KEAR GROUNDWATER

TO: Bert Rapp, PE
Upper Ventura River Basin GSA Formation Committee

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DATE: March 17, 2016

SUBJECT: *Memorandum re: Basin Boundary Modification*
Upper Ventura River Basin (DWR Basin No. 4-3.01)

Kear Groundwater ("KG") provides this memorandum in support of the potential modification of the boundaries of the Upper Ventura River Basin (Bulletin 118 Basin No. 4-3.01) ("UVRB"). This effort is conducted at the request of the Upper Ventura River Basin Groundwater Sustainability Agency Formation Committee ("GSA-FC"), and follows on our research, discussions, and meetings with Department of Water Resources ("DWR") staff, meetings with the GSA-FC, and receipt of comments.

I. INTRODUCTION

This technical memorandum presents hydrogeologic information in support of a groundwater basin boundary modification request for the UVRB and follows the requirements outlined in regulations recently adopted by DWR ("Regulations").[1]

The alluvial groundwater basin, as delineated in Bulletin 118 (DWR, 2003), is based primarily on mapping at the 1:250,000 scale by Strand and Jennings (Strand and Jennings, 1969). The section of the Bulletin 118 describing the UVRB was last updated on February 27, 2004.

Recent mapping by the US Geological Survey ("USGS") and California Geological Survey (CGS), as well as local water well data, knowledge and experience, provides a more accurate representation of geologic, geomorphic, and hydrogeologic features critical to groundwater basin delineation. The proposed change is a refinement of the boundary in Bulletin 118 based on a better definition of bedrock/alluvial contacts, local faults, and depths of alluvium (Figures 1-9). Existing and potential stream gauging stations are also considered.

Work conducted by Tan and Jones (2006) suggests that the UVRB boundaries depicted in Bulletin 118 include many areas where alluvium is either absent or too thin to store groundwater and transmit it to wells at significant rates and via wells constructed to state standards. More recent mapping by the USGS (Minor et al., 2015) corroborates a redefining of UVRB boundaries

[1] See Cal. Code of Regulations, Title 23, Div. 2, Chp. 1.5.

to be more accurate with respect to their geomorphic features. Bedrock and alluvial contacts, local faults, locations of stream gauges and potential locations for stream gauging, as well as areas of known alluvial thicknesses and well extraction data, resulted in the drafting of the postulated basin boundaries.

Bulletin 118 defines a "groundwater basin" as an alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and a definable bottom. Rock or sediments with very low permeability or a geologic structure such as a fault act as lateral basin boundaries that significantly impede groundwater flow. Bottom boundaries would include rock or sediments of very low permeability if no aquifers occur below those sediments within the basin.

Bulletin 118 defines an "aquifer" as a body of rock or sediment that yields significant amounts of groundwater to wells or springs. In many instances, the word "significant" is replaced by "economic." Of course, either term is a matter of perspective, which has led to disagreement about the nature of an aquifer. As discussed herein, coarse-grained sediments such as sands and gravels deposited in alluvial or marine environments tend to function as the primary aquifers in California. These alluvial aquifers are the focus of Bulletin 118 and have been incorporated into our research to delineate the proposed boundaries of the UVRB.

Incorporating Bulletin 118's definitions of aquifer and groundwater basin in the proposed UVRB boundaries, we evaluate the local hydrogeology to include the areas of the UVRB that meet each of the following criteria:

- Mapped as Quaternary alluvial deposits (CGS, 2012)
- Correlative subsurface hydraulic lateral continuity with the main stem gravels of the Ventura River, meeting the definition of "groundwater basin" (DWR, 2003)
- Unseparated from the main stem of the Ventura River by significant groundwater and surface water divides, meeting the lateral boundary definition presented in Bulletin 118 (DWR, 2003)
- Adequately thick and perennially-saturated alluvium such that wells constructed therein yield significant amounts of groundwater to wells and therefore meet the DWR's definition of "Aquifer" (DWR, 2003)

II. DESCRIPTION OF PROPOSED BOUNDARY MODIFICATION (§ 344.6)

A. Overview of Request for Boundary Modification (§ 344.6(a))

As currently delineated in Bulletin 118, the UVRB is bounded on the south by the Lower Ventura River Sub-Basin (Bulletin 118 Basin No. 4-3.02), on the east by the Ojai Valley Basin (Bulletin 118 Basin No. 4-2), and elsewhere by impermeable rocks of the Santa Ynez Mountains. The current Bulletin 118 UVRB area covers 11.6 square miles. Much of this area incorporates bedrock outcrop and areas of thin, unsaturated alluvial terrace deposits that have little to no significant groundwater storage capacity as mapped by Minor (2015) and others. Bedrock characteristics that contribute to UVRB's hydrogeology include its acting as a secondary source to recharge by funneling inflow from its tributary areas (CSWRB, 1956) as well as groundwater flow from fractured and weathered bedrock from subcropped contact with alluvium (DBS&A, 2010).

Instead of 11.6 square miles, the proposed basin area would cover approximately 7.5 square miles. The proposed UVRB boundaries are based on hydrologic and geologic information as follows:

- Boundaries at three points of significant surface water entry and one point of exit from the UVRB:
  - Camino Cielo Bridge (potential surface water gaging point, inflow)
  - Coyote Creek (historic gaging station, inflow)
  - San Antonio Creek (historic gaging station, inflow)
  - Casitas Vista Bridge (historic gaging station, outflow)
- Boundaries along alluvial limits excluding thin terrace deposits where wells typically extract groundwater from bedrock formations or are de minimis quantity extractors (less than 2 acre-feet per year). In earlier mapping, many of these areas consist of contiguous alluvium at ground surface; recent mapping illustrates bedrock outcrops completely surrounding these terrace deposits (Minor, 2015). These areas generally include:
  - The Miramonte/Highlands/Oak View/Rancho La Vista areas between San Antonio Creek and the Ventura River gravels
  - Much of the western portion of the Rancho Matilija Area
- Boundaries coinciding with the Arroyo Parida-Santa Ana Fault which separates thin terrace alluvium to the south from the deeper alluvium in the Meiners Oaks' area
- An eastern boundary with the Ojai Valley Groundwater Basin along a bedrock high in the vicinity of the Ojai Country Club.

Figure 1 illustrates both the current UVRB Bulletin 118 boundaries and the proposed modifed boundaries.

1. Category of Proposed Boundary Modification (§344.6(a)(1))

A scientific boundary modification is proposed to better align both internal and external basin boundaries. The external boundary of the UVRB would be relocated based on hydrogeologic conditions. The shared boundary with the Ojai Valley Basin will be modified, technically creating an internal modification. The shared boundary with the Lower Ventura River Sub-basin remains unchanged.

2. Identification of All Affected Basins or Subbasins (§344.6(a)(2))

Both the Ojai Valley Basin and the Lower Ventura River Sub-Basin are considered affected basins within the meaning of the Regulations.

As shown in Figure 1, the common boundary between the UVRB and the Ojai Valley Basin would shift eastward under the proposal, such that a portion of the current Ojai Valley Basin would be transferred to the UVRB. Several authors have recognized the presence of the groundwater divide in the area of the proposed boundary (SGD, 1992; Turner, 1971) and recent water well data indicate the presence of a bedrock high in this area as well. A surface water divide also coincides here, as well as a narrowing of bedrock outcropping south and north of the proposed new boundary between the Ojai Valley Basin and the UVRB. The Ojai Basin Groundwater Management Agency, listed as the Groundwater Sustainability Agency ("GSA") for the Ojai Valley Basin, supports this modification of the common boundary (letter of support to be provided).

On the south side, the boundary between the UVRB and the Lower Ventura River Sub-Basin would remain unchanged. (See Figure 1.)

3. Additional Information (§ 344.6(c))

This modification strives to exclude areas that do not store significant quantities of alluvial groundwater or yield significant quantities of alluvial groundwater to wells. Many of these areas currently included in the basin are terrace deposits which tend to be relatively thin and isolated in highland areas of the currently-delineated UVRB. These areas are generally east and west of the main river channel outside of the Meiners' Oaks area. Water accumulating at the base of the terrace deposits (disconnected from the main stem of the UVRB) would either percolate into bedrock or flow to the low points of the terrace-bedrock contact outcrop, and flow out as springs and surface flow before recharging the UVRB or surface water system. Based on the definition of aquifer and groundwater basin and the criteria presented above, these terrace deposit areas should not be included in the UVRB.

By excluding these extraneous areas, the quantification of groundwater in storage will tend to better reflect the amount stored in the UVRB and available to groundwater production wells. Figure 9 identifies production wells by purveyor agency as well as private wells in the UVRB area (only the proposed boundary is included for simplicity). This more accurate delineation and accounting will lead to improved UVRB management and groundwater sustainability.

III. GENERAL INFORMATION (§ 344.10)

A. Description of Lateral Basin Boundaries and Definable Bottom (§ 344.10(a))

The proposed modified UVRB is bounded along all sides by outcropped and sub-cropped alluvial contacts with bedrock, except for the fault boundary along the Arroyo Parida-Santa Ana Fault between Meiners Oaks and Rancho La Vista. Because the tributary streams enter the UVRB where groundwater transitions from flowing in a known and defined channel to groundwater percolating within the basin, areas of surface water inflow at Camino Cielo, Coyote Creek, and San Antonio Creek comprise the other (non-contact, non-fault) proposed boundaries. The modification request would not affect URVB's downstream boundary with the Lower Ventura River Sub-Basin (surface water outflow). In general hydrogeologic terms, the proposed lateral UVRB boundary is the extent of the contiguous area overlying the principal aquifer, excluding the non-contiguous terrace deposits. Similar to the current basin delineation, the proposed bottom of the basin consists of the contact between the permeable sediments and the underlying bedrock, which defines the contiguous base of the principal aquifer within the lateral basin boundary. Figures 4-8 depict a cross-sectional conceptual geologic schematic of the proposed modification to UVRB including the basin's basal contacts.

