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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. W1-W4 Contested Case W1-103 UNITED STATES' OBJECTIONS TO ARIZONA DEPARTMENT OF WATER RESOURCES' SUBFLOW ZONE DELINEATION REPORT

CONTESTED CASE NAME:	*In re Subflow Technical Report, San Pedro River Watershed,* W1 - 103.
HSR INVOLVED:	None
DESCRIPTIVE SUMMARY:	The United States' Objections to the Arizona Department of Water Resources' 2009 Subflow Zone Delineation Report, San Pedro River Watershed.
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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 United States submits its objections to the June 2009 Subflow Zone Delineation Report for the San Pedro River Watershed ("ADWR Report"). These objections are supported by the attached affidavit of Peter M. Pyle (attached hereto as Exhibit 1)("Pyle Affidavit") and accompanying exhibits.

Introduction

ADWR has produced a flawed delineation of the subflow zone in the San Pedro River watershed. While the agency has done a commendable job of accumulating data and presenting geologic maps of river floodplain deposits, it has lost sight of the fact that subflow is fundamentally a hydrological concept. The numerous court decisions ruling on this issue hold that groundwater occurring in the floodplain and hydrologically connected to intermittent and perennial streams and rivers is subflow. ADWR, however, excludes large areas of saturated floodplain deposits - indeed, eliminated large segments of perennial rivers - based on geologic units, not hydrogeology. ADWR must re-analyze its data, and if necessary procure more definitive data, and produce a delineation of the subflow zone that includes the entire pre-development saturated Holocene floodplain alluvium.

Objections

Objection Number 1: ADWR has failed to delineate subflow based on pre-development conditions.

ADWR recognizes that it must use predevelopment streamflow conditions in its analysis of subflow. ADWR Report at 2-1. Accordingly, ADWR accumulated published and unpublished historic accounts, a record of historic irrigation ditch and ore mill diversions, historic streamflow and diversion measurements, aerial photographs, published predevelopment streamflow maps, recent instream flow claims, wet/dry surveys, recent streamflow and diversions measurements, and recently published streamflow maps. *Id.* at 3-5 to 3-22. ADWR has taken the "practical approach" approved by the Court, *see* 2005 Order at 21, yet has still managed to accumulate and analyze multiple sources of information and large amounts of data. By any

measure, the agency's delineation of predevelopment conditions is thorough, accurate and reliable.

From the accumulated evidence, ADWR makes the following conclusions:

- Prior to development, the San Pedro River was perennial or intermittent from the International Border (Stream Mile 157) to its confluence with the Gila River (Stream Mile 0). ADWR Report at 3-19.
- Prior to development, the Babocomari River was perennial or intermittent downstream of Elgin at Babocomari Ranch (Stream Mile 21) to its confluence with the San Pedro River (Stream Mile 0). ADWR Report at 3-21.
- Aravaipa Creek was perennial or intermittent at predevelopment from about six miles upstream of Klondyke at Stream Mile 36 to its confluence with the San Pedro River at Stream Mile 0. ADWR Report 3-22.

In sum, then, the entire San Pedro River; 21 miles of the Babocomari River; and, 6 miles of the Aravaipa Creek were perennial or intermittent streams and rivers prior to development. In addition, ADWR has performed a geologic analysis and concludes that the San Pedro and Babocomari rivers and the Aravaipa Creek all exist within an alluvial channel in the floodplain Holocene alluvium.[1/] Furthermore, as the Court has previously ruled, saturation in the entire extent of the floodplain Holocene alluvium is assumed. 2005 Order at 18.

Putting both the physical evidence (predevelopment perennial and intermittent rivers and

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[1/] *See e.g.*, ADWR Report at 4-3 ("the width of floodplain Holocene alluvium along the San Pedro River is typically hundreds of feet wide and can reach almost one mile wide in some areas. Where bound, its width can be less than 100 feet."); ADWR Report at 4-4 ("The current channel and floodplain of the Babocomari River is typically covered with coarse alluvium and entrenched from 3 to 20 feet below terraces formed by abandoned floodplains."); ADWR Report at 4-5 ("The active floodplain of Aravaipa Creek is typically sandy, from 300 feet or more wide, and entrenched from 6 to 15 feet below older Holocene terraces and Tertiary basinfill deposits.")

