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	)	W-1 (Salt)
	)	W-2 (Verde)
	)	W-3 (Upper Gila)
	)	W-4 (San Pedro)
	)	
	)	Contested Case No. W1-103
	)	
	)	AFFIDAVIT OF PETER M. PYLE

CONTESTED CASE NAME: *In re Subflow Technical Report, San Pedro River Watershed.*

HSR INVOLVED: None

DESCRIPTIVE SUMMARY: Affidavit of Peter M. Pyle

NUMBER OF PAGES: 5

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STATE OF CALIFORNIA
COUNTY OF MARIN

Affidavit of Peter M. Pyle, PG, CHG

Review of -
Arizona Department of Water Resources, Subflow Delineation Report for the San Pedro River Watershed, June 2009

Qualifications:

I am a licensed Professional Geologist and Certified Hydrogeologist with 27 years experience in geology, hydrogeology, water rights, ground and surface water modeling, groundwater development and related fields. I have worked for Stetson Engineers since January 1991 on various hydrogeologic studies in the western U.S., including Arizona. I have been involved in the subflow and groundwater and surface water interaction aspects of the Gila River Adjudication for Stetson Engineers including the San Pedro River subflow determination since 1993.

EXHIBIT 1

Experience in San Pedro Watershed and Gila River Watershed 1993 - Present

- Drilling, lithologic logging, and geophysics
- Litigation support and expert witness testimony preparation
- Review of ADWR reports, Court rulings, and consultants reports
- Research and preparation of reports and documents, coauthored reports and assisted with briefs, declarations and rebuttal affidavits
- Attendance at hearings and reviewed testimony
- Review of previous work by USGS, ADWR and other consultants
- Met with USGS and reviewed model.
- Met with USDA and discussed use of soils data for mapping Subflow zone.
- Field trips:
  - With Judge Goodfarb
  - Detailed survey of the geology along the San Pedro River from Hereford to with GPS waypoints, photos, field log and filed declaration

1. San Pedro River Subflow is occurring in areas where AGS has mapped tributary Holocene alluvium within the San Pedro River floodplain and ADWR has eliminated those areas from the subflow zone.

ADWR (2009) has stated that it based its delineation of the subflow zone on recent mapping by the Arizona Geological Survey (AGS) and that if that mapping showed tributary alluvium in the floodplain of the San Pedro River, it was allowed to remain as mapped even though high flow events would remove the tributary alluvium temporarily deposited in the San Pedro River floodplain (pg 4-4).

> Where the introduction of tributary alluvium is particularly large, the floodplain may narrow and the river changes course, at least temporarily, to accommodate the additional sediment. Eventually, a large flood may remove this 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).

There is little doubt that subflow associated with the floodplain of the San Pedro River flows in the direction of the River in these areas. 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. This interpretation allows the setbacks to occur all along the River and interfere with the interpretation of subflow to the extent that is assumed by ADWR not to exist in some areas, including the middle of the flowing San Pedro River channel itself.

Examples provided in ADWR, 2009 Volume 1, Figure 5-1 show areas where the setbacks

applied by ADWR in areas where the San Pedro River floodplain Holocene alluvium is mapped as relatively narrow due to lateral encroachment from areas mapped as piedmont or tributary stream alluvium. Several extreme examples of this occur on the Land, Hereford and Lewis Springs quads, as shown in a comparison of those quads in Appendix D1 and Appendix D3.

ADWR has recognized that strict adherence to the exclusion of tributary Holocene alluvial deposits from the subflow zone has led to the implausible narrowing or even elimination of the subflow zone along much of the San Pedro River (ADWR, 2009, p. 4-13). In recognition of these anomalous areas, ADWR provided a "possible approach" to rectifying these problems which could "result in a more regular floodplain boundary". ADWR also recognized that more direction is needed by the court to resolve the problems of strict adherence to the source of material now occurring in the floodplain as a basis for defining the floodplain Holocene alluvium. We would argue that the remedy that is needed is not one that results in a more "regular" boundary, but one that recognizes fundamental hydrogeologic principles, geomorphology and criteria set by the Court. These principles and criterion include:

1) Subflow moves in the same direction as the flow of the San Pedro River
2) Holocene alluvium within the floodplain of the San Pedro River
3) Topography

Some of the tributary alluvium mapped by the AZGS and categorized as piedmont deposits occur within the floodplain of the San Pedro River. In the floodplain, these deposits lie on top of areas containing the subflow of the San Pedro River.

