Carpinteria Groundwater Sustainability Agency

Workshop #2

November 16, 2022

1. Groundwater Model

2. Monitoring Networks

Presented by:

Robert Marks/Pueblo Water Resources

Mike Burke/Pueblo Water Resources

Carpinteria Groundwater Basin GSP Development Project Groundwater Model

Workshop No. 2

11/16/22 6:00 PM

Robert C. Marks, PG, CHg

Principal Hydrogeologist

Pueblo Water Resources, Inc.

PUEBLO water resources

Presentation Outline

1. What is a Groundwater Model & Why Use One?
2. Existing Groundwater Model Background
3. Model Updates for GSP
4. Model Description
5. Model Calibration Results
6. Q&A

What is a Groundwater Model?

- Groundwater models are computer models that provide a simplified representation of the processes that occur in the natural groundwater systems.

- There are substantial data requirements - they are typically based on:
  1. Hydrogeologic Conceptual Model (HCM)
  2. Water Budget

Why Use a Groundwater Flow Model?

- Capable of simulating varying hydrologic conditions
- Capable of handling complex scenarios
- Useful for making decisions about groundwater management

What will the Groundwater Flow Model be used for in the GSP?

1. Simulate 50-yr projected water budget scenario
2. Simulate various projects and management actions that may be needed to achieve & maintain basin sustainability

Existing Groundwater Flow Model Background

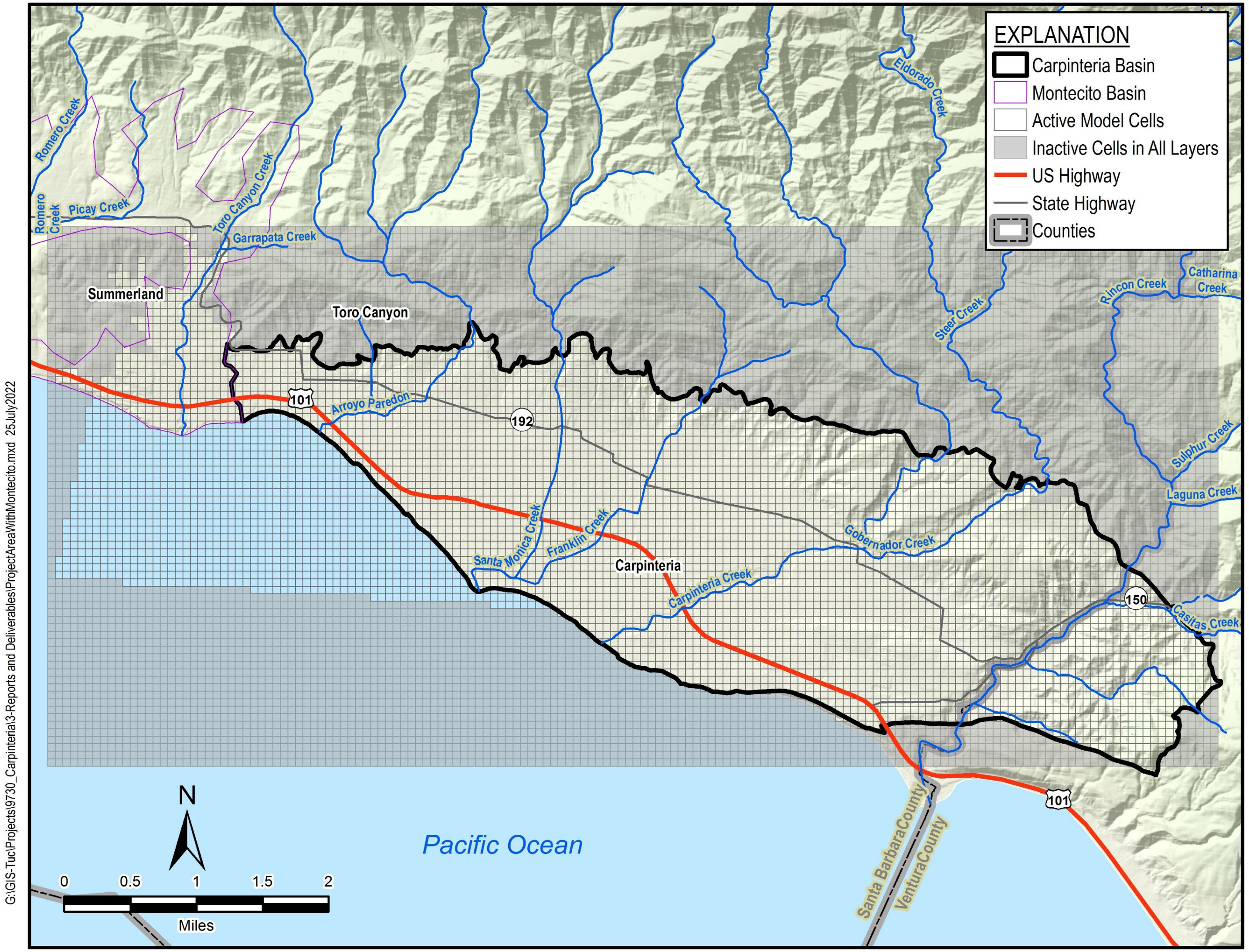
- Model originally developed in 2012 by HydroMetrics WRI
- USGS MODFLOW-NWT model code (Niswonger et al., 2011)
- Based on 2012 HCM and water budget (PWR, 2012)
- Annual Stress Periods
- Calibrated to WY 1985 – 2008 period

Existing Groundwater Flow Model - Improvements for GSP

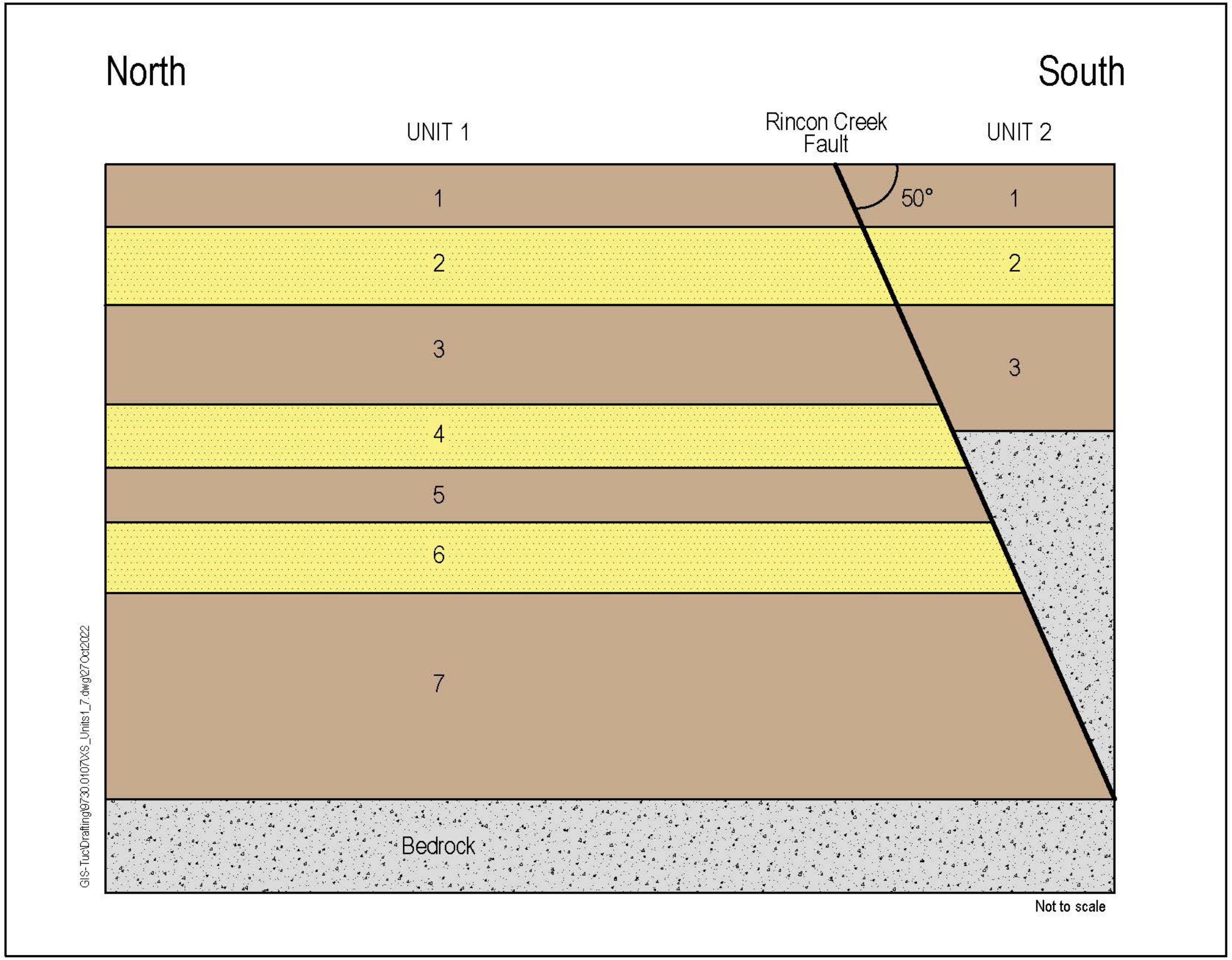
Model update is being performed by Montgomery & Associates:

- Grid revised to conform with updated 2018 Basin Boundary
- Converted to monthly stress periods
- Period extended to WY 2020
- Re-calibrated to WY 1985 – 2020 period

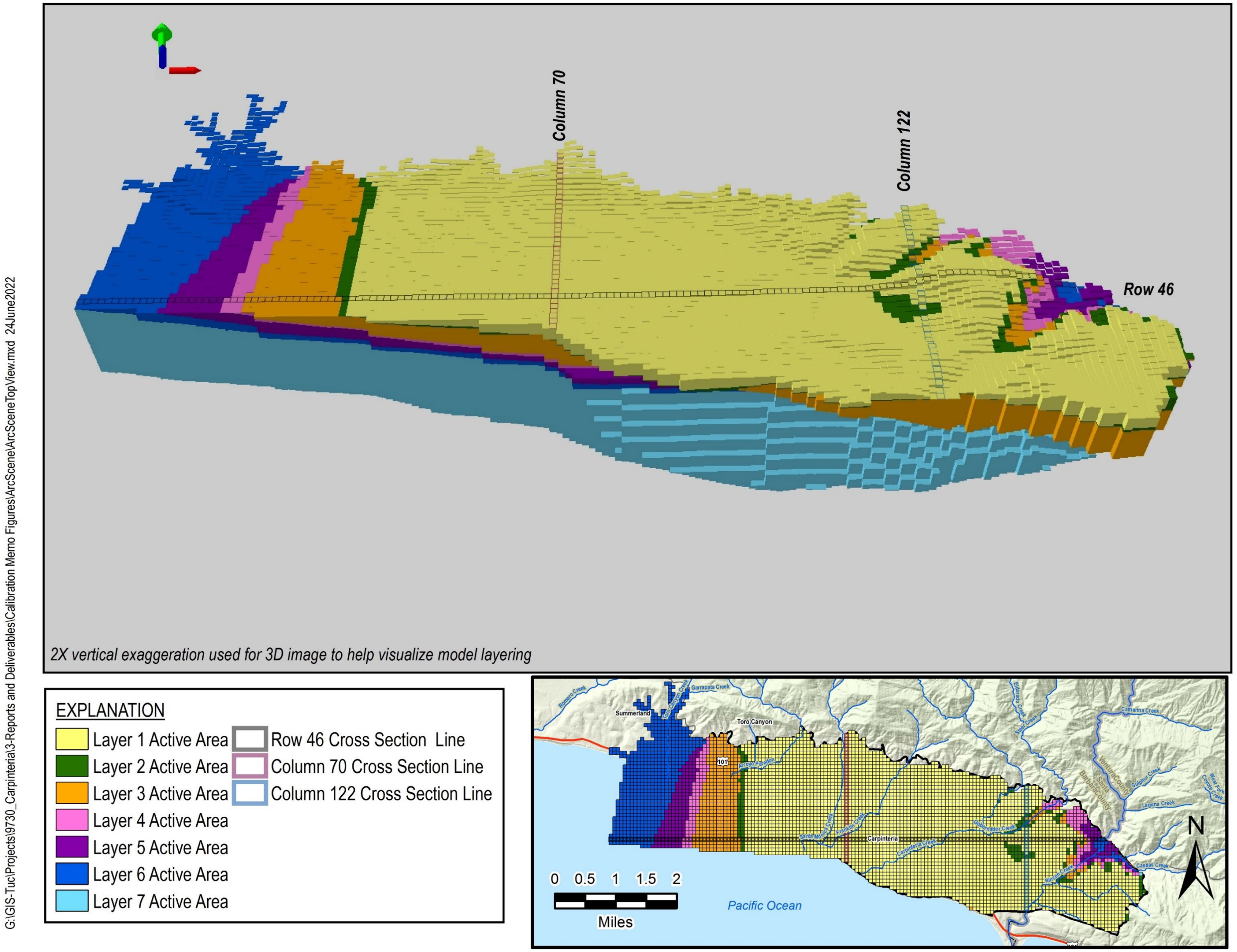
Model Domain and Grid



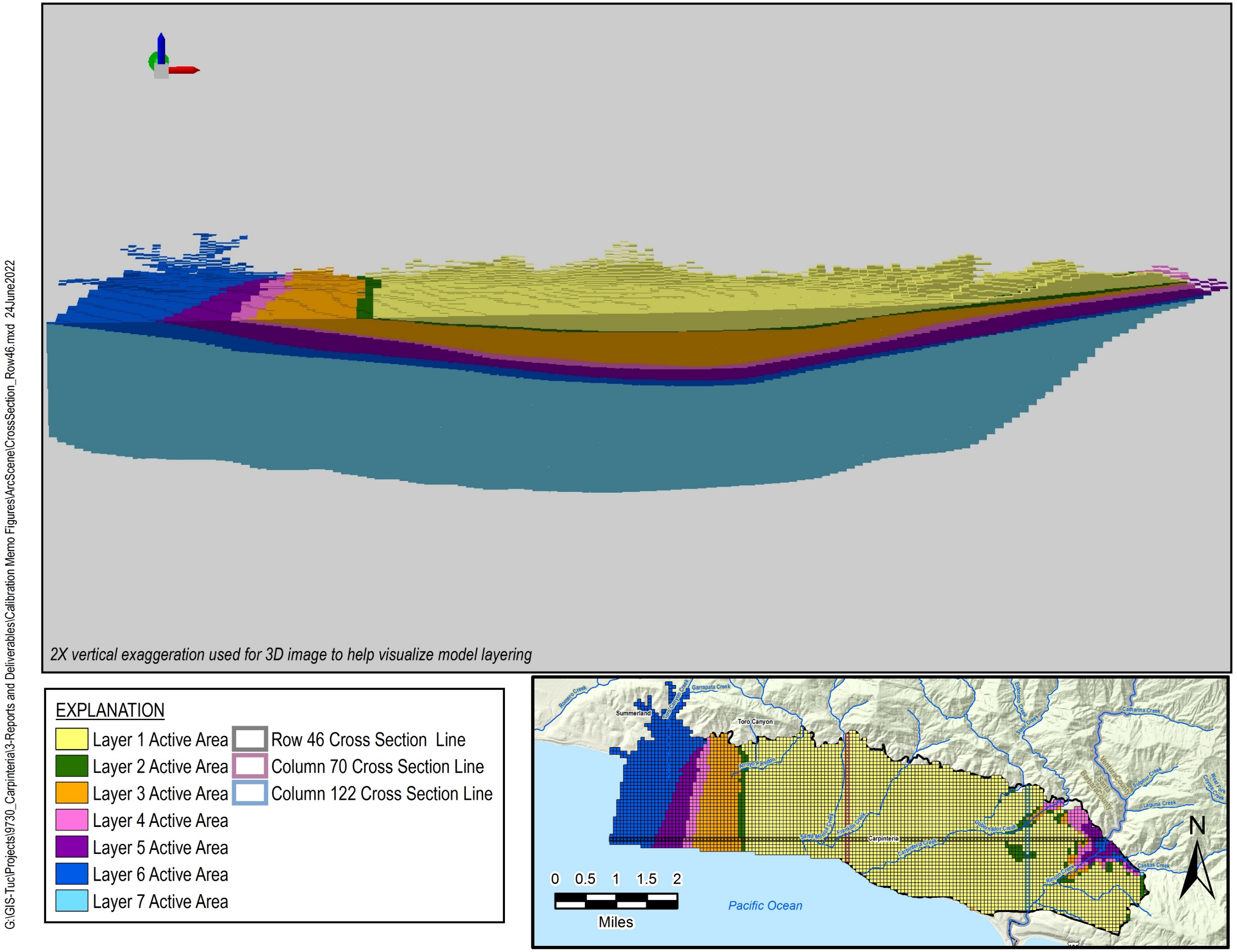
Model Layering Schematic



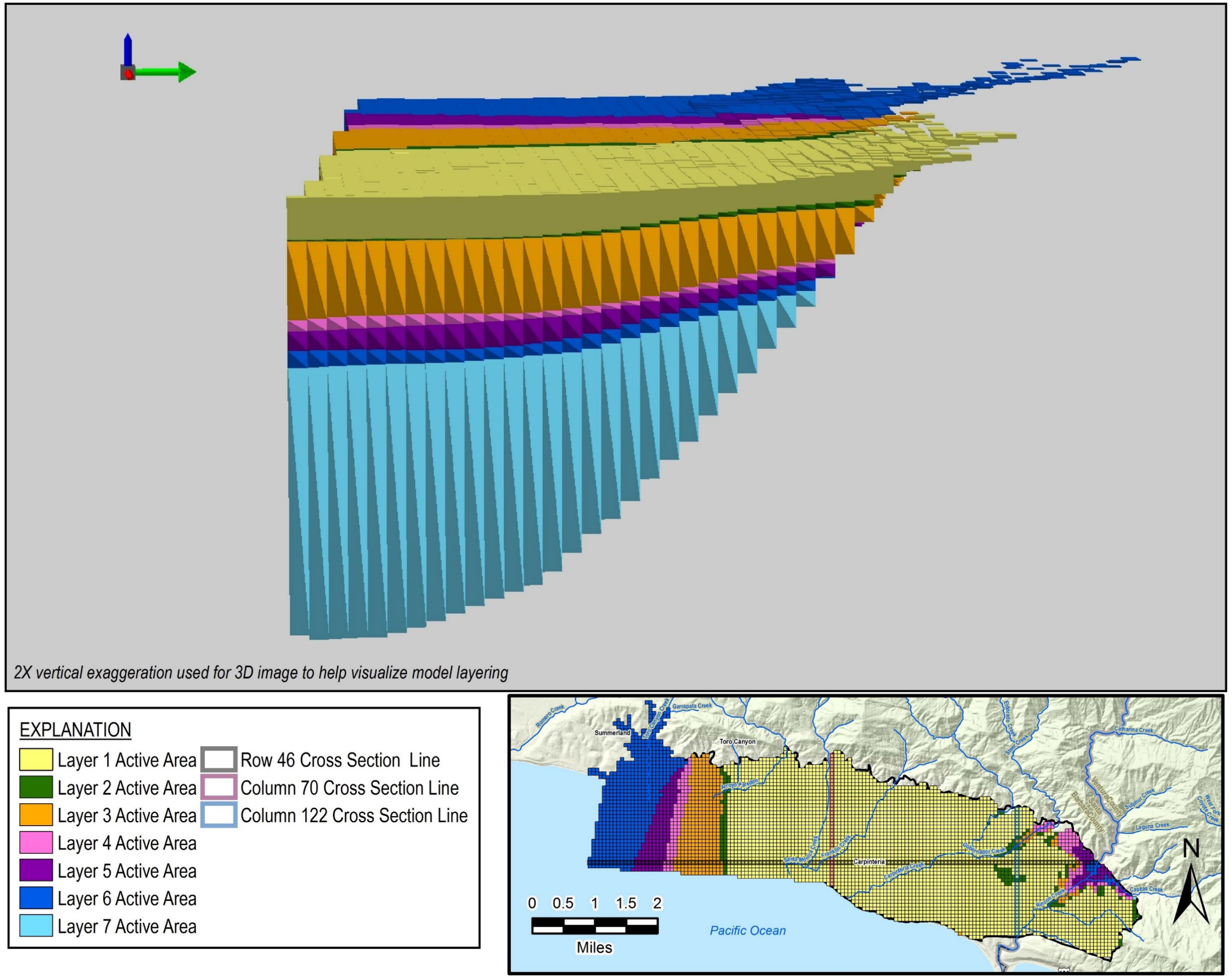
3D Visualization and Cross-Section Locations