As proposed to be modified, the basin boundary effectively encloses an area at ground surface beneath which the gravels of the Ventura River and the alluvium of the Meiners Oaks area are present in appreciable thicknesses to yield groundwater to wells. As modified, within this boundary is a contiguous groundwater reservoir capable of storing significant amounts of groundwater and supplying water to wells.

The proposed basin area would exclude Quaternary terrace deposits that are thin, underlain directly by shallow bedrock, and/or lack a direct subsurface hydraulic connection to the UVRB.

B. Graphical Map of Lateral Basin Boundaries (§ 344.10(b))

Figure 2 presents a graphical map of the proposed UVRB basin boundaries, along with affected public water systems within the boundaries. Included as recognized affected agencies are those with jurisdictional boundaries that overly part or all of the existing or proposed UVRB, or those which may be included as cooperative in basin or watershed management with the UVRB GSA This includes purveyors who have a wholesale water connection to Casitas Municipal Water District. Agencies and public water systems affected by the existing delineation and proposed basin boundary modification are listed below:

<u>Affected Agencies</u>

- Casitas Municipal Water District
- City of San Buenaventura
- City of Ojai
- Ojai Water Conservation District
- Ojai Basin Groundwater Management Agency
- County of Ventura
- Meiners' Oaks Water District
- Ventura River Water District

<u>Affected Water Systems</u>

- Casitas Municipal Water District
- North Fork Springs Mutual Water Company
- Ventura Water (City of San Buenaventura)
- Old Creek Road Mutual Water Company
- Rancho Del Cielo Mutual Water Company
- Tres Condados Girl Scout Council
- Meiners' Oaks Water District
- Ventura River Water District
- Casitas Mutual Water Company
- Golden State Mutual Water Company

- Krotona Institute of Theosophy
- Ojala Mutual Water Company
- Rancho Matilija Mutual Water Company
- Sheriff's Honor Farm
- Del Vasco Mutual Water Company
- Tico Mutual Water Company
- Villanova Road Water Well Association

IV. HYDROGEOLOGIC CONCEPTUAL MODEL (§ 344.12(a))

A conceptual model is a compilation and interpretation of available information on the physical system being modeled. For a groundwater basin, it includes a characterization of basin structure, boundary conditions, aquifer geometry, physical parameters, and components of inflow and outflow. The following descriptions summarize the conceptual model components of the UVRB.

A. Principal Aquifers (§ 344.12(a)(1))

One principal aquifer is currently recognized in the Upper Ventura River Valley Subbasin comprised of the alluvium within the lateral UVRB boundaries. The aquifer's hydraulic properties are relatively uniform, with two main units of older alluvial deposits and younger, active river channel deposits. The active channel deposits tend to be of a higher hydraulic conductivity than the older alluvium, but are thinner and less laterally extensive. Unconfined conditions predominate in this aquifer.

B. Lateral Boundaries (§ 344.12(a)(2))

A detailed description of UVRB's proposed boundary at both the sub-surface and ground surface is presented below and depicted in Figure 3. Cross-sections describing delineation of the proposed UVRB boundary are included in Figures 4-8.

1. Segment 1: Camino Cielo Bridge

Camino Cielo Bridge is a three-channeled concrete structure that allows flow to enter the area overlying the UVRB near the confluence of Matilija Creek and North Fork near the community of Ojala. Upstream from this point, flow is perennial and is typically over shallow alluvium or bedrock outcroppings. Downstream from the Camino Cielo Bridge, the flow percolates into the UVRB over this (typically) losing reach of the Ventura River. Inflow and losses of surface water to groundwater can best be measured using UVRB's uppermost point (Figures 3 and 4, Photograph 1).

Photograph 1: Camino Cielo Bridge at inflow point to the UVRB
(Photo by J. Kear, 15 February 2016)

2. Segment 2: Bedrock – Alluvium Contact Along Cozy Dell and McDonald Creek

Along the northeast portion of the UVRB, more accurate mapping of the contact between Quaternary alluvium and the underlying Sespe formation is provided by recent fieldwork and subsurface data. Owing to the steep structural geologic orientations of units associated with the Matilija Overturn, the underlying contact between alluvium and bedrock can be very steep and deep portions of the UVRB can be relatively proximal to the surface exposure of this contact (Figures 3 and 8).

3. Segment 3: Buried Bedrock Ridge Along UVRB's Boundary With Ojai Valley Basin

Several investigators (CSWRB, 1956; Turner, 1971; SGD, 1991) have noted buried bedrock high, a groundwater divide, and a surface water divide at UVRB's proposed boundary with the Ojai Valley Basin. East of the divides, surface and groundwater flow east towards Ojai and its pumping wells or natural discharge points. West of the divides, the prevailing surface and subsurface flows are to the west and southwest toward the UVRB (Figures 3 and 5).

4. Segment 4: Bedrock Outcrop Near Ojai Valley Inn

An isolated bedrock outcropping and associated onlapped alluvium mark this segment of the proposed boundary (Figures 1, 3).

5. Segment 5: Fault Along Krotona Hill

Several investigators (Dibblee, 1987, and Minor, 2015) have mapped an unnamed fault in this area. The surface outcropping comprises the basin boundary at this location. Based on well log data presented in our cross-sections, this feature becomes more predominant to the west. We propose to call the structure "Krotona Hill Fault" owing to its hydrogeologic significance, separating the two deeper portions of the UVRB (Figures 3, 5, 6, and 8).

6. Segment 6: Older Alluvium Contact and Uplift

Uplifted, and possibly faulted, older alluvium of fine-grained nature and more complete cementation than the younger alluvium to the northwest comprises this segment of the proposed basin boundary (Figure 3).

7. Segment 7: Arroyo Parida-Santa Ana Fault

One of the most significant structural features of the UVRB — the Arroyo Parida-Santa Ana Fault — expresses local tectonic strain via a south-side up displacement of 200 feet locally and is a known barrier to groundwater flow (Rockwell, 1984). South of the fault a very thin veneer of alluvial terraces are present, making the fault a clear location of a basin boundary where it is not dissected by the modern Ventura River Channel (Figures 3, 4, and 8).

8. Segment 8: Bedrock – Alluvium Contact Through Oak View

Along the east side of the modern trace of the Ventura River gravels an onlapping contact between alluvium to the west and bedrock, chiefly marine shale formations, can be observed. Recent mapping indicates several outcroppings previously considered to be continuous alluvium across this boundary, but the detailed mapping of uplifted river terraces through this segment indicate the isolation of the highlands area and discontinuous hydrogeologic conditions. Terrace deposits, even where potentially thick, exhibit no physical feature holding the water therein. Given their elevation and steep (down to the west) basal slope, water would not tend to pool or be stored for a very long time such that significant quantities of water could be extracted via wells. Water would pass through to the main stem as if the terrace deposits were in ex-basin stream channels, acting as an ephemeral saturated zone at best (Figures 3 and 6).

Photograph 2: Unsaturated alluvial terrace deposits overlie tilted Monterey Shale (bedrock) in the Oak View area. (Photo by J. Kear, 22 February 2016)

9. Segment 9: San Antonio Creek gage/Highway 33 Bridge

A historic stream gauge and the proximity of the confluence, where the "known and defined channel" of San Antonio Creek meets the Ventura River, comprise this boundary. Surface and subsurface inflow to the UVRB can be monitored and measured at this location. The DWR has excluded the San Antonio Creek from the UVRB in several publications, including Bulletin 118, owing to thin to non-existent alluvium and its recognition as a surface water feature (Figure 3).

10. Segment 10: Bedrock – Alluvium Contact Through/East of Casitas Springs

Along the east side of the modern trace of the Ventura River gravels an onlapping contact between alluvium to the west and bedrock, chiefly marine shale formations, can be observed east of Casitas Springs. This proposed boundary is quite similar to Bulletin 118's current delineation. (Figure 3).

11. Segment 11: Casitas Vista River Gage/Lower Ventura River Sub-Basin Boundary

The proposed boundary between the UVRB and the Lower Ventura River Sub-Basin is effectively the same as the existing boundary. A surface water gage and the capacity to estimate groundwater flow suggest that this boundary remain unchanged (Figure 3, 7).

12. Segment 12: Bedrock – Alluvium contact South of Coyote Creek

Along the west side of the modern trace of the Ventura River gravels an onlapping contact between alluvium to the west and bedrock, chiefly marine shale formations, can be observed near Foster Park. This proposed boundary is very similar to the current Bulletin 118 delineation. (Figures 3 and 7).

13. Segment 13: Coyote Creek Gaging Station

A historic stream gauge and the proximity of the confluence, where the "known and defined channel" of Coyote Creek meets the Ventura River, comprise this boundary. Surface and subsurface inflow to the UVRB can be monitored and measured here. The DWR has excluded Coyote Creek from the UVRB in several publications, including Bulletin 118, owing to thin to non-existent alluvium and its recognition as a surface water feature (Figure 3).

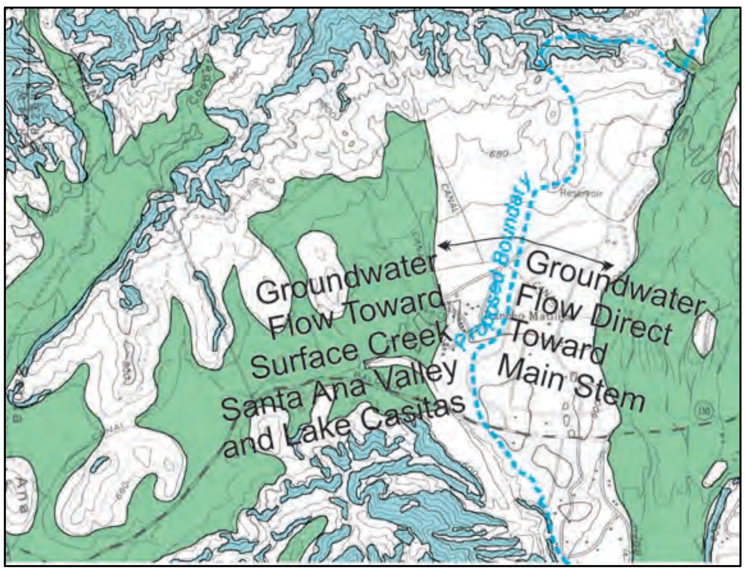
14. Segment 14: Bedrock – Alluvium Contact between Lake Casitas and Ventura River

Along the west side of the modern trace of the Ventura River gravels an onlapping contact between alluvium to the west and bedrock, chiefly marine shale formations, can be observed along Casitas Vista road east of Lake Casitas. This proposed boundary is very similar to the current Bulletin 118 delineation. (Figures 3, 6).

