Appendix C.7

Public Works Department Presentation –
Paso Robles Groundwater Basin Model Update
June 4, 2015

PASO ROBLES GROUNDWATER BASIN MODEL UPDATE

County of San Luis Obispo

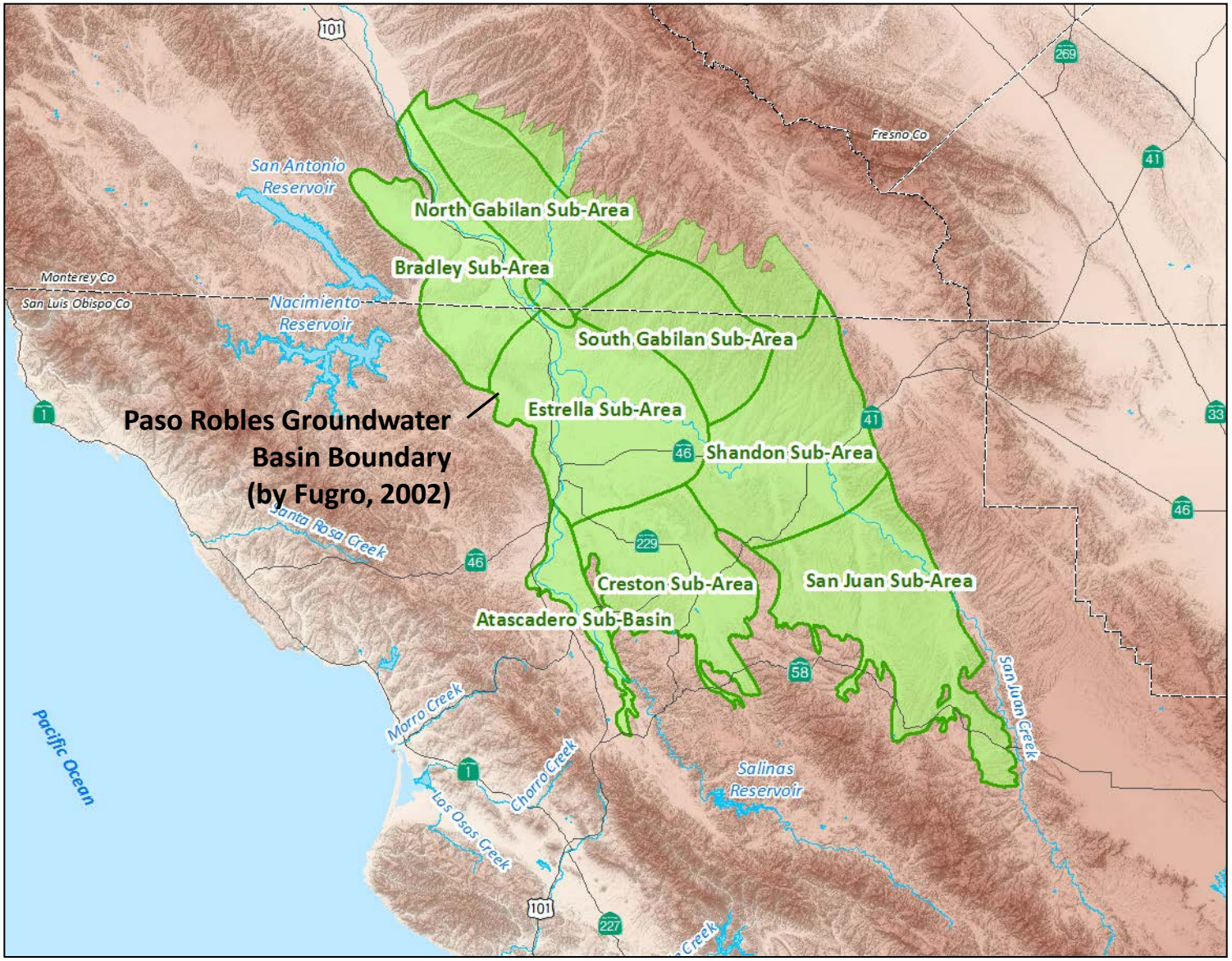
Planning Commission

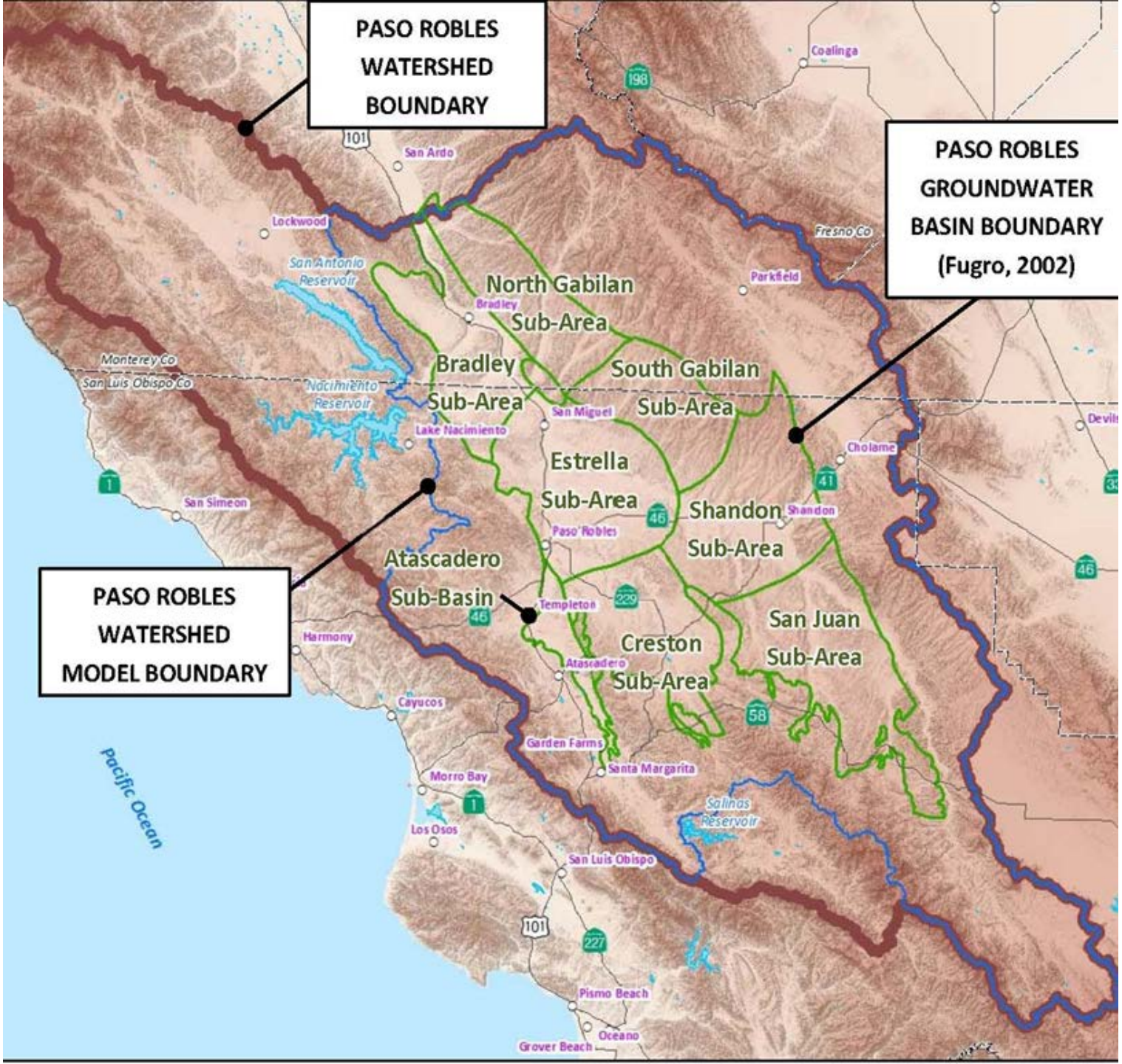
June 4, 2015

Overview

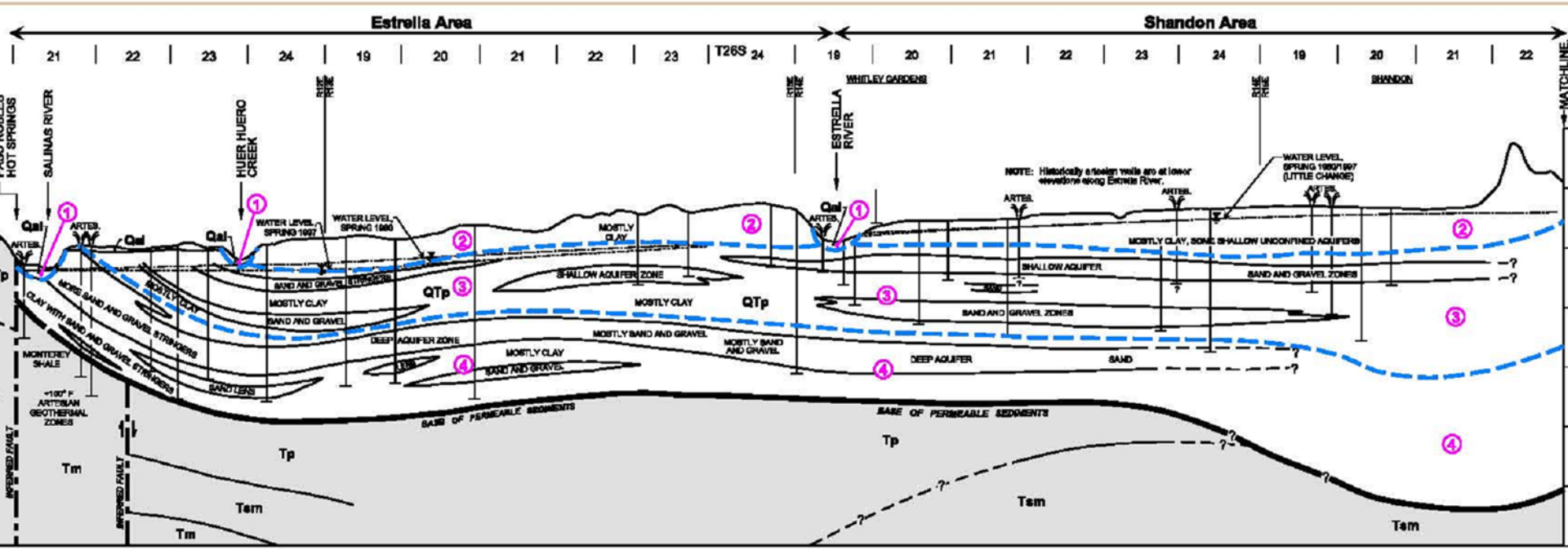
- Introduction
- Model Update Process
- Perennial Yield Estimate
- Results of Predictive Scenarios
- Next Steps

Basin Computer Model




PASO ROBLES WATERSHED BOUNDARY
PASO ROBLES GROUNDWATER BASIN BOUNDARY (Fugro, 2002)
PASO ROBLES WATERSHED MODEL BOUNDARY
North Gabilan Sub-Area
Bradley Sub-Area
South Gabilan Sub-Area
Estrella Sub-Area
Shandon Sub-Area
Atascadero Sub-Basin
Creston Sub-Area
San Juan Sub-Area
Coalinga
San Ardo
Lockwood
San Antonio Reservoir
Fresno Co
Parkfield
Bradley
Monterey Co
San Luis Obispo Co
Nacimiento Reservoir
San Miguel
Lake Nacimiento
Cholame
Shandon
San Simeon
Paso Robles
Templeton
Harmony
Atascadero
Cayucos
Garden Farms
Santa Margarita
Morro Bay
Salinas Reservoir
Los Osos
San Luis Obispo
Pismo Beach
Oceano
Grover Beach
Pacific Ocean
198
101
1
46
41
229
58
227

Basin Model Cross Section



Purpose of Basin Model Update

- **The primary objective of the Basin Model update is to provide an updated, accepted tool for simulating Basin response under current and projected future conditions.**

Scope of Basin Model Update

- Extend model period over water years 1981-2011
- Improve water balance assessment
- Refine perennial yield estimate
- Evaluate basin response to “No Growth” and “Growth” scenarios 2012-2040

