

Reconnaissance-Level Evaluation of ASR and IPR

**City of Santa Cruz Water Department
Water Supply Advisory Committee
Enrichment Session
April 22, 2015**

**Robert C. Marks, P.G., C.Hg.,
Principal Hydrogeologist
Pueblo Water Resources, Inc.**



Presentation Overview

- **What is Aquifer Storage and Recovery (ASR)?**
- **What is Indirect Potable Reuse (IPR)?**
- **Basic Components of an ASR / IPR Project**
- **Purpose and Scope of Study**
- **ASR Conceptually Applied to Santa Cruz**
- **Describe Hydrogeologic Settings**
 - Available Aquifer Storage Space
 - Well Injection Capacities
- **Conceptual ASR Project**
- **Conclusions and Recommendations**
- **Q & A / Discussion**

What is Aquifer Storage and Recovery (ASR)?

Formal Definition: *Aquifer Storage and Recovery (ASR) is the recharge of an aquifer via injection wells during times when water is available, and recovery of the water from the same wells during times when it is needed (Pyne, 1994)*

- Essentially a Form of Managed Aquifer Recharge, or "Groundwater Banking", that Utilizes Wells for the Injection and Later Recovery of Excess Water Supplies.
- In CA ASR Utilizes Excess Potable Water Supplies.

What is Indirect Potable Reuse (IPR)?

➤ **Similar to ASR:**

- Utilizes Injection Wells
- Depleted Aquifer Storage Space

➤ **Fundamental Difference from ASR:** Treated Recycled (Non-Potable) Water is Used

- Same Wells Cannot Be Used for Both Injection and Recovery
- Injection Wells Need to be Located at Prescribed Distances from Drinking Water Supply / Recovery Wells

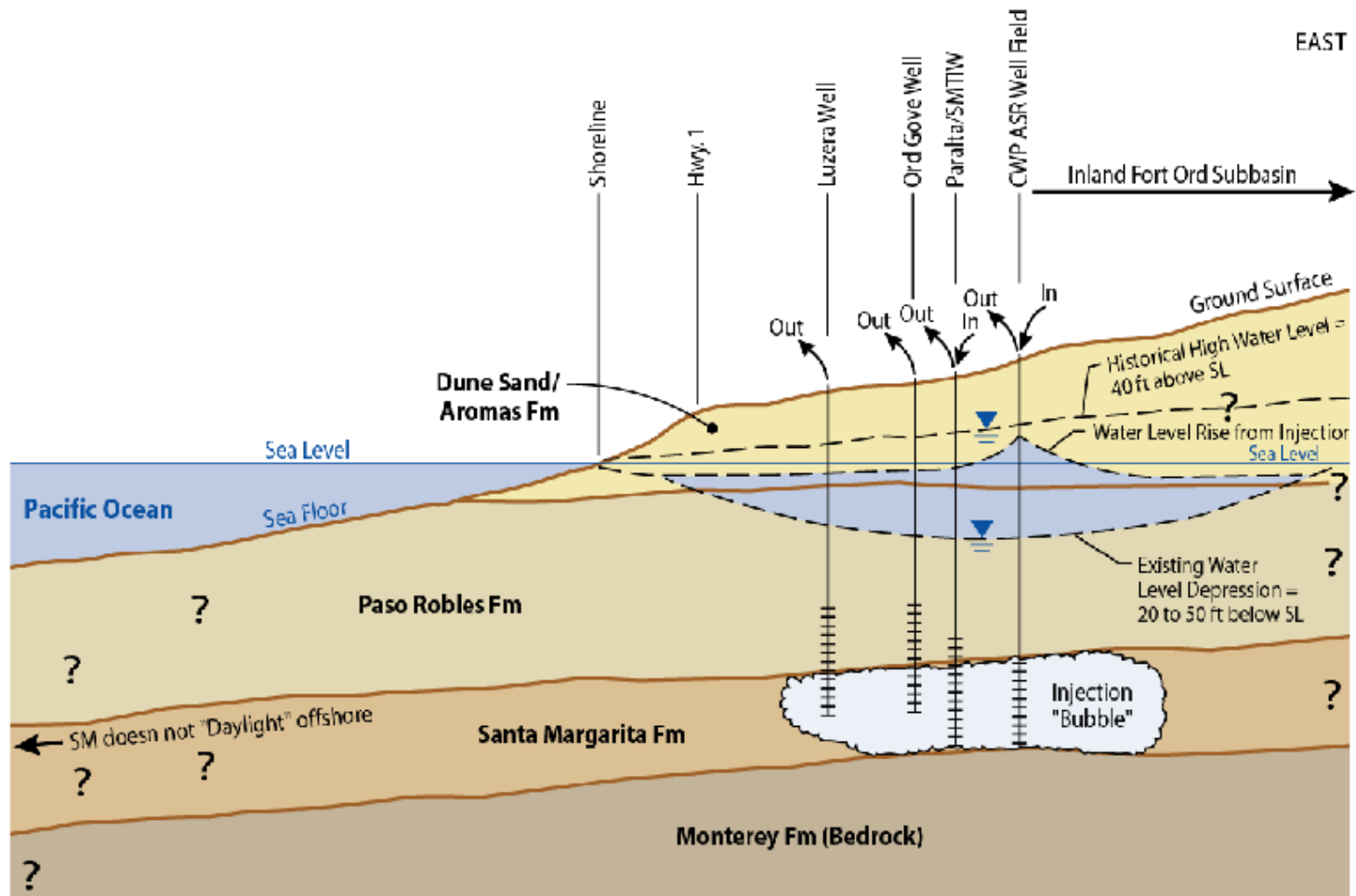
Basic Components of a Typical ASR / IPR Program

1. Source of Excess Water
2. Diversion / Treatment / Conveyance Infrastructure
3. Groundwater Basin with Available Storage Capacity
4. Injection / Recovery Wells

Injection Well Technology

- Aquifer Recharge via Injection Wells Has Existed Since the 1950's.
- General Conclusions Regarding Injection/ASR Include:
 1. ASR is an effective and economical water supply management tool
 2. Injection is most effective using treated Potable-Quality Source Water
 3. It is typically possible to recover the entire volume of injected water
 4. Water-Quality degradation is typically minimal (or even beneficial)
 5. Well Injection Rates are typically 50% to 80% of pumping rates

Seaside Basin ASR Schematic



Purpose and Scope

Purpose: Perform Reconnaissance-Level Feasibility Study of ASR and IPR for Santa Cruz

Scope: Review Readily Available Existing Information Related to Key Components of ASR Project and Identify “What is Known” and “What is Not Known” Regarding a Potential Project:

- Compile and Review Existing Data
- Define Hydrogeologic Settings
- Estimate Available Aquifer Storage Space
- Estimate Well Injection Capacities
- Develop Conceptual ASR Project