15. Segment 15: Buried Bedrock high and surface water divide through Rancho Matilija

A thin veneer of alluvium blankets much of Rancho Matilija west of the modern channel of the Ventura River. Minor (2015) has mapped an outcropping of bedrock between the river channel and the terrace immediately to the west. Owing to the continuity near the Highway 150 bridge and the Arroyo Parida Fault, the thickest portion of the (eastern) terrace deposits are included in the proposed modification, east of a shallowing of the bedrock and an area where surface water drains over a bedrock canyon (Figures 3, 5).

Based on available well logs, and as shown on Figure 5, alluvium in this area has an average thickness of 10 to 15 feet. Importantly, the State's seismic hazard zone mapping program (CGS, 2003) indicates a distinct geologic, geomorphic, and hydrogeologic separation between Rancho Matilija and the thicker alluvium to the east. The proposed boundary along the west side of the UVRB follows this well-established separation, as mapped in the above-cited studies.



Shown above is a portion of the Seismic Hazard Zone Official Map, Matilija Quadrangle (CGS, 2003). Areas in green are where groundwater conditions are consistent and shallow and indicate the potential for liquefaction. The distinct separation of green zones east and west of the white area through Rancho Matilija indicates groundwater prone to flow east (toward the Ventura River main stem) and west (toward Santa Ana Valley and Lake Casitas) in this area.

16. Segment 16: Bedrock – Alluvium Contact along west side of river channel between Ranch Matilija and Camino Cielo

Along the west side of the modern trace of the Ventura River gravels an onlapping contact between alluvium to the west and bedrock, chiefly Sespe formation, can be observed between Rancho Matilija and Camino Cielo, near the Robles Diversion and a canal leading to Lake Casitas. This proposed boundary closely mimics the current Bulletin 118 delineation. (Figure 3).

C. Geologic Features Impacting Groundwater Flow (§ 344.12(a)(2)(A,B,C))

In addition to the discussion and presentations provided herein, the descriptions of Turner (1971) and DBS&A (2010) are incorporated by reference. Detailed mapping by Minor (2015), incorporated herein by reference, provides the most accurate and detailed descriptions UVRB's geologic features. Most of the faults mapped in the Ventura River Watershed area are understood to cut bedrock only, but the "Active Faults" shown on the Alquist-Priolo map of the Matilija Quadrangle which traverse the Ventura River include the Arroyo Parida-Santa Ana Fault, the Villanova Fault, and the "Krotona Hill Fault" (CGS, 1986). Of these, the Krotona Hill Fault exhibits north-side-up displacement and the Arroyo Parida-Santa Ana Fault exhibits south-side-up displacement, effectively creating a downdropped block or "graben" where groundwater flow slows and is stored under a historically-consistently losing reach of the Ventura River (Figure 4).

D. Key Surface Water Bodies and Significant Recharge Sources (§ 344.12(2)(D))

UVRB's key surface water features are the Ventura River, which exhibits balanced, losing, detached, absent (ephemeral) and gaining features over the UVRB, and Lake Casitas, an off-stream storage reservoir that receives flow from the Ventura River via the Robles Diversion and canal system. Although some recharge occurs as water lost to groundwater from Lake Casitas, the primary recharge source is native flow in the Ventura River, entering the UVRB at the Camino Cielo Bridge. Compared to the Camino Cielo Bridge inflow point, other tributaries contribute a less consistent and smaller amount of recharge to the UVRB.

E. Recharge and Discharge Areas (§ 344.12(a)(3))

Recharge originates as precipitation within the watershed and primarily occurs along the main stem river channel over the losing reach of the UVRB between Camino Cielo Bridge and the Arroyo Parida Fault. Discharge under natural conditions occurs via phreatophytic evapotranspiration, discharge to surface water over the gaining portion of the Ventura River (typically over two miles south of the Arroyo Parida Fault, about 1/2 mile south of Santa Ana Boulevard), and outflow to the Lower Ventura River Sub-Basin. A detailed groundwater balance budget was presented by DBS&A (2010).

F. Definable Bottom of Basin (§ 344.12(a)(4))

The definable bottom of the UVRB is the contact between alluvium and bedrock within the delineated basin boundary areas. Cross-sections A-A', B-B', C-C', D-D', and E-E', as shown on Figures 4 through 8, provide a graphical depiction of the bottom of the UVRB based on well data and geologic mapping.

V. TECHNICAL INFORMATION FOR SCIENTIFIC MODIFICATION (§ 344.14)

G. Qualified Map (§ 344.14(a)(1))

The proposed "Qualified Map" is as published by the California Geological Survey, within Special Report 217 (Revised). Plate 9 of SR217 includes the UVRB area. Within the Matilija Quadrangle, which comprises the UVRB, SR217 includes the work conducted by Tan and Jones

(2006). These publications suggest that the boundaries depicted in Bulletin 118 include many areas where alluvium is either absent or too thin to store groundwater and transmit it to wells at significant rates and via wells constructed to state and county standards. Based on the DWR definitions of "groundwater basin" and "alluvial aquifer," as well as the correlative definition-based criteria presented above, these areas with thin alluvium are therefore excluded from the proposed alluvial UVRB. The qualified map has been incorporated into Figures 1 and 3.

More recent mapping by the USGS (Minor, S.A., and Brandt, T.R., 2015) corroborates and supports the proposed changes in UVRB's boundaries to be more accurate with respect to geomorphic features.

H. Technical Study (§ 344.14(a)(2))

Several technical studies of the UVRB have been conducted and are discussed herein by reference. Future exploration and resource development, including ongoing monitoring, will continue to contribute to the technical understanding of the UVRB. Figures 4 through 8 present an updated cross-sectional understanding of basin morphology. Many of these studies and referenced papers are available in the "Documents Library" as presented on the Ventura River Watershed Council website (see www.venturawatershed.org and specifically https://drive.google.com/folderview?id=0B1dEIkrhx2ScWnZHQldhV3JoMFk&usp=sharing).