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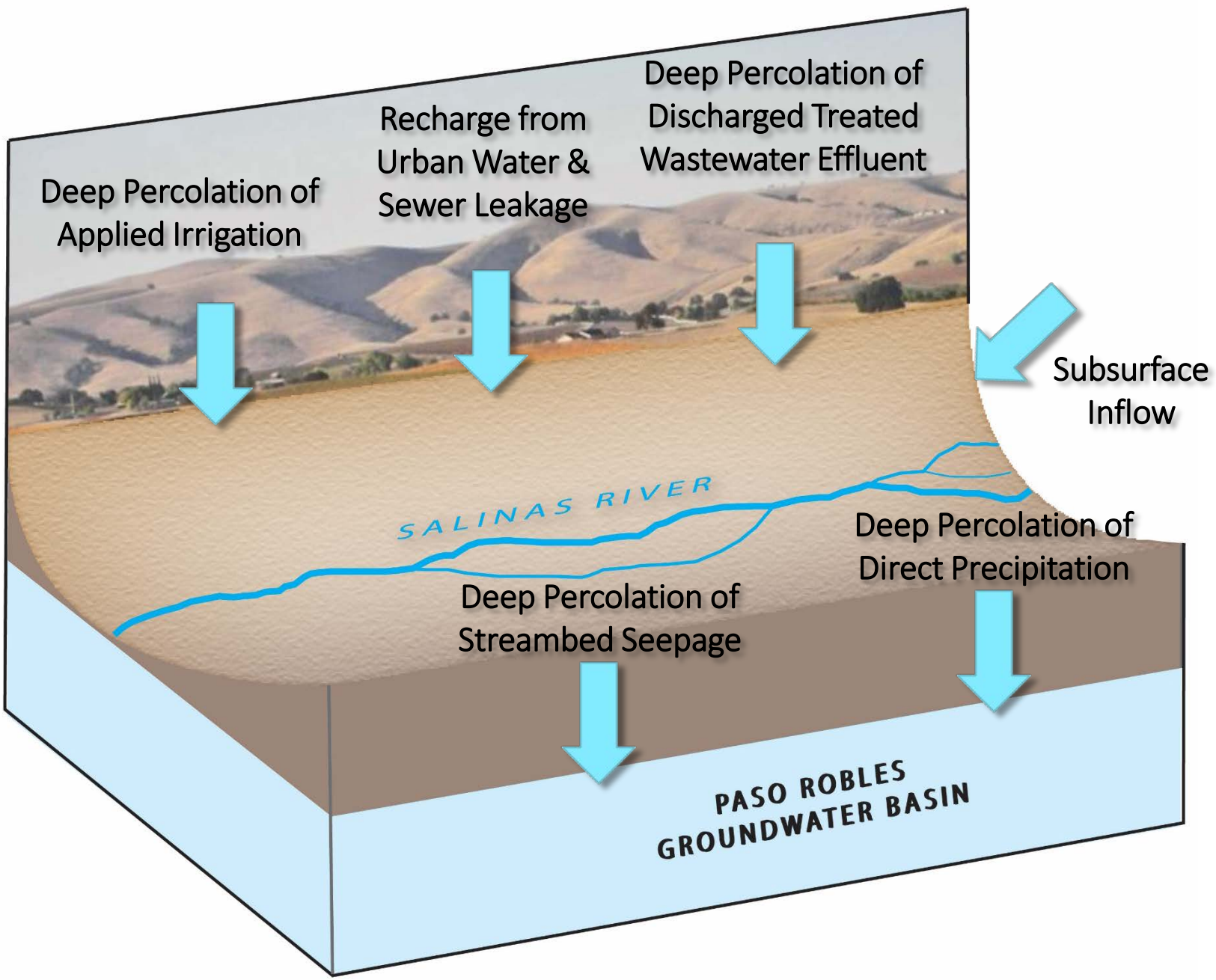
Computer Model Update Process

- ✓ Data Collection and Integrity Analysis
- ✓ Special Studies
- ✓ Watershed Model (Inflow/Outflow Preliminary Analysis)
- ✓ Post Model Input Audit
- ✓ Model Calibration/Analysis Refinement
- ✓ Sensitivity Analysis

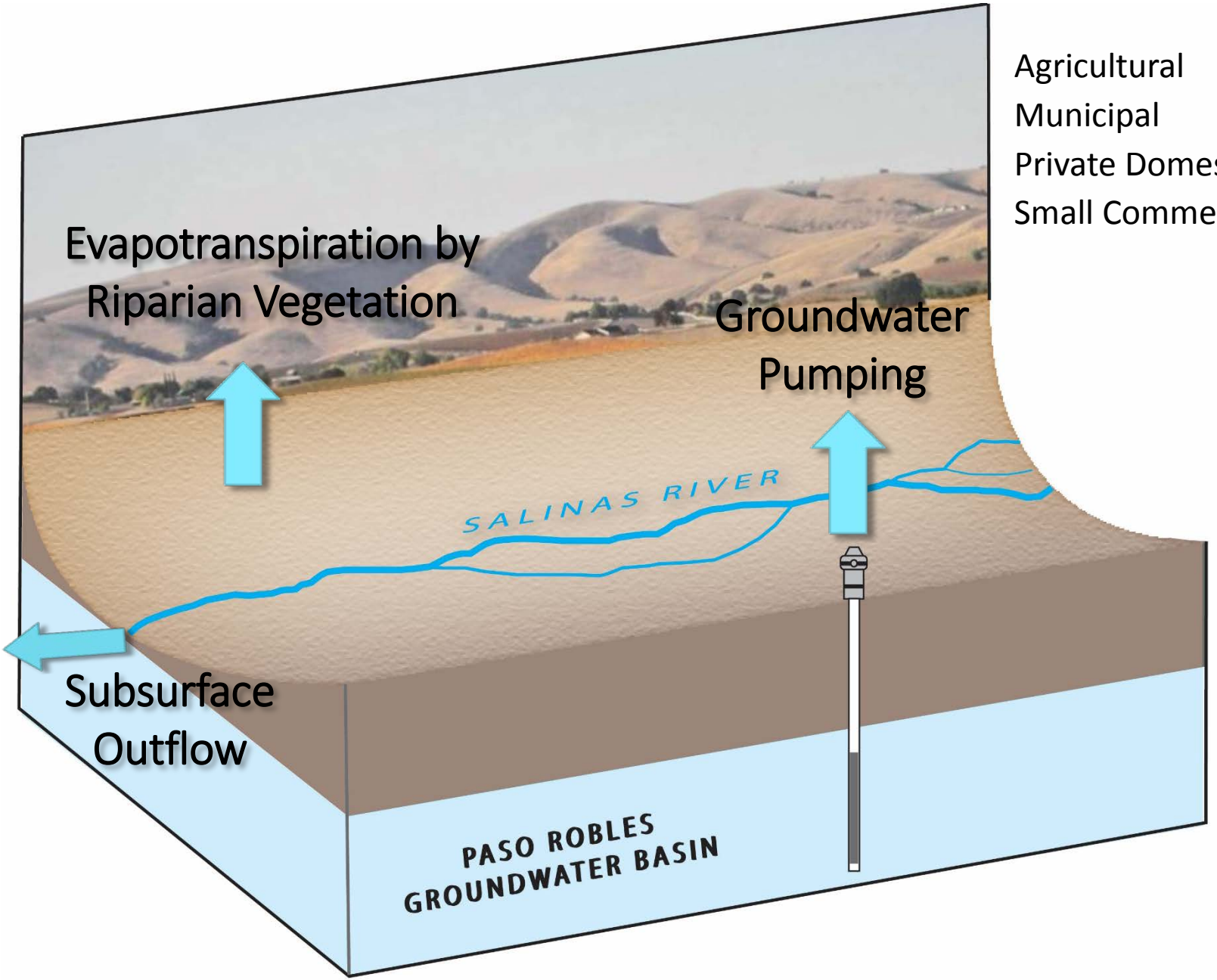
Data Collection

- Topography
- Ground cover
- Climatic
- Geology
- Soil types
- Groundwater
- Land use
- Streamflow
- Surface water
- Nacimiento deliveries
- Crop coefficients
- Irrigation efficiency
- Treated wastewater discharge
- Water demand factors

Basin Recharge Components



Basin Discharge Components



Agricultural
Municipal
Private Domestic
Small Commercial

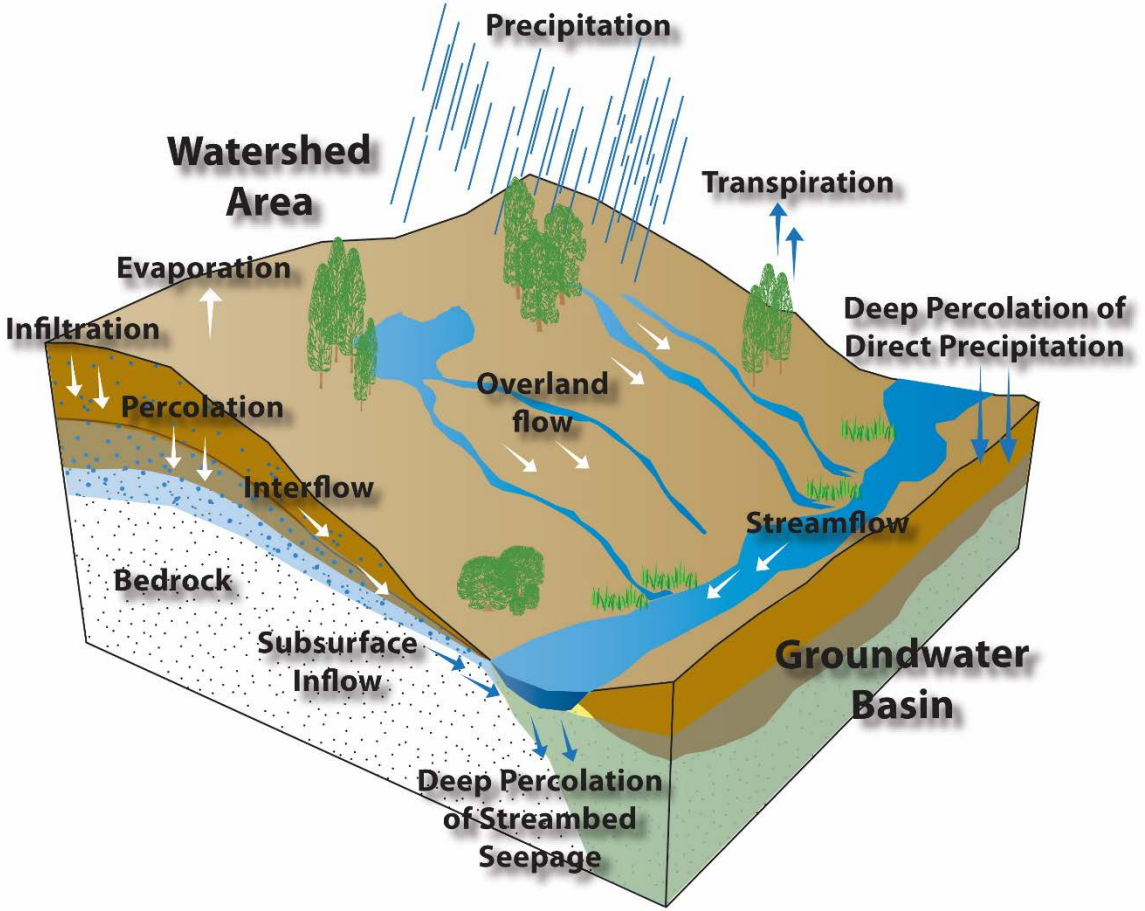
Update Water Balance Estimation

- Extend previous period 1981-1997 to 1981-2011
- Extend from limits of groundwater basin to surrounding watershed
- Develop watershed model to quantify basin recharge components
- Refine and update basin discharge components

