Santa Cruz Water Commission

Aquifer Storage and Recovery Project
Phase 1 Investigation Update

City of Santa Cruz Water Department

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

Outline

- Phase 1 Feasibility Investigation Status
- Groundwater Modeling
  - Overview
  - Scenario Descriptions
  - Results for Key Scenarios
  - Summary of Key Findings
  - Potential Future Scenarios
- Water Supply Advisory Committee Performance Metrics Update
- Next Steps
- Q & A

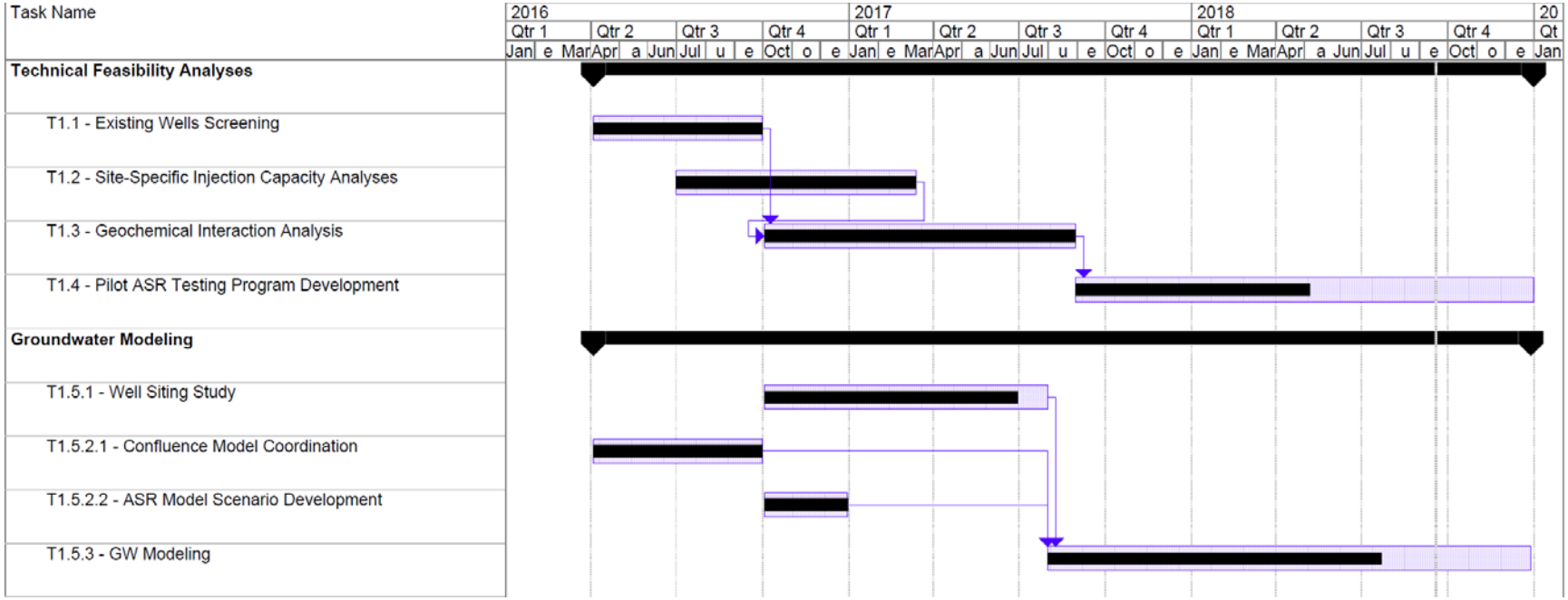
Phase 1 Technical Feasibility Investigation Primary Purposes

- Validate (and refine) WSAC ASR Recon-Study Findings:
  1. Per-well injection capacities
  2. Geochemical interaction potential
  3. Aquifer storage capacities
  4. Aquifer hydraulic losses
- Develop information needed to scope and budget Phase 2 ASR Pilot Testing

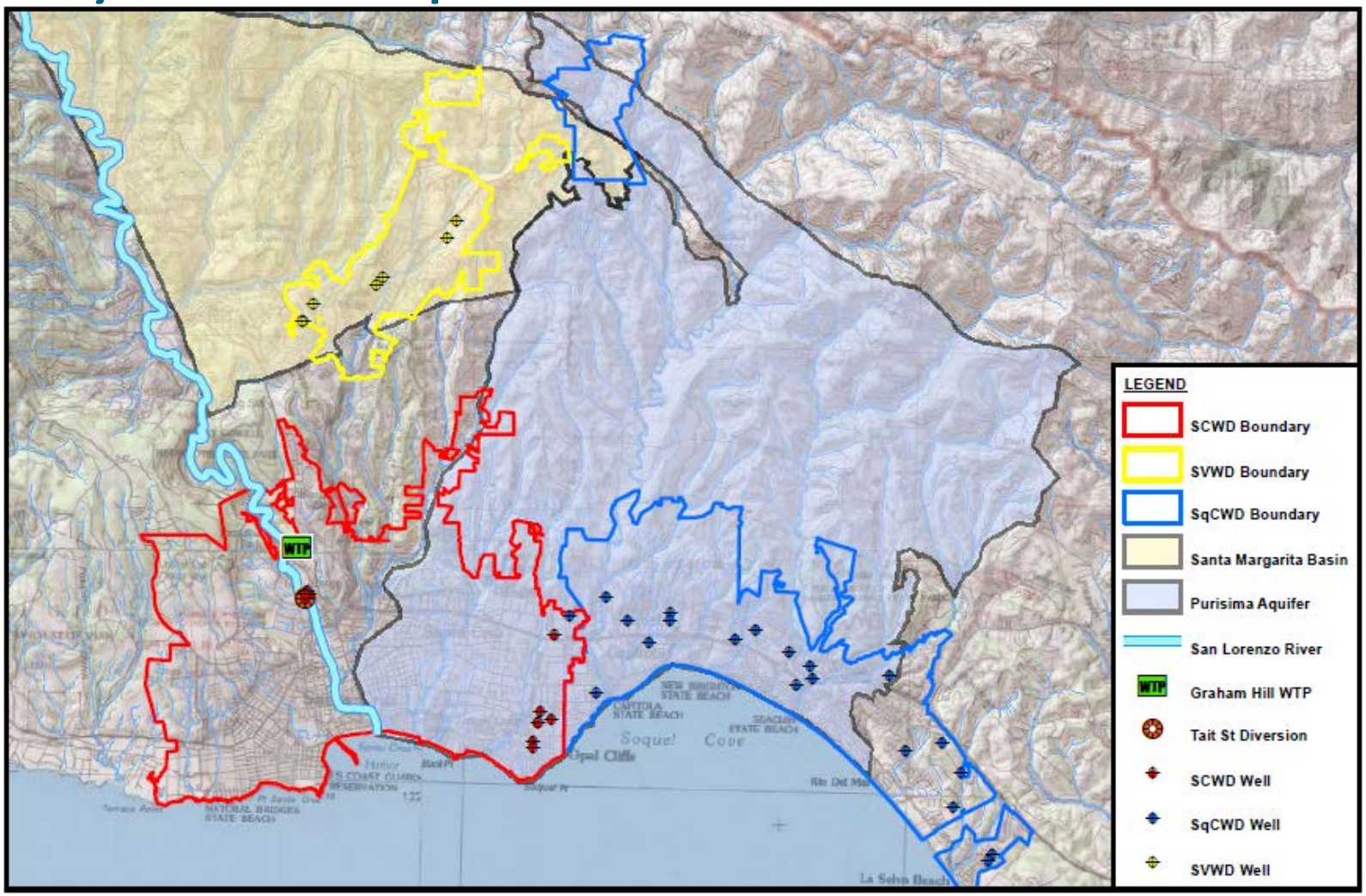
Phase 1 Technical Feasibility Investigation Current Status