Row 46 East – West Cross Section



Column 70 North – South Cross Section



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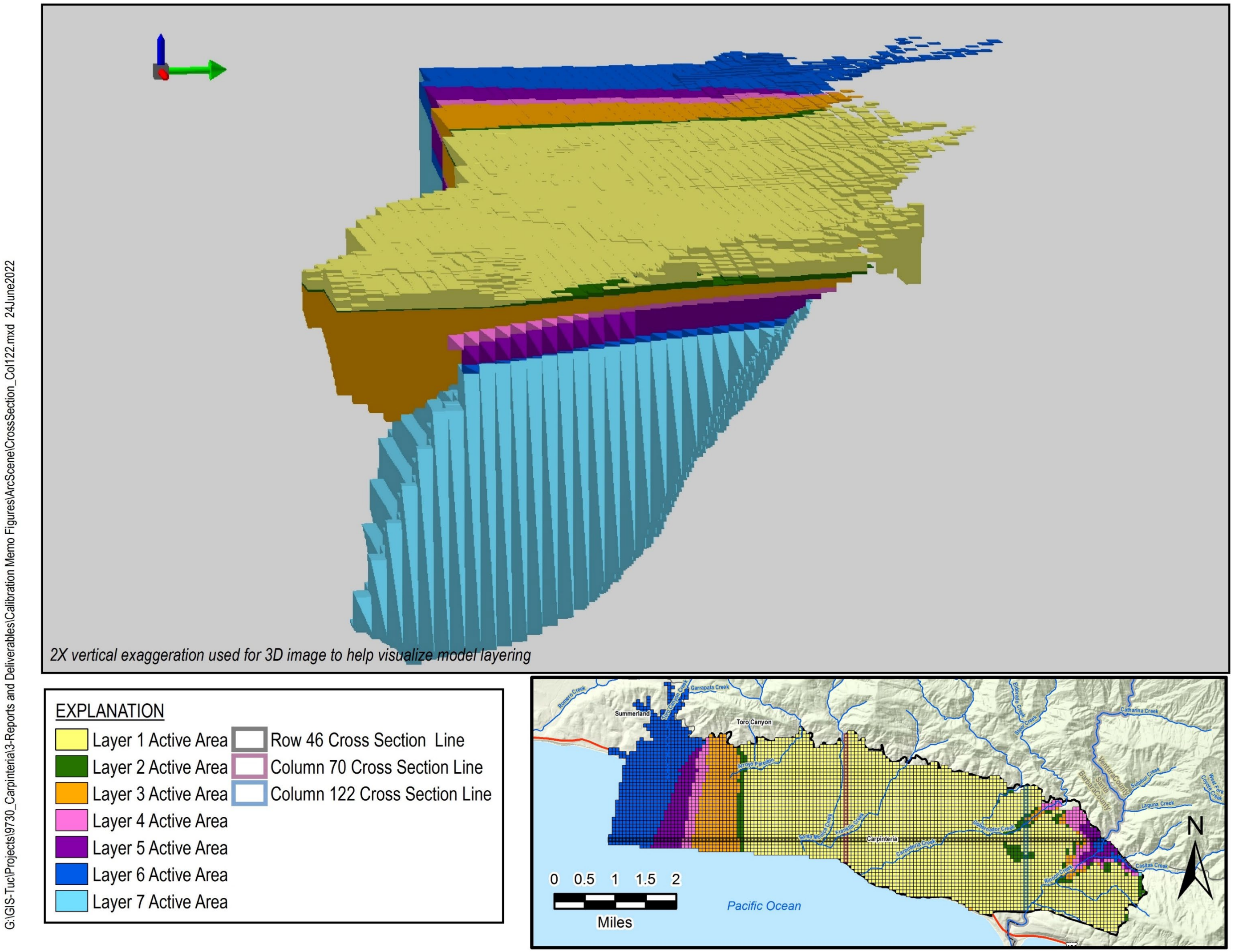
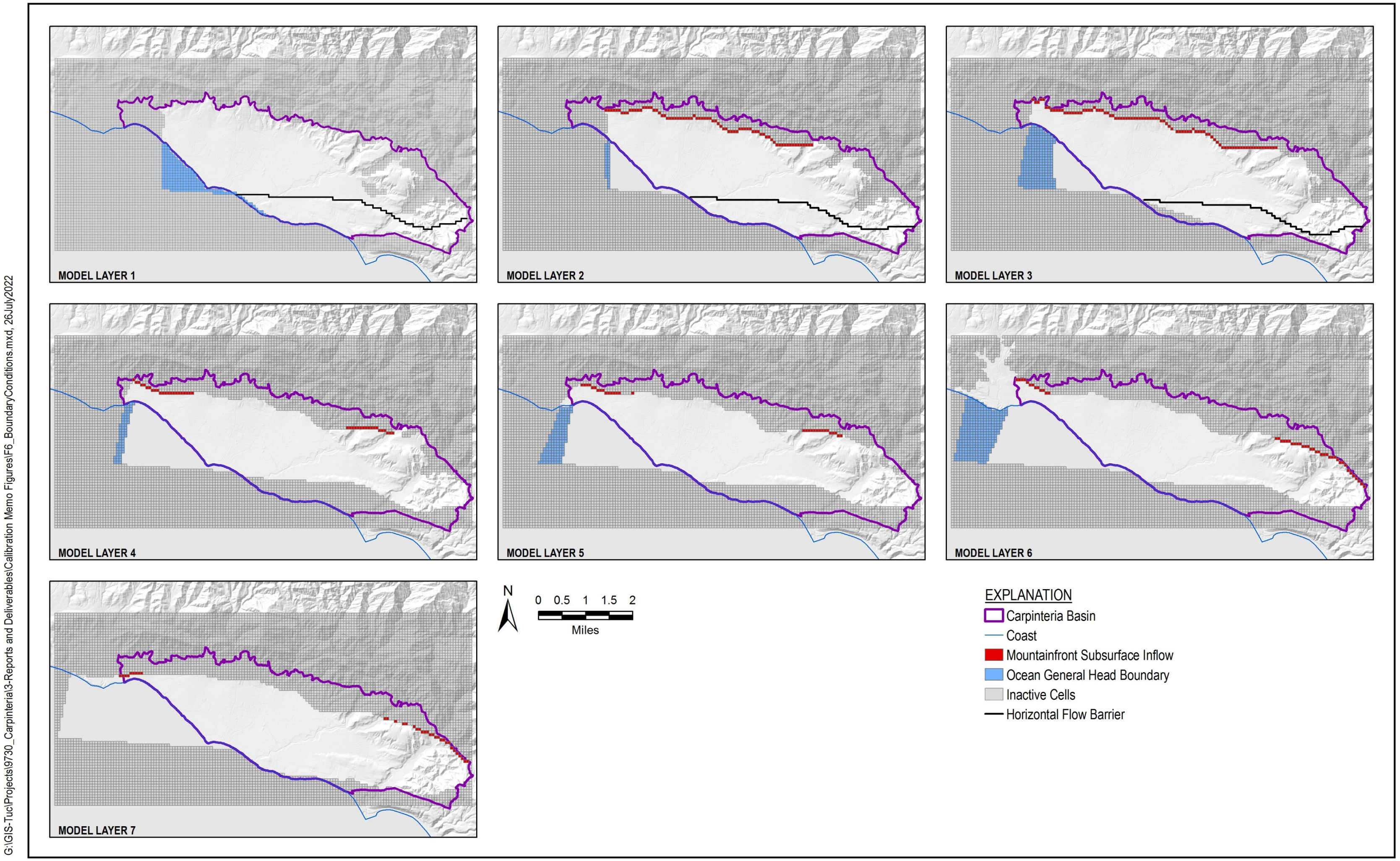
Column 122 North – South Cross Section



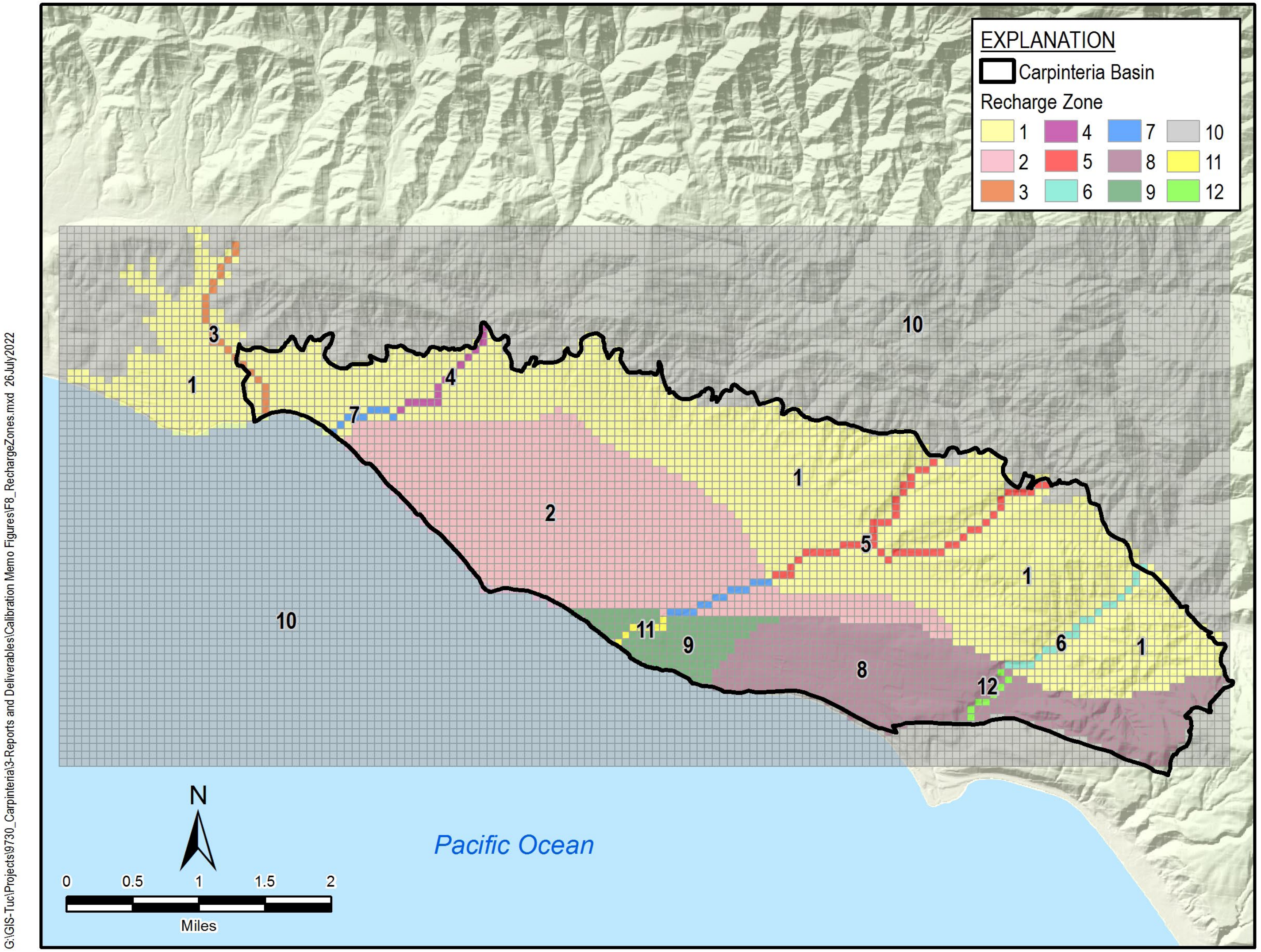
Boundary Conditions (by layer)



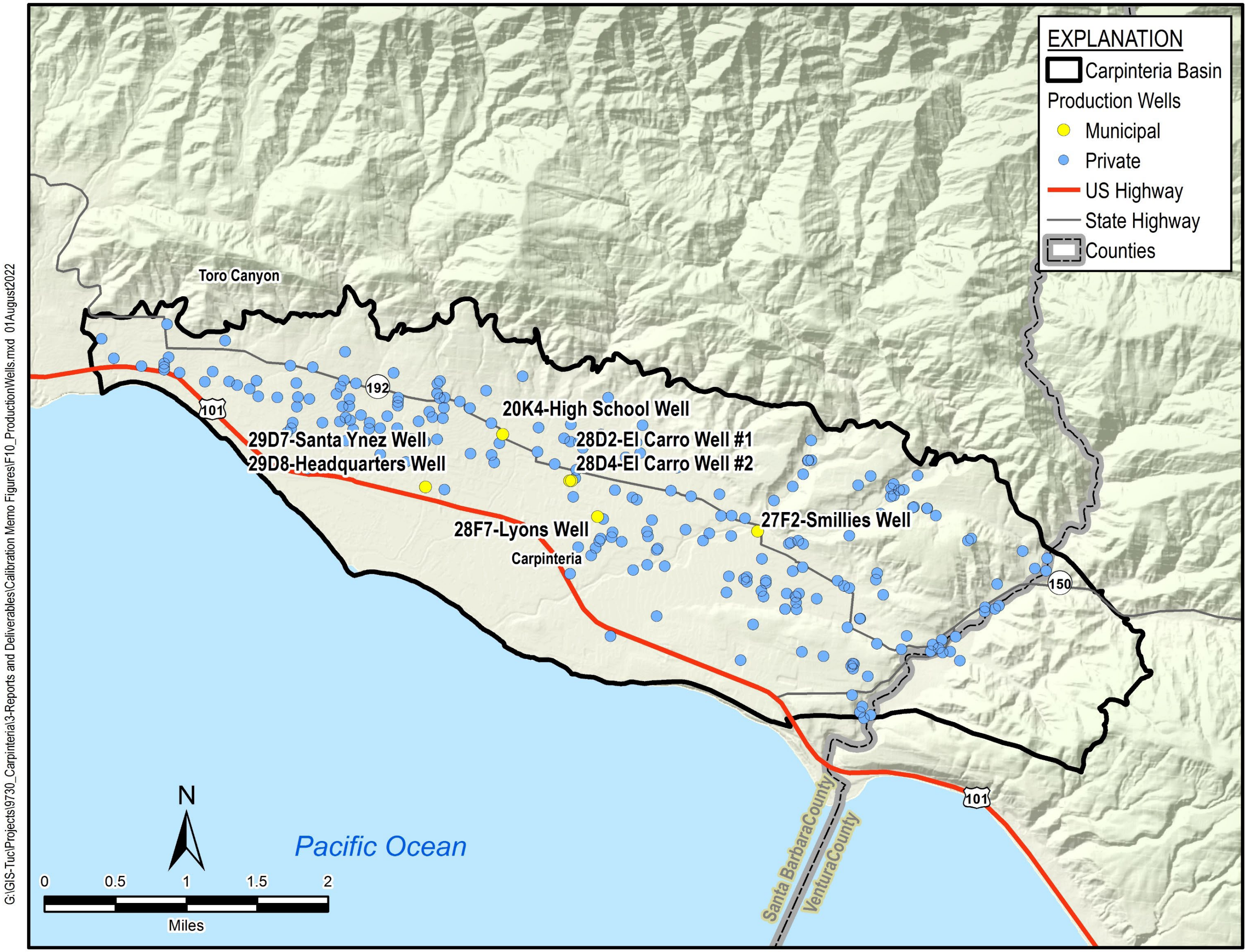
Model Recharge Components

- Mountain Front Recharge
- Percolation of Precipitation
- Streambed Percolation
- Irrigation Return Flows
- Phreatophyte Transpiration (outflow)