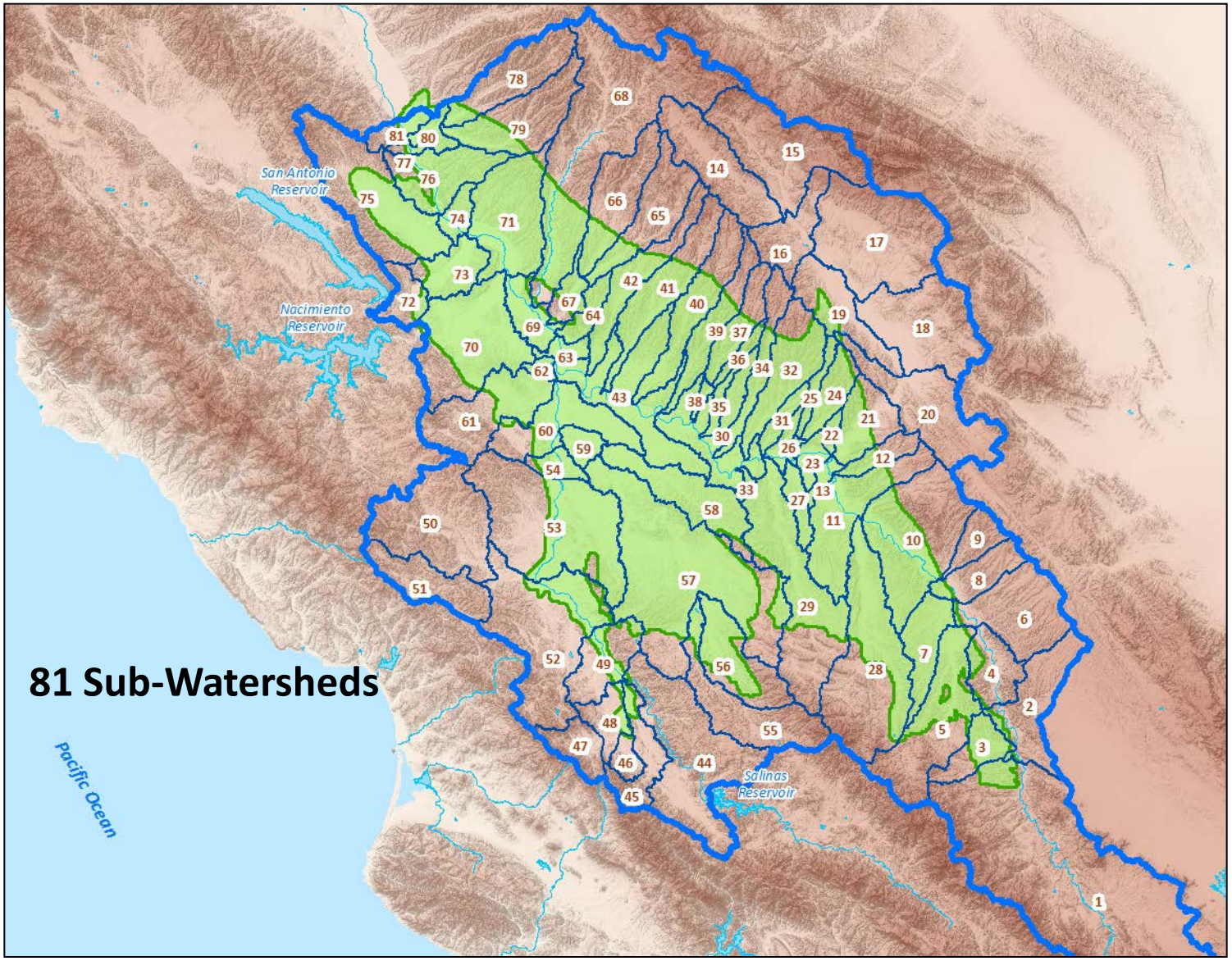
Watershed Model

HSPF (Hydrological Simulation Program FORTRAN) is a model evolved from the "Stanford Watershed Model"

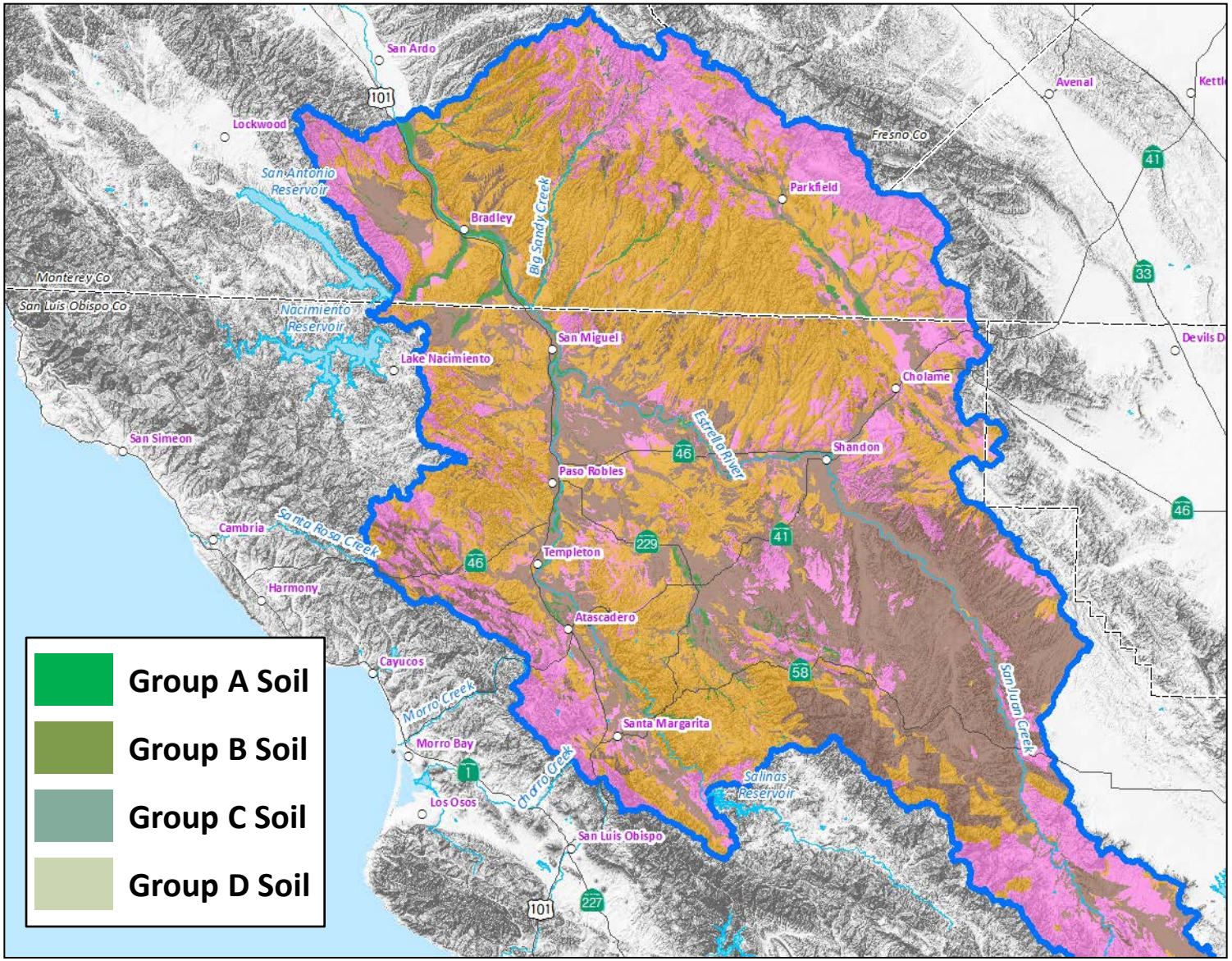
- Adds independent analysis of recharge to basin
  - Subsurface inflow
  - Streambed percolation
  - Deep percolation of direct precipitation
- Improves spatial and temporal distribution
- Improves updated basin model calibration