ASR / IPR Conceptually Applied to Santa Cruz

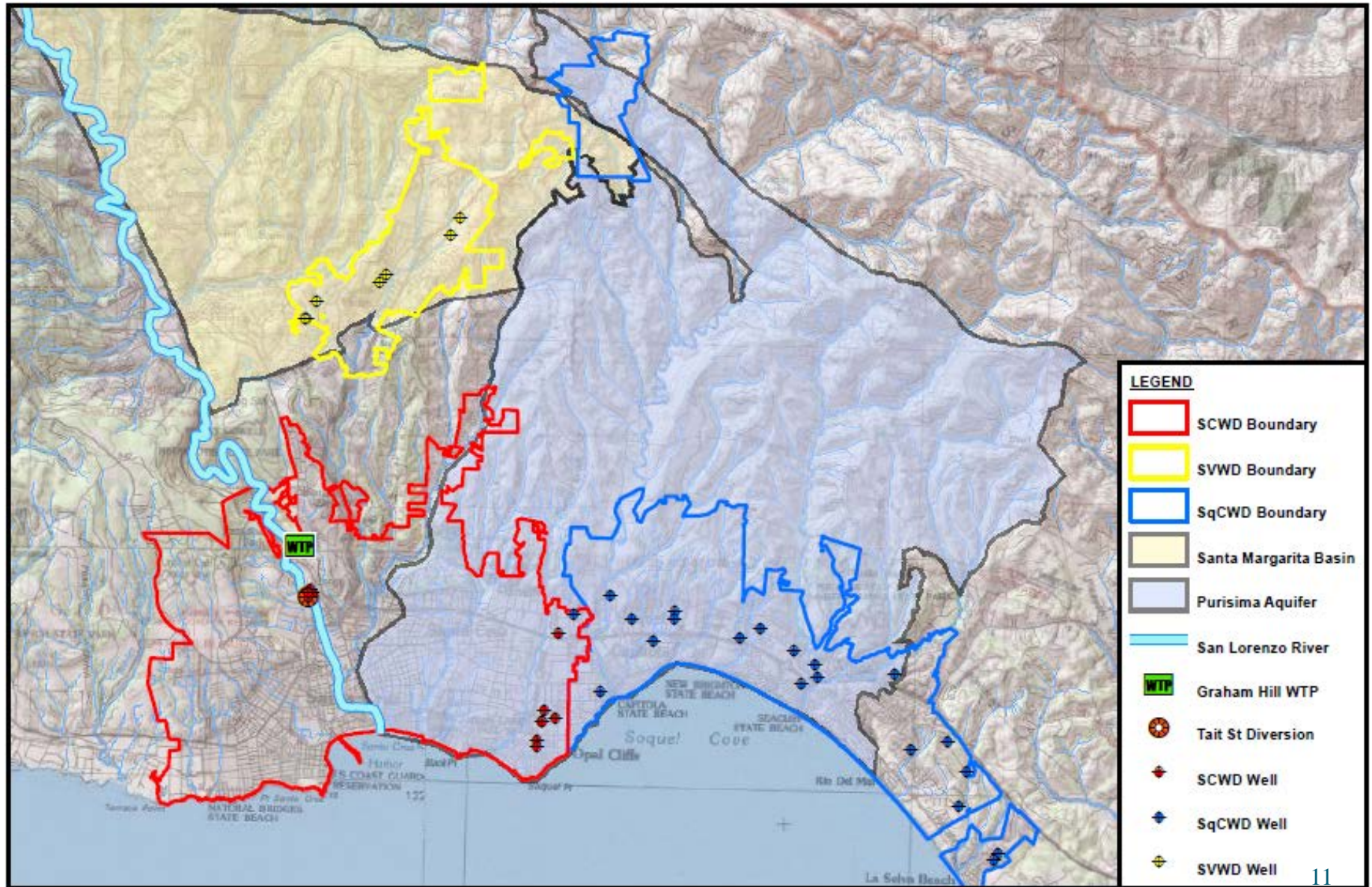
1. Source Water: “Excess” San Lorenzo River Flows (ASR) and/or Treated Wastewater (IPR)
2. Infrastructure: Tait St. Diversion / GHWTP / Existing (or improved) SCWD Distribution (ASR)
3. Storage Aquifers: Purisima Aquifer and/or Santa Margarita Groundwater Basin (SMGB)
4. Injection / Recovery Wells: Existing and/or Dedicated New ASR / IPR Wells

Hydrogeology

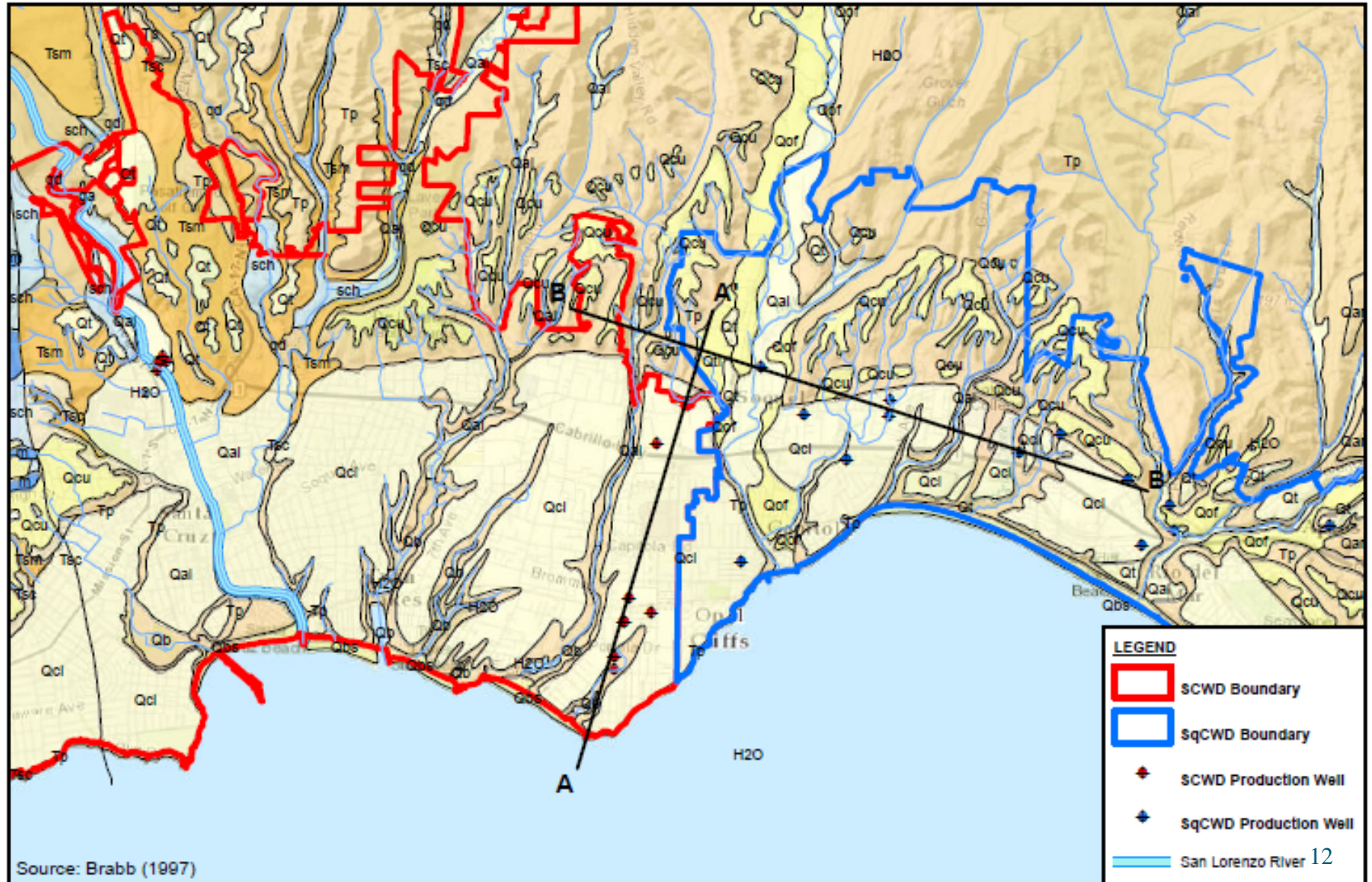
Hydrogeology Controls Two Key ASR/ IPR Project Components:

1. Available Aquifer Storage Space
2. ASR Well Capacity
 - a. Per-Well Injection Capacity
 - b. # of Wells Required

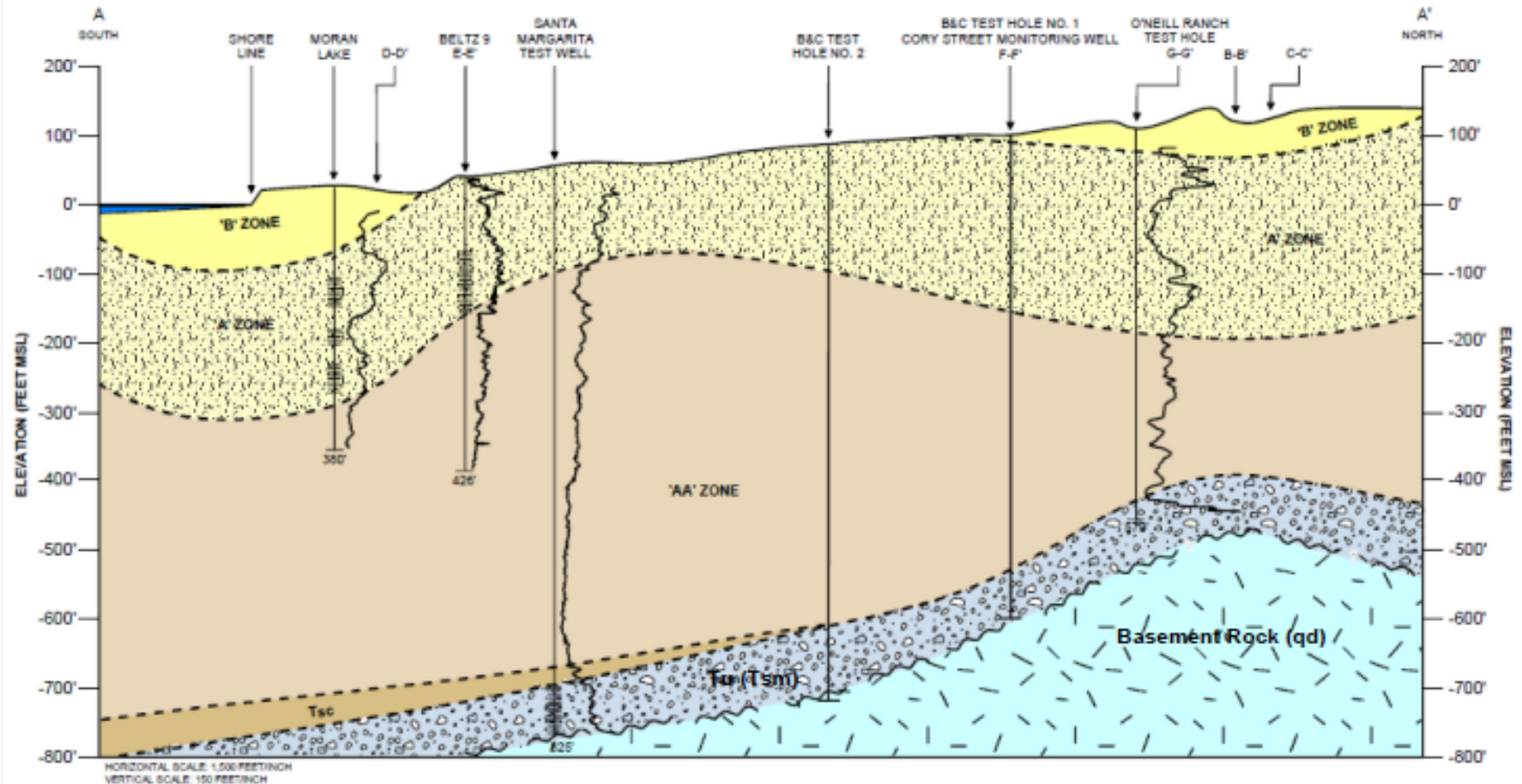
Study Area Map