- Technical Feasibility Analysis Tasks:
  1. ID Existing Wells for ASR Pilot Testing - COMPLETE
  2. Site-Specific Injection Capacity Analyses - COMPLETE
  3. Geochemical Interaction Evaluation - COMPLETE
  4. Phase 2 ASR Pilot Test Work Plans – **PARTIALY COMPLETE**
- Groundwater Modeling Tasks
  1. New ASR Well Siting Studies – COMPLETE
  2. Groundwater Modeling – **PARTIALY COMPLETE**

Phase 1 Technical Feasibility Investigation Current Schedule



Groundwater Modeling Study Area Map



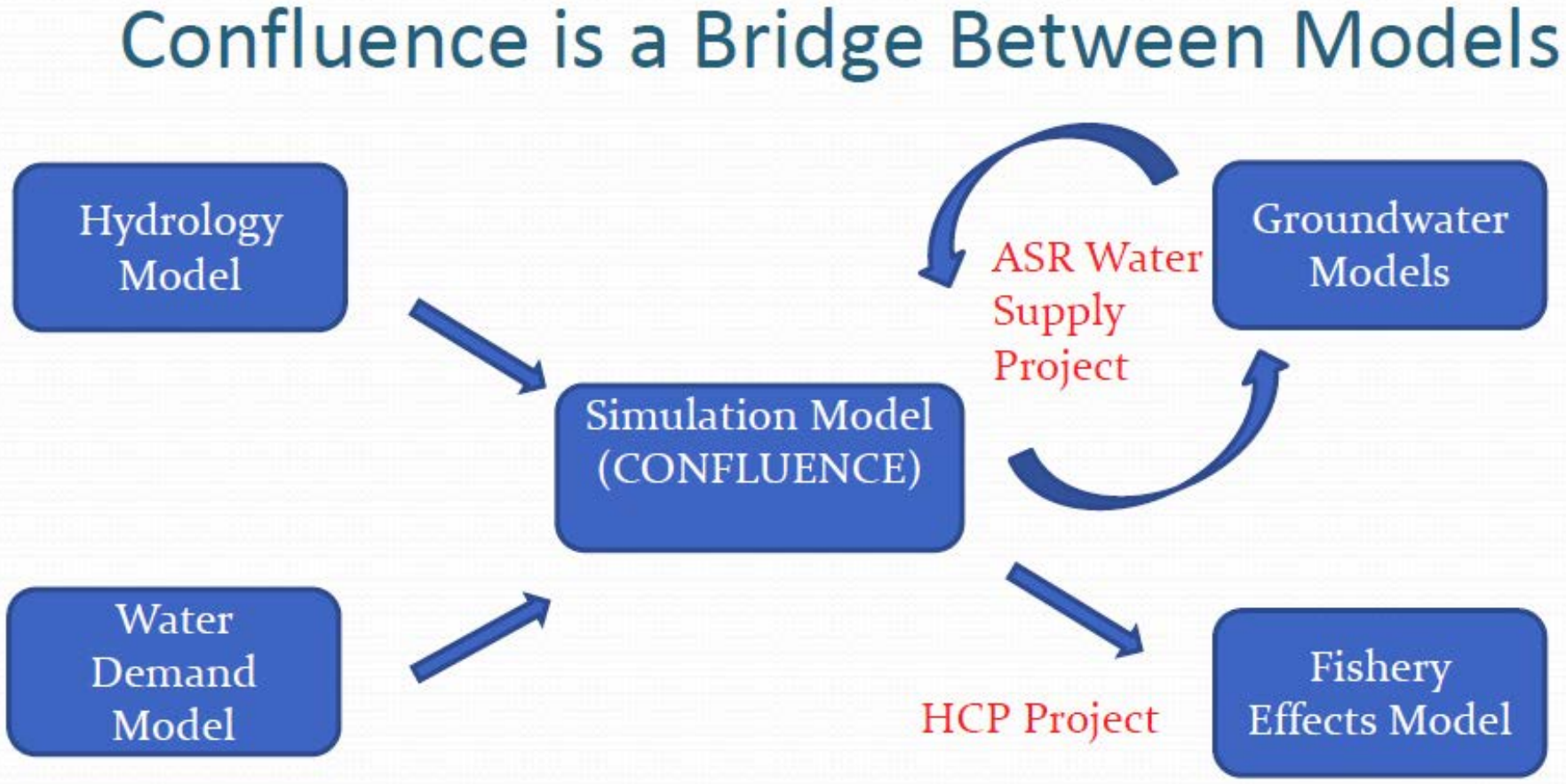
Groundwater Modeling

- **Overview**
  - **Two independent models:**
    - Santa Margarita Groundwater Basin (SMGB)
    - Santa Cruz Mid-County Groundwater Basin (MGB)
  - **Both utilize USGS MODFLOW code**
  - **Calibrated against historical based periods of 1985 – 2015**

Groundwater Modeling

- **Primary Purpose – Validate WSAC Assumptions regarding feasibility of ASR**
  - **GW Basin Storage Capacities (3 bg combined)**
  - **Storage Losses (20%)**
  - **Per-Well Injection Rates (0.3 - 0.5 mgd avg)**