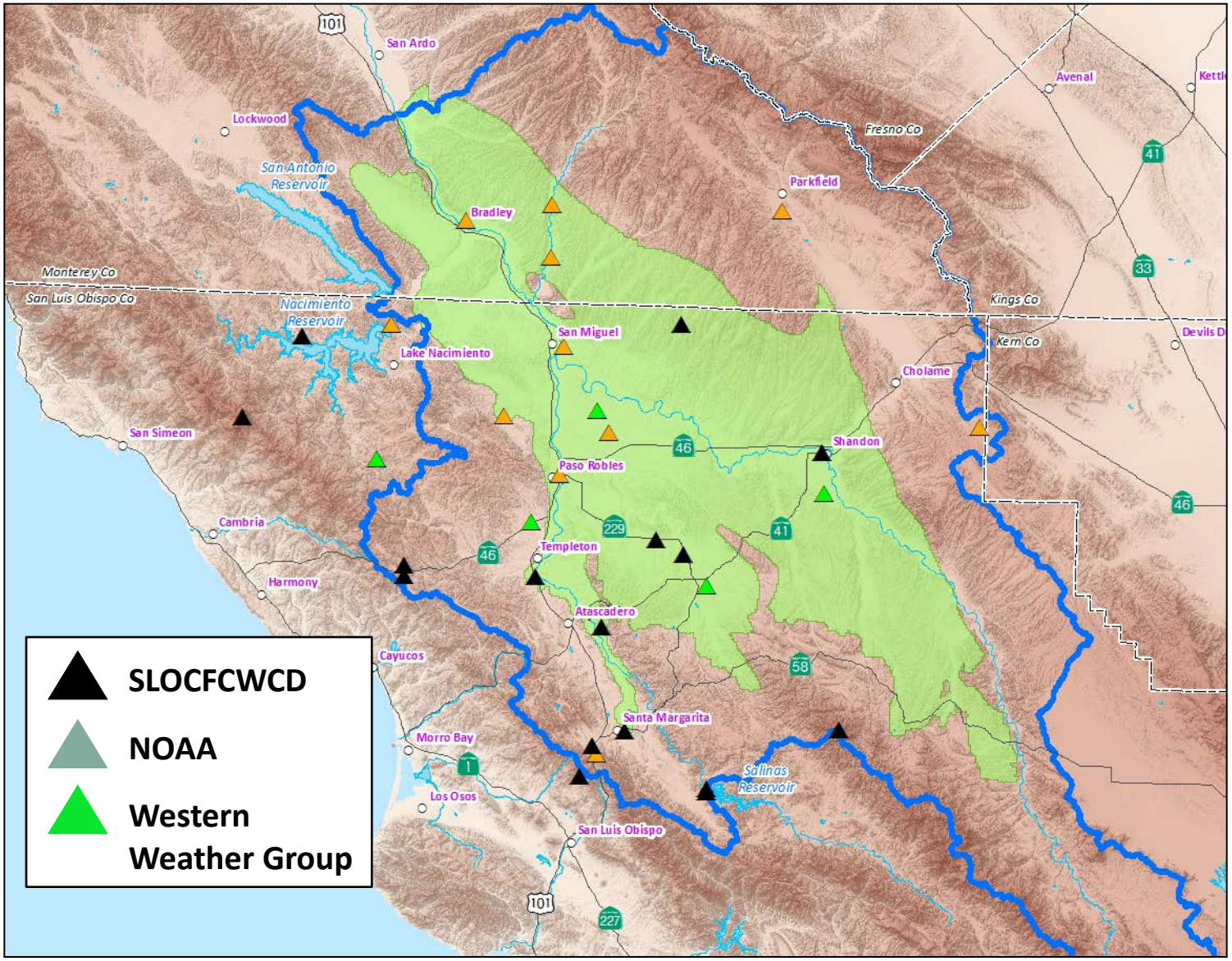
Delineated Sub-Watersheds



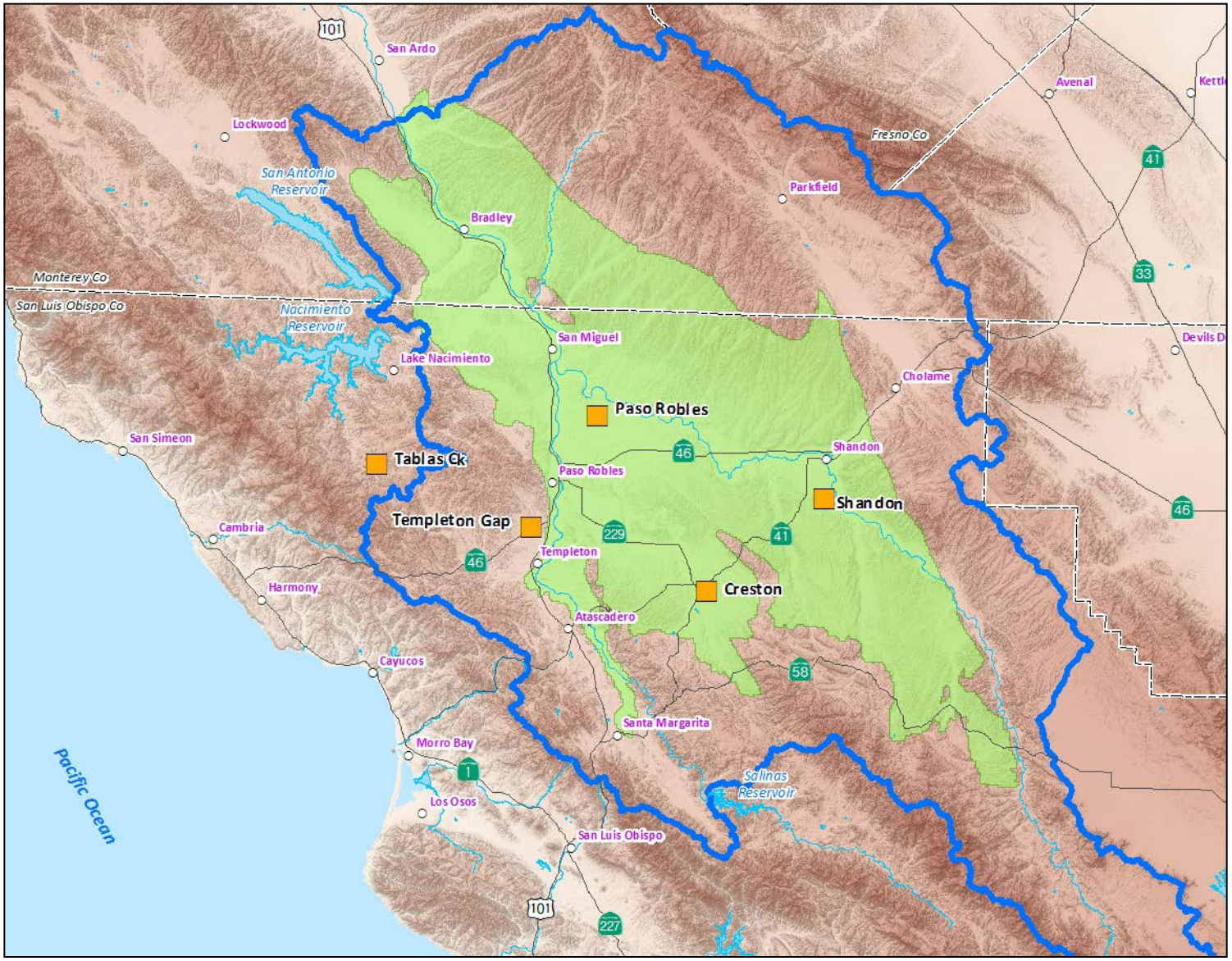
Map of Soil Types



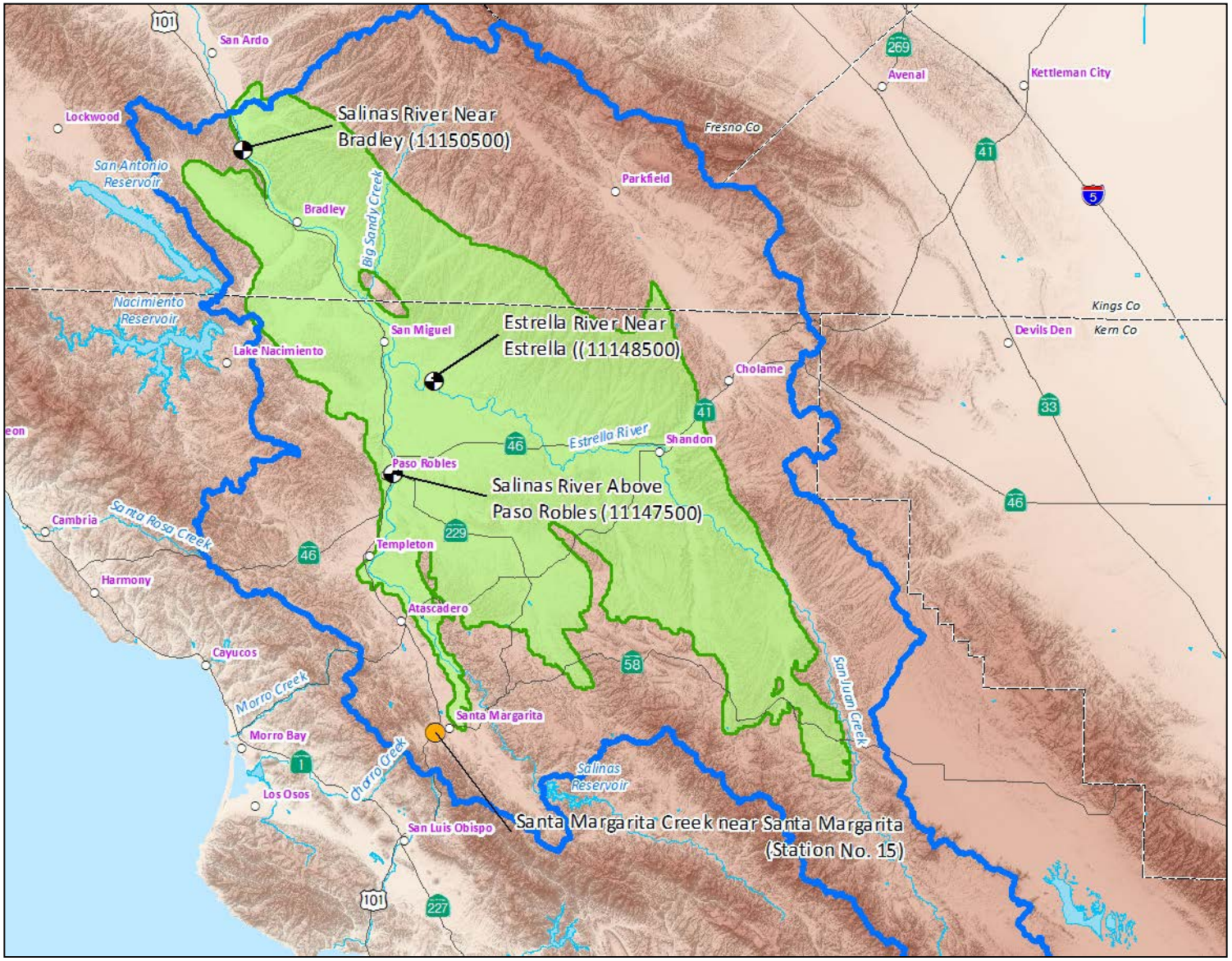
Precipitation Stations

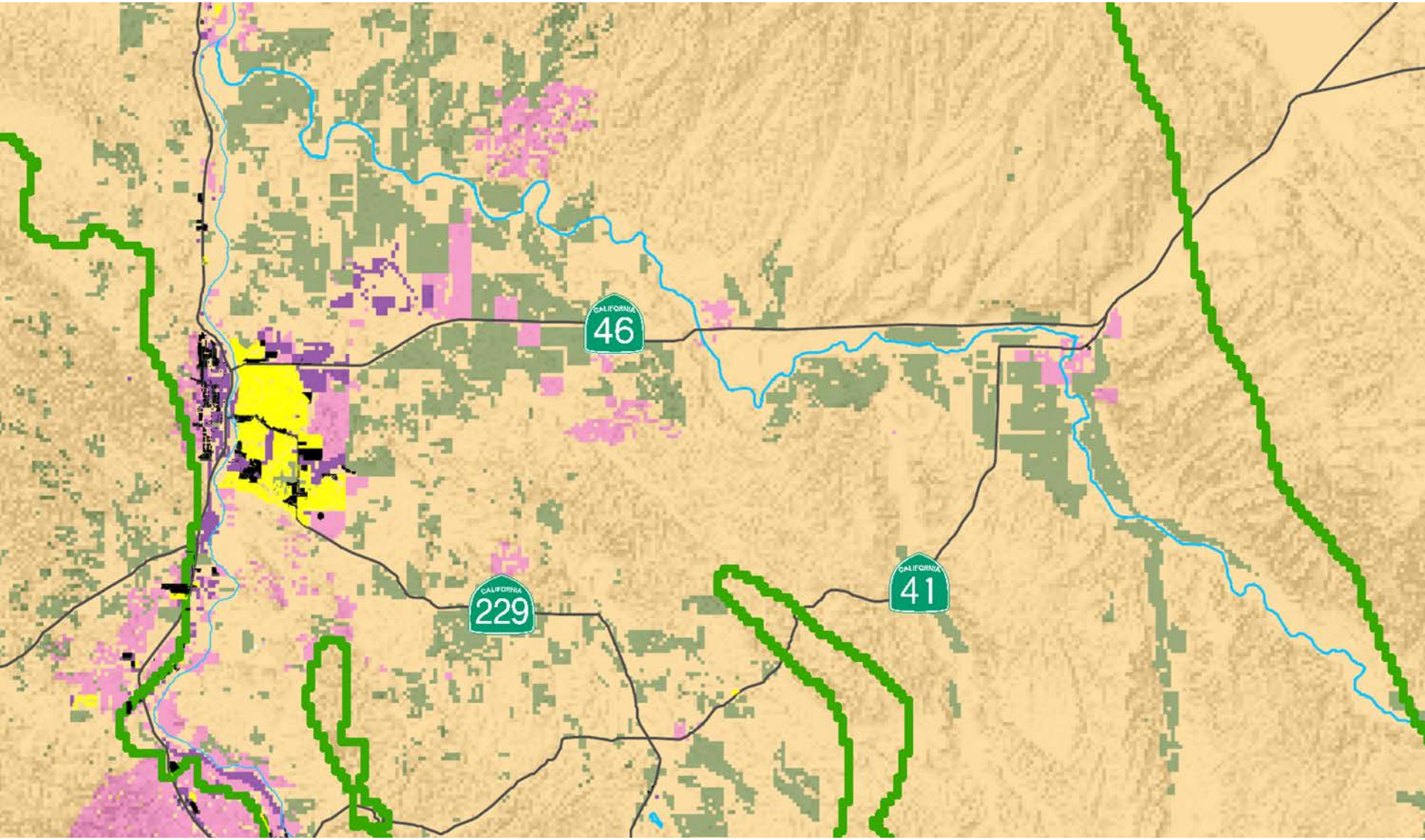


Evapotranspiration Stations



Streamflow Gaging Stations



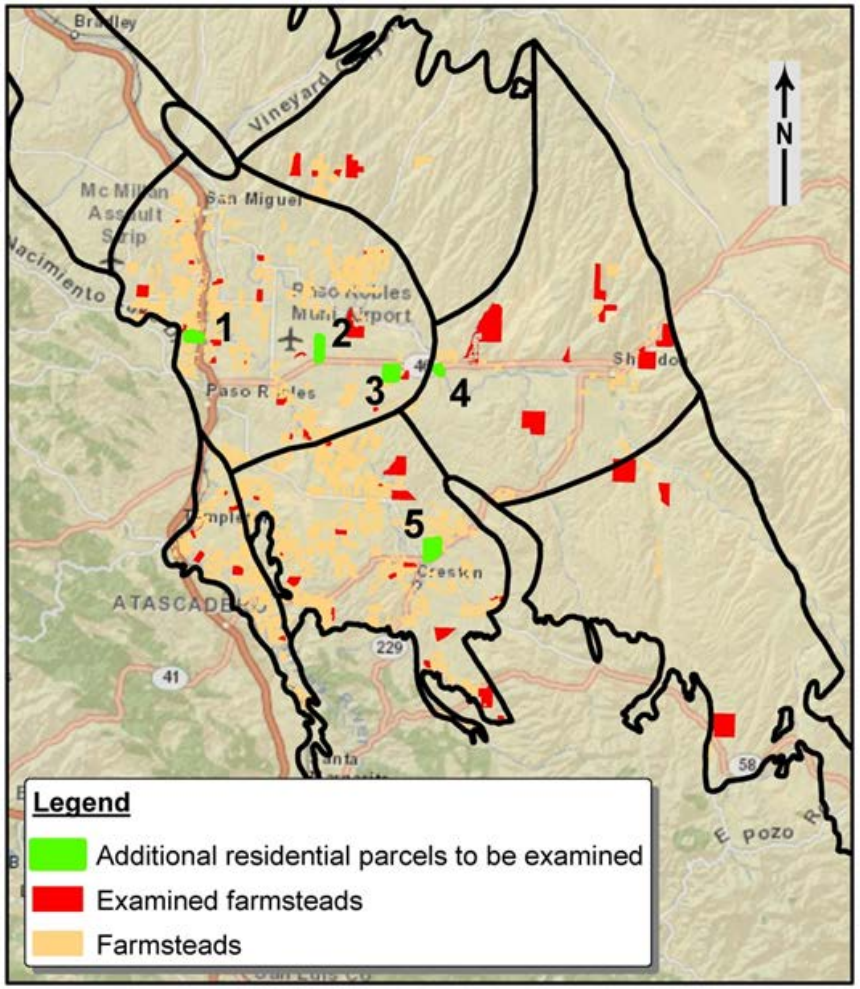

CALIFORNIA
46
CALIFORNIA
229
CALIFORNIA
41

Estimation of Pumping

- Most pumping is agricultural
  - Required detailed analysis through crop-specific daily soil moisture balances
  - Annual crop acreages estimated from land use and county crop coverage maps
  - Analysis of vineyard water demand factors
- Rural domestic pumping
  - Improved accuracy of water demand factor

Rural Residential Demand

- Previous unit estimates
  - 1.7 AFY/dwelling unit
  - 1.0 AFY/dwelling unit
- Two surveys
- 0.13 acres/farmstead irrigated
- Indoor + outdoor = 0.75 AFY/dwelling unit

