



SAN LUIS OBISPO COUNTY  
**DEPARTMENT OF PUBLIC WORKS**

Wade Horton, Director

---

County Government Center, Room 206 • San Luis Obispo CA 93408 • (805) 781-5252

Fax (805) 781-1229

email address: [pwd@co.slo.ca.us](mailto:pwd@co.slo.ca.us)



July 12, 2016

Mr. Timothy Godwin  
California Department of Water Resources  
1419 9<sup>th</sup> Street  
Sacramento, California 95814

Subject: County of San Luis Obispo's Response to the California Department of Water Resources Draft Basin Boundary Modifications - Denied Recommendation for the Los Osos Valley Groundwater Basin (3-08) Basin Boundary Modification Request

Dear Mr. Godwin:

The County of San Luis Obispo (County) appreciates the opportunity to respond to the California Department of Water Resources (DWR) Basin Boundary Modifications - Denied Recommendation to the Los Osos Valley Groundwater Basin (3-08) Basin Boundary Modification Request (BBMR), publicized on July 1, 2016. The County respectfully disagrees with DWR's draft recommendation and urges your support to ensure sustainable groundwater management. We believe the record shows that the proposed BBMR meets the two objectives of California's Sustainable Groundwater Management Act (SGMA)<sup>1</sup> required for approval:

- 1) Technical justification based on decades of data and local, State and Federal analysis; and
- 2) Approval of the BBMR would improve the likelihood of sustainable management by aligning the boundary in Bulletin 118 with said data and analysis upon which basin management efforts have been developed.

Pursuant to the adjudication, the current governance structure for Los Osos Groundwater Basin includes all local water purveyors and the County who have developed and are implementing a plan to address the undesirable results consistent with the SGMA. Most significantly, the \$183 million dollar water reclamation facility is in the testing and commissioning phase and will be operational by the end the year.<sup>2</sup> The water purveyors have also begun implementing basin management plan projects such as a nitrate removal facility, well modifications, blending project, and water metering in previously unmetered urban areas. The County encourages DWR to support Los Osos community in its efforts to achieve sustainability in its groundwater basin management with the proposed BBMR. To help provide context, this letter discusses sustainable groundwater management and provides supportive scientific information for the boundary request.

---

<sup>1</sup> SGMA provides new authorities to local agencies and requires various actions be taken in order to achieve sustainable groundwater management in high and medium priority groundwater basins, including the Los Osos Valley Groundwater Basin.

<sup>2</sup> The water reclamation facility total budget is \$183 million dollars, referenced from the Los Osos Wastewater Project, Project Construction Quarterly Update (January through March 2016). <http://www.slocounty.ca.gov/PW/LOWWP.htm>

## **1. IMMEDIATE ACTIONS TOWARD SUSTAINABLE GROUNDWATER MANAGEMENT**

It is crucial to start with the BBMR's underlying intent: approval of the BBMR will greatly improve basin users' ability to achieve sustainable groundwater management.

Consistent with SGMA emphasis on local management, the BBMR ensures scientifically-based boundary alignment with the areas subject to implementing the Basin Management Plan, consistent with the October 2015 final court order (litigation referenced in Water Code Section 10720.8(d)). The Basin Management Plan aims at taking bold, decisive and immediate actions to solve basin challenges and protect basin sustainability by halting seawater intrusion and providing water supplies for existing and future demands. Better boundary alignment also reduces potential governance conflicts that will inhibit sustainable management by increasing competition for limited institutional resources and delaying necessary actions by basin users and the court-established Basin Management Committee (BMC) to achieve sustainability.

### **1.1. Current Sustainable Governance Structure:**

**Basin Management Committee** – To create a sustainable basin, the BMC has already implemented groundwater sustainability programs.<sup>3</sup> Proposed future and ongoing programs include a wellhead protection program, groundwater monitoring, water conservation measures, and septic tank repurposing.

The proposed boundary modification will allow the BMC to design and implement projects on a scale that is appropriate for the true size of the basin for sustainability. Having a basin that does not reflect the correct size could create undesirable results, such as reduction of groundwater storage with increased groundwater pumping due to the false premise of increased recharge and groundwater storage volume.

**Los Osos Sewer Service Area** - The Los Osos Sewer Service Area (formerly known as the Prohibition Zone) has implemented sustainable groundwater management through the County construction and operation of the Los Osos Water Recycling Facility (LOWRF). The LOWRF will prevent nitrate loading with the decommissioning of septic systems and the installation of sewer lateral lines into a recycled wastewater treatment system. The tertiary treated recycled water will help to replenish the nitrate contaminated upper aquifer and raise the groundwater level to help mitigate sea water intrusion. In addition, use of recycled water for irrigation in lieu of potable groundwater pumping will help to mitigate the undesirable results. The sewer project has also implemented a robust water conservation program that provides rebates to upgrade all indoor water fixtures to low flow, since low flow fixtures are required for all homes and businesses prior to connecting to the sewer.

## **2. SGMA UNDESIRABLE RESULTS (§ 354.26.)**

The Los Osos Sewer Service Area (Service Area) and the Basin Management Committee (BMC) have and will continue to address undesirable results for the Los Osos Basin, which includes seawater intrusion, degradation of water quality, and the decline in groundwater levels and storage.

**2.1 Seawater Intrusion:** The Lower Aquifer has been impacted by seawater intrusion, with the inland advance of the 250 mg/L chloride isopleth averaging 190 feet per year between 2005 and 2015. Currently, the BMC has a monitoring well network used for

---

<sup>3</sup> Reference: Cleath-Harris Geologists, 2016, Los Osos Basin Plan, Groundwater Monitoring Program 2015 Annual Report, San Luis Obispo County, California, June 2016.

contouring the 250 mg/L<sup>4</sup> chloride isopleth for the Lower Aquifer. A Chloride Metric target level, based on water quality at four key wells, is set at 100 mg/L or less.

*Management Solutions:* Seawater Intrusion mitigation has been addressed by the reduction in pumping from the Lower Aquifer and ongoing infrastructure programs that shift production to the Upper Aquifer and promote recycled water reuse. Future monitoring results should provide measurable declines in chloride concentrations with the reduced pumping and increased hydraulic head in the Lower Aquifer.

**2.2 Groundwater Storage and Groundwater Levels:** Groundwater storage and levels are addressed through water conservation measures and recycled water usage. The Los Osos Service Area has increased water conservation measures with water saver fixtures and septic tank repurposing for rainwater capture. To illustrate water conservation measures, the County has listed the average production from the 2015 Annual Groundwater Monitoring Report within the proposed BBMR:

- From 2005 -2009: Average Production is 3,060 acre-foot per year (AFY)
- From 2010 – 2014: Average Production is 2,600 AFY
- 2015: Average Production is 2,170 AFY

The Average Production value shows a significant reduction in total production from 2005 to 2015. In addition, recycled water for irrigation from the LOWRF will also help mitigate the decline in groundwater levels by decreasing groundwater pumping.

**2.3 Degradation of Water Quality (Nitrates):** BMC has defined the Nitrate Metric as the average concentration of nitrate in five key wells located in areas of the basin that have been impacted by elevated nitrate concentrations. The Nitrate Metric target level is 10 mg/L (the drinking water standard) or lower.

*Management Solutions:* Nitrate loading within the basin will largely stop with the removal of septic systems from the proposed BBMR. Nitrate concentrations in the basin are expected to begin declining with rainwater infiltration, plant nitrate uptake from the soil, and repurposing of septic tanks.

Sustainable groundwater management is being achieved by implementing activities and projects that maintain and improve groundwater levels, including but not limited to: reducing groundwater pumping, increasing overall water supply, increasing water reuse or recycled water supply, protecting and increasing groundwater recharge, and limiting future increases in groundwater pumping.

### **3. LATERAL BASIN BOUNDARIES**

The proposed BBMR includes removing the Southern Beach area and Eastern Valley area from the Los Osos Groundwater Basin, as well as extending the western boundary from the bay shore to the Pacific Ocean coastline as shown on the enclosed Figure 1. The current DWR Bulletin 118 basin area covers 6,990 acres (10.9 square miles) and the proposed BMMR would cover 6,380 acres (10 square miles). The lateral boundaries' proposed delineations are based on the best available scientific data and historical reports from both DWR and USGS.

The following sections reiterate points made in the Los Osos Valley Groundwater Basin Boundary Modification Request Technical Memorandum (Basin Boundary Technical

---

<sup>4</sup> A chloride concentration of 250 mg/L is the recommended limit for drinking water.

Memorandum) regarding lateral boundaries (§ 344.12(2)).

### **3.1 Southern Beach Area**

The Southern Beach area encompasses approximately 1.7 square miles (Figure 1). This area is proposed for removal from the groundwater basin because the primary storage unit (Paso Robles Formation) is interpreted as being absent, unsaturated, or having a restricted hydraulic connection to the basin.

#### ***a. Geological Separation***

There is a physical separation that prevents groundwater flow to and from the Southern Beach area. The Basin Boundary Technical Memorandum Figure 2, which shows the lateral boundaries (enclosed), references numerous geologic cross-sections, and rock outcrops along the proposed basin boundary perimeter. Cleath-Harris Geologists interpreted well logs, geologic maps, geophysics, water levels, and water quality to create geologic cross sections and to form the basis for the proposed BBMR boundary segments. Boundary Segments 4 and 5 delineate the proposed southern Los Osos Basin Boundary. As shown in Figure 2, cross-sections C-C' and D-D' traverse Boundary Segment 5 (refer to Appendix A, Figures A4 and A5, enclosed) and cross-sections E-E' traverse Boundary Segment 4 (refer to Appendix A, Figures A6, enclosed).

Faulting, both adjacent and within basin sediments, is present, which can significantly impede and impact groundwater flow. The attached cross-sections illustrate offsets within basin sediments, including an uplifted portion of the basin along the southern boundary (refer to Appendix A, Figures A5 and A6, enclosed) and refer to Basin Boundary Technical Memorandum § 344.12(2) for descriptions of each segment relative to rock outcrops, etc.

#### ***b. Hydrogeology***

In the Southern Beach area, the primary groundwater storage unit (Paso Robles Formation) is interpreted as being absent, unsaturated, or having a restricted hydraulic connection that impedes groundwater flow to the basin. Geologic maps and cross-sections by U.S. Geological Survey<sup>5</sup> show bedrock rising to the surface along the southern basin boundary, which was extended due west to the coast from bedrock outcrops near oil exploration well "Spooner 1" (well location shown on PG&E figures in Appendix B – Figure B.1 and B.2, enclosed). The main strand of the Los Osos fault zone has also been mapped as a concealed trace along this general east-west alignment. South Beach area exploratory boring MBO-2 (well 30S/10E-23C1) is interpreted to penetrate non-water bearing sediments of the Pismo Formation (Miguelito member) on the north side of the main strand of the Los Osos fault (Appendix C – Well log, enclosed).

#### ***c. Additional Supporting Information:***

This data provides supporting maps and figures that show a hydrogeologic barrier resulting from limited hydraulic connectivity between the Southern Beach area and the proposed BBMR boundary. PG&E (refer to Appendix B - Figure B1, enclosed) shows a 2014 base map with offshore geology and a fault splay that, when projected to the main trace of the Los Osos fault zone, lines up with the proposed BBMR.

- A lithologic log for well 23C1 (refer to Appendix C – C1, enclosed) consists of mostly clay below 70 feet depth, and is interpreted by DWR as Pliocene-age.

---

<sup>5</sup> Reference: Yates, E.G., and Wiese, J. H., 1988, Hydrogeology and Water Resources of the Los Osos Valley Ground-Water Basin, San Luis Obispo County, California, U. S. Geological Survey, Water-Resources Investigations Report 88-4081.

This correlates to the Pismo Formation (non-water bearing and not included in the proposed BBMR), which outcrops south of main strand of Los Osos/Edna fault zone - out of basin.

In 2005, offshore seafloor surveys were incorporated into the basin boundary interpretation, and an additional portion of the Southern Beach area was removed along a southeast-northwest alignment, connecting bedrock exposures on the seafloor to those near "Spooner 1" (refer to Appendix B – Figure B1, enclosed). Available well completion reports along Pecho Valley Road within this additional portion of the Southern Beach area are interpreted to indicate rising bedrock with **groundwater elevations much higher than basin levels**. A potential splay of the Los Osos fault zone has also been mapped offshore along the proposed basin boundary alignment (refer to Appendix B - Figures B1 and B2, enclosed).

The northwest trending fault line at the Southern Beach boundary delineates an uplift (refer to Appendix B - Figures B1, enclosed) which **impedes** water from flowing from the Southern Beach boundary into the proposed Los Osos Basin Boundary (refer to Appendix B - Figure B2, enclosed). Appendix B - Figure B2 (yellow line) shows the top of Edna (Pismo) Formation rising toward ground surface between line marker 38000 and 36000.

- Bedrock mapped on the ocean floor west of the sandspit beginning at approximately 30 feet below sea level indicates that the Basin boundary turns to the northwest from its east-west alignment along the Los Osos fault.

### 3.2 Eastern Valley Area

The Los Osos Valley alluvial deposits from Warden Lake east to the watershed divide encompass approximately 2.4 square miles (Figure 1). The proposed modified basin boundary terminates at Warden Lake and there is a hydrogeologic barrier between the Eastern Valley and the proposed BBMR.

#### a. Geological Separation

The Basin Boundary Technical Memorandum Figure 2, which shows the lateral boundaries (enclosed), references numerous geologic cross-sections, and rock outcrops along the proposed basin boundary perimeter. Cleath-Harris Geologists interpreted well logs, geologic maps, geophysics, water levels, and water quality to create geologic cross sections and to form the basis for the proposed BBMR boundary segments. Boundary Segments 2 and 3 delineate the proposed Los Osos Basin Boundary from the Eastern Valley area. As shown in Figure 2, cross-sections G-G' and I-I' traverse Boundary Segment 2 (refer to Appendix A, Figures A7 and A8, enclosed) and cross-sections A-A', B-B' and C-C' traverse Boundary Segment 3 (refer to Appendix A, Figures A2, A3 and A4, enclosed). Refer to Basin Boundary Technical Memorandum § 344.12(2) for descriptions of each segment relative to rock outcrops, etc.

As SWRCB notes, the Boundary Technical Memorandum references several past studies, including reports by U.S. Geological Survey (Yates and Wiese, 1988),<sup>6</sup> DWR (1989)<sup>7</sup>, and Morro Group (1987).<sup>8</sup> It is important to note that these past reports also **excluded** the Eastern Valley area alluvial deposits from the Los Osos Groundwater Basin, which are referenced in the Basin Boundary Technical Memorandum (§ 344.14 (a)(2)). As noted in the referenced 1989 DWR report, *"Only in areas less than 4 miles from the coast do water-bearing sediments of*

<sup>6</sup> Reference: Yates, E.G., and Wiese, J. H., 1988, Hydrogeology and Water Resources of the Los Osos Valley Ground-Water Basin, San Luis Obispo County, California, U. S. Geological Survey, Water-Resources Investigations Report 88-4081.

<sup>7</sup> Reference: Department of Water Resources (DWR), 1989, Geohydrology and Management of Los Osos Valley Ground Water Basin, San Luis Obispo County, Southern District Report, July 1989.

<sup>8</sup> Reference: Morro Group, 1987, Los Osos Wastewater Project Environmental Impacts Report, SCH# 84121914, August 1987.

