles and constitutes the subflow zone. See 2005 Order, at 10 (Court agreed with the Special Master's recommendation without qualification).

In Judge Goodfarb's 66-page 1994 Order, he presented a detailed analysis of the evidence and the Gila II "principles." Comparing the legal analysis in Gila II and Maricopa County Munic. Water Cons. Dist. No. 1 v. Southwest Cotton Co., 39 Ariz. 64, 4 P.2d 369 (1931), with the scientific evidence presented to him at the hearing, Judge Goodfarb stated:

> The only logical and rational way the 'Southwest Cotton' and [Gila II] theories as to "subflow" can be made consistent with the scientific principles testified to is to turn to the tests on page 392 of 175 Ariz. where the Supreme Court [in Gila II] itself urged [consideration] of flow direction, elevation, gradient, and chemical composition.

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[2] In its 2002 Technical Report, ADWR concluded that the Gila II "principles" were subsumed into the analysis that resulted in Judge Goodfarb's finding that the saturated floodplain Holocene alluvium constitutes the subflow zone. Relying upon Judge Goodfarb's 1994 Order and Gila IV, DWR stated: "The trial court applied the criteria described in *Gila II* and concluded that the saturated floodplain Holocene alluvium was the 'most credible' subflow zone." 2002 Technical Report, at 2.

[3] Responding to questions raised by some parties about whether ADWR needed to further evaluate the factors embodied in the concept of subflow as part of its work, the Special Master recommended: "The Court should adopt the finding that the criteria specified in *Gila IV* to delineate the subflow zone have been taken into account in the Supreme Court's holding that the saturated floodplain Holocene alluvium is the subflow zone." 2004 Master's Report, at 42.

1994 Order, at 34 (also quoting the Gila II passage quoted above) (emphasis in original). He continued:

> If we add to those tests the concept that if a "subflow" zone can be differentiated from adjacent geologic units such as tributary aquifers and the basin-fill aquifer which discharge into it or receive discharge from it, a set of principles can be developed to define "subflow" and still be consistent with "Southwest Cotton" and science.

Id.

Judge Goodfarb went on to further clarify seven specific principles for delineating the subflow zone. See 1994 Order, at 35-36. He then applied those principles to the various subflow determination methodologies presented by each of the parties' experts. Specifically, he found:

> After consideration of flow direction, water level elevation, the gradation of water levels over a stream reach, the chemical composition if available, and lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and "subflow" direction, the Court finds the most accurate of all the markers is the edge of the saturated floodplain Holocene alluvium.

Id. at 56.

B. Specific considerations in delineating the saturated floodplain Holocene alluvium

The process to define the subflow zone took nearly twenty years to complete. The task now at hand is merely to "delineate" the lateral extent of the subflow zone (i.e., the saturated floodplain Holocene alluvium), which should be a relatively straightforward and simple process. As a result of ADWR's misinterpretation of Judge Goodfarb's 1994 Order, however, it is first necessary to revisit some of the basic premises of and rulings set forth in the 1994 Order to demonstrate how ADWR has failed, in certain critical respects, to comply with that order in mapping the San Pedro subflow zone.

1. Concepts of subflow zone delineation rejected by Judge Goodfarb's 1994 Order

After a thorough review and discussion of geologic and hydrologic principles that apply in general to the Gila River System and in particular to the San Pedro River (including, among other things, a hydrologic overview of younger alluvium, tributary aquifers, and alluvial valley streams, various reports prepared by ADWR, expert witness reports, and a report prepared by Richard Hereford entitled "Entrenchment and Widening of the Upper San Pedro River, Arizona"), Judge Goodfarb applied those general geologic and hydrologic principles to the definition of subflow set forth in Gila II. See generally 1994 Order, at 9-34. Judge Goodfarb noted that there were four basic positions taken by the parties as to how a "subflow" zone should be delineated: (1) a narrow band defined by the edge of the river principal channel; (2) a slightly larger post-1880 entrenchment depositional layer; (3) the edge of the central valley's younger alluvium; or (4) an area determined by the growth of phreatophytic plants located in the riparian zone. See 1994 Order, at 35.

Judge Goodfarb first discussed the two proposed subflow zones delineated by the edge of the principal channel and the post-1880 entrenchment, which were the narrowest of the four proposed subflow zones. He found that the sole merit of these two narrow subflow zone proposals was that the banks or edges of the channel could be easily found on aerial photography. See 1994 Order, at 36-37. Judge Goodfarb determined, however, that the contour lines found in the principal channel proposed subflow zone bore no relationship to any geologic difference in the alluvial formation and that this proposed subflow zone was based on the theory of using the most easily found ground feature and then dealing with the real problems of surface water depletion on a case-by-case method by determining the extent of each well's "cone of depression," which he noted was a complicated, difficult, and expensive process. See id. Judge Goodfarb found that the real problem with the principal channel subflow zone proposal was that today's principal channel boundaries have no stability and that the principal channel is subject to being moved by high floods and high water flows.

Id. at 39. He requested that ADWR compare 1935 aerial photography of the San Pedro River with 1990 aerial photography along the entire river and report any channel changes found. The ADWR report indicated that the San Pedro River channel is not stable over time and that it narrows, widens, and shifts significantly. In fact, the study showed a single channel widening of up to 168 feet and a narrowing in twenty-seven locations of from sixty-seven feet to 976 feet, and it also showed twenty-eight shifts in overall channel location of from sixty-six feet to 1,200 feet. Id. at 40.[4]

After a thorough discussion of the lack of stability of the proposed principal channel subflow zone delineation, see 1994 Order, at 40-45, Judge Goodfarb turned to the proposed post-1880 entrenchment subflow zone delineation theory, which was the principal theory proposed by the "groundwater users." Id. at 45. Judge Goodfarb found this narrow subflow zone delineation proposal to be subject to the same lack of stability problems as the principal channel boundary proposal. Id. at 45-48. He found another problem with the post-1880 entrenchment theory to be the lack of consistency between the lateral and vertical limits of the proposed "subflow" zone. Id. at 48. Therefore, Judge Goodfarb rejected both the principal channel boundary theory and the post-1880 entrenchment theory of subflow zone delineation, finding both of them to be without merit. Id. at 52.