Model Scenario Development

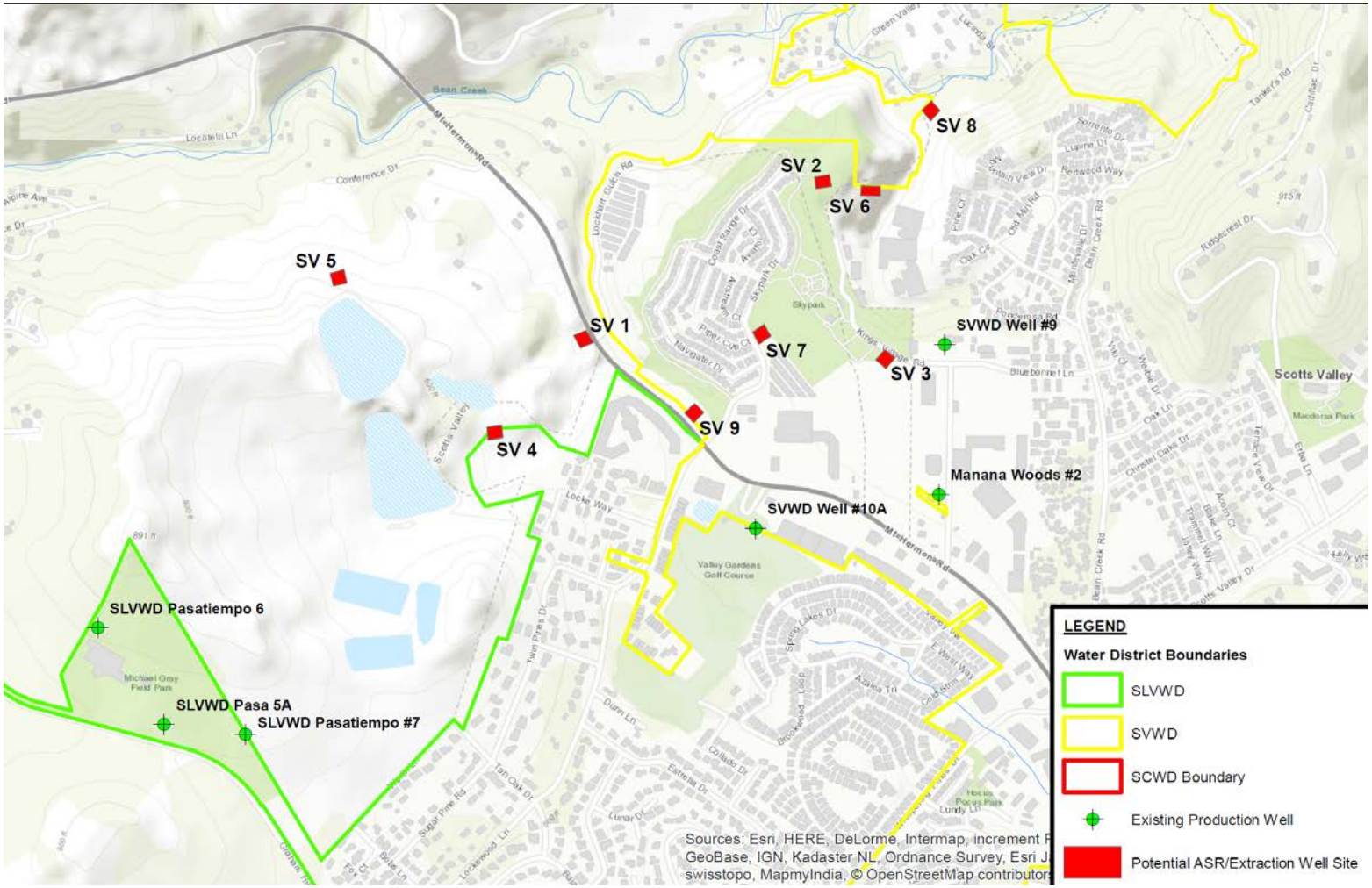


Confluence Modeling Results: Infrastructure Requirements

		BASE ASSUMPTIONS	HISTORICAL FLOWS			CLIMATE CHANGE		
			1. In-Lieu	2. ASR	3. In-Lieu/ ASR	4. In-Lieu	5. ASR	6. In-Lieu/ ASR
Infrastructure & Water Rights	Fill	N/A	Direct Felton Diversion	Direct Felton Diversion	Direct Felton Diversion	Direct Felton Diversion	Direct Felton Diversion	Direct Felton Diversion
			N/A	5.5 mgd injection	1.5 mgd injection	N/A	6.0 mgd injection	2.0 mgd injection
	Drawdown	N/A	4.0 mgd extraction	4.0 mgd extraction	4.0 mgd extraction	4.0 mgd extraction	6.0 mgd extraction	6.5 mgd extraction
Water Supply Reliability	Worst-Year PS Shortage (mg)	Historical: 1380 Clim Chg: 1230	400	0	0	470	0	0
	Two-Year PS Shortage (mg)	Historical: 1850 Clim Chg: 2310	400	0	0	470	0	0