*significant thickness occur. Farther east, bedrock is overlain by sediments of low permeability, which are less than 30 feet thick. Thus, the groundwater basin begins about 4 miles inland and deepens to the west.*" This is consistent with the County's proposed BBMR, and proposed removal of the Eastern Valley area.

The following reiterates points made in the Basin Boundary Technical Memorandum regarding the thickness of the alluvial deposits in the Eastern Valley area. Well completion reports were reviewed by the consultant and reported in order to convey information known about the Eastern Valley area. The *depth of the alluvium* from ground surface ranged between 15 feet and 80 feet, with an average thickness of 48 feet, based on 23 reports for wells within the eastern valley alluvial deposits. *Saturated alluvial aquifer thickness*, based on water levels reported following well completion, averaged 30 feet. Eastern Valley area wells were also completed an average of 39 feet into bedrock beneath the alluvium, for an average completed well depth of 87 feet. Neither the application nor the technical memorandum claim what alluvium thickness is negligible, but rather focuses on describing the geologic setting.

#### **b. Hydrogeology**

The proposed Los Osos Basin Boundary Technical Memorandum (§344.14) describes the water supply of the Eastern Valley area, and focuses on its limited hydraulic connection with the proposed Los Osos Groundwater Basin. Several key points are highlighted below relating to eastern valley yield/supply source, lack of hydraulic connectivity to proposed BBMR, and supportive water quality data. The Basin Boundary Technical Memorandum §344.14 should be reviewed for a more comprehensive understanding.

The Eastern Valley area alluvial deposits are relatively thin (average unconfined saturated thickness of 30 feet) with generally low yields (less than 50 gallons per minute). Local growers can combine the yields from multiple shallow wells to sustain agricultural operations on the north side of Los Osos Valley Road in the Eastern Valley area. Local **bedrock aquifers** provide a significant contribution to groundwater production in the area. Agricultural irrigation on the south side of Los Osos Valley Road is supplied by groundwater wells producing from bedrock aquifers along the base of the Irish Hills, where metavolcanics have been fractured by movement along the Los Osos fault zone.

*The Eastern Valley area does not contribute significantly, if any, to groundwater recharge within the proposed BBMR.* The eastern valley watershed, approximately nine square miles, is drained by an unnamed tributary into the Warden Lake marsh, from which Warden Creek flows along approximately 3,700 feet of the northern proposed basin boundary, at low invert elevations in an area underlain by shallow bedrock.

The Basin Boundary Technical Memorandum offers water quality data to further support the **hydrogeologic barrier** between the proposed Los Osos Basin Boundary and the Eastern Valley (§344.12(2)(A,B,C)). The technical memorandum describes differences in several neighboring wells' stiff diagrams (shown on cross section B-B', Appendix A - Figure A3, enclosed), a lack of detectable nitrate concentrations in the proposed basin area well, and available water level data. These differences support prior investigators' conclusions that alluvial groundwater from the eastern valley does not flow west in significant quantities across the proposed basin boundary.

### ***c. Additional Supporting Information***

This data provides supporting maps and figures that indicate a hydrogeologic barrier with impediment to groundwater flow between the Eastern Valley and the proposed BBMR boundary.

- Cross-Section B-B' Figure (Appendix C - Figure C3) shows the structural barrier interpretation between the main basin and the Eastern Valley area from 1972. This structural barrier creates groundwater flow impedance and delineates the boundary between the proposed Los Osos basin and Eastern Valley area.
- PG&E Seismic Survey interpretation for geophysical lines 105 and 121 (Figure 5-17 and 5-21) show rising bedrock and line 121 shows a possible fault/fold coming up beneath the edge of the cemetery mesa (refer to Appendix B – Figures B1, B3 and B4, enclosed). The shallow bedrock impedes flow across the boundary between the proposed Los Osos basin and Eastern Valley area.
- FER-200 report excerpts highlights the break in slope along the east edge of the cemetery mesa and discusses the possibility of structural impoundment of Warden Lake (refer to Appendix D – Figure D1, enclosed). Thus, groundwater from the Eastern Valley area is conveyed into Warden Lake and flows into Morro Bay Estuary following the perimeter of the proposed BBMR.
- Groundwater contour maps from the 2015 Draft Annual Report show water level contours along the east edge of the cemetery mesa (inside proposed BBMR) that are above the ground surface elevation of the adjacent Eastern Valley area, which would restrict flow into the basin from the Eastern Valley area (refer to Appendix E – Figure E1 – E2, enclosed). To illustrate groundwater conveyance narrative, Figures E1 and E2 shows the **general conveyance of groundwater from the Eastern Valley to Warden Lake and into Morro Bay estuary.**

### **3.3 Proposed Addition of Morro Bay Estuary and Pacific Ocean Coastline**

Within this proposed western boundary extension to the Pacific Ocean coastline, seawater intrusion is currently the greatest threat to maintaining a sustainable groundwater basin. This is because the principal basin aquifers extend offshore and are hydraulically connected to the Pacific Ocean. The proposed modification moves the current Bulletin 118 boundary from the bay front to the coastline, encompassing the aquifers beneath Morro Bay, which include freshwater-bearing zones, and aquifers beneath the sandspit, where groundwater monitoring wells are located.

The scientific geological, hydrogeologic, and water quality data, as well as prior reports from the DWR, U.S. Geological Survey and Morro Group support the proposed Los Osos Groundwater Basin boundary modification's removal or the creation of a subbasin. The evidence and the correlation of data in the proposed BBMR application to DWR and the additional supporting information (seismic data interpretation and groundwater elevation figures) supports the removal of the Southern Beach area and the removal of or subbasin status for the Eastern Valley area. We urge DWR's support for the proposed Los Osos Valley Groundwater Basin boundary modifications to ensure sustainable groundwater management. Please contact Cathy Martin, Water Resources Engineer, at (805) 781-5275 or Carolyn Berg, Senior Water Resources Engineer, at (805) 781-5536 with any questions.

Sincerely,



WADE HORTON  
Director of Public Works

Enclosures:

- Referenced figures (excerpts from Proposed Los Osos Basin Boundary Modification Technical Memorandum Figures 1 and 2)
- Appendix A – Geological Cross-Sections (excerpts of applicable figures)
- Appendix B – PG&E Seismic Survey (excerpts of applicable figures)
- Appendix C – Department of Water Resources, Sea Water Intrusion, Bulletin 63-6 (excerpts of applicable figures)
- Appendix D – California Division of Mines and Geology Fault Evaluation Report (excerpts of applicable figures)
- Appendix E – Los Osos Groundwater Monitoring Report, 2015 Annual Report (excerpts of applicable figures)

Cc: Erik Ekdahl, Director, State Water Resources Control Board (via email only)  
Mark Hutchinson, County Public Work Deputy Director (via email only)

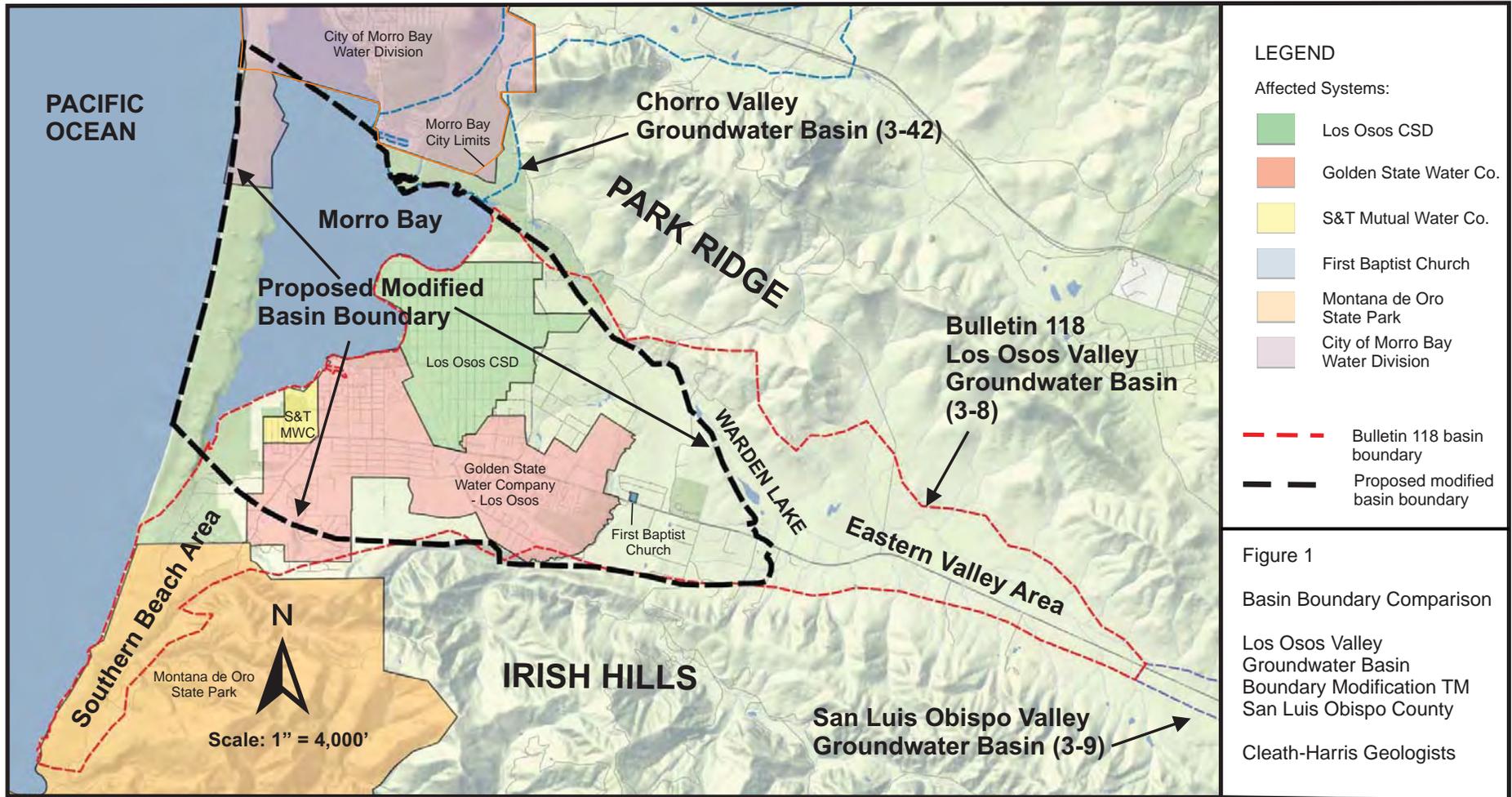
File: CF 340.300.01 SGMA

L:\Water Resources\2016\July\Response to DWR and Support Info ltr.docxCM.mj

**County of San Luis Obispo**

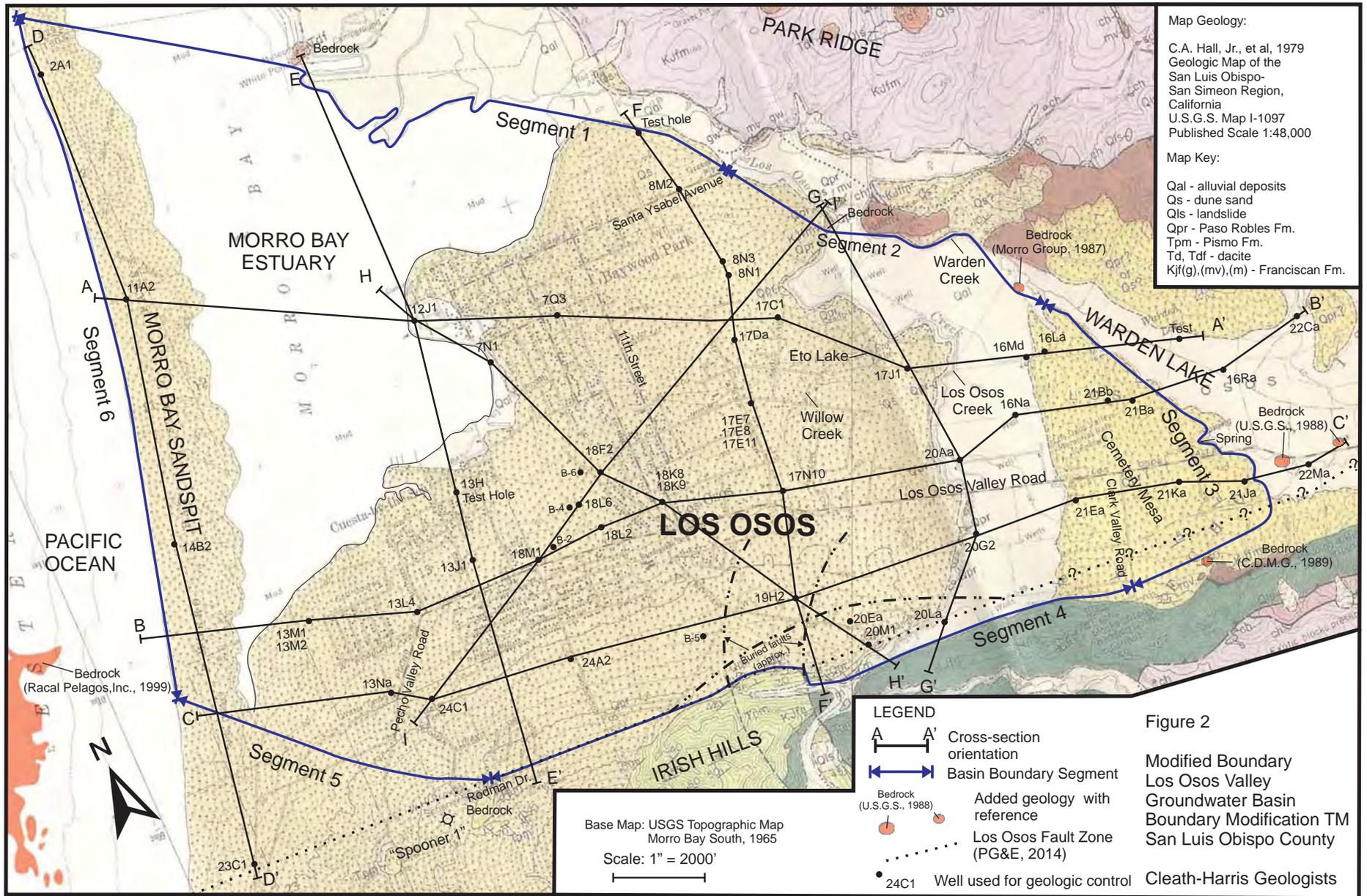
**Referenced Figures**

**Figure 1: Modified Basin Boundary Comparison**



**Notes:**

1. The Proposed Modified Basin Boundary includes moving the Western boundary from the bay shore to the coastline at the Pacific Ocean, moving the Eastern Valley boundary from the drainage divide to the east side of Warden Lake, and removing a portion of the Southern Beach area.
2. The current Bulletin 118 basin area covers 6,990 acres (10.9 square miles) and the proposed modified basin area would cover 6,380 acres (10 square miles).



Map Geology:  
 C.A. Hall, Jr., et al, 1979  
 Geologic Map of the  
 San Luis Obispo-  
 San Simeon Region,  
 California  
 U.S.G.S. Map I-1097  
 Published Scale 1:48,000

Map Key:  
 Qal - alluvial deposits  
 Qs - dune sand  
 Qls - landslide  
 Qpr - Paso Robles Fm.  
 Tpm - Pismo Fm.  
 Td, Tdf - dacite  
 Kjf(g),(mv),(m) - Franciscan Fm.