The only exception to ADWR's conclusion that the river beds are composed of floodplain alluvium appears to be a small section of the Babocomari River where "[c]hannel alluvium is thin to absent only along bedrock reaches in its headwaters near the Mustang Mountains and along a 1-mile bedrock canyon near its confluence with the San Pedro River." ADWR Report at 4-5 However, even here ADWR states that Holocene floodplain alluvium is present but "narrows to less than a 100 feet." *Id.*

steams and Holocene alluvium in the bed of the rivers and streams) and the physical assumptions (saturation in the Holocene alluvium) together, subflow must exist - at a minimum - in the alluvium beneath the bed of the predevelopment perennial and intermittent rivers and steams. In other words, the evidence and assumptions compel a finding that a subflow zone exists along at least the width of the bed of the entire length of the San Pedro River and most of the Babocomari River and the Aravaipa Creek.

ADWR, however, does not delineate subflow along the entire length of these rivers and streams. Instead, the agency's subflow delineation has large gaps along the course of the predevelopment perennial and intermittent rivers and steams. *See* ADWR Report, Figure 6-1 (Subflow Zone Along Major Streams in the San Pedro River Watershed). ADWR excludes these segments because of the existence of tributary alluvium in the floodplain and/or the extension of 200 and 100 foot "setbacks" which overlap and consequently remove portions of the rivers and streams from subflow designation.[2]/ As shown below, ADWR misinterprets these criteria, but more importantly, the agency has applied these exclusions to an illogical and irrational extreme. The agency has allowed its "exceptions" to consume the rule. The rule is the saturated floodplain Holocene alluvium of the predevelopment perennial and intermittent rivers and streams is subflow. Because this condition exists along, at least, the beds of the entire length of the San Pedro River, and most of the Babocomari River and the Aravaipa Creek, no segments of these rivers and streams should be excepted from subflow delineation.

Objection Number 2: **Areas where saturated floodplain Holocene alluvium are overlain by tributary deposits are still areas of subflow and should not be excluded.**

Despite the existence of subflow, i.e., areas of predevelopment perennial and intermittent rivers in Holocene floodplain alluvium presumed to be saturated, along the continuous length of

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[2]/ Somewhat confusingly, ADWR states that it did delineate a subflow zone along the entire length of the San Pedro River and all except the upper reaches of the Babocomari River and Aravaipa Creek, *see* ADWR Report at 6-1, but then states that it did not delineate a subflow zone along numerous reaches of each stream, *see id.* at 6-2. Both statements cannot be correct. As discussed, *infra*, ADWR's first conclusion is correct.

the rivers and streams in the San Pedro watershed, ADWR has excluded large river segments from its subflow delineation. ADWR explains that it is excluding these areas based upon the 2005 Subflow Order p. 42, ¶ 6, approving the Special Master's July 16, 2004 Subflow Decision, Recommendation No. 18. The Special Master's recommendation states "[t]he Court should direct ADWR to exclude tributary aquifers, areas of basin fill recharge, and the alluvial plains of ephemeral streams from the subflow zone." Interpreting these directions, ADWR mapped the width of the floodplain Holocene alluvium and areas where tributaries have recently deposited alluvium on top of the floodplain. ADWR Report at 4-12. ADWR then applied a 100 foot setback at the boundary of the floodplain Holocene alluvium with the basin fill, and a 200 foot setback at the boundary of the floodplain Holocene alluvium with alluvial deposits from ephemeral streams tributary to the San Pedro River, the Babocomari River and Aravaipa Creek. Consequently, where recent tributary deposits overlie the river floodplain alluvium, combined with 200 foot setbacks, large segments of the Holocene floodplain alluvium are excluded from subflow delineation.