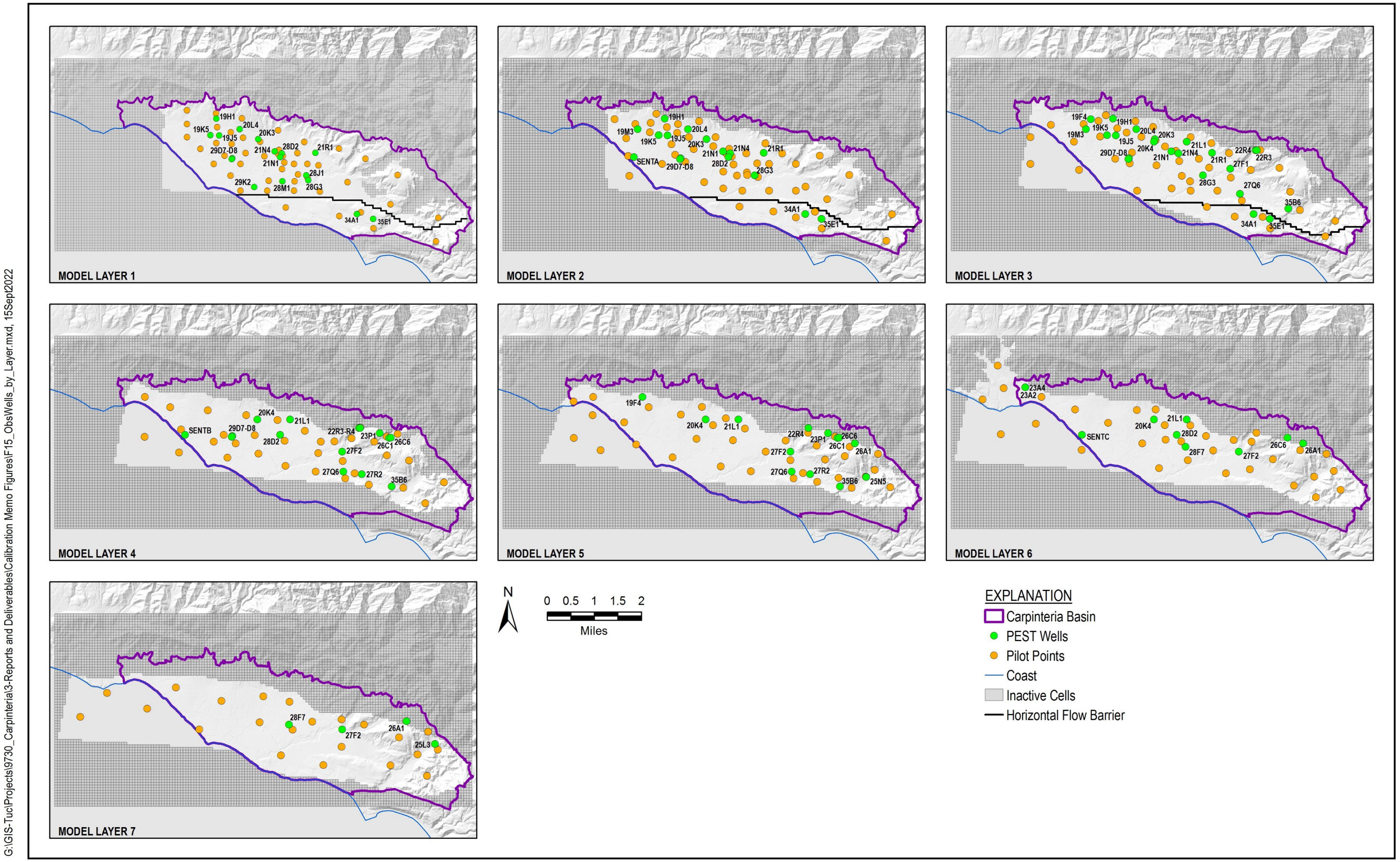
Model Recharge Zones



Model Pumping Wells



Model Calibration – Monitoring Well Targets



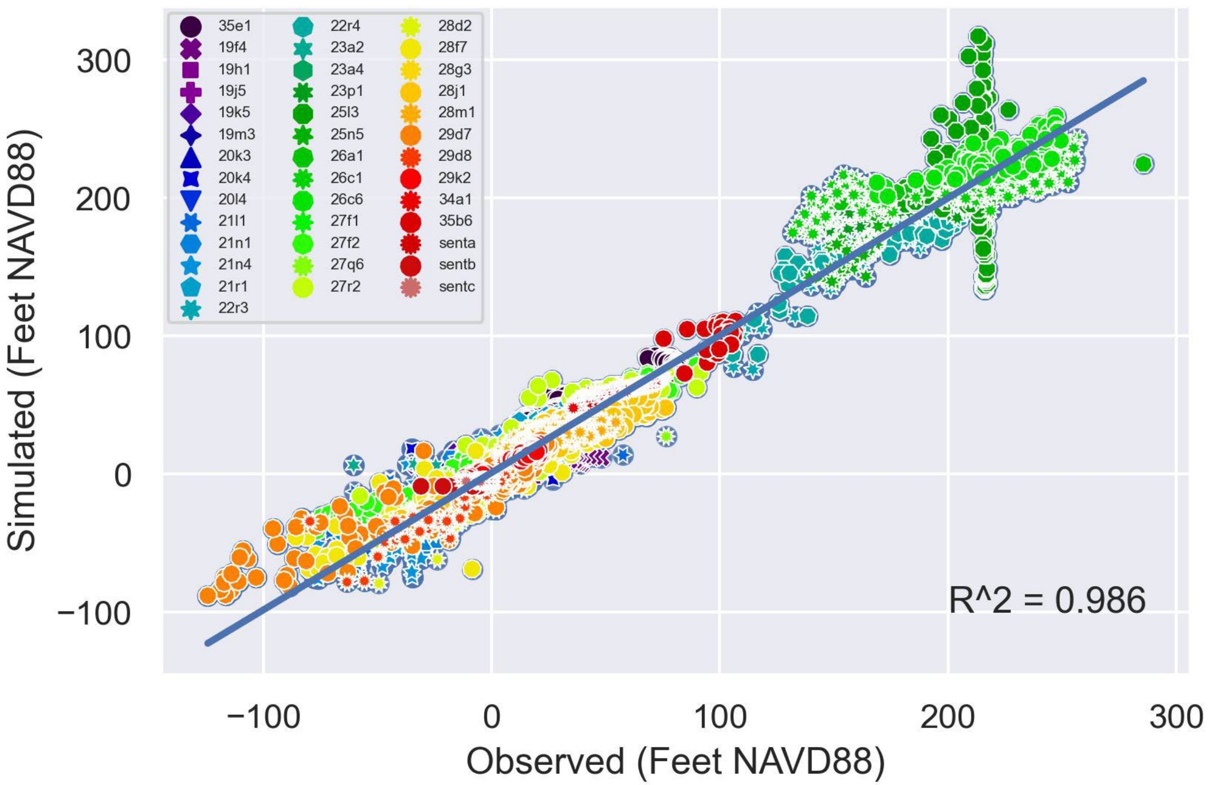
Model Calibration Statistics - Measures of Success

Measures of successful model calibration (Anderson and Woessner, 1992):

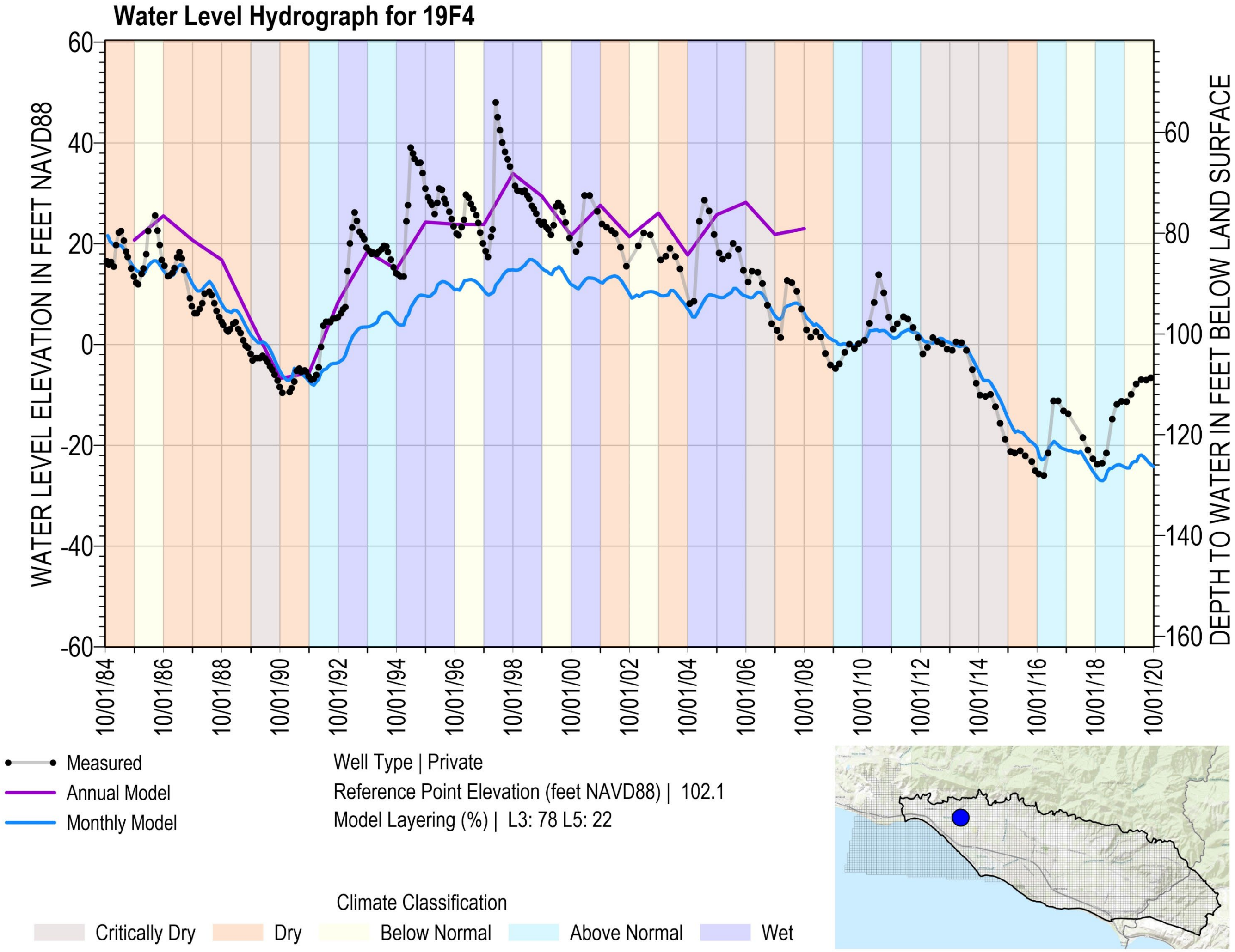
1. Ratio of error spread to total head range in the system should be less than 10%.
2. Mean error should be less than 5% of the total model head range.

Model Calibration Statistics – Results

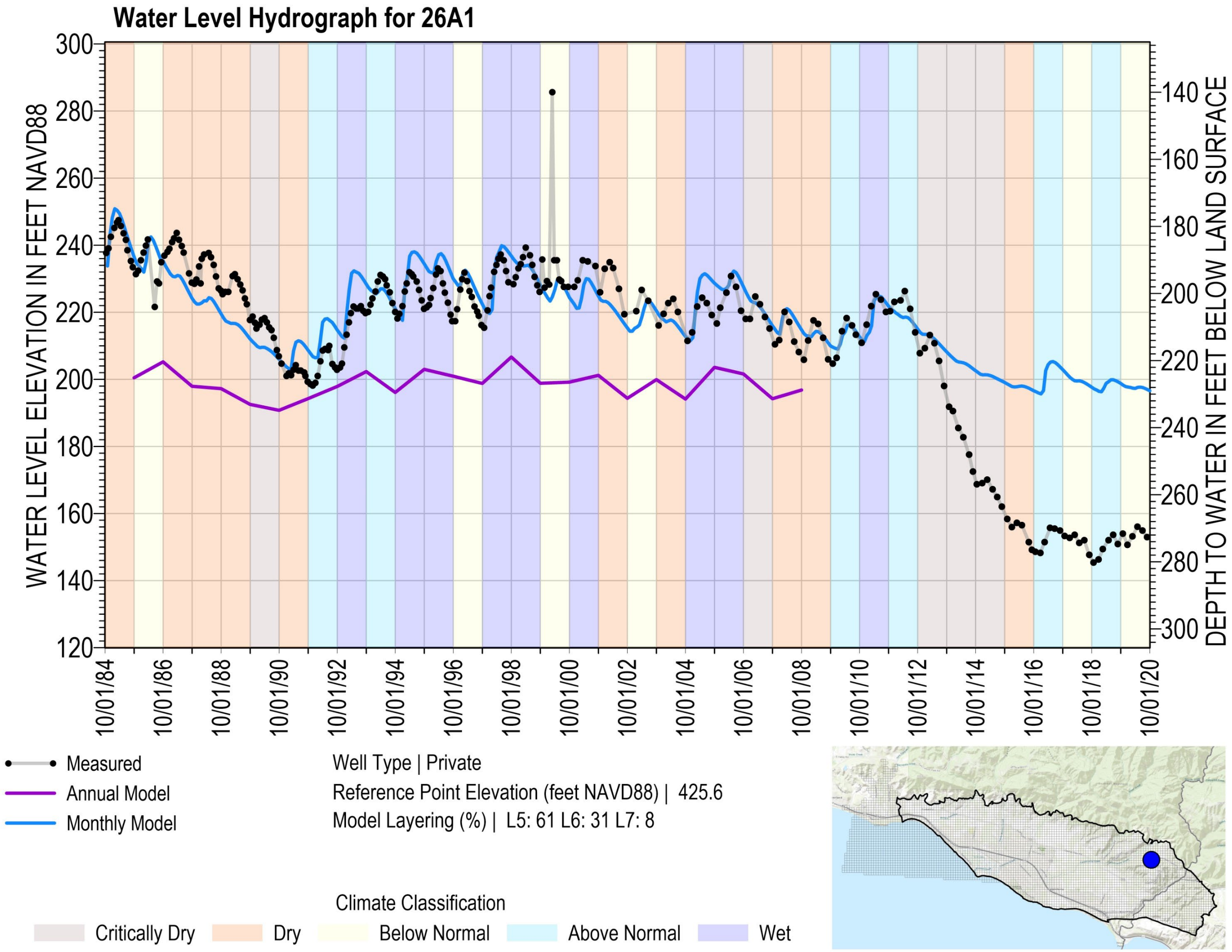
- Standard deviation of residuals is approximately 3.4% of the total head range.
- Mean residual is approximately 2.3% of the total head range, while geometric mean residual is 1.3% of total head range.
- **The model can be considered well-calibrated.**



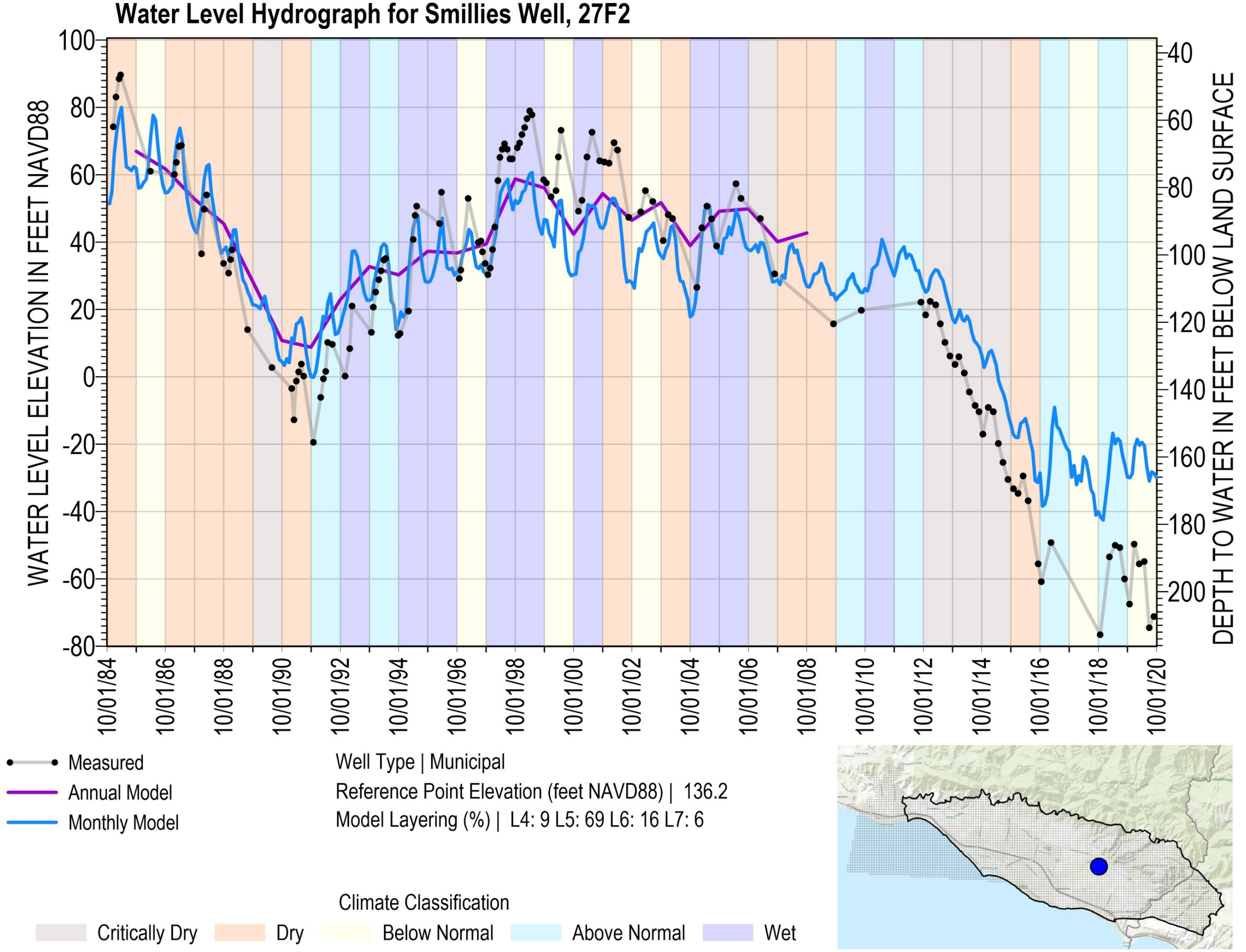
Model Calibration Hydrograph (19F4)



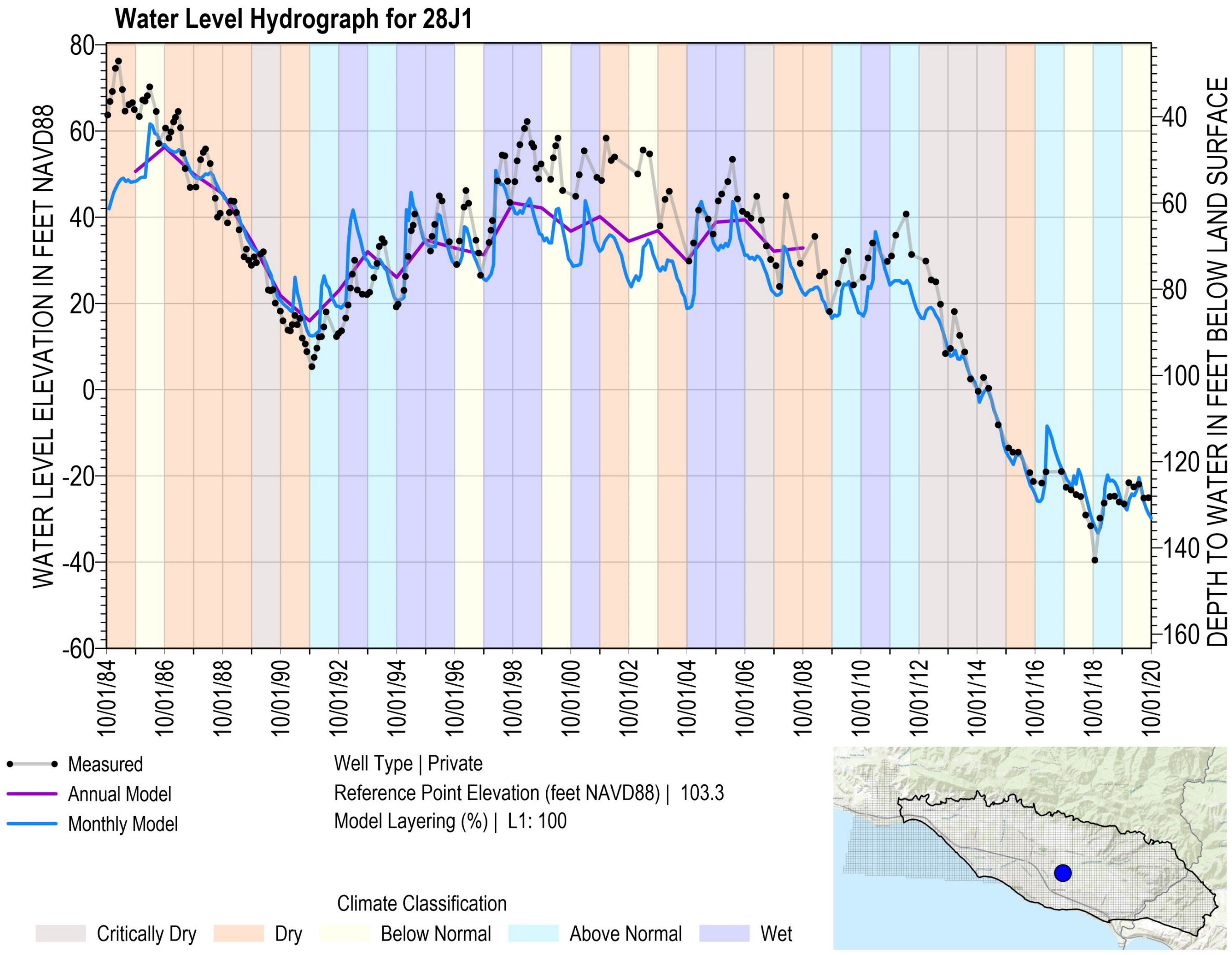
Model Calibration Hydrograph (26A1)