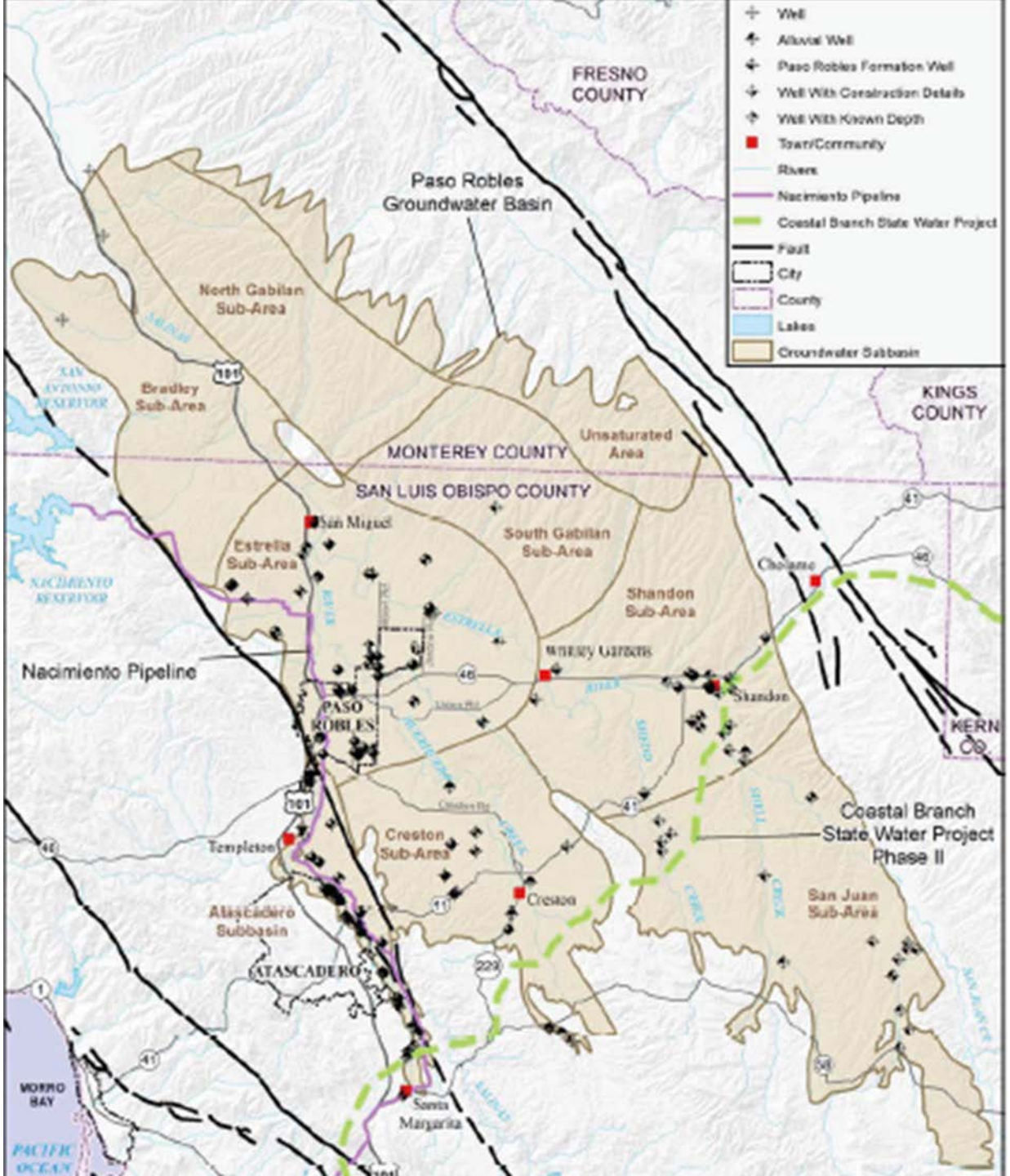


Basin Model Update

- Model description in report
- Original model domain, cell size and layers were unchanged
- Model recalibration and sensitivity

The most sensitive model parameters are:

- **Groundwater pumping**
- **Streambed percolation**


Well
Alluvial Well
Paso Robles Formation Well
Well With Construction Details
Well With Known Depth
Town/Community
Rivers
Nacimiento Pipeline
Coastal Branch State Water Project
Fault
City
County
Lakes
Groundwater Subbasin
FRESNO COUNTY
Paso Robles Groundwater Basin
North Gabilan Sub-Area
Bradley Sub-Area
MONTEREY COUNTY
Unsaturated Area
SAN LUIS OBISPO COUNTY
KINGS COUNTY
San Miguel
Estrella Sub-Area
South Gabilan Sub-Area
Shandon Sub-Area
Chalame
Whitley Gardens
Shandon
Nacimiento Pipeline
PASO ROBLES
KERN CO.
Templeton
Creston Sub-Area
Coastal Branch State Water Project Phase II
Creston
San Juan Sub-Area
Atascadero Subbasin
ATASCADERO
Santa Margarita
MORRO BAY
PACIFIC OCEAN
NACIMIENTO RESERVOIR
SAN ANDREAS RESERVOIR
101
41
46
1
229

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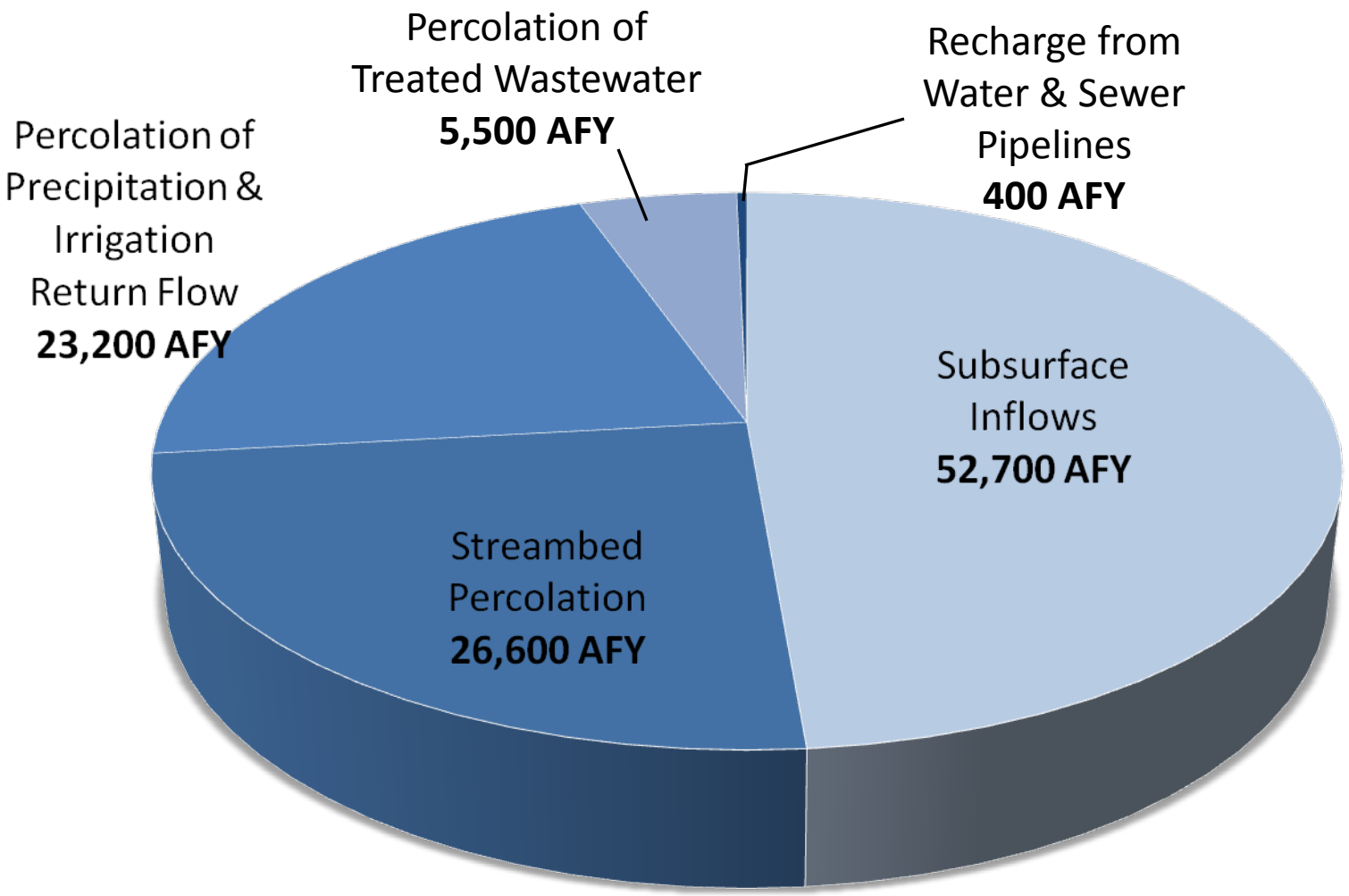
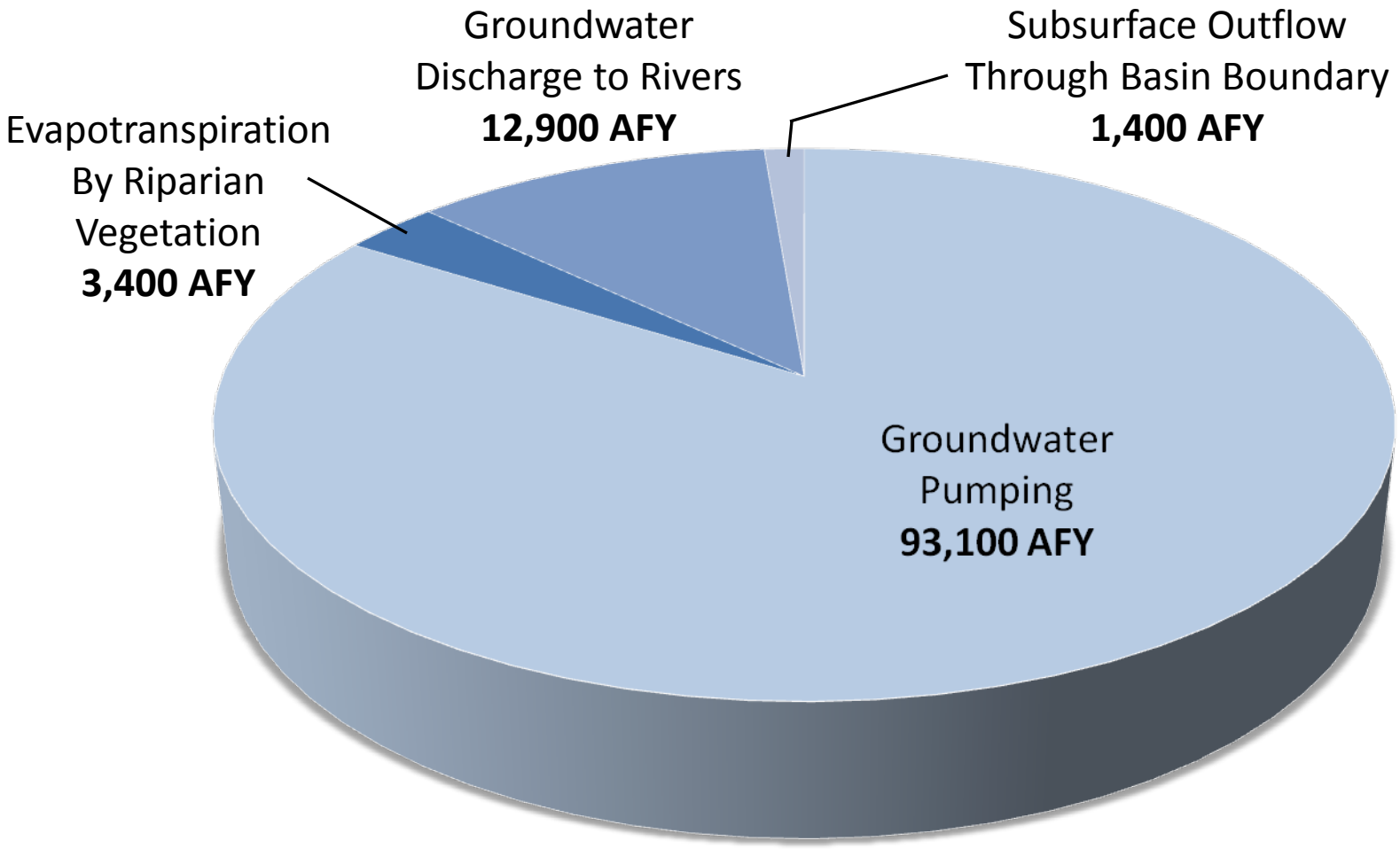
Average Annual Inflows (1981-2011)



TOTAL AVERAGE ANNUAL INFLOW = 108,400 AFY

Average Annual Outflows (1981-2011)



TOTAL AVERAGE ANNUAL OUTFLOW = 110,800 AFY

Average Annual Outflows (1981-2011)

- Agricultural pumping - 68%
- Municipal pumping - 11%
- Private Domestic pumping - 3%
- Small commercial pumping - 2%

- Evapotranspiration (ET) by riparian vegetation - 3%
- Groundwater discharge to rivers - 12%
- Subsurface outflow - 1%

Table 26 – Inflows and Outflows (1981-2011)