As demonstrated in detail in Section V below, ADWR's 2009 subflow zone delineation proposal for the San Pedro River is too narrow and suffers from the same lack of stability over time found by Judge Goodfarb in the principal channel boundary and post-1880 entrenchment theories of subflow zone delineation. The narrow subflow zone proposed by the 2009 ADWR Report would be constantly redefined after shifts in the channel of the San Pedro River caused

[4] The issue of channel stability arising from ADWR's comparison of the 1935 and 1990 aerial photography was so significant that Judge Goodfarb allowed the parties to submit expert witness affidavits and then conducted a two-day evidentiary hearing (on June 14 and 15, 1994) on this issue alone, which was in addition to the ten-day evidentiary hearing in February 1994 and the two-day field trip to the San Pedro River watershed in March 1994. See Gila IV, 198 Ariz. at 336, 9 P.3d at 1066.

by flooding and other high water flows. This ever-changing snap-shot approach is unacceptable for any subflow zone delineation that must meet the test of time.

2. Concepts of subflow zone delineation embraced by Judge Goodfarb's 1994 Order

After rejecting the principal channel boundary and post-1880 entrenchment theories, Judge Goodfarb next considered the phreatophytic plant growth/riparian zone subflow zone delineation theory proposed by The Nature Conservancy ("TNC"). See 1994 Order, at 52-56. The TNC approach was an alternative proposal, i.e., defining the subflow zone by the delineation of Holocene alluvium or, alternatively, defining the subflow zone by readily observable surface indicators of where underground water is located, those being the phreatophytic plants located in the riparian area or zone immediately adjacent to the river. Id. at 53.

Judge Goodfarb found some merit in the proposed riparian zone subflow delineation criteria, but he found several problems to exist. See 1994 Order, at 55-56. First, he found that the delineation of all riparian areas in their pre-development stage, as advocated by TNC, would be a difficult task. Second, he noted that the study of channel changes and shifts he had requested from ADWR included an analysis of any change in riparian habitat along the San Pedro River from 1935 to 1990. That study indicated significant riparian changes from reductions of up to 3,100 feet along one transect to an additional 1,900 feet along another transect. Id. at 55. He found that, "[t]o the extent that phreatophication exists or can be documented in the areas adjacent to the principal channel, it does mark that portion of the area of the 'subflow' zone. If it extends to the lateral edge of the saturated floodplain Holocene alluvium, then it is a vital marker . . . . ." Id. at 55-56. He also concluded that "[t]he boundaries of the riparian zones are helpful and certainly within the subflow zones if they do not extend over the top of tributary aquifer or basin fill." Id. at 56. He then concluded, however, that, "[a]fter consideration of flow direction, water level elevation, the gradation of water levels over a stream reach, the chemical composition if available, and the lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and 'subflow' direction, the Court finds the most accurate of all markers is the edge of the saturated floodplain Holocene alluvium." Id. at 56.

3. ADWR's deviation from Judge Goodfarb's 1994 Order

ADWR's delineation of the San Pedro River subflow zone deviates from Judge Goodfarb's 1994 Order in several major and critical respects. The 1994 Order provides, among other things: "The "subflow" zone must be distinguished from adjacent tributary aquifers or connecting basin fill." 1994 Order, at 36.

After adopting the saturated floodplain Holocene alluvium as the "subflow" zone, and in reliance on the testimony of Steve Erb, ADWR's witness at the 1994 subflow evidentiary hearing, Judge Goodfarb stated in his "CONCLUSION":

> 3. Even though there may be a hydraulic connection between the stream and its floodplain alluvium to an adjacent tributary aquifer or basin-fill aquifer, neither of the latter two or any part of them may be part of the "subflow" zone.
>
> 4. That part of the floodplain alluvium which qualifies as a "subflow," beneath and adjacent to the stream, must be that part of the geologic unit where the flow direction, the water level elevations, the gradations of the water level elevations and the chemical composition of the water in that particular reach of the stream are substantially the same as the water level, elevation and gradient of the stream.
>
> 5. That part of the floodplain alluvium which qualifies as a "subflow" zone must also be where the pressure of side recharge from adjacent tributary aquifers or basin fill is so reduced that it has no significant effect on the flow direction of the floodplain alluvium. (i.e., a 200-foot setback from connecting tributary aquifers and a 100-foot setback from the basin-fill deposits).
>
> 6. Riparian vegetation may be useful in marking the lateral limits of the "subflow" zone particularly where there is observable seasonal and/or diurnal variations in stream flow caused by transpiration. However, riparian vegetation on alluvium of a tributary aquifer or basin fill cannot extend the limits of the "subflow" zone outside of the lateral limits of the saturated floodplain Holocene alluvium.

1994 Order, at 65.

In its 2009 report, ADWR has made critical errors in, among other things: (1) its analysis of the principles and criteria set forth by Judge Goodfarb relating to excluding adjacent tributary aquifers, the alluvial plains of ephemeral streams, and connecting basin fill and inliers; (2) its application of the 100-foot and 200-foot setbacks set forth in Paragraph 5 of Judge Goodfarb's "CONCLUSION"; (3) its failure to recognize riparian vegetation as a useful subflow zone marker; and (4) its creation and application of a new concept of "tributary Holocene alluvium." See Sections IV through VI, infra.[5]

III. SRP Generally Agrees with ADWR's Hydrologic Criteria and Analysis.

As set forth below, SRP generally agrees with the hydrologic criteria and analysis contained in ADWR's report.

A. SRP agrees with ADWR's hydrologic criteria.

SRP agrees with ADWR's hydrologic criteria and procedures described in Section 2.1 of its report, including the definitions of perennial, intermittent, and ephemeral streams; and the use of predevelopment flow conditions. See 2009 ADWR Report, at 2-1 to 2-3. ADWR's hydrologic criteria accurately summarize these criteria and procedures from the 2005 Order.

B. SRP agrees with ADWR's estimate of phreatophyte evapotranspiration.

SRP agrees with the general magnitude of ADWR's estimate of phreatophyte evapotranspiration in 1991. See 2009 ADWR Report, at 3-4. However, increasing cultural depletions are another major explanation of the decrease in annual stream flow in the 20th Century, in addition to increases in riparian vegetation, climate change, and changes in upland vegetation. See id. at 3-4 to 3-5.

