Salinas Valley Basin
Groundwater Sustainability Agency

SALINAS VALLEY GROUNDWATER BASIN SETTING

INITIAL REVIEW FOR DEVELOPMENT OF GROUNDWATER SUSTAINABILITY PLAN

HydroMetrics WRI

May 10, 2018

Prepared for Salinas Valley Basin Groundwater Sustainability Agency

Outline

- **Purpose and Background**
- Salinas Valley Basin Hydrogeology
- Water Budgets
- Sub-basins

Purpose of Presentation

- GSP Section 2.2 GSP: "Basin Setting" sets stage for the Plan
  - *Hydrogeologic Conceptual Model*
  - *Current and Historical Groundwater Conditions*
  - *Water Budget Information*
  - *(Management Areas, if applicable)*
- "The Long Valley"
  - *Considerable local knowledge w/ many viewpoints*
  - *Basin-wide framework for discussion of projects/management actions*
  - *Distinguish between "uncertainty" and "controversy"*

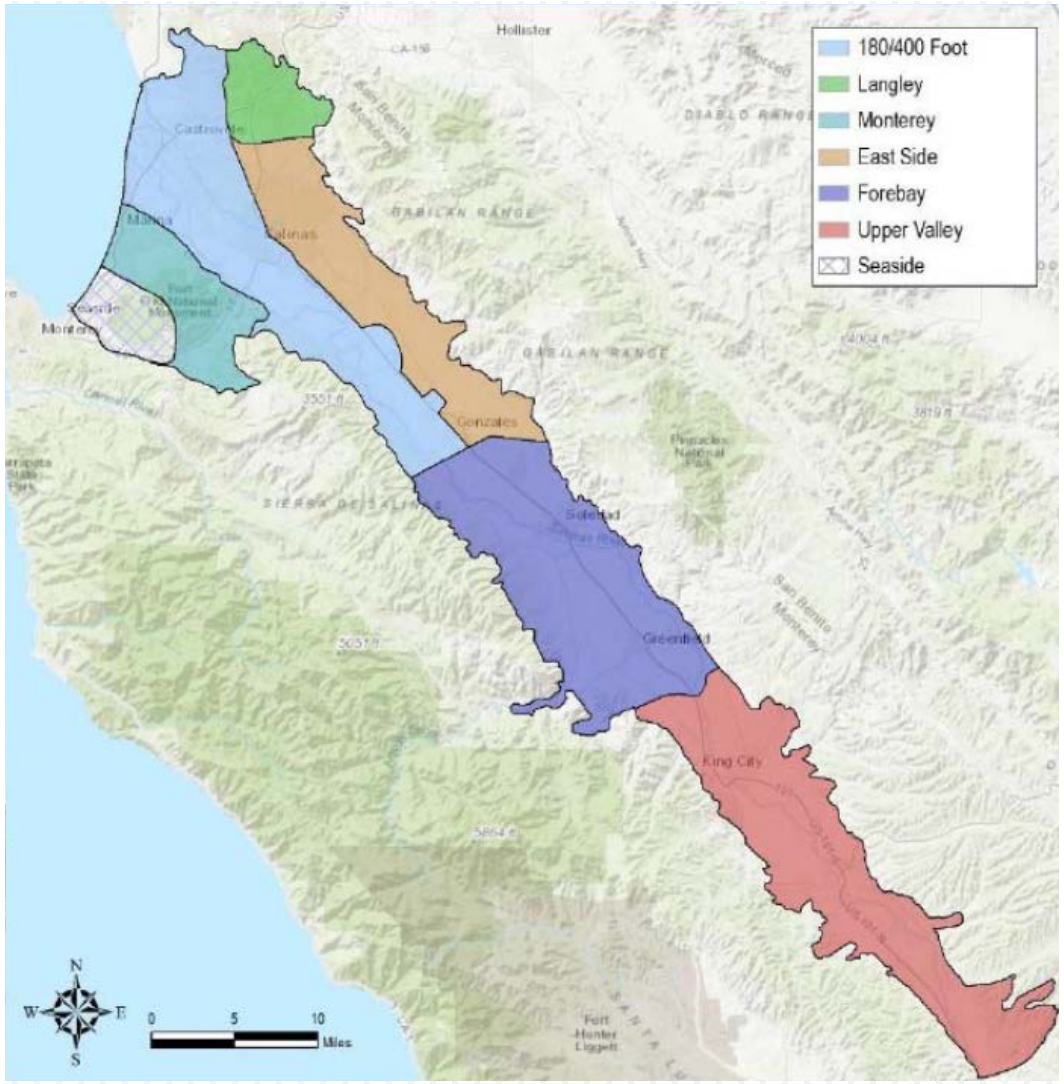
Background

- DWR Bulletin 52 (jointly funded by State and County) - 1946
  - Defined "Water Supply Areas" that are basis of DWR-defined "subbasins"
  - Overdraft, water quality, and recommended solution
- Monterey County Water Resources Agency (MCWRA) - 1947
  - Flood control, sustainable water supply
  - Groundwater level and water quality monitoring – 1940s
  - Nacimiento and San Antonio reservoirs for water conservation – 1957/1967
  - Collect groundwater extraction data from operators – 1992
  - Seawater intrusion control – CSIP and SVWP projects – 1998
- Salinas Valley Basin Groundwater Sustainability Agency – 2017
  - Plan for long-term sustainable management of groundwater resources
  - Incorporate actions of other agencies and plans into GSP

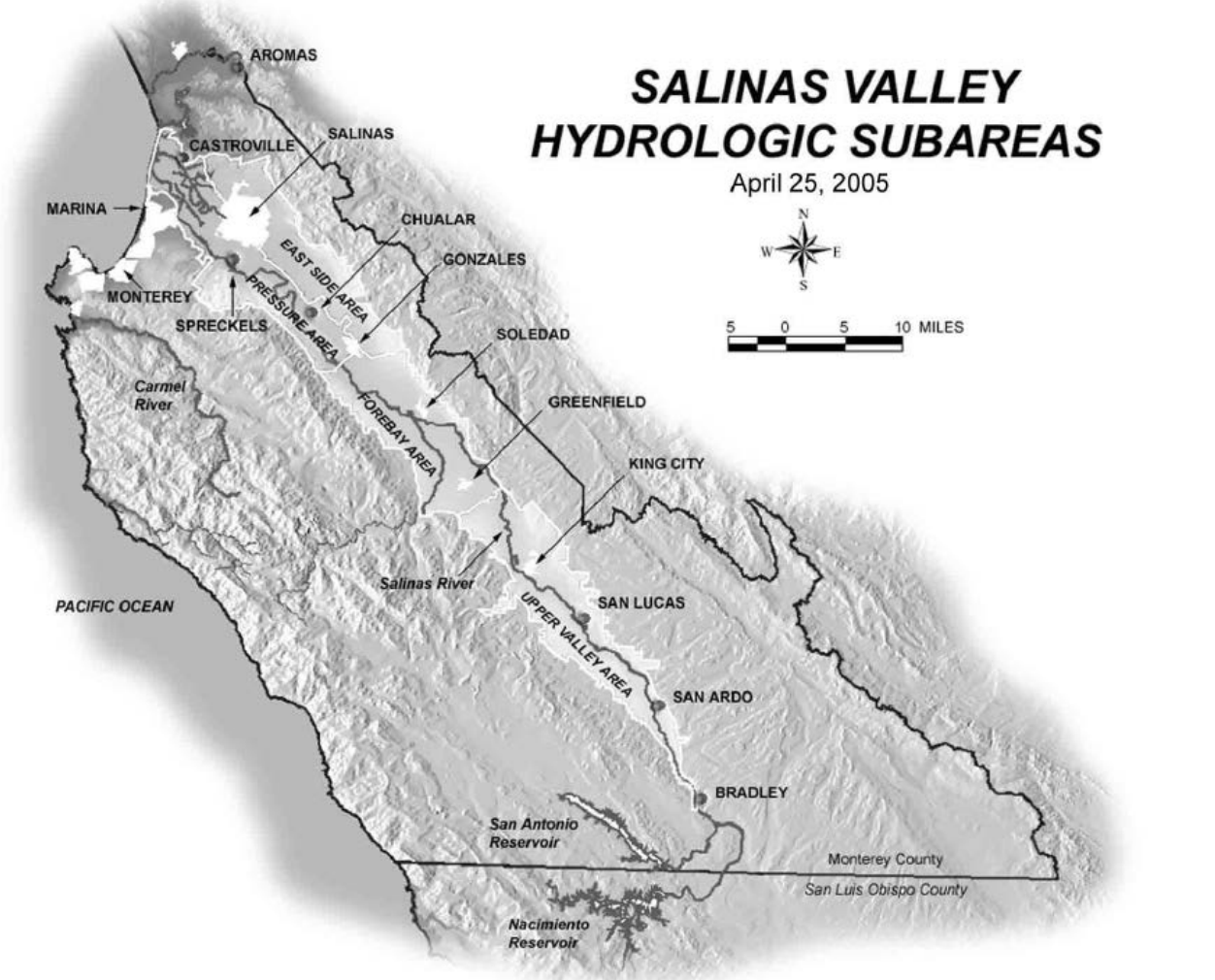
Background

- Key Sources of Information
  - "Salinas Basin Investigation - Bulletin 52" – 1946 California DWR
  - "Hydrogeology and Water Supply of Salinas Valley" 1995 – MCWRA
  - "Ground Water Extraction Summary Reports" annual since 1995 - MCWRA
  - "Hydrostratigraphic Analysis of the Northern Salinas Valley" 2004 – MCWRA
  - "State of the Salinas River Groundwater Basin" 2015 - MCWRA
  - "Water Quality Control Plan" 2016 –RWQCB, Central Coast Region
  - Recommendations to Address Expansion of SWI in the SV GB, 2017 - MCWRA
  - Various maps and publications - USGS
  - SVIHM (unpublished) USGS-MCWRA
  - https://www.water.ca.gov/Programs/Groundwater-Management/Data-and-Tools
  - Other SGMA-focused websites, e.g. TNC

Sub-basins defined by DWR (Bulletin 118)



Subareas used by MCWRA



Source: MCWRA 2005 GW Conditions Report

MCWRA 1999

Outline

- Purpose and Background
- **Salinas Valley Basin Hydrogeology**
- Water Budgets
- Sub-basins

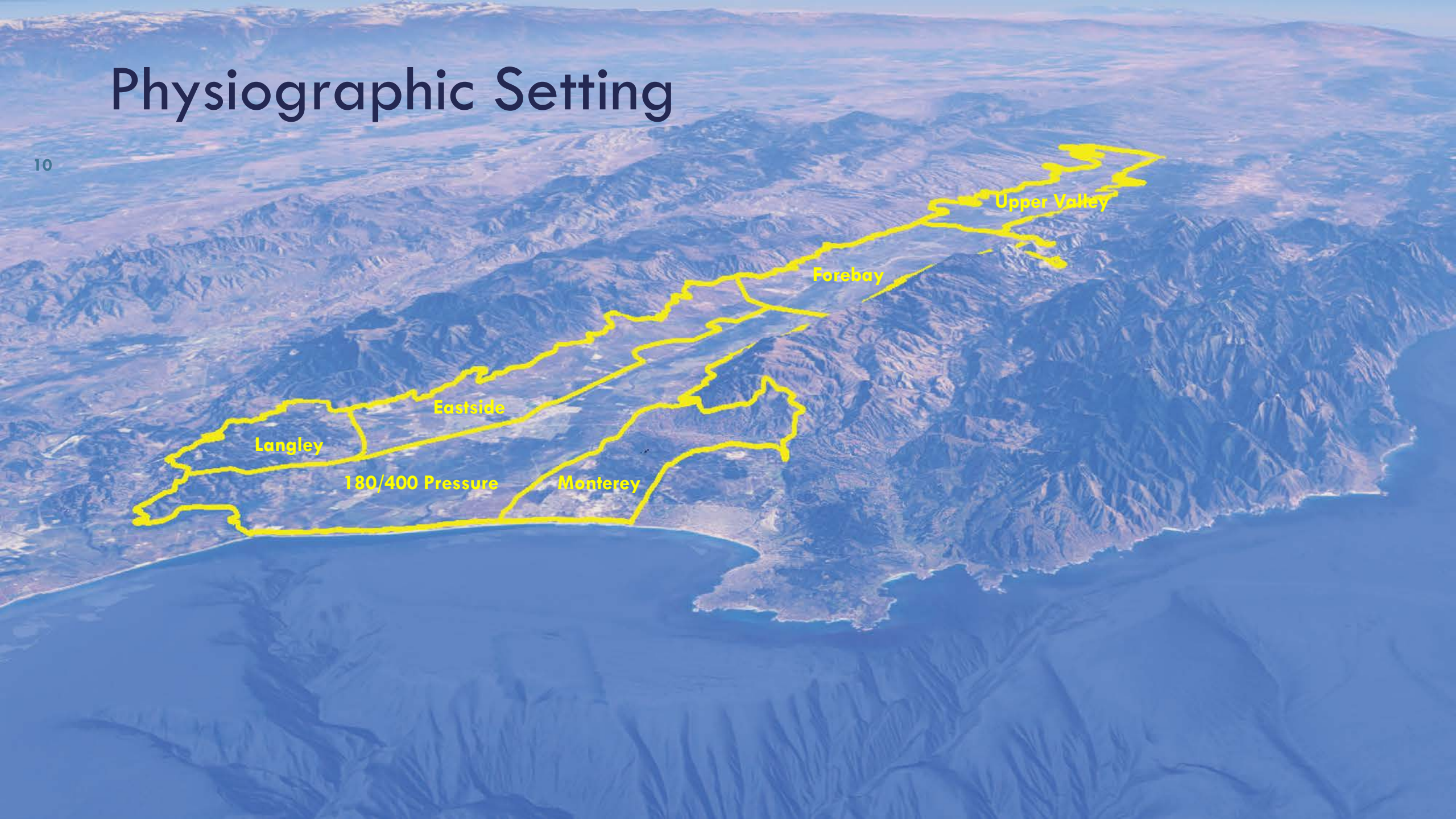
Salinas Valley Basin Groundwater

- Overview
- Conceptual Model
- Geologic Setting
- Hydrostratigraphy
- Groundwater Flow
- Water Quality

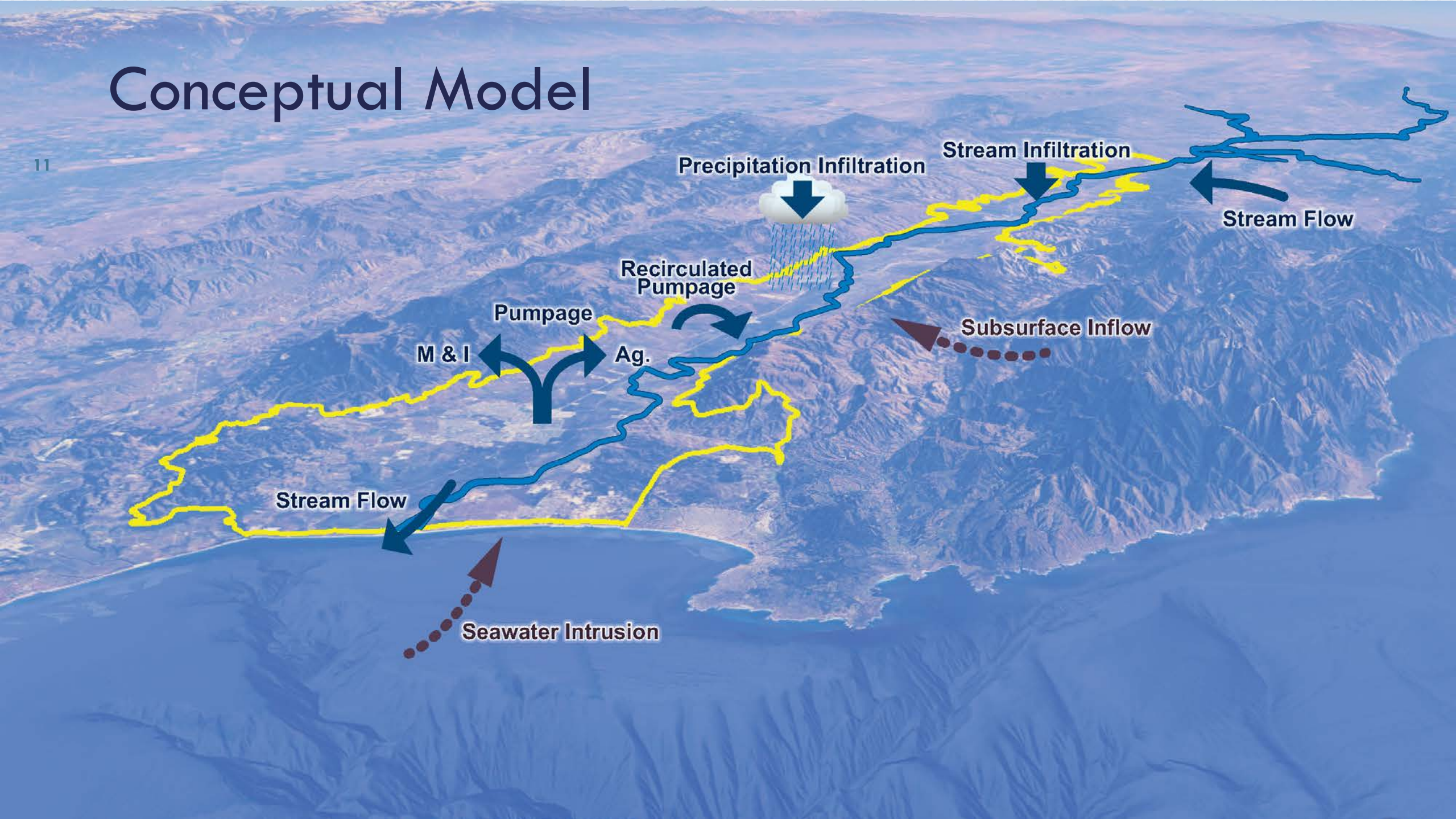
Salinas Valley Basin

- Unique: Large agriculture-based economy with no imported water
- Conjunctive use water system: Salinas River – Groundwater
- Water Sources:
  - Salinas River and tributaries, including groundwater recharge
  - Rainfall percolation to groundwater
- Water Storage:
  - Groundwater - critical storage reservoir 16 million acre-feet estimated in storage
  - San Antonio and Nacimiento Reservoirs = 0.7 million acre-feet
- Water Distribution System:
  - Few canals/pipelines to move water w/in the basin
  - Salinas River acts as the primary "trunk line"
  - Surface water diversions
  - Groundwater acts as distributed but very slow conveyance/delivery system
- Challenges due to spatial and temporal variability in water availability and demand