Summary of Annual Water Budgets for the Recalibrated Paso Robles Groundwater Basin Model (Water Years 1981-2011)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
	INFLOW						OUTFLOW								
Water Year	Deep Percolation of Direct Precipitation and Return Flow from Applied Irrigation Water	Deep Percolation of Streambed Seepage	Subsurface Inflow Through the Basin Boundary	Deep Percolation of Discharged Treated Wastewater Effluent	Deep Percolation of Urban Water and Sewer Pipe Leakage	Total Inflow	Agricultural Groundwater Pumping	Municipal Groundwater Pumping	Private Domestic Well Groundwater Pumping	Small Commercial Groundwater Pumping	Evapotranspiration by Riparian Vegetation	Groundwater Discharge to Rivers	Subsurface Outflow through Basin Boundary	Total Outflow	Change in Groundwater Storage
	[acre-ft]														
1981	10,435	21,625	22,151	4,047	225	58,483	110,560	7,220	1,984	2,164	3,453	11,060	1,885	138,325	-79,842
1982	14,015	24,846	33,207	4,132	227	76,426	98,375	7,201	2,030	1,930	3,453	15,353	1,685	130,026	-53,600
1983	47,777	55,544	136,946	4,217	233	244,716	92,265	7,432	2,076	1,872	3,453	17,618	1,660	126,376	118,340
1984	7,432	16,310	11,234	4,302	273	39,552	107,514	9,346	2,124	2,218	3,453	15,897	1,605	142,157	-102,605
1985	6,738	14,997	8,223	4,388	276	34,622	98,218	9,436	2,173	2,167	3,453	13,300	1,567	130,313	-95,690
1986	26,394	31,207	68,481	4,474	287	130,844	87,829	9,882	2,223	2,080	3,453	12,777	1,559	119,802	11,042
1987	6,312	12,967	5,477	4,561	305	29,622	90,797	10,692	2,274	2,204	3,453	12,419	1,537	123,377	-93,755
1988	7,811	15,892	13,743	4,648	314	42,408	81,775	11,032	2,326	2,050	3,453	12,230	1,530	114,397	-71,989
1989	7,756	13,818	12,050	4,735	321	38,681	83,752	11,336	2,380	2,153	3,453	11,812	1,512	116,397	-77,716
1990	6,208	9,833	3,547	4,806	313	24,706	83,069	10,834	2,435	2,253	3,453	11,413	1,495	114,952	-90,245
1991	22,726	20,416	36,327	5,018	306	84,792	72,647	10,267	2,491	2,252	3,453	10,989	1,422	103,520	-18,727
1992	21,412	20,382	33,454	5,136	323	80,707	69,792	11,008	2,548	2,175	3,453	10,270	1,380	100,625	-19,918
1993	66,778	62,269	164,404	5,254	330	299,035	63,309	11,224	2,607	2,166	3,453	11,236	1,432	95,426	203,609
1994	11,650	12,073	4,234	5,253	339	33,548	62,607	11,689	2,667	2,114	3,453	10,853	1,368	94,750	-61,202
1995	67,456	64,366	173,178	5,502	327	310,829	55,364	10,860	2,728	2,106	3,453	11,933	1,394	87,838	222,991
1996	21,219	20,955	37,608	5,130	351	85,263	54,926	12,420	2,791	2,186	3,453	12,642	1,361	89,778	-4,515
1997	40,117	42,687	106,409	5,647	377	195,237	50,599	13,183	2,855	2,250	3,453	13,747	1,351	87,438	107,799
1998	57,998	55,780	162,335	5,848	346	282,308	47,832	11,455	2,921	1,990	3,453	15,376	1,378	84,405	197,904
1999	6,232	10,387	3,867	5,563	369	26,418	63,149	12,901	2,988	2,131	3,453	14,354	1,321	100,296	-73,879
2000	14,767	18,667	29,501	5,671	398	69,005	63,816	14,230	3,057	2,211	3,453	13,834	1,295	101,895	-32,891
2001	19,036	20,701	37,518	6,108	408	83,772	68,161	14,310	3,127	2,177	3,453	13,810	1,282	106,320	-22,548
2002	6,991	12,063	3,881	6,291	434	29,659	76,724	15,398	3,199	2,289	3,453	13,279	1,248	115,590	-85,931
2003	12,617	14,637	18,173	6,331	435	52,195	67,603	15,441	3,273	2,172	3,453	12,922	1,231	106,094	-53,899
2004	6,822	11,246	3,750	6,393	460	28,670	80,032	16,600	3,348	2,396	3,453	12,181	1,214	119,223	-90,554
2005	76,967	78,098	222,216	6,573	414	384,269	59,824	14,137	3,425	2,112	3,453	14,558	1,252	98,762	285,507
2006	23,395	21,300	41,962	6,660	443	93,761	66,057	15,506	3,504	2,306	3,453	14,157	1,197	106,179	-12,418
2007	3,783	12,729	2,743	6,569	461	26,284	91,734	16,473	3,585	2,421	3,453	12,616	1,331	131,613	-105,328
2008	20,526	23,726	49,633	6,801	459	101,146	83,706	16,138	3,667	2,389	3,453	11,972	1,437	122,762	-21,617
2009	6,208	12,299	4,639	6,517	417	30,079	89,704	14,310	3,752	2,272	3,453	11,016	1,439	125,945	-95,866
2010	34,814	32,645	83,427	6,733	401	158,020	70,414	13,319	3,838	2,114	3,453	11,164	1,452	105,754	52,266
2011	37,368	40,005	100,169	6,793	398	184,733	60,285	13,119	3,765	2,104	3,453	11,941	1,453	96,120	88,614

Water Balance for Recalibrated Basin Model

- **Total Inflow – Total Outflow = Change in Groundwater Storage**

Water Balance of Paso Robles Groundwater Basin Average of 1981 – 2011 [AFY]

Total Inflow	Total Outflow	Change in Storage
108,400	110,800	-2,400

Perennial Yield Estimate

- **Perennial Yield = Total Groundwater Pumping +/- Change in Groundwater Storage**
- **Hydrologic Base Period = Covers Wet, Dry and Average Hydrologic Cycles**

Perennial Yield of Paso Robles Groundwater Basin Average of Base Period 1982 – 2010 [AFY]

Total Pumping	Change in Storage	Perennial Yield
92,594	-2,946	89,600

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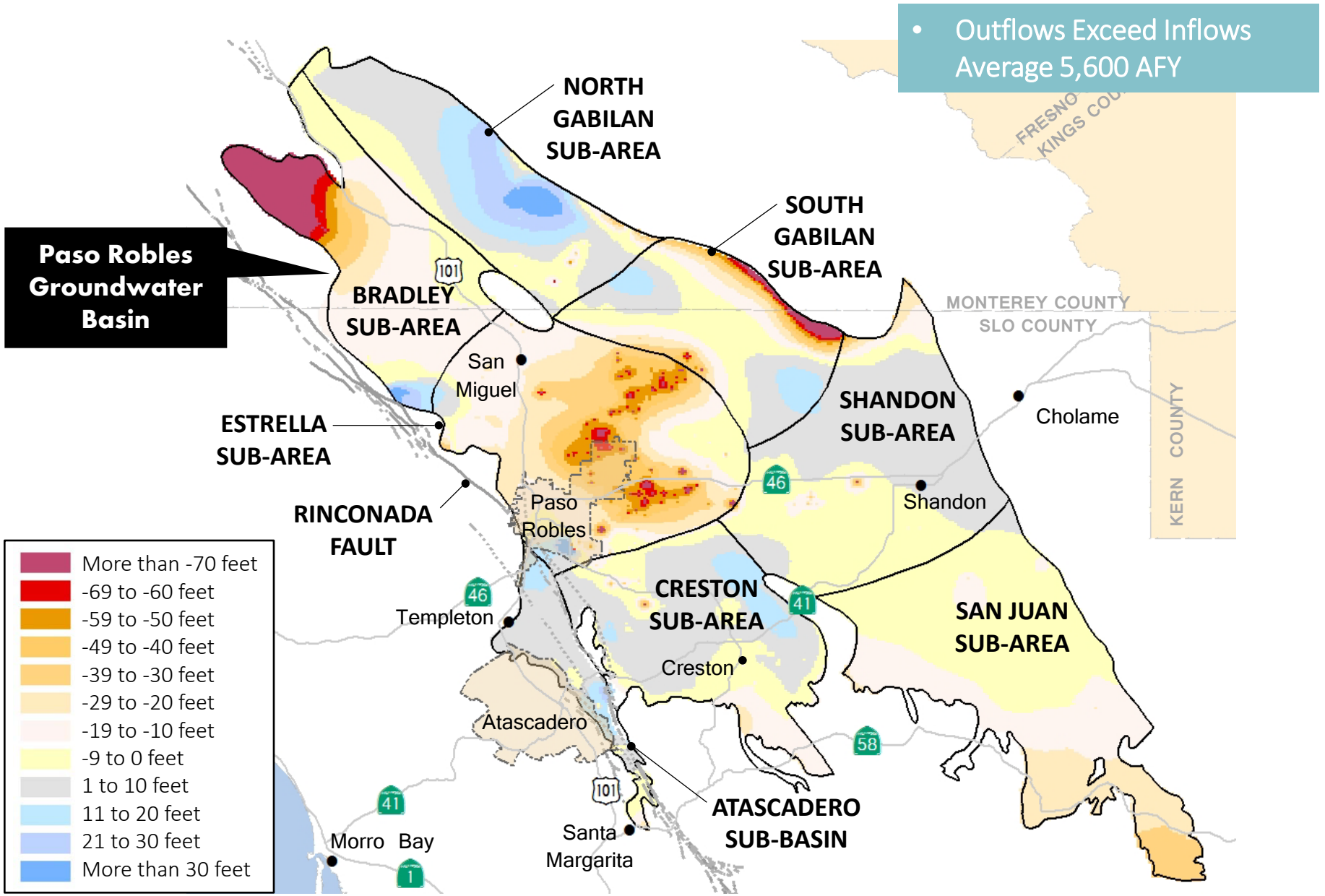
Assumptions Used for Predictive Model Runs

Model Run	Model Simulated Period	Hydrology	Nacimiento Water Project Deliverables	Water Demand
Run 1 No-Growth	2012-2040	1982-2010	2011 (Actual)	2011 (Actual)
Run 2 Growth	2012-2040	1982-2010	2012-2040 (Projected)*	1% Increase per Year

* Includes actual NWP deliverables for 2012

Change in Layer 4 Groundwater Elevations (2012-2040)
Model Run 1 – Baseline with No Growth

- Outflows Exceed Inflows
  Average 5,600 AFY



Change in Layer 4 Groundwater Elevations (2012-2040)
Model Run 2 – Baseline with Growth