By focusing on the presence of alluvial plains of ephemeral streams, ADWR has misinterpreted the Court's instructions. Fundamentally, the subflow delineation is a determination of groundwater "that is more closely associated with the stream than with the surrounding [basin] alluvium." *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 175 Ariz. 382, 392, 857 P.2d 1236, 1246 (1993) ("*Gila II*"). After rejecting the trial court's first definition of subflow that included a temporal test on the effects of well pumping on a river or stream, the Arizona Supreme Court approved a second definition that applied each of the criteria announced in *Gila II*:

> For example, the [trial court] order states: 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.

In re the General Adjudication of All Rights to Use Water in the Gila River System and Source, 198 Ariz. 330, 337, 9 P.3d 1060, 1076 (2000)("*Gila IV*"); *see also id.*, 9 P.3d at 1083 (approving

the trial judge's determination "in all respects"). The hydrologic conditions, therefore, within the floodplain Holocene alluvium define the concept of subflow.

In excluding large areas of Holocene floodplain alluvium covered by ephemeral tributary deposits, however, ADWR has made no attempt to discern whether groundwater beneath the tributary deposits is water that flows in the direction of the river or stream and is "more closely associated with the stream." Indeed, instead of considering whether "hydraulic pressure from tributary aquifers" is consistent with the stream flow direction, ADWR has eliminated large segments of floodplain based solely on surficial geology. *See* ADWR Report at 4-13 ("ADWR does not consider tributary Holocene alluvium to be part of the floodplain Holocene alluvium").

Peter Pyle, a licensed professional geologist and certified hydrogeologist involved in the adjudication's subflow cases since 1993, explains the error in ADWR's methodology as follows:

> Most small tributaries sustain little or no surface or subflow, and may only be partially saturated during high runoff events. Therefore, it is unreasonable to allow temporary deposits of tributary stream alluvium or encroachment of piedmont tributary alluvium to narrow the subflow zone, particularly in cases where setbacks are applied such that the subflow zone disappears entirely. It is unlikely that the Court envisioned this application of the setback rules, or that tributary alluvium would be interpreted in such a way as to extend continuously on either side of the floodplain Holocene alluvium rather than terminating where tributary washes join the San Pedro River floodplain.

Pyle Affidavit, at 2. A more reasonable application of the Supreme Court's criteria is one that recognizes fundamental hydrogeologic principles of groundwater flow combined with the geology and geomorphology. Pyle recommends an approach that applies the Court's criteria without requiring ADWR to invest large additional expenditures of time and money:

> We believe the most appropriate criteria to use from this point forward is to define the San Pedro River floodplain based on geology, topography and geomorphology and the direction of flow within the Holocene alluvium. Initially this approach will allow drawing a boundary that includes mapped Holocene alluvial deposits within the San Pedro River floodplain which contains subflow by the Court's definition. If there is any doubt as to the boundary in some areas of Holocene alluvium, then the general direction of groundwater flow within it should be determined by measurements or inferred from existing data and experience in similar areas. If groundwater flow in the floodplain Holocene alluvium is in the direction of the San Pedro River, then the area should be within the subflow boundary.

Pyle Affidavit at 3. First, therefore, ADWR should use its existing geologic and topographic maps to identify, as *Gila IV* directs, "the edge of the saturated floodplain Holocene alluvium." 9

P.3d at 1076. Once the edge of the saturated floodplain Holocene alluvium is located, appropriate setbacks to account for hydraulic pressure from tributary aquifers and basin fill recharge may be applied. This setback is 200 feet near tributary alluvial washes where they meet the floodplain deposits and 100 feet at the basin fill boundary with the floodplain deposits.