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[5] Unfortunately, ADWR's 2002 Technical Report did not set forth the procedures ADWR intended to follow in excluding tributary aquifers, the alluvial plains of ephemeral streams, connecting basin fill and inliers, and how the 100-foot and 200-foot setbacks would be applied. The 2009 ADWR Report is, therefore, the first time that any of the parties has had an opportunity to see a physical demonstration of how ADWR intended to apply the 1994 Goodfarb criteria.

C. SRP agrees with ADWR's estimate of cultural depletions.

SRP agrees with ADWR's summary of cultural depletions in Section 3.1.4. See 2009 ADWR Report, at 3-4 to 3-5. As noted above, the increase in water withdrawals from near zero in 1900 to over 40,000 acre-feet per year recently, is a major reason for decline in stream flows over that same period of time.

D. SRP agrees with ADWR's evaluation of predevelopment flows and water levels.

SRP agrees with ADWR's analysis of predevelopment flows and water levels described in Sections 3.2 through 3.4 of its report. See 2009 ADWR Report, at 3-5 to 3-22. However, it is worth noting that future efforts by ADWR on many streams will not need to be as intensive as required for the San Pedro River watershed because it will be clear that the stream has always been perennial, intermittent, or ephemeral.

IV. ADWR's Exclusion of Stream Reaches is Inappropriate.

SRP objects to ADWR's criteria for excluding "mountain front streams" from subflow delineation due to short length, isolation from major streams, and difficulties with access. See 2009 ADWR Report, at 1-6 to 1-7. Streams may be excluded only if the stream was ephemeral under predevelopment conditions and there is not a connection of saturated floodplain Holocene alluvium between the ephemeral stream and a perennial or intermittent stream. See 2005 Order, at 22-23.

The Court has not authorized ADWR's exclusion criteria in its 2009 report (short length, isolation from major streams, and difficulties with access). Figure 1-2 of the 2009 ADWR Report shows a number of "Potential Perennial or Intermittent Mountain Front Stream[s]" that ADWR did not specifically evaluate. It appears that many of these streams are short reaches that lie upstream of relatively long ephemeral reaches, which is perhaps what ADWR means by "short length" and "isolation from major streams." In such cases, ADWR must evaluate each of these streams and make findings that such streams are excluded due to their ephemeral nature, the lack of a connection of saturated floodplain Holocene alluvium between the ephemeral stream and a perennial or intermittent stream, and that there are no appropriative water rights to the isolated intermittent or perennial reach of stream. Access should not be an issue; the Adjudication Court could require landowners to provide access to ADWR. See Pre-Trial Order No. 3 re: Discovery Procedures, at 21 (March 25, 1988); Rules for Proceedings Before the Special Master § 9.11; A.R.S. § 45-256.

SRP also objects to ADWR's exclusion of at least two stream reaches (Redfield Canyon and Buehman Canyon) without explanation, even though they are shown as "potential perennial or intermittent mountain front streams." See 2009 ADWR Report, at Figure 1-2. Both of those reaches are connected to intermittent or perennial streams. Id.

SRP objects to ADWR's exclusion of all reaches of Aravaipa Creek upstream of the Stream Mile 36 from its delineation of subflow. See 2009 ADWR Report, at 3-22 and Figure 3-23. The mapping of actual irrigation diversions by the Arizona Water Commissioner in 1921 between Stream Miles 42 and 46 is strong evidence that the stream was historically intermittent or perennial. Id.[6]

V. SRP Agrees with Some, but Not All, of ADWR's Geologic and Hydrogeologic Criteria and Applications.

SRP agrees in part and objects in part to ADWR's geologic and hydrologic criteria and applications, as set forth below.

A. SRP agrees in part with ADWR's use of maps, consideration of mapping methods, and hydrogeologic criteria.

In general, SRP agrees with ADWR's procedures concerning the use of existing maps, consideration of mapping methods for previous work, using the largest scale maps possible, and taking special care in transfers and projections of maps summarized in Section 2.2 of the report. See 2009 ADWR Report, at 2-3 to 2-4. SRP agrees with ADWR's hydrogeologic criteria that the entire lateral extent of floodplain Holocene alluvium is saturated. See id. at 2-

[6] SRP's expert, Jon Ford, mapped the Aravaipa subflow zone upstream of Stream Mile 36, as discussed in Section VI and shown on *Attachment 10*, Sheet 6 of 6, Figure 15; and Map 21 of *Attachment 11*.

4. SRP also agrees with ADWR's criteria of excluding "tributary aquifers, areas of basin fill recharge, and the alluvial plains of ephemeral streams." Id. As discussed in the rest of this section, however, SRP objects to ADWR's application of the geologic and hydrogeologic criteria to exclude areas where dry alluvial materials form a thin veneer overlying saturated floodplain Holocene alluvium.

B. The Arizona Geological Survey maps have certain limitations for use in this context.

The Arizona Geological Survey ("AGS"), 2008, has appropriately mapped the surficial geology along the San Pedro River. See 2009 ADWR Report, at Appendix C-1. SRP agrees with the AGS methods and procedures.

The limitation of the AGS mapping of surface geologic units is that it does not provide important subsurface information for the floodplain Holocene alluvium—i.e., the thickness of each of the units and the subsurface lateral extent of the older floodplain Holocene alluvium underlying younger floodplain Holocene alluvium. The primary reference to subsurface relationships is shown on Figure 3. See 2009 ADWR Report, at 10; see also id. at Figure 4-1. SRP objects to Figure 3 because it does not properly show the subsurface relationships among the geologic units. It erroneously shows that the following mapping units lie directly on basin fill (Tsy):

Qy4r – Flood channel and low terrace deposits

Qy3r – Historical river terrace deposits

Qy2r – Latest Holocene to historical river terrace deposits

Qy1r – Late to early Holocene river terrace deposits

AGS Figure 3 also erroneously shows that basin fill (Tsy) is exposed at the ground surface between units Qy2r and Qy3r and likewise between Qy3r and Qy4r. Id. This conflicts with the AGS mapping, which does not show that basin fill is exposed in terraces anywhere on the floodplain of the San Pedro River. See 2009 ADWR Report, at Appendix C-5.