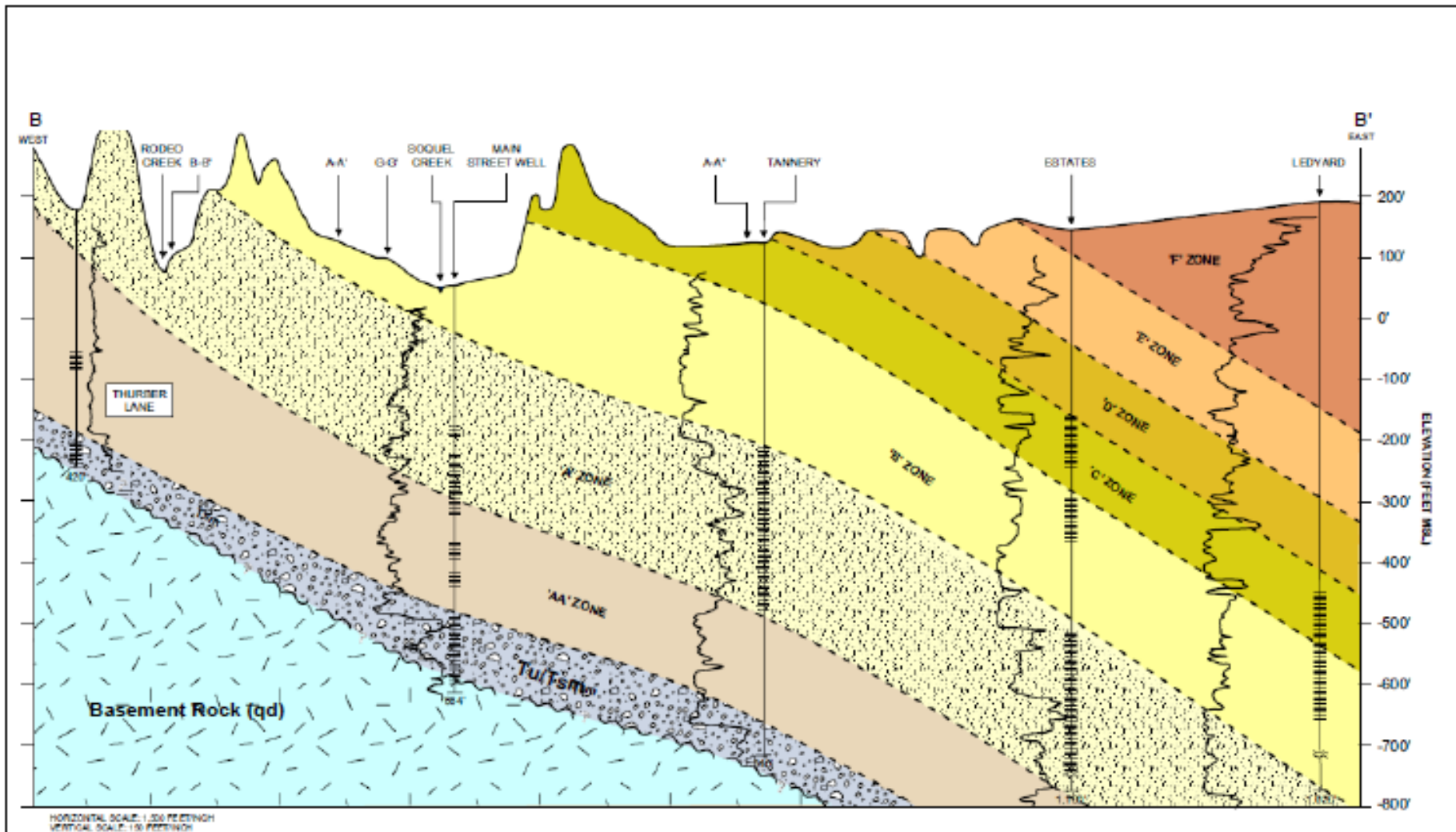
Geologic Map – Purisima



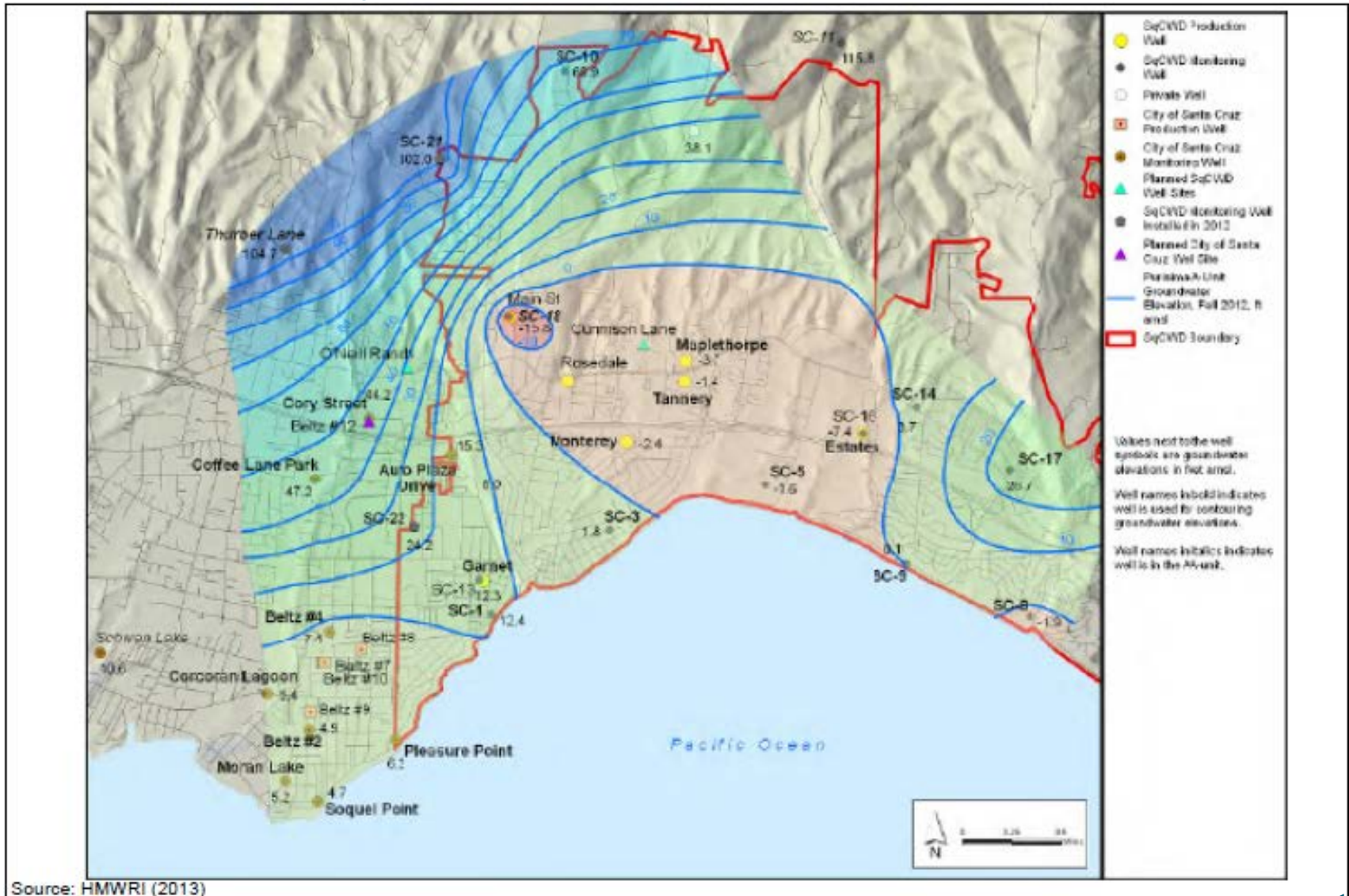
Purisima X-Section A-A'



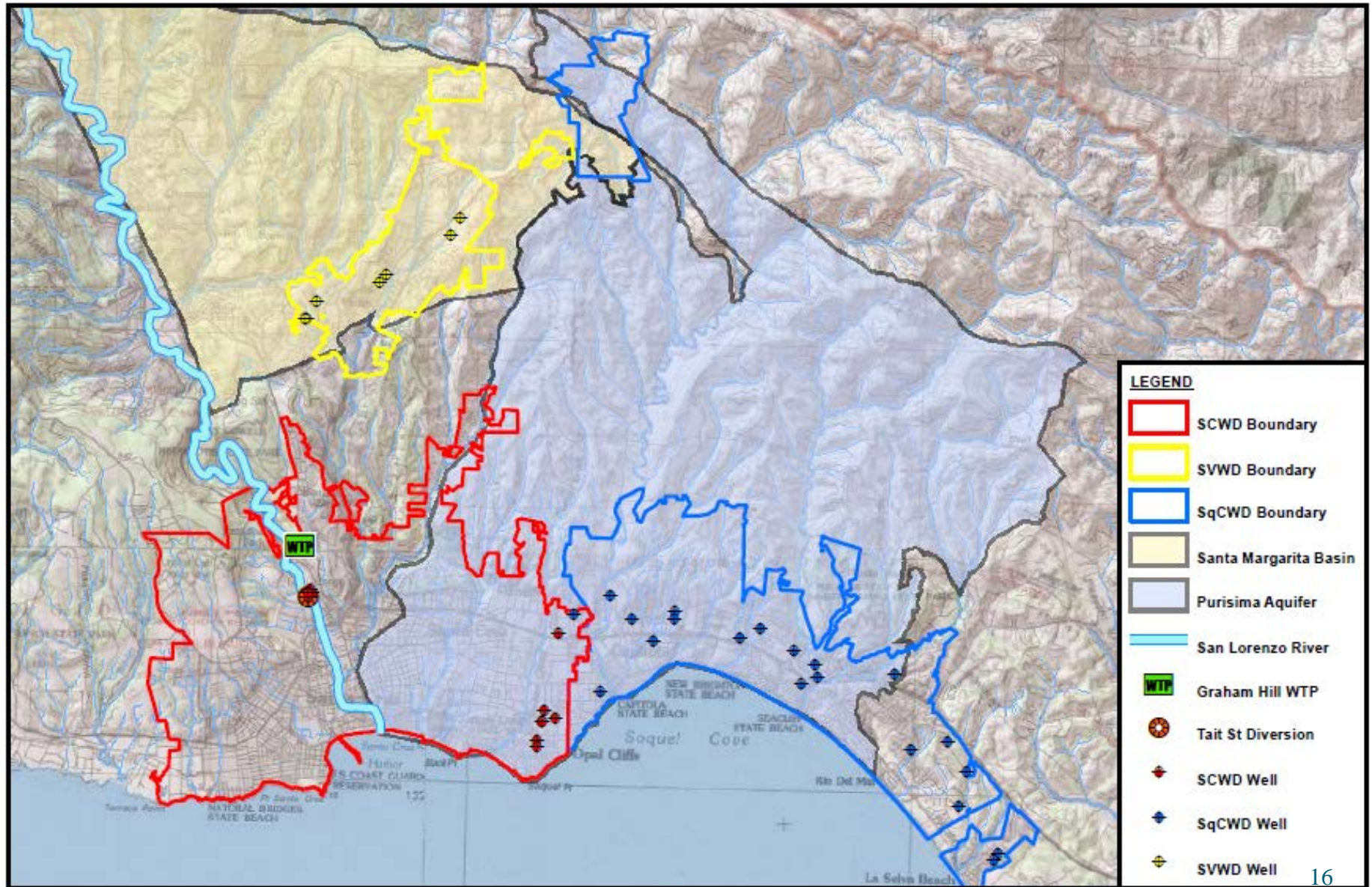
Purisima X-Section B-B'