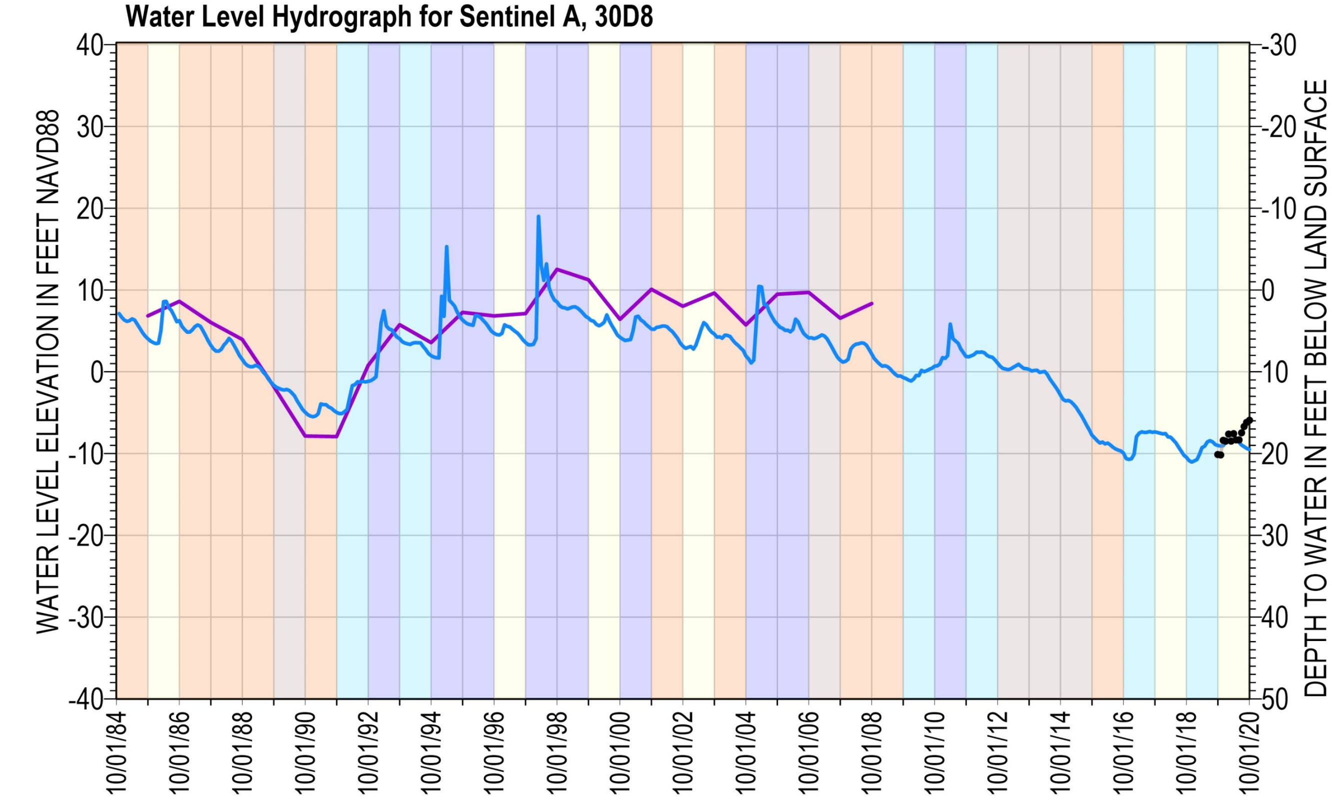
Model Calibration Hydrograph (27F2 - Smille)

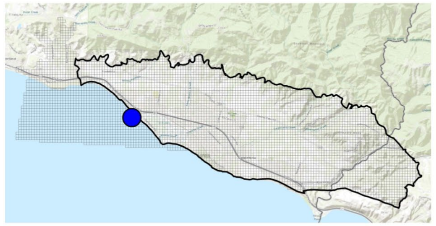


Model Calibration Hydrograph (28J1)

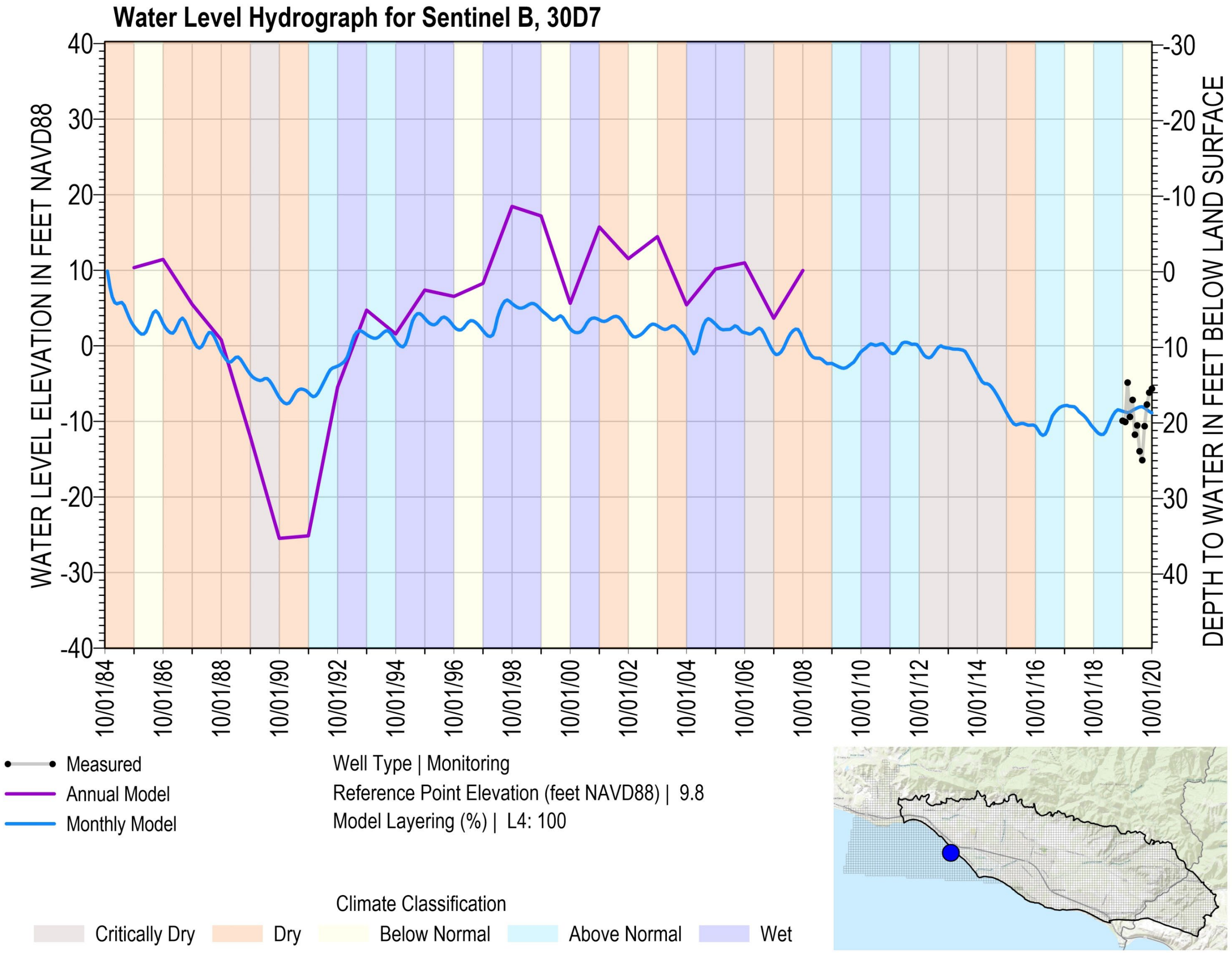


Model Calibration Hydrograph (Sentinel Well A)

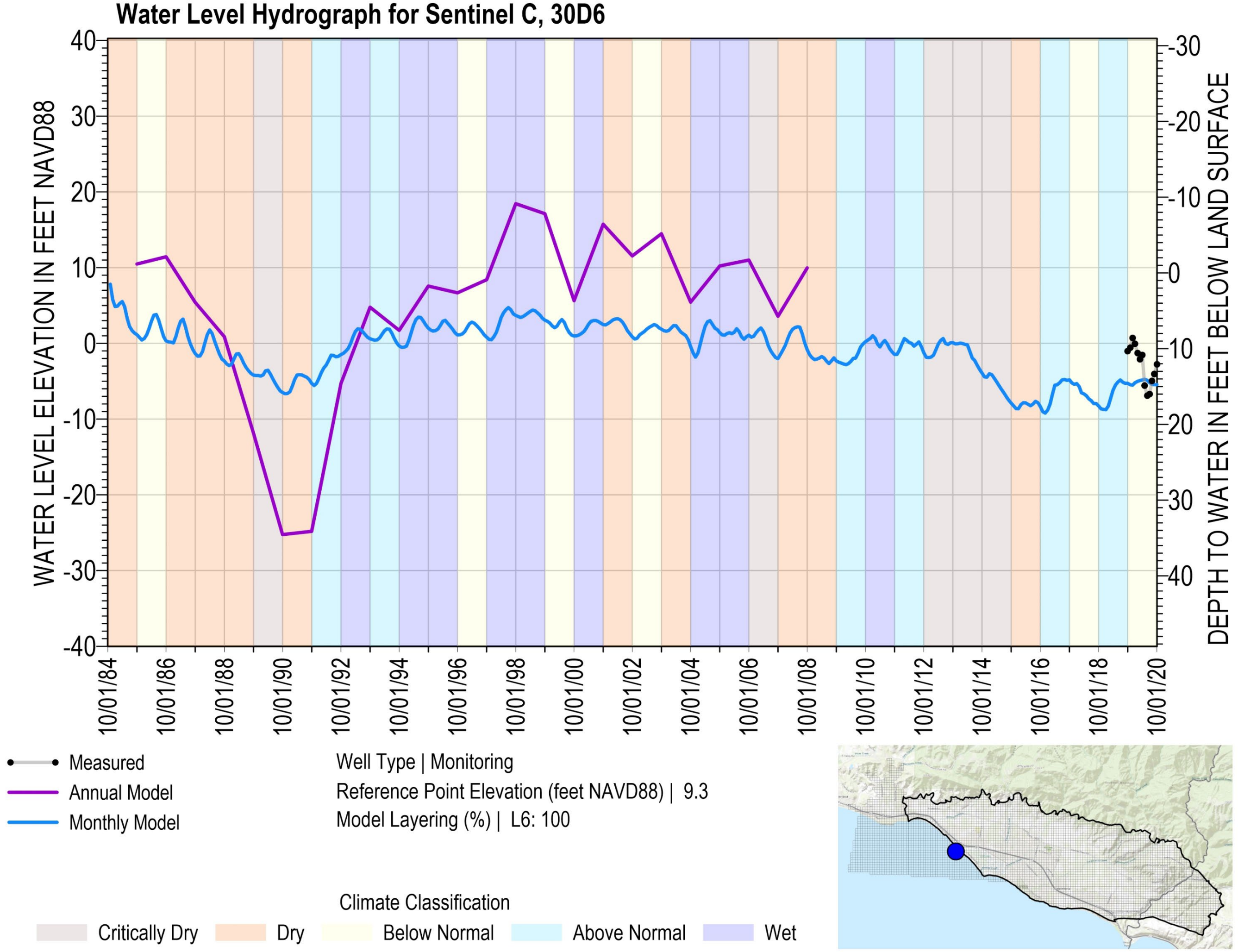




Model Calibration Hydrograph (Sentinel Well B)



Model Calibration Hydrograph (Sentinel Well C)



Groundwater Model- Next Steps

Develop Projected Conditions

Develop 50 yr projected future scenario through WY 2073:

- Represent projected future basin conditions
- Utilize CVWD and private pumping projections
- Incorporate effects of climate change on basin conditions

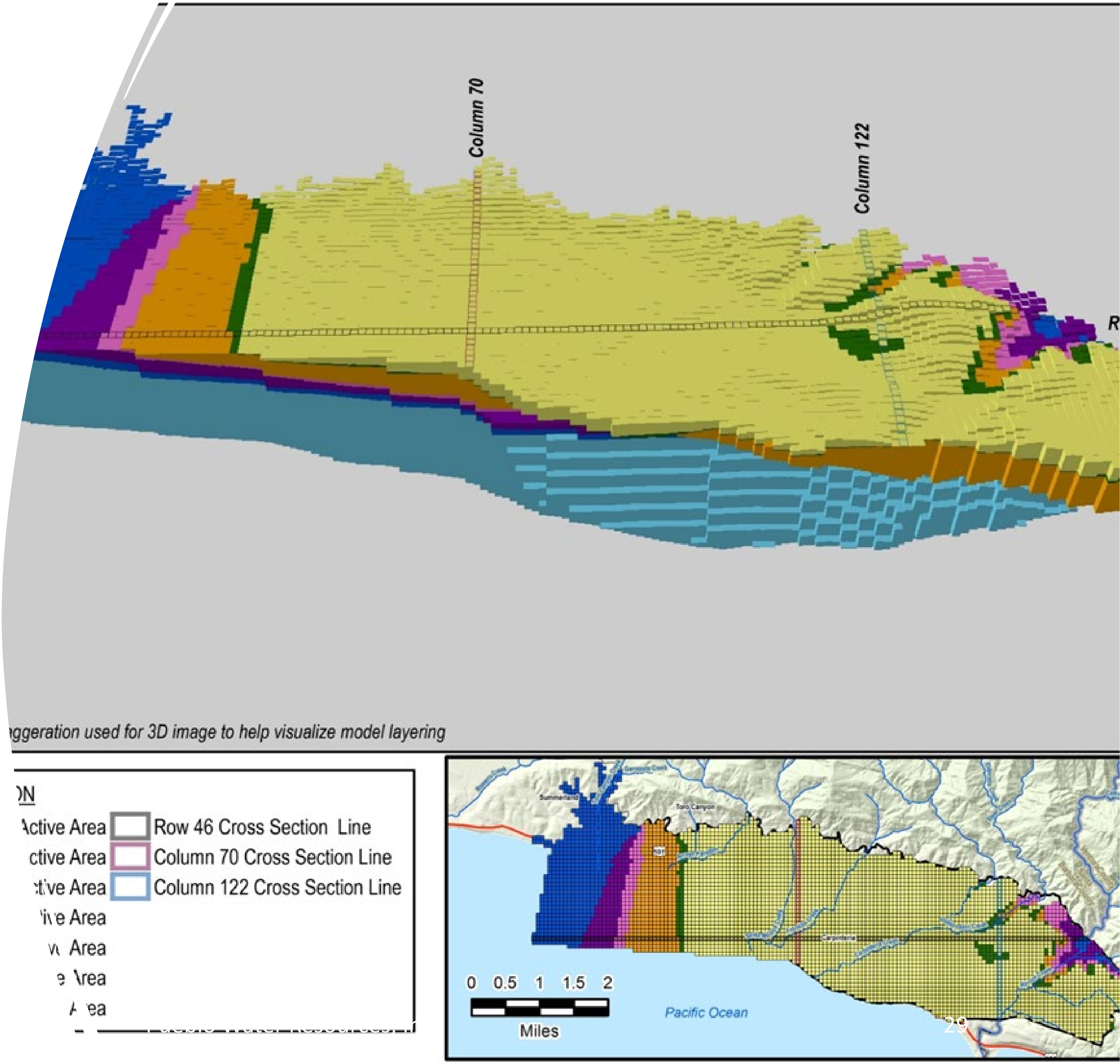
Simulate Scenarios

Simulate various projects and management actions:

- Achieve basin sustainability by 2043 (20 yrs following GSP adoption)
- Maintain basin sustainability through 2073 (50 yrs following GSP adoption)

Groundwater Model

Q&A



Carpinteria Groundwater Basin GSP Development Project Monitoring Networks

Workshop No. 2

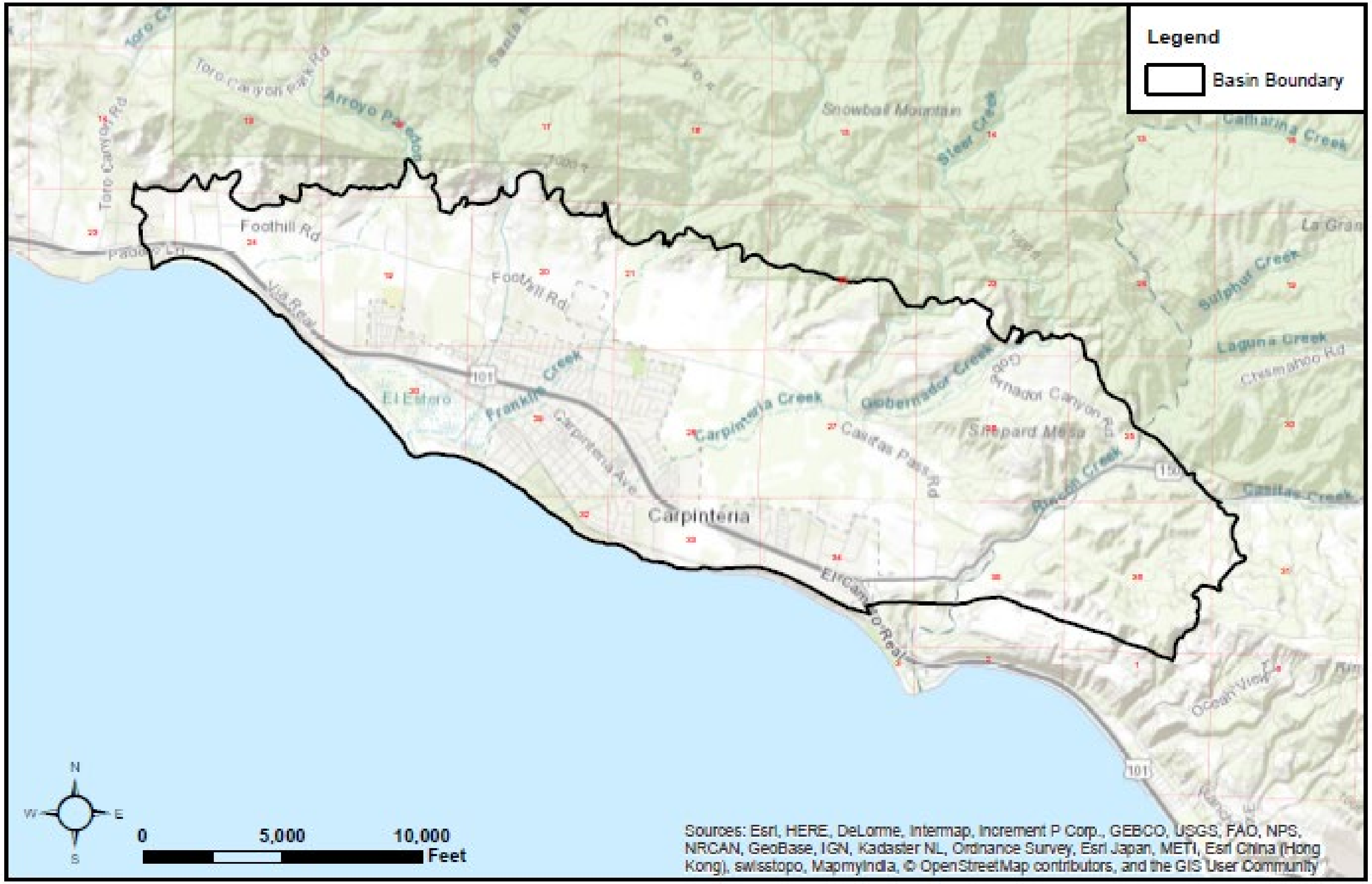
11/14/22; 6:00 PM

Michael Burke, PG, CHg

Principal Hydrogeologist

Pueblo Water Resources, Inc.