- Outflows Exceed Inflows Average 26,200 AFY

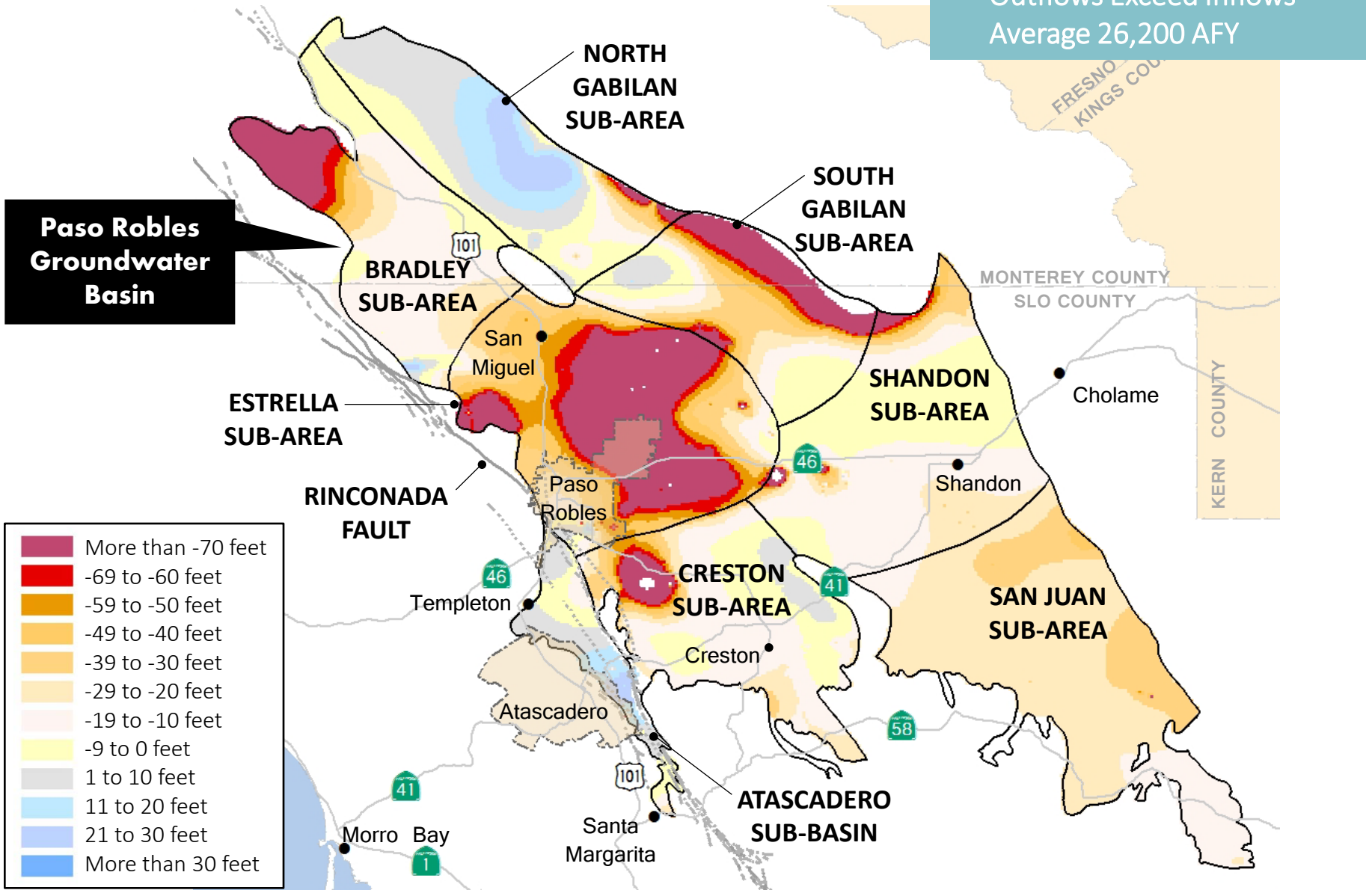
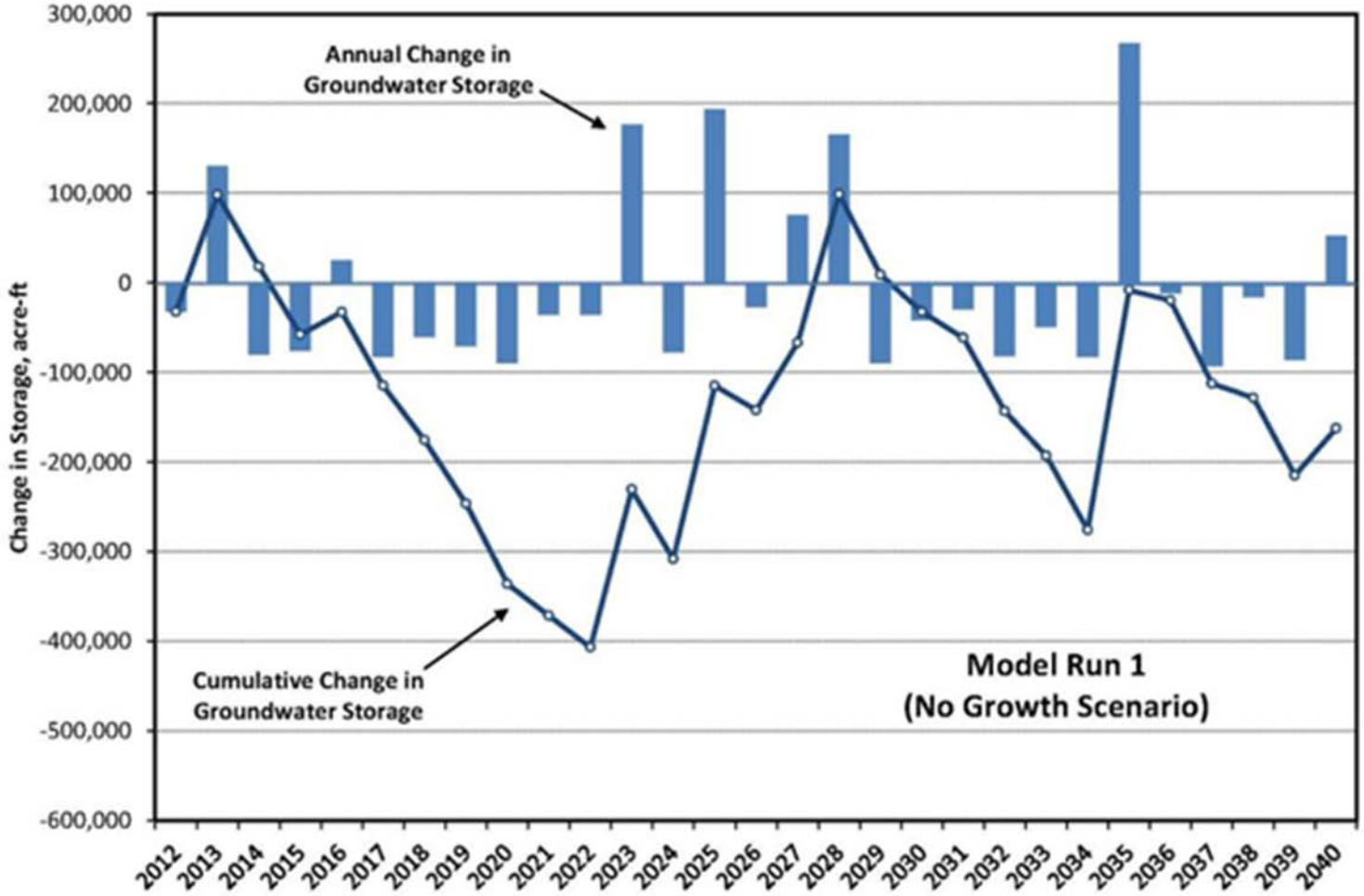
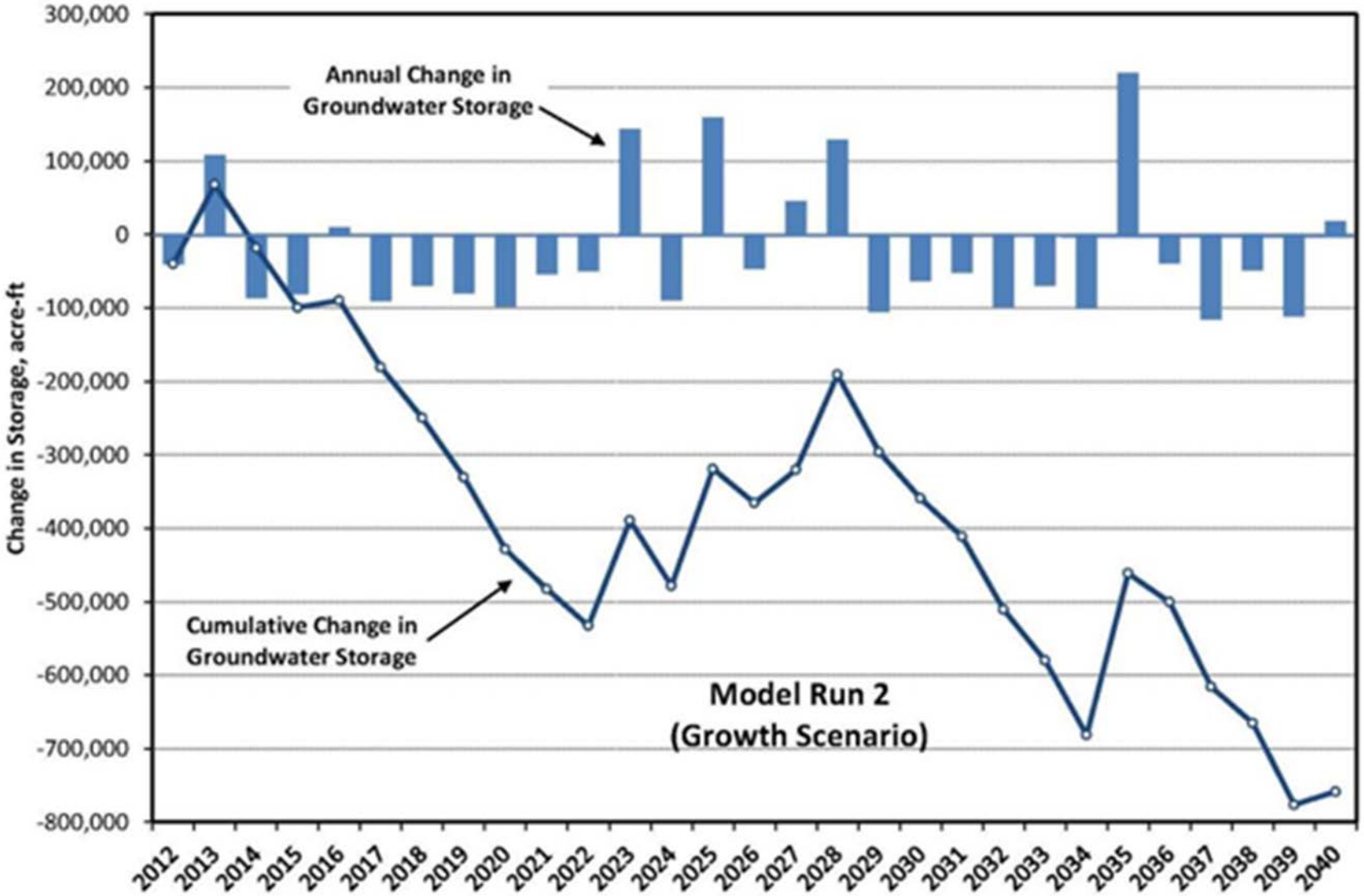


Figure ES-7. Predicted Annual and Cumulative Change in Storage for Paso Robles Groundwater Basin Model Runs 1 and 2 (Water Years 2012-2040)




300,000
200,000
100,000
0
-100,000
-200,000
-300,000
-400,000
-500,000
-600,000
-700,000
-800,000
Change in Storage, acre-ft
Annual Change in Groundwater Storage
Cumulative Change in Groundwater Storage
Model Run 2
(Growth Scenario)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040

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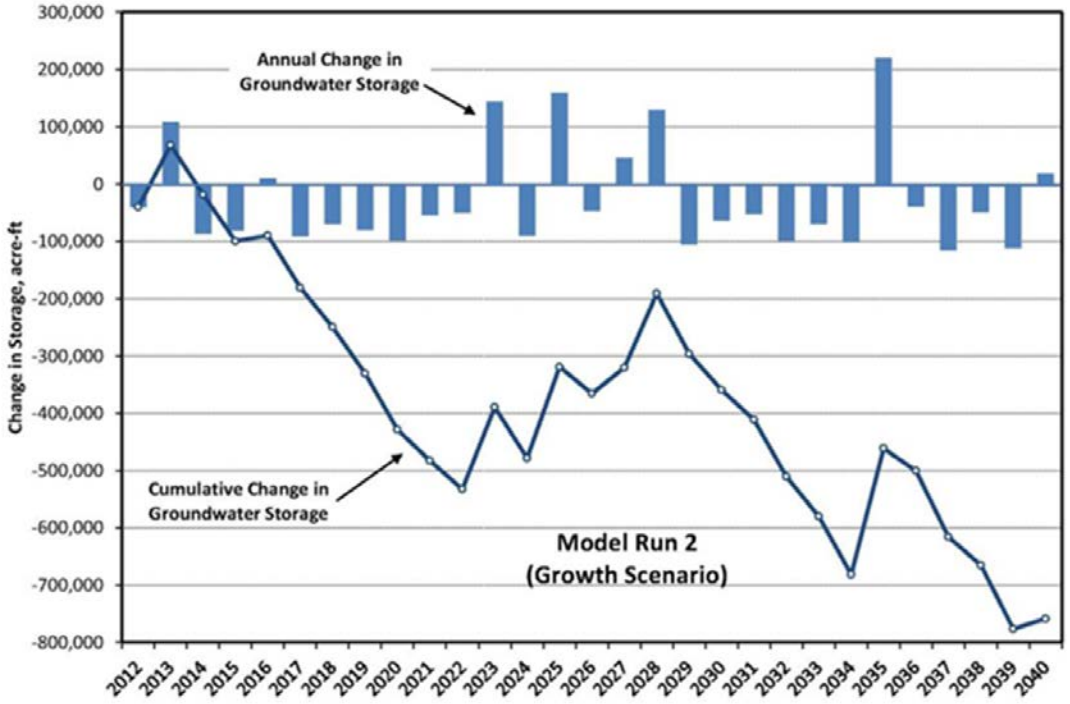
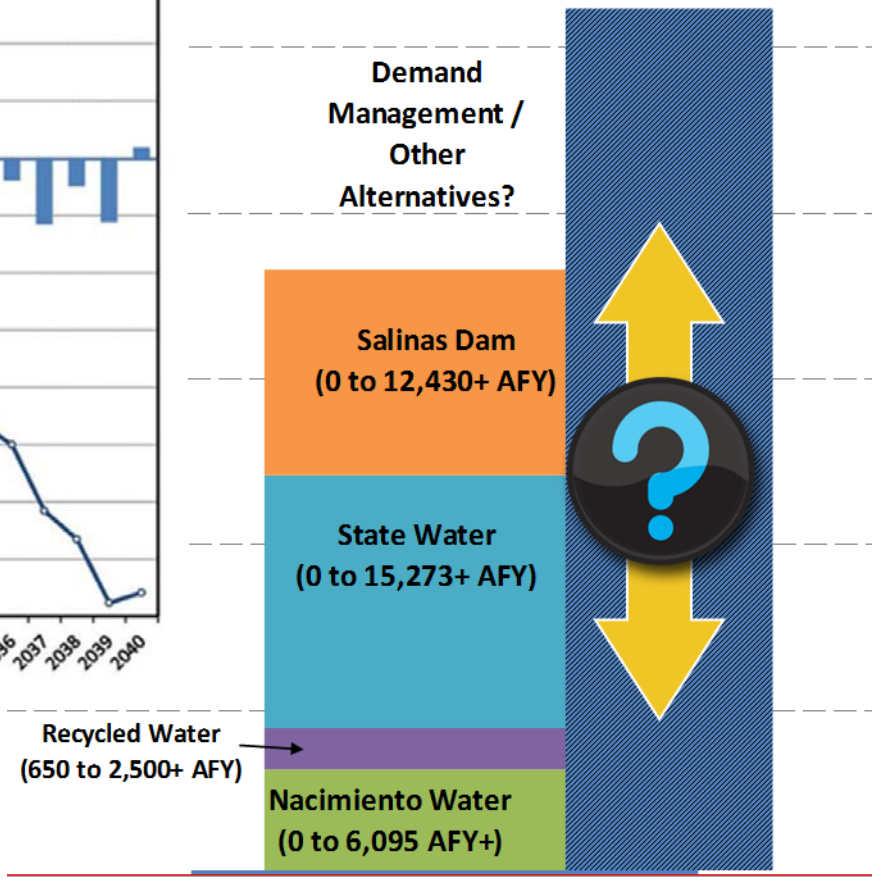
Next Step