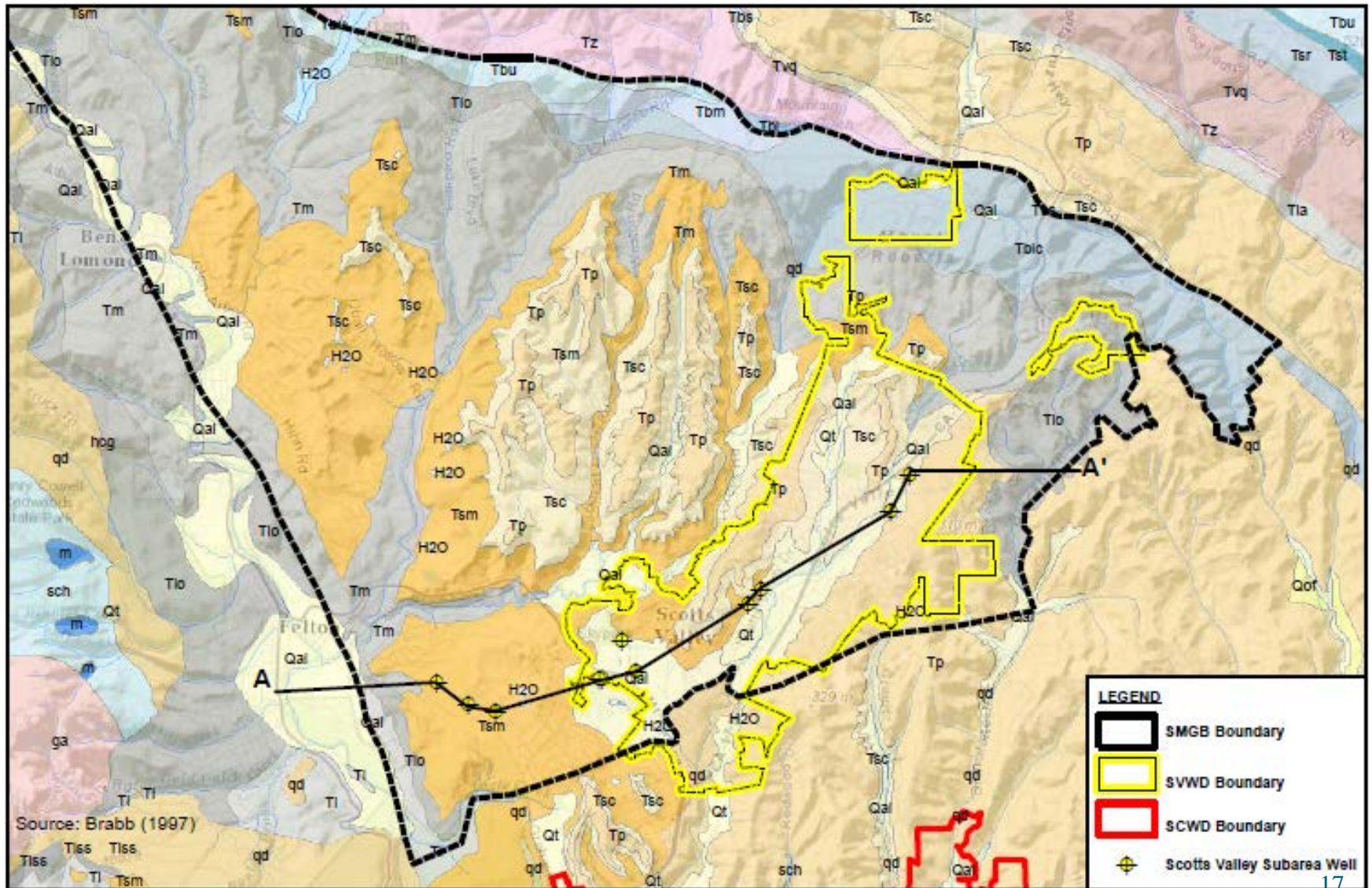
Purisima Aquifer Water Levels – Fall 2012