Attachment 2, Figure A shows AGS Figure 3 which has been modified to include SRP's interpretation of how the subsurface geologic relationships should be presented, which shows that the oldest floodplain alluvium (Units Qy1r and Qy2r) extend beneath units Qy3r and Qy4r. Figure A also shows how the lateral limits of saturated floodplain Holocene alluvium should be defined compared to how ADWR defines it. <u>See</u> Section VI, <u>infra</u>.

Attachment 2, Figures B and C are geologic cross-sections across the floodplain in the vicinity of TNC's San Pedro Preserve and at the Hereford[7] meander. The San Pedro Preserve cross-section (Figure B) is based upon the AGS mapping and well driller's logs. The Hereford meander cross section (Figure C) is based upon the AGS mapping, three test borings done by the United States prior to the 1994 hearing, and well driller's logs.[8] Both cross-sections show that the Holocene floodplain alluvium extends beneath the more recent Holocene floodplain alluvium. The cross-sections also show that Holocene floodplain alluvium extends to depths of 80 to 140 feet. This depth range is consistent with a similar cross-section in the Palominas area that was included as Figure 9.1 in Mr. Ford's 1993 report filed prior to the 1994 hearing by Judge Goodfarb.[9] It is also consistent with the 1973 Roeske and Werrell report prepared by ADWR's predecessor, the Arizona Water Commission.[10]

C. <u>**ADWR's interpretation of the subflow zone from geologic mapping of surficial deposits is in error.**</u>

SRP objects to ADWR's exclusion of dry "tributary Holocene alluvium" overlying the saturated floodplain Holocene alluvium. <u>See</u> 2009 ADWR Report, at 4-12 to 4-13. As discussed above, the prior court decisions focused on distinguishing tributary <u>aquifers</u> from

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[7] The "Hereford meander" is shown on Figure 5; Hereford, Richard, 1993, Entrenchment and Widening of the Upper San Pedro River, Arizona: Geological Society of American Special Paper 282. Hereford's report was Exhibit 190 in the 1994 proceedings.

[8] Stetson Engineers' Rebuttal Affidavit, The Delineation of Subflow in the San Pedro River Basin, Arizona; February 24, 1994; Well Log 55-566902 from ADWR records.

[9] This was Exhibit 1 in the record before Judge Goodfarb.

[10] Roeske, R.H. and W.L. Werrell, Hydrologic Conditions in the San Pedro River Valley, Arizona, 1971: Arizona Water Commission, Bulletin 4 (1973).

the subflow zone, not dry alluvial material deposited on top of the saturated floodplain Holocene alluvium such as fans and other deposits, which are only thin veneers. See Section II, supra. ADWR has misinterpreted language in the 1994 Order referring to the exclusion of "floodplain alluvium of ephemeral streams." See 1994 Order, at 57. The 1994 Order referred to ephemeral stream alluvium in the context of tributary aquifers:

> Where the alluvial plain of tributary aquifers or ephemeral streams connects to the floodplain Holocene alluvium of the stream itself and provides tributary or basin fill recharge, that tributary aquifer must also be excluded because its flow direction is different and often perpendicular to the stream-flow direction.

1994 Order, at 57 (emphasis added).

Chapter 4 of the 2009 ADWR Report concludes with several summary paragraphs, which explain the basis of key flaws in ADWR's approach. ADWR elected to exclude all areas "where tributaries have recently deposited alluvium on top of the floodplain," even though "this tributary Holocene alluvium may eventually get washed away during a large flood." 2009 ADWR Report, at 4-12. Although fundamental and essential to the entire effort of delineating the lateral extent of the saturated floodplain Holocene alluvium, ADWR states that it would be "impractical and was considered beyond the scope of this project" to identify where saturated floodplain Holocene alluvium underlies surface deposits of "tributary Holocene alluvium." Id. Taking a couple of sentences out of context from the 1994 and 2005 Orders, ADWR declares that its approach is consistent with prior direction from the Court.[11] See 2009 ADWR Report, at 4-13. ADWR's statement that it "does not consider tributary Holocene alluvium to be part of the floodplain Holocene alluvium," id., misses the point in situations where a thin, dry, surface mantle of alluvium overlies the saturated floodplain

[11] The 1994 Order's reference to "tributary alluvial deposits" was in the context of "inliers" in the broad alluvial plains south of Benson and St. David. The 2005 Order approved Recommendation 5 of the Special Master, which stated: "If other deposits or materials (such as Pleistocene) are found within the floodplain alluvium of a stream, the presence and existence of those deposits shall be reported, but the criterion is the floodplain Holocene alluvium." 2004 Master's Report, at 38. The Special Master's recommendation was in the context of distinguishing "Pleistocene or relic fan deposits" and using "its best technical analysis and evaluation to delineate the lateral extent of the floodplain Holocene alluvium." Id. at 34.

Holocene alluvium. The issue at hand is the lateral extent of the saturated floodplain Holocene alluvium and its interaction with tributary aquifers, not the presence of a surface veneer of some other material or whether it is actually "part of" the saturated floodplain Holocene alluvium.

ADWR's approach to delineating the saturated floodplain Holocene alluvium excluded all geologic units except the following:

Qycr – Active river channel deposits

Qy4r – Flood channel and low terrace deposits

Qy3r – Historical river terrace deposits

Qy2r – Latest Holocene to historical river terrace deposits

Qy1r – Late to early Holocene river terrace deposits

Id. at 4-12.

ADWR excluded the following geologic units from the saturated floodplain Holocene alluvium because they were piedmont[12] alluvial deposits or surficial deposits:

Qyc – Modern stream channel deposits

Qy3 – Latest Holocene alluvium

Qyaf – Latest Holocene, active fan deposits

Qy2 – Late Holocene alluvium

Qy1 – Older Holocene alluvium

Qys – Holocene fine-grained deposits

Qy – Holocene alluvial deposits, undifferentiated

Id. at 4-11 to 4-12; Appendix C, at 45-48; Appendix D-1.