Source: Table 8, Fiske Technical Memorandum dated 3/8/17

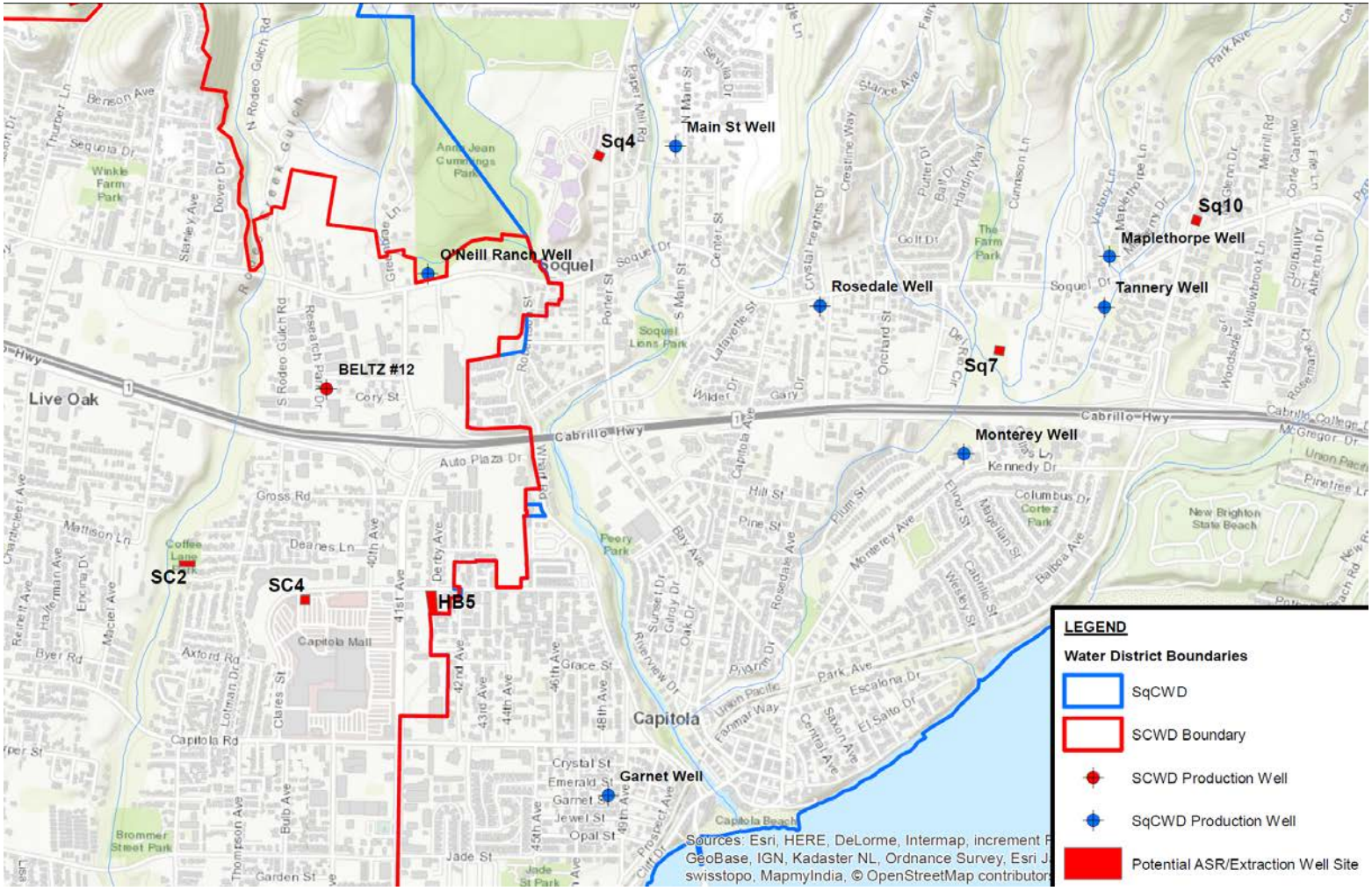
Simulated ASR/Recovery Wells SMGB



Simulated ASR/Recovery Wells SMGB

Well ID	Target Aquifer	Estimated Capacities			
		Injection		Production	
		(gpm)	(mgd)	(gpm)	(mgd)
SV-1	Tlo	150	0.22	750	1.0
SV-2	Tlo	205	0.30	750	1.0
SV-3	Tlo	200	0.29	750	1.0
SV-4	Tlo	435	0.63	750	1.0
SV-5	Tlo	250	0.36	750	1.0
SV-6	Tlo	195	0.28	750	1.0
SV-7	Tlo	205	0.30	750	1.0
SV-8	Tlo	230	0.33	750	1.0
SV-9	Tlo	210	0.30	750	1.0
	Subtotals	**2080**	**3.00**	**6750**	**9.0**

Simulated ASR/Recovery Wells MCGB



Simulated ASR/Recovery Wells MCGB

Well ID	Target Aquifer	Estimated Capacities			
		Injection		Production	
		(gpm)	(mgd)	(gpm)	(mgd)
HB5	A/AA/Tu	340	0.49	750	1.0
SC2	AA/Tu	245	0.35	750	1.0
SC4	A/AA/Tu	375	0.54	750	1.0
SQ4	AA/Tu	375	0.54	580	0.8
SQ7	A/AA	375	0.54	750	1.0
SQ10	A/AA	375	0.54	750	1.0
	Subtotals	**2085**	**3.00**	**4330**	**5.8**

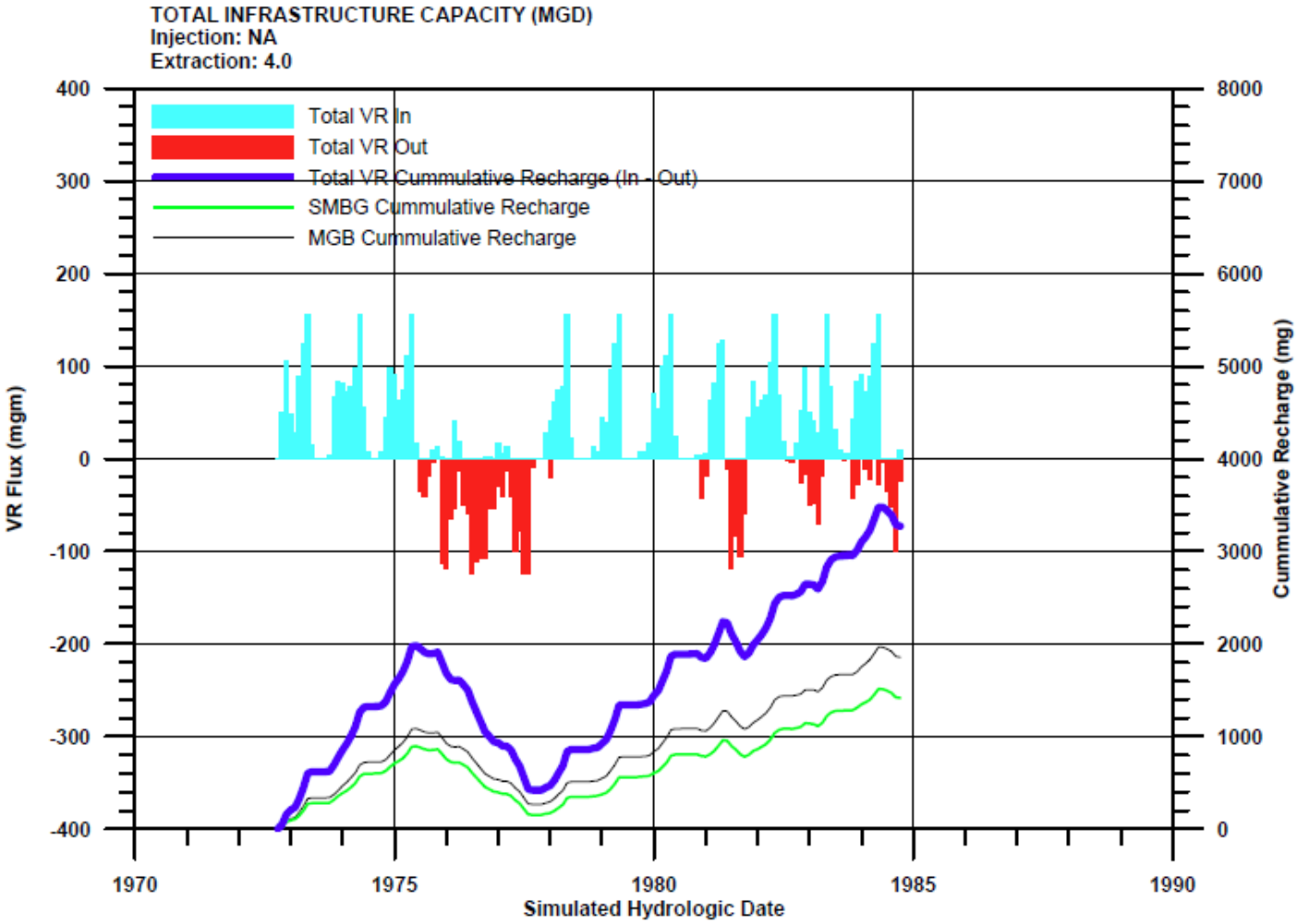
Model Scenario Descriptions

- Scenarios 1 – 3: Historical Hydrology of 1985 – 2015
  - In-Lieu Only (Scenario 1)
  - ASR Only (Scenario 2)
  - In-Lieu plus ASR (Scenario 3)
- Scenarios 4 – 6: Historical Hydrology of 1973 - 1984
  - In-Lieu Only (Scenario 4)
  - ASR Only (Scenario 5)
  - In-Lieu plus ASR (Scenario 6)
- Scenarios 7 – 9: Climate Change Hydrology of 2020 – 2070
  - In-Lieu Only (Scenario 7)
  - ASR Only (Scenario 8)
  - In-Lieu plus ASR (Scenario 9)