**LEGEND**

A—A' Cross-section orientation

↔ Basin Boundary Segment

Bedrock (U.S.G.S., 1988)

Added geology with reference

Los Osos Fault Zone (PG&E, 2014)

• 24C1 Well used for geologic control

Figure 2

Modified Boundary

Los Osos Valley

Groundwater Basin

Boundary Modification TM

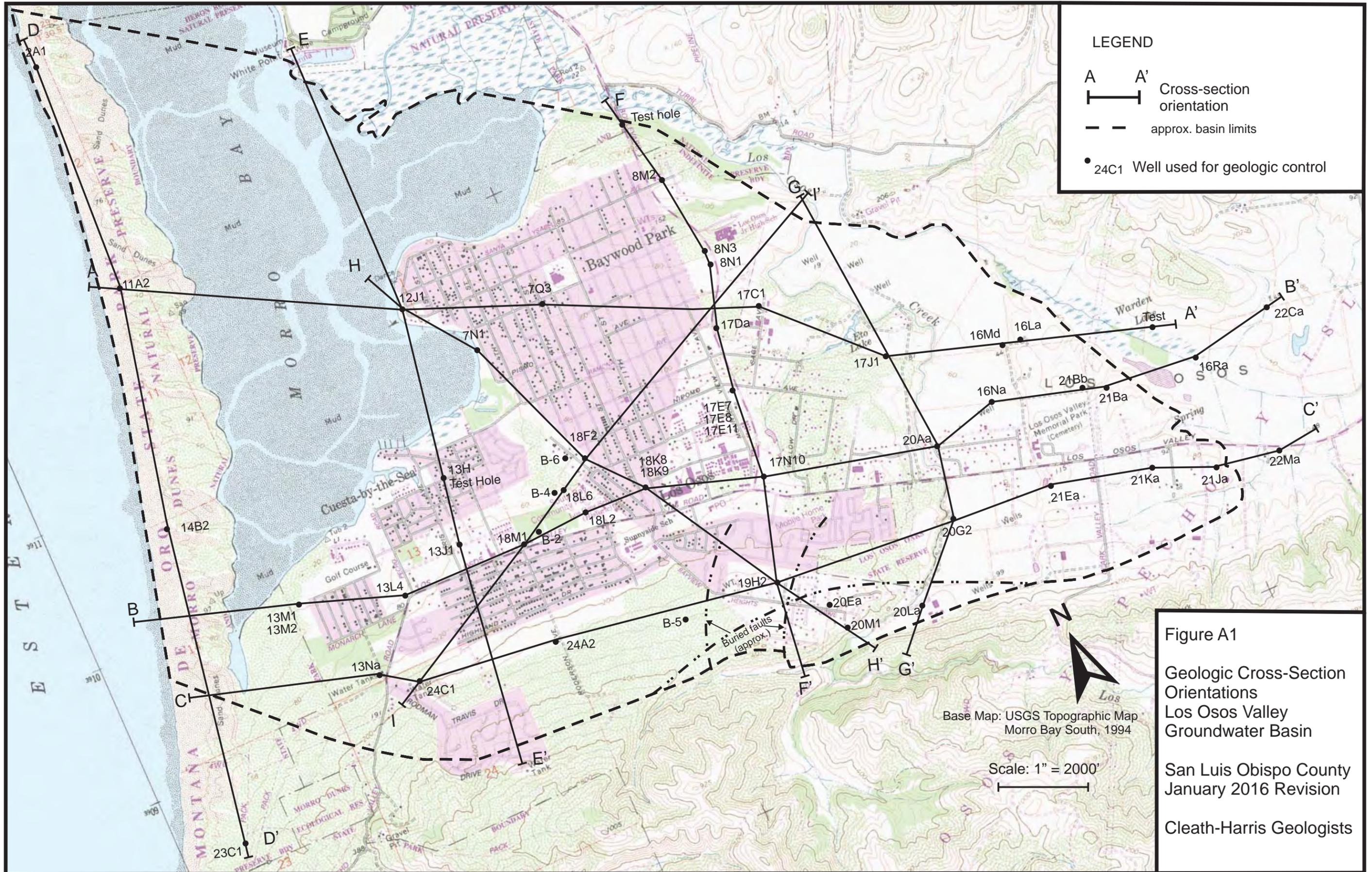
San Luis Obispo County

Cleath-Harris Geologists

Base Map: USGS Topographic Map  
 Morro Bay South, 1965

Scale: 1" = 2000'

**APPENDIX A**  
**Geologic Cross-Sections**



**LEGEND**

A — A' Cross-section orientation

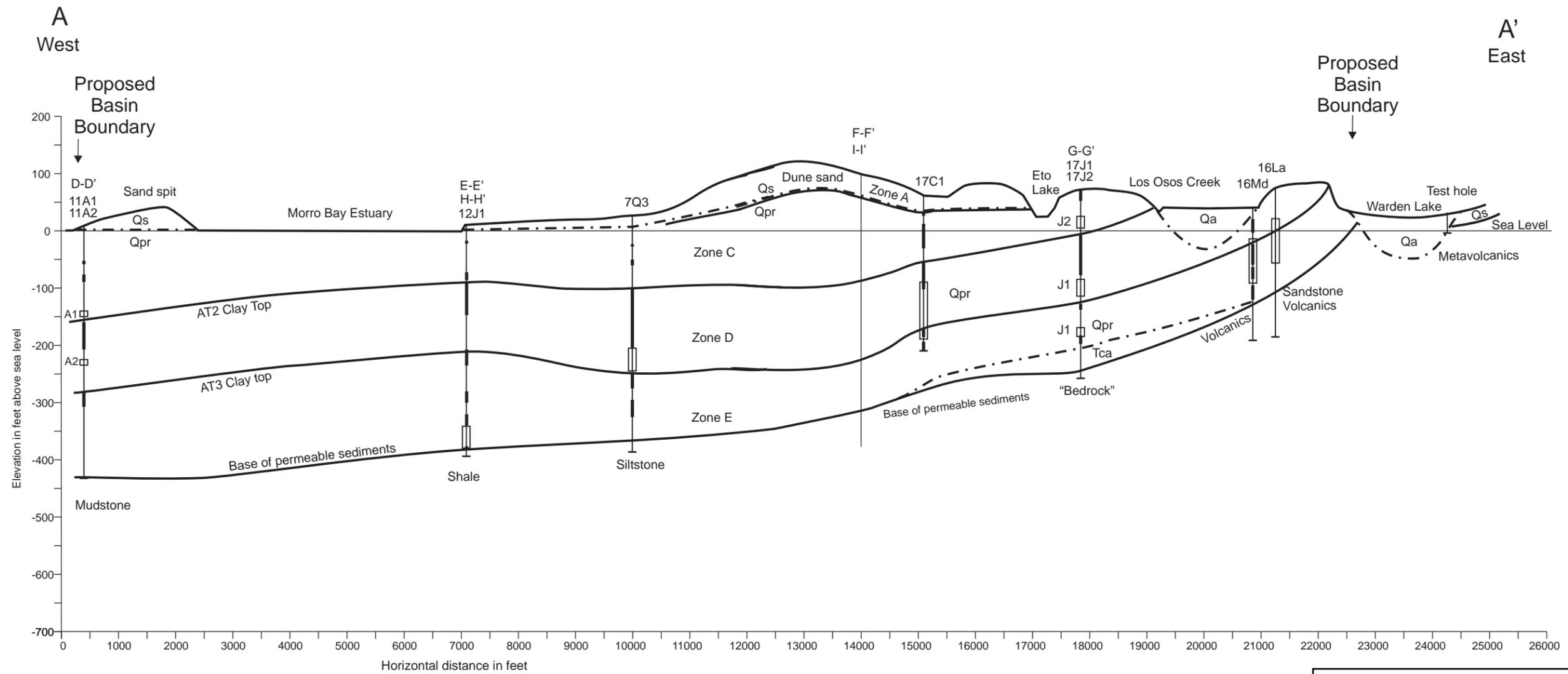
- - - approx. basin limits

● 24C1 Well used for geologic control

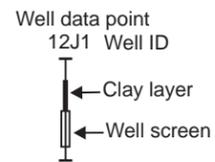
**Figure A1**  
 Geologic Cross-Section Orientations  
 Los Osos Valley Groundwater Basin  
 San Luis Obispo County  
 January 2016 Revision  
 Cleath-Harris Geologists

Base Map: USGS Topographic Map Morro Bay South, 1994

Scale: 1" = 2000'



Aquifer Zones:  
 Zone A - Perched Aquifer  
 Zone B - Transitional Aquifer  
 Zone C - Upper Aquifer  
 Zone D - Lower Aquifer (shallow)  
 Zone E - Lower Aquifer (deep)

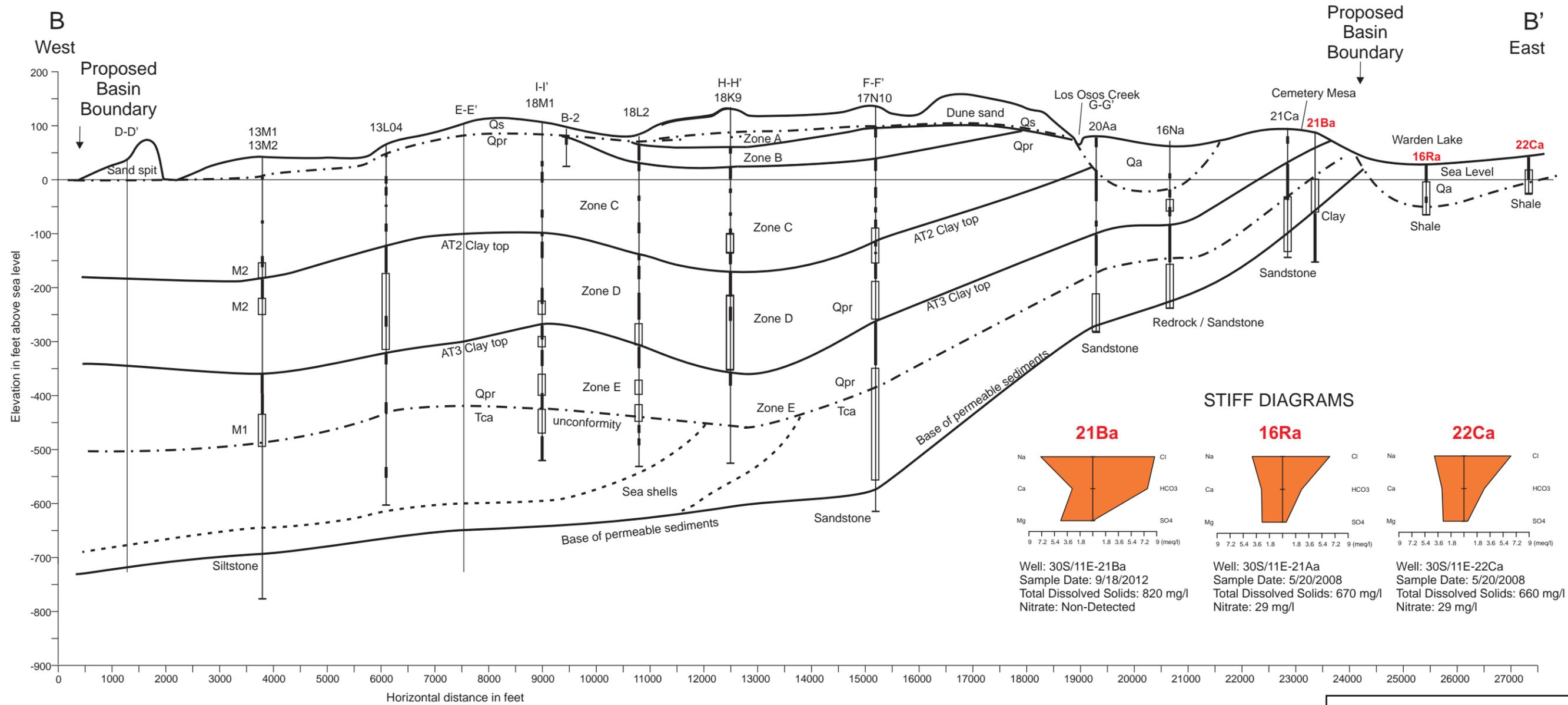


Formation:  
 Qa - alluvium  
 Qs - dune sand  
 Qpr - Paso Robles Formation  
 Tca - Careaga Formation

Figure A2  
 Cross-Section A-A'  
 Los Osos Valley  
 Groundwater Basin

San Luis Obispo County  
 January 2016 Revision

Cleath-Harris Geologists

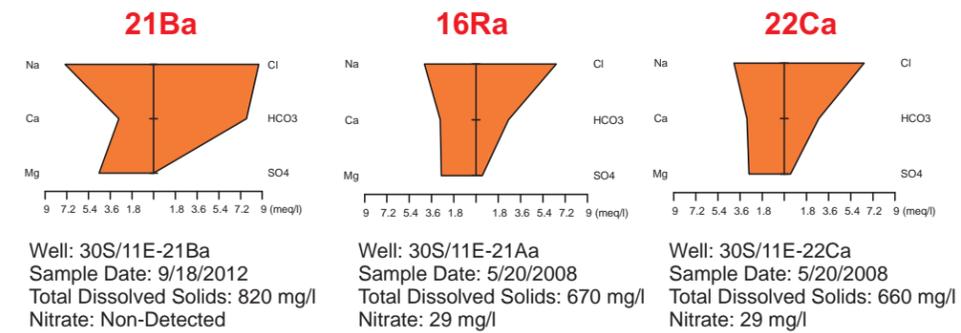


**Aquifer Zones:**  
 Zone A - Perched Aquifer  
 Zone B - Transitional Aquifer  
 Zone C - Upper Aquifer  
 Zone D - Lower Aquifer (shallow)  
 Zone E - Lower Aquifer (deep)