Physiographic Setting



Conceptual Model

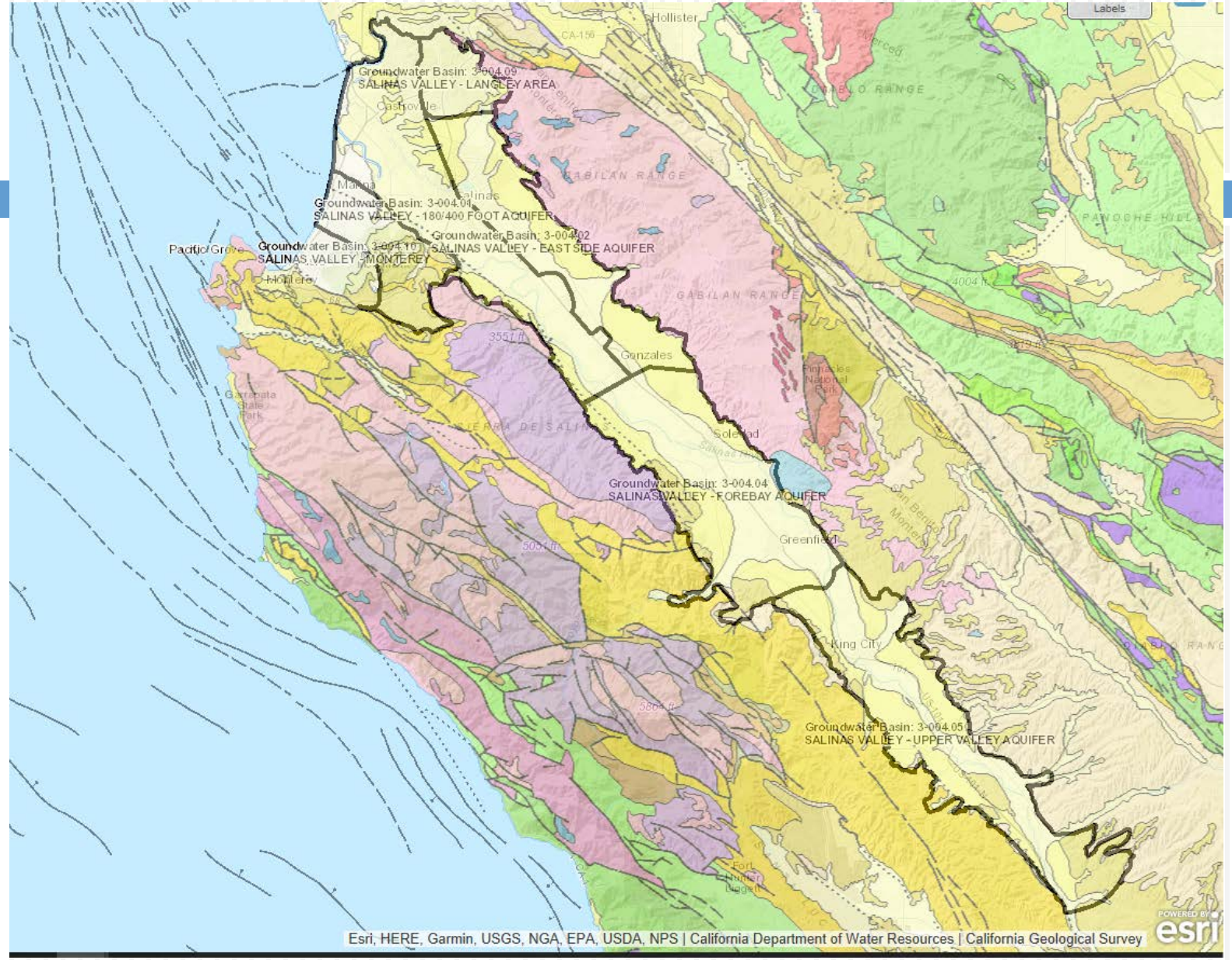


Basin Surficial Geology

Alluvial basin fill

bounded by relatively impermeable sedimentary rock

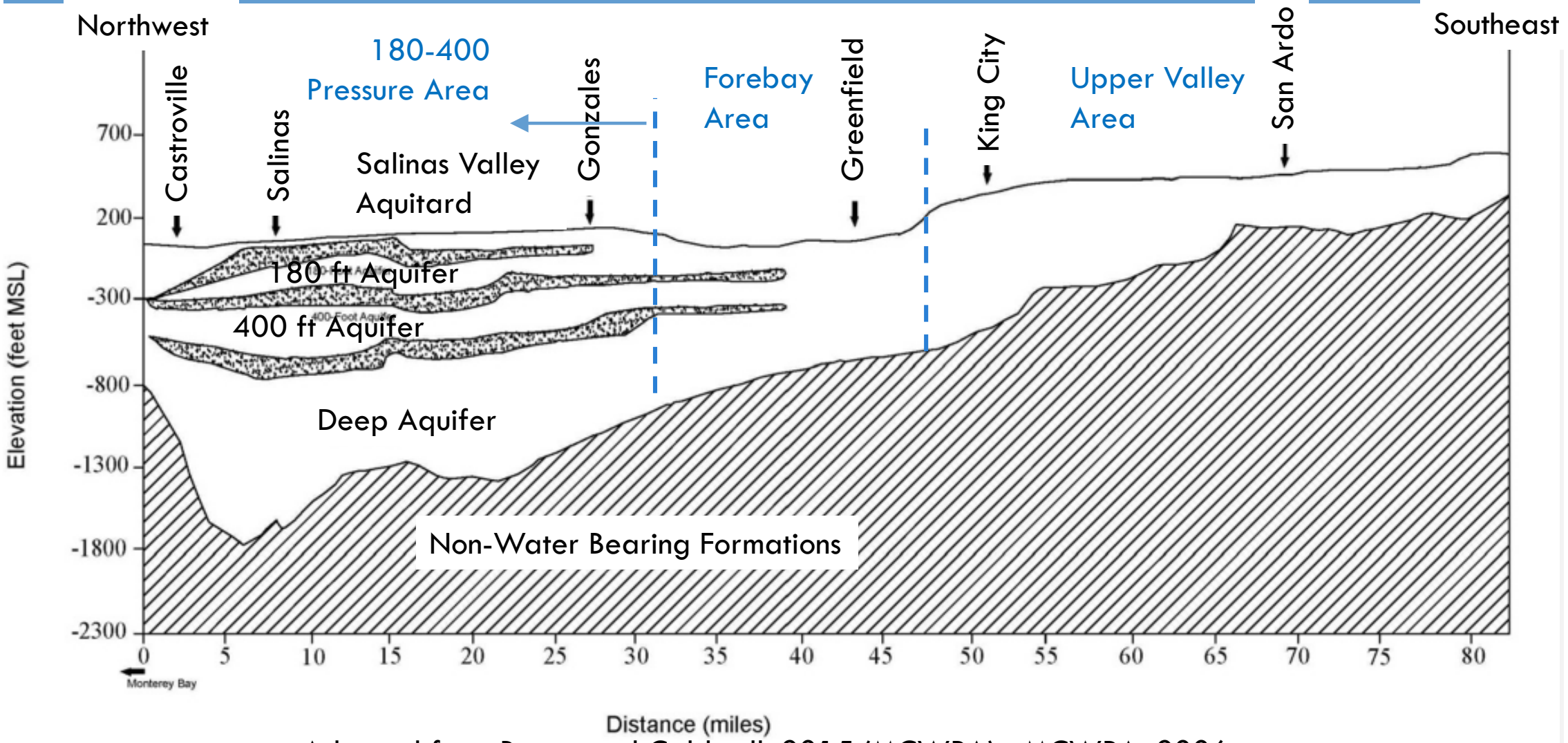
or granitic basement



Source: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer

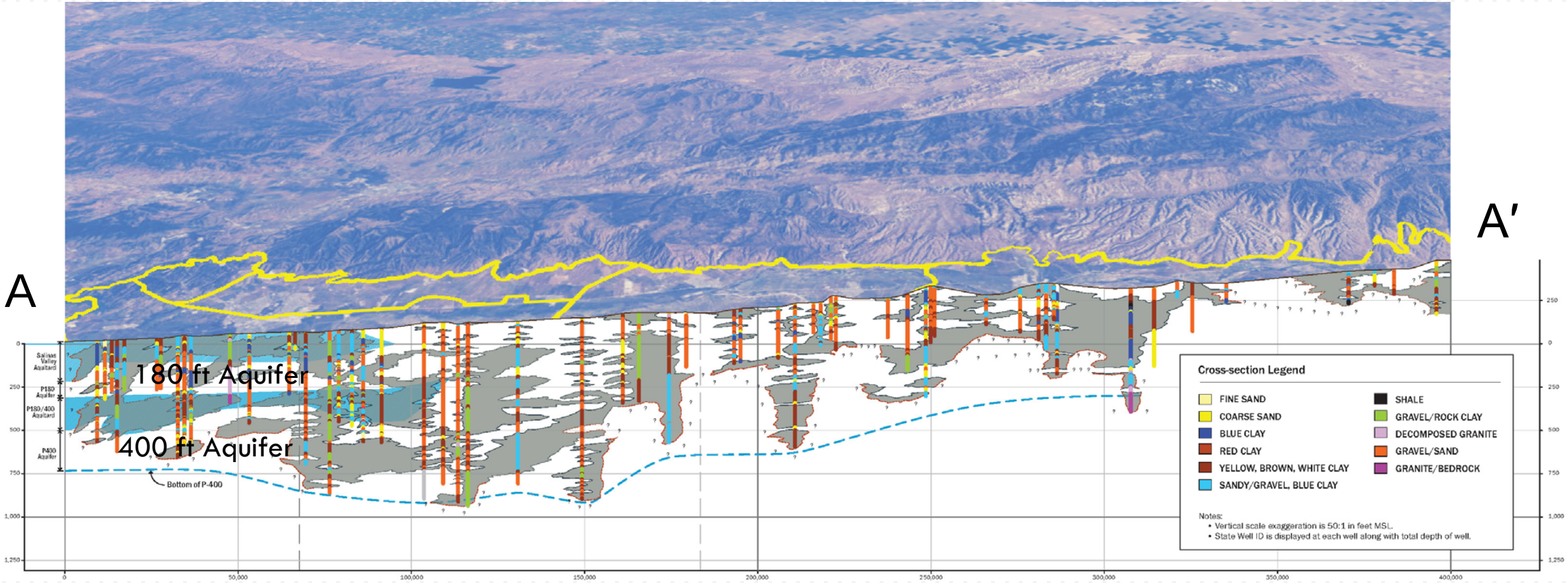
California Geological Survey, 2013. *Geologic Map of California*. 1:750,000

Conceptual Cross-Section



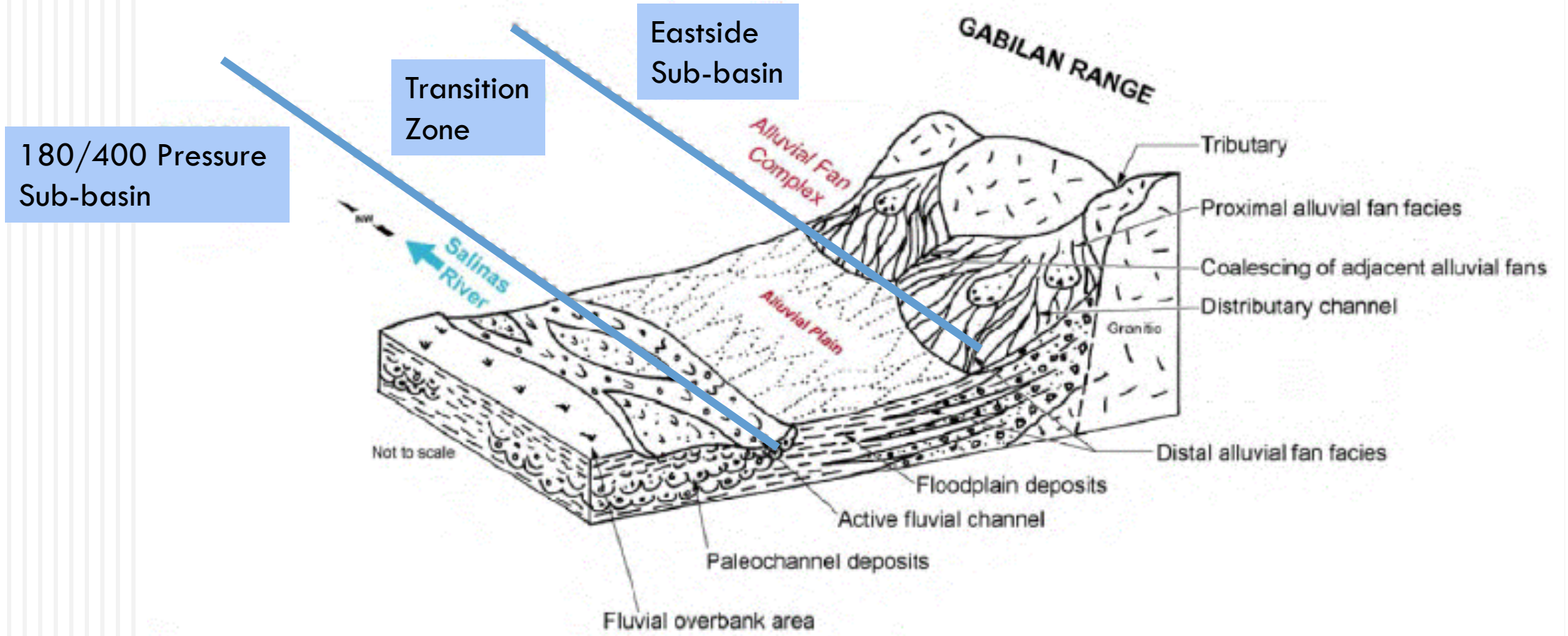
Adapted from Brown and Caldwell, 2015 (MCWRA); MCWRA, 2006.

Cross-Section: Hydrostatigraphy



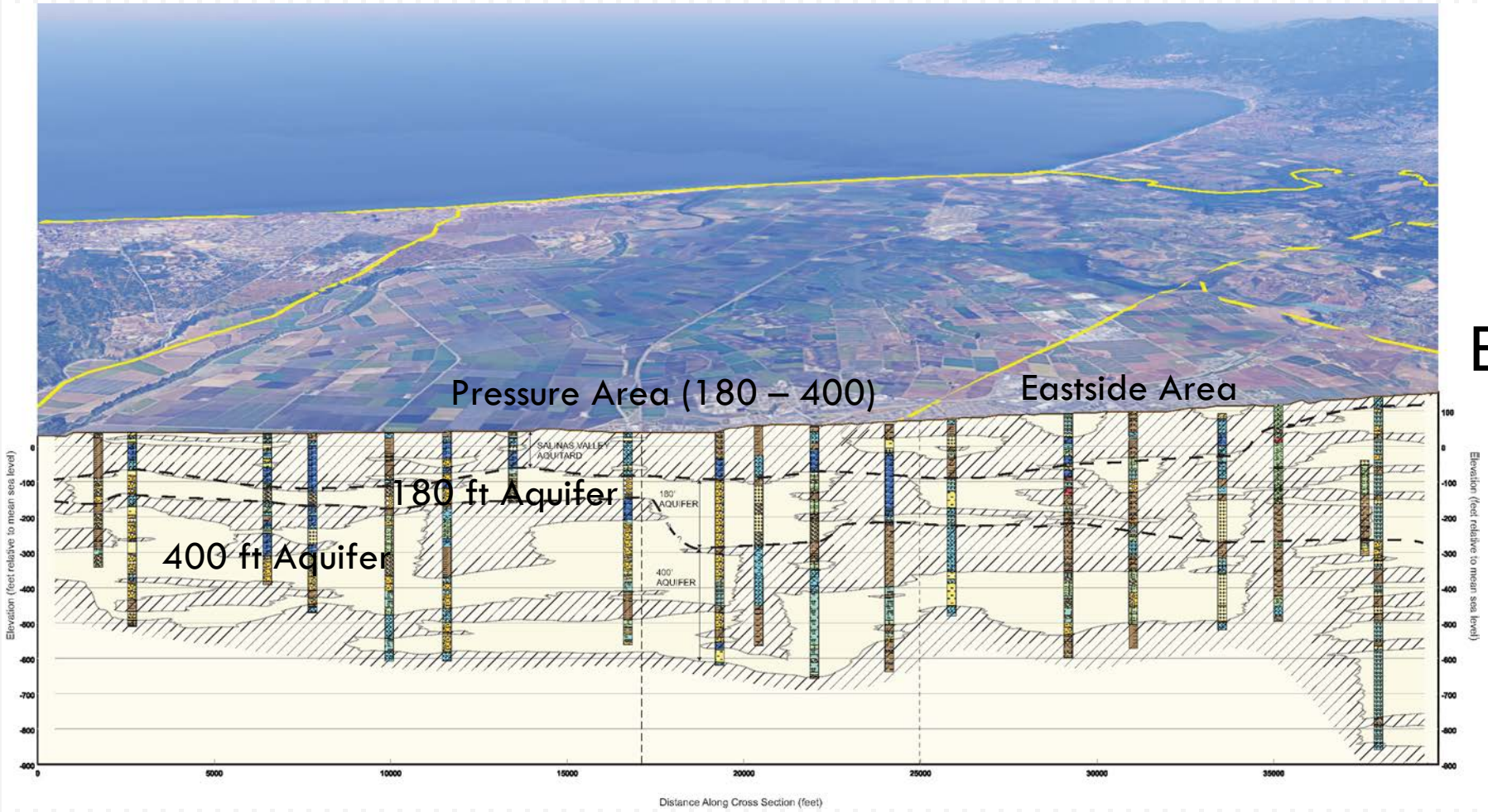
Cross-Section Source: Brown and Caldwell, 2015 (MCWRA).

Depositional Transition from 180/400 to Eastside



Source: Brown and Caldwell, 2015, after Kennedy/Jenks 2004 (MCWRA)

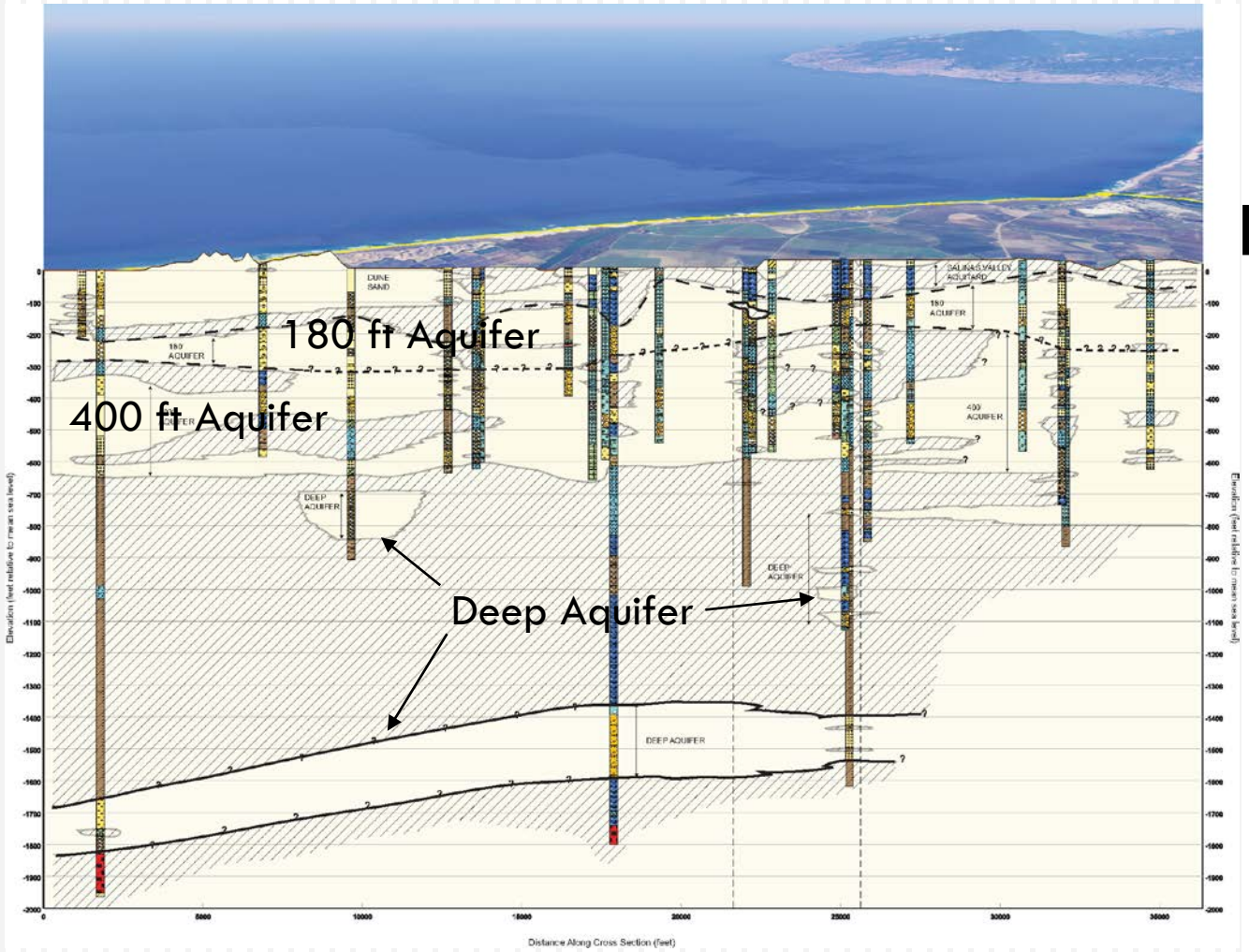
Cross-Sections: Hydrostatigraphy



Cross-Section Source: Kennedy-Jenks, 2004 (MCWRA).