These deposits were excluded because ADWR considered them to be alluvium of tributary drainages, even though ADWR recognizes (as does the AGS) that these geologic

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[12] "Piedmont" refers to "Tributary Alluvium and Younger Basin Fill." 2009 ADWR Report, at Figures 4-1 and 4-7.

units are deposited on top of the saturated floodplain Holocene alluvium and that they are temporary deposits that will eventually be washed away. Id. at 4-12.

In summary, ADWR's approach is incorrect for at least two reasons. First, as discussed above in this section, it is geologically incorrect in that it excludes saturated floodplain Holocene alluvium (the subflow zone as defined by Judge Goodfarb), which lies beneath significant portions of ADWR's "tributary" alluvium. Second, it results in a subflow zone that will be redefined after major flood events, which is not a stable delineation. See Section V.D, infra.

D. **ADWR's subflow zone is not a stable geologic feature, which is required by the 1994 Order.**

As summarized above, SRP objects to ADWR's delineation of only a part of the saturated floodplain Holocene alluvium because it is not a stable geologic feature, which is required by the 1994 Order. See Section II.B.1, supra. The San Pedro River, like its tributaries and all streams that are not confined by bedrock, meanders and changes course over time, periodically working its way back and forth across the entire floodplain.

Attachment 2, Figure E shows the location of the active channel of the San Pedro River in the Dudleyville area at various times between 1877 and the present. This figure demonstrates that the San Pedro River has migrated back and forth across the floodplain over the last 120 years and, in places, the river channel has historically been outside of the ADWR Subflow Zone.

Attachment 2, Figure F is a reproduction of Appendix O-3, Exhibit 319 of Judge Goldfarb's 1994 Order. This figure was originally prepared by Leonard Rice Engineers, Inc. for the field trip portion of the hearing. It shows how the San Pedro River has migrated in the past in the Pomerene area. Figure F also shows how the Pomerene Canal Company diversion structure on the San Pedro River had to be relocated as a result of the river migration. Similarly, although they are not included here, Appendix O-1, Exhibit 317; Appendix O-2,

Exhibit 338; Appendix O-4, Exhibit 320; and Appendix O-5, Exhibit 325 of the 1994 Order all show how the San Pedro River has migrated over time.

Attachment 3 contains a series of maps of the northern half of the San Pedro River and lower Aravaipa Creek, showing the 1935 and 2008 river channels relative to the ADWR subflow delineation. These maps show the shifts in the location of the river channel over time as well as the numerous locations where the 1935 and 2008 channels are outside of ADWR's delineation. See Section V.H, infra.[13]

Attachment 2, Figure B shows a geologic cross-section across the floodplain of the San Pedro River at TNC's San Pedro Preserve near Dudleyville. This figure shows that late Holocene, active fan deposits and somewhat older alluvial fan deposits, which ADWR defines as tributary alluvium and not part of the saturated floodplain Holocene alluvium, overlie San Pedro River Holocene floodplain deposits including the 1947, 1955, 1972, 1980, and 1990 active channel deposits of the San Pedro River.

The current active channel of the San Pedro River meanders back and forth across the entire floodplain at many places. There are at least 184 locations along the San Pedro River where the active channel is on one side of the floodplain or the other. *Attachment 2*, Figure G shows several examples of where this occurs; the maps in *Attachment 3* show many more of these instances along the northern half of the San Pedro River. This meandering process has occurred throughout the Holocene. It began soon after the San Pedro first incised a channel into the basin fill sediments. This meandering process removed and redistributed alluvial fans and other deposits brought onto the floodplain by tributary streams. Eventually, this process resulted in the formation of the current floodplain.

As recognized by ADWR, this process is still going on today. See 2009 ADWR Report, at 4-12. *Attachment 2*, Figure H shows how the active channel of the San Pedro River has removed the toe of a recent alluvial fan deposited at the mouth of a tributary stream.

[13] 1992 USGS Digital Orthophotos were used to register aerial photography as part of the mapping process for channel changes. Slight shifts due to registration are possible but are expected to be less than 100 feet.

Eventually, the entire fan will be completely removed and reworked by the San Pedro River to become part of the floodplain.

The San Pedro River is actively eroding other "tributary" deposits as shown on *Attachment 2*, Figure I. There are at least 295 locations with a total length of approximately twenty-four miles, where erosion of ADWR "tributary" alluvial deposits is active and ongoing.

Attachment 2, Figures B, and D through I show that the ADWR approach is incorrect in that it does not result in a stable subflow zone and it excludes much of the saturated floodplain Holocene alluvium.

E. ADWR inappropriately applied 200-foot setbacks in numerous locations where a tributary aquifer or inflow from ephemeral stream alluvium does not exist.

There are a few minor exceptions to delineating the entirety of the saturated floodplain Holocene alluvium as the subflow zone. Those exceptions, namely the presence of geological "inliers" in the saturated floodplain Holocene alluvium and "setbacks" from the exterior edge of the saturated floodplain Holocene alluvium, are intended to exclude the presence and effects of tributary aquifers.

Mr. Erb's 1994 testimony regarding inliers resulted in the concept of "setbacks" inside the edge of the saturated floodplain Holocene alluvium to account for the perceived effect of inflow from tributary aquifers. Judge Goodfarb was concerned that some uncertainty existed about the direction of flow to the stream versus flow with the stream along the boundary between a tributary aquifer and the saturated floodplain Holocene alluvium. See Reporter's Transcript of Proceedings, vol. X, a 81-82 (February 16, 1994) (excerpts attached hereto as *Attachment 4*). Judge Goodfarb asked Mr. Erb: "How far should I pull in those parameters to be certain in my own mind that I've now got subflow going in the same direction as the stream?" Id. at 83-84. Mr. Erb responded: ". . . I would say [on] the order of 100 to 200 feet . . . ." Id. Ultimately, the 1994 Order established setbacks of 200 feet inside the connecting zone between saturated floodplain Holocene alluvium and a tributary aquifer or floodplain alluvium of ephemeral streams, and 100 feet where the connection is between the saturated floodplain Holocene alluvium and basin fill. See 1994 Order, at 57-58.