**Well data point**  
 18M1 Well ID  
 ← Clay layer  
 ← Well screen

**Formation:**  
 Qa - alluvium  
 Qs - dune sand  
 Qpr - Paso Robles Formation  
 Tca - Careaga Formation

**STIFF DIAGRAMS**



**Figure A3**

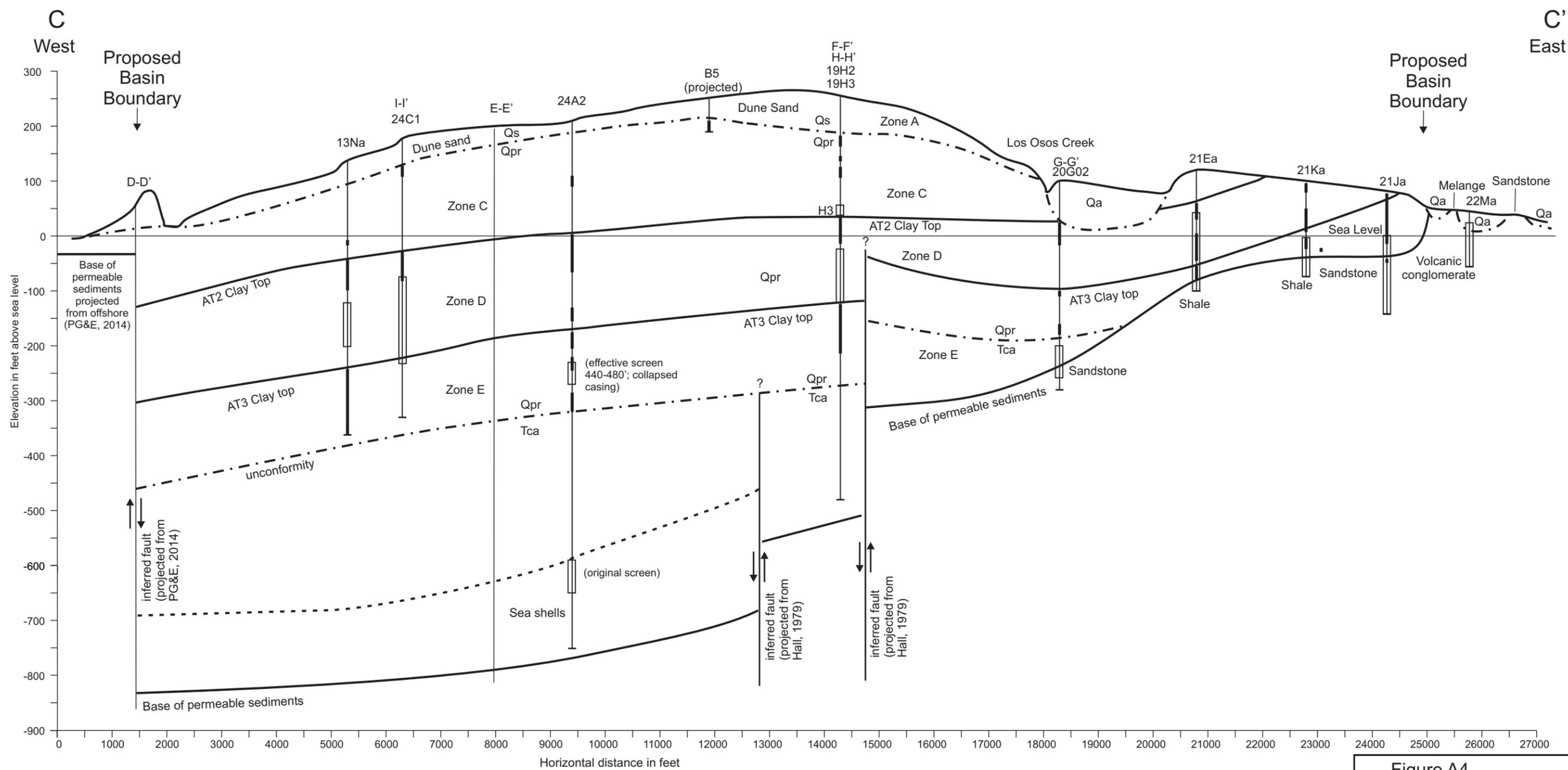
**Cross-Section B-B'**  
**Los Osos Valley**  
**Groundwater Basin**

San Luis Obispo County  
 January 2016 Revision

Cleath-Harris Geologists

**County of San Luis Obispo Note:**

1. **Stiff Diagrams** - Differences in the stiff diagrams, a lack of detectable nitrate concentrations in the proposed basin area well #21Ba, and available water level data supports prior investigators conclusions from DWR and USGS that alluvial groundwater from the Eastern Valley **does not flow west in significant quantities across the proposed basin boundary**, as referenced in the Los Osos Valley Groundwater Basin Boundary Modification Request Technical Memorandum, March 2016.

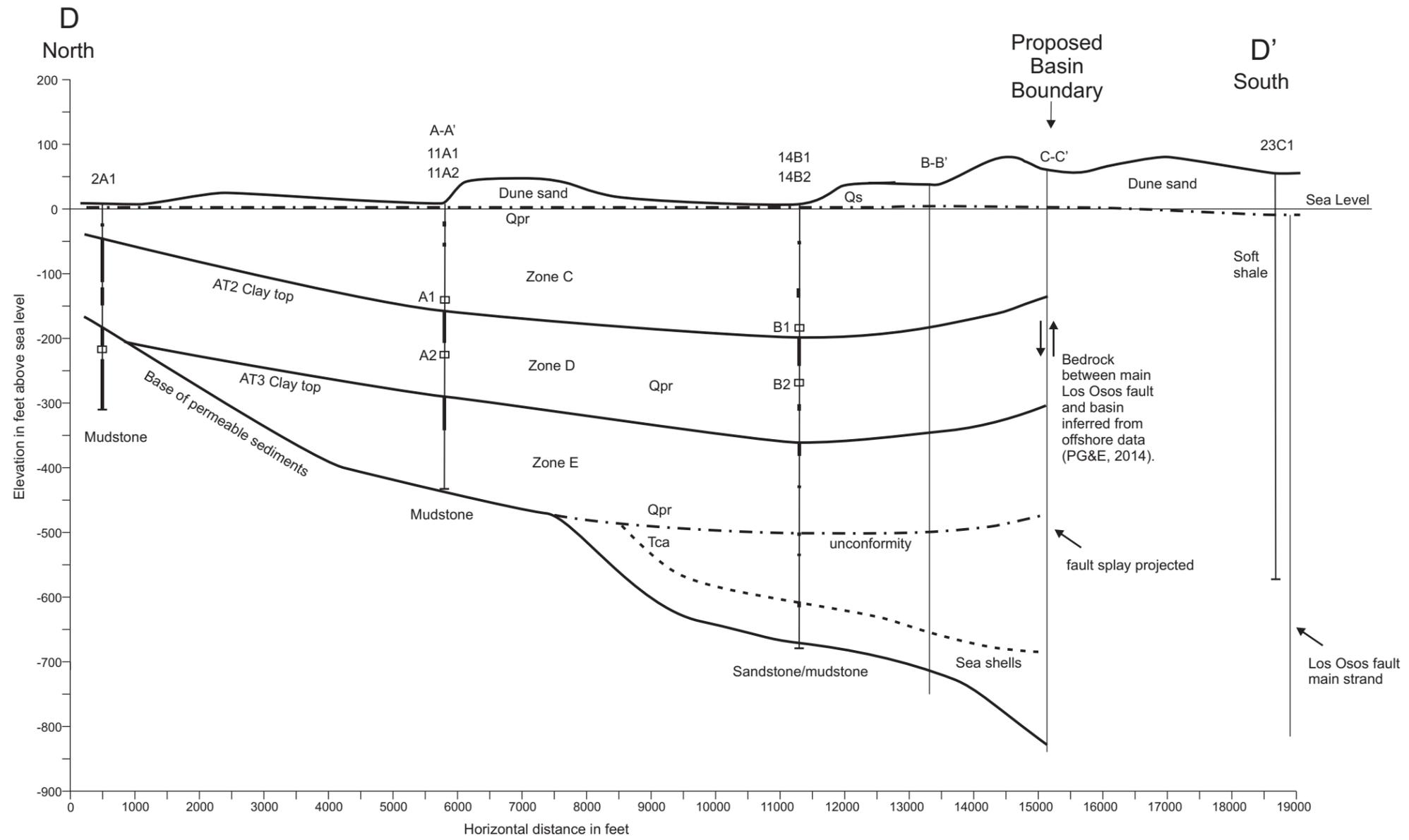


Aquifer Zones:  
 Zone A - Perched Aquifer  
 Zone B - Transitional Aquifer  
 Zone C - Upper Aquifer  
 Zone D - Lower Aquifer (shallow)  
 Zone E - Lower Aquifer (deep)

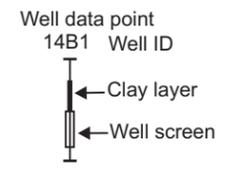
Well data point  
 24A2 Well ID  
 ← Clay layer  
 ← Well screen

Formation:  
 Qa - alluvium  
 Qs - dune sand  
 Qpr - Paso Robles Formation  
 Tca - Careaga Formation

**Figure A4**  
 Cross-Section C-C'  
 Los Osos Valley  
 Groundwater Basin  
 San Luis Obispo County  
 July 2016 Revision  
 Cleath-Harris Geologists



Aquifer Zones:  
 Zone A - Perched Aquifer  
 Zone B - Transitional Aquifer  
 Zone C - Upper Aquifer  
 Zone D - Lower Aquifer (shallow)  
 Zone E - Lower Aquifer (deep)



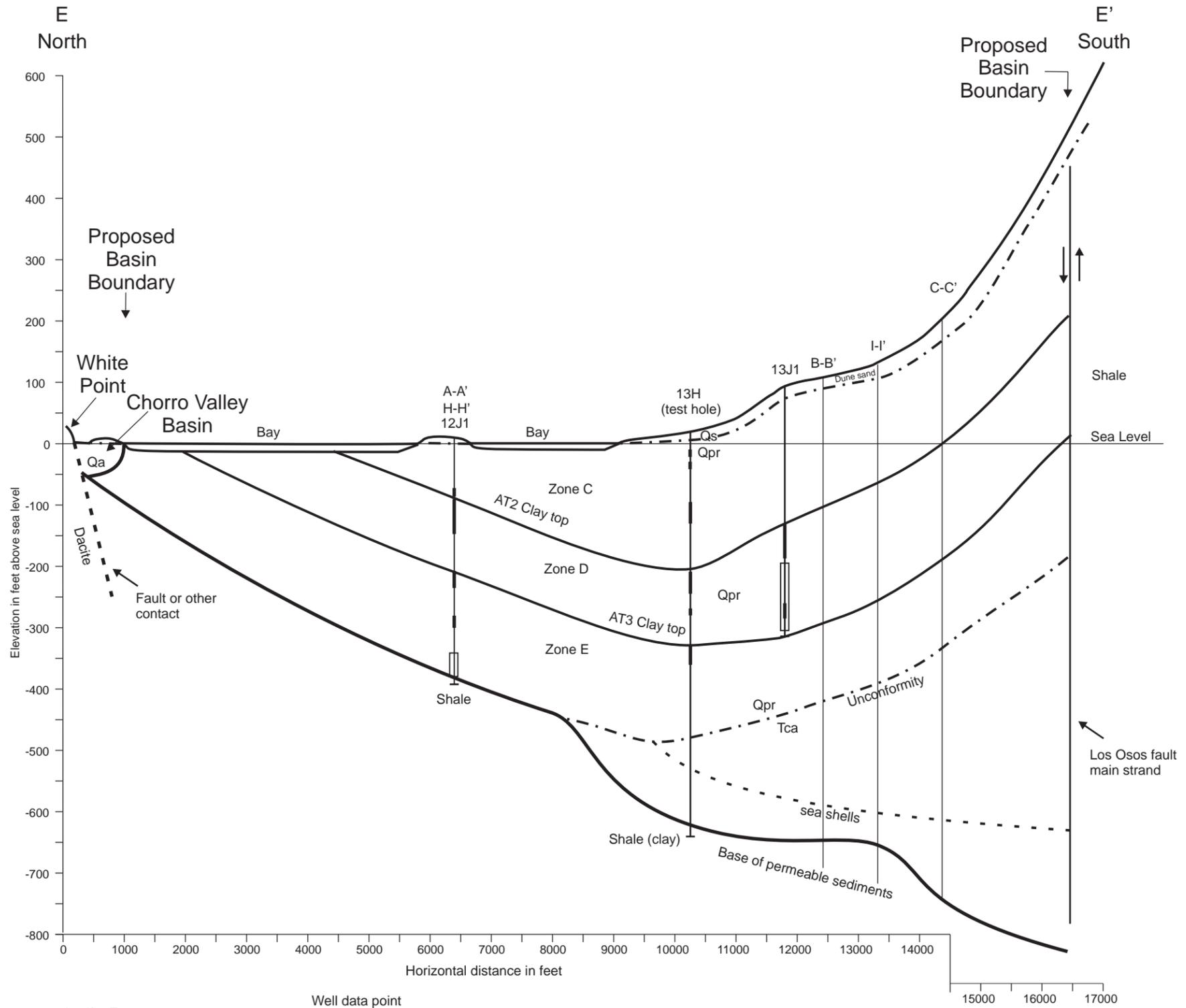
Formation:  
 Qa - alluvium  
 Qs - dune sand  
 Qpr - Paso Robles Formation  
 Tca - Careaga Formation

Figure A5

Cross-Section D-D'  
 Los Osos Valley  
 Groundwater Basin

San Luis Obispo County  
 July 2016 Revision

Cleath-Harris Geologists

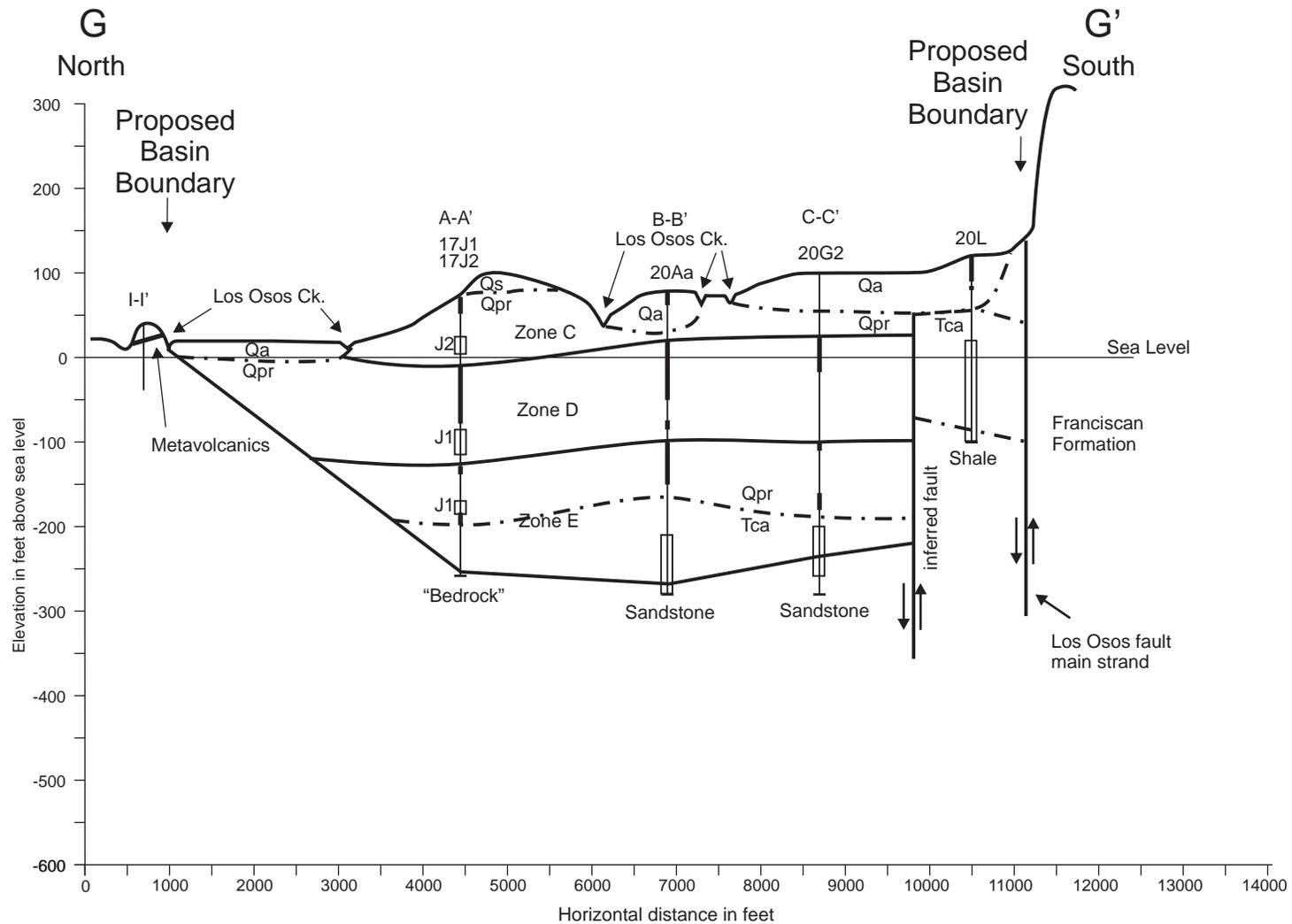


Aquifer Zones:  
 Zone A - Perched Aquifer  
 Zone B - Transitional Aquifer  
 Zone C - Upper Aquifer  
 Zone D - Lower Aquifer (shallow)  
 Zone E - Lower Aquifer (deep)