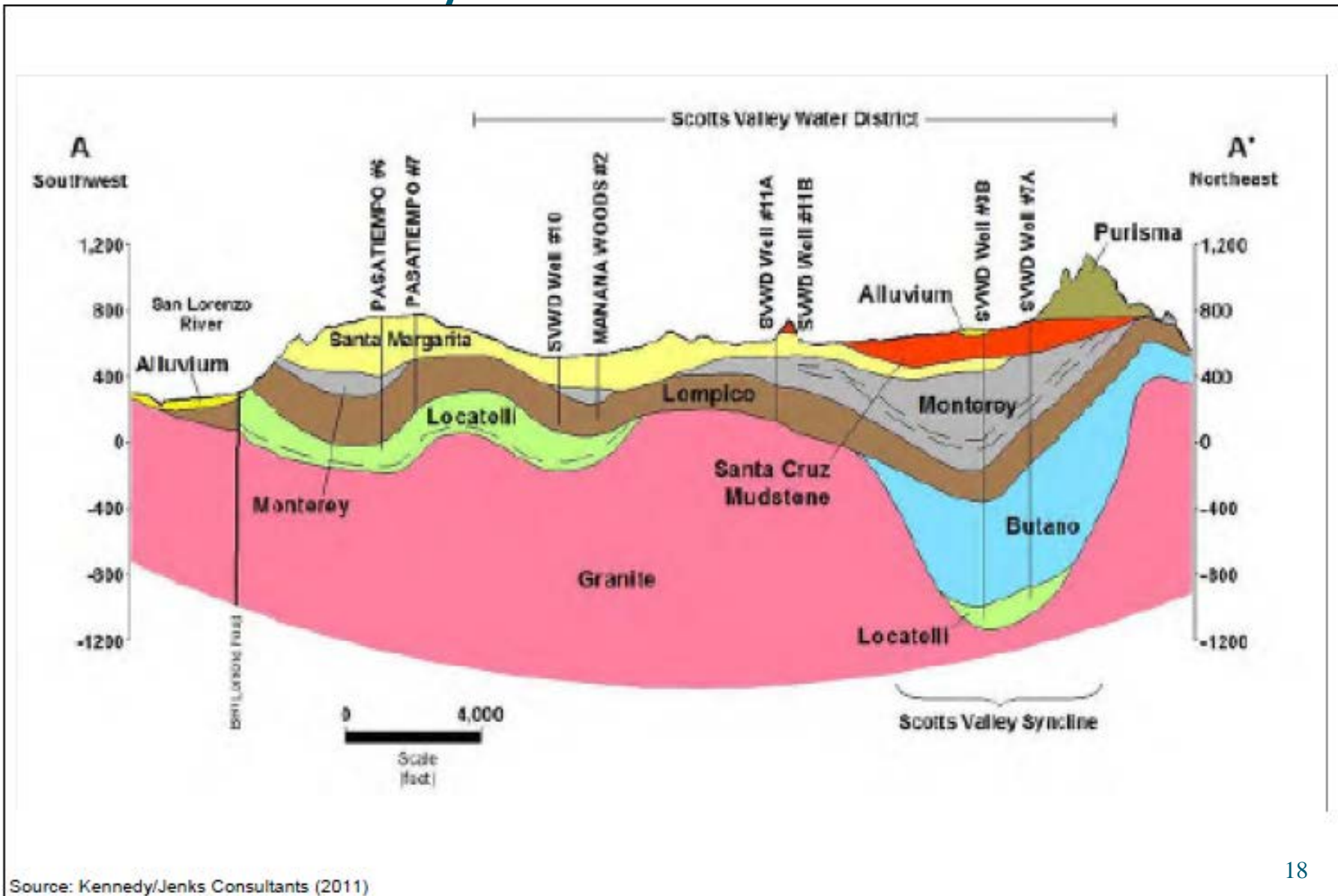
Study Area Map



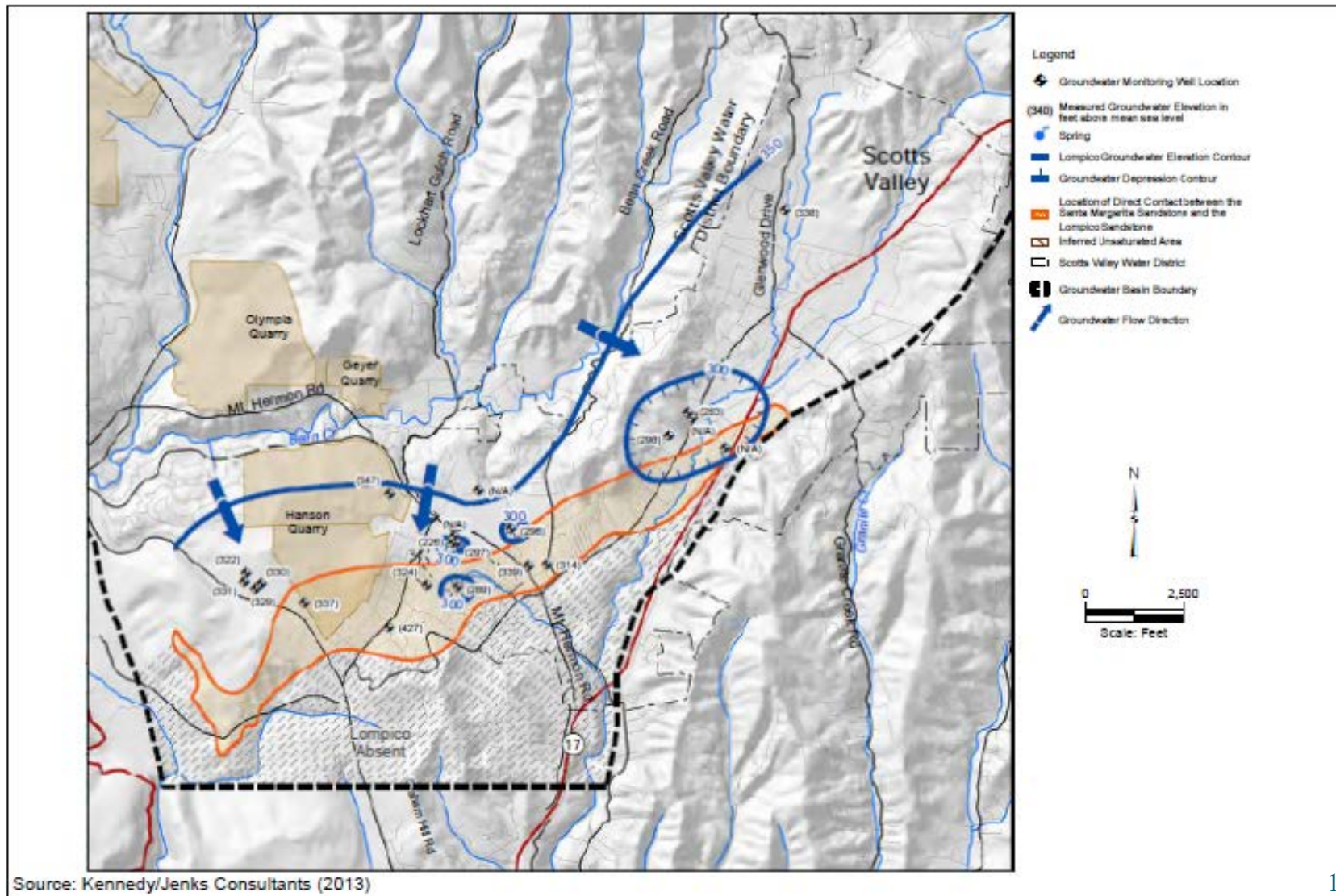
Geologic Map – Santa Margarita Basin



Scotts Valley Subarea X-Section A-A'