Cross-Sections: Hydrostatigraphy

B

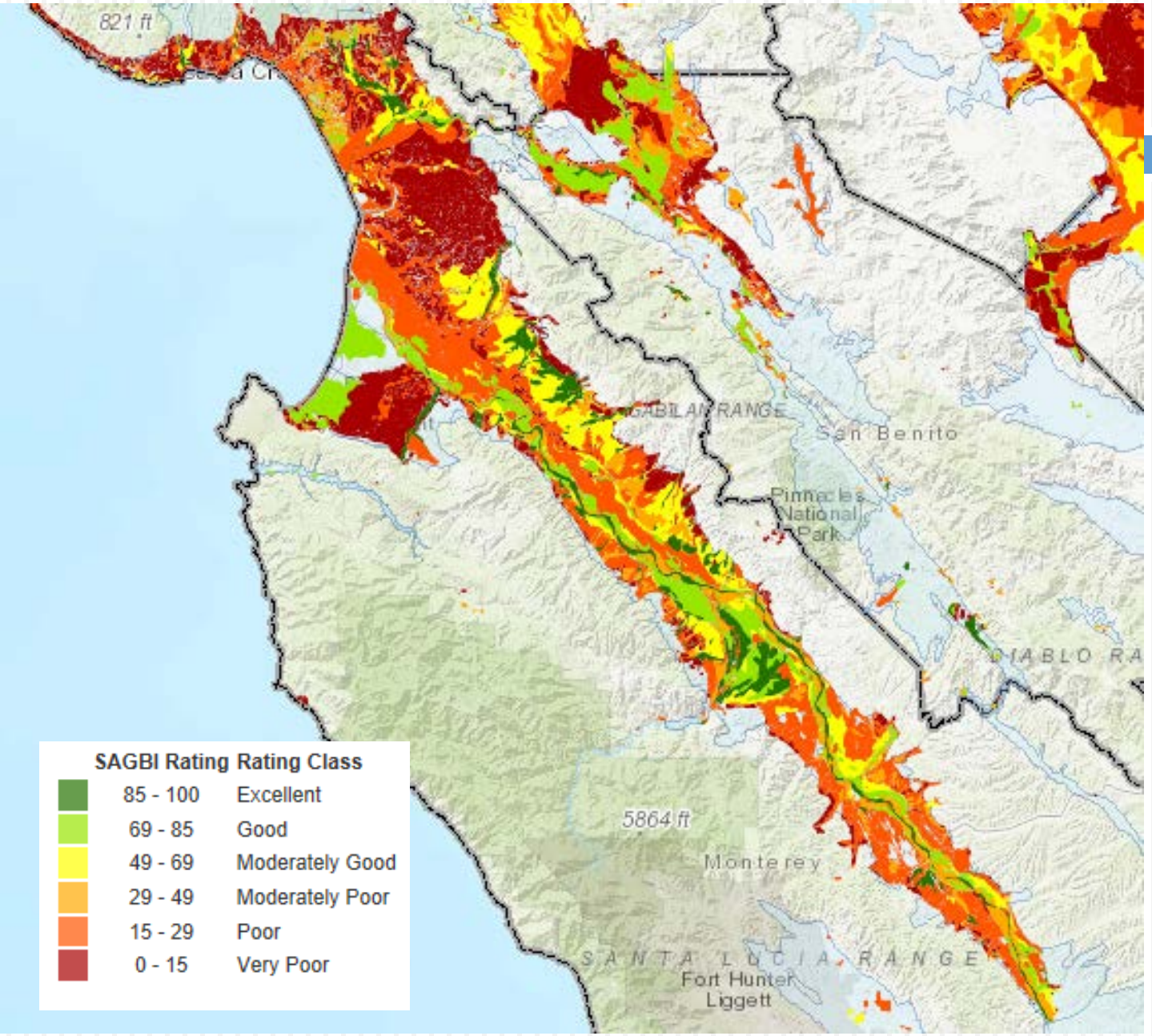


B′

Cross-Section Source: Kennedy-Jenks, 2004 (MCWRA).

Soil Characteristics

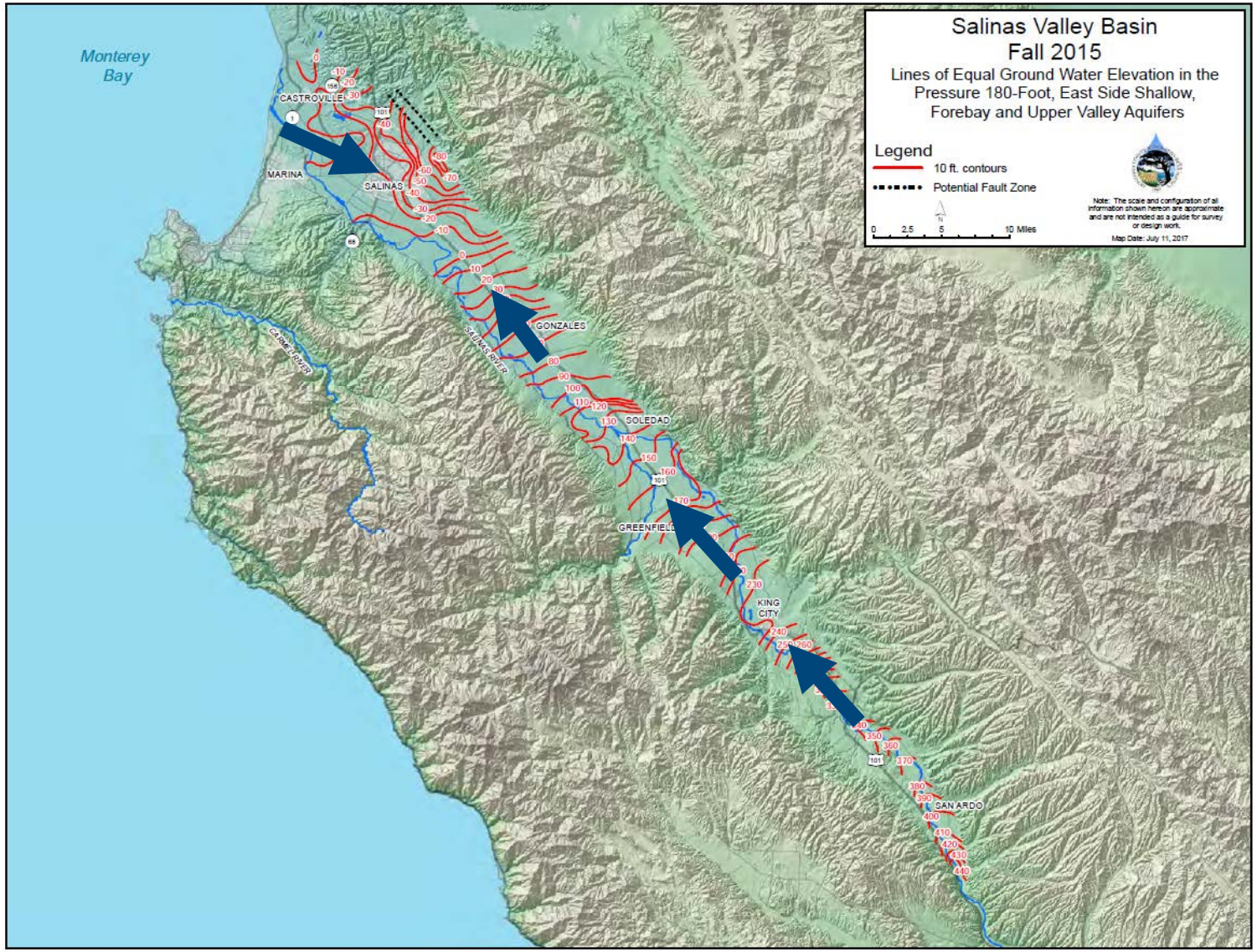
- Soil Agricultural Groundwater Banking Index (SAGBI), UC Davis
- Feasibility of groundwater recharge on agricultural land



Source: DWR landuse viewer
https://gis.water.ca.gov/app/CADWRLandUseViewer/

Groundwater Flow

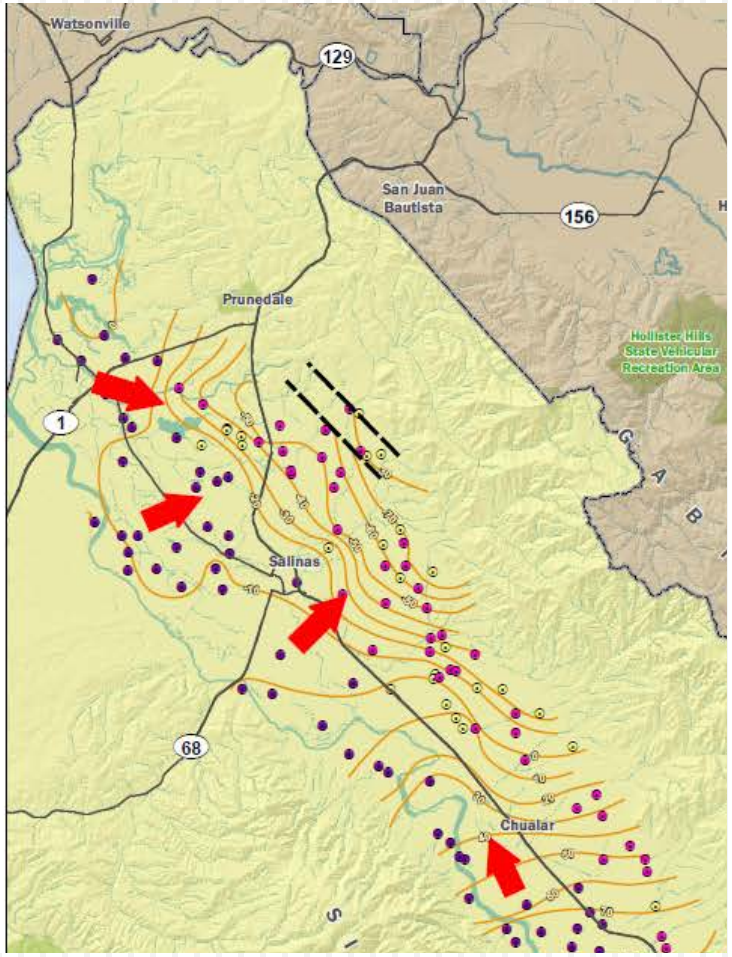
- Inferred from water level measurements in wells
- GW flow is generally down the valley
- Inward flow from the ocean at the coastal margin where GW elevations are below sea level due to pumping
- Based on Fall measurements



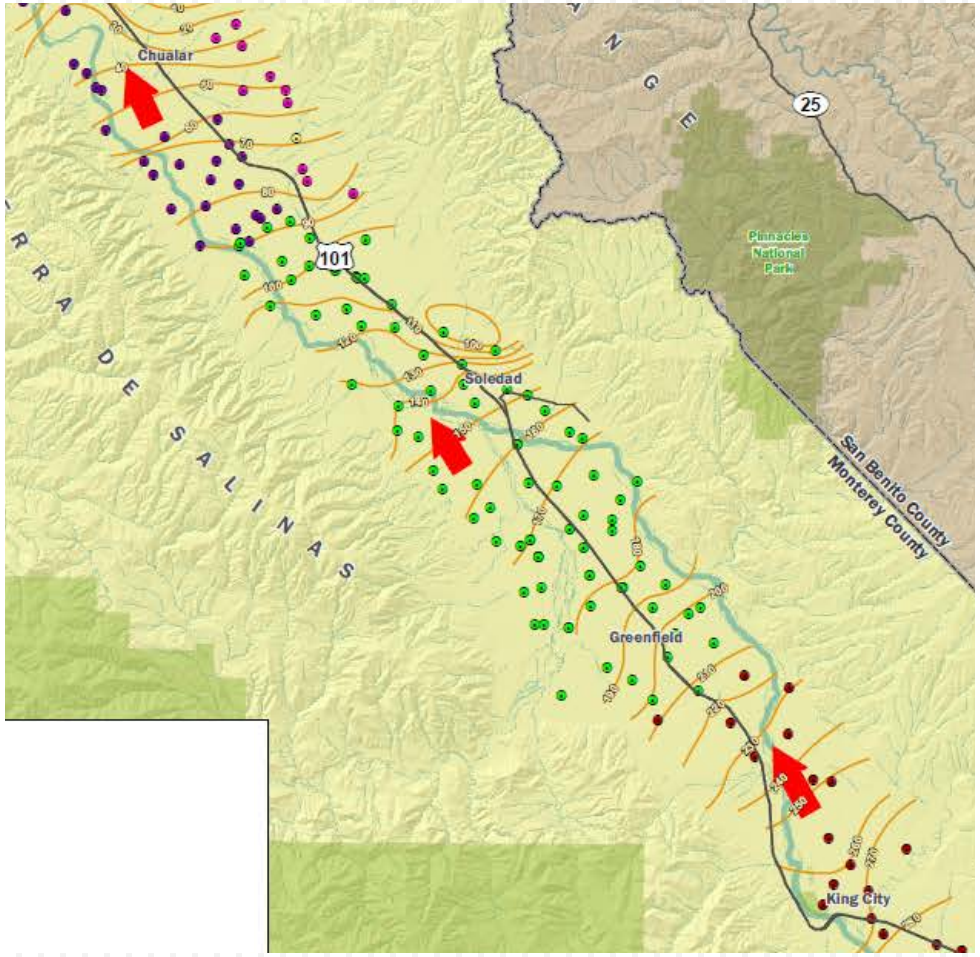
Source: MCWRA 2017.

Groundwater Flow

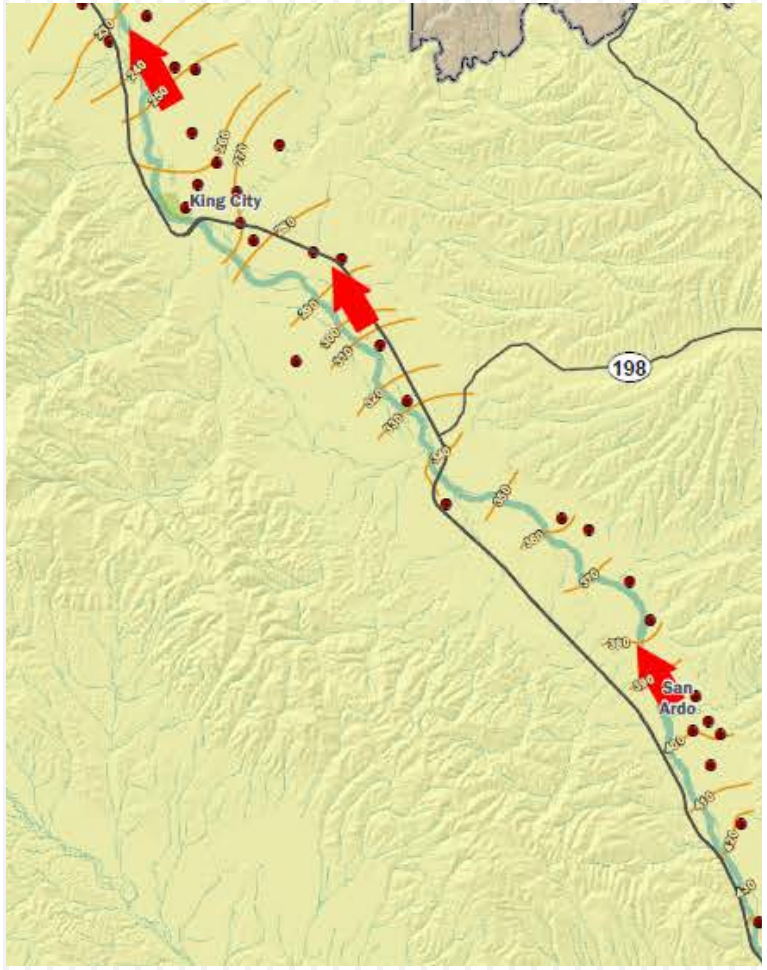
180-400 Foot (Pressure)/East Side



Forebay



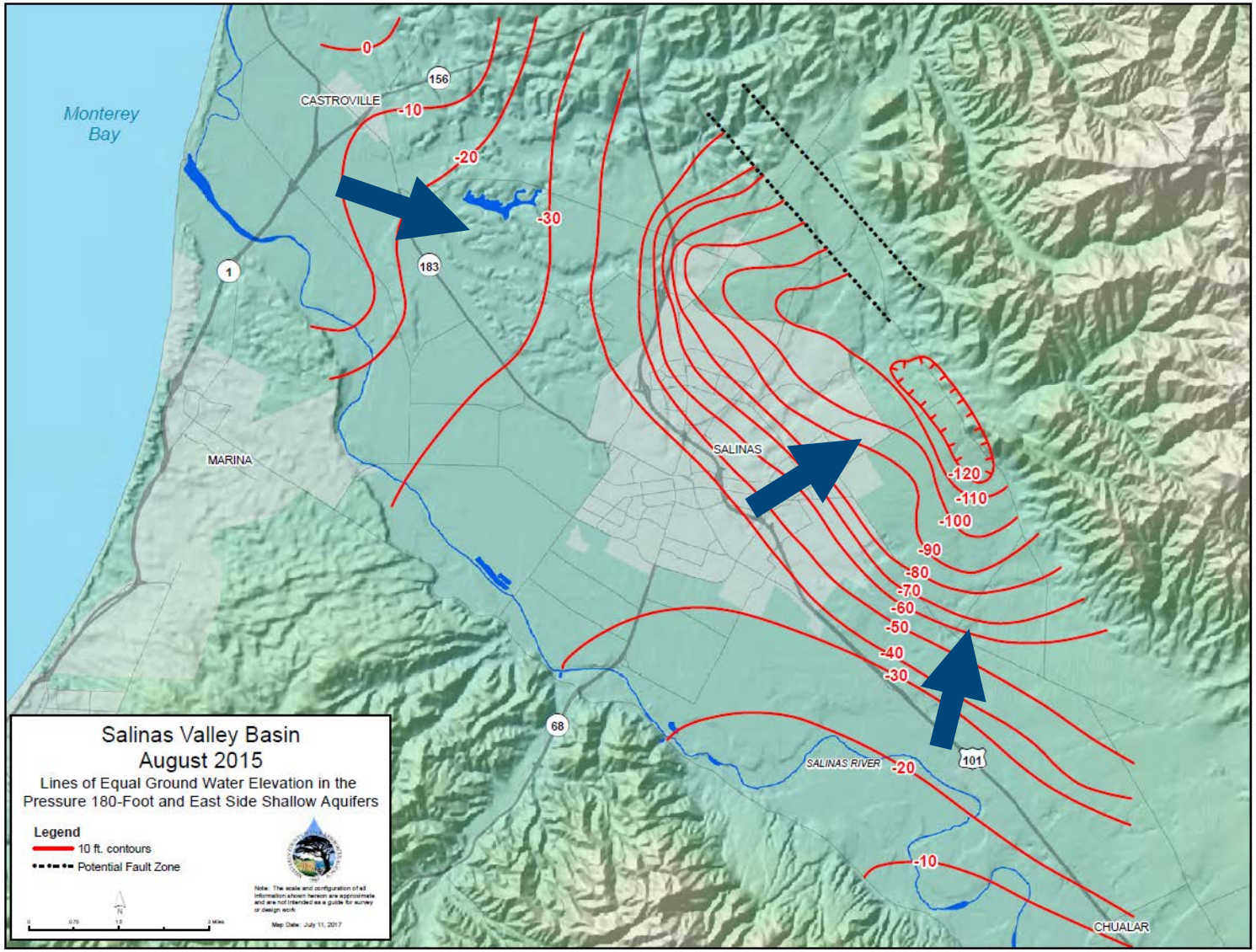
Upper Valley



Source: Fall 2015. Brown and Caldwell 2015 (MCWRA)

Groundwater Elevation and Flow (180-foot Aquifer)