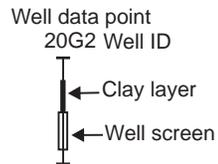
Well data point  
 12J1 Well ID  
 ← Clay layer  
 ← Well screen

Formation:  
 Qa - alluvium  
 Qs - dune sand  
 Qpr - Paso Robles Formation  
 Tca - Careaga Formation

Figure A6  
 Cross-Section E-E'  
 Los Osos Valley  
 Groundwater Basin  
 San Luis Obispo County  
 January 2016 Revision  
 Cleath-Harris Geologists



Aquifer Zones:  
 Zone A - Perched Aquifer  
 Zone B - Transitional Aquifer  
 Zone C - Upper Aquifer  
 Zone D - Lower Aquifer (shallow)  
 Zone E - Lower Aquifer (deep)



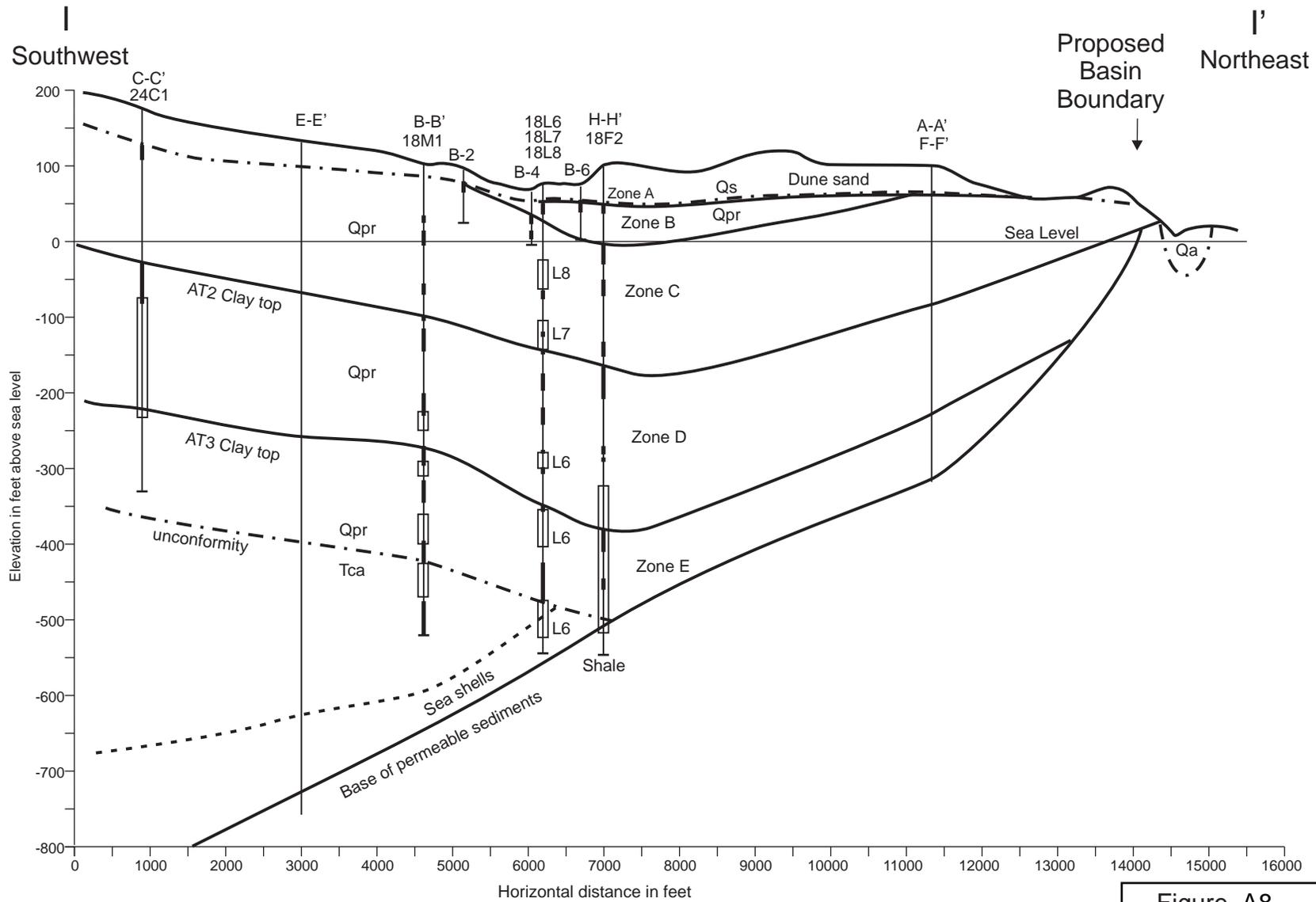
Formation:  
 Qa - alluvium  
 Qs - dune sand  
 Qpr - Paso Robles Formation  
 Tca - Careaga Formation

Figure A7

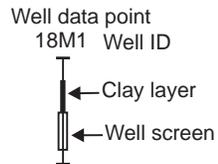
Cross-Section G-G'  
 Los Osos Valley  
 Groundwater Basin

San Luis Obispo County  
 January 2016 Revision

Cleath-Harris Geologists



**Aquifer Zones:**  
 Zone A - Perched Aquifer  
 Zone B - Transitional Aquifer  
 Zone C - Upper Aquifer  
 Zone D - Lower Aquifer (shallow)  
 Zone E - Lower Aquifer (deep)



**Formation:**  
 Qa - alluvium  
 Qs - dune sand  
 Qpr - Paso Robles Formation  
 Tca - Careaga Formation

**Figure A8**

**Cross-Section I-I'**  
**Los Osos Valley**  
**Groundwater Basin**

**San Luis Obispo County**  
**January 2016 Revision**

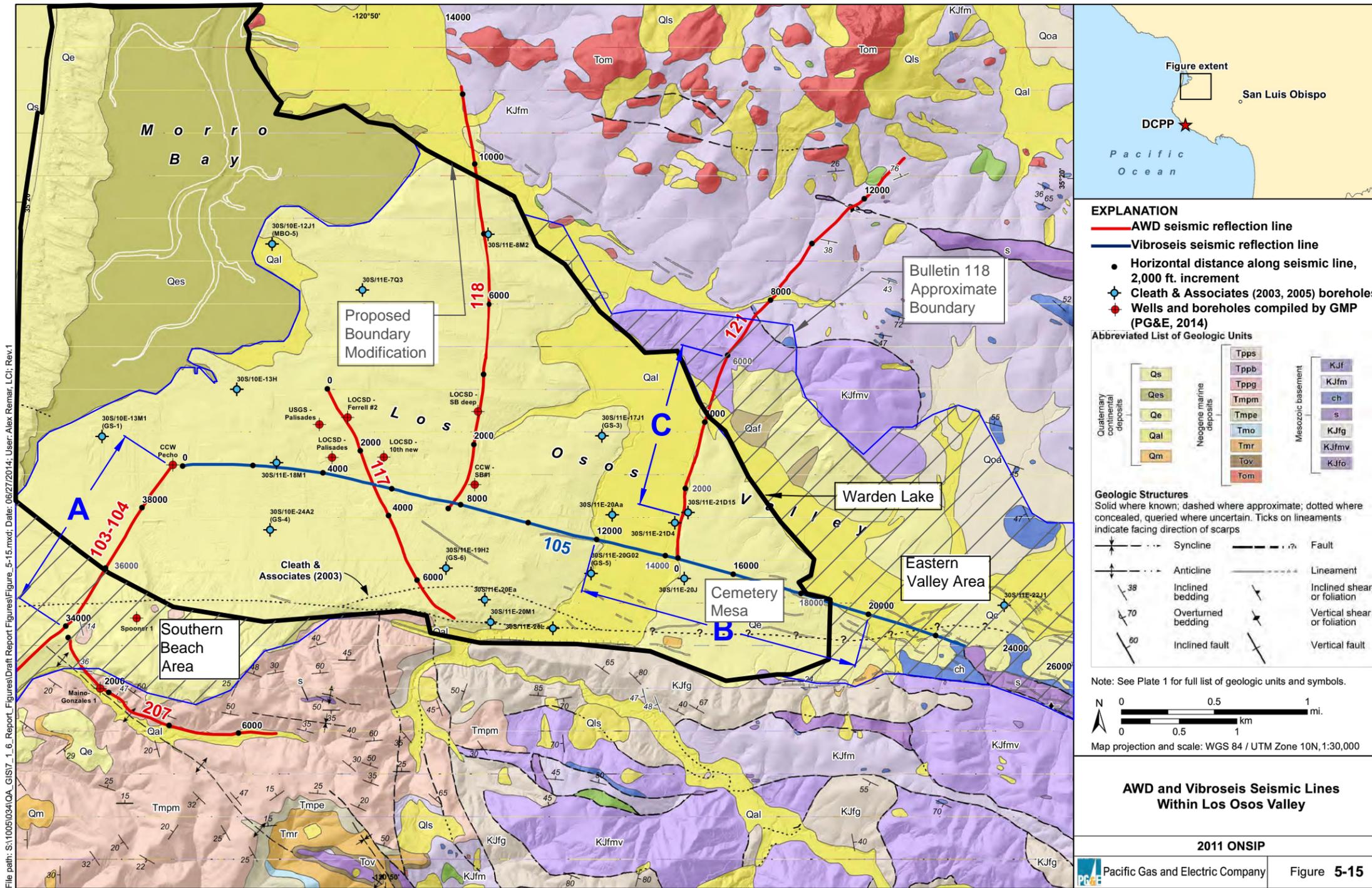
**Cleath-Harris Geologists**

**APPENDIX B**

Seismic Survey from PG&E

(excerpts of applicable figures)

# SUPPORTING INFORMATION FOR THE PROPOSED LOS OSOS BASIN BOUNDARY MODIFICATION AND SEISMIC SURVEY MODIFIED MAP



- GEOLOGIC UNITS**
- Qs - Quaternary offshore marine sediments
  - Qes - Quaternary estuarine deposits
  - Qe - Quaternary aeolian sands
  - Qal - Quaternary alluvial deposits
  - Qm - Quaternary marine terrace deposits
  - Tpps - Upper Pismo Formation Squire Member
  - Tppb - Upper Pismo Formation Bellevue Member
  - Tppg - Upper Pismo Formation Gragg Member
  - Tmpm - Lower Pismo Formation Miguelito Member
  - Tmpe - Lower Pismo Formation Edna Member
  - Tmo - Miocene Obispo Formation
  - Tmr - Miocene Rincon Formation
  - Tov - Oligocene Vaqueros Formation
  - Tom - Oligocene Morro Rock-Islay Hill volcanic intrusive complex
  - KJf - Cretaceous to Jurassic Franciscan Complex
  - KJfm - Cretaceous to Jurassic Franciscan Complex mélangé
  - ch - green, white, or red chert
  - s - serpentinite
  - KJfg - Cretaceous to Jurassic Franciscan Complex graywacke
  - KJfmv - Cretaceous to Jurassic Franciscan Complex metavolcanic rocks
  - KJfo - Cretaceous to Jurassic Franciscan Complex ophiolite

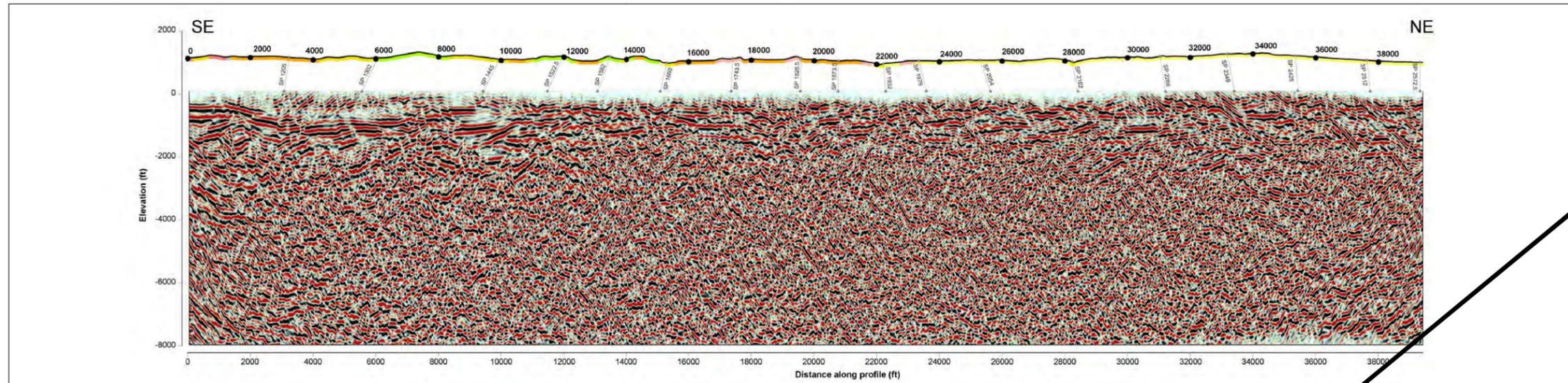
Reference: Base Map with Seismic Lines is from Pacific Gas and Electric Company, 2014.

- NOTES:**
- SOUTHERN BEACH AREA Seismic Survey Line 103-104** intersects the proposed basin boundary line at approximately 36000 feet, the horizontal distance along the seismic line. The cross-section for the seismic faults and geological uplifts are shown on **Figure B2**.
  - EASTERN VALLEY AREA - Seismic Survey Line 105** intersects the proposed basin boundary line at approximately 19000 feet, the horizontal distance along the seismic line. The cross-section for the seismic faults and geological uplifts are shown on **Figure B3**.
  - EASTERN VALLEY AREA - Seismic Survey Line 121** intersects the proposed basin boundary line at approximately 4000 feet, the horizontal distance along the seismic line. The cross-section for the seismic faults and geological uplifts are shown on **Figure B4**.