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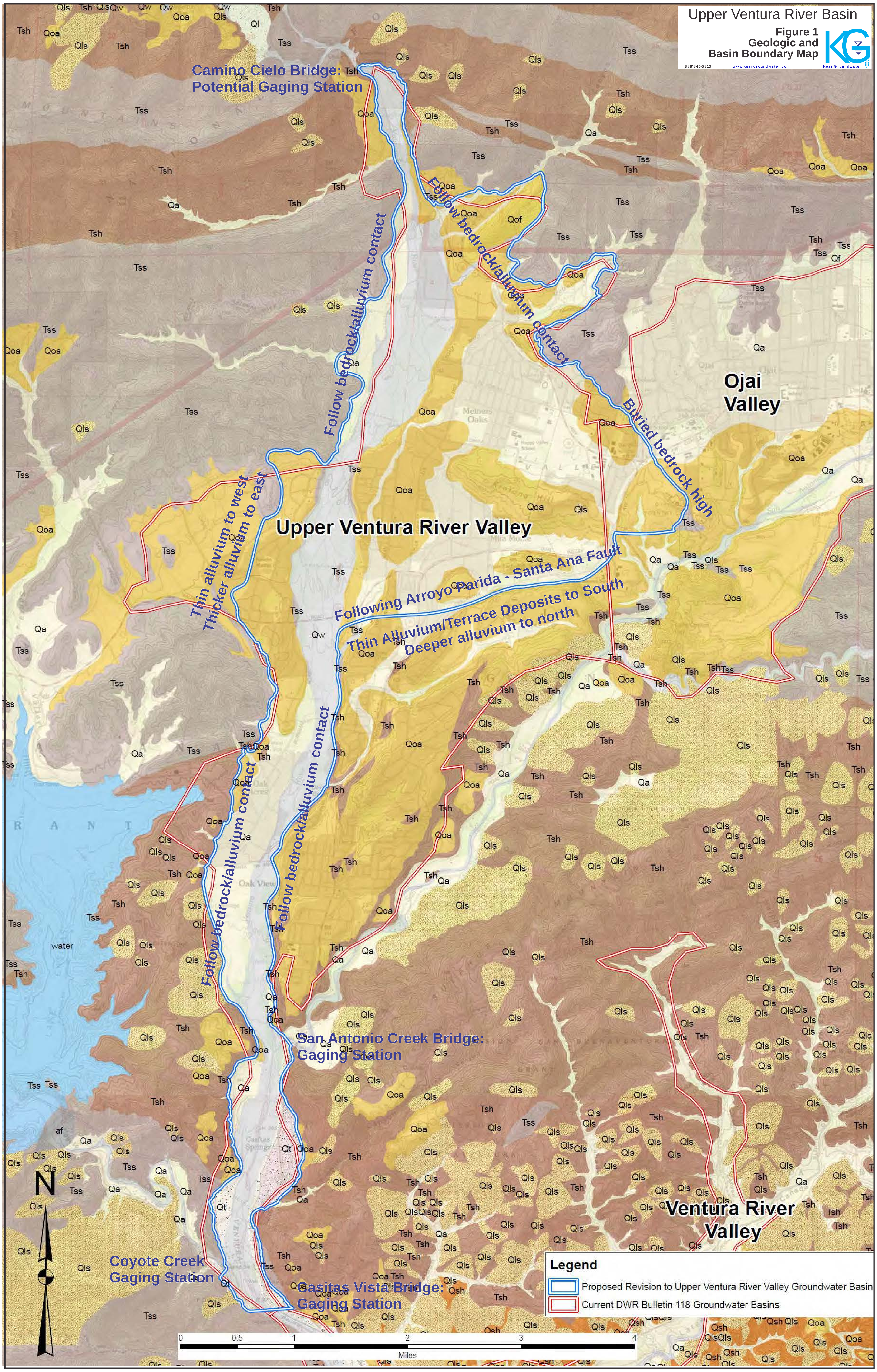
Upper Ventura River Basin
Figure 1
Geologic and
Basin Boundary Map
Camino Cielo Bridge:
Potential Gaging Station
Follow bedrock/alluvium contact
Follow bedrock/alluvium contact
Ojai
Valley
Buried bedrock high
Upper Ventura River Valley
Thin alluvium to west
Thicker alluvium to east
Following Arroyo Parida - Santa Ana Fault
Thin Alluvium/Terrace Deposits to South
Deeper alluvium to north
Follow bedrock/alluvium contact
Follow bedrock/alluvium contact
San Antonio Creek Bridge:
Gaging Station
Coyote Creek
Gaging Station
Casitas Vista Bridge:
Gaging Station
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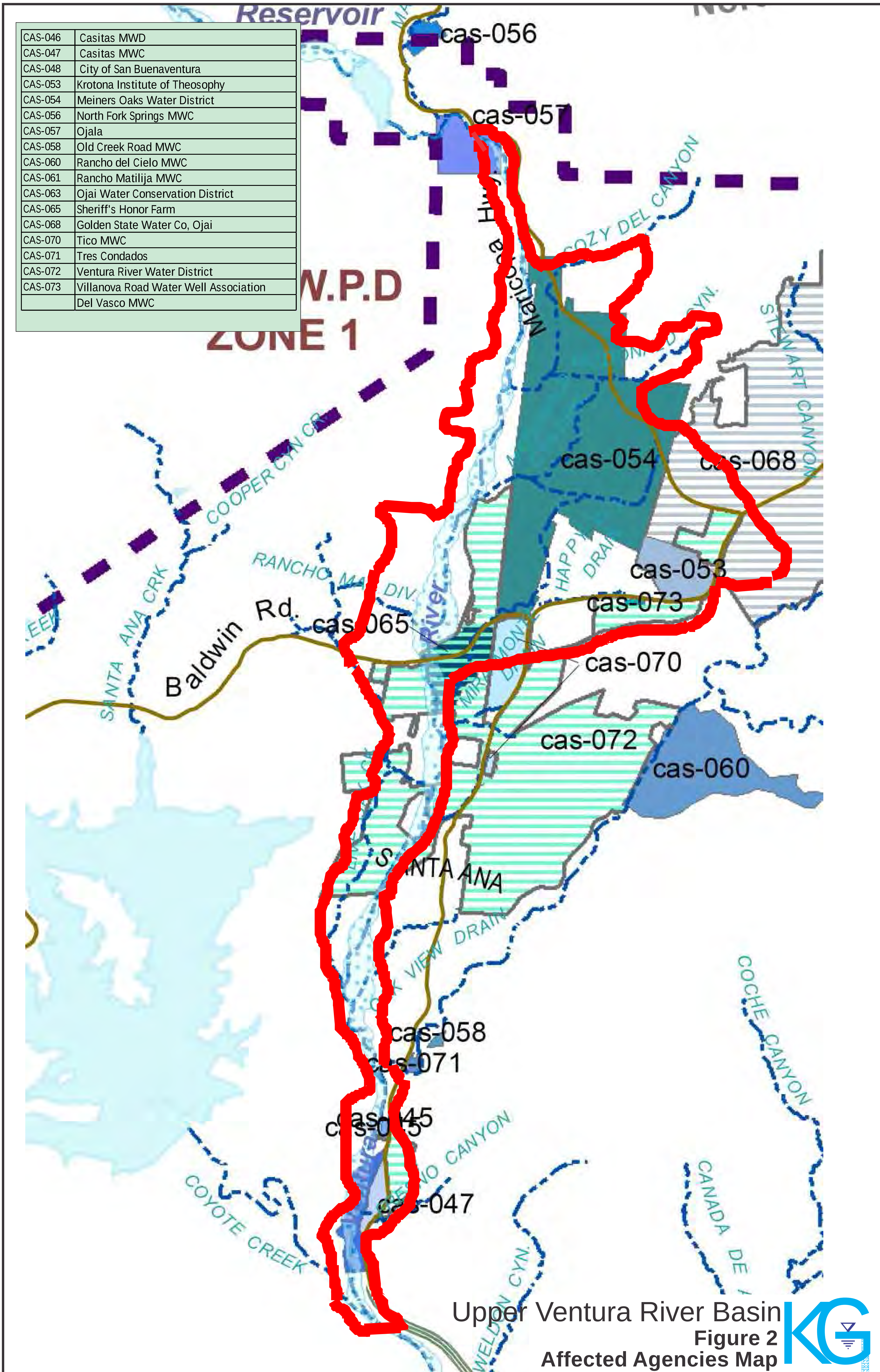
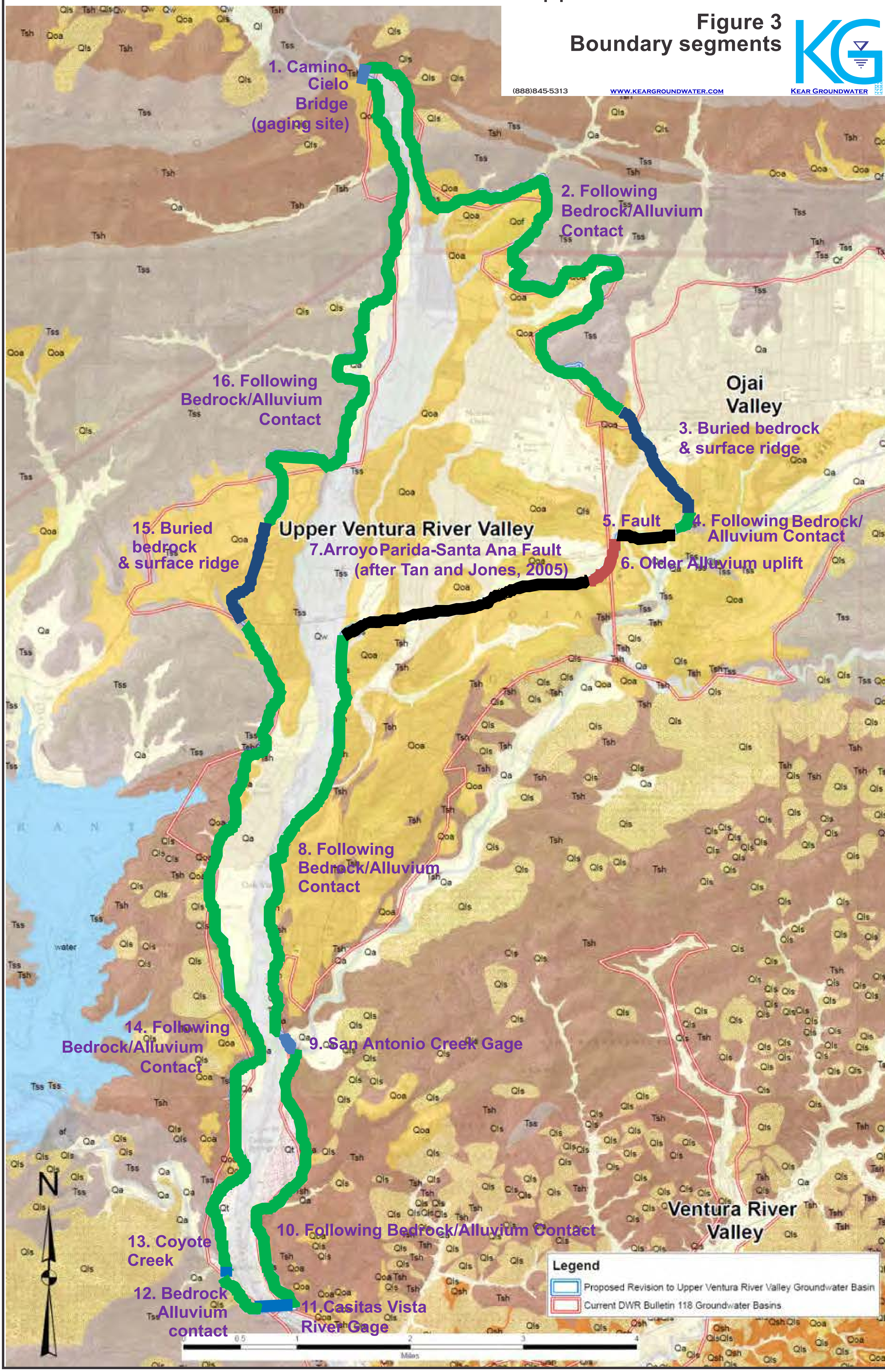
Proposed Revision to Upper Ventura River Valley Groundwater Basin
Current DWR Bulletin 118 Groundwater Basins