Basin Topographic Map



Monitoring Networks

1. Fundamental Components of a GSP.
2. Require Adequate Spatial and Temporal Coverage for Multiple Data Sets (water levels, water quality, etc).
3. Allow for Tracking of Sustainability Indicators.
4. Refine the Understanding of the Basin and Dynamic Flow Conditions.
5. Demonstrate Progress toward Achievement of Sustainability Goals.

Pathway to Sustainability

Addressing the Six Undesirable Results

- Chronic Lowering of Groundwater Levels
- Water Quality Degradation
- Reduction of Groundwater Storage
- Interconnected Surface Water Depletions
- Land Subsidence
- Seawater Intrusion

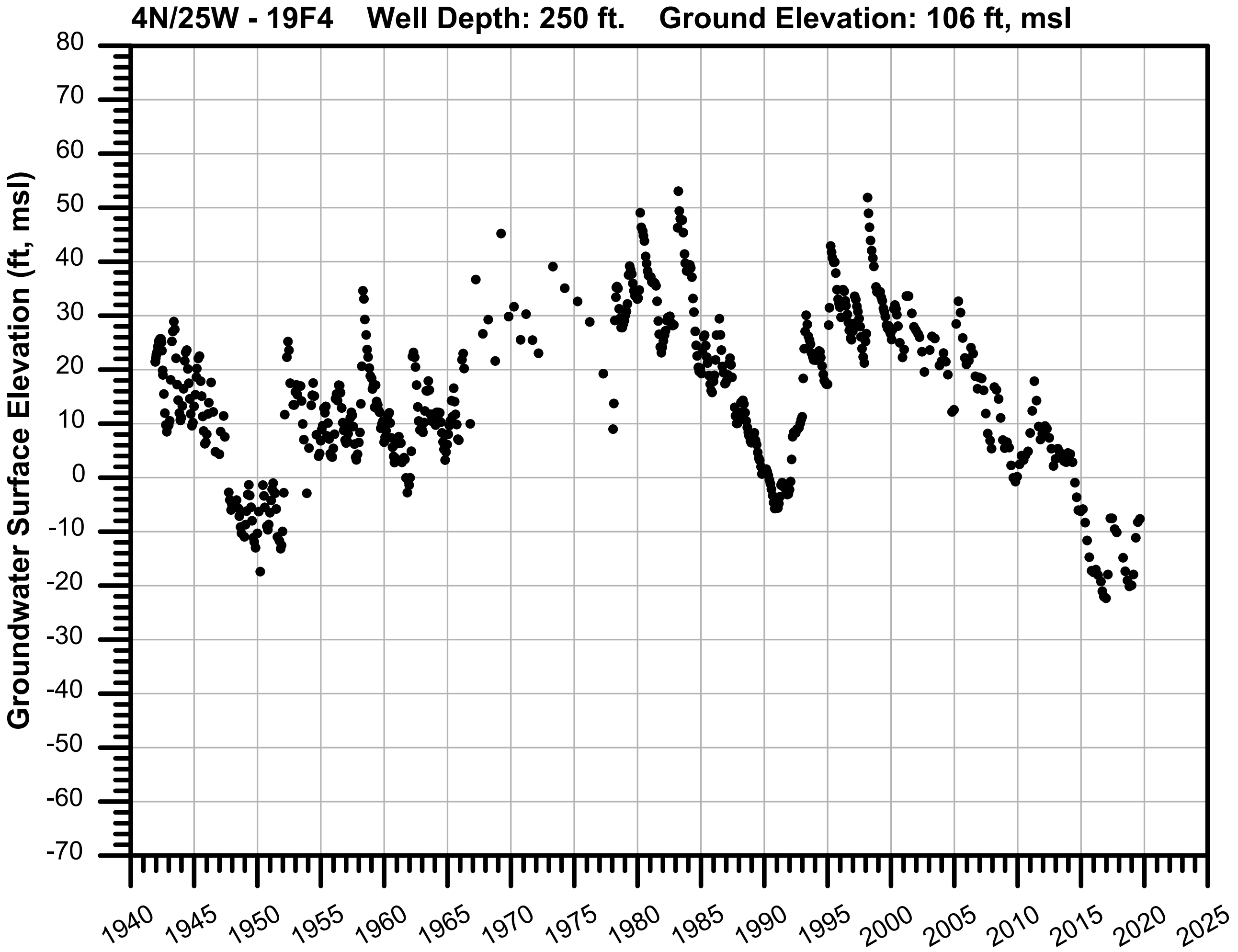
Existing Monitoring Networks for the CGB

- Carpinteria Valley Water District formed in 1941 – Commenced Systematic Compilation and Assessment of USGS Water Level Data from Wells throughout the CGB.
- Formalized Groundwater Management Program in 1999 through AB3030.

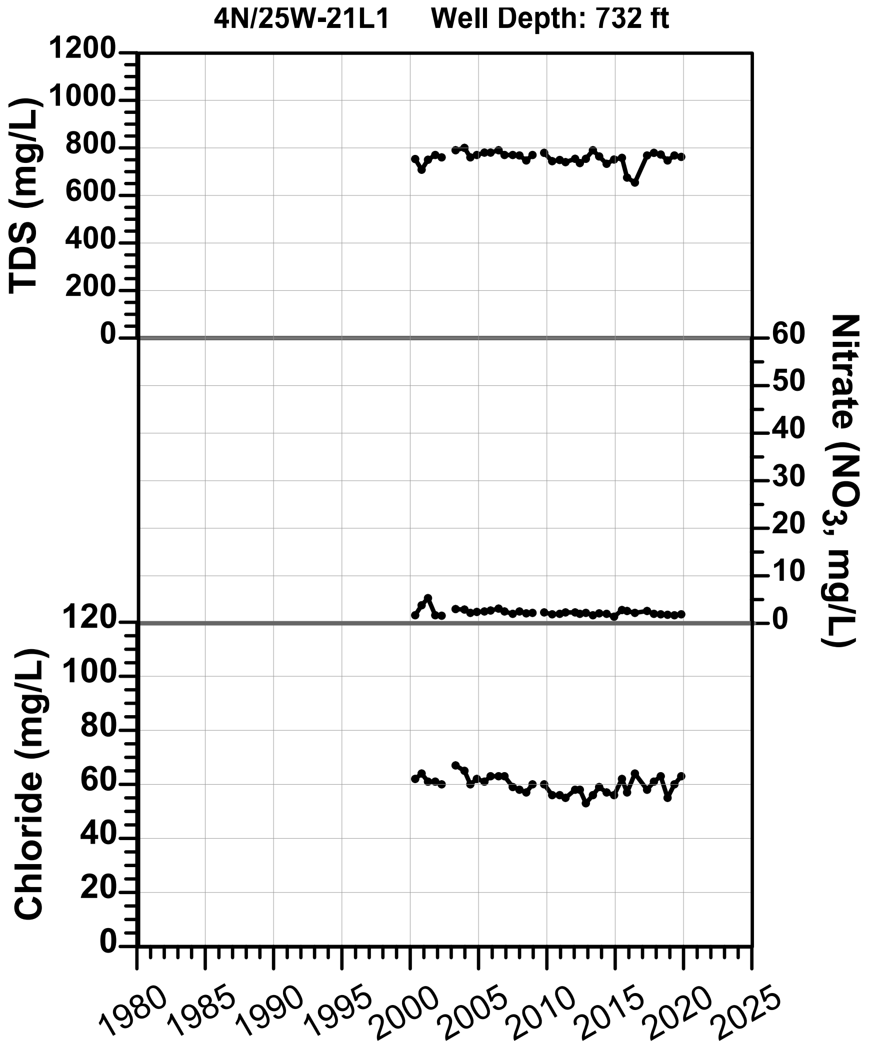
AB3030 GWMP Elements

1. Bi-Monthly Collection of Water Levels
2. Semi-Annual Water Quality Sampling of Wells
3. Semi-Annual Water Quality Sampling of Streams
4. Utilization of SB County Precipitation Data
5. Tabulation of District Pumpage
6. Estimation of Private Pumpage

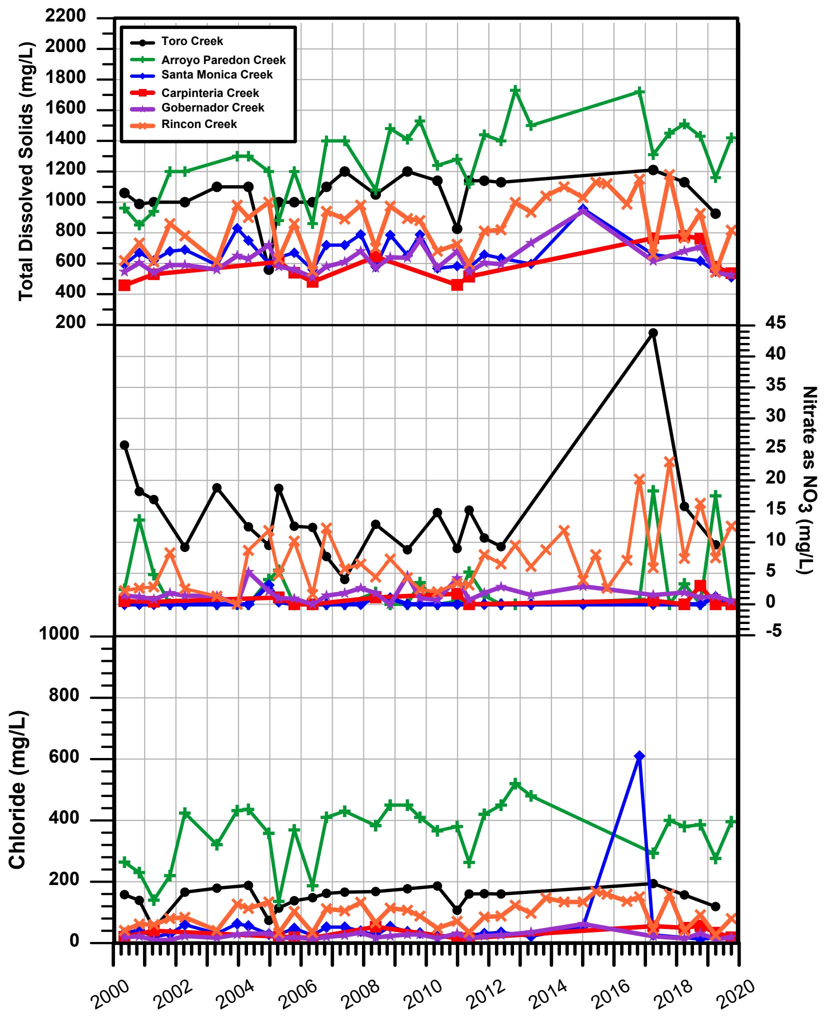
Historic Hydrograph



Groundwater Quality



Stream Water Quality



Enhancements to Existing Monitoring Well Network

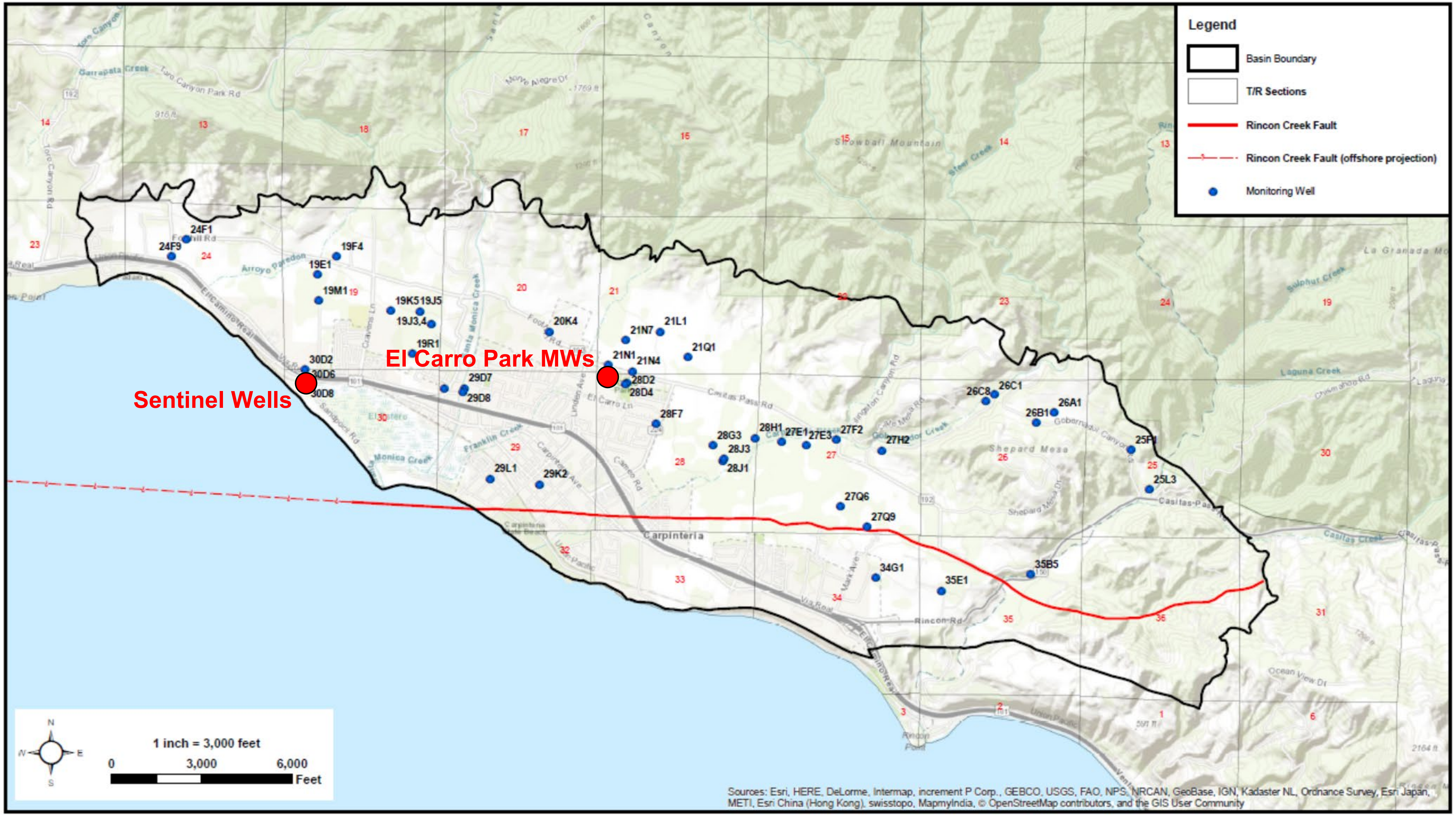
- **Installation of Depth-Discrete Monitoring Well Clusters:**