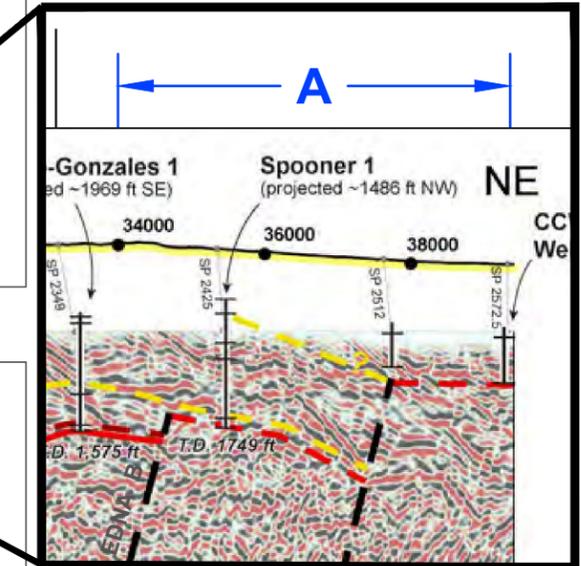
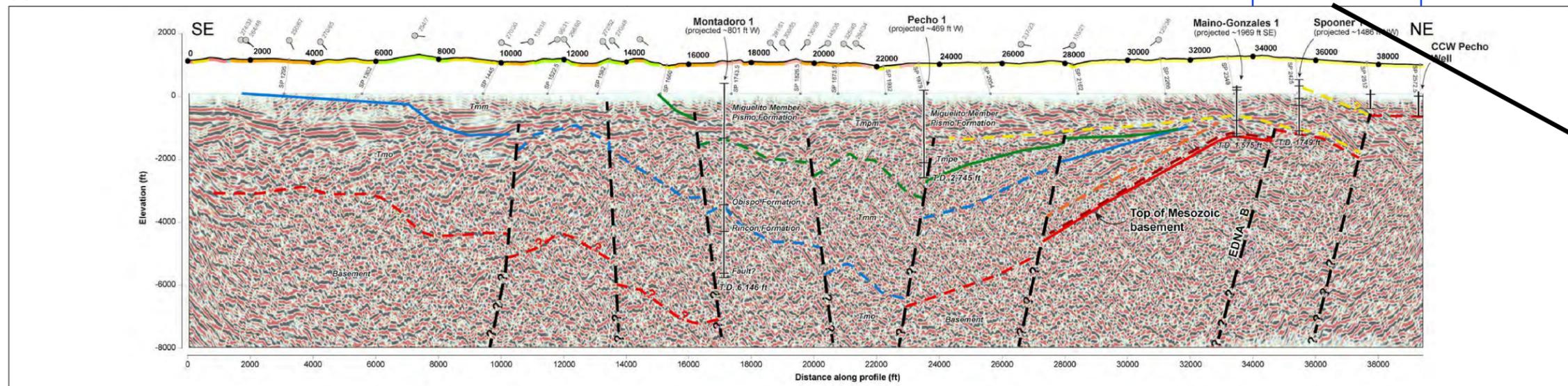
**FIGURE B1**  
Proposed Los Osos Groundwater Basin  
County of San Luis Obispo

# SOUTHERN BEACH AREA CROSS-SECTION SEISMIC SURVEY MODIFIED MAP

(a) Uninterpreted



(b) Interpreted



**Note:**  
The Los Osos fault cross-section at the Southern Beach boundary is delineated by Section A and shows the top of Edna (Pismo) Formation rising toward ground surface between line marker 38000 to 36000 (yellow line). Groundwater impedance is interpreted at approximately 36000 between the proposed Los Osos Basin boundary and the Southern Beach boundary.

**EXPLANATION**

- Fault: solid where well located, dashed where approximately located
  - *Tme* Top of Edna Formation
  - *Tmm* Top of Monterey Formation
  - *Tmo* Top of Obispo Formation
  - *Tmr* Top of Rincon Formation
  - *Tov* Top of Vaqueros Formation
  - *KJf* Top of Mesozoic Basement
  - 2000 Horizontal distance along seismic line, 2,000 ft increment
- Profile strike/dip**

True dip  
Strike  
Apparent dip

Shot point tie line location

Notes:  
- Seismic line QA\_bpfagc\_103\_104\_AWD\_FBM\_psdm\_1\_mix\_depth\_notvfacg\_ieee.  
- Geology along topographic profile from Plate 1; see Plate 1 and Figure 5-1 for explanation of map units.  
- Horizontal offsets are shown along a topographic profile above the seismic line.



**Alternative Interpretation of  
AWD Line 103-104:  
(a) Uninterpreted and (b) Interpreted**

2011 ONSIP

Pacific Gas and Electric Company Figure 5-3

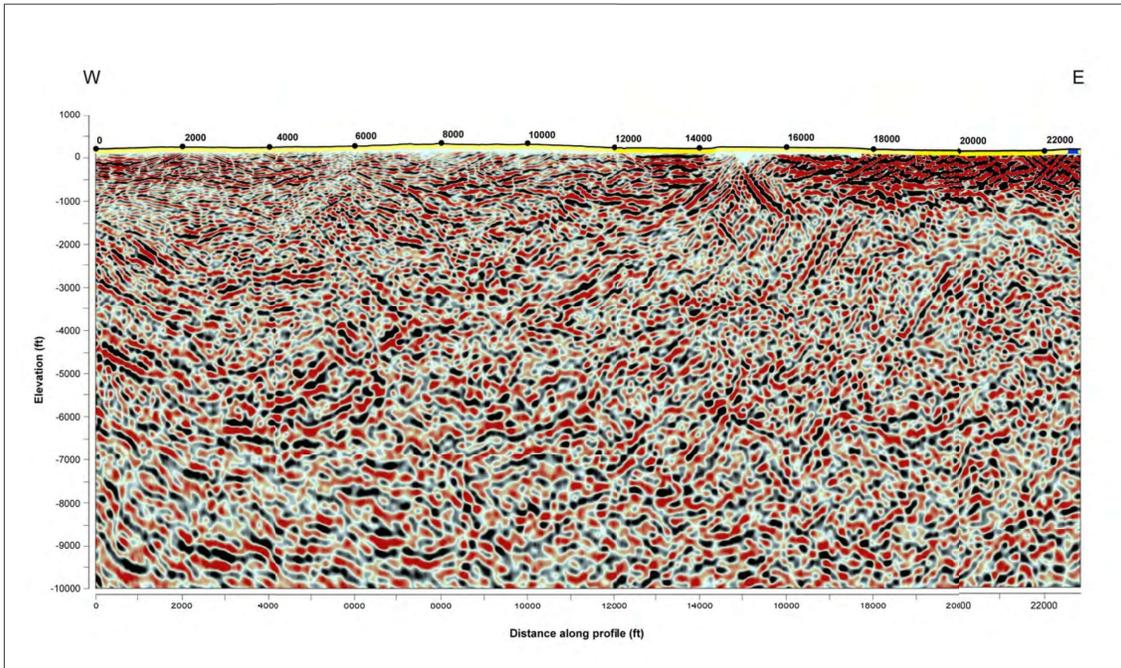
Ch7.GEO.DCPP.TR.14.03 R0

Reference: Base Map with Seismic Lines is from Pacific Gas and Electric Company, 2014.

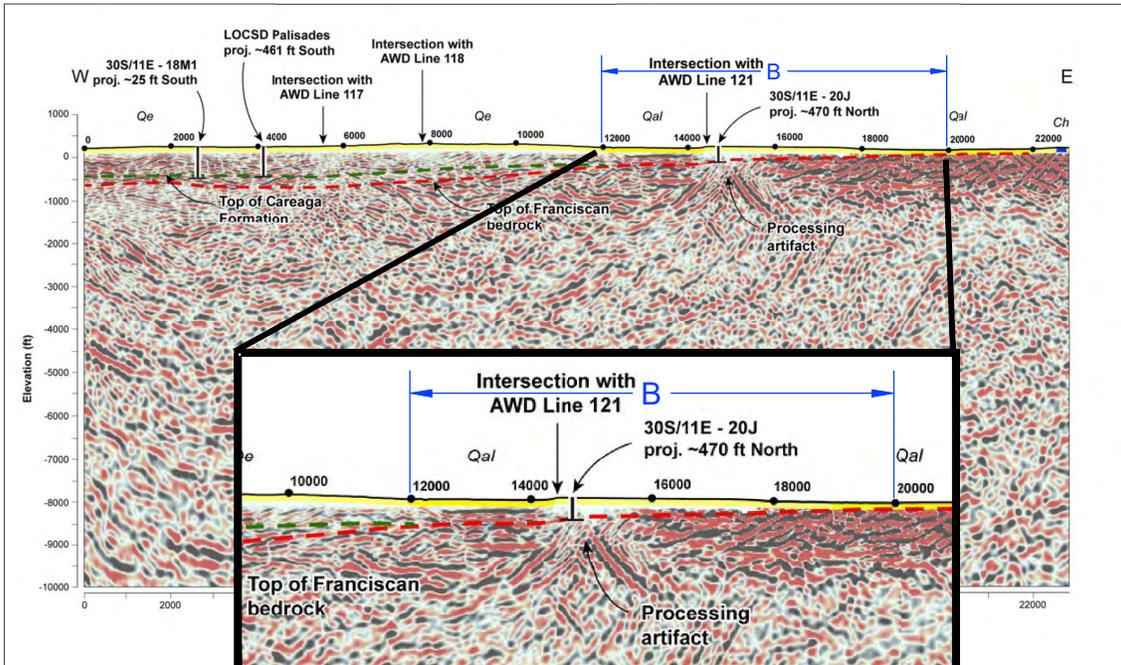
**FIGURE B2**  
Proposed Los Osos Groundwater Basin  
County of San Luis Obispo

# EASTERN VALLEY AREA CROSS-SECTION SEISMIC SURVEY MODIFIED MAP

(a) Uninterpreted



(b) Interpreted



**Note:** Section B shows rising bedrock at the cemetery mesa, delineating the Los Osos and Eastern Valley boundary at approximately 19000 feet (the horizontal distance along the seismic line).

**EXPLANATION**

- Fault: solid where well located, dashed where approximately located
- Tpc* Top of Careaga Formation
- K/J* Top of Mesozoic Basement
- 2000 ● Horizontal distance along seismic line, 2,000 ft increment

- Notes:
- Seismic line trimmed\_105\_2D\_beam\_50k\_vibeonly\_poly\_sl\_stackgc\_JEEE.
  - Geology along topographic profile from Plate 1; see Plate 1 and Figure 6-1 for explanation of map units.
  - Horizontal offsets are shown along a topographic profile above the seismic line.



**Vibroseis Line 105:  
(a) Uninterpreted and (b) Interpreted**

2011 ONSIP

Pacific Gas and Electric Company

Figure 5-17

Ch7.GEO.DCPP.TR.14.03 R0

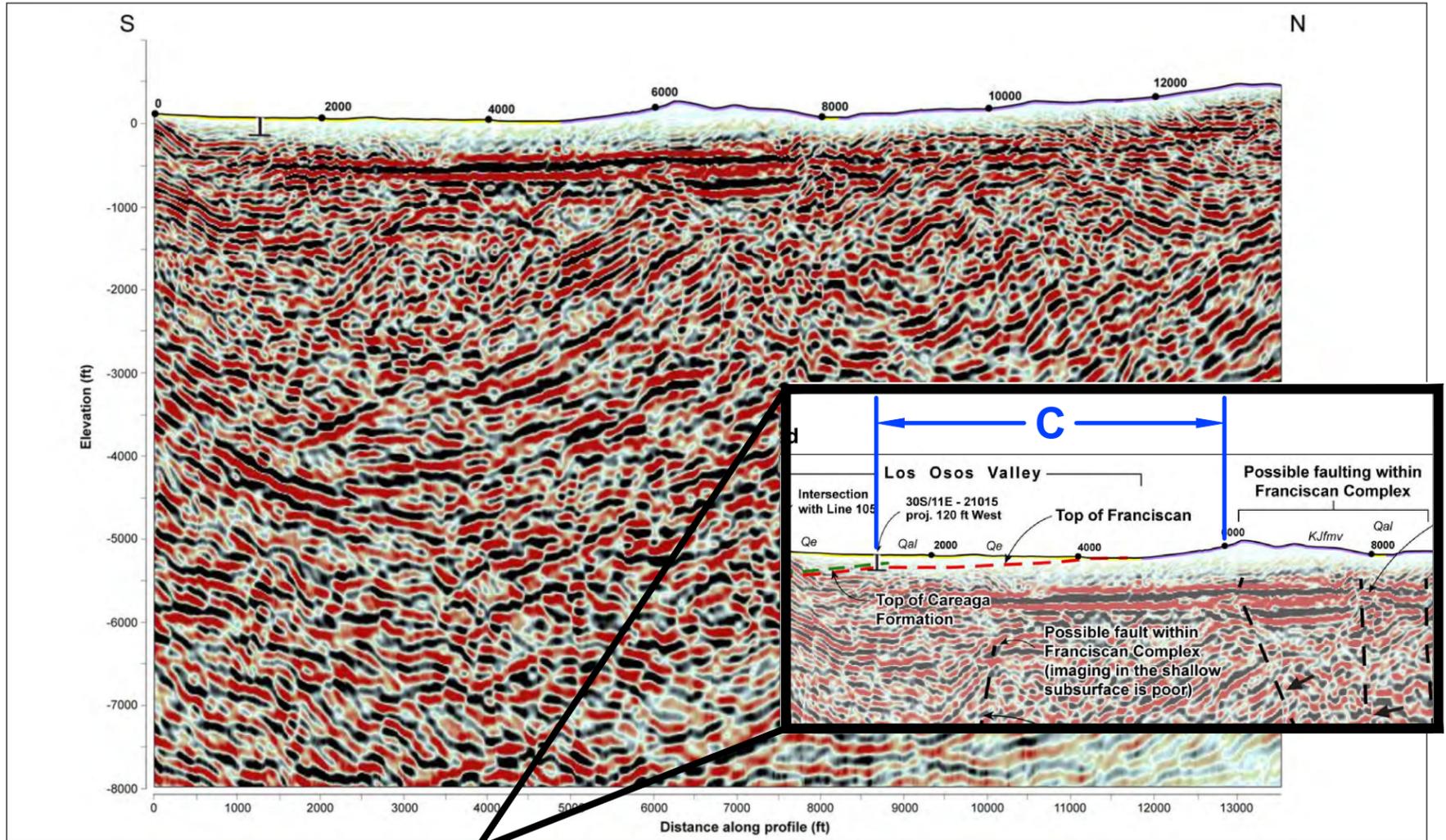
Reference: Base Map with Seismic Lines is from Pacific Gas and Electric Company, 2014.