Scotts Valley Subarea (Tlo) Water Levels



Available Groundwater Storage Capacities

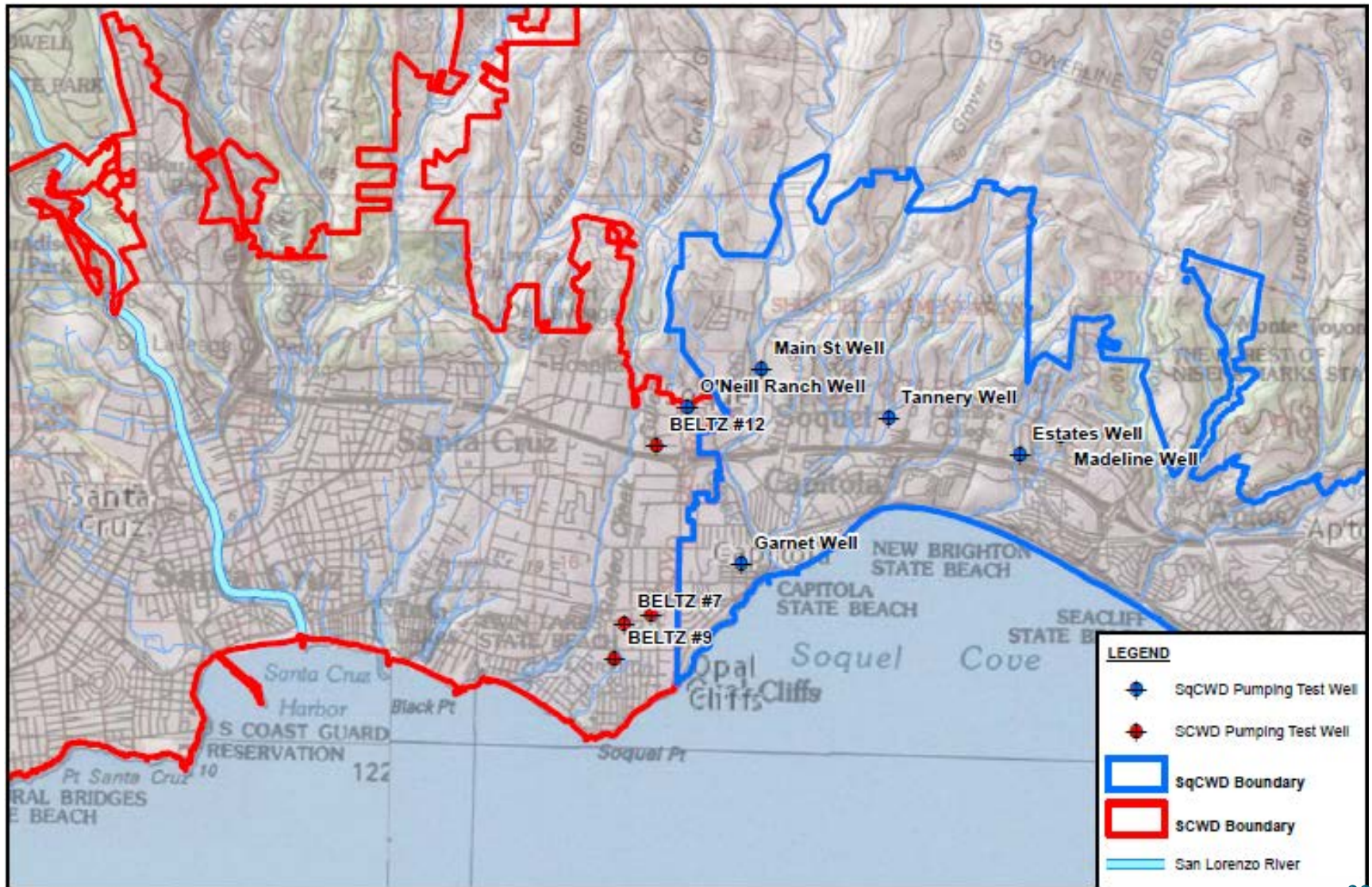
First-Approximation Estimates

- **Based on Estimated Historical Storage Depletion**
 - Estimated Water Balances for Each Basin
 - Long-Term Overpumping = Cumulative Storage Loss
- **Purisima Aquifer**
 - = 3.3 bg (10,100 af) (HMWRI, 2012)
- **SMGB (Scotts Valley Subarea)**
 - = 3.6 bg (10,990 af) (KJ, 2013)

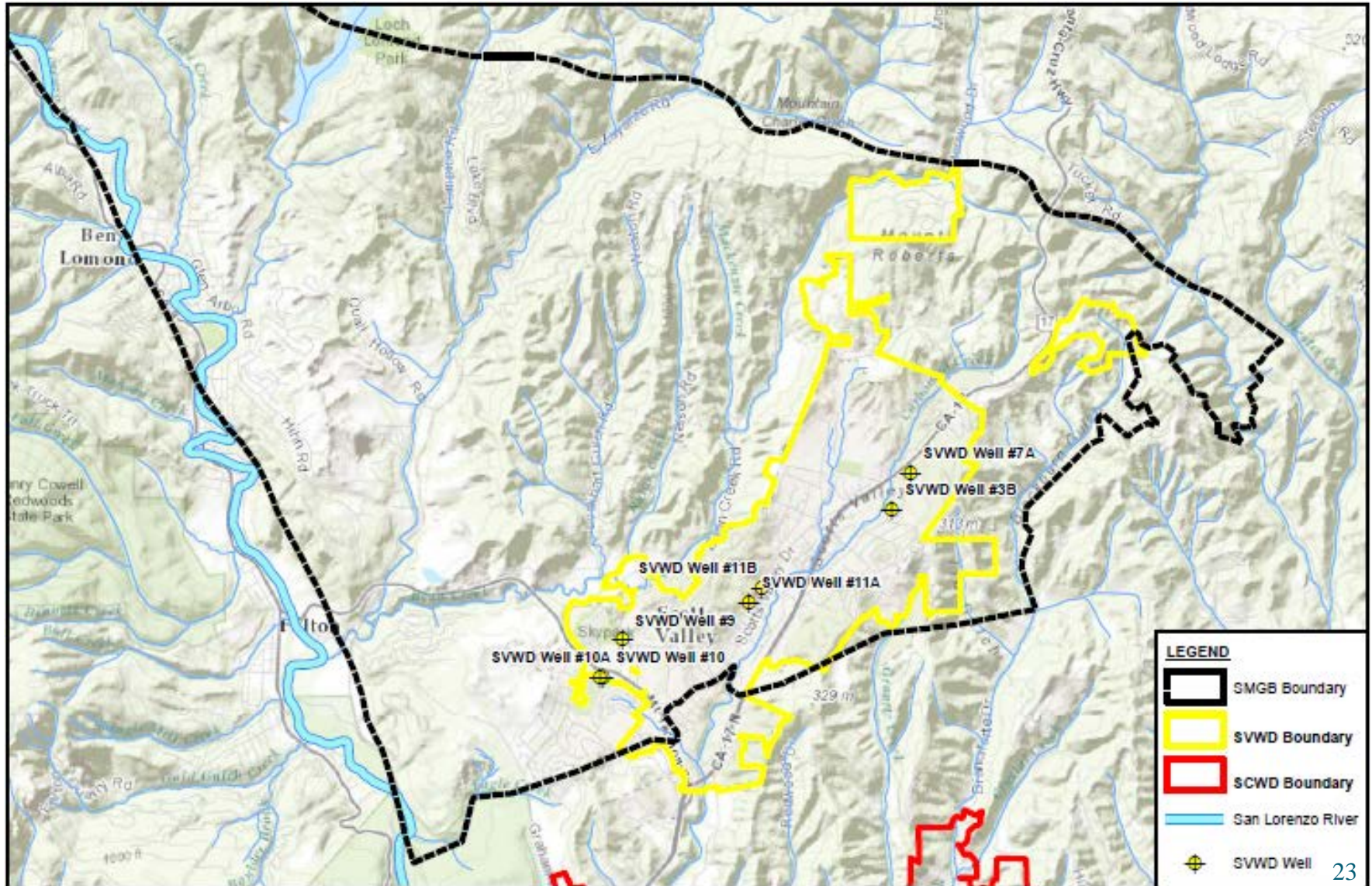
Potential Well Injection Capacities

- **Two Main Factors Affect Injection Capacity:**
 1. Available “Freeboard” in Water Levels
 2. Well Performance (Specific Capacity / Injectivity)
- **Existing Wells in All 3 Water Service Areas Evaluated:**
 1. SCWD: 5 Wells (Purisima Aquifer)
 2. SqCWD: 12 Wells (Purisima Aquifer)
 3. SVWD: 6 Wells (Scotts Valley Subarea)