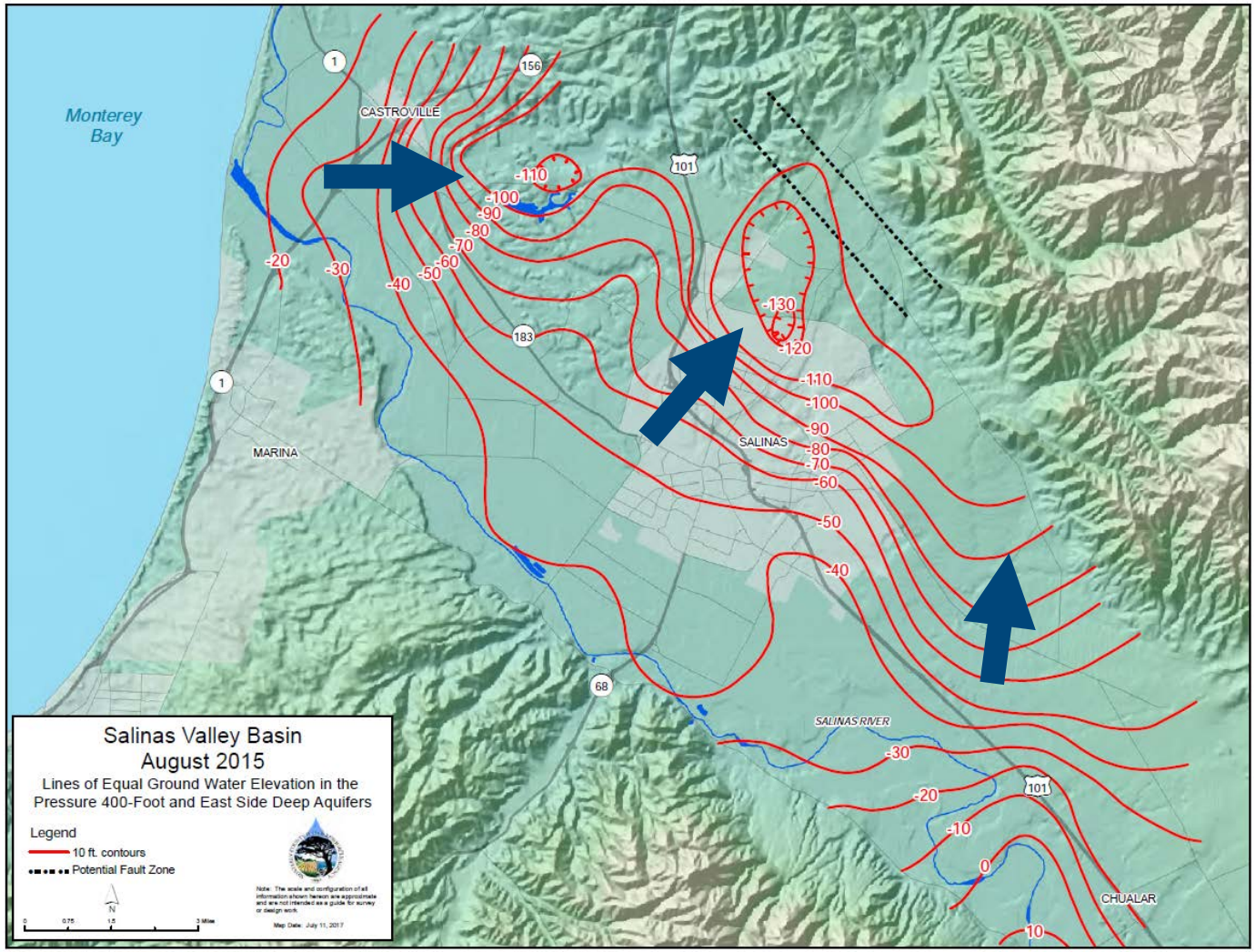
- August 2015 water levels



Adapted from MCWRA, 2017

Groundwater Elevations and Flow (400-foot Aquifer)

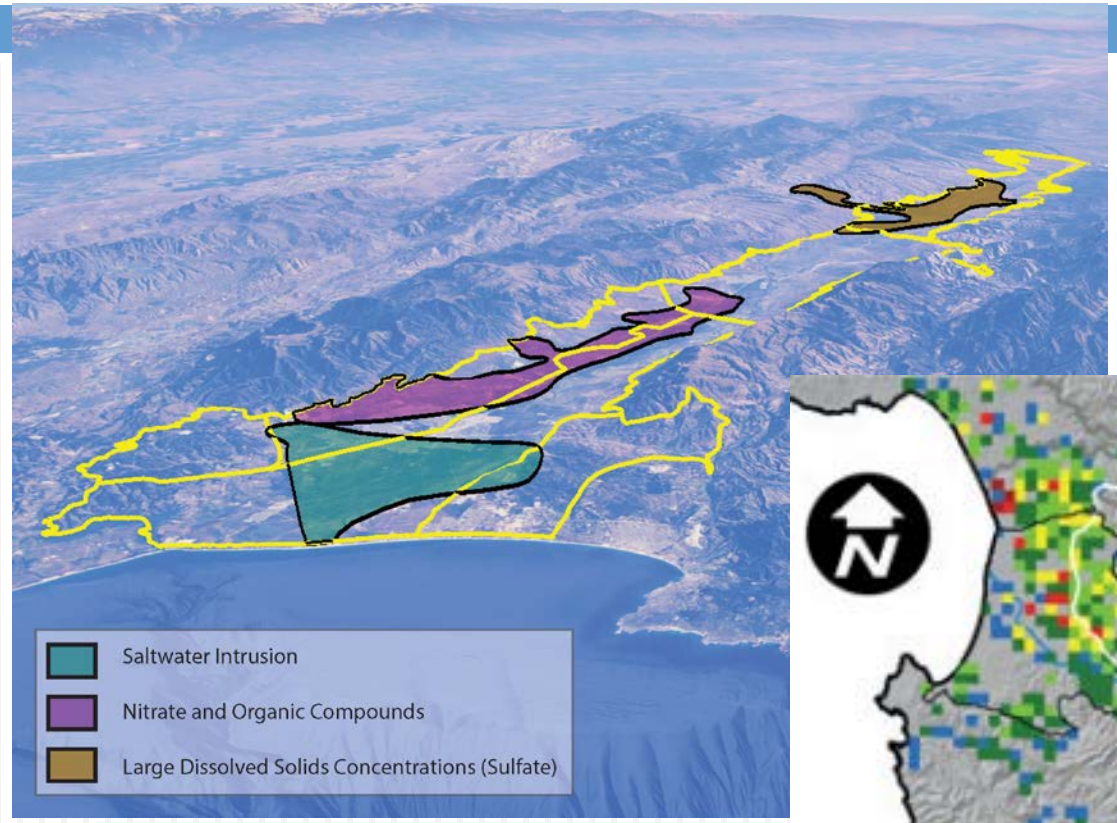
- August 2015 water levels

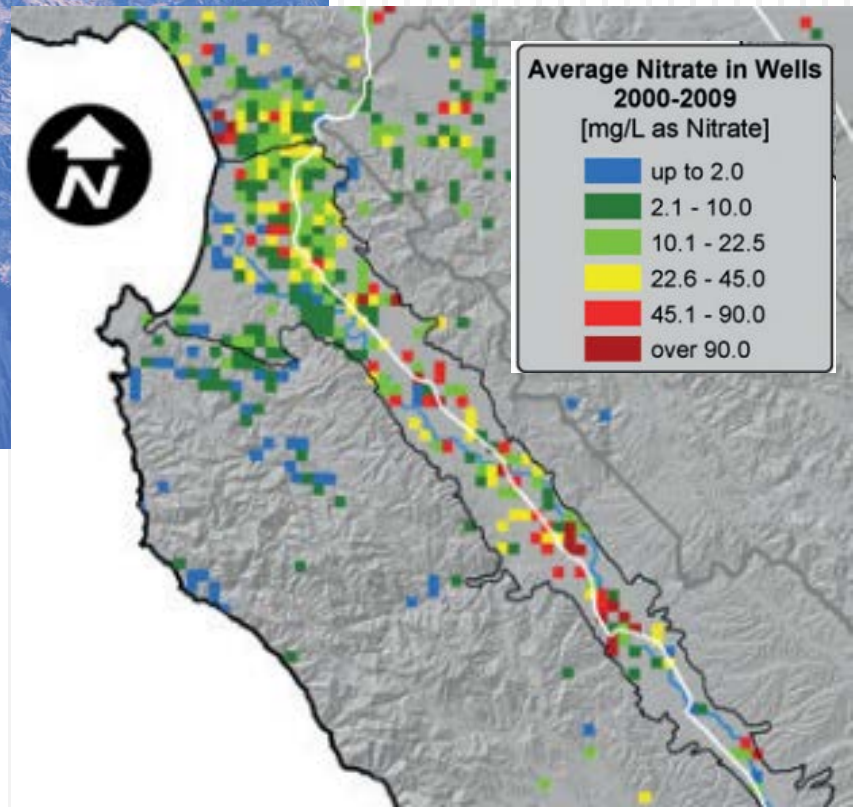


Adapted from MCWRA, 2017

Groundwater Quality

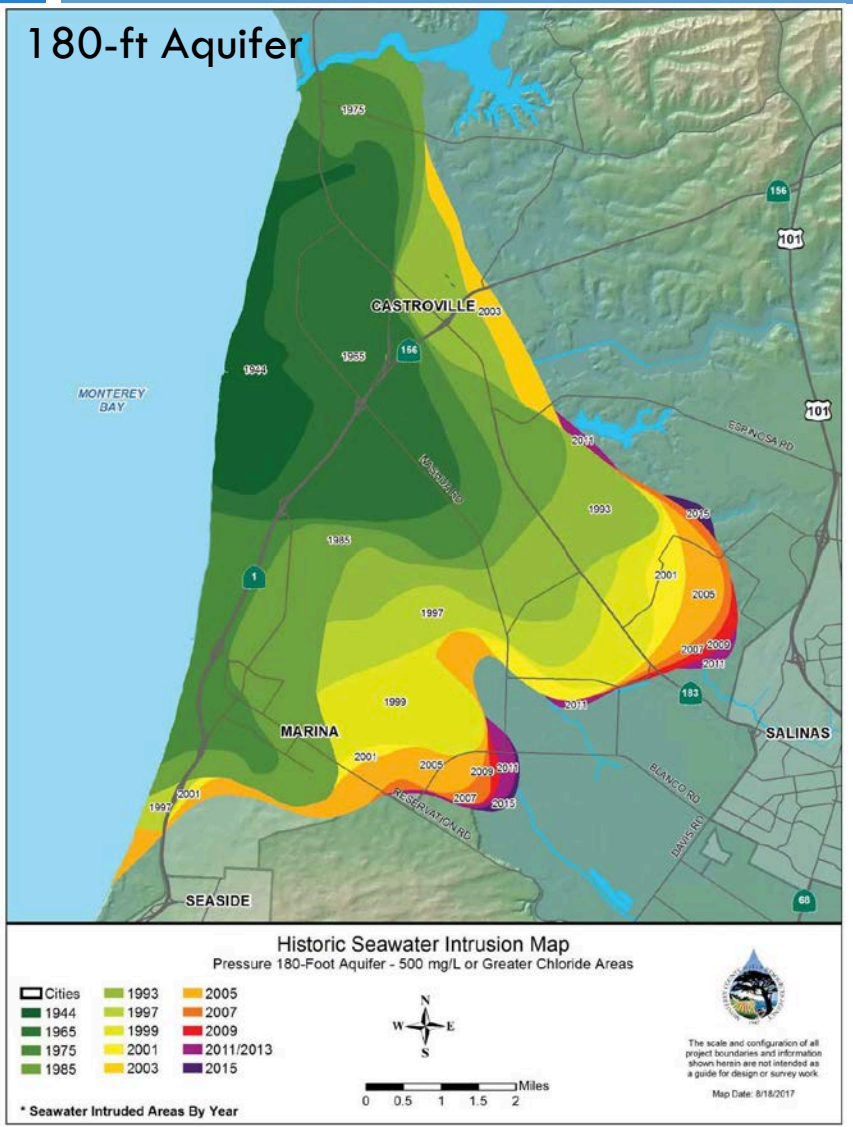
- Elevated salinity due to seawater intrusion
- Nitrates from agriculture
- Organic compounds from industry
- High TDS associated with sulfate and boron