SRP objects to ADWR's use of 200-foot setbacks in locations where thin veneers of dry "tributary alluvium" overlie the saturated floodplain Holocene alluvium. Except for the mouths of larger ephemeral streams or washes (which may have periodic flow in the alluvium underlying those tributaries), the setbacks should be 100 feet from the edge of the saturated floodplain Holocene alluvium because the basin fill aquifer adjoins the saturated floodplain Holocene alluvium.[14] For these purposes, SRP defines a "large" ephemeral stream or wash as being a named watercourse on a USGS quadrangle map. In contrast to unnamed washes and watercourses, named ephemeral streams and washes typically have sufficient watershed size to generate periods of sustained flow in the alluvium underneath the channel.[15]

F. ADWR ignored the extensive presence of dense phreatophytes outside of its subflow delineation.

SRP objects that ADWR ignored the presence of dense communities of phreatophytes outside of its subflow zone delineation as one indicator of the presence of saturated floodplain Holocene alluvium underlying the shallow veneers of "tributary alluvium." The 1994 Order noted:

> To the extent that phreatophication exists or can be documented in the areas adjacent to the principal channel, it does mark that portion of the area of the 'subflow' zone. If it extends to the lateral edge of the saturated floodplain

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[14] Small washes rarely add substantial amounts of groundwater to the Holocene floodplain alluvium. 100-foot setbacks are appropriate along the San Pedro River, Aravaipa Creek, and the Babocomari River, even where regional pumping has lowered the water table below the level in the saturated floodplain Holocene alluvium because the basin fill was tributary to the saturated floodplain Holocene alluvium under predevelopment contributions. The San Pedro and Babocomari Rivers, and Aravaipa Creek, and their saturated floodplain Holocene alluvium are located on broad, deep sedimentary basins or "basin fill." See 2009 ADWR Report, at 4-5.

[15] See A. Coes and D.R. Pool, Ephemeral-Stream Channel and Basin-Floor Infiltration and Recharge in the Sierra Vista Subwatershed of the Upper San Pedro Basin, Southeastern Arizona, U.S. Geological Survey Open File Report 2005-1023.

> Holocene alluvium, then it is a vital marker. The boundaries of riparian [phreatophyte] zones are helpful and certainly within the 'subflow' zones if they do not extend over the top of tributary aquifer or basin fill.

1994 Order, at 55-56. ADWR makes no mention of the use of the "vital marker" of phreatophytes to assist in the delineation of the subflow zone.

Attachment 5 is a series of maps showing the extent of dense mesquite and cottonwood-willow communities along the main channel of the northern half of the San Pedro River relative to the ADWR and SRP[16] subflow delineation.[17] A substantial amount of the dense phreatophyte cover, which indicates the roots are withdrawing water from the water table, occurs outside of ADWR's subflow delineation. *Attachment 5* also contains detailed maps showing the same phreatophyte communities on an aerial photograph base along with the ADWR and SRP subflow delineations. The high density of the phreatophytes straddling and outside of ADWR's delineation is evident on these maps. Also, the dense phreatophytes are within SRP's subflow delineation, except for small areas within the setbacks and near the mouths of major ephemeral washes.

G. ADWR ignored the direction of water flow parallel to the stream underlying thin veneers of alluvial material overlying the saturated floodplain Holocene alluvium.

The Nature Conservancy ("TNC") provided SRP with a water table map in the vicinity of TNC's San Pedro Preserve (known as the Paul Sale property during the 1994 proceedings).[18] See *Attachment 6*. This map, which was prepared by a TNC contractor,

[16] SRP's subflow delineation is shown on the attached maps as the "LRE Subflow Zone," which was mapped by Jon Ford or Leonard Rice Engineers, Inc. ("LRE").

[17] 1992 USGS Digital Orthophotos were used to register aerial photography as part of the mapping process for riparian vegetation. Slight shifts due to registration are possible but are expected to be less than 100 feet. The riparian vegetation, including phreatophytic communities, were mapped using photo interpretation of 2008 aerial photography of the San Pedro mainstem, supplemented by field verification. Only the dense phreatophytic communities are shown on *Attachment 5*.

[18] The San Pedro Preserve is part of the Roosevelt Habitat Conservation Plan discussed in Note 1, supra.

shows that groundwater flowing in the floodplain beneath ADWR's designation "tributary" alluvium flows in the same general direction as the San Pedro River so the area beneath the tributary alluvium should be included in the saturated floodplain Holocene alluvium.

Attachment 2, Figure M shows a more regional interpretation of the water table. This figure is from Pool and Coes (1999), with SRP's interpretation of the saturated floodplain Holocene alluvium added.[19] It shows how groundwater flows toward and into the subflow zone then down-gradient in the same general direction as the San Pedro River.

H. ADWR's delineation is in error where it mapped no subflow zone due to mistakes in geologic interpretation and misapplied setbacks.

ADWR's blind focus on surficial geology and mechanical application of setbacks results in absurd subflow delineations in a number of locations. For example, ADWR identifies and then excludes "islands of floodplain Holocene alluvium," which have been circumscribed by "tributary Holocene alluvium" deposited on top of the floodplain. See 2009 ADWR Report, at 4-13. These "islands" are comprised of the same saturated floodplain Holocene alluvium that underlies the surficial deposits, all of which is the same as, and is connected to, the saturated floodplain Holocene alluvium bordering the stream. Id. at Figure 4-9. These islands, as well as the surrounding thin veneer of alluvium overlying the saturated floodplain Holocene should be incorporated into the subflow zone.

In many other locations, ADWR has excluded the active river channel itself from the saturated floodplain Holocene alluvium by routine application of setbacks from the "tributary Holocene alluvium." There are almost 500 places where the active river channel is excluded from the ADWR saturated floodplain Holocene alluvium. *Attachment 2*, Figure D shows an example of this situation. Additional examples are shown in the maps in *Attachment 3*. By definition, the active river channel contains saturated floodplain Holocene alluvium, which must be part of the subflow zone.

[19] See Pool, D.R. and A.L. Coes, 1999, Hydrogeologic Investigations of the Sierra Vista Subwatershed of the Upper San Pedro Basin, Cochise County, Southeast Arizona: USGS WRI 99-4197.