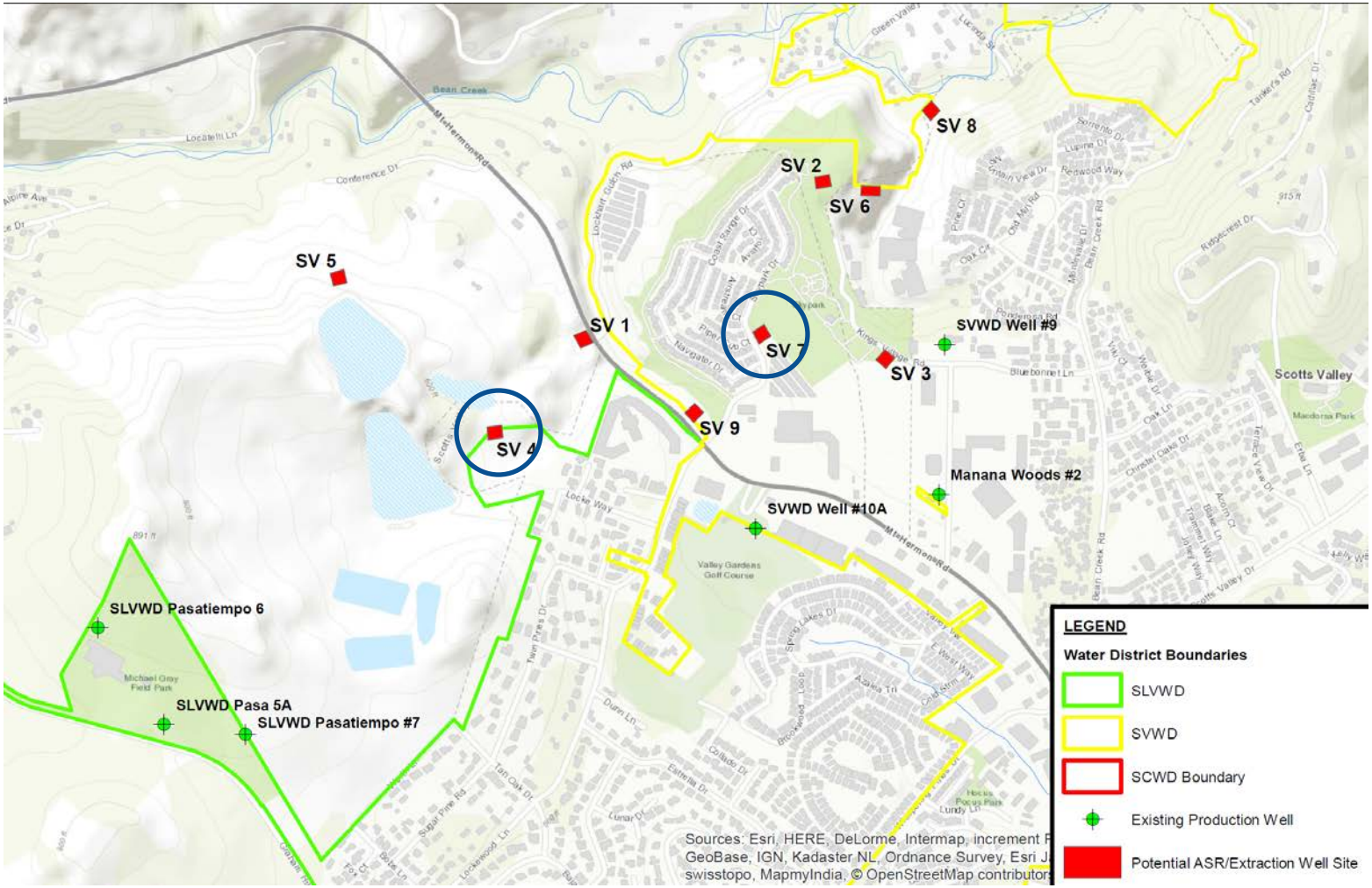
Model Scenarios 4 - 6

- Basic Parameters
  - Historical Climate of 1973 – 1984 (includes the 1976 – 1977 drought conditions)
  - Distribution of Project Flows Between Basins:
    - **Scenario 4 - In-Lieu Only**: Flows distributed proportionally between basins based on relative In-Lieu demands of each District (SqCWD, SVWD and SLVWD)
    - **Scenario 5 - ASR Only:** 50/50 split distribution of flows between basins
    - **Scenario 6 - In-Lieu plus ASR:** In-Lieu flows distributed proportionally, ASR flows 50/50 split distribution

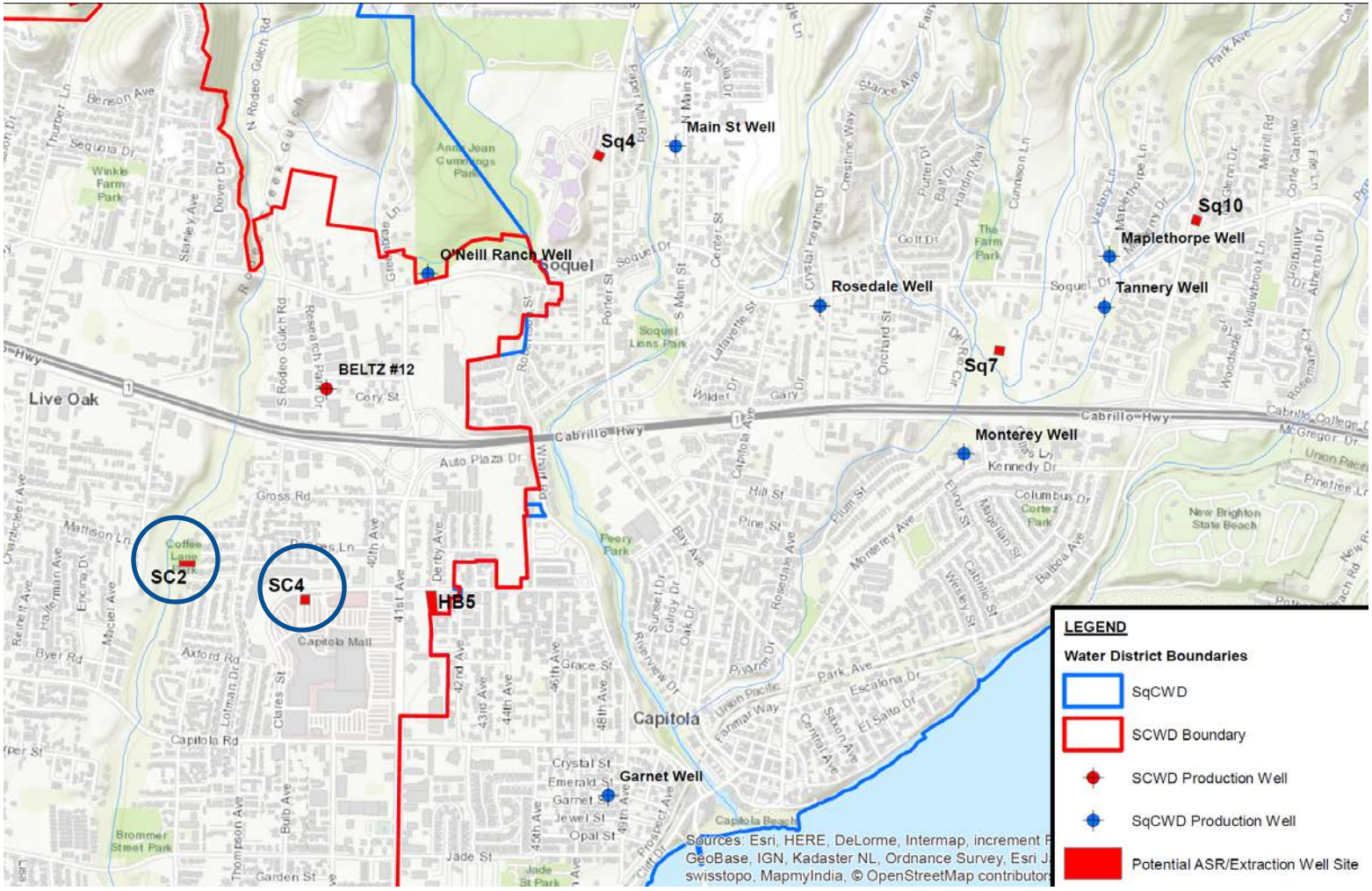
Scenario 4 – In-Lieu Only Results
Recharge – Recovery Flows