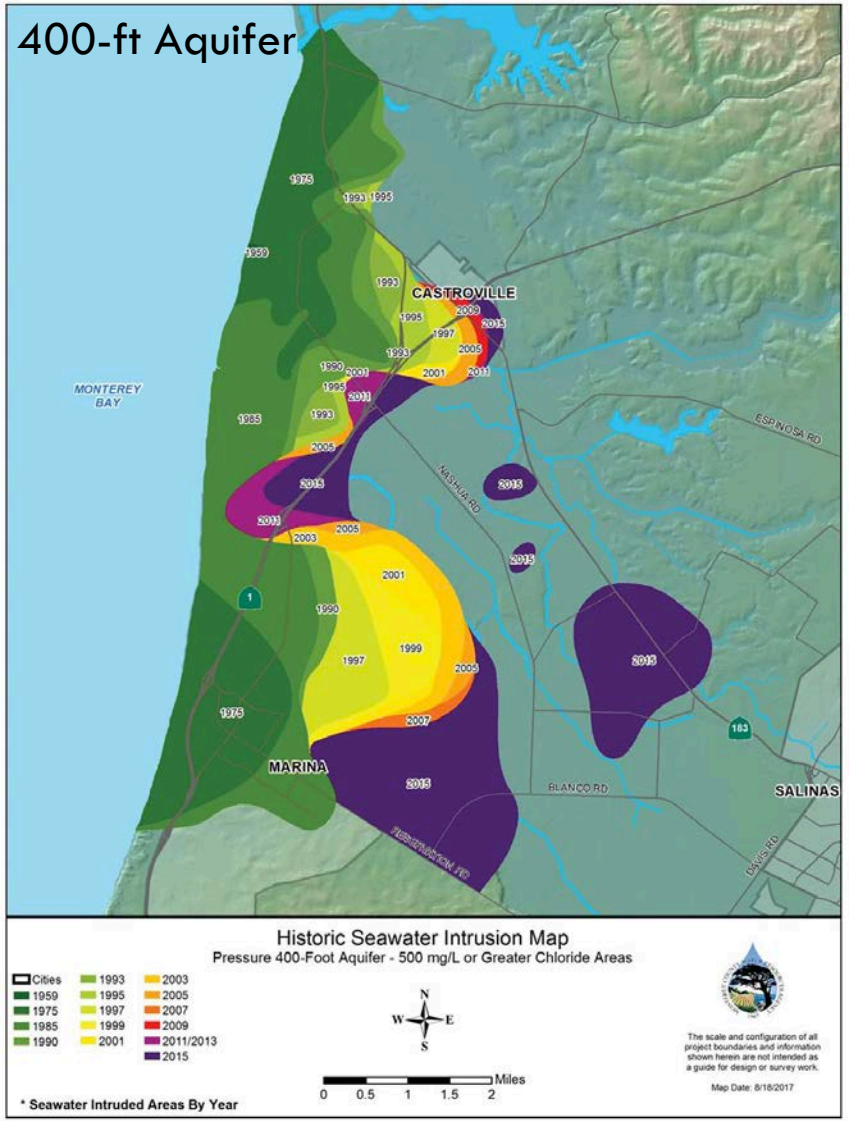


Sources: DWR Bull 118, USGS, 1983
Boyle et al., UC Davis, 2012

Seawater Intrusion



Maps show estimated extent of groundwater with chloride > 500 mg/L

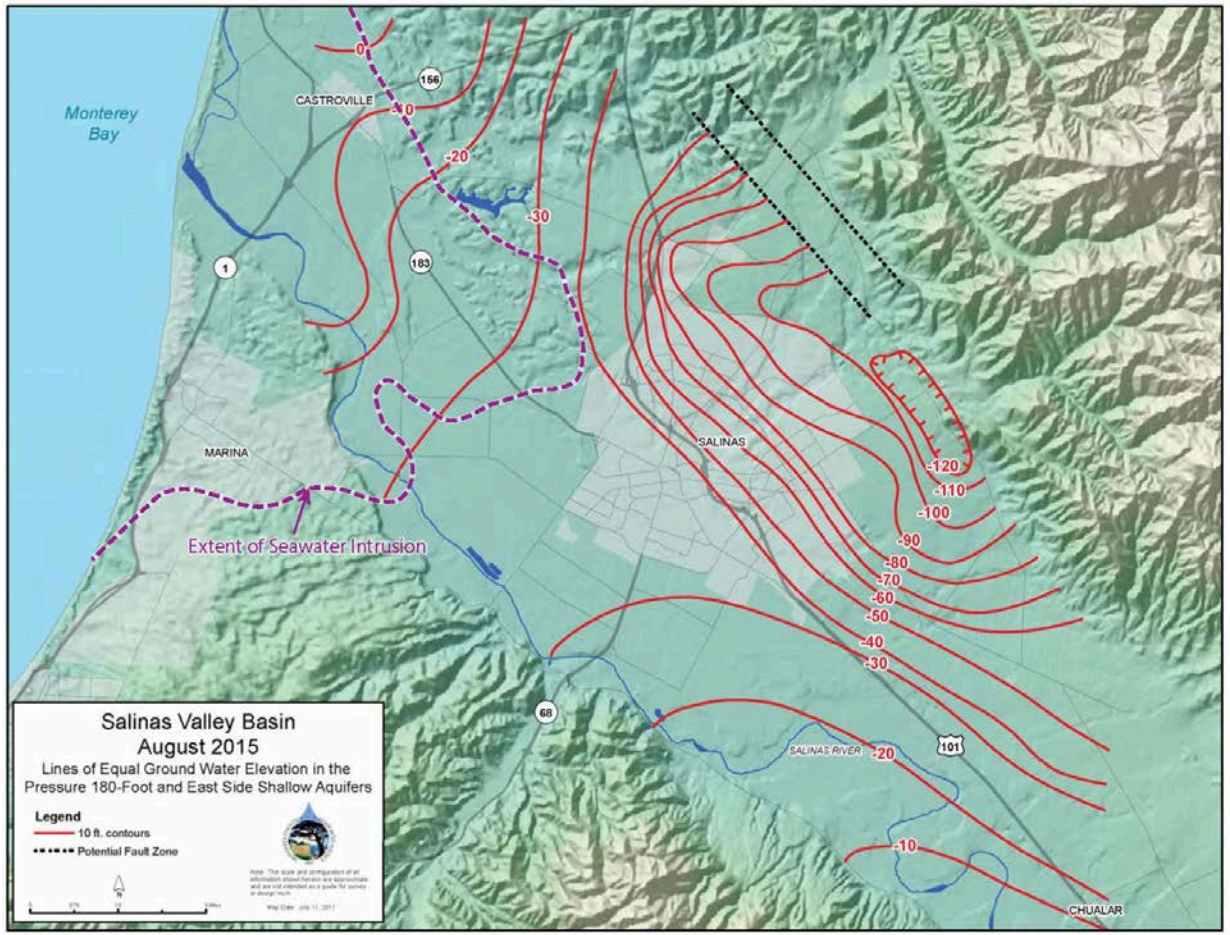


Source: MCWRA, 2017

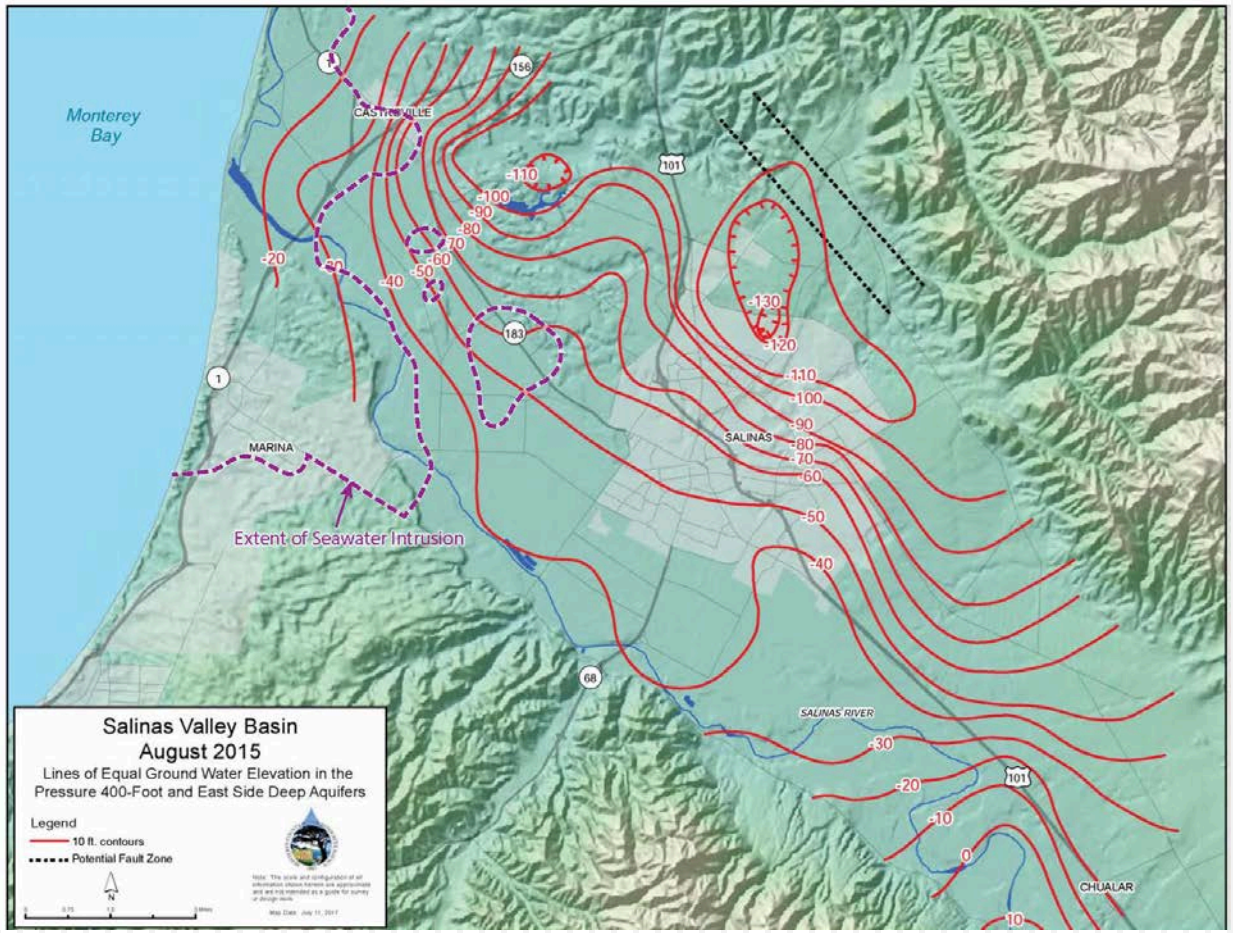
Seawater Intrusion

Aug 2015 water levels

180-ft Aquifer



400-ft Aquifer



Adapted from MCWRA, 2017

Seawater Intrusion Conceptual Model
180- and 400-foot Aquifers

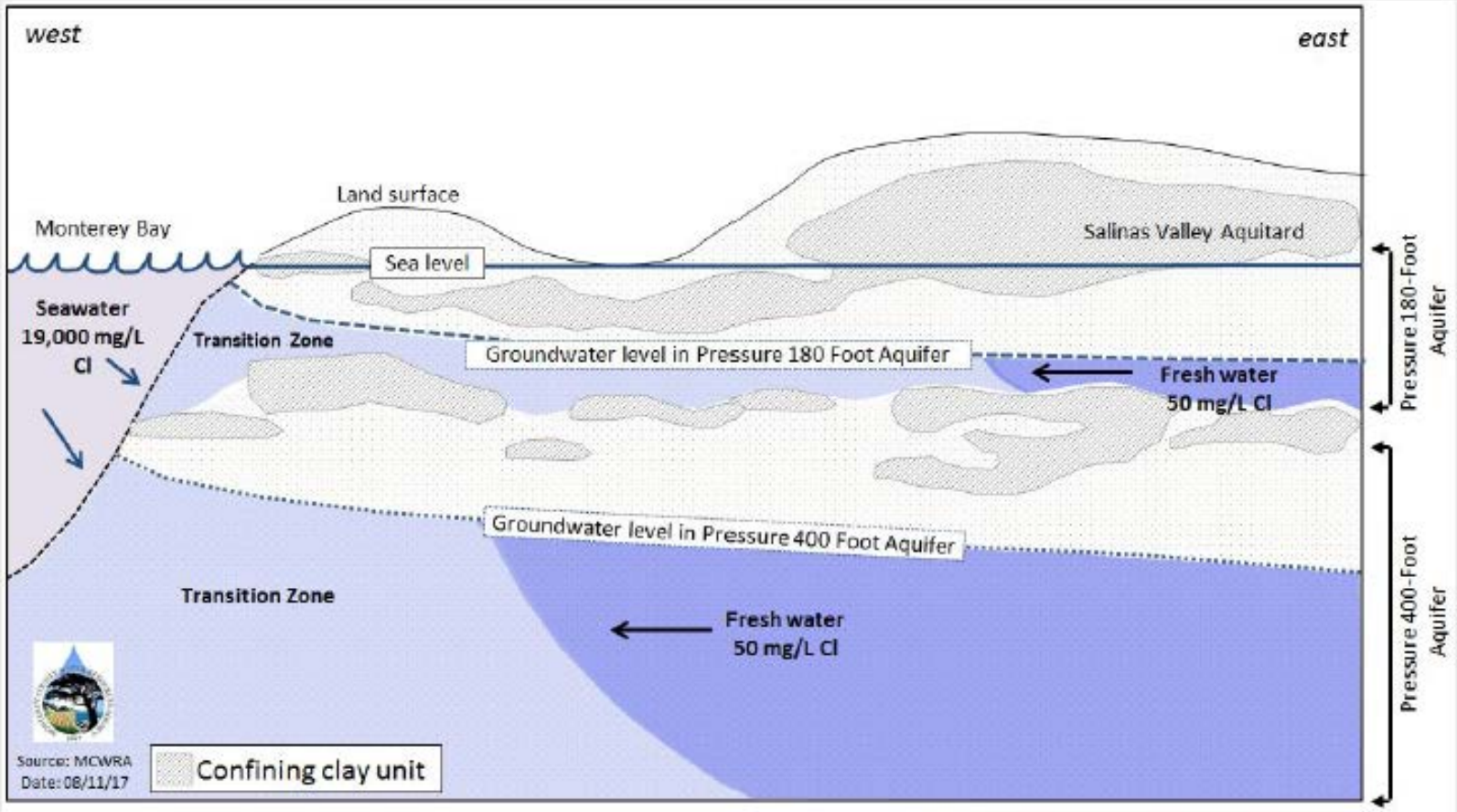


Figure 9B. With regional seawater intrusion, seawater moves inland because there are submarine outcrops of the geologic formations and a landward groundwater gradient.

Source: MCWRA, 2017

SWI Conceptual Model
180- and 400-foot Aquifers

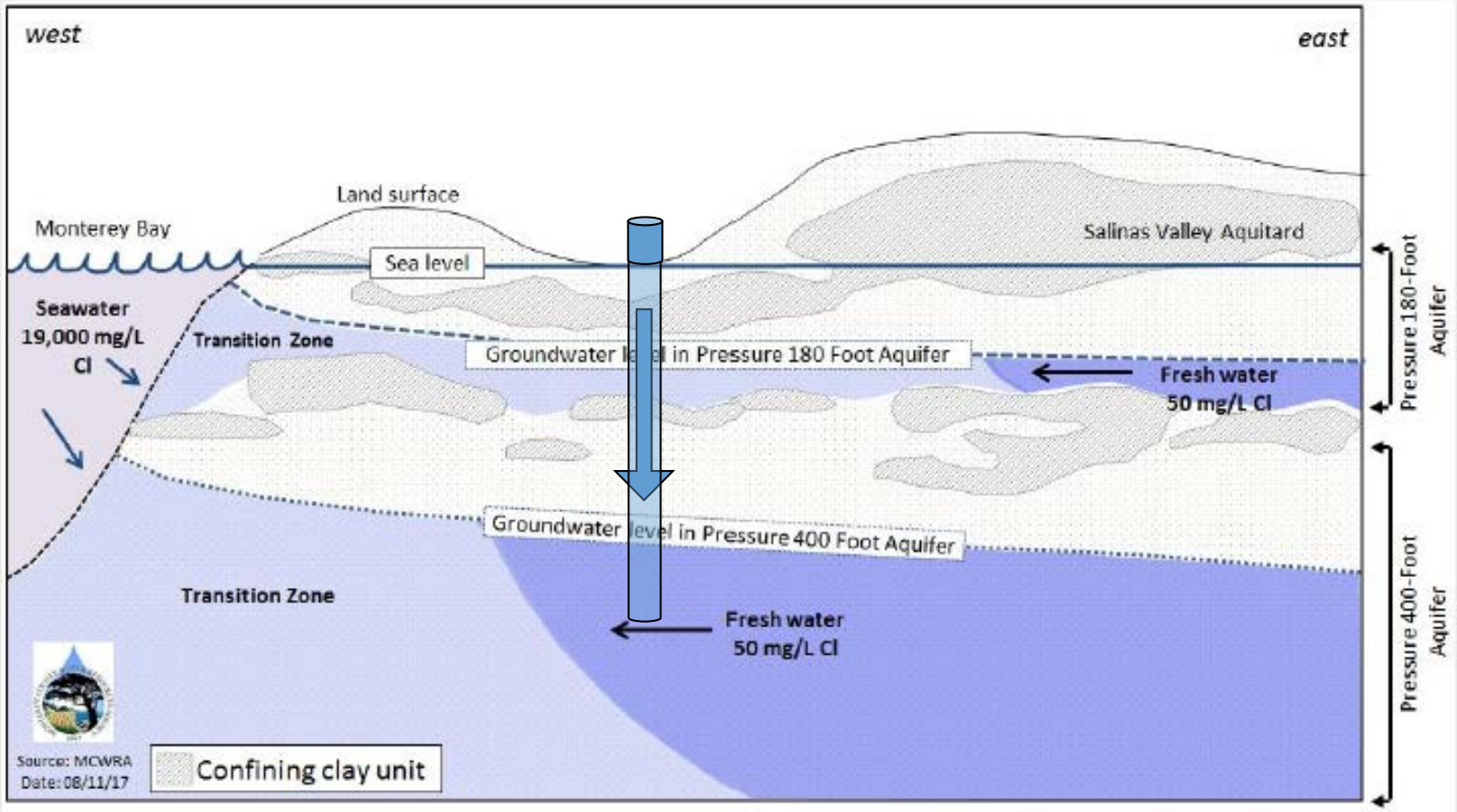
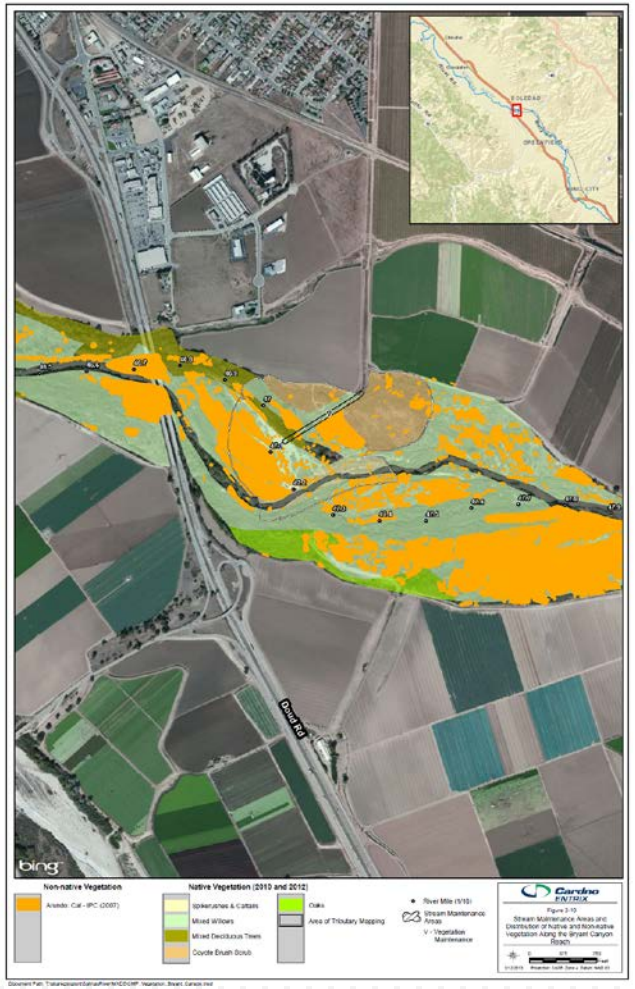


Figure 9B. With regional seawater intrusion, seawater moves inland because there are submarine outcrops of the geologic formations and a landward groundwater gradient.

Source: MCWRA, 2017

Groundwater-Surface Water Interaction and Groundwater Dependent Ecosystems



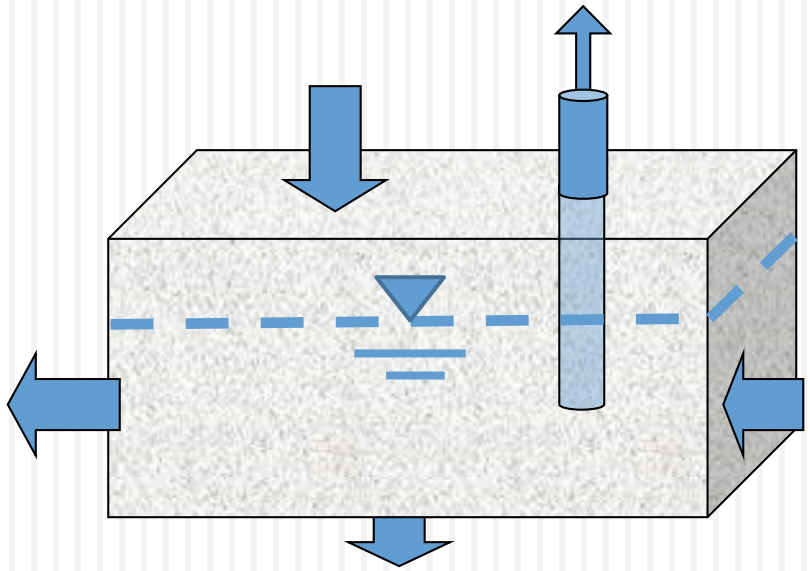
Source: https://gis.water.ca.gov/app/NCDatasetViewer/

Outline

- Purpose and Background
- Salinas Valley Basin Hydrogeology
- **Water Budgets**
- Sub-basins

Water Budgets – "Think Inside the Box"

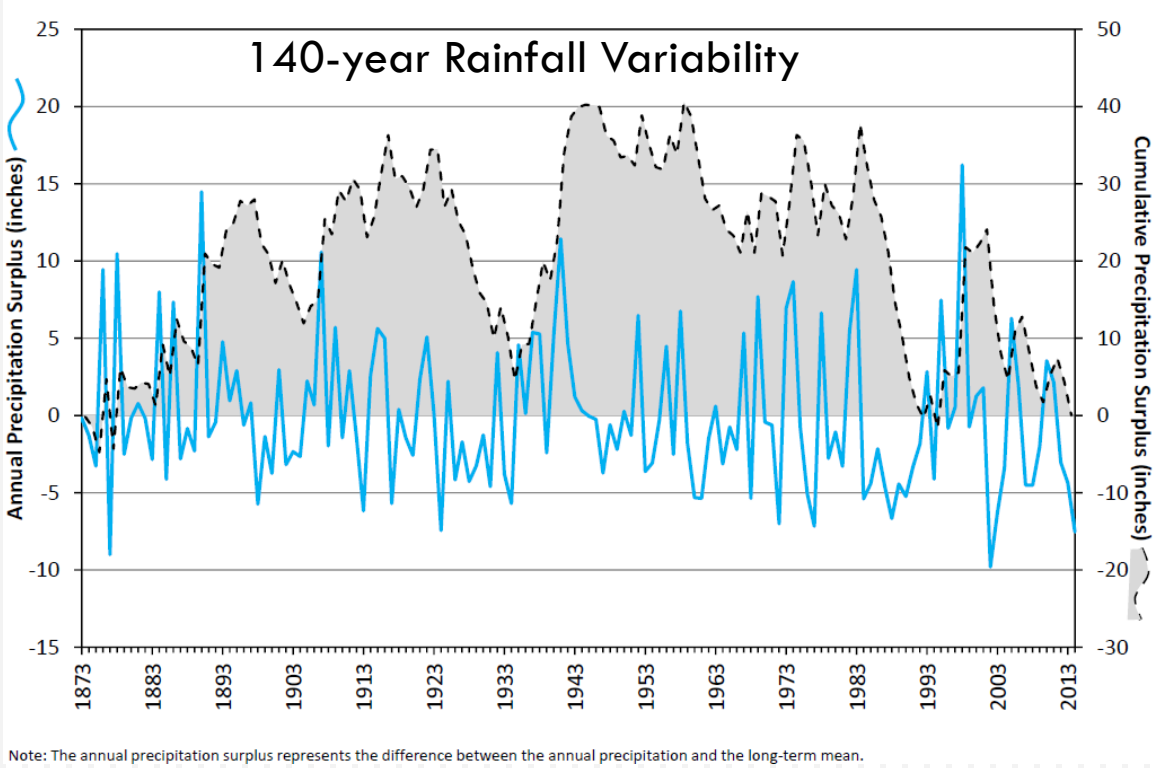
- Define spatial boundaries on all sides
- Define time period
- Water inflow and outflow
  - Regional horizontal flow
  - Recharge and vertical flow
  - Sources and sinks (e.g., wells)
- Change in storage during the period



Inflow – Outflow = Change in Storage

Water Budgets – "Think Inside (which) Box(?)"