  1. CGB Sentinel Wells (2019);
  2. El Carro Park Monitoring Wells (2023)

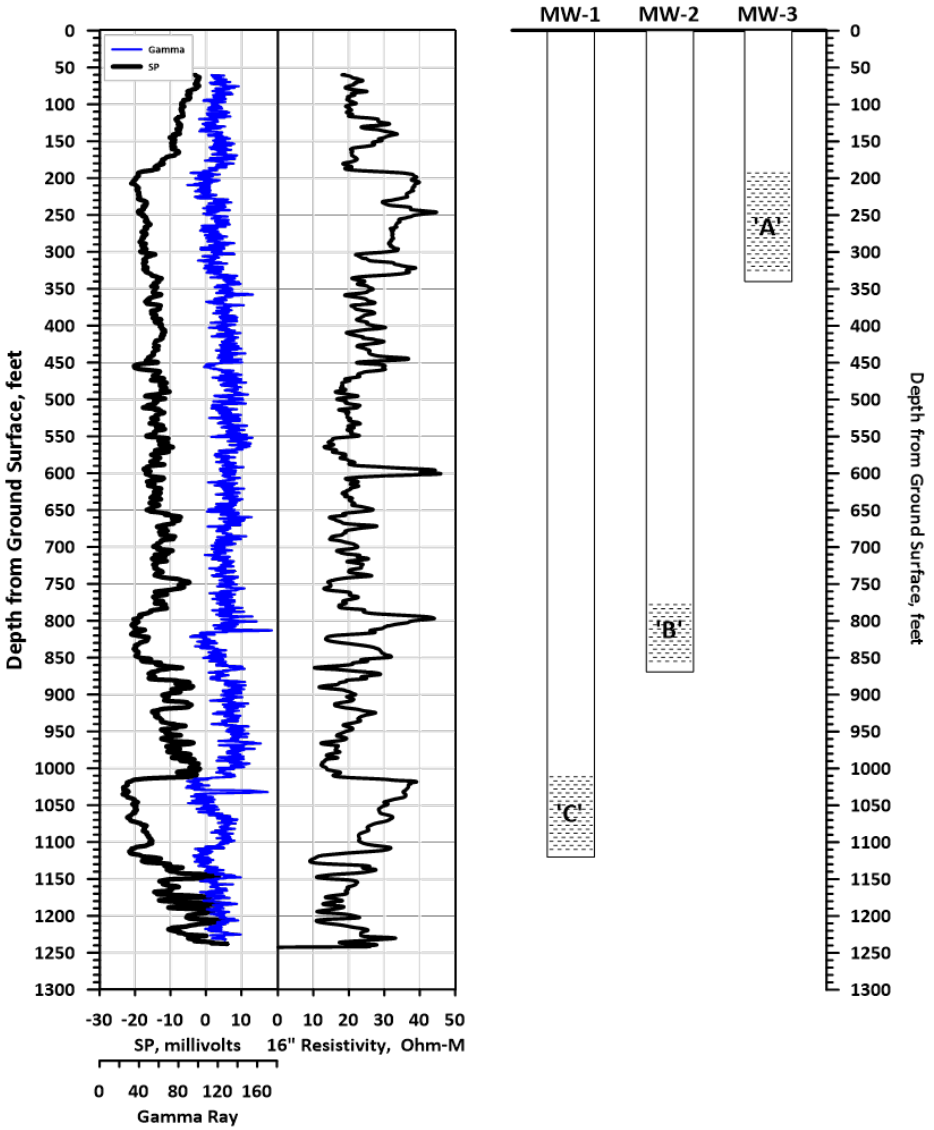
- **Well Characteristics:**

  1. Fully Penetrate Principal Aquifer to Increase Understanding of CGB Hydrostratigraphy
  2. Depth-Discrete Monitoring Well Completions in 3 Main Water Bearing Zones (A, B, and C Zones)
  3. Allow for Identification and Quantification of Vertical Hydraulic Gradients
  4. Allow for Depth-Discrete Characterization of Groundwater Quality

Depth-Discrete MW Clusters



Depth-Discrete Monitoring Well Clusters



Available GSP Monitoring Networks for Water Level, Water Quality, & Storage

1. Existing Monitoring Well Network
2. Existing Groundwater Level and Water Quality Programs
3. Existing Surface Water Sampling Program
4. Data from USGS and DWR Streamflow Gauges
5. Data from SB County Rainfall Gauge Data

CGB Monitoring Well Inventory

- State Well No.
- Well Owner (Confidential if Private)
- Well Status (Active, Inactive, Monitoring)
- Water Level Monitor, Water Quality Monitor, or Both
- Year Drilled and Well Completion Information
- Availability of Well Logs
- Beginning of Monitoring Period

Well No.	Owner	Use	Water Level Monitor	Water Quality Monitor	Year Drilled	Drilled Depth (ft)	Casing Depth (ft)	Log D - Driller E - E-Log	Water Level Data Start
4N/25W-19E1	Private	A		yes	1992	600	400	DE	
4N/25W-19F4	Private	M	yes		1930	250			1941
4N/25W-19J4	Private	A		yes		150 vs 200?			
4N/25W-19J5	Private	M	yes		1939	100			1941
4N/25W-19K5	Private	A	yes	yes	1921				1946
4N/25W-19M1	Private	A/I		yes		204			
4N/25W-19R1	Private	A		yes		146			
4N/25W-20K4	CVWD	I	yes		1989	1988	903	D	1989
4N/25W-21L1	Private	A	yes	yes	1991	810	732	DE	1992
4N/25W-21N1	Private		yes		1936	405			1938
4N/25W-21N4	Private	I/A	yes		1947		406?	D	1949
4N/25W-21N7	Private	A		yes	2008	880	875	D	
4N/25W-21Q1	Private	A		yes	1991	820	740	DE	
4N/25W-25F1	Private	A		yes	1989	800	450	DE	
4N/25W-25L3	Private	A	yes	yes		190		D	1996
4N/25W-26A1	Private	M	yes		1941	228 vs 480?		D	1946
4N/25W-26B1	Private	A		yes	1944	552	240	D	
4N/25W-26C1	Private	M	yes			250			1949
4N/25W-26C8	Private	A/I		yes	1947	360	144	D	
4N/25W-27E1	Private	A		yes	1930	300			
4N/25W-27E3	Private	A		yes	2016	830	805	D	
4N/25W-27F2	CVWD	A	yes	yes	1975	1150	825	DE	1975
4N/25W-27Q6	Private	M	yes		1949	580	100	D	1989
4N/25W-27H2	Private	A		yes	2016	600	515	D	
4N/25W-28D2	CVWD	DM	yes		1990	2706	1214/924?	DE	1990
4N/25W-28D4	CVWD	A	yes	yes	2010	1220	1210	DE	2003
4N/25W-28D5,6,7	CGSA	DM	yes	yes	2023	1240	360, 925, 1040	DE	2023
4N/25W-28F7	CVWD	A	yes	yes	1976	1271	1240/980	DE	1976
4N/25W-28G3	Private	A/I	yes	yes	1994	310	300	D	1995
4N/25W-28H1	Private	A		yes	1992	520	500	DE	
4N/25W-28J1	Private	A	yes	yes	1919	175	175	D	1940
4N/25W-28J3	Private	A		yes	2016	890	860	D	
4N/25W-29D1	Private	M	yes			147		D	1938
4N/25W-29D7	CVWD	DM	yes		1972	982	950	DE	1977
4N/25W-29D8	CVWD	A	yes	yes	2002	978	958	DE	2005
4N/25W-29K2	Private		yes		1989	320	320	DE	1992
4N/25W-29L1	Private	M	yes			110			1946
4N/25W-30D2	Private	M	yes				232		2022
4N/25W-30D6,7,8	CVWD	DM	yes	yes	2019	1240	340, 870, 1130	DE	2019
4N/25W-27Q9	Private	A		yes	2003	1000	800	D	
4N/25W-34G1	Private	M	yes		1990	279	278	D	1991
4N/25W-35B5	Private	A		yes	1990	285	280	D	
4N/25W-35E1	Private	M	yes		1939	385	260		1949
4N/26W-24F1	Private	A		yes	1922	262 vs 146	227 vs 146	D	
4N/26W-24F9	Private	A	yes	yes	1990	481	440	D	2022

* Data sources includes information collected from State Well Drillers reports, field inspection and SB Co. EHD Well Permits.

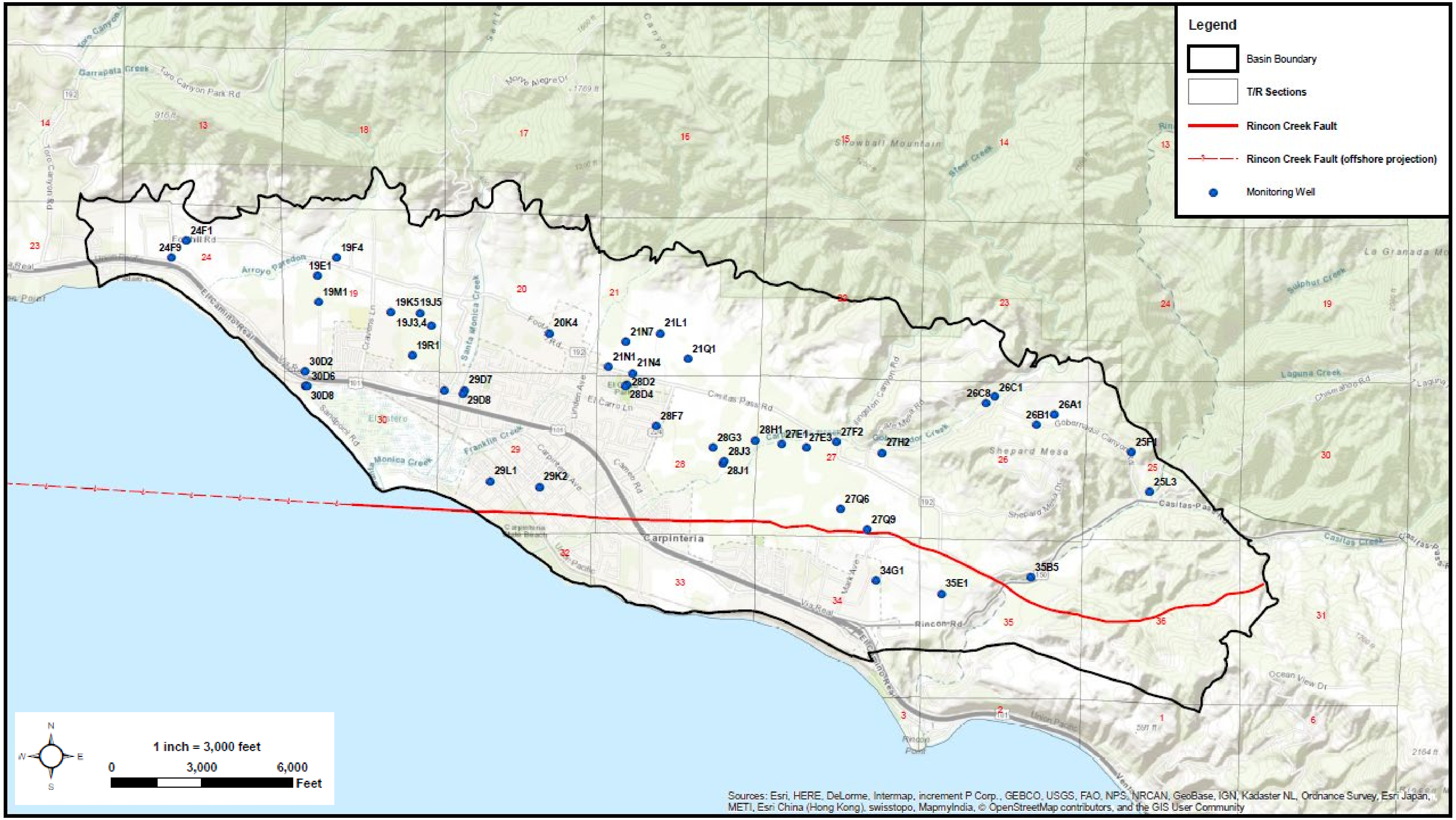
Use Categories: A - Active Production Well; I - Inactive Production Well; M - Monitoring Well; DM - Dedicated Monitoring Well.

CGB GSP Monitoring Wells

- 45 Total Monitoring Wells in Network
- 28 Water Level Monitoring Wells
- 29 Water Quality Monitoring Wells
- 2 Depth Discrete Monitoring Well Clusters
- >2 Water Level Monitoring Wells and Water Quality Monitoring Wells per Square Mile within the Basin*.

* SGMA's Best Management Practices (BMPs) Recommends 2 Wells per 100 Square Miles for basins Similar to the CGB.

Monitoring Well Location Map



GSP Groundwater Quality & Surface Water Quality Program

1. Semi-Annual Data Collection.
2. General Mineral Constituents (Anions, Cations, Dissolved Solids, Nitrates, Electrical Conductance)

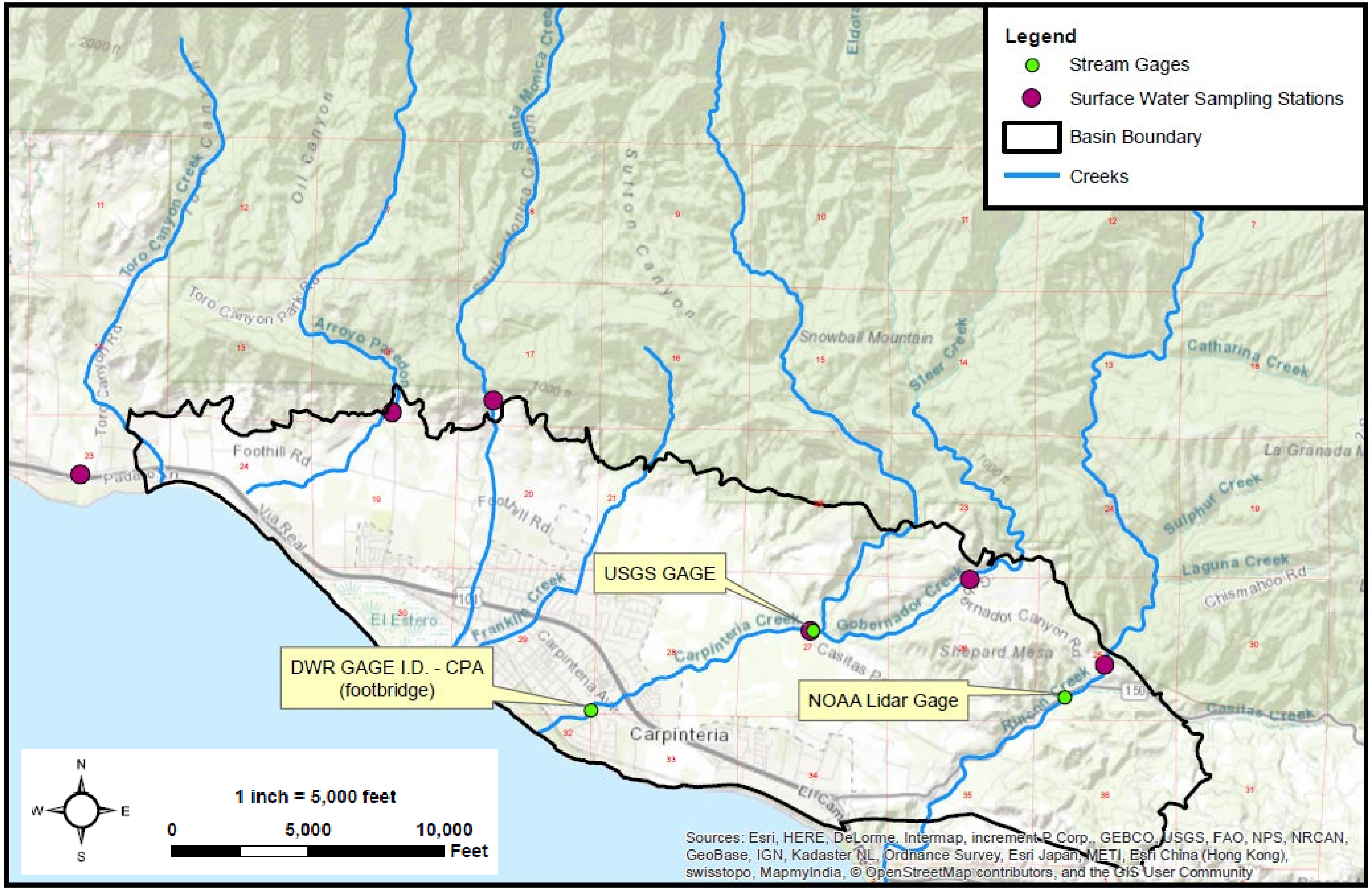
Streamflow Gaging in the CGB

1. USGS Gage on Upper Carpinteria Creek (1941)

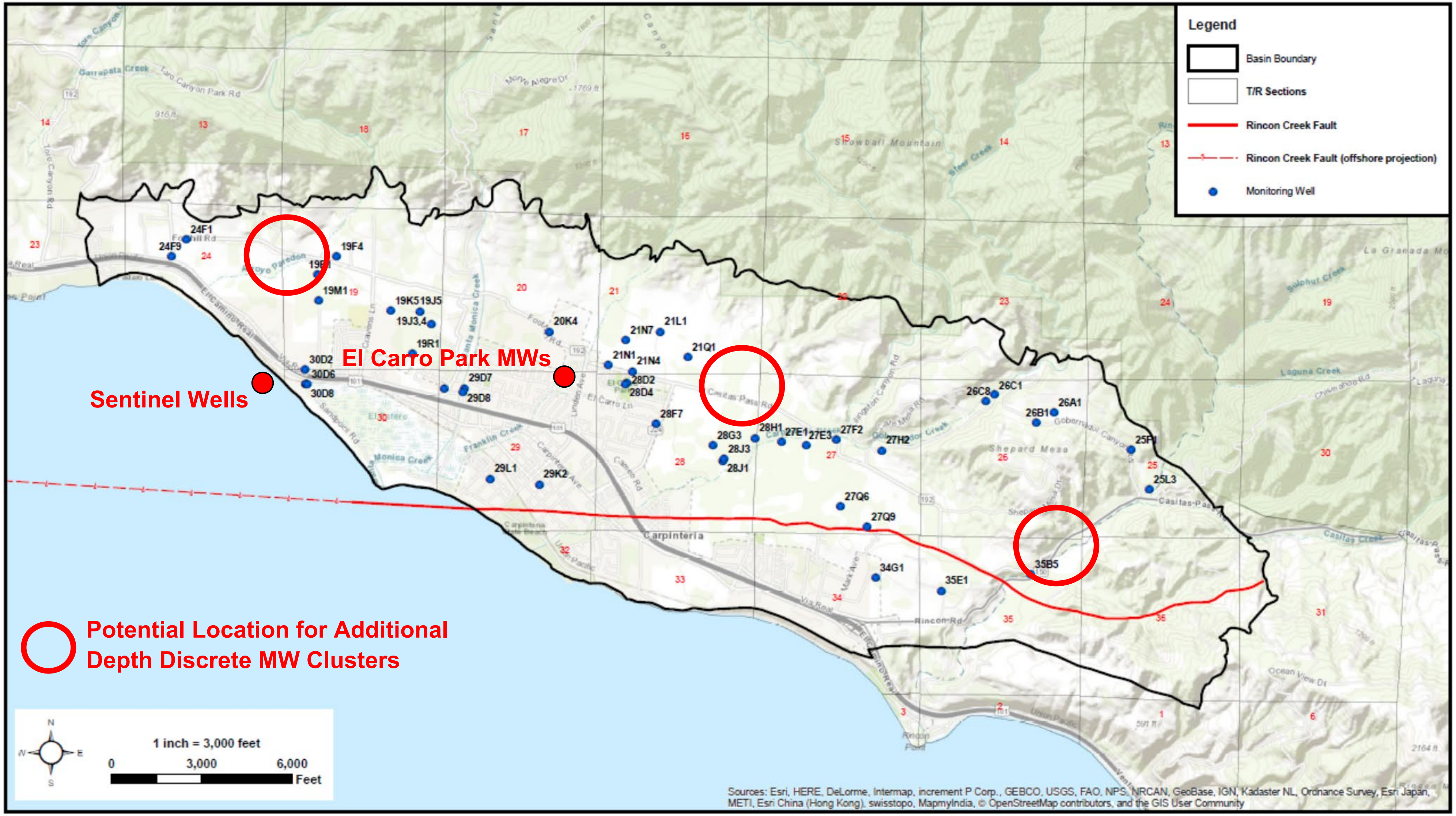
2. DWR Gage on Lower Carpinteria Creek (2022)

3. NOAA Demonstration Project Scanning LiDAR (Light Detection And Ranging) Gage on Rincon Creek is Potential Option for an Additional Streamflow Gage.