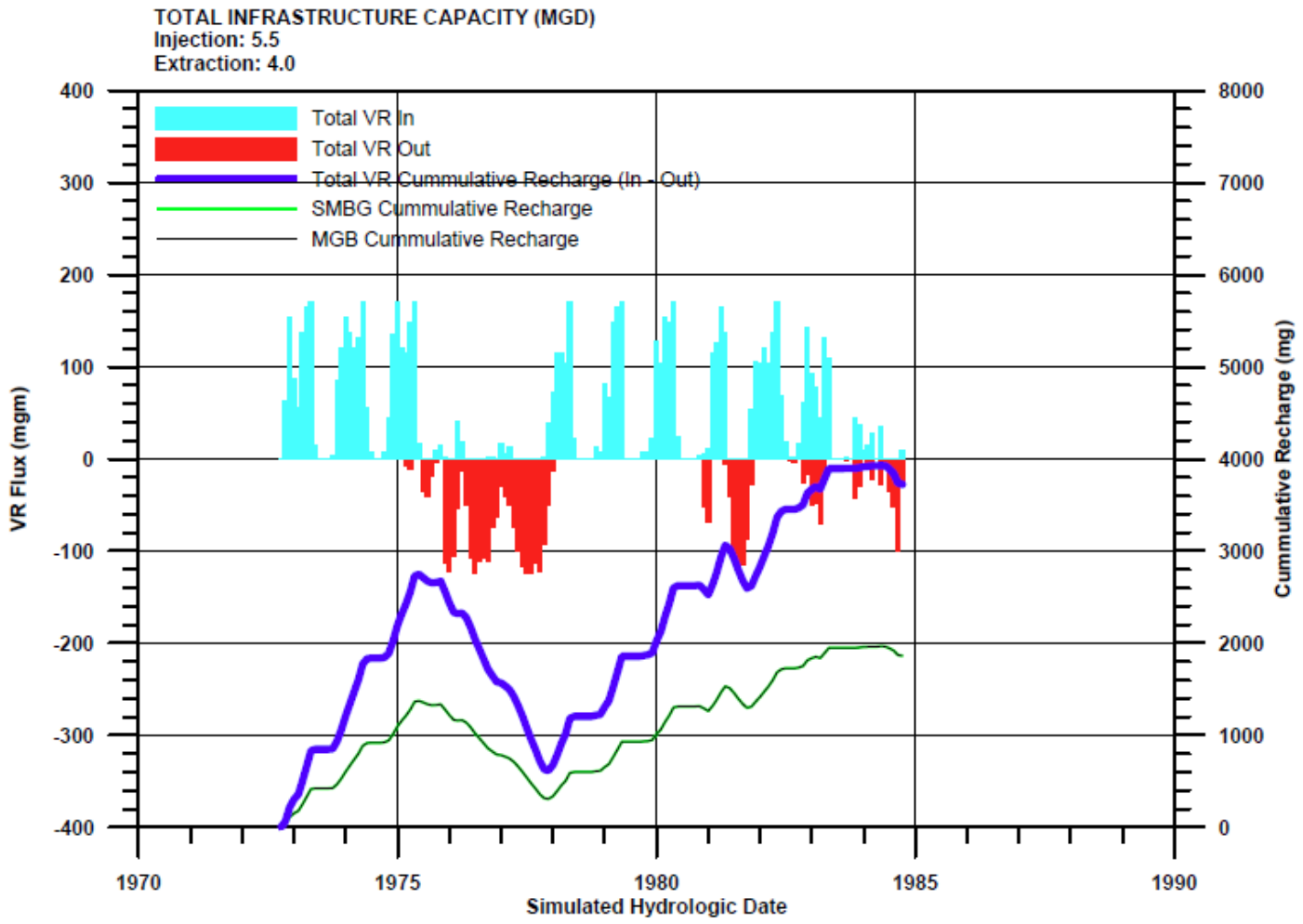
Scenario 4 – In-Lieu Only
Simulated Recovery Wells - SMGB