- What spatial boundaries?
  - Sub-basins or management areas
  - Surface water
  - Crop use, return flow, excess irrigation
  - Flow between layers/zones
- What time period?
  - Long-term average
  - Climatic cycles (e.g. droughts)
  - Seasonal
  - Future scenarios for planning

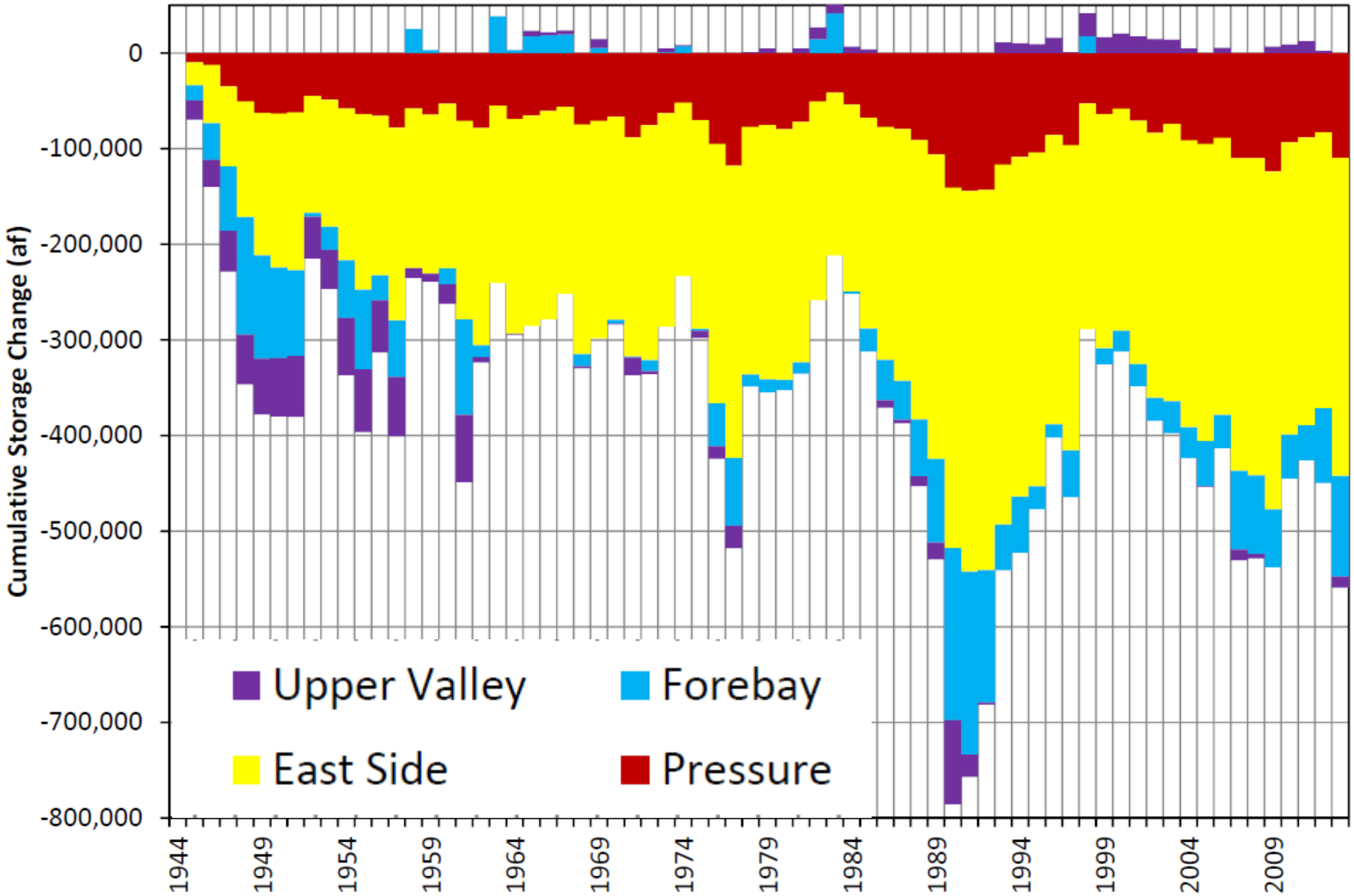


Source: Brown & Caldwell, 2015 (MCWRA)

Inflow – Outflow = Change in Storage

Change in Groundwater Storage

- Cumulative storage change by subarea (1994 – 2015)
- Does not include loss of fresh water storage due to seawater intrusion



Source: Brown and Caldwell, 2015 (MCWRA)

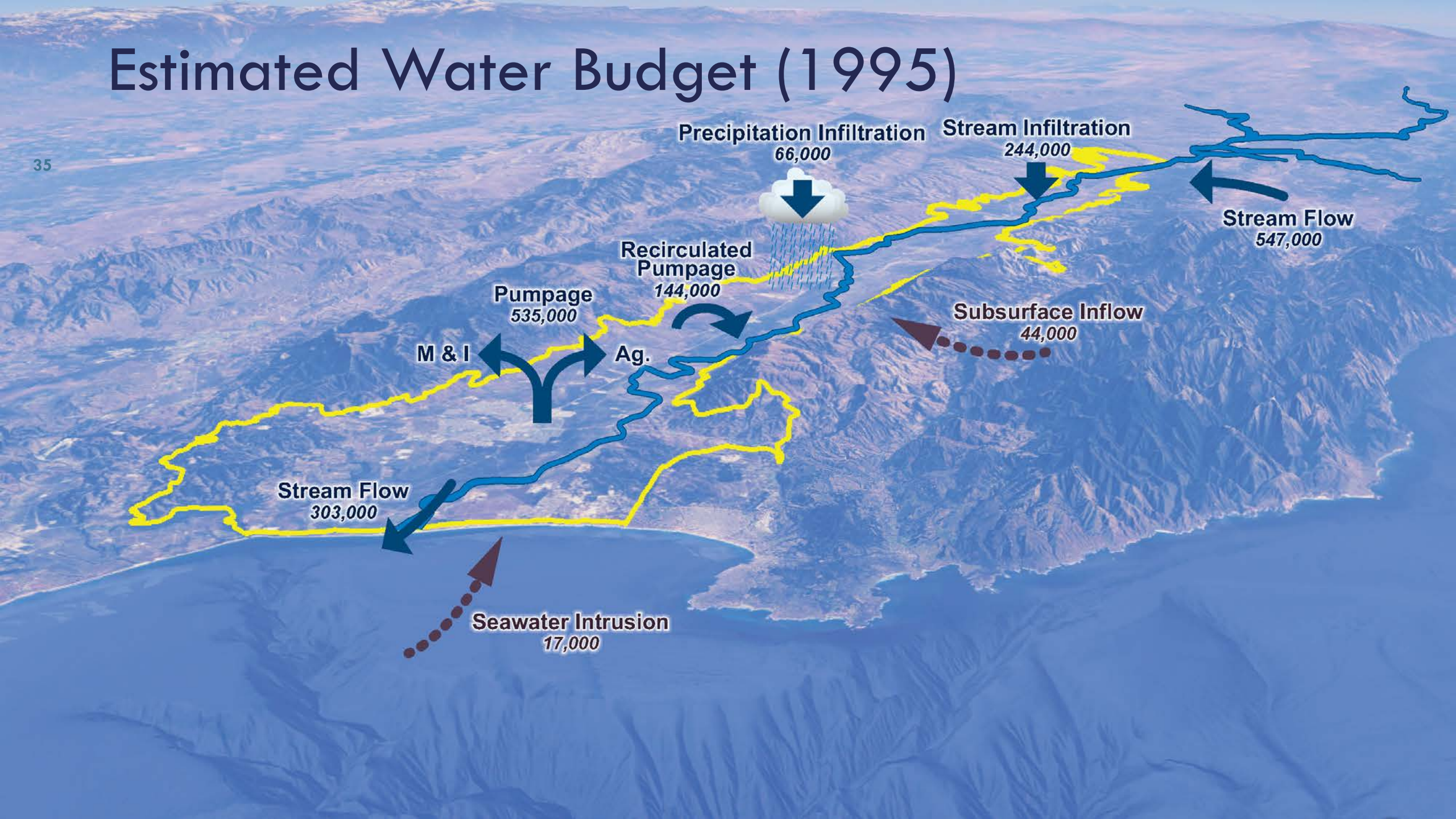
Example Published Water Budgets

- 1946 Bulletin 52 (DWR)
- 1995 White Paper Summary of Basin Groundwater (for MCWRA)
- 2015 State of the Basin Report (Brown and Caldwell for MCWRA)
- Differences reflect both uncertainties and choice of boundaries/periods

Annual Water Budget Estimates (acre-feet/year)

	1929-1945 Bulletin 52	19170-1992 1995 White Paper	1959-2013 2015 State of Basin
Water Inflow to Basin			
Salinas River and Tributaries	701,000	547,000	-
Valley Floor Percolation	239,000	66,000	-
Groundwater Flow	-	44,000	-
Recycled water / desalination water	-	-	-
Total Inflow	940,000	657,000	508,000
Water Consumption in Basin			
Agriculture Demand	400,000	-	464,000
Municipal, Industrial, Domestic Demand	15,000	-	59,000
Native Vegetation ET	-	-	-
Total Water Consumption	415,000	391,000	523,000
Water Outflow and Storage			
River Discharge to Ocean	503,000	303,000	-
Net Groundwater Flow (Intrusion) to Ocean	24,000	(17,000)	(11,000-18,000)
Annual Change in Storage	(2,000)	(20,000)	(6,000)

Estimated Water Budget (1995)



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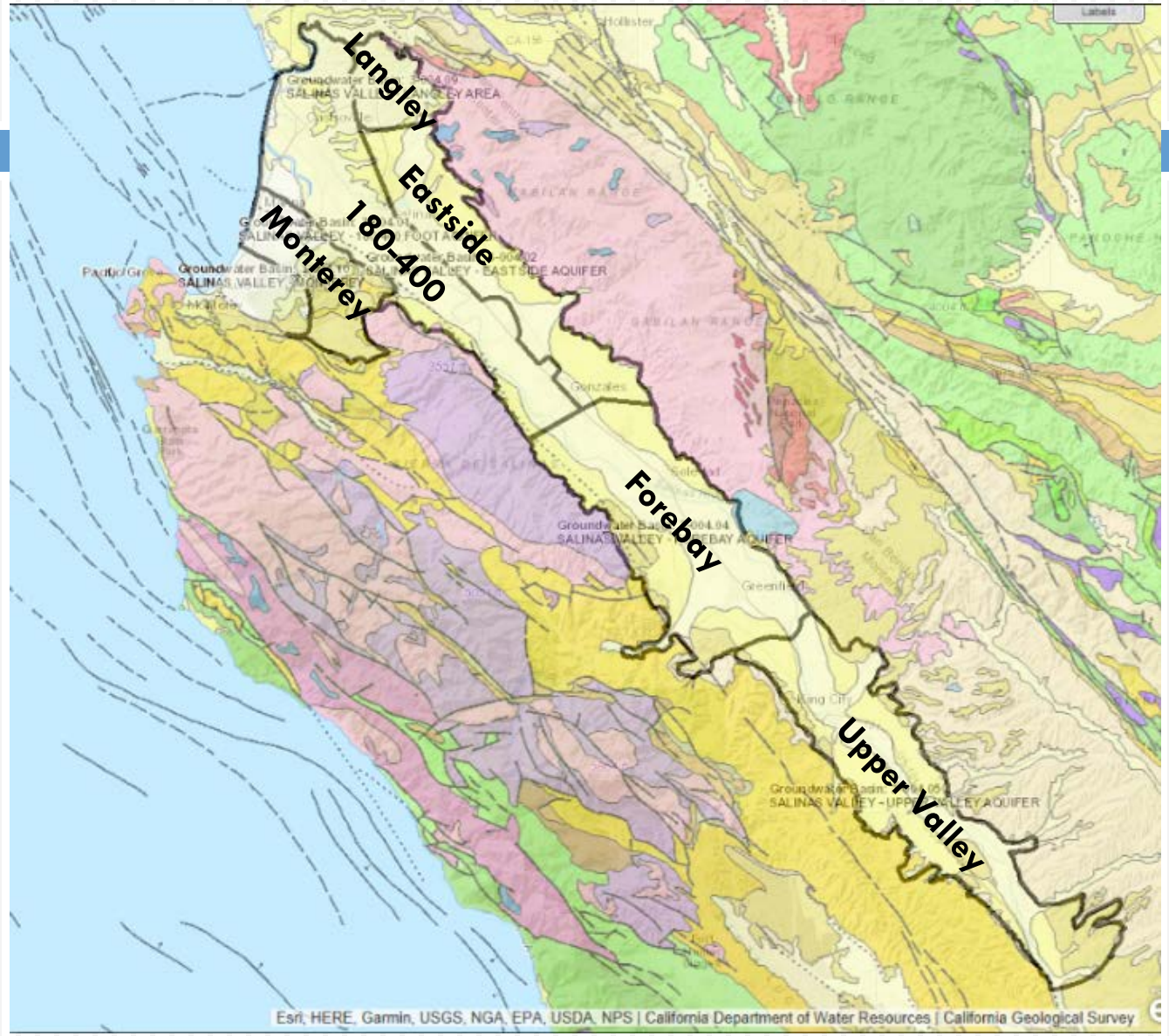
- **Sub-basins**

Sub-basins – Geology

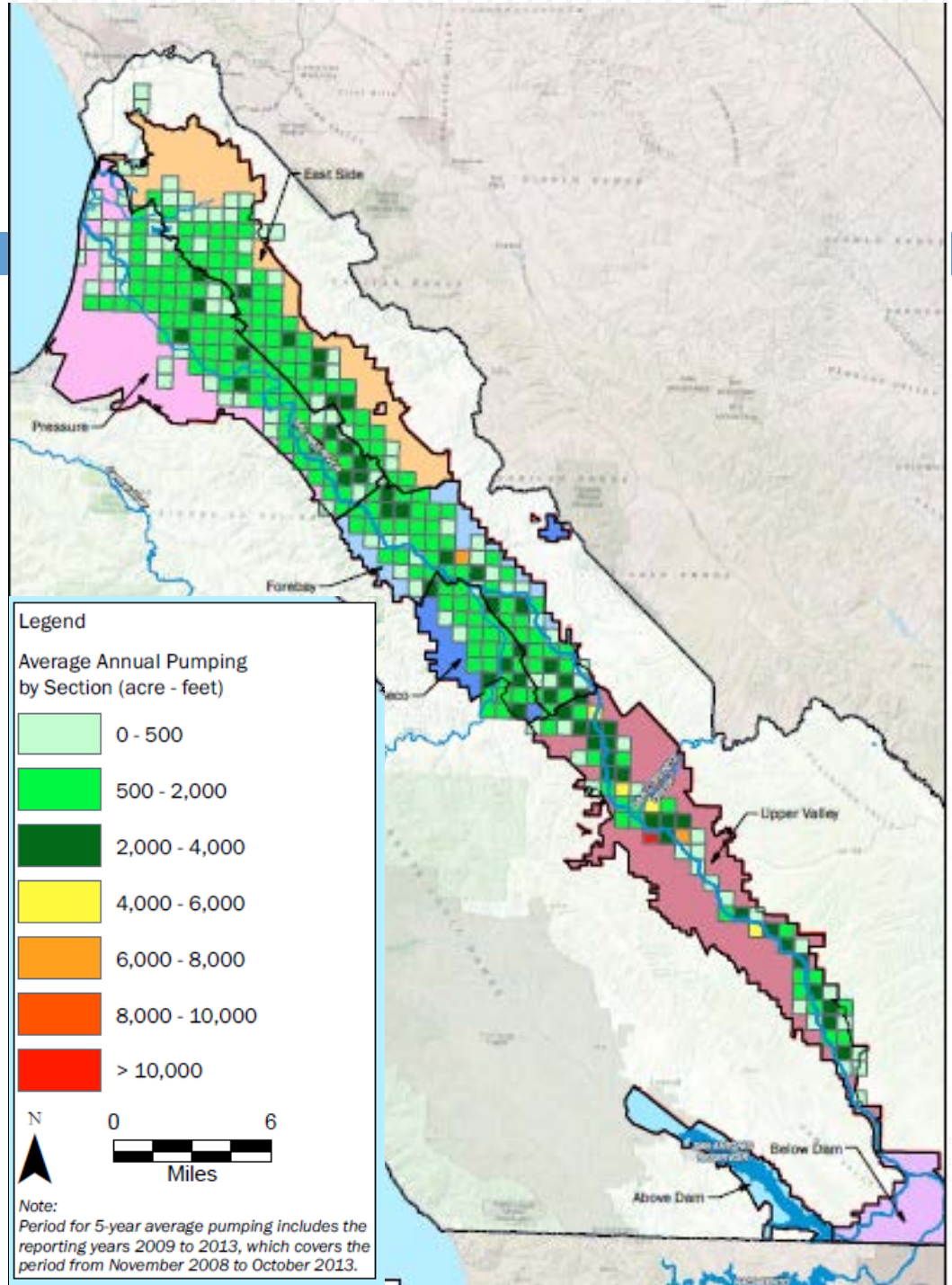
Alluvial basin fill 
bounded by relatively impermeable sedimentary rock 
or granitic basement 



https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer

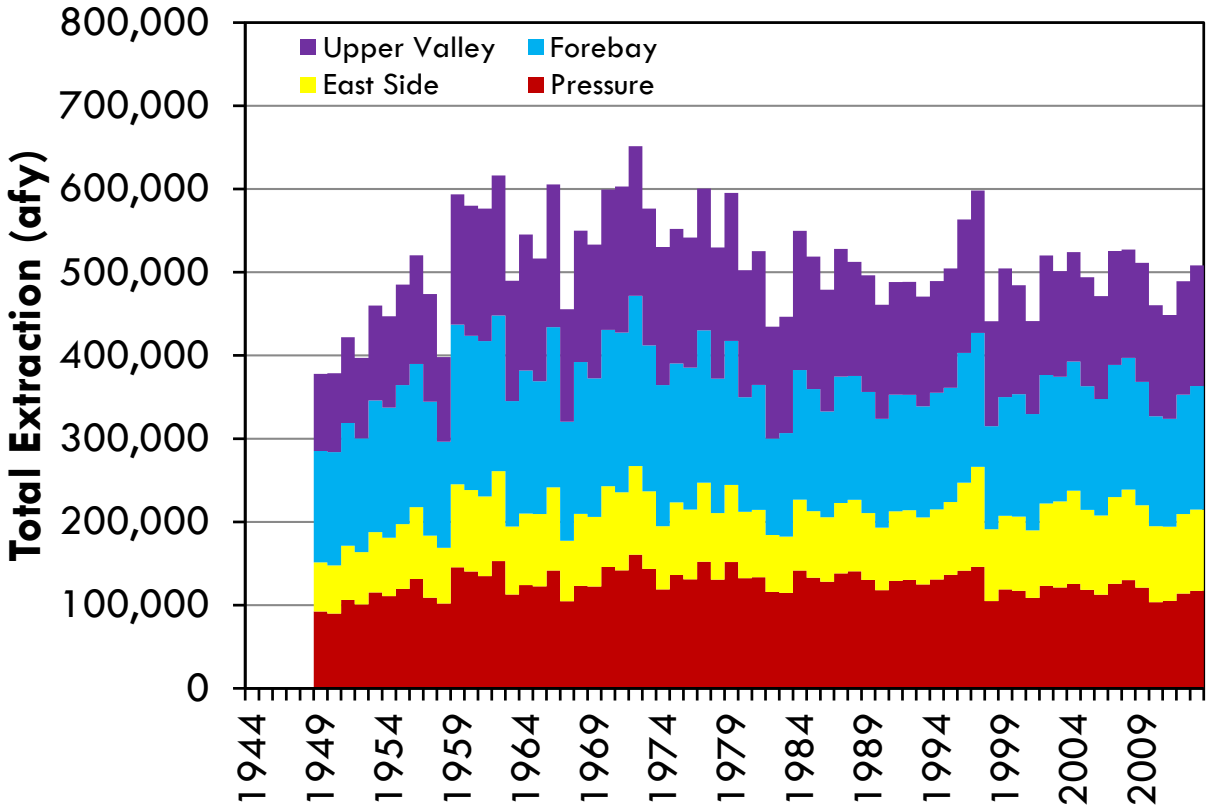
Sub-Basins – Pumping

Average Annual Pumping (ac-ft/yr) by Section

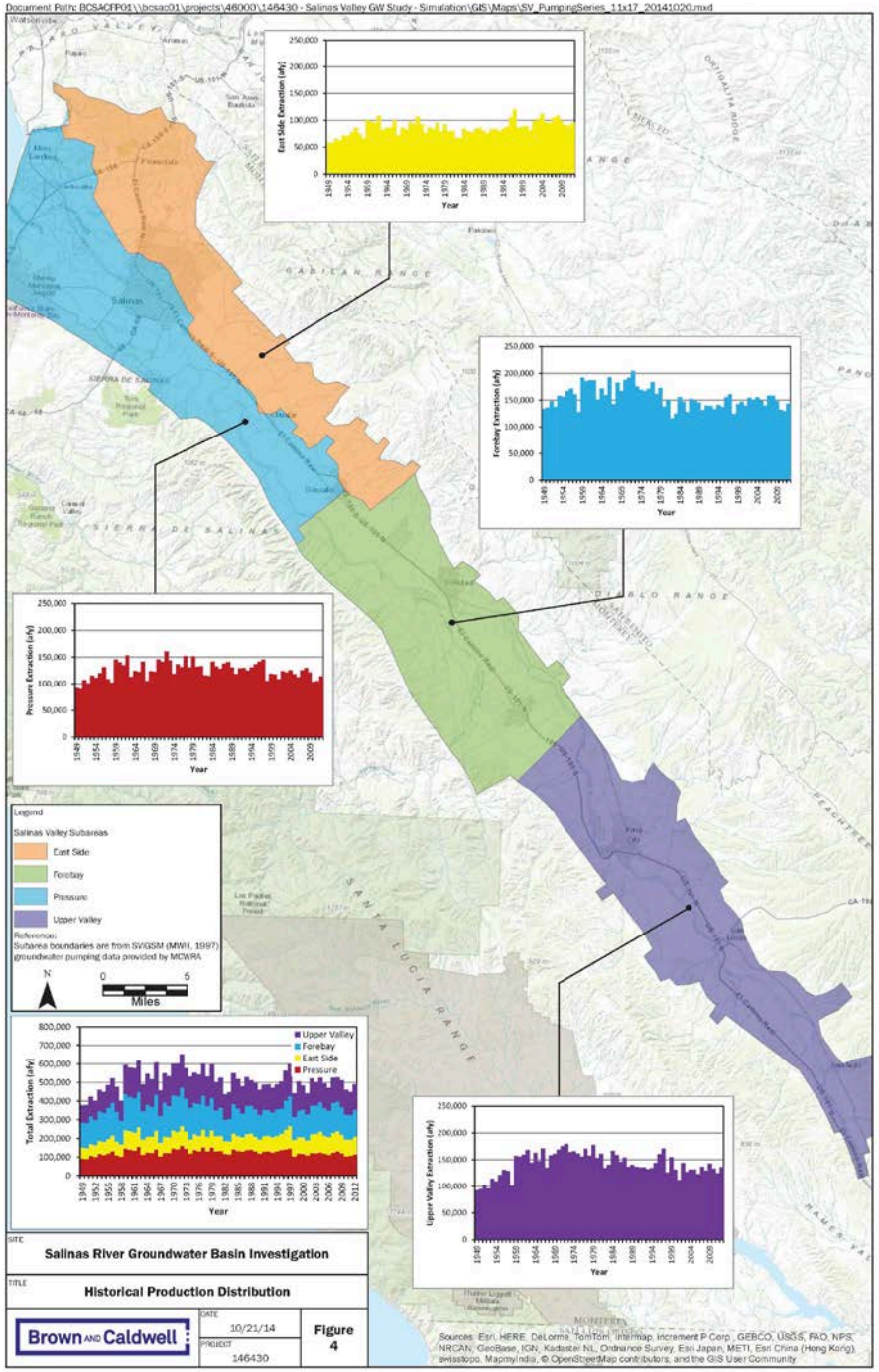


Source: Brown and Caldwell 2015 (MCWRA)