Streamflow Gages and Surface Water Quality Stations

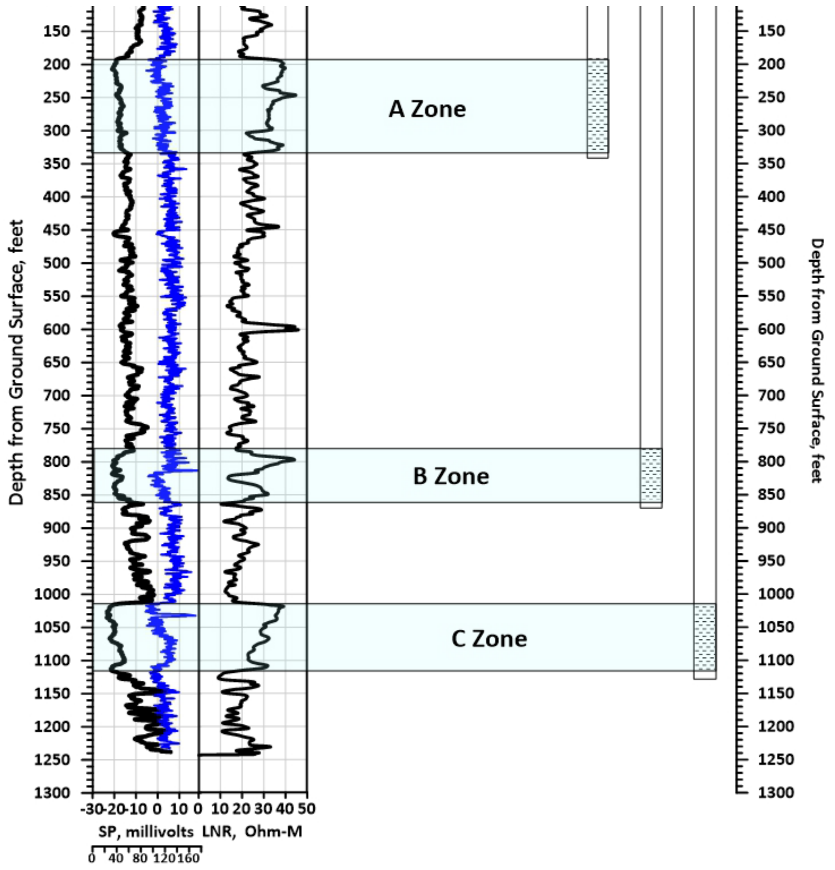


Expansion of GSP Monitoring Well Network

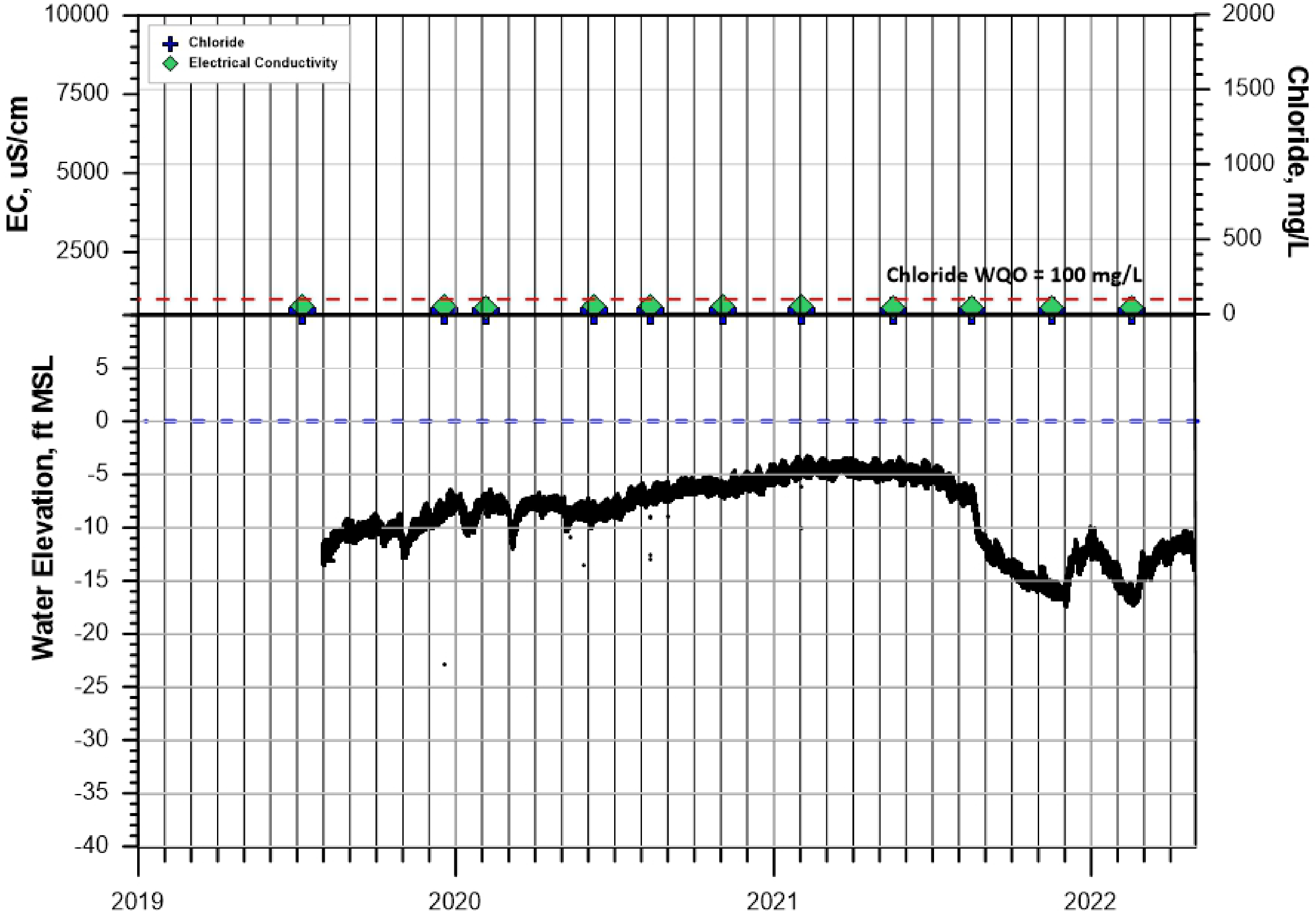


Seawater Intrusion Monitoring Network

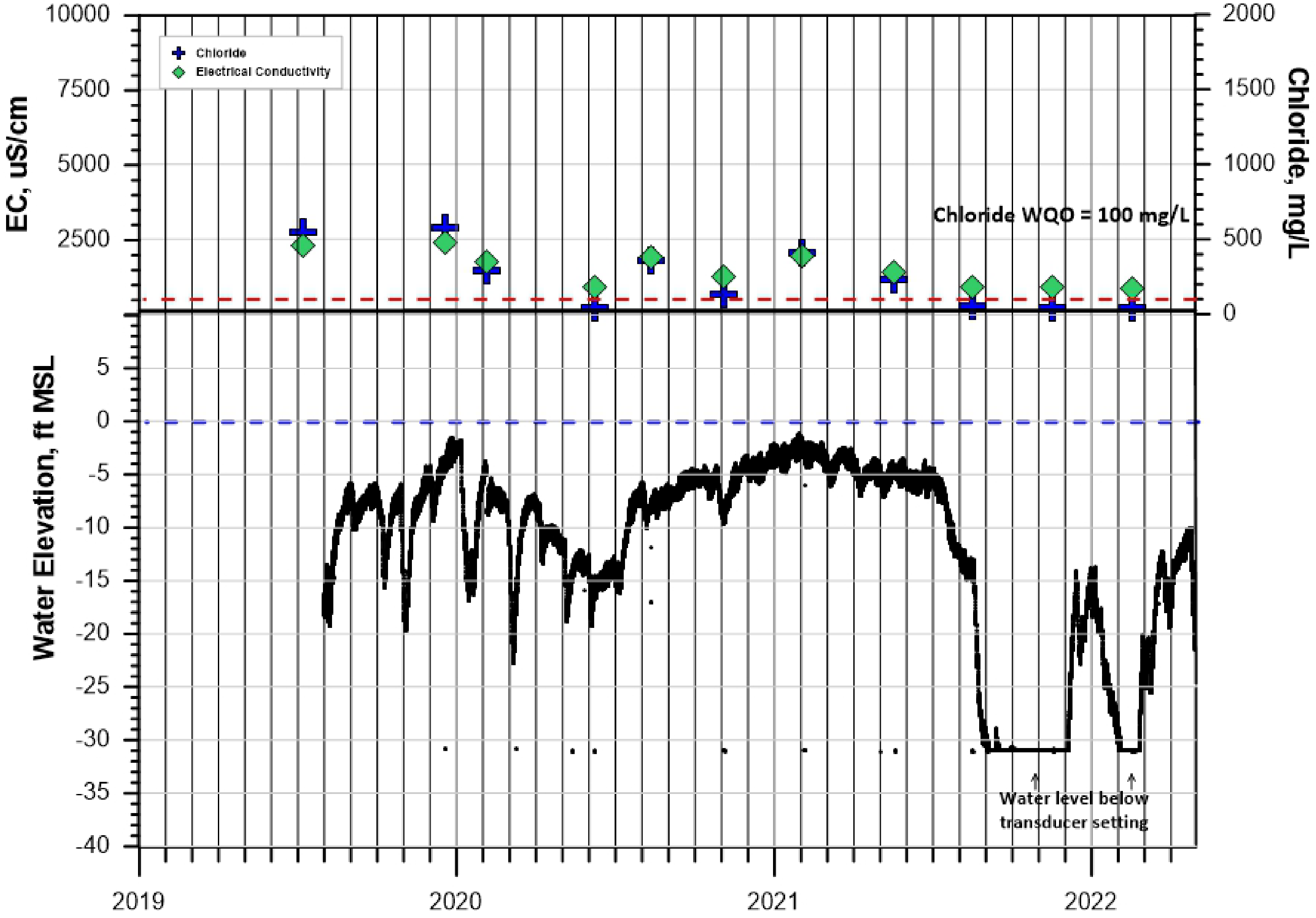
- Sentinel Monitoring Wells drilled in 2019
- Prior to drilling of Sentinel Monitoring Wells, no wells existed at the coast that were deep enough into the A, B and C Zones.
- Primary purposes:
    - Allow for the collection of water-level and water-quality data through routine monitoring;
    - Establish a mechanism to track water-quality changes in distinct water bearing zones through routine induction logging, and;
    - Serve as an early warning indicator (i.e., “sentinel”) for seawater intrusion into the basin.



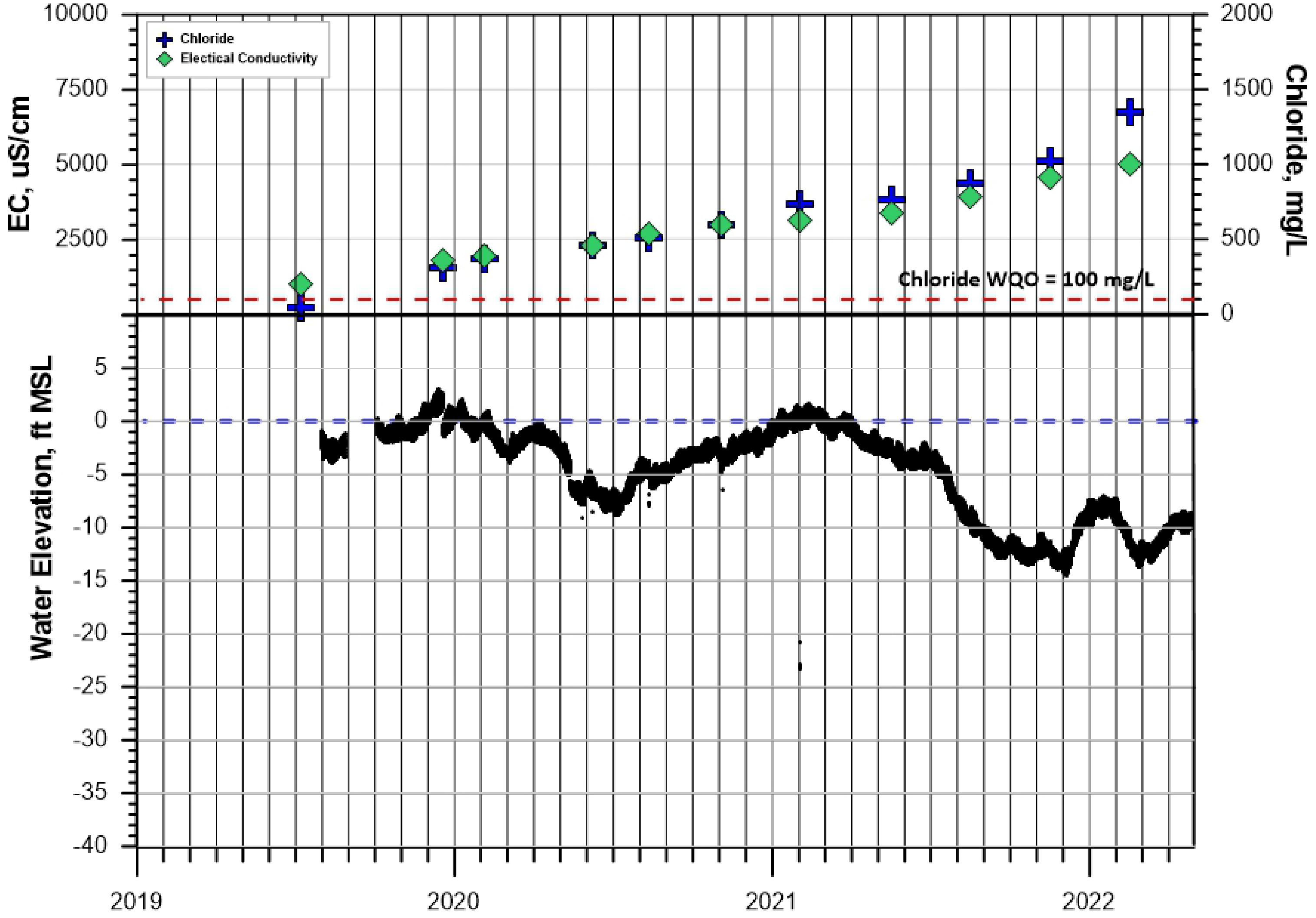
Sentinel Well Data - MW-3 (A Zone)



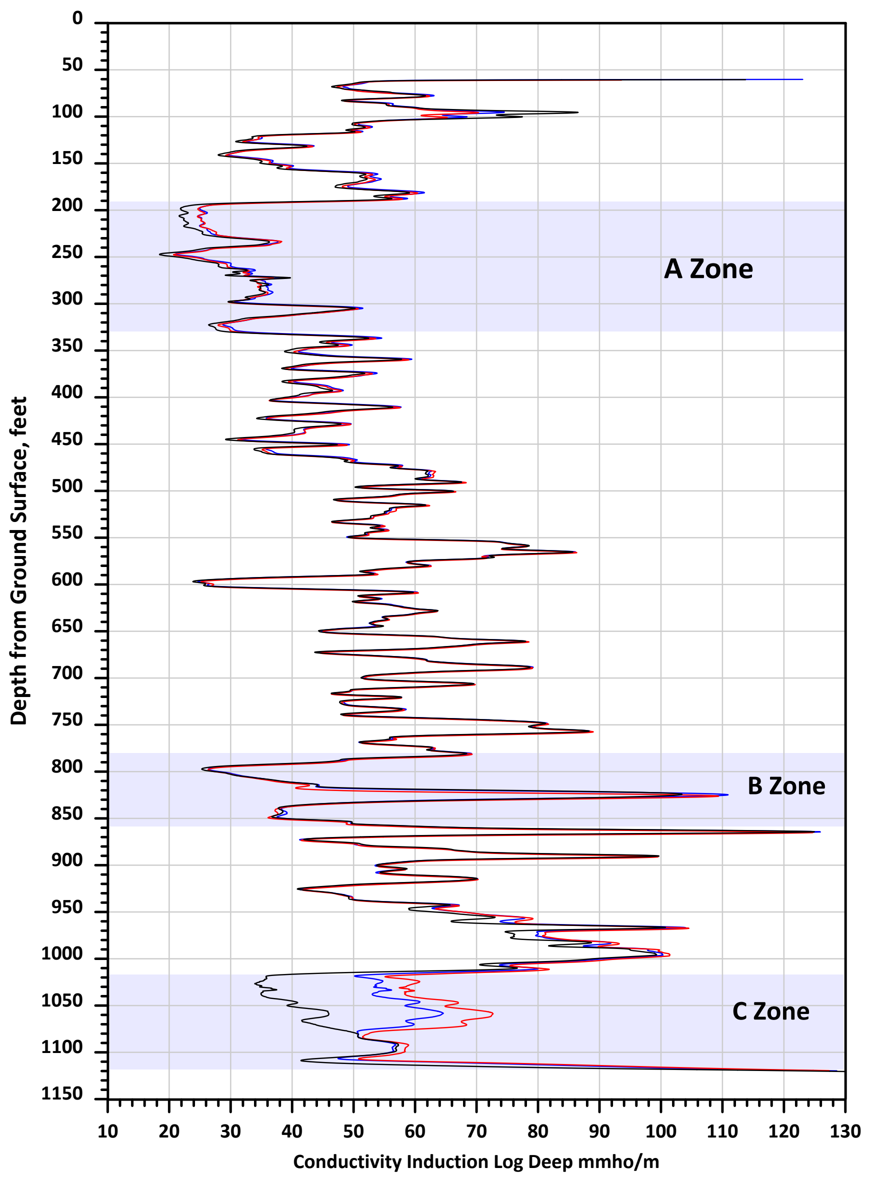
Sentinel Well Data - MW-2 (B Zone)