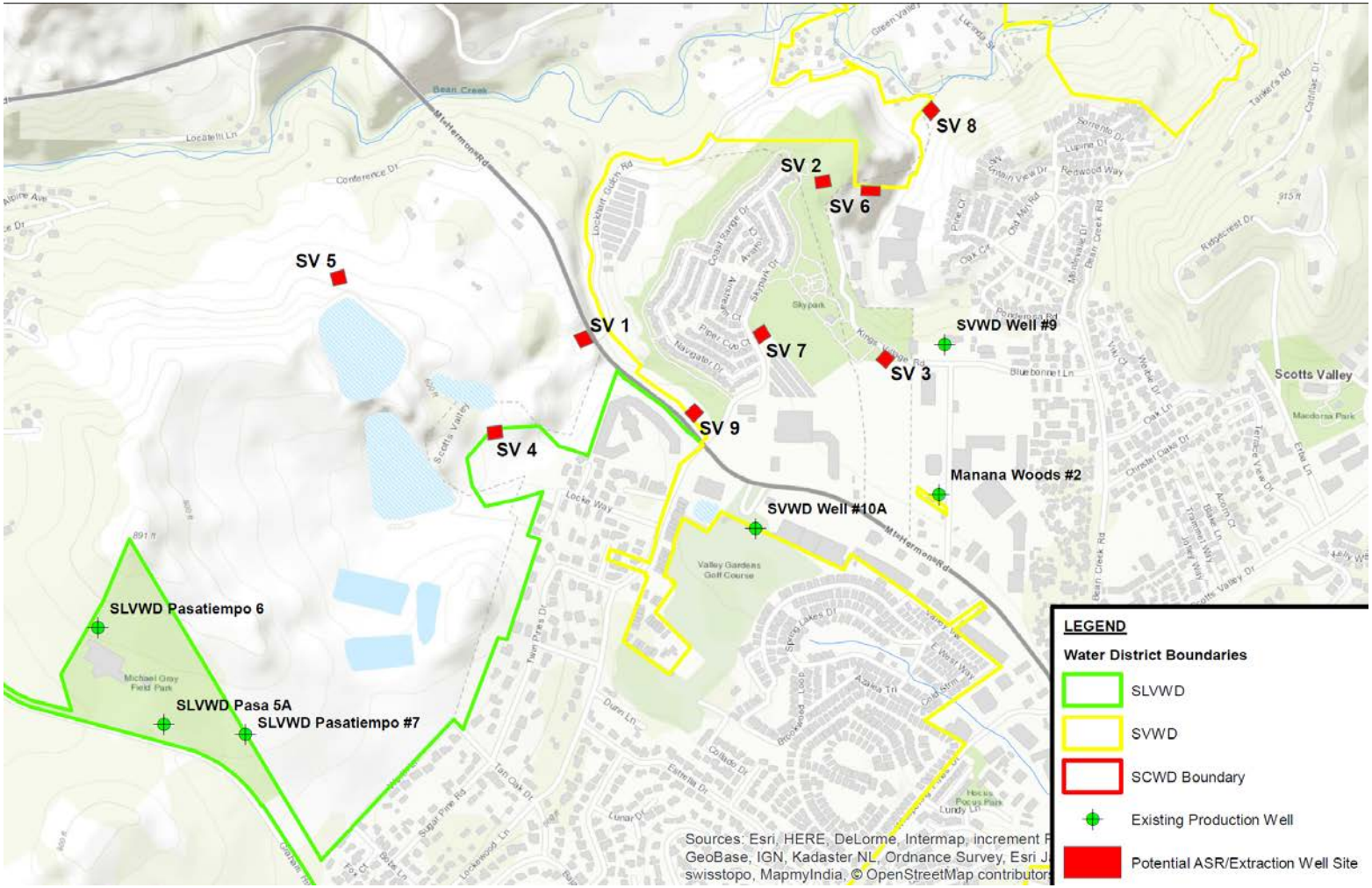
Scenario 4 – In-Lieu Only
Simulated Recovery Wells - MCGB



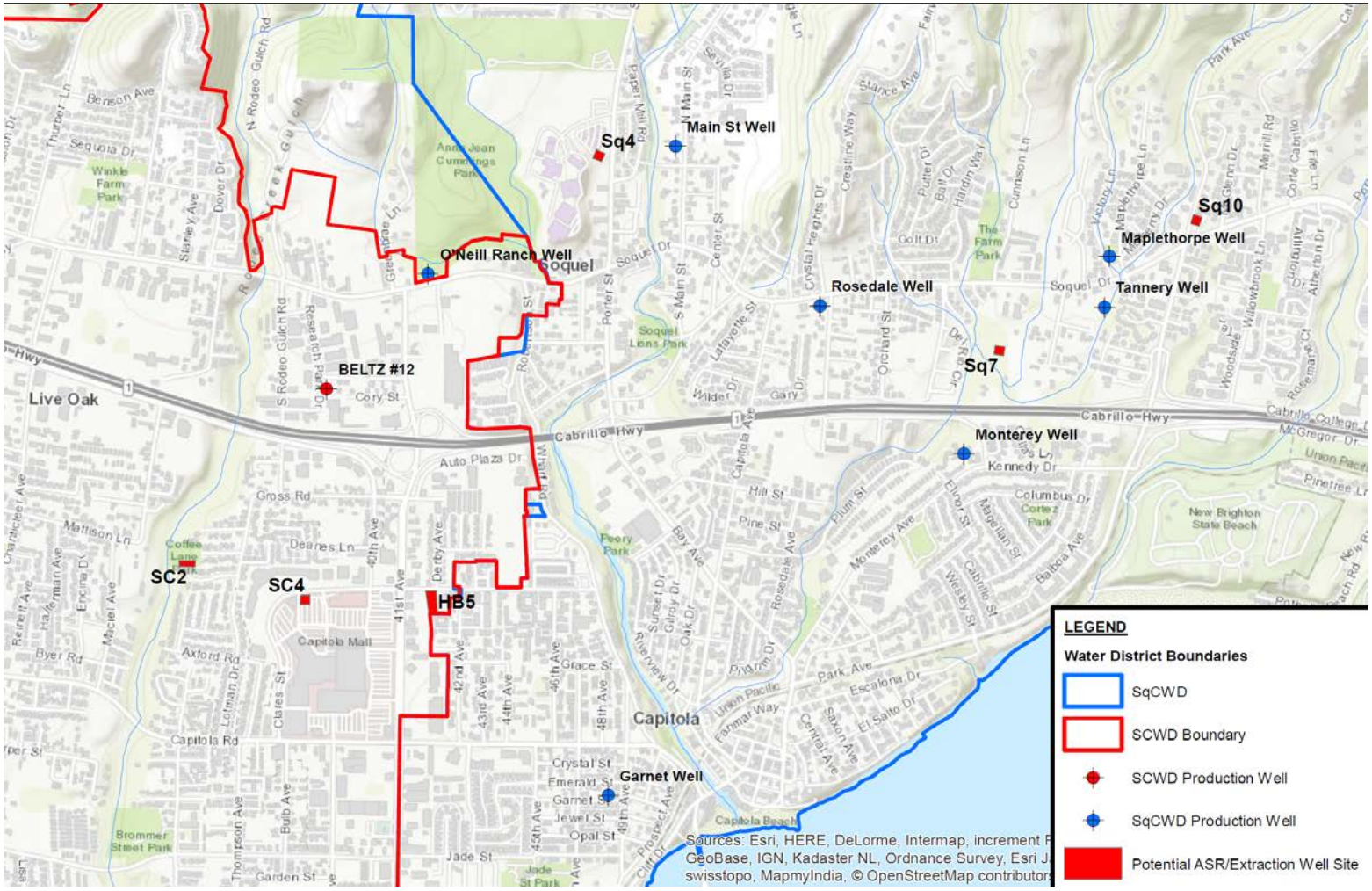
Scenario 5 – ASR Only
Recharge – Recovery Flows