In another instance along Aravaipa Creek, AGS mapped a finger of late Holocene alluvium (Qy2) extending onto the floodplain. See 2009 ADWR Report, at Figure 5-5; see also Appendix C-5, Sheet 5 of 6, Figure 11. Because of its mechanical application of setbacks to this so-called "tributary" alluvium, ADWR concludes there is no subflow zone along a ½-mile stretch of lower Aravaipa Creek. Moreover, this "geologic unit" is actually a man-made berm bulldozed into place in order to protect a well and agricultural fields from the frequent floods on Aravaipa Creek. *Attachment 7* contains two panoramic photos of the berm and surrounding floodplain, both of which are underlain by the saturated floodplain Holocene alluvium (i.e., the subflow zone).

I. Combined, ADWR's methodology results in an overly narrow, discontinuous, and geologically incorrect delineation of the subflow zone, in contradiction to the 1994 Order.

SRP objects to the narrow width of the ADWR subflow zone, which is as narrow or narrower in many places as the post-1880 entrenchment and principal channel approaches rejected by Judge Goodfarb in his 1994 Order. See Section II.B.1, supra. It is also discontinuous in some locations, which will ultimately raise questions regarding whether water rights that rely in part on subflow can be administered between arbitrarily unconnected reaches of stream. *Attachment 8* contains a series of maps of the San Pedro and Babocomari Rivers and Aravaipa Creek showing the location of the post-1880 entrenchment mapped by Montgomery and Associates, Inc. for the 1994 proceedings before Judge Goodfarb. These maps also show the 2009 ADWR subflow delineation and SRP's mapping of the saturated floodplain Holocene alluvium/subflow zone. These maps (especially Maps 1, 5, and 12) show that there is relatively little difference between the ADWR subflow delineation and the post-1880 entrenchment that Judge Goodfarb specifically rejected in his 1994 Order.

ADWR's rote approach to applying setbacks and excluding various geologic map units lying on the floodplain has resulted in a number of disconnected reaches along the San Pedro and Babocomari River and Aravaipa Creek. Examples are provided in Figures 5-1 and 5-2 of the 2009 ADWR Report. Other examples can be found by examination of the maps in *Attachment 8*; see also *Attachment 11*.

Attachment 9 is a series of maps showing the extent of large wells within and adjacent to the ADWR and SRP subflow zones along the San Pedro and Babocomari Rivers and Aravaipa Creek.[20] Approximately 355 wells that are not likely to be classified as *de minimis* are located outside of ADWR's proposed subflow zone but within SRP's proposed subflow zone. These wells would be subject to the "cone test" to determine how much of the water pumped is subflow, which is likely to approach or equal 100% of their pumping given their proximity to the subflow zone.[21] Thus, ADWR's narrow subflow delineation will require enormous amounts of additional time and money to be spent by ADWR, the parties, and the Court.

J. ADWR's approach in Appendix D-4 to include some of the areas it erroneously excluded is a step in the right direction but does not go far enough toward accurately identifying the full extent of the saturated floodplain Holocene alluvium.

ADWR recognized that its definition of the subflow zone is flawed because it excludes saturated floodplain Holocene alluvium beneath "tributary" sediments that have been temporarily deposited over saturated floodplain Holocene alluvium. In Appendix D-4,

[20] The locations of "large wells" shown on the maps in *Attachment 9* include one or more pumping wells registered in the ADWR "55" database. The claimed water use from these wells is for commercial, industrial, irrigation, mining, municipal, production, recreation, subdivision, or utility company purposes. Not included in the analysis are domestic, monitor, piezometer, geotechnical, or cathodic wells. ADWR's 55 database locates a well by its cadastral or ¼ ¼ ¼ (10 acre) legal description. The Geographic Information System ("GIS") tools used to create these well maps locates the well to the center point of the 10-acre parcel. The depicted well locations are accurate to within a 330-foot radius of the mid-point of the 10-acre designation. Thus, the actual location of the well (within the 10-acre parcel) could theoretically fall inside or outside of a subflow zone delineation and would need to be verified in the field using Global Positioning System ("GPS") or survey instruments. For recent wells, ADWR initiated a new well registration process, which requires the well driller to include the latitude and longitude coordinates of the well. This information is ascertained using a hand-held GPS or survey equipment and recorded on the well driller's report or well log (ADWR Form 55-55).

[21] For context, there are 325 wells within both the ADWR and LRE zones and an additional 19 wells only within the ADWR zone.

ADWR outlines an approach to solving this problem that is based upon the ratio of the perimeter to the length of the deposit. ADWR prepared three figures (D-4a-c) that illustrate the process. For reasons not explained, however, the approach was not adopted.

Although SRP agrees with ADWR that the exclusion of saturated floodplain Holocene alluvium is a problem, SRP objects to the potential mechanical method of using a simple mathematic formula (which appears to have no scientific basis) to include some areas where tributary alluvium overlaps saturated floodplain Holocene alluvium. *Attachment 2*, Figure J is ADWR Figure D-4a with SRP's interpretation of the subflow zone added to it. Figure J shows that the ADWR ratio approach is not adequate but that it more closely matches the saturated floodplain Holocene alluvium than does the ADWR subflow zone delineation.

VI. <u>The Proper Subflow Zone</u>

Mapping of the saturated floodplain Holocene alluvium can be done accurately and inexpensively using basic scientific principles and professional judgment without resorting to detailed subsurface analysis using driller's logs. SRP's expert, Jon Ford, accomplished this when he prepared a map of the subflow zone for the hearing before Judge Goodfarb in 1994 using topographic slope breaks, aerial photograph interpretation, and analysis of the vegetation, coupled with two days of field verification.

Attachment 2, Figure H shows how geologic mapping and topographic slope change can be used to map the edge of the saturated floodplain Holocene alluvium. It also shows how changes in vegetation can be used to map the edge of the saturated floodplain Holocene alluvium where it is beneath alluvium deposited by ephemeral side tributaries.