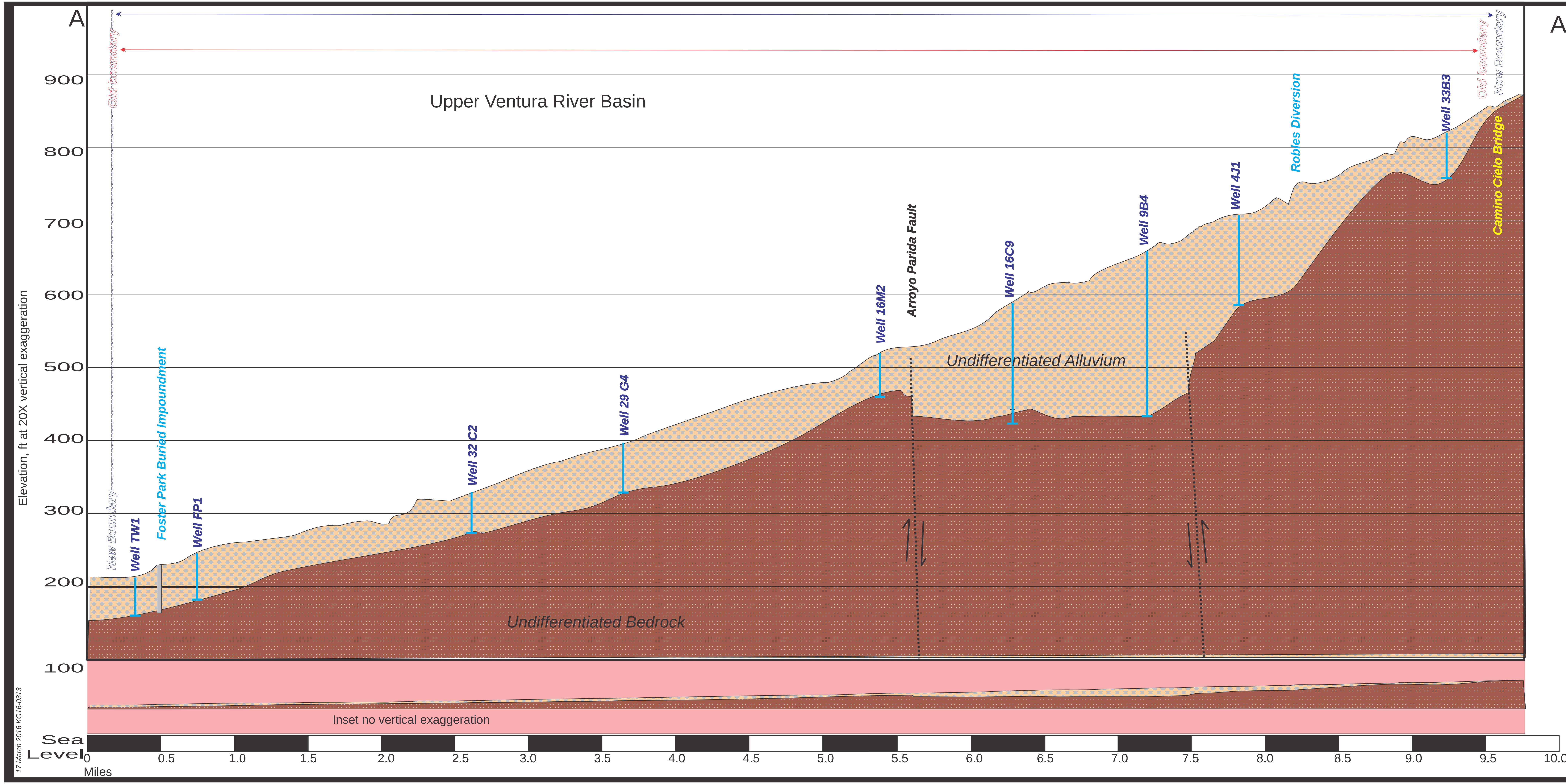


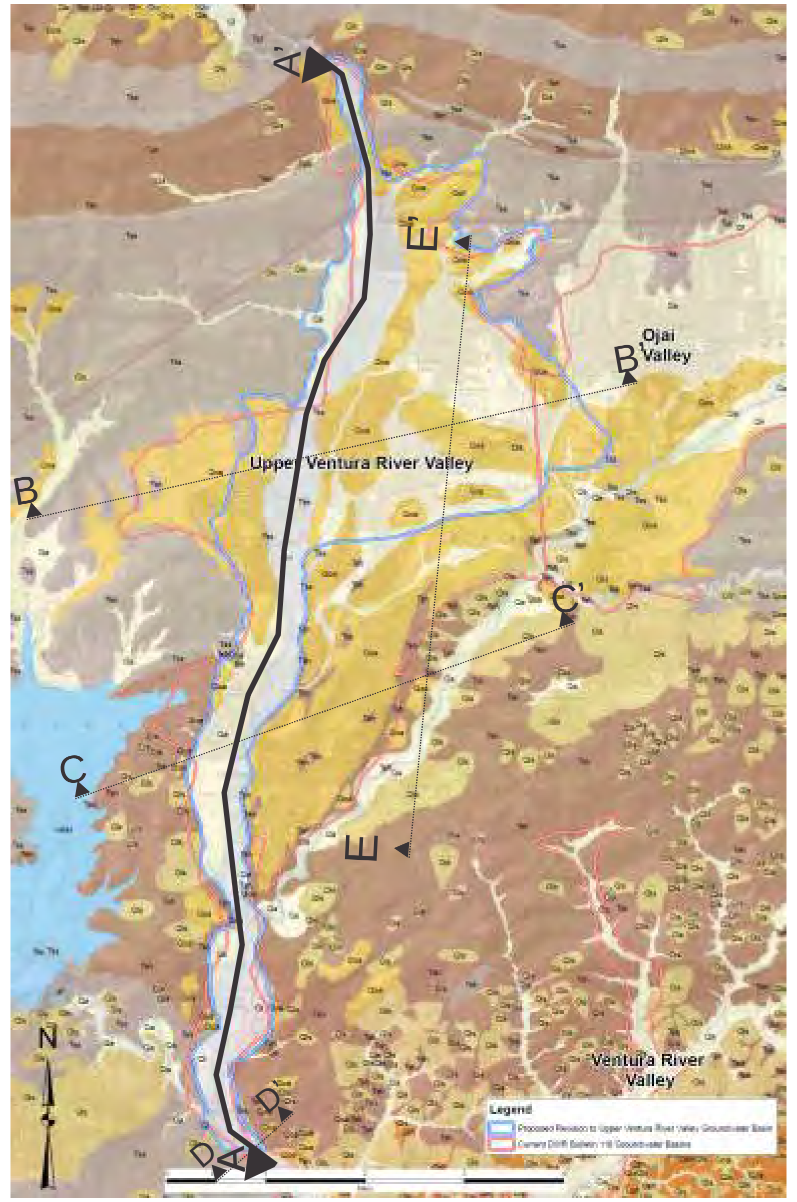
CAS-046	Casitas MWD
CAS-047	Casitas MWC
CAS-048	City of San Buenaventura
CAS-053	Krotona Institute of Theosophy
CAS-054	Meiners Oaks Water District
CAS-056	North Fork Springs MWC
CAS-057	Ojala
CAS-058	Old Creek Road MWC
CAS-060	Rancho del Cielo MWC
CAS-061	Rancho Matilija MWC
CAS-063	Ojai Water Conservation District
CAS-065	Sheriff's Honor Farm
CAS-068	Golden State Water Co, Ojai
CAS-070	Tico MWC
CAS-071	Tres Condados
CAS-072	Ventura River Water District
CAS-073	Villanova Road Water Well Association
	Del Vasco MWC

Upper Ventura River Basin
Figure 2
Affected Agencies Map

Upper Ventura River Basin







Upper Ventura River Basin

Figure 4
Central Cross Section
Ventura River Profile
View looking west

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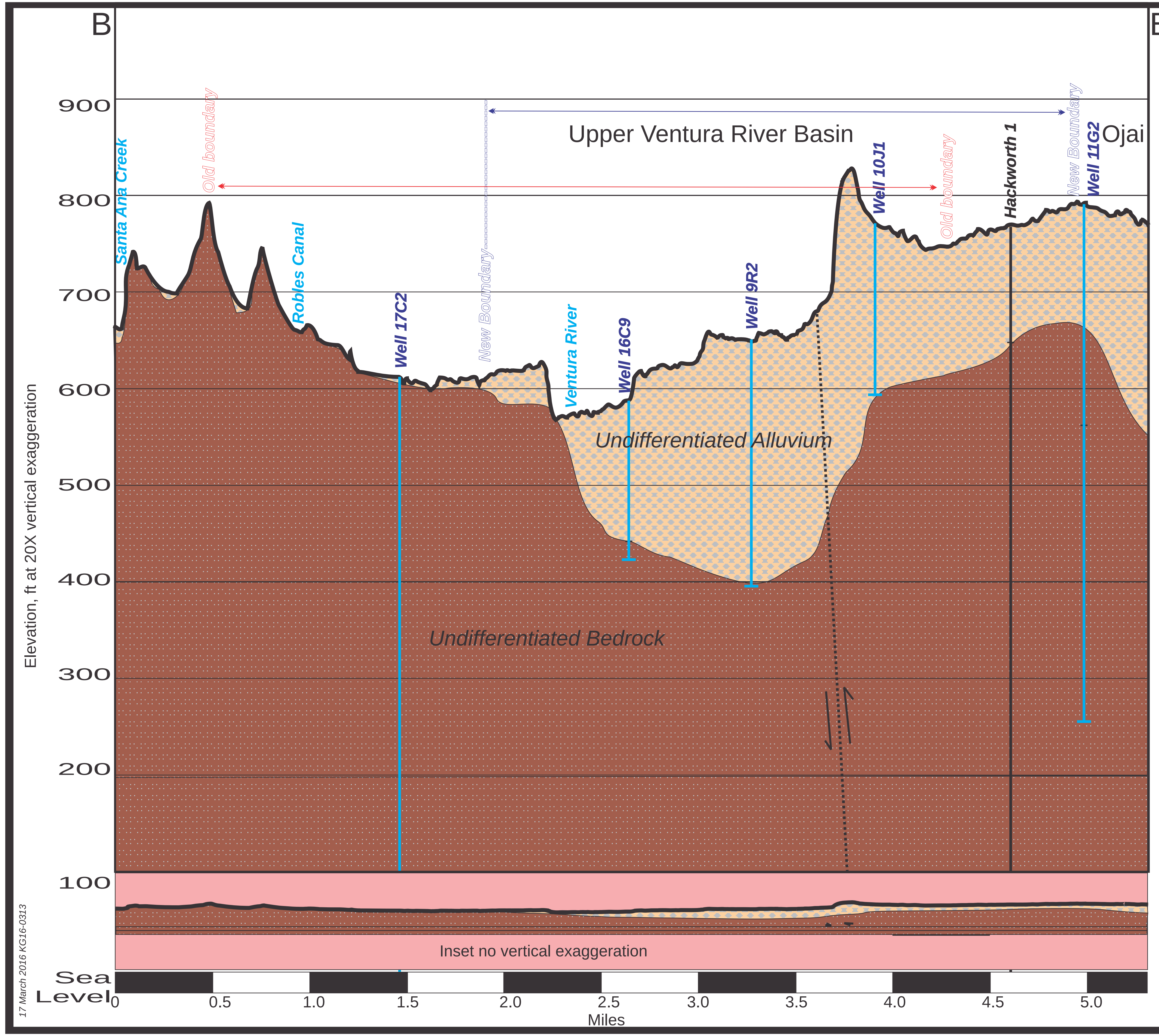