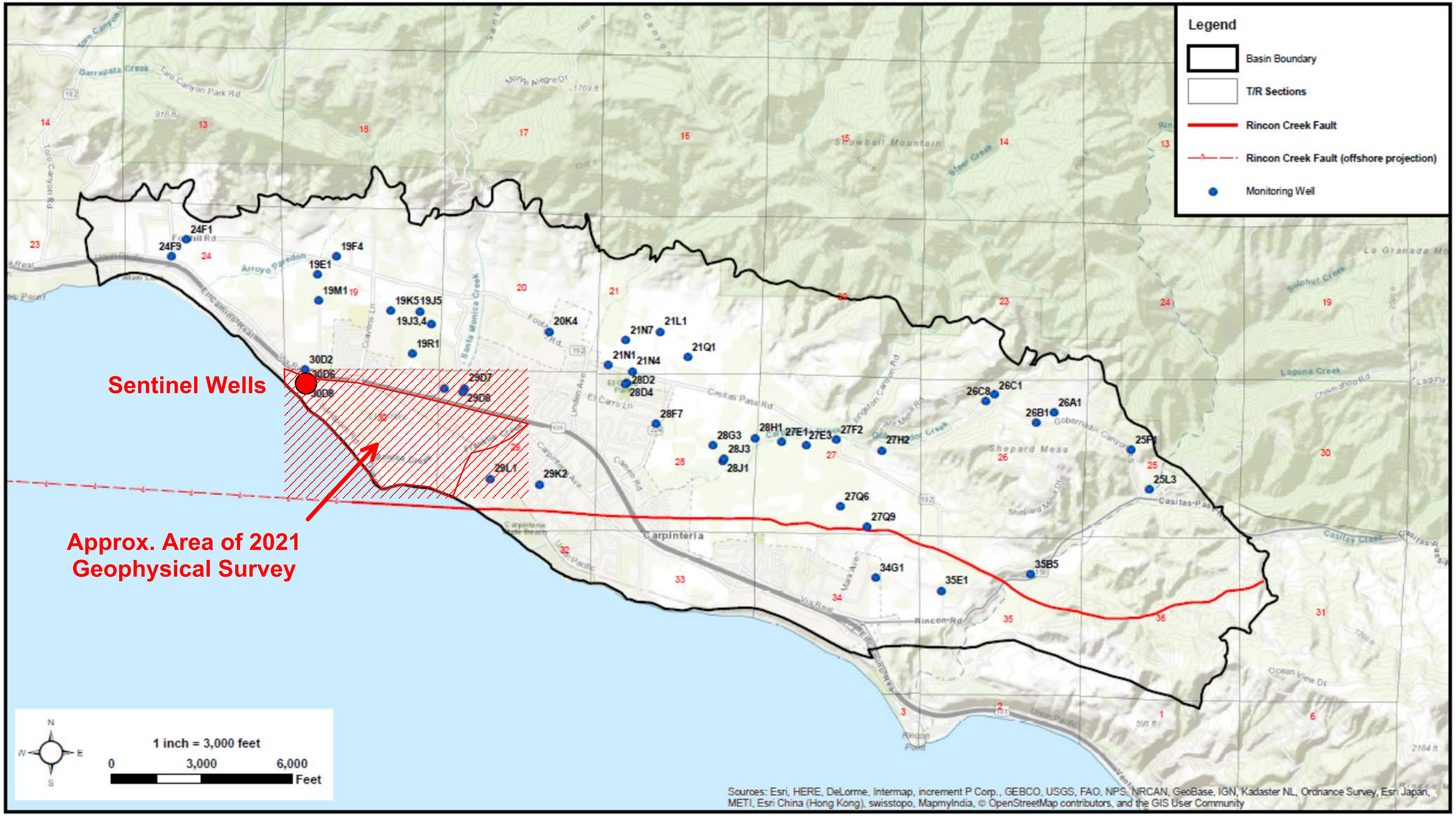
Sentinel Well Data - MW-1 Data (C Zone)



Induction Logging



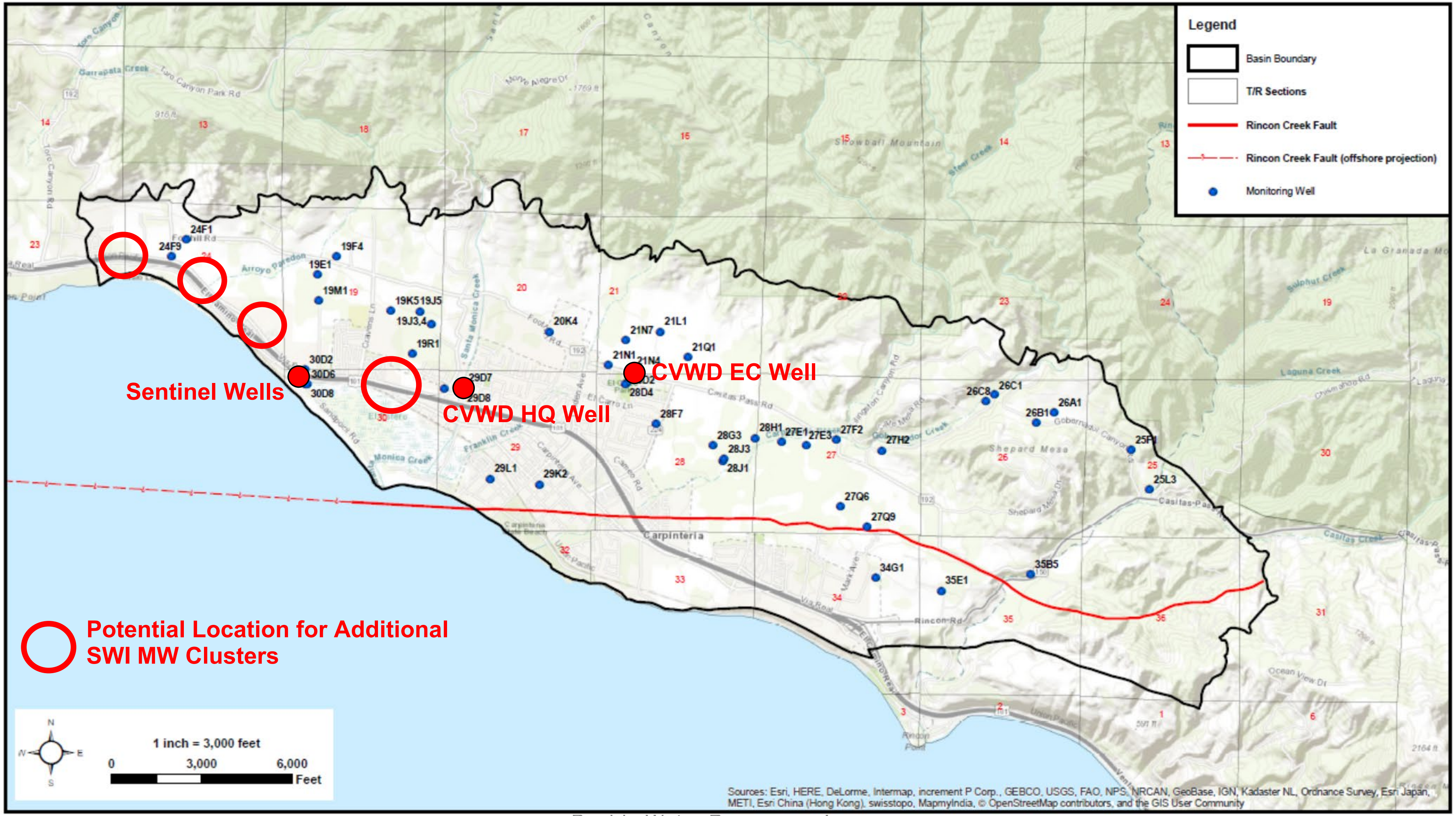
Location of 2021 Geophysical Survey



GSP Monitoring Program for Seawater Intrusion

- Quarterly Water Quality Sampling of 3 Sentinel Wells
- Quarterly Induction Logging of MW-1 (Deep)
- Continuous Water Level Monitoring (Pressure Transducers/Data Loggers)
- Regularly Scheduled Geophysical (ERT) Surveys (5 years)

Expansion of Seawater Intrusion Monitoring Well Network



Monitoring for Land Subsidence

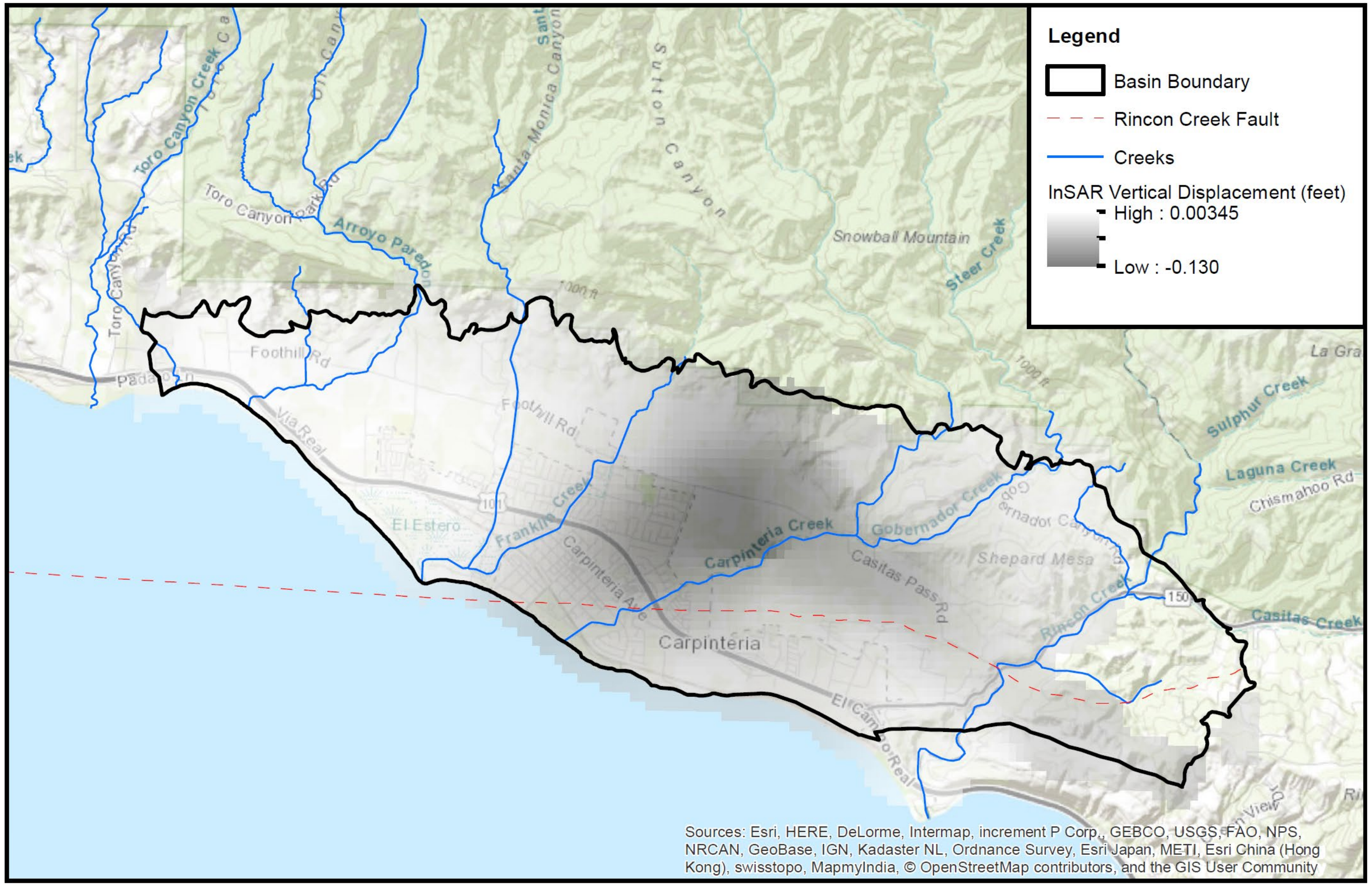
For land subsidence to occur certain conditions are needed, such as:

- Drainage and decomposition of organic soils,
- Underground mining, oil and gas extraction, hydrocompaction, natural compaction, sinkholes, and thawing permafrost, or,
- Aquifer-system compaction.

None of these conditions are previously known to be present in the basin.

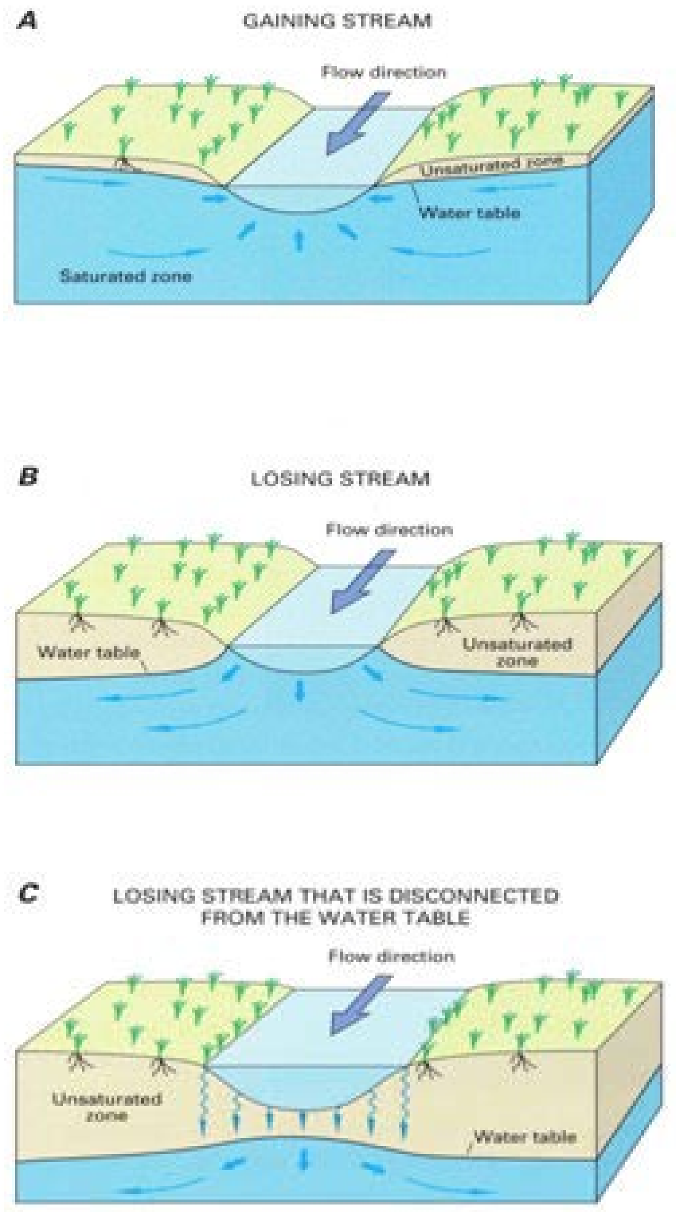
No past or present anecdotal evidence of groundwater withdrawal induced subsidence in the basin (i.e. damage to roads, bridges, pipelines, etc.).

Subsidence – InSAR Data from DWR
Vertical Displacement (June 2015 – July 2022)



Surface Water and Groundwater Interaction

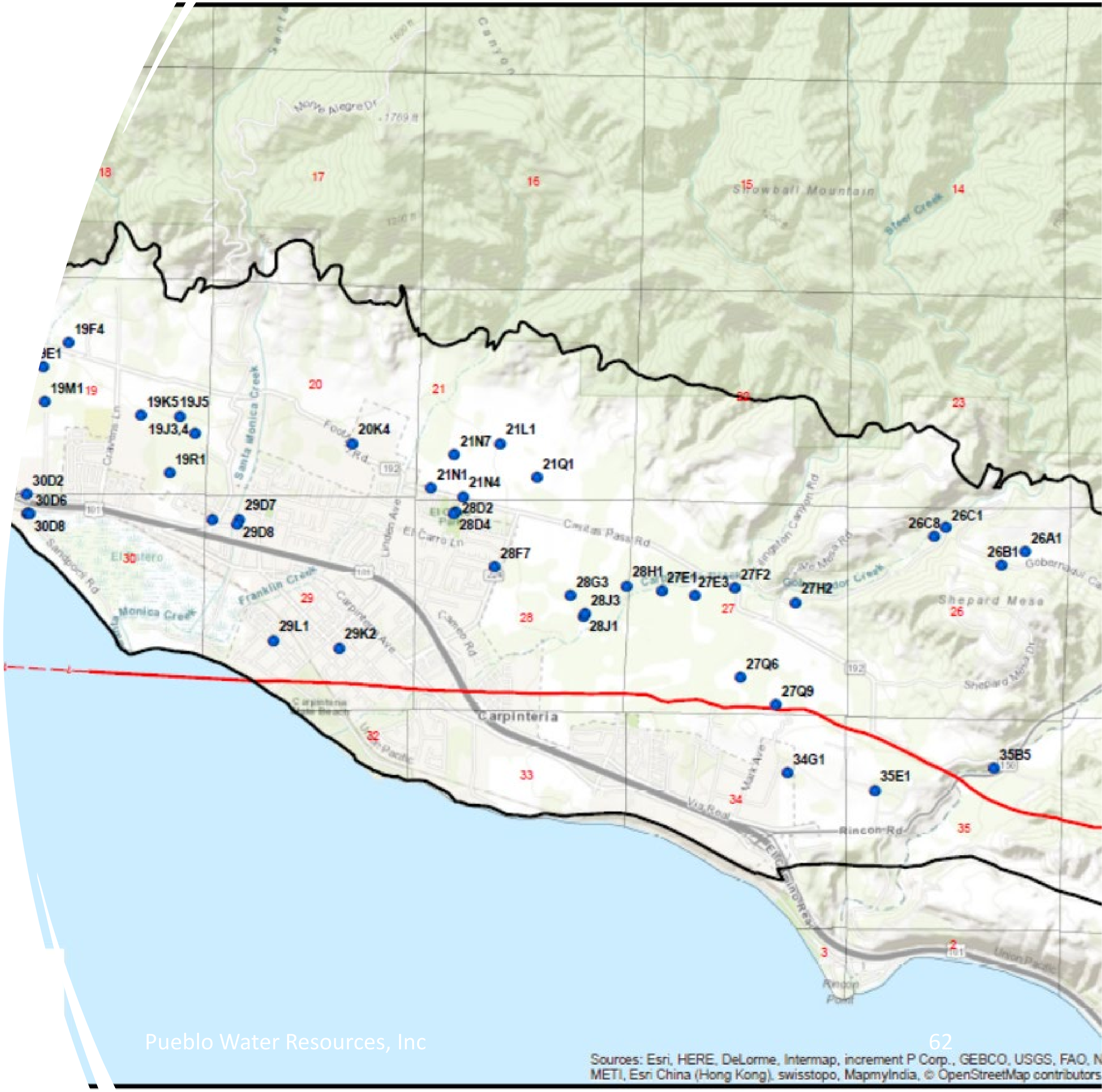
- The potential interactions between surface water bodies (such as creeks) and groundwater in a basin can take place in three basic ways:
  - A gaining stream or creek that receives water from groundwater,
  - A losing stream or creek that recharges basin aquifers from surface water, or
  - A stream or creek that may be separated from groundwater by a hydrologic formation, such as a low-permeability aquitard that prevents interaction between surface water and groundwater completely.



CGB Surface Water Characterization

- Carpinteria, Gobernador, and Rincon Creeks are Losing Streams – No Groundwater/Surface Water Interaction.
- Franklin and Santa Monica Creeks are Concrete Lined Across Basin – No Groundwater/Surface Water Interaction.

Monitoring Networks Q&A



Meeting No. 2 Wrap-Up

Context	• SGMA: Water Model & Monitoring Networks
What's next	• Sustainable Management Criteria (SMC
Meeting No 3	• Tentatively Jan 18, 2023