ADWR's (2009) suggested method for developing a more regular subflow boundary is presented in their Appendix D-4. An example of this approach is shown in Figure D-4a (enclosed herein as Attachment A). It involves an equation or ratio of the perimeter of the excluded feature to its length at the edge of the floodplain. 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. Stetson Engineers strongly disagrees with this approach.

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.

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. Once a more scientifically based boundary is drawn, the floodplain Holocene alluvium boundary

can then be determined that includes the appropriate offsets near tributary alluvial washes where they meet the San Pedro River floodplain (200 feet) and at the basin fill boundary (100 feet) that have been specified by the Court. The 200 ft offset for tributaries where they meet the San Pedro River floodplain should only apply for large tributaries that have groundwater flow in the tributary Holocene alluvium at the edge of the San Pedro River floodplain year round. It is only in these areas that the groundwater flow in the tributary alluvium is expected to be perpendicular to that of the San Pedro River subflow as defined by the Court.

An example of Stetson Engineers proposed method this is shown on Attachment B of this affidavit. Attachment B shows the northern portion of the revised Hereford quad geologic map (AZGS- DGM 57 V2, 2009) with the approximate FHA boundary added (in green) based on ADWR (2009, Appendix D-3, Map 13 of 33) following specified alluvial geologic unit contacts. Also included on Attachment B is an alternative, approximate floodplain Holocene alluvium subflow boundary proposed by Stetson Engineers (in red) based primarily on geology and topography. The setbacks of 100 feet for basin fill and 200 feet for large tributaries as defined above, would have to be added to the floodplain Holocene alluvium boundary to create a new subflow boundary. An example of the possible locations of piezometers to be used to determine groundwater flow direction is shown on Attachment B with black X's.

The boundary of Holocene alluvium in the San Pedro River floodplain may be more difficult to define in some places rather than others due to limited basin fill or bedrock outcrops, and low topography. However, this example shows that the proposed approach to defining the Holocene floodplain alluvium, regardless of its source, would serve the intent of the court better than, 1) the floodplain Holocene floodplain alluvium (subflow) boundary drawn by ADWR (2009, Appendix D-3), or 2) ADWR's suggested approach to redefining the boundary in some areas described in Appendix D-4, Figure D-4a (Attachment A of this affidavit).

2. The ADWR has based it subflow boundary on temporary surficial tributary alluvium and piedmont deposits.

The 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. The ADWR has acknowledged that these changes occur in their report (ADWR, 2009) as quoted above under item (1). The Court instructed ADWR to define a stable boundary. A stable boundary is the edge of the San Pedro River floodplain which is based on hydrogeology and topography. The boundary plotted by Stetson Engineers on Attachment B of this affidavit is an example of such a boundary.

3. San Pedro River subflow is occurring where ADWR has erroneously applied setbacks where the River flows through bedrock.

ADWR (2009, p. 5-2) states:

> "ADWR applied a 100-foot setback where the floodplain Holocene alluvium was bordered by basin fill and a 200-foot setback where it was bordered by tributary Holocene alluvium. The 1994 Subflow order did not discuss hydrostatic pressure effects from bedrock bordering the floodplain. "

However, ADWR appears to have reduced the width of the subflow boundary or eliminated it entirely where the San Pedro River flows through two areas of bedrock in the northern part of the Lewis Springs quad as shown in a comparison of Appendix D1 - Map 19 and Appendix D3 - Map 19.

A review of the AZGS (2009, DGM-57, V2) revised Lewis Springs geologic quad shows an example of where the River flows through an area of bedrock with deposits of Holocene floodplain alluvium (Attachment C, this affidavit). There are also insignificant deposits of undifferentiated Pleistocene alluvium (Qi) to which ADWR has applied a setback of 200 feet which narrows the subflow boundary in that area to zero. San Pedro River subflow must occur in at least the Holocene alluvium in this reach, highlighting the problem with applying setbacks in all areas. 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.