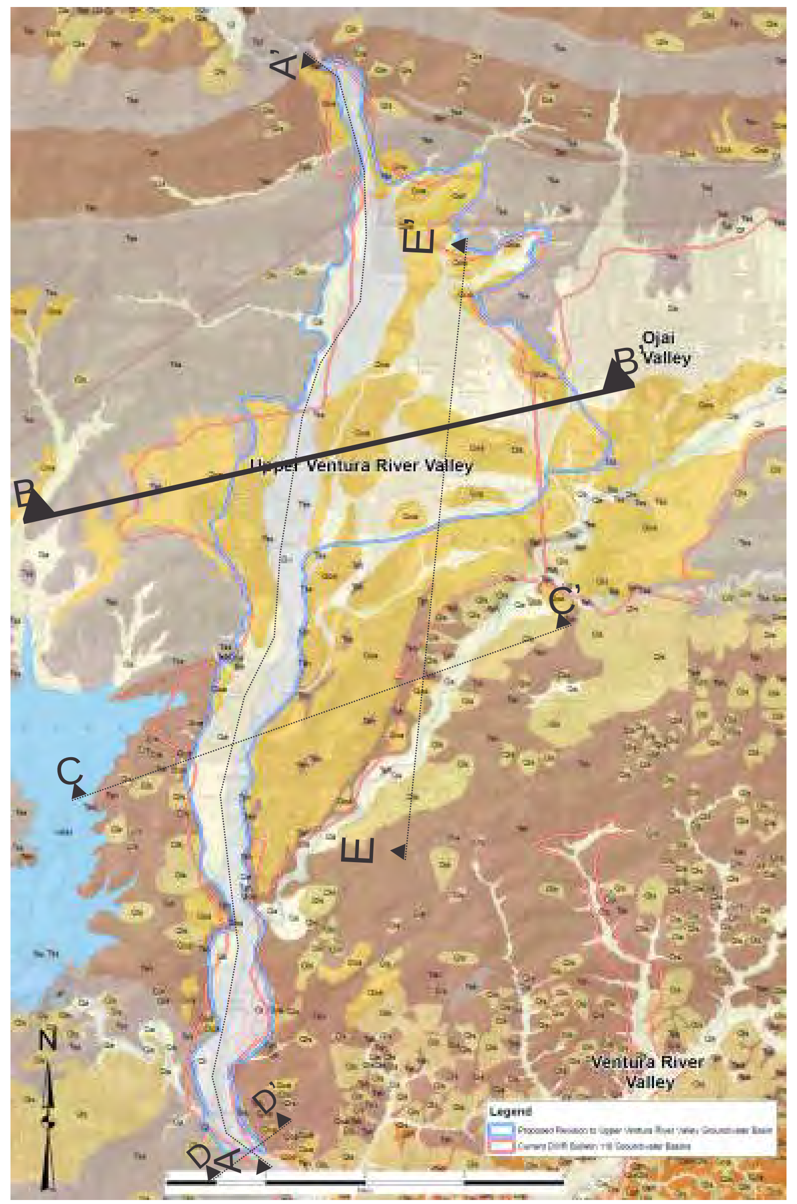

Upper Ventura River Basin

Figure 5

Central Cross Section

Santa Ana Creek to Ojai
View looking north

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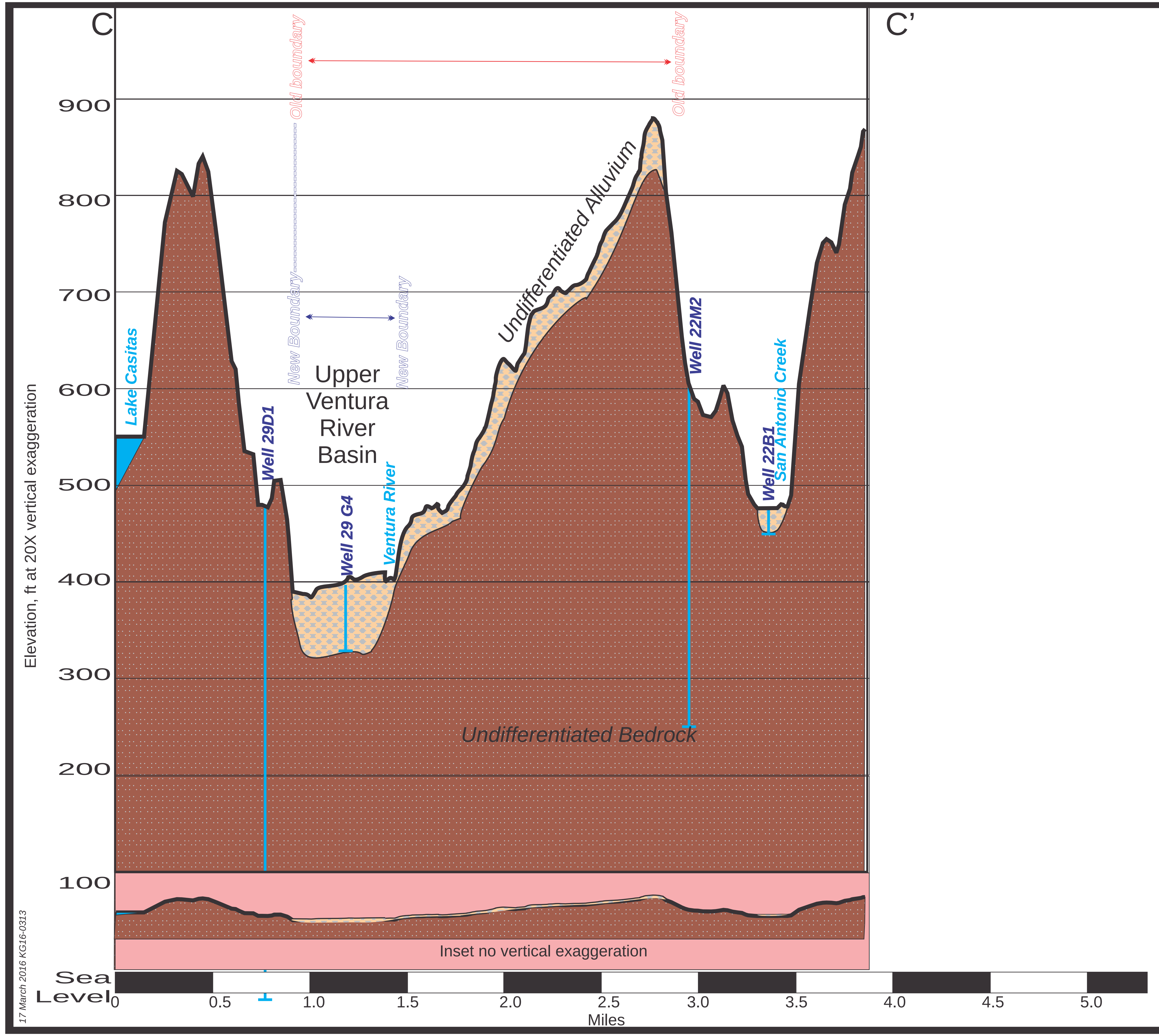