As shown on Attachment B of the Pyle affidavit this approach uses the easily identifiable floodplain deposits and topography to establish the Holocene floodplain alluvium boundary. Applying a 100 foot and 200 foot setback from the boundary (the black line on Pyle's Attachment B) then delineates the subflow boundary. This method creates a more uniform boundary that does not contain a multitude of "edges" that have little bearing on the presence of saturated floodplain Holocene alluvium. It is a relatively quick, effective and inexpensive means of mapping the Holocene floodplain alluvium boundary and adheres to the Supreme Court's observation that "the saturated floodplain Holocene alluvium is readily identifiable; that DWR can quickly, accurately, and relatively inexpensively determine the edge of that zone . . . ." *Gila IV*, 9 P.3d at 1081.

As Pyle further recommends, if there is any doubt as to the subflow boundary in some areas of Holocene alluvium, then the general direction of groundwater flow within the floodplain may be determined by measurements or inferred from existing data and experience in similar areas. Pyle Affidavit at 4. This approach applies the general principle that groundwater in the floodplain alluvium adjacent to perennial and intermittent rivers and streams flows in the direction of the river and streams and is "more closely associated with the stream." Pyle proposes a simple test to confirm this:

> A simple field test to determine the direction of flow can be performed in areas where the subflow boundary is uncertain. This test can involve driving three well points or piezometers into the Holocene alluvium and carefully measuring the water levels and measurement point elevation.

Pyle Affidavit at 3. An example of the possible locations of piezometers to be used to determine groundwater flow direction in the floodplain of the San Pedro River is shown on Attachment B with black X's. Such a test may determine if there is "a lack of hydraulic pressure from tributary aquifer and basin fill recharge which is perpendicular to stream and 'subflow'

direction." *Gila IV*, 9 P.3d at 1076. If there is no such perpendicular hydraulic pressure, then ADWR's exclusion of large swaths of river floodplain merely because tributary deposits lie on top of the floodplain Holocene alluvium is clearly erroneous.

Objection Number 3: **ADWR has erroneously eliminated from subflow delineation areas where the San Pedro River is flowing adjacent to bedrock.**

ADWR has reduced the width of the floodplain Holocene alluvium or eliminated it entirely where the San Pedro River flows through two areas of bedrock in the northern part of the Lewis Springs quad. *See* ADWR Report Appendix D1 - Map 19 and Appendix D3 - Map 19. However, even where bedrock outcrops are adjacent to the river, there are deposits of floodplain Holocene alluvium in the beds and banks. Attachment C to the Pyle Affidavit is a revised geologic map of the Arizona Geological Society's Lewis Springs quad showing where the San Pedro River flows through an area of bedrock with deposits of Holocene floodplain alluvium. As Pyle states,

> San Pedro River subflow must occur in at least the Holocene alluvium in this reach, highlighting the problem with applying setbacks in all areas.[3]/ The flow direction test described above and shown in Attachment B would confirm that groundwater in this segment flows in the direction of the river in the Holocene alluvium, but it is unnecessary because it can be inferred based on existing data and experience. The subflow boundary should be extended through this bedrock area and no setbacks should be applied.

Pyle Affidavit at 4. The elimination of the subflow zone even where it is shown that a perennial river is flowing in Holocene alluvium is clearly erroneous.

Objection Number 4: **ADWR's method to compensate for large gaps in the delineation of subflow of the rivers and streams is arbitrary and speculative.**

To its credit, ADWR recognizes that there is a serious deficiency in its delineation of subflow and the resulting exclusion of large areas of river floodplain due to the presence of surficial tributary deposits and application of "setbacks." ADWR Report at 4-13. The agency proposes to correct for these omissions by use of a formula comparing the tributary deposits'

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[3]/ Pyle also notes that "[t]here are also insignificant deposits of undifferentiated Pleistocene alluvium (Qi) to which ADWR has applied a setback of 200 feet which narrows the subflow in that area to zero."

length and perimeter.

> Where tributary Holocene alluvium likely overlies floodplain Holocene alluvium, it borders the floodplain or forms fingers of material that extend out into the floodplain. To determine whether these features should be treated as floodplain Holocene alluvium, a ratio could be used of the perimeter of the feature (P) to its length at the edge of the floodplain (L).