Subareas - Historical Production 1949 to 2012



Source: Brown and Caldwell 2015 (MCWRA)



Subsurface Flow

Arrows are preliminary schematic representation of subsurface flow at basin boundaries

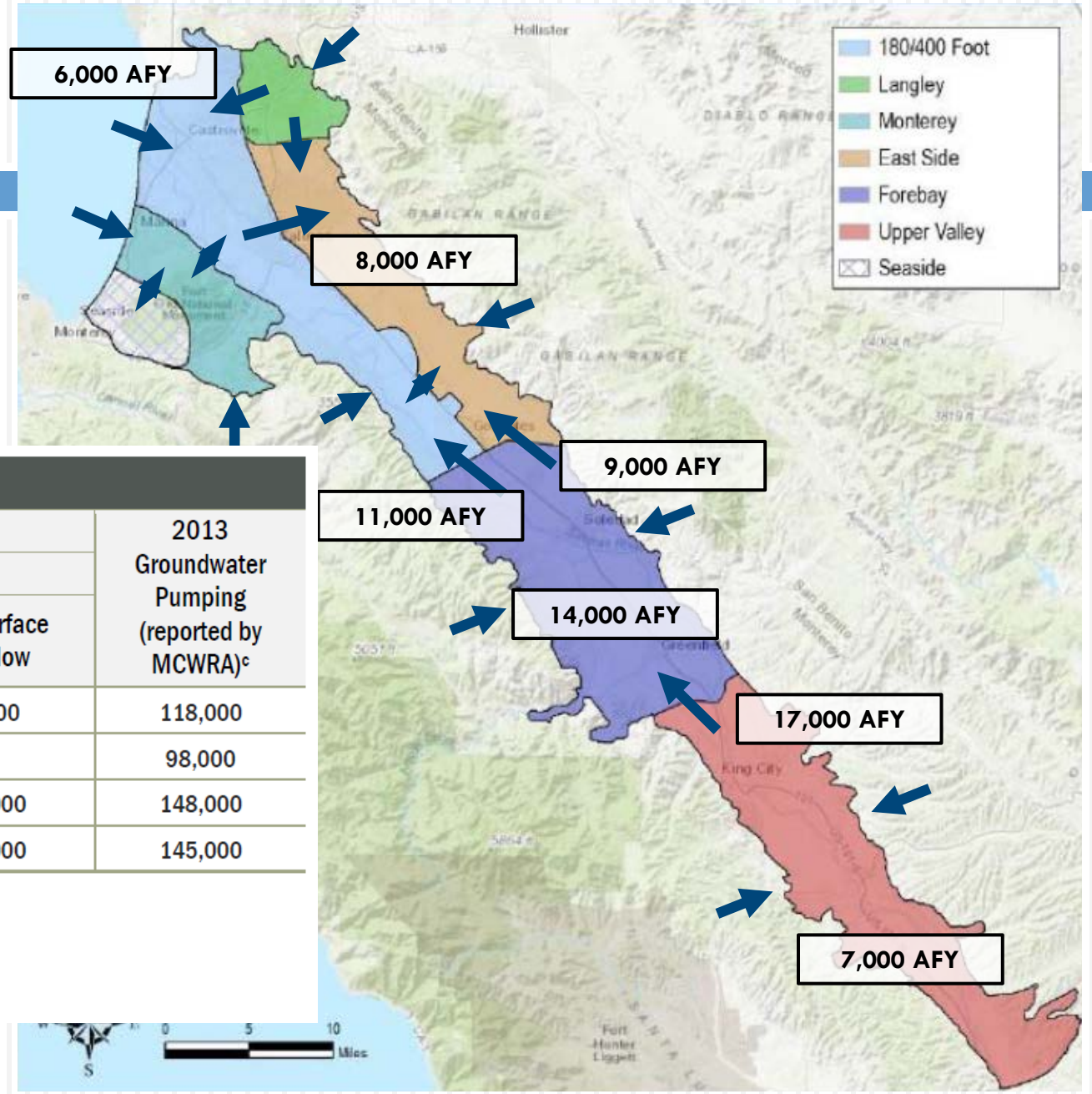


Table 4-3. Water Budget Components by Subarea

Subarea	Average of WY 1958-1994 (from MW, 1998)				2013 Groundwater Pumping (reported by MCWRA)[c]
	Inflow		Outflow		
	Natural Recharge[a]	Subsurface Inflow	Groundwater Pumping[b]	Subsurface Outflow	
Pressure	117,000	17,000	130,000	8,000	118,000
East Side	41,000	17,000	86,000	0	98,000
Forebay	154,000	31,000	160,000	20,000	148,000
Upper Valley	165,000	7,000	153,000	17,000	145,000

Note: All estimates in acre-feet per year (afy).

[a] *Includes agricultural return flow, stream recharge, and precipitation.*

[b] *Groundwater pumping as reported by MW (1998) is presented to provide a complete water budget.*

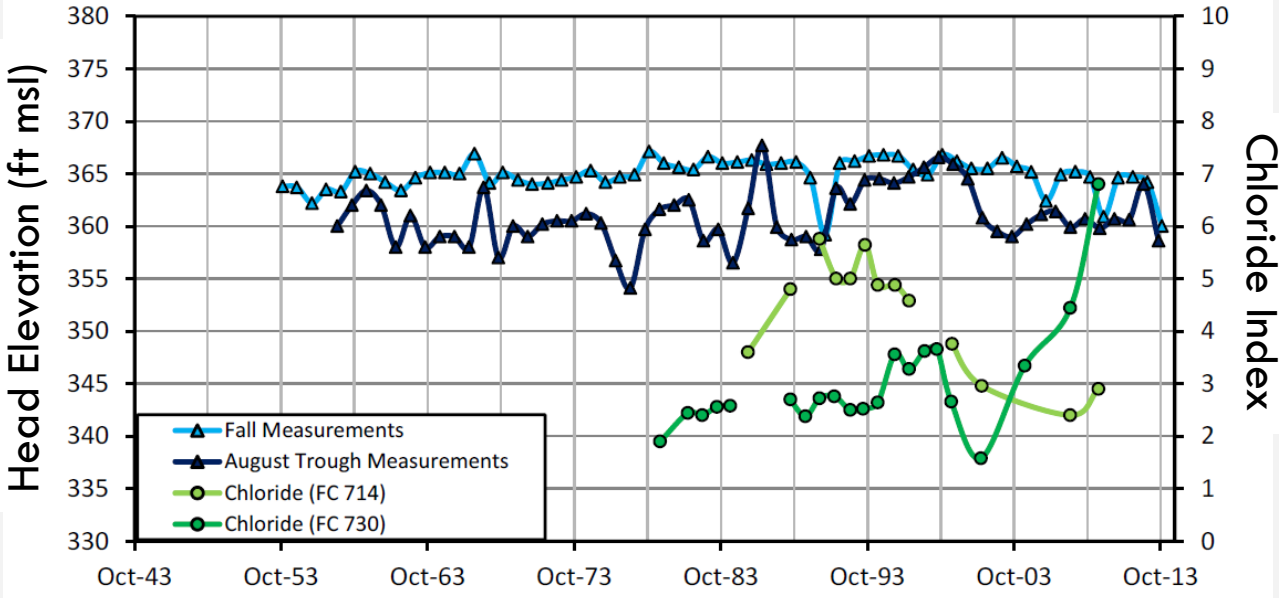
[c] *The 2013 groundwater pumping totals are provided for comparison.*

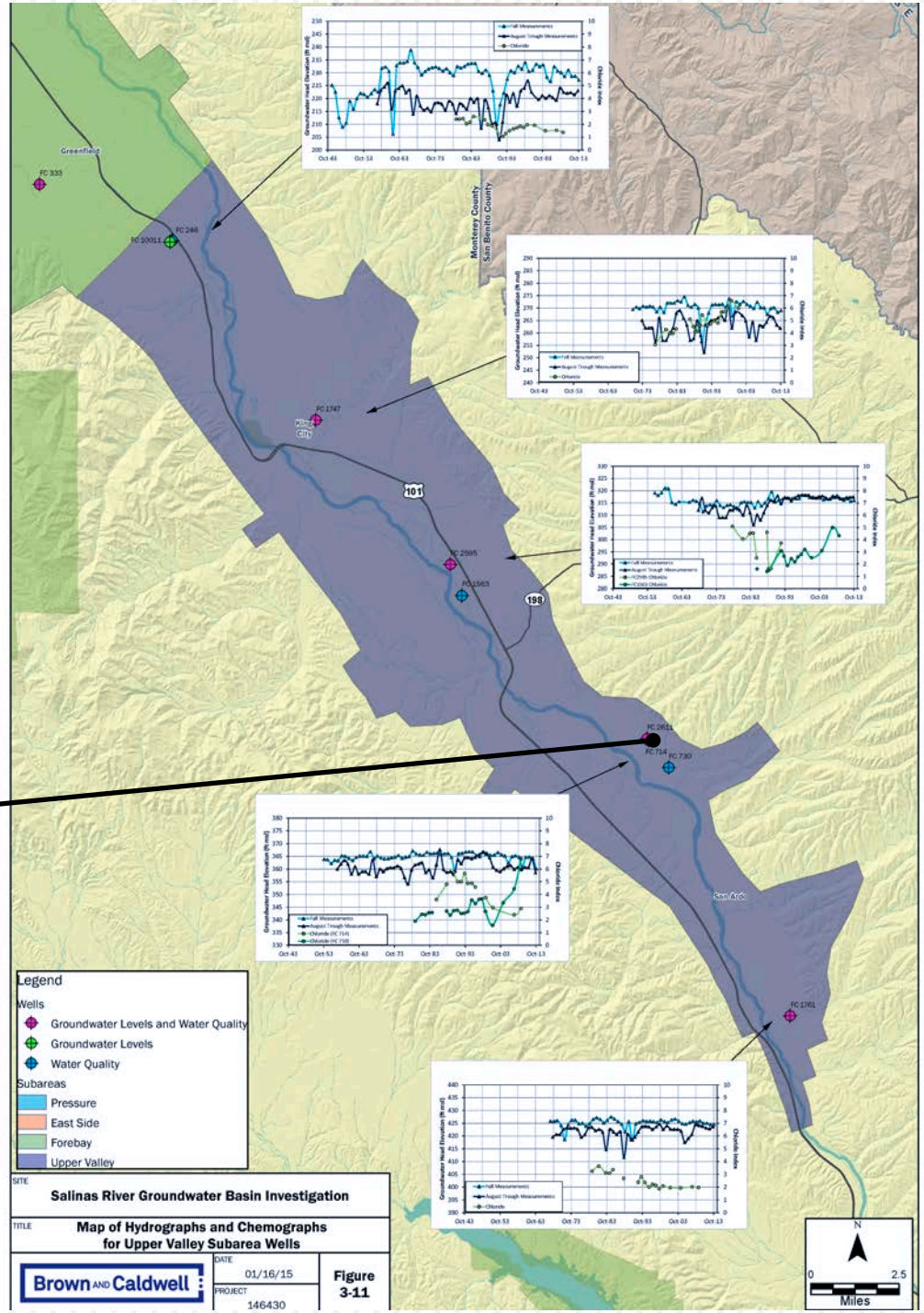
Adapted from : Brown & Caldwell 2015 (MCWRA)

Groundwater Levels with Time (Hydrographs) with Chloride

Upper Valley Subarea

- Groundwater levels stable and above sea level
- Small difference between peak irrigation and end of irrigation



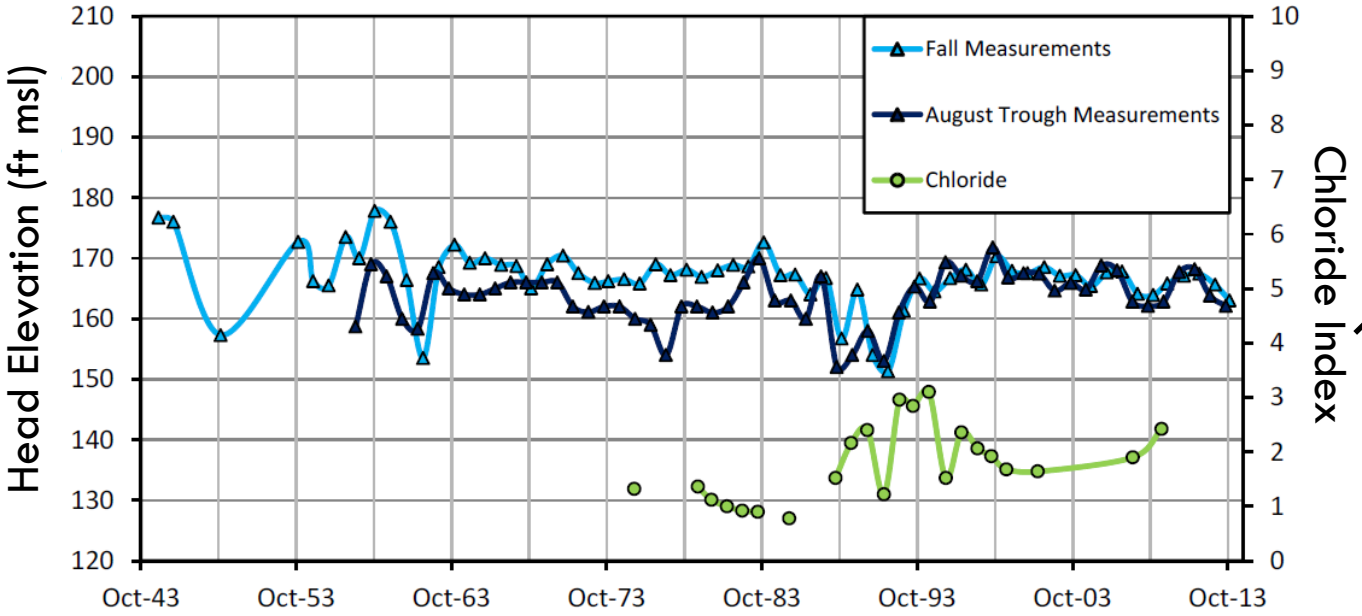


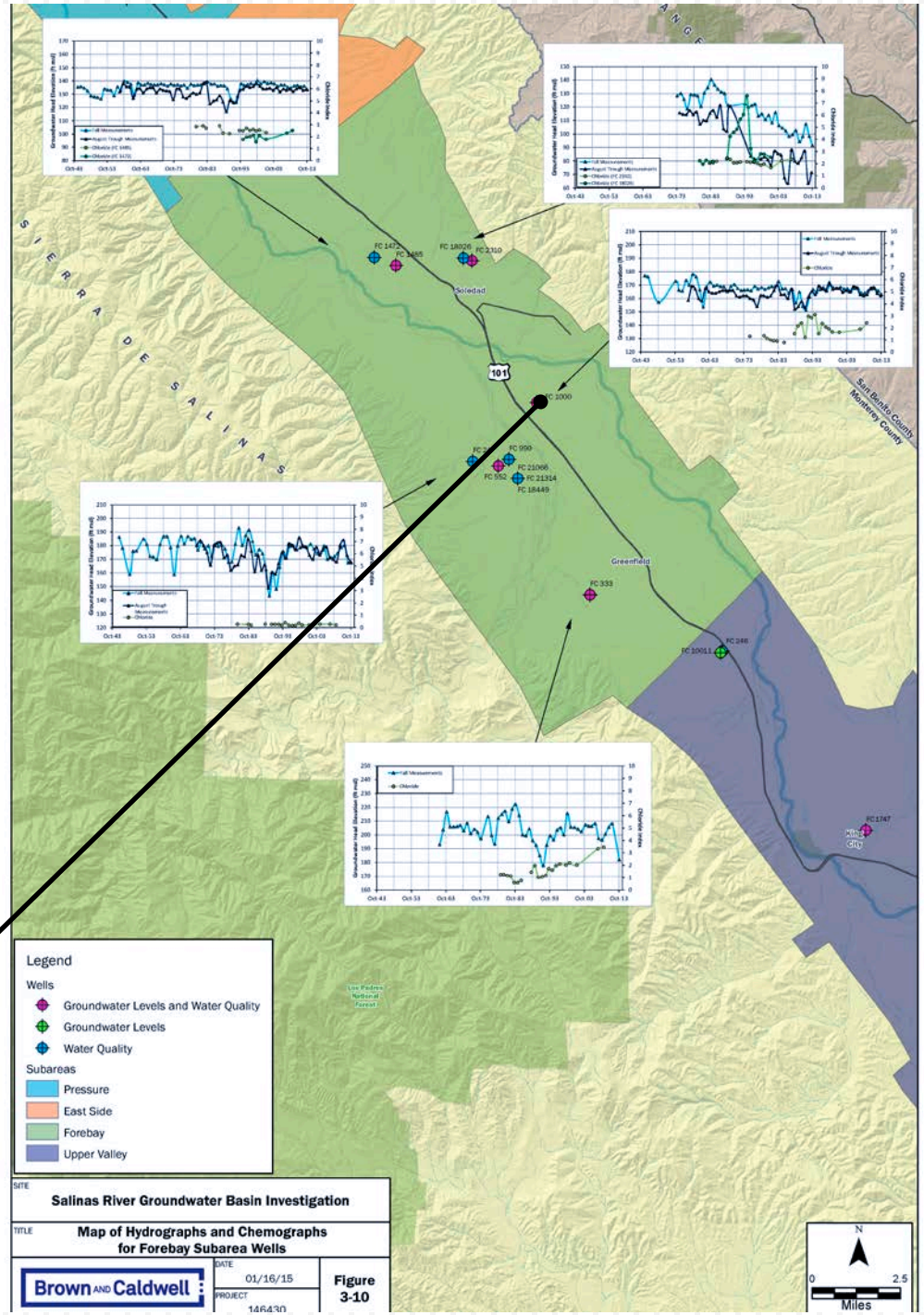
Source: Brown and Caldwell 2015 (MCWRA)

Groundwater Levels with Time (Hydrographs) with Chloride

Forebay Subarea

- Groundwater levels generally stable or declining but more than 100 ft above sea level
- Small difference between peak irrigation and end of irrigation