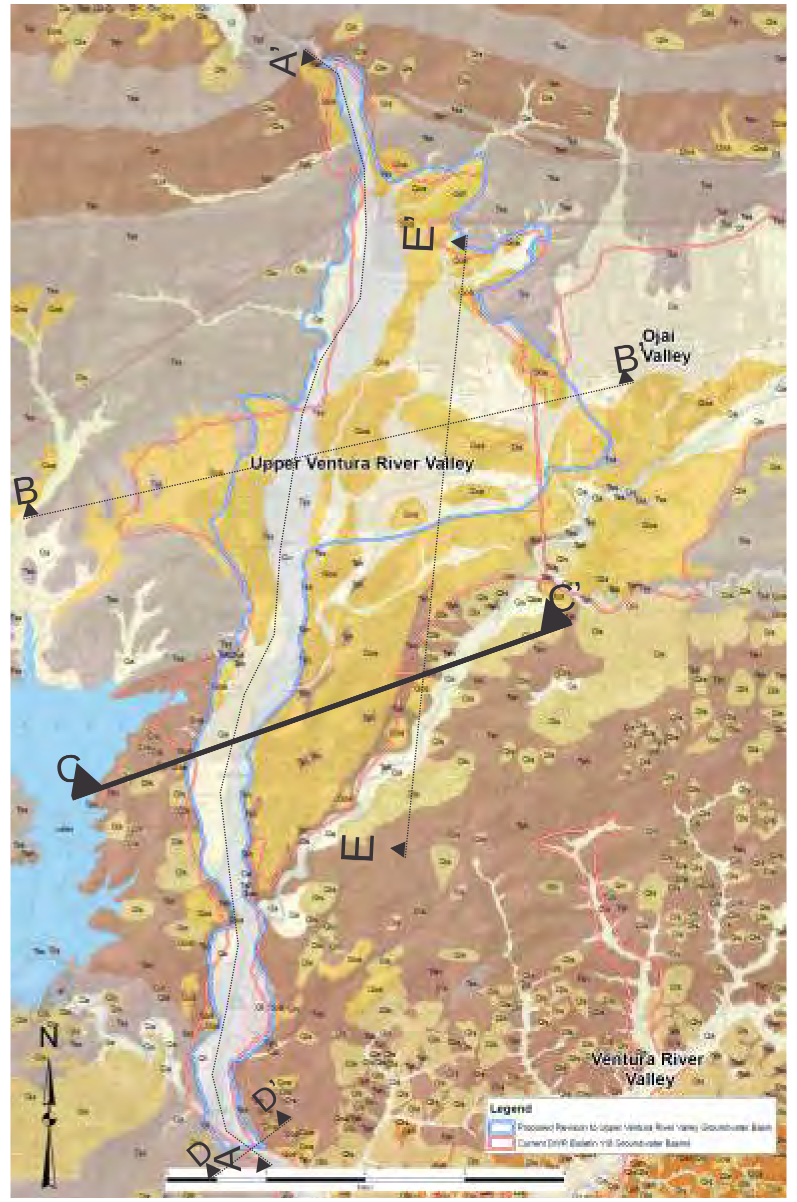

Upper Ventura River Basin

Figure 6
South Cross Section

Along Southern Central transect View looking north

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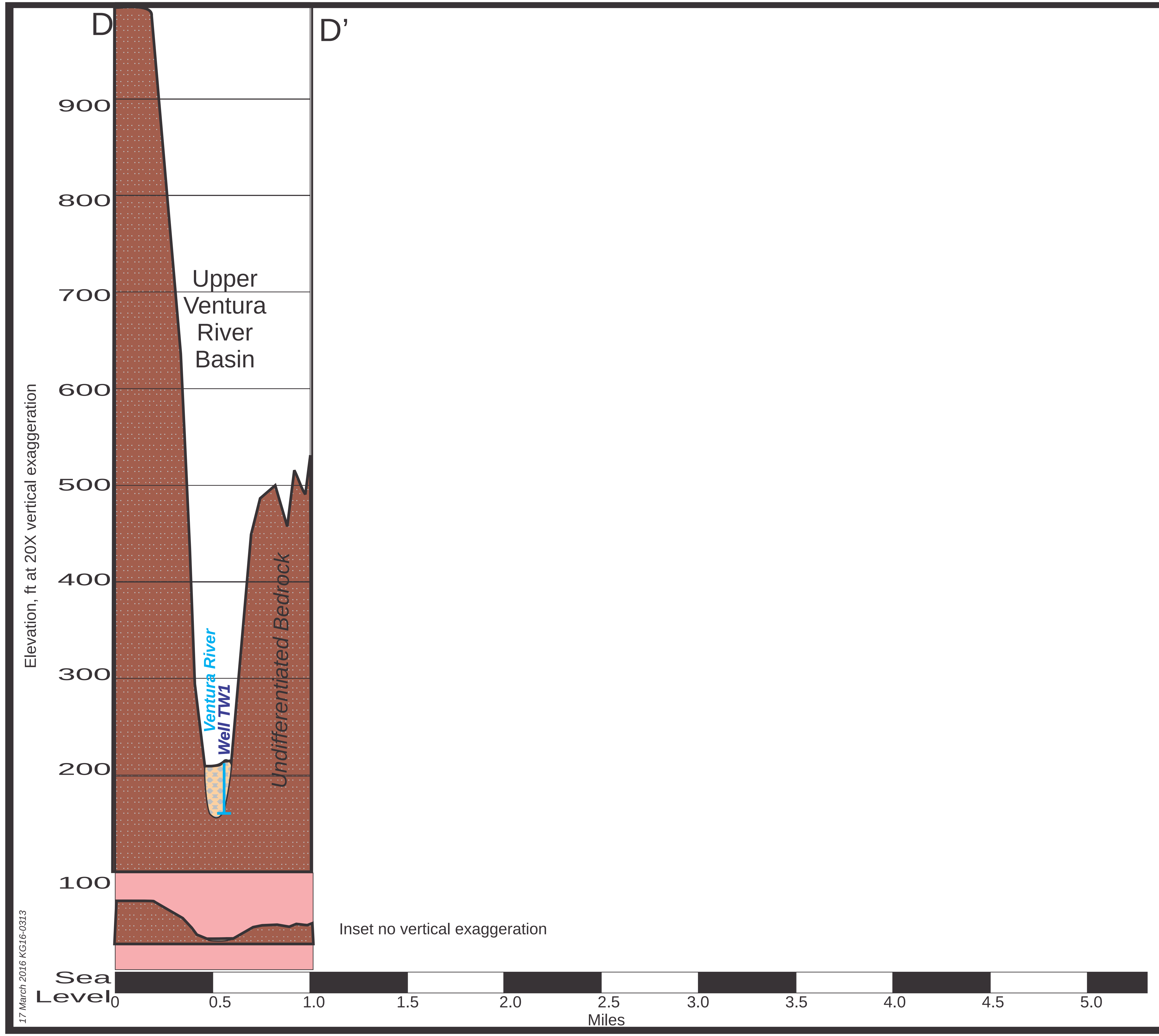