ADWR Report at D-4-1. ADWR does not cite to any scientific authority, published or unpublished, showing that its proposed methodology is generally accepted in the scientific community. It is unlikely that such scientific support exists, for the reason noted by Pyle:

> One problem with this is that the length at the edge of the floodplain is a straight line joining two random points unrelated to geology or the floodplain boundary and is entirely arbitrary. This approach fails to recognize that earth processes such as sediment deposition and stream geomorphology are not readily approximated by simple equations and linear features.

Pyle affidavit at 3. ADWR's ratio methodology, therefore, appears to be entirely arbitrary and speculative. ADWR includes an interesting justification for its proposed ratio methodology. The agency claims it "result[s] in a more regular floodplain boundary." The United States agrees that, consistent with the Arizona Supreme Court's instruction in *Gila IV* to locate "the edge of the saturated floodplain Holocene alluvium," the floodplain boundary (or edge) should be more regular. However, the means to produce a more regular boundary is to map the edge of the Holocene floodplain with geologic and topographic data, not by using speculative methods not generally accepted by the scientific community.

Objection Number 5: Tributary surficial deposits are subject to flood and regular river processes and are not reliable indicators of the subflow boundary.

The courts have held, and consistently reiterated, that the adjudication's jurisdiction is limited to the Holocene alluvium because it constitutes "the only stable geologic unit which is beneath and adjacent to most rivers and streams. . . . " *Gila IV*, 9 P.3d at 1076; *see also* 2005 Order at 16, Order dated June 30, 1994, at 56, Special Master's Report dated July 16, 2004, at 33. Stability of the geologic units, therefore, is a key factor when mapping the extent of subflow. ADWR, however, limits the extent of subflow, and in places eliminates it entirely, based on what it admits is unstable deposits of tributary alluvium in the floodplain.

The Department recognizes "[e]ventually, a large flood may remove this [tributary

alluvium] material and allow the river to return to its prior course. As a result, tributary alluvium may temporarily cover floodplain Holocene alluvium at the surface and, overtime, interfinger with it in the subsurface (Figure 4.1)." ADWR Report at 4-4.[4]/ Despite this acknowledgment that tributary surficial deposits are temporary, these geologic units form the basis for ADWR's delineation of a subflow boundary. ADWR Report at 4-12 ("Although this tributary Holocene alluvium may eventually get washed away during a large flood, at the time of mapping, AZGS distinguished it from the floodplain deposits.")

Because subflow should be based on, in part, a "stable geologic unit," ADWR has erred in using the tributary alluvium deposits to map the boundary and extent of the floodplain Holocene alluvium.

Conclusion

ADWR should be directed to amend its subflow delineation report and include all areas where under predevelopment conditions there is saturated floodplain Holocene alluvium. The agency should not exclude areas of saturated floodplain Holocene alluvium based on the presence of overlying temporary tributary alluvium deposits and "setbacks" from these tributary deposits or from adjacent bedrock outcrops. If the agency is in doubt whether groundwater in the floodplain is more associated with the river than a nearby basin fill or tributary aquifer it should perform a simple test to confirm groundwater flow direction.

RESPECTFULLY SUBMITTED this 28th day of December, 2009.

UNITED STATES OF AMERICA

BY: _____
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[4]/ Our expert agrees with ADWR and states that "[t]he location of the edges of the tributary alluvium and piedmont deposits in the floodplain of the San Pedro River are subject to change due to ongoing erosion and deposition." Pyle Affidavit at 4. Furthermore, mapping the edges of the tributary alluvium does not define a stable boundary. *Id.*

CERTIFICATE OF SERVICE

The original and one copy of the foregoing sent via Federal Express this 28th day of December, 2009 to:

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A copy of the foregoing mailed this 28th day of December, 2009, to all parties on the Court-approved W-1-W-4 mailing list dated July 27, 2009.