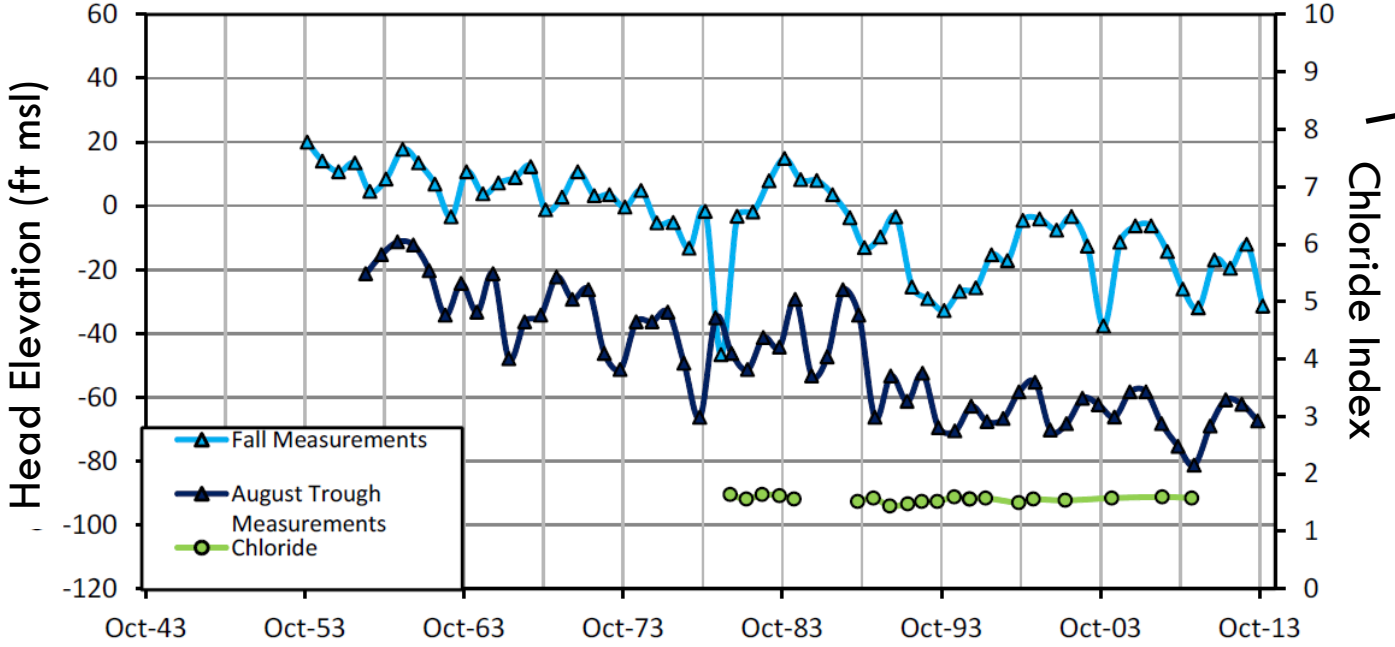


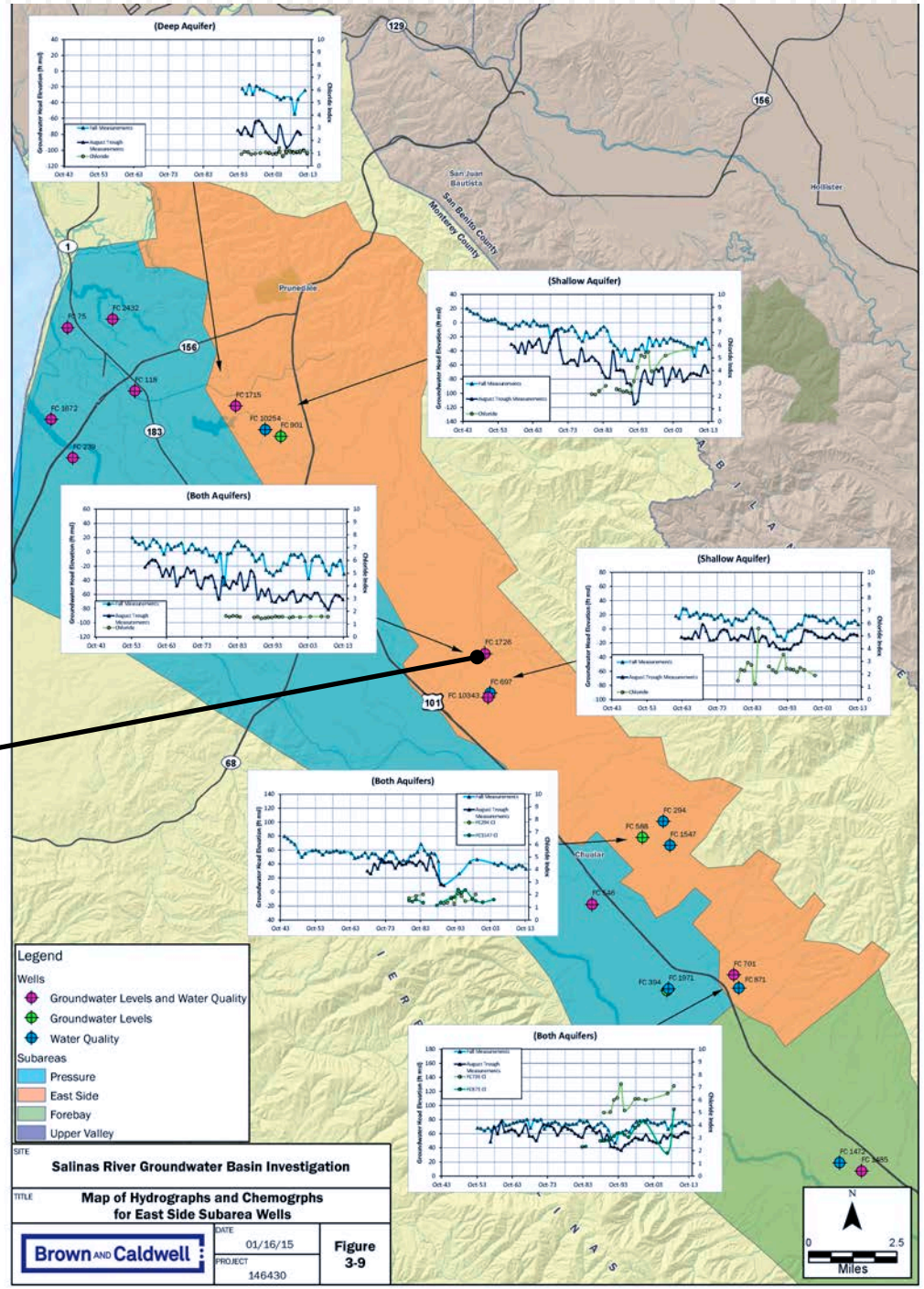
Source: Brown and Caldwell 2015 (MCWRA)

Groundwater Levels with Time (Hydrographs) with Chloride

Eastside Subarea

- Groundwater levels below sea level except in SE
- Declining groundwater levels but low salinity
- Large difference between peak irrigation and end of irrigation (≈ 40 ft)



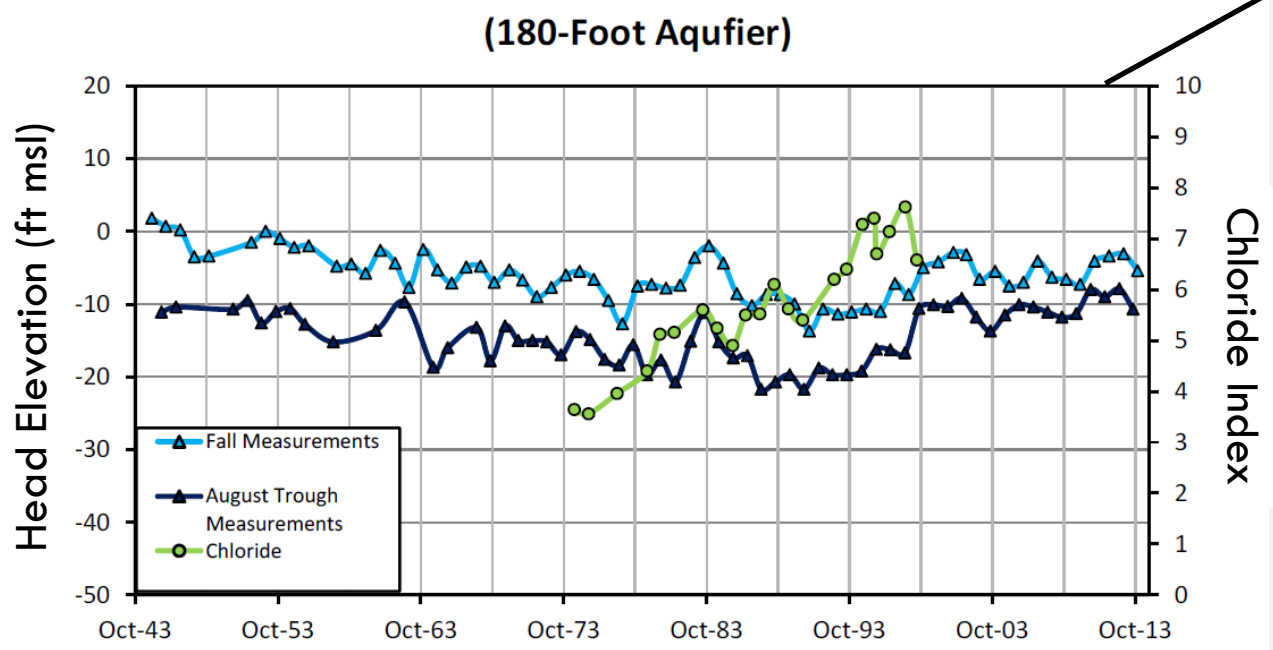


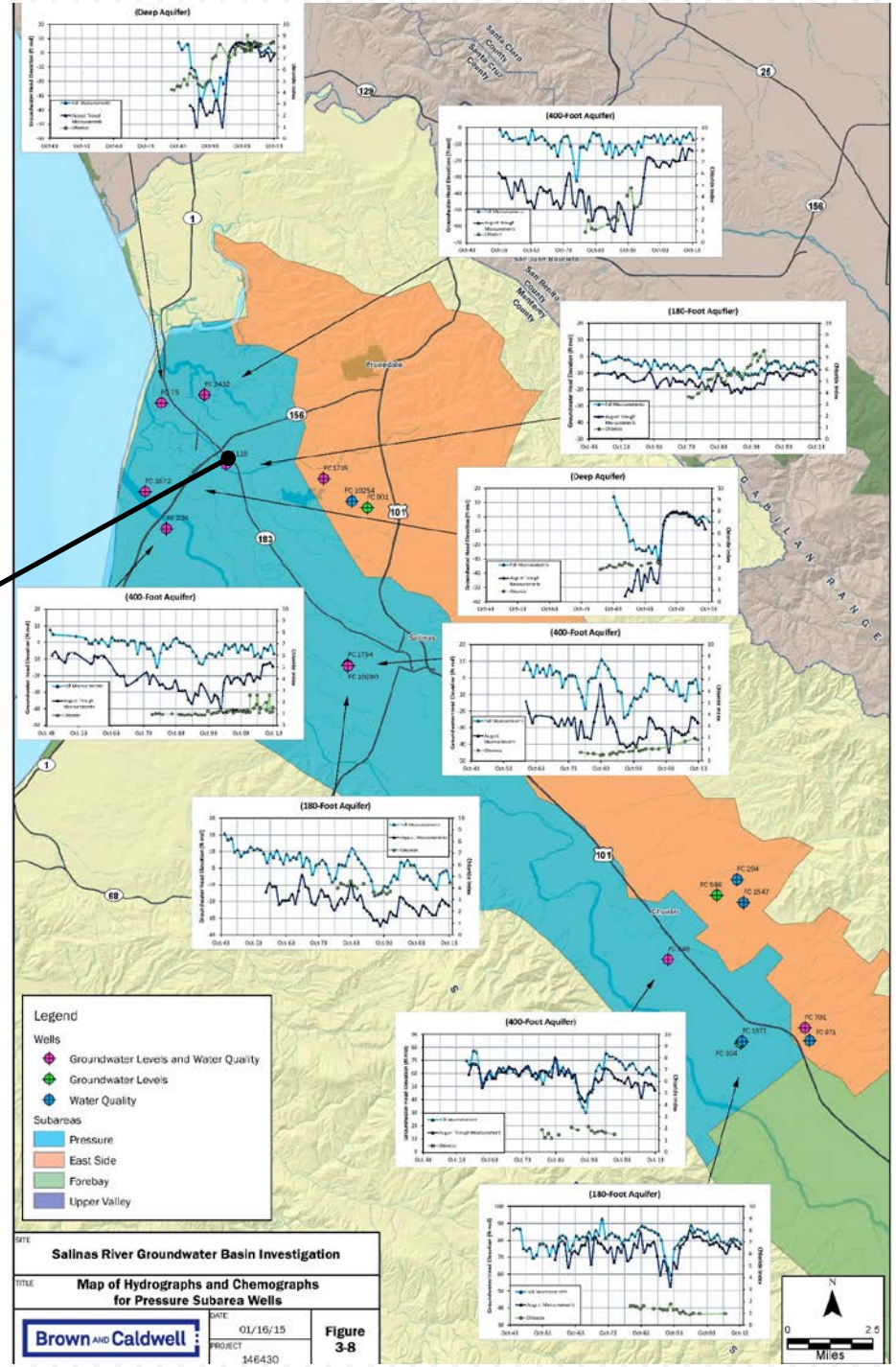
Source: Brown and Caldwell 2015 (MCWRA)

Groundwater Levels with Time (Hydrographs) with Chloride

Pressure Subarea

- Groundwater levels below sea level NW of Salinas
- Declining groundwater levels and increasing salinity
- Moderate difference between peak irrigation and end of irrigation
-



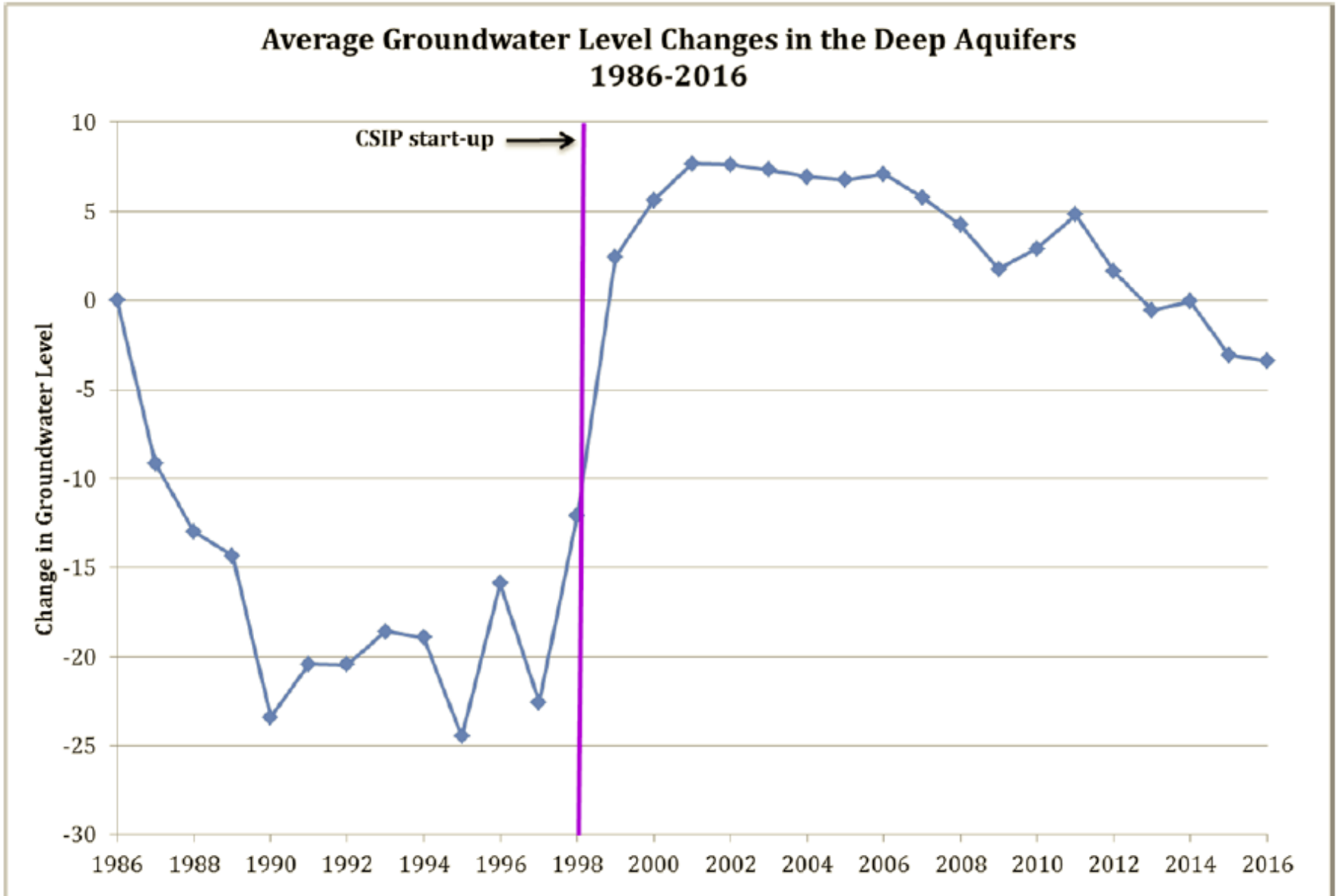


Source: Brown and Caldwell 2015 (MCWRA)

CSIP --- Recovery of Deep Aquifer

CSIP deliveries:

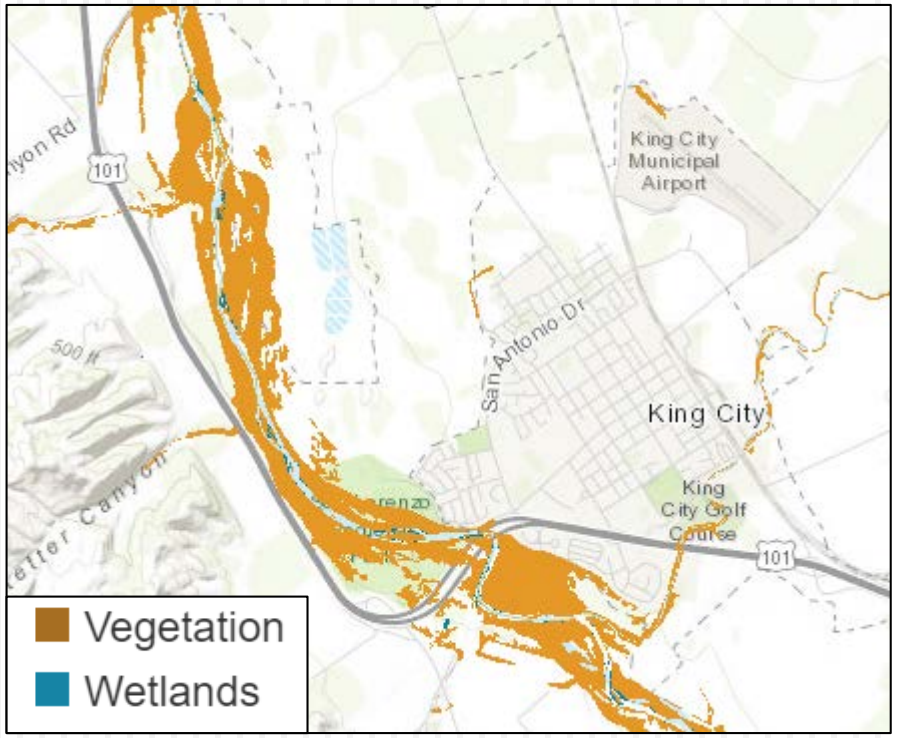
- Decreased pumping
- Water levels in portions of the deep aquifer recovered



Source: MCWRA, 2017

Groundwater-Surface Water Interaction and Groundwater Dependent Ecosystems

Example from Upper Valley:



Example from East Side:

Source: https://gis.water.ca.gov/app/NCDatasetViewer/

Questions / Comments?

- Purpose and Background
- Salinas Valley Basin Hydrogeology
- Water Budgets
- Sub-basins