**FIGURE B3**  
Proposed Los Osos Groundwater Basin  
County of San Luis Obispo

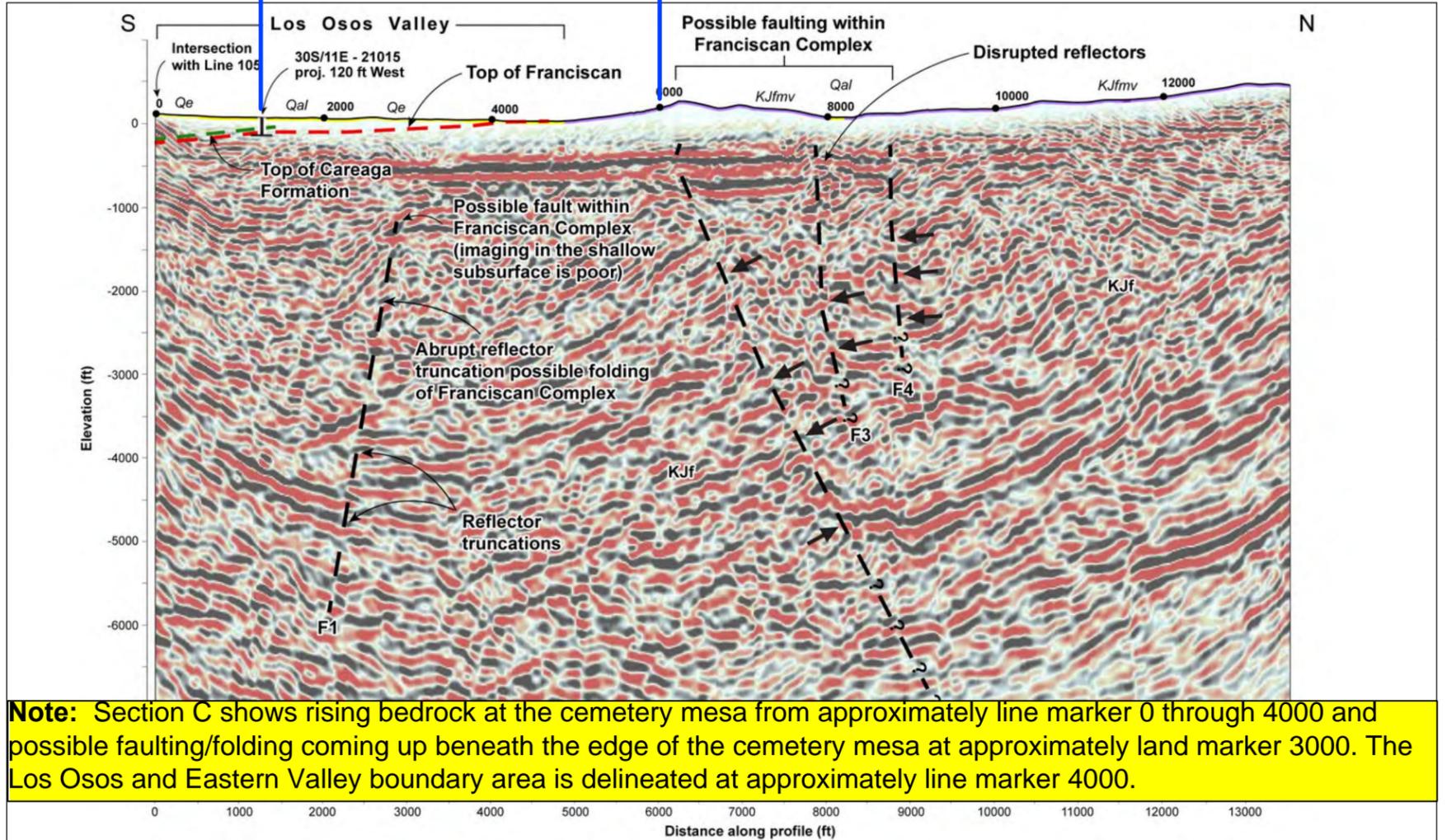
File path: S:\1005\034\OA\_GISV\_1\_6\_Report\_Figures\Draft Report Figures\Figure 5-17\_Line\_105.mxd; Date: 06/10/2014; User: Jereme Chandler, LCI, Rev. 1

# EASTERN VALLEY AREA CROSS-SECTION SEISMIC SURVEY MODIFIED MAP

**(a) Uninterpreted**



**(b) Interpreted**



**EXPLANATION**

- Fault: solid where well located, dashed where approximately located
- Tpc Top of Careaga Formation
- KJf Top of Mesozoic basement
- 2000 Horizontal distance along seismic line, 2,000 ft increment
- ← Arrows marking offset or truncated reflectors

- Notes:
- Seismic line 121 awd fbn psdm 1 mix depth tvfagc.
  - Geology along topographic profile from Plate 1; see Plate 1 and Figure 6-1 for explanation of map units.
  - Horizontal offsets are shown along a topographic profile above the seismic line.



**AWD Line 121:  
(a) Uninterpreted and (b) Interpreted**

**2011 ONSIP**

Pacific Gas and Electric Company

Figure **5-21**

Ch7.GEO.DCPP.TR.14.03 R0

Reference: Base Map with Seismic Lines is from Pacific Gas and Electric Company, 2014.

**FIGURE B4**

Proposed Los Osos Groundwater Basin  
County of San Luis Obispo

**APPENDIX C**

Department of Water Resources, Sea Water Intrusion, Bulletin 63-6

(excerpts of applicable figures)

**Figure C1: Southern Beach Area- Modified Lithologic Log for Well 23C1**

Note: Well lithologic log consist of mostly clay below 70 feet depth, and is interpreted by DWR as Pliocene. This correlates to the Pismo Formation, which outcrops south of main strand of Los Osos/Edna fault zone, and is interpreted to be outside of the proposed Basin Boundary in the Southern Beach Area.

**LITHOLOGIC LOG**

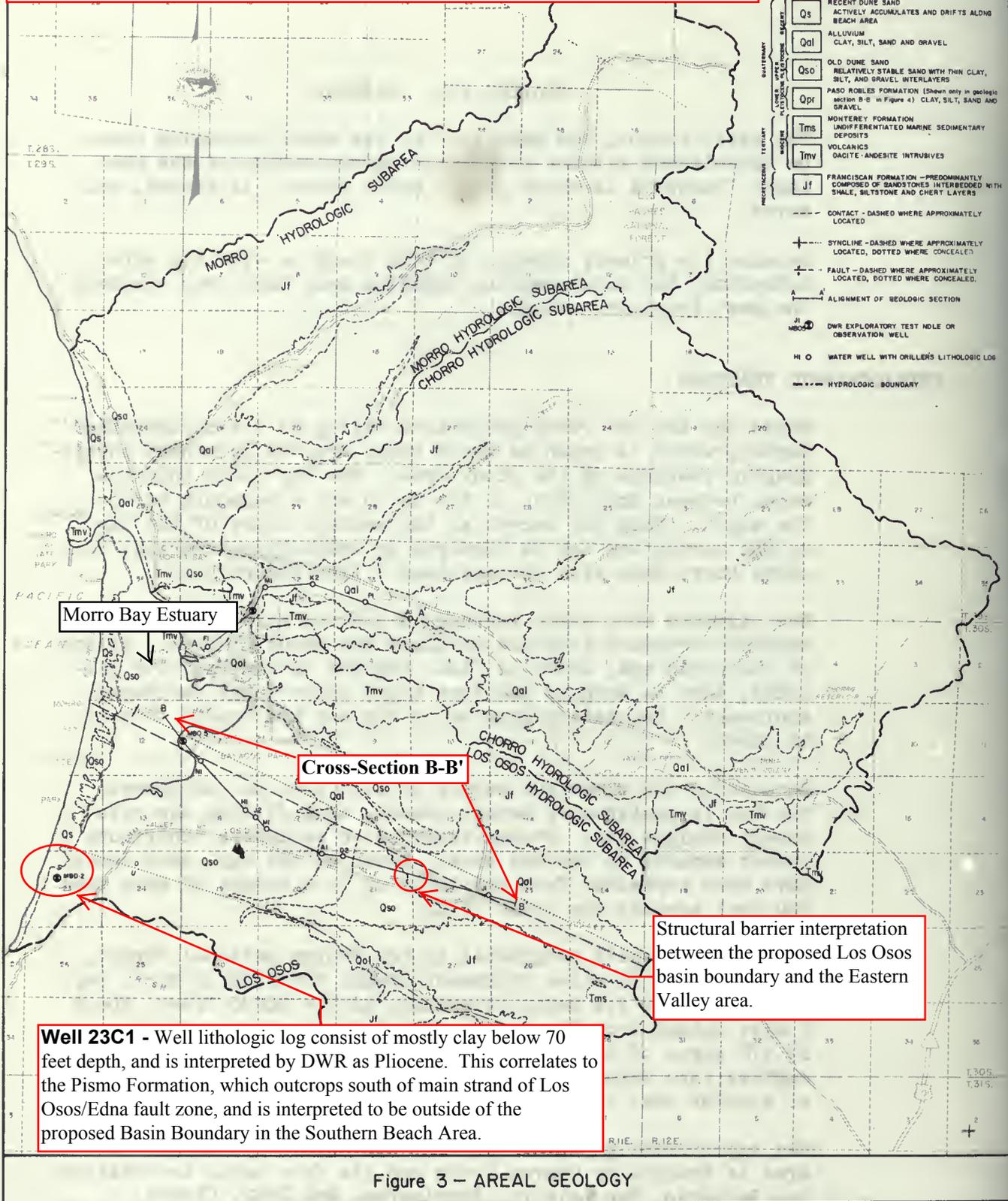
Drill Site No. MBO -2  
 Drilling Method: Rotary  
 Ground Surface Elevation: 75 feet

State Well No. 30S/10E-23C1  
 Diameter: 6-3/4 inches  
 Depth: 631 feet

<u>Depth in feet</u>	<u>Material</u>
0- 70	Sand: Tan, orange, red, light grey, white, subround, very fine to medium- to coarse-grained sand; light and dark brown wood fragments; granules (less than 5% at 45 feet; increase to 20 - 30% at 55 feet); light green and some yellow clayey silt lenses at 58 to 70 feet.
70- 85	Silt: Light green clayey silt with very fine- to coarse-grained sand (40%); increase in light green siltstone particles at 75 feet.
85- 94	Clay: Light green, silty, sandy clay with gravel (10 - 20%).
94-106	Clay, Sand, and Gravel: Light green silty clay; light and dark green; tan, very fine- to coarse-grained sand with gravel.
106-119	Clay: Light bluish-green, silty, sandy clay; granules (less than 5%).
119-121	Sand and Gravel: Light and dark green, brown, tan, white, very fine- to coarse-grained sand with gravel.
121-198	Clay: Bluish-green sandy, gummy clay; light and dark green, brown, tan, white, very fine- to medium-grained sand stringers.
198-200	Gravel: Light green (shale), tan, dark brown, red, black, sandy gravel; few light and dark brown wood fragments.
200-360	Clay: Light bluish-green, silty, gummy clay with tan, light and dark brown, white, light green (shale), red, very fine- to coarse-grained sand stringers; light and dark brown wood fragments.
360-403	Clay and Silt: Light green, sandy clay with silt; very fine- to medium- to coarse-grained sand (less than 5%); trace of gravel.
403-455	Clay: Light green, silty, sandy clay; medium- to coarse-grained sand (less than 5%); light and dark brown wood fragments; trace of gravel.
455-523	Clay: Green, gummy clay; tan, light and dark brown, yellow, light green, very fine- to coarse-grained sand (less than 5%); few granules; few light and dark brown wood fragments.
523-565	Clay and Silt: Light green sandy clay with silt; few light and dark brown wood fragments.
565-569	Shale: Light green, white (trace) shale.
569-580	Clay: Light green, silty, sandy clay; light and dark brown wood fragments.
580-631	Clay and Silt: Light green, sandy (very fine-grained) clay with silt; light green shale chips; few light and dark brown wood fragments; few tan and white granule fragments.

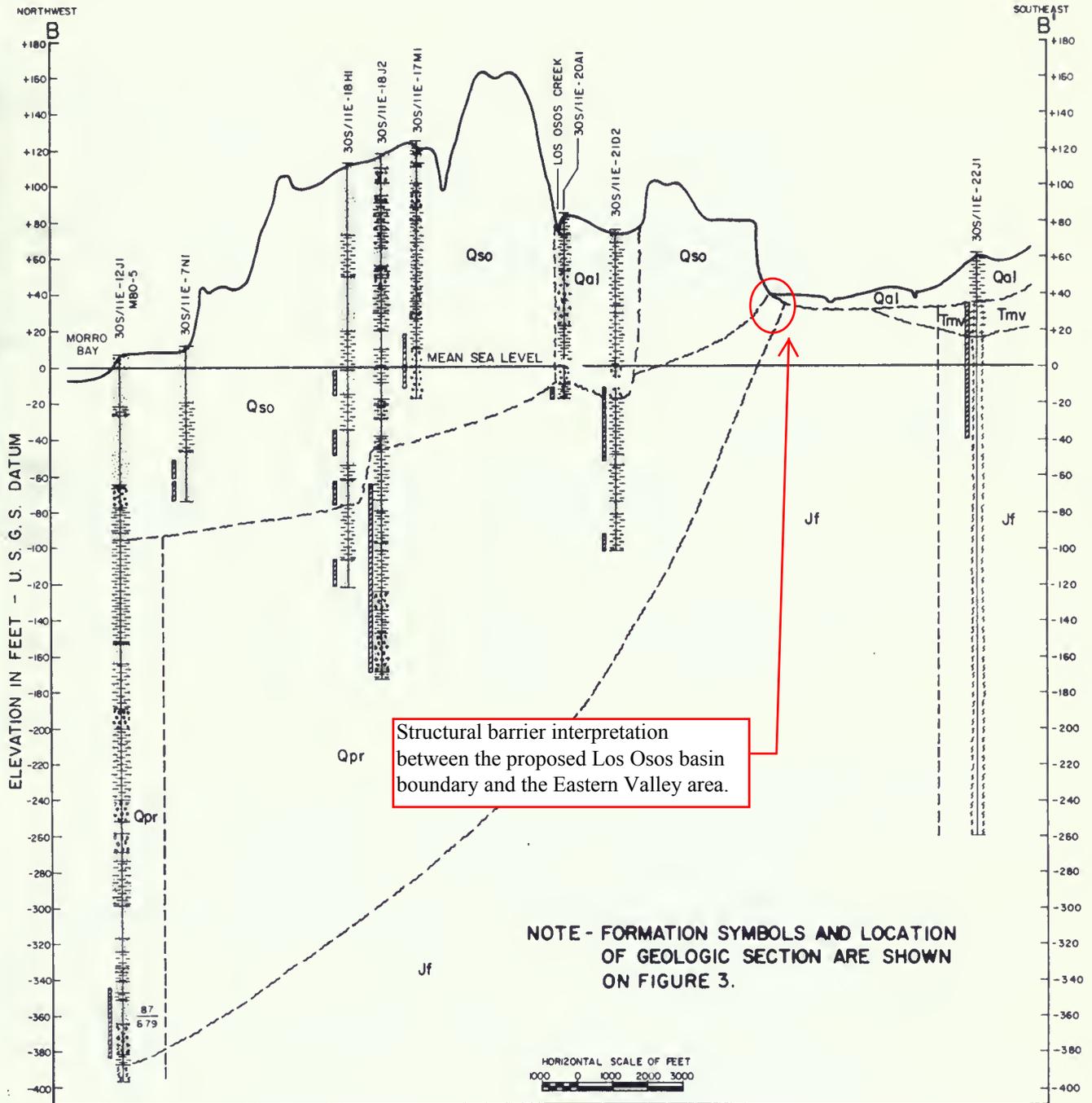
Reference: Department of Water Resources (DWR), State of California, 1972, Sea Water Intrusion: Morro Bay Area, San Luis Obispo County, Bulletin 63-6, February 1972.

**Figure C2: Los Osos Basin - Modified Location of Cross-Section B-B' and Well 23C1, Areal Geology**



Reference: Department of Water Resources (DWR), State of California, 1972, Sea Water Intrusion: Morro Bay Area, San Luis Obispo County, Bulletin 63-6, February 1972.

**Figure C3: Los Osos - Modified Cross-Section B-B'**



Reference: Department of Water Resources (DWR), State of California, 1972, Sea Water Intrusion: Morro Bay Area, San Luis Obispo County, Bulletin 63-6, February 1972.