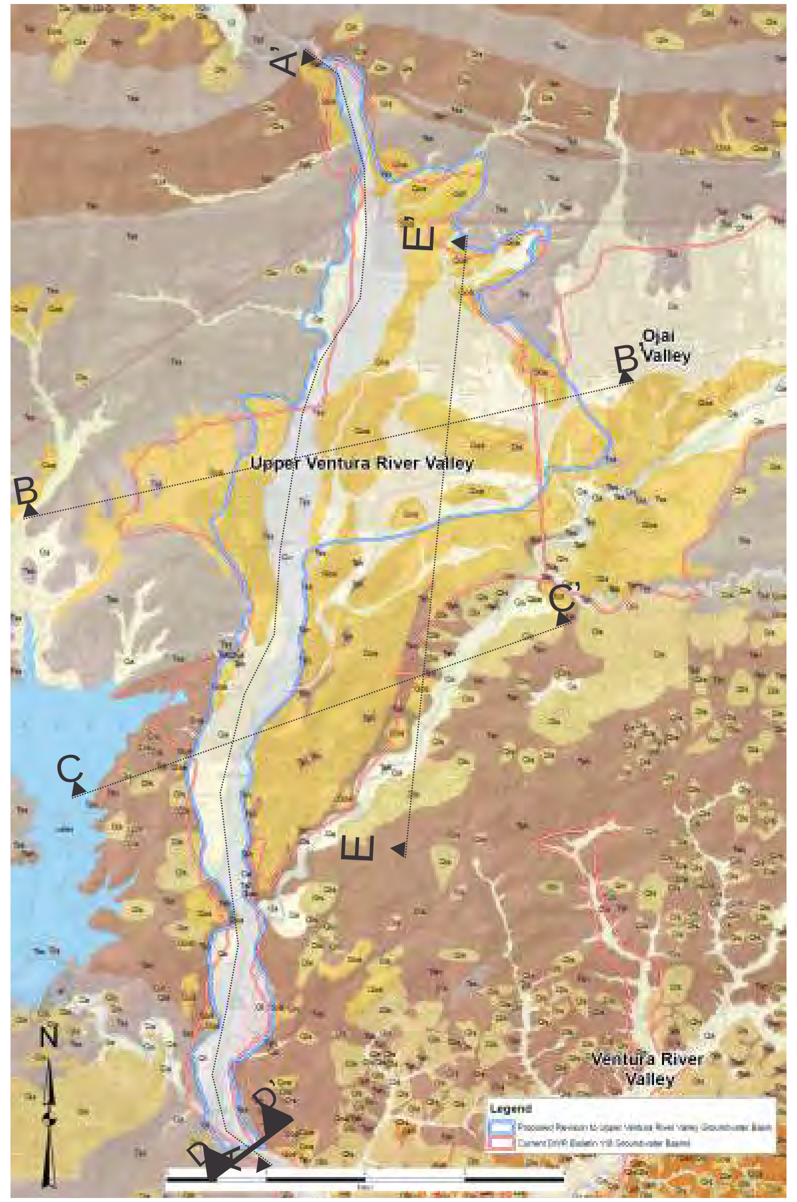

Upper Ventura River Basin

Figure 7
South Cross Section

Along Southern Sub-Basin Boundary
View looking north

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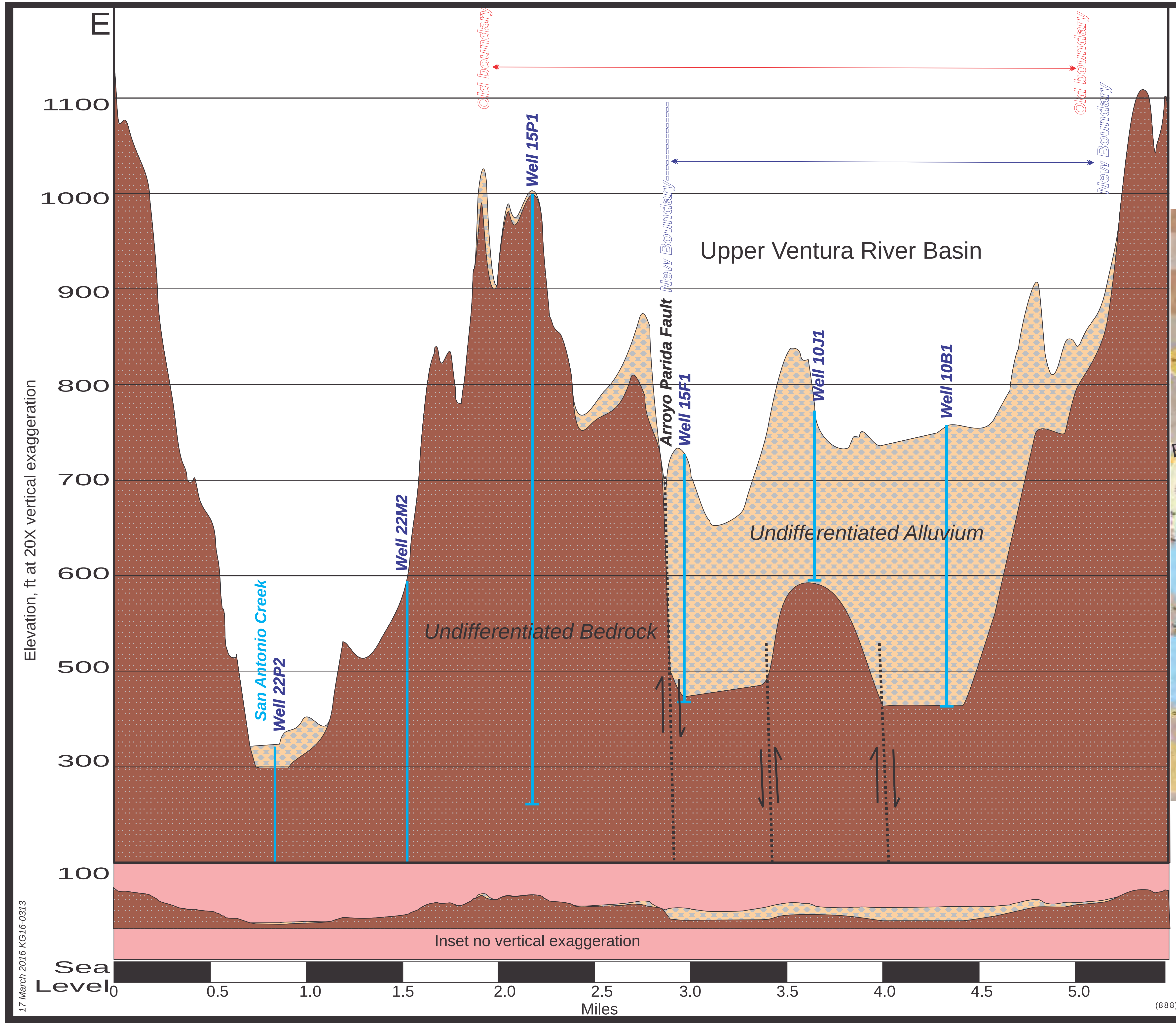

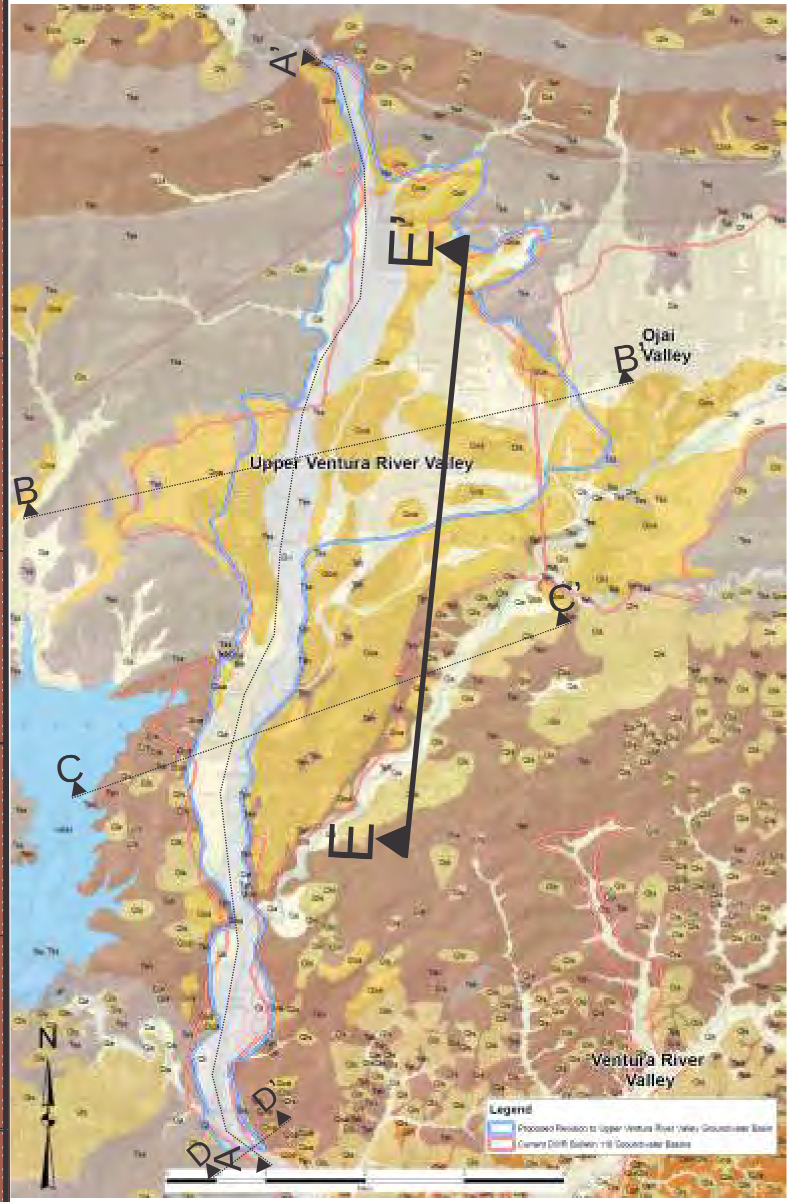

Upper Ventura River Basin

Figure 8
East Cross Section

McDonald Canyon to
San Antonio Creek
View looking west

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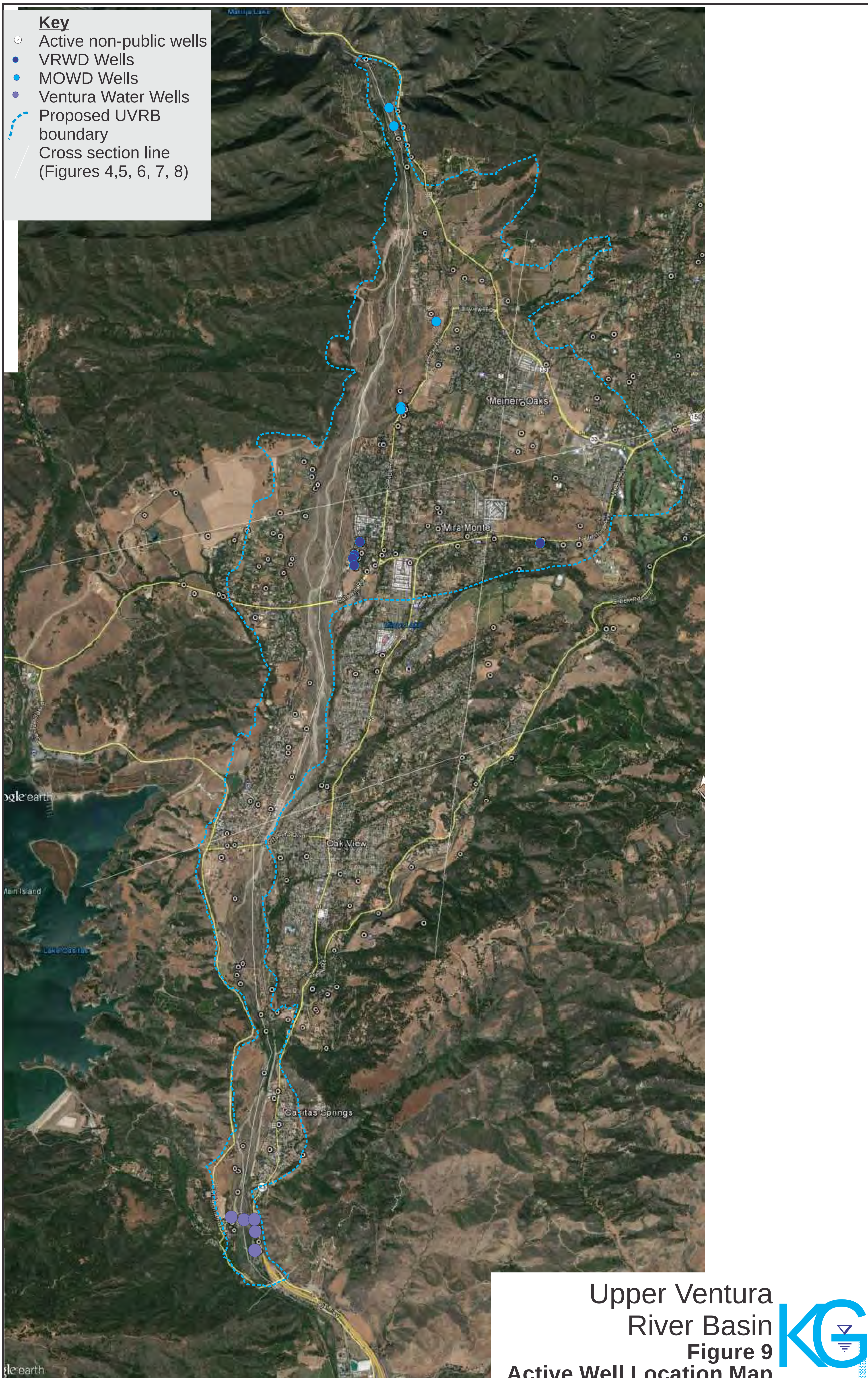

Upper Ventura River Basin

Figure 9

Active Well Location Map