Attachment 2, Figure K shows a portion of Mr. Ford's mapping for the 1994 hearing compared to his current interpretation of the lateral extent of the saturated floodplain Holocene alluvium. The current interpretation is based upon the 2008 AGS survey mapping done for ADWR and the direction provided by the 1994 Order, the 2004 Master's Report, and the 2005 Order. Figure K shows that the flat broad floodplain, along with its Holocene alluvium, is an obvious feature compared to the steep side slopes of basin fill dissected by arroyos. The figure also shows that the two interpretations (1994 and current) agree very well. Based upon making this comparison throughout the entire basin, Mr. Ford concluded that the saturated floodplain Holocene alluvium can be mapped with little difficulty where it underlies deposits ADWR has deemed to be "tributary."

To illustrate his interpretation of the saturated floodplain Holocene alluvium and the saturated floodplain Holocene alluvium with the required 100- and 200-foot setbacks, Mr. Ford has added them to AGS Sheets 1-6. See *Attachment 10.* On these maps, the saturated floodplain Holocene alluvium with and without the setbacks can be seen relative to the geology. These maps show how Mr. Ford interpreted the edge of the saturated floodplain Holocene alluvium beneath the veneer of deposits brought onto the floodplain by tributary streams and washes. Where it is beneath other deposits, the location of the edge of the saturated floodplain Holocene alluvium is based upon professional geologic judgment using exposures of basin fill and Pleistocene deposits mapped by the AGS, topographic slope analysis (geomorphology), and vegetation analysis. *Attachment 11* is a series of maps showing Mr. Ford's updated subflow delineation versus ADWR's delineation throughout the watershed.[22]

As mentioned above, in some locations, inliers of basin fill (Tsd), which are remnants of basin fill protruding through the veneer of thin alluvium deposited over the basin fill by ephemeral side drainages, can be used to map the edge of the saturated floodplain Holocene alluvium on the San Pedro River floodplain. *Attachment 2*, Figure L shows how this is done.

After the lateral limits of the saturated floodplain Holocene floodplain were defined, Mr. Ford developed a process to incorporate the 100- and 200-foot setbacks defined in the 1994 Order. Because the AGS mapping shows Holocene sediments have been deposited on

[22] Mr. Ford did not map the subflow zone along streams that ADWR shows as "potential perennial or intermittent mountain front streams," see Section IV, supra, because there is not sufficient information in the record to determine if they are actually perennial or intermittent, and whether any appropriative water rights exist on those stream reaches. If the Court determines that some or all of those streams should be included, ADWR should delineate the saturated floodplain Holocene alluvium using the process described herein.

top of floodplain Holocene floodplain alluvium nearly everywhere along the edge of the floodplain, a process for determining which washes were subject to the setback needs to be developed. Additionally, the process would include adjusting the setbacks to avoid having the San Pedro River active channel outside of the subflow zone.

The setback process used by Mr. Ford consisted of the following steps:

1. To account for the possibility of groundwater inflow from basin fill into the Holocene floodplain alluvium, Mr. Ford applied a 100-foot setback line along the entire length of the saturated floodplain Holocene floodplain delineation on both sides of the floodplain. Each 100-foot setback line is parallel to and located on the floodplain side of the saturated floodplain Holocene floodplain line.

2. Mr. Ford identified named washes from topographic maps and determined how far their alluvial fans extended upstream and downstream on the floodplain along the saturated floodplain Holocene floodplain line. The AGS mapping and topography were used to make this determination. In many places, alluvial fans overlap and, in those cases, professional judgment was used to make the determination.

3. Once the extent of the alluvial fans of named washes were identified, a 200-foot setback line was applied to the extent of each fan parallel to the saturated floodplain Holocene floodplain line.

4. The 200-foot alluvial fan setback line was connected to the 100-foot setback line by drawing a line from the point where the 200-foot setback line reached the edge of each named wash alluvial fan to the 100-foot setback line. This connecting line was drawn at a 45-degree angle between the 100- and 200-foot setback lines. The curving nature of the setback lines causes the connecting line to be only approximately 45 degrees in many places.

5. The 100-foot setback line within the named wash alluvial fans was then removed.

6. The composite 100- and 200-foot setback lines were then reviewed to identify areas where the setbacks caused the river channel, as identified by AGS, to be outside of the

subflow zone. In those places, the setbacks were adjusted so that the river channel was included in the subflow zone.

SRP asserts that ADWR should have used this process, or one like it, in dealing with the setback issues in its report.

VII. **Summary and Requested Action**

ADWR was correct on several issues when delineating the San Pedro River subflow zone, but certain significant problems exist with ADWR's methodology. SRP requests that the Court reject ADWR's report and require ADWR to revise the subflow zone delineation mapping and modify both ADWR Figure 4-1 and AGS Figure 3 in accordance with the correct criteria as set forth herein.

DATED this 28th day of December, 2009.

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ORIGINAL of the foregoing, with
hard copy attachments, hand-
delivered this 28th day of December, 2009 to:

Clerk of the Superior Court of Maricopa County
101/201 West Jefferson
Phoenix, AZ 85003-2205

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. . .

AND COPY, with hard copy attachments and DVD containing attachments, hand-delivered this 28th day of December, 2009 to:

Honorable Eddward P. Ballinger
Judge of the Superior Court
Northeast Regional Court Center
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Phoenix, Arizona 85032

Special Master George A. Schade
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Maricopa County Superior Court
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Arizona Department of Water Resources
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Phoenix, AZ 85012

AND COPY, with DVD containing attachments, mailed this 28th day of December, 2009 to all persons appearing on the Court-approved mailing list in W1-W4 dated July 27, 2009.

Francine Ford Bush

Attachments

Attachment 1 Affidavit of Jon R. Ford

Attachment 2 Figures A through M

Attachment 3 1935 and 2008 Channel Comparison Maps

Attachment 4 Steve Erb Testimony; Reporter's Transcript of Proceedings, vol. X, pp. 75-85 (February 16, 1994)

Attachment 5 Riparian Vegetation Maps

Attachment 6 The Nature Conservancy Water Table Map

Attachment 7 Aravaipa Creek Berm Photos

Attachment 8 Montgomery Post-1880, ADWR, and LRE Subflow Zone Comparison Maps

Attachment 9 Large Wells In and Near the Subflow Zone

Attachment 10 LRE Subflow Zone on AGS Maps

Attachment 11 ADWR and LRE Subflow Zone Comparison Maps