In conclusion, I find that the method used by ADWR (2009) to define the San Pedro River floodplain Holocene alluvium is flawed due to strict adherence to the source areas of Holocene alluvium found in the floodplain of the San Pedro River. Their suggested approach to rectifying this error, as demonstrated in Appendix D-4 of that report, is also seriously flawed and arbitrary. An alternative approach is provided in this affidavit that incorporates the criteria set fourth by the Court and uses, geology, topography and groundwater flow direction to define the boundaries of the San Pedro River Holocene alluvium.

I declare upon penalty of perjury that the foregoing is true and correct.
EXECUTED this 28th day of December, 2009, at San Rafael, California.

Peter M. Pyle, PG, CHG

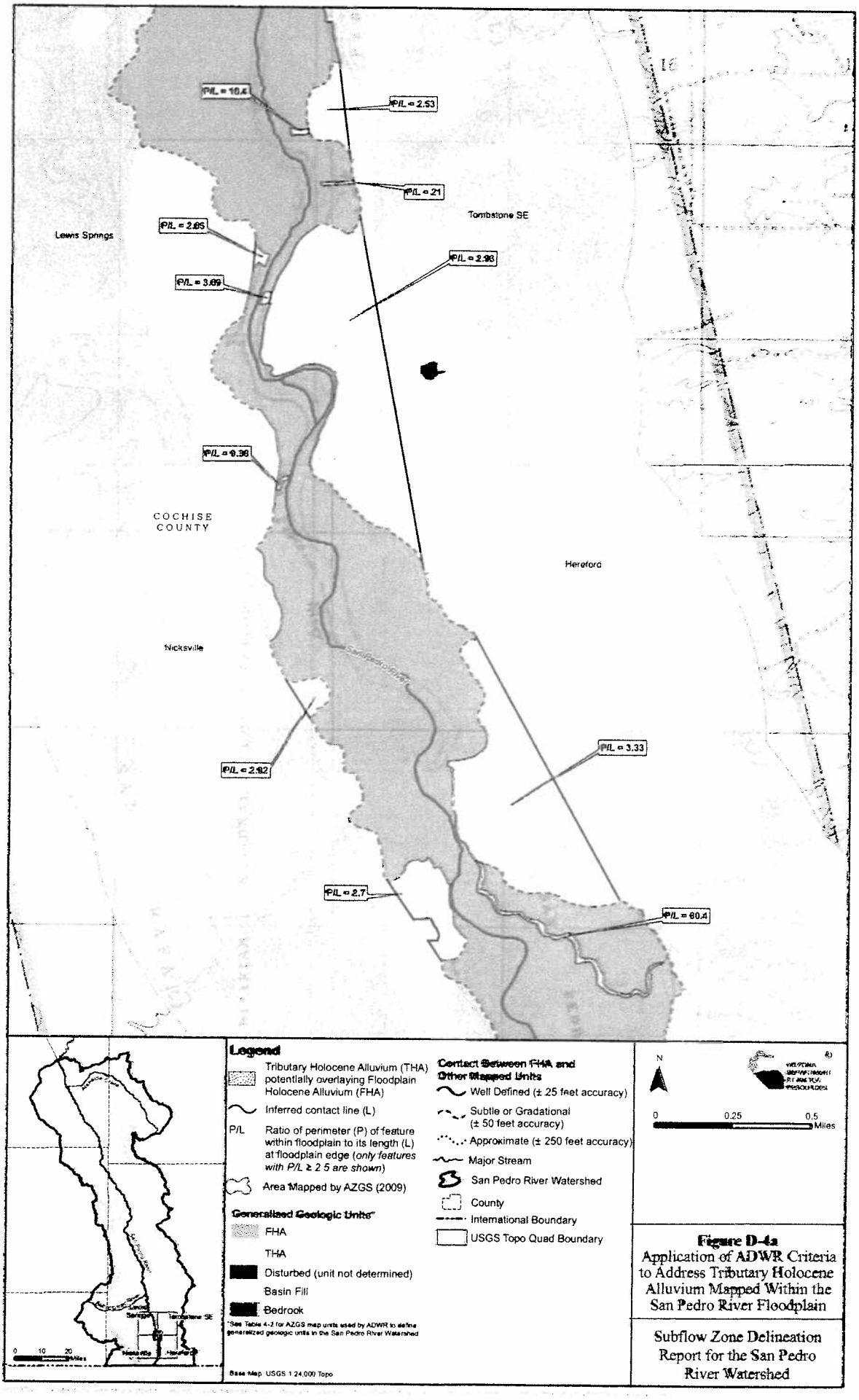
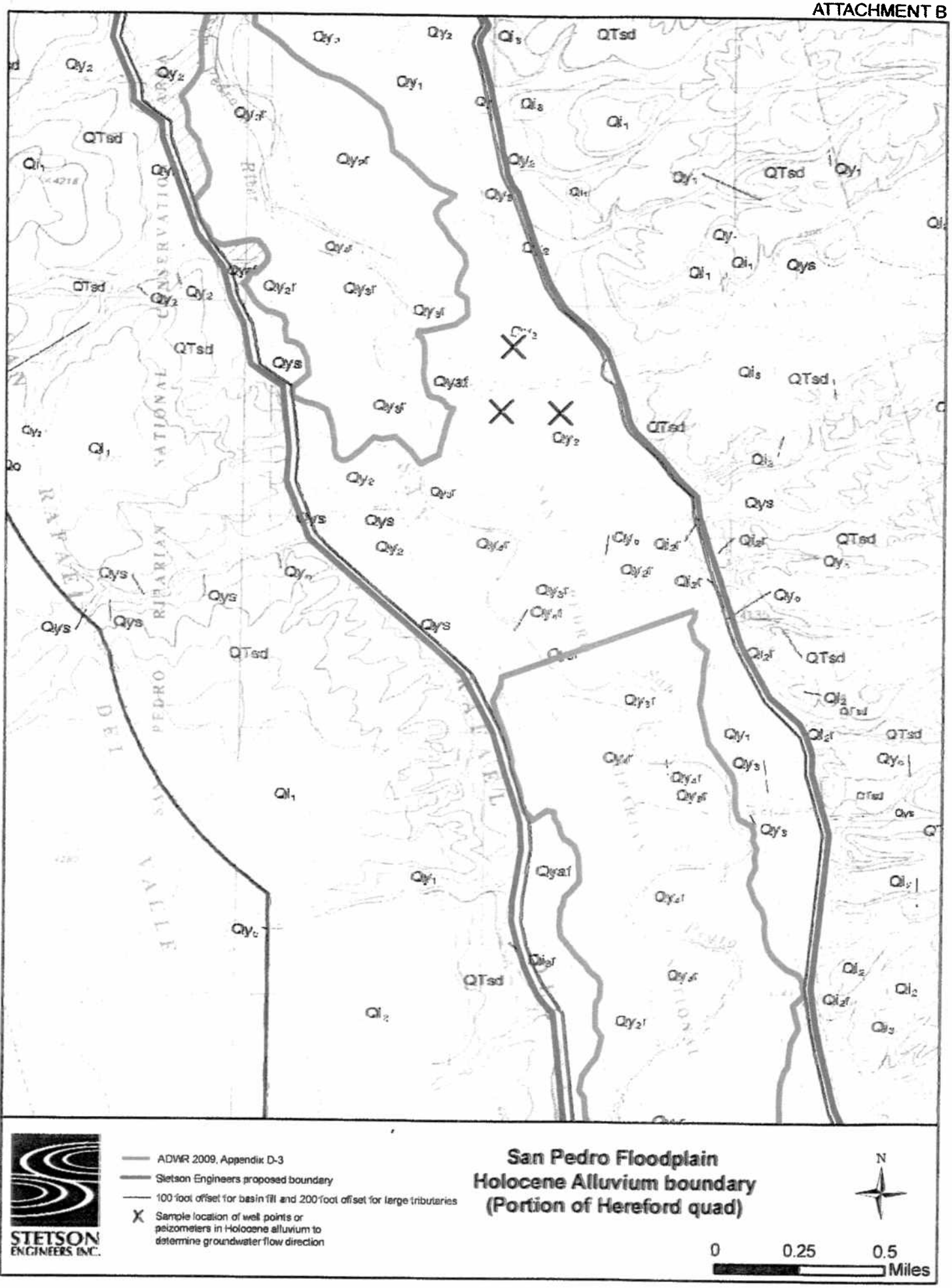
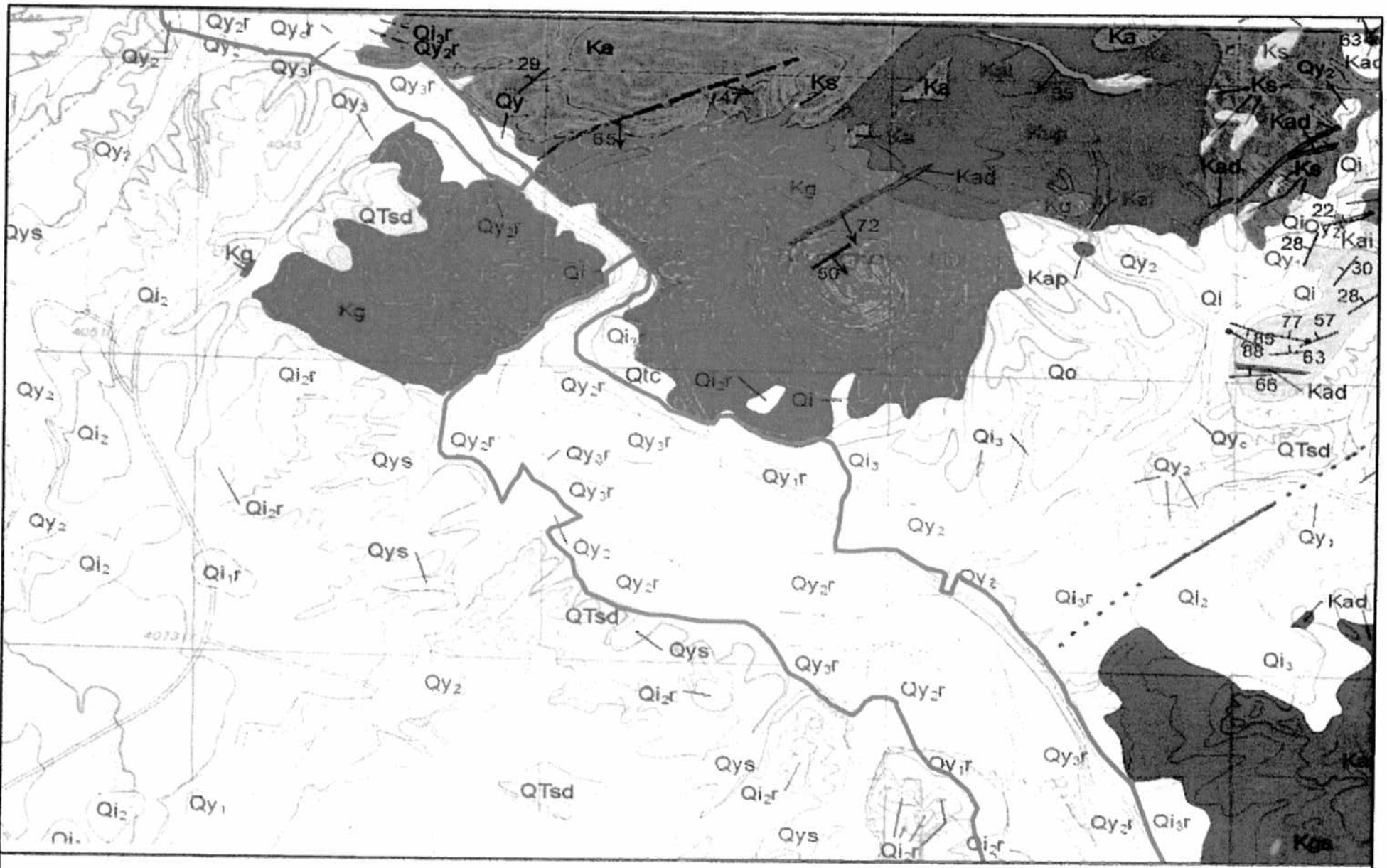


Figure D-4a
Application of ADWR Criteria to Address Tributary Holocene Alluvium Mapped Within the San Pedro River Floodplain

Subflow Zone Delineation Report for the San Pedro River Watershed

ATTACHMENT B





Floodplain Holocene Alluvium Boundary within Bedrock defined by ADWR, 2009
(portion of Lewis Springs quad)

STETSON ENGINEERS INC.

N

0 1,500 3,000 Feet

ATTACHMENT C

J:\jn2324\Attachment C.mxd N.Wasserman 12/16/2009