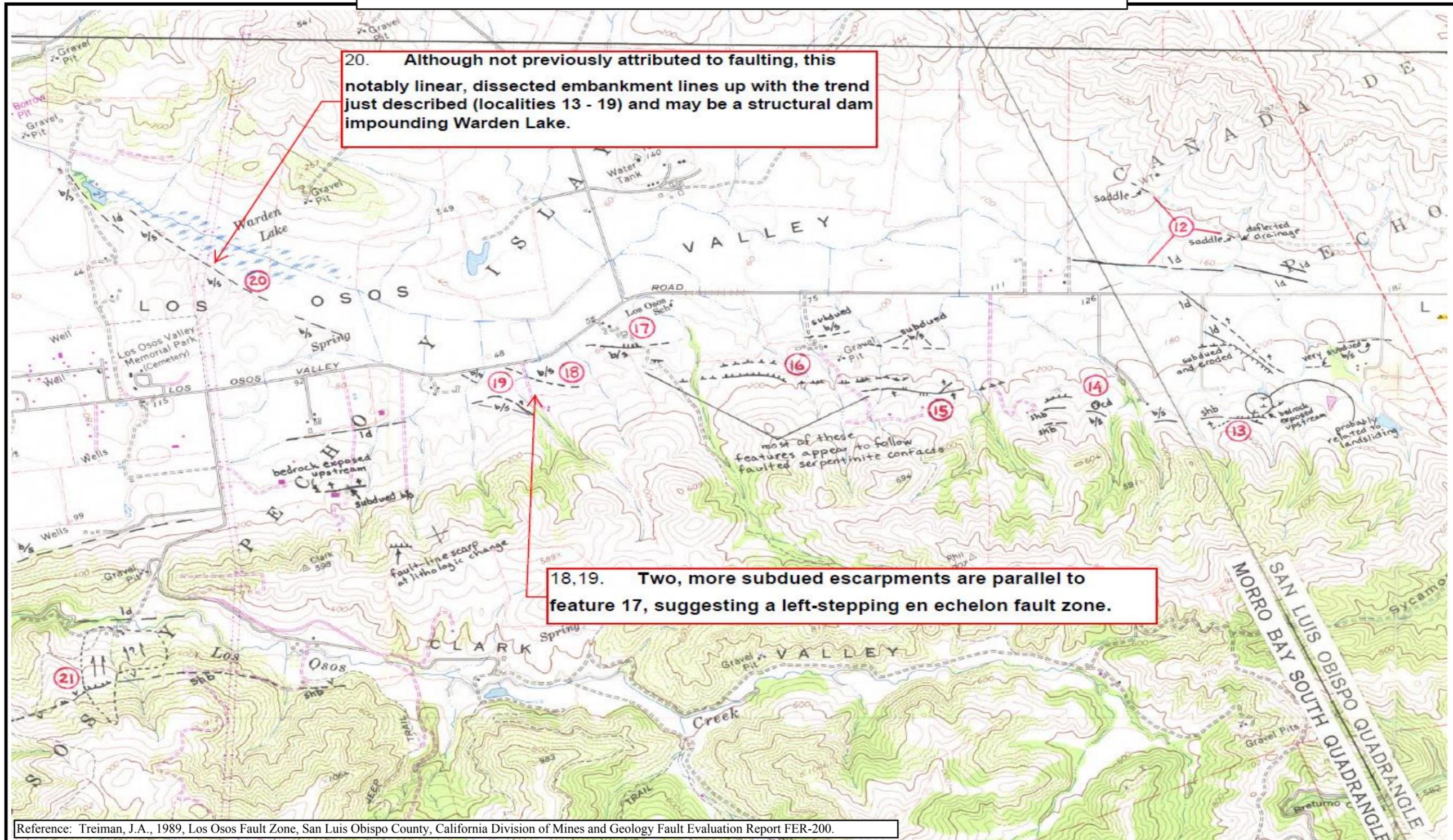
SECTIONS A-A' AND B-B'

**APPENDIX D**

California Division of Mines and Geology Fault Evaluation Report

(excerpts of applicable figures)

**Figure D1 - Modified California Division of Mines and Geology Fault Figure**



**Notes:** Warden Lake is interpreted as a **structural dam impoundment** as referenced by Figure D1. Other scientific documents referenced in the Los Osos Valley Groundwater Basin Boundary Modification Request Technical Memorandum (§ 344.14(a)(2)), such as **USGS, DWR, and Morro Group**, have also discussed the Eastern Valley Area as **conveying an insignificant amount of groundwater** to the Los Osos Basin Boundary.

1. "In these areas of the (DWR Bulletin 118) groundwater basin, alluvium and Paso Robles Formation are apparently underlain at shallow depth by older rocks that have a **limited capacity to store and transmit water**. Also, because of the physical relationships between rock units at the easterly and northeasterly limits of the Paso Robles [Formation] storage unit, the **potential for recharge of the storage unit from areas to the east would appear to be very limited**" - **Morro Group (1987)**
2. " **Little or no groundwater enters the basin from the east end of Los Osos Valley for two reasons. First, shallow slopes and thin, clayey soils greatly hinder the horizontal movement of water. Second, the mesalike terrace just inside the east end of the basin probably creates a local groundwater mound, which would tend to prevent inflow from the east.**" - **U.S. Geological Survey (Yates and Wiese, 1988)**
3. " **Only in areas less than 4 miles from the coast do water-bearing sediments of significant thickness occur. Farther east, bedrock is overlain by sediments of low permeability, which are less than 30 feet thick. Thus, the groundwater basin begins about 4 miles inland and deepens to the west.**" - **DWR (1989)**

**APPENDIX E**

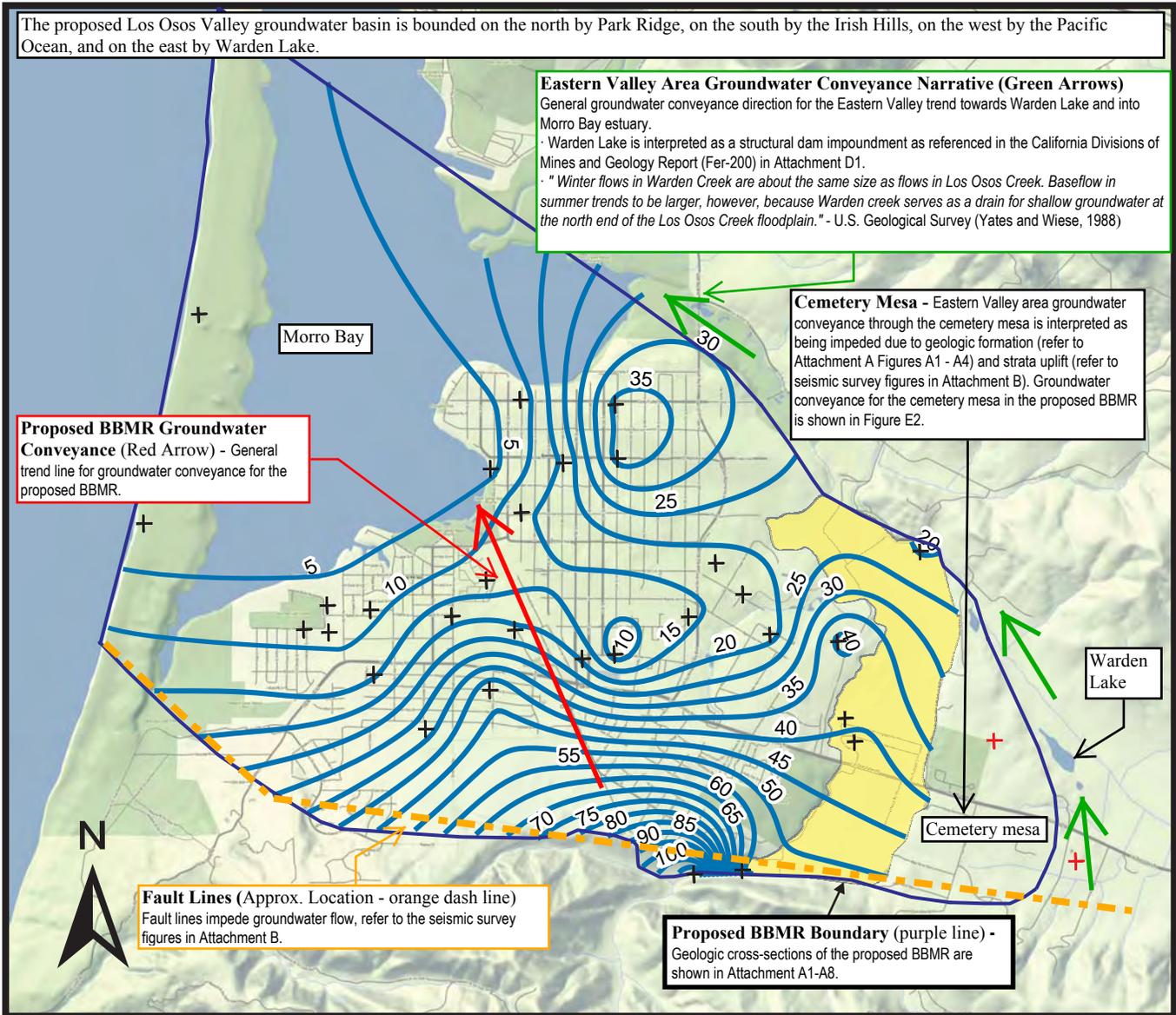
Los Osos Basin Plan

Groundwater Monitoring Report, 2015 Annual Report

Spring 2015 Water Level Contours (excerpts of applicable figures)

**MODIFIED UPPER AQUIFER GROUNDWATER CONVEYANCE FIGURE**

The proposed Los Osos Valley groundwater basin is bounded on the north by Park Ridge, on the south by the Irish Hills, on the west by the Pacific Ocean, and on the east by Warden Lake.



Base Image: Stamen-Terrain



Scale: 1 inch ≈ 4,000 feet

**Explanation**

-  Groundwater elevation contour in feet above sea level (NAVD 88 datum)
-  Limits of Alluvial Aquifer
-  Spring 2015 groundwater elevation data point (contours blanked outside of Upper Aquifer and Alluvial Aquifer limits)
-  Alternate date groundwater elevation data point

**Abbreviations**

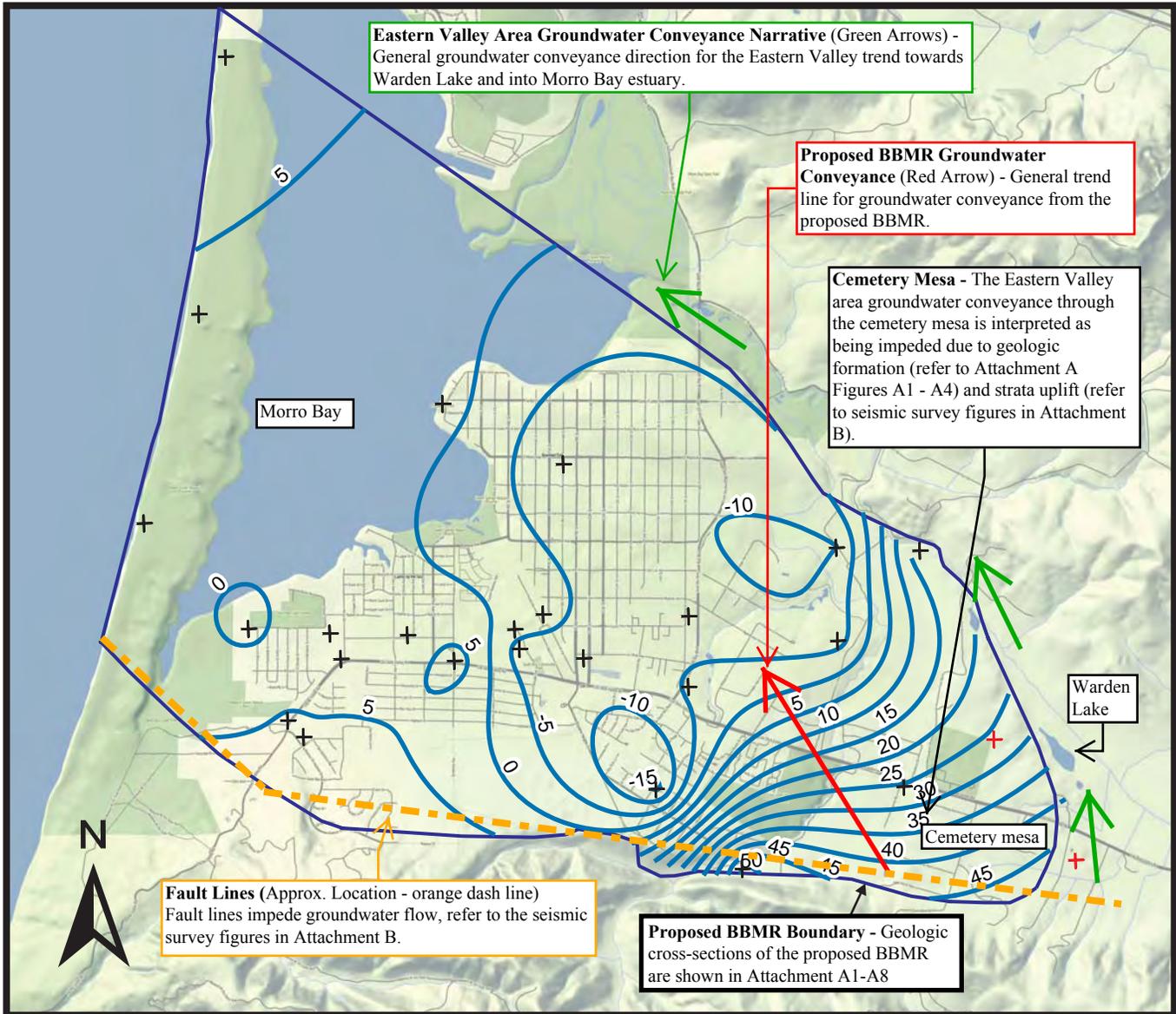
BBMR - Basin Boundary Modification Request

Figure E1  
 Spring 2015 Water Level Contours  
 Upper Aquifer and Alluvial Aquifer  
 Los Osos Groundwater Basin  
 2015 Annual Report

Cleath-Harris Geologists

Reference: Cleath-Harris Geologists (CHG), 2015, Los Osos Basin Plan Groundwater Monitoring Program, 2015 Annual Report, prepared for Los Osos Basin Management Committee.

**MODIFIED LOWER AQUIFER GROUNDWATER CONVEYANCE FIGURE**



Base Image: Stamen-Terrain



Scale: 1 inch ≈ 4,000 feet

**Explanation**

- Groundwater elevation contour in feet above sea level (NAVD 88 datum)
- Spring 2015 groundwater elevation data point
- Alternate date groundwater elevation data point

**Abbreviations**

BBMR - Basin Boundary Modification Request

Figure E2  
Spring 2015 Water Level Contours  
Lower Aquifer  
Los Osos Groundwater Basin  
2015 Annual Report  
  
Cleath-Harris Geologists

Reference: Cleath-Harris Geologists (CHG), 2015, Los Osos Basin Plan Groundwater Monitoring Program, 2015 Annual Report, prepared for Los Osos Basin Management Committee.