Perform additional predictive scenarios

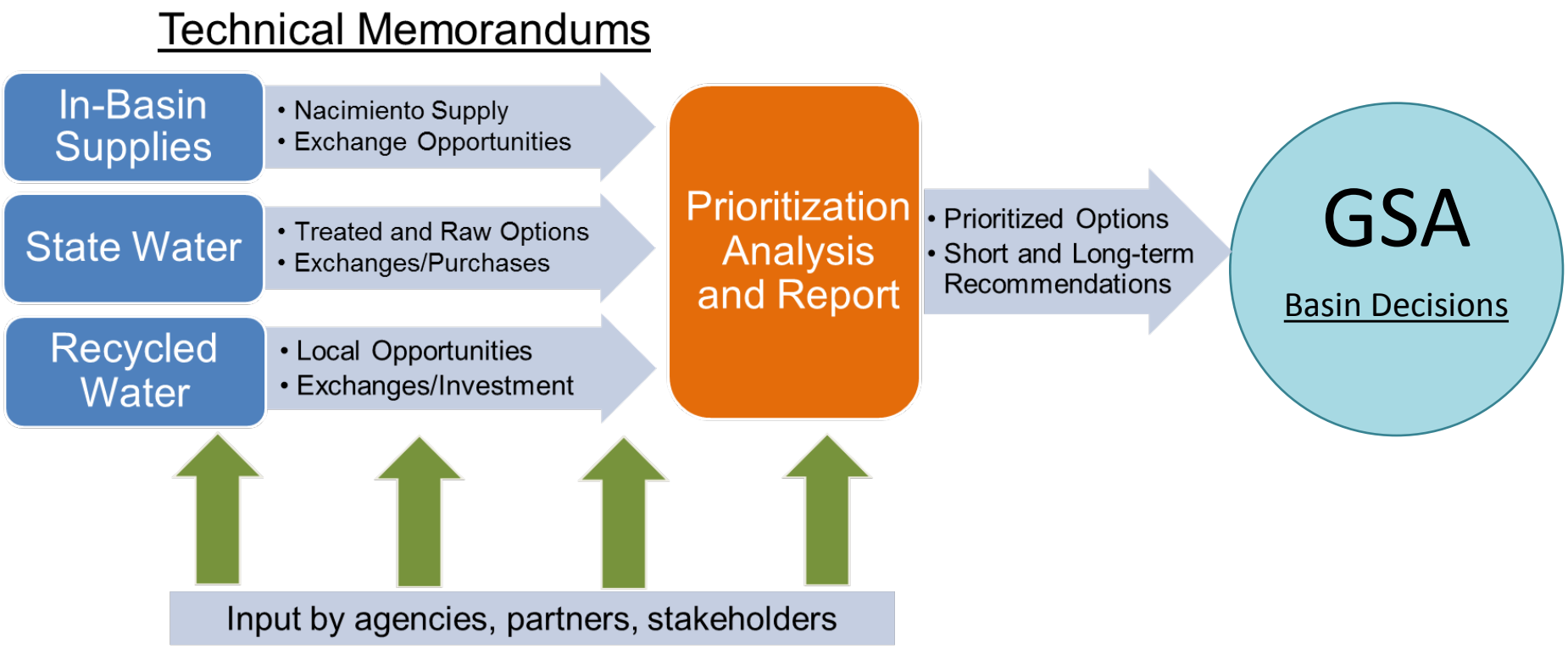
- Analysis 1 – Demand Reduction Scenario
- Analysis 2 – Salinas River Recharge
- Analysis 3 – Offset Basin Pumping with Recycled Water
- Analysis 4 – Offset Water Demand in Estrella Sub-Area
- Analysis 5 – Additional Releases to Huer Huero Creek
- Analysis 6 – Additional Releases to Estrella Creek
- Analysis 7 – Offset Pumping in Creston Sub-Area with Supplemental Water
- Analysis 8 – Offset Pumping in Shandon Sub-Area with Supplemental Water

Supply Options Study

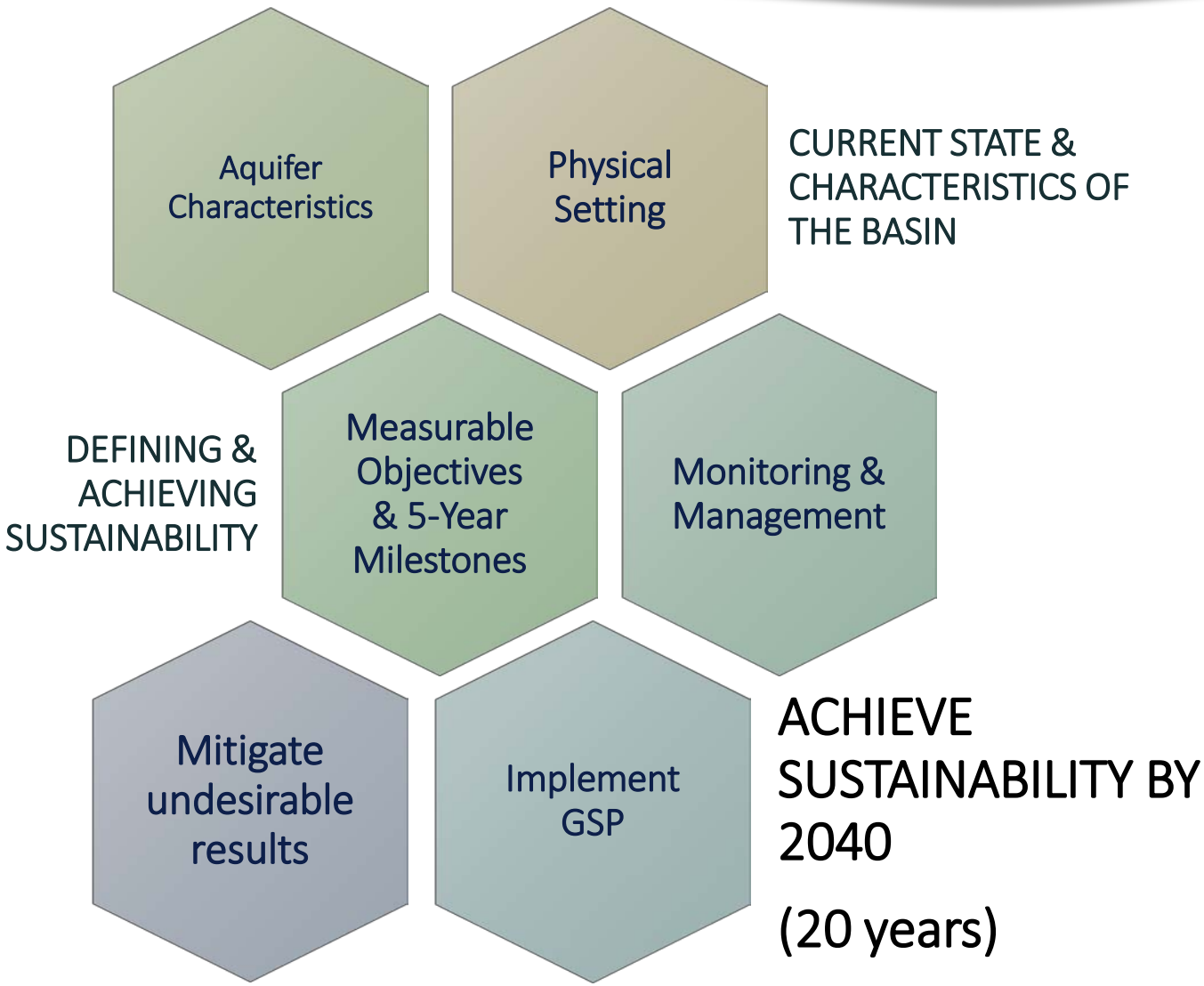




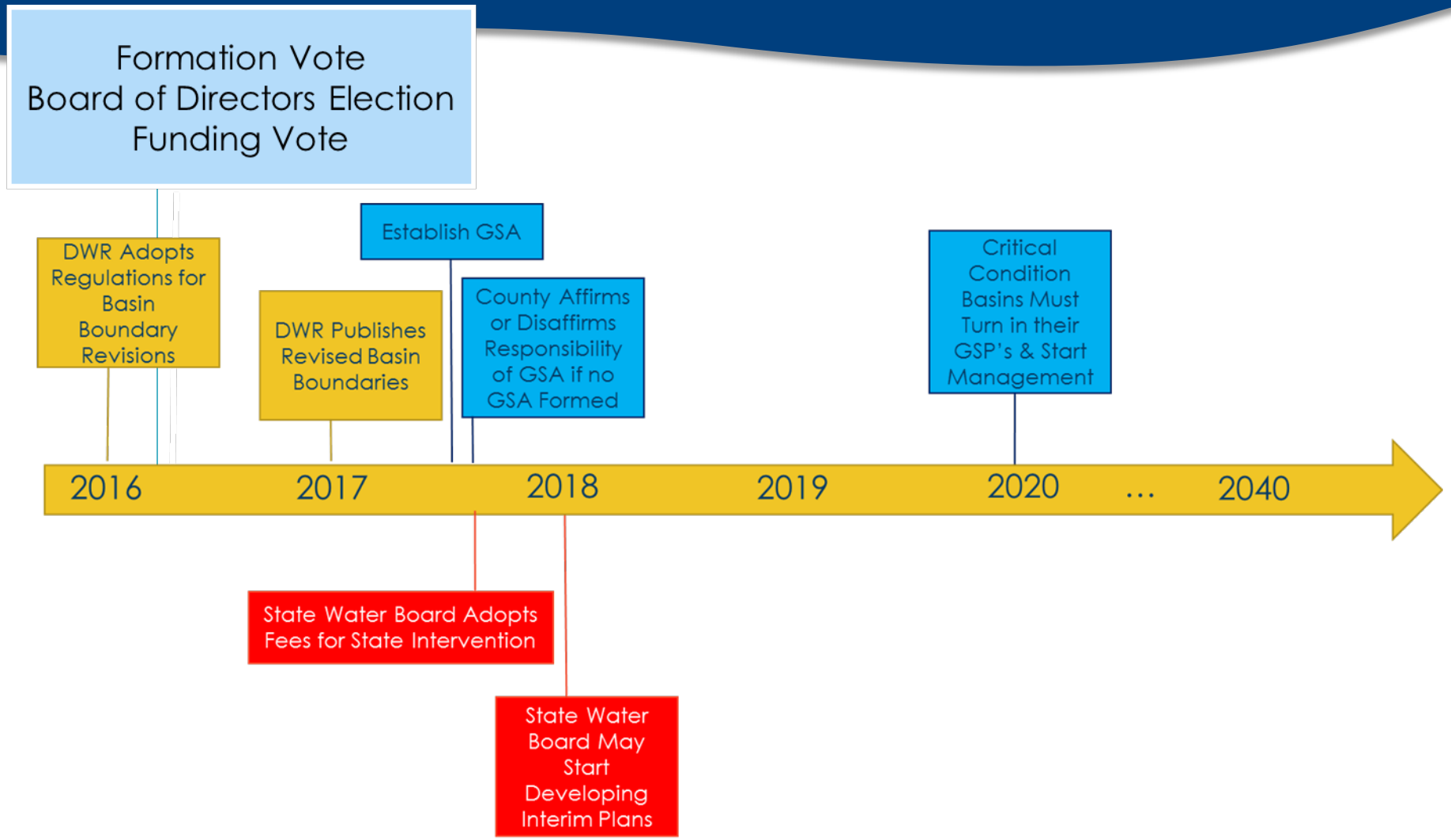
Supply Options Study



Groundwater Sustainability Plan



Timing Considerations



QUESTIONS?