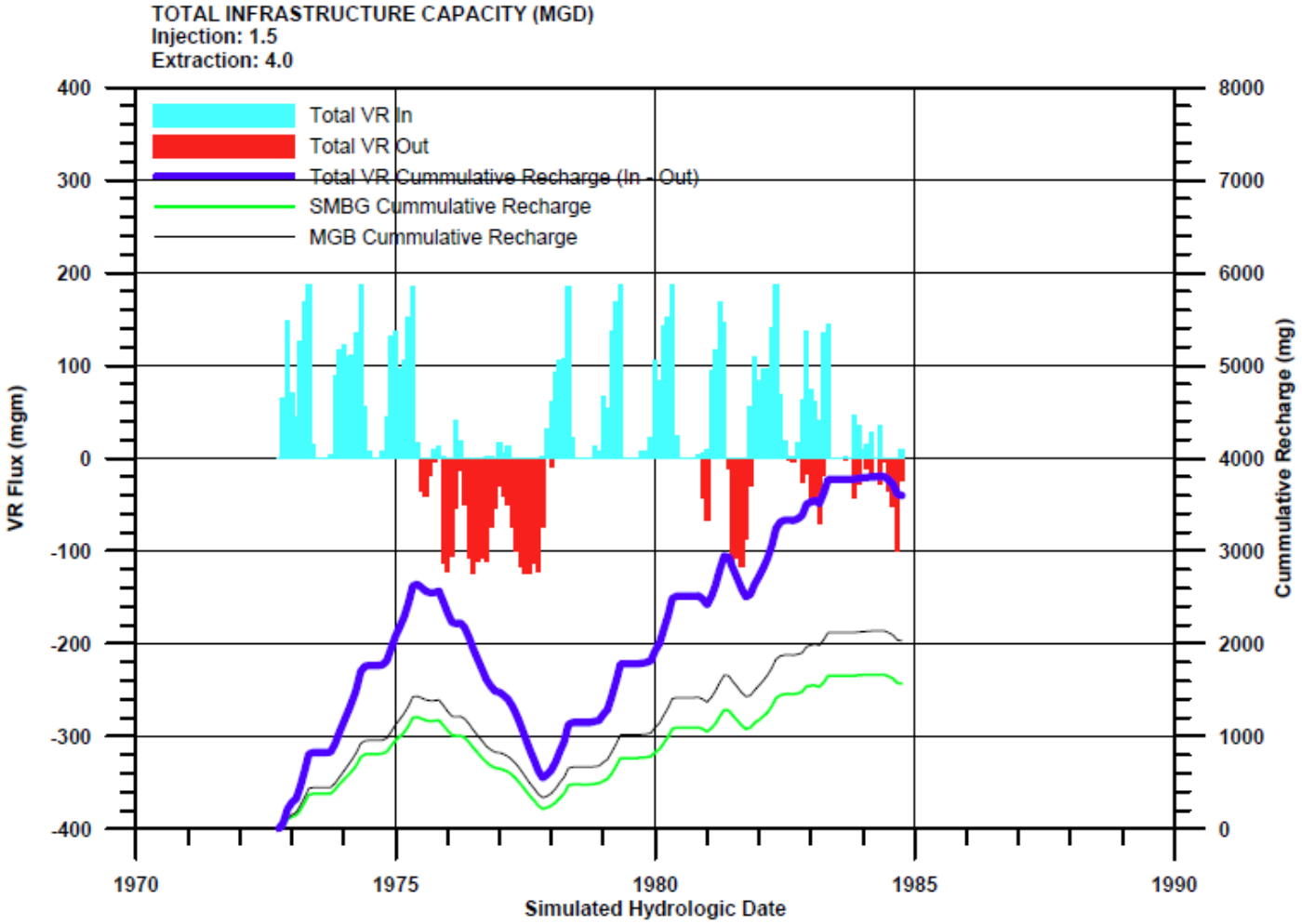
Scenario 5 – ASR Only
Simulated ASR Wells - SMGB



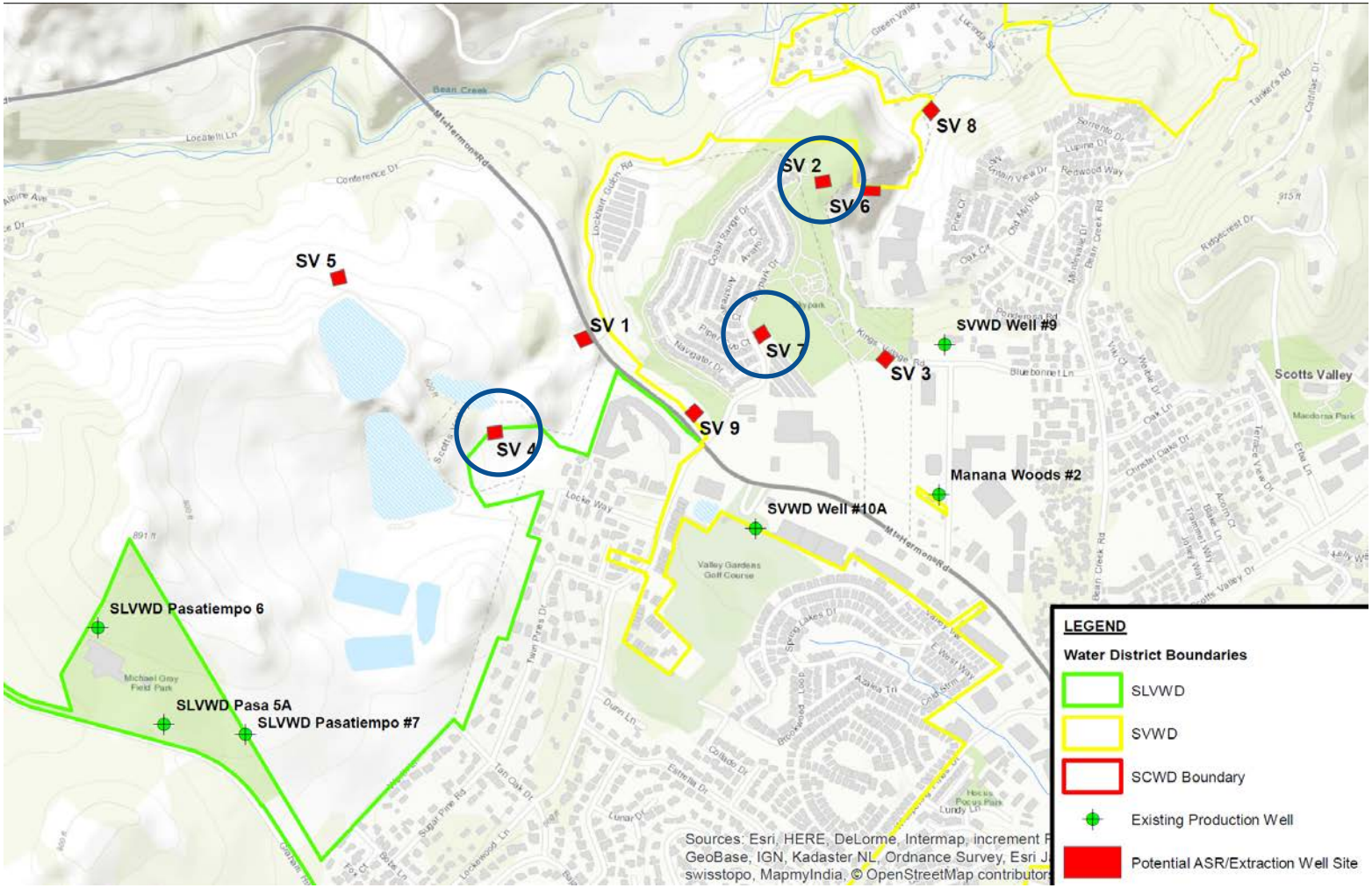
Scenario 5 – ASR Only
Simulated ASR Wells - MCGB