Well Location Map – Purisima Aquifer



Well Location Map – SVWD



Potential Well Injection Capacities

➤ **Purisima Aquifer (SCWD and SqCWD)**

- ~ 0.5 mgd (350 gpm) per well

➤ **SMGB (SVWD)**

- ~ 0.35 mgd (250 gpm) per well

Conceptual ASR Project Phase 1

Description: Maximize Existing Diversion/Treatment

- **Infrastructural Improvements: None**
- **Capacity: 2 mgd**
- **# of ASR Wells: 4**
- **Average Annual Yield: 130 mgd (400 afy)**
- **Estimated Capital Costs: \$13M**

Conceptual ASR Project

Phase 2

Description: Maximize Available San Lorenzo Flows

- **Infrastructural Improvements: Tait Diversion and GHWTP**
- **Capacity: 8 mgd**
- **# of ASR Wells: 19**
- **Average Annual Yield: 500 mgy (1,500 afy)**
- **Estimated Capital Costs: \$130M**

Applicability to IPR

➤ **Areas of Applicability**

1. Groundwater Storage Capacities
2. Per Well Injection Capacities

➤ **Areas of Differentiation**

1. Source Water is Different (Recycled Wastewater)
2. Same Wells Can't Be Used for Both Injection and Recovery
3. Injection Wells Must Be Spaced From Drinking Water Wells for 2-mths (minimum) Retention Time (~500 ft)

➤ **ASR and IPR could be combined**

- IPR as SWI Barrier with Injection Wells along Coast
- ASR inland

ASR Project Implementation Steps

1. Reconnaissance-Level Feasibility Study ✓
2. Site Specific Assessment(s)
3. Pilot Testing (short-term – 1 to 2 months)
4. Full-Scale Demonstration (long-term – 1 to 2 years)
5. Permanent Project (e.g., Phase 1)
6. Project Expansion (e.g., Phase 2)

Conclusions

1. **ASR Appears Technically Feasible**
2. **Key Components for an ASR Project Exist:**
 - Source Water:
 - Available “Excess” San Lorenzo Flows: > 550 mgd (1,700 afy)
 - Diversion / Treatment Infrastructure:
 - Existing Infrastructure Limited to 2 mgd (130 mgd / 400 afy /)
 - Expanded Infrastructure Technically Feasible to 8 mgd (500 mgd / 1,500 afy)
 - Available Aquifer Storage Space:
 - ~ 6.9bg (21,000 af)
 - Per-Well Injection Capacities:
 - 0.35 – 0.5 mgd ea (250 to 350 gpm)

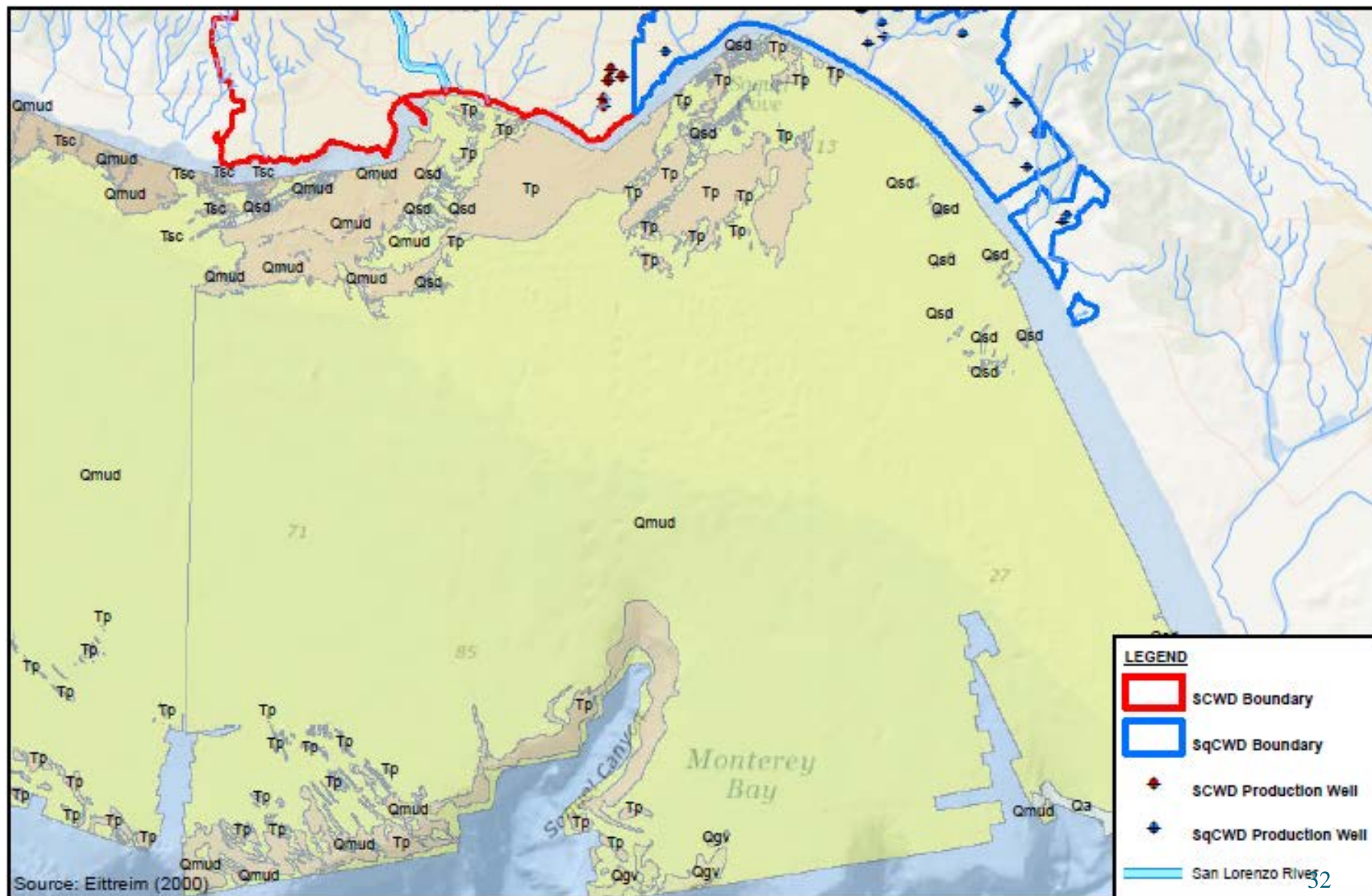
Recommendations

- 1. Perform Site-Specific ASR Well Analysis**
 - a. Refined Injection Capacity Analysis
 - b. Geochemical Interaction Modeling
- 2. Implement Pilot ASR Testing at Existing Well**
 - a. Confirm Injection / Recovery Capacity
 - b. Well Plugging Rates
 - c. Evaluate Water-Quality Interactions
 - d. Monitor Aquifer Hydraulic Response to ASR
 - e. Establish O&M Parameters
- 3. Perform Hydraulic Modeling of SCWD Distribution System**
 - a. Confirm Hydraulic Capacity to Convey Flows to/from ASR Sites
- 4. Perform Groundwater Modeling of ASR / IPR Scenarios**
 - a. Evaluate Potential for Hydraulic Losses
 - b. Optimal ASR / IPR Well Spacing
 - c. IPR in Conjunction With ASR



Questions / Discussion

Offshore Geologic Map



ASR Pilot Test at Existing Well (1996)



Shallow Pilot Scale Project (1998)



Full-Scale Demonstration Well (2001)



Permanent Project (2006)



Project Expansion (2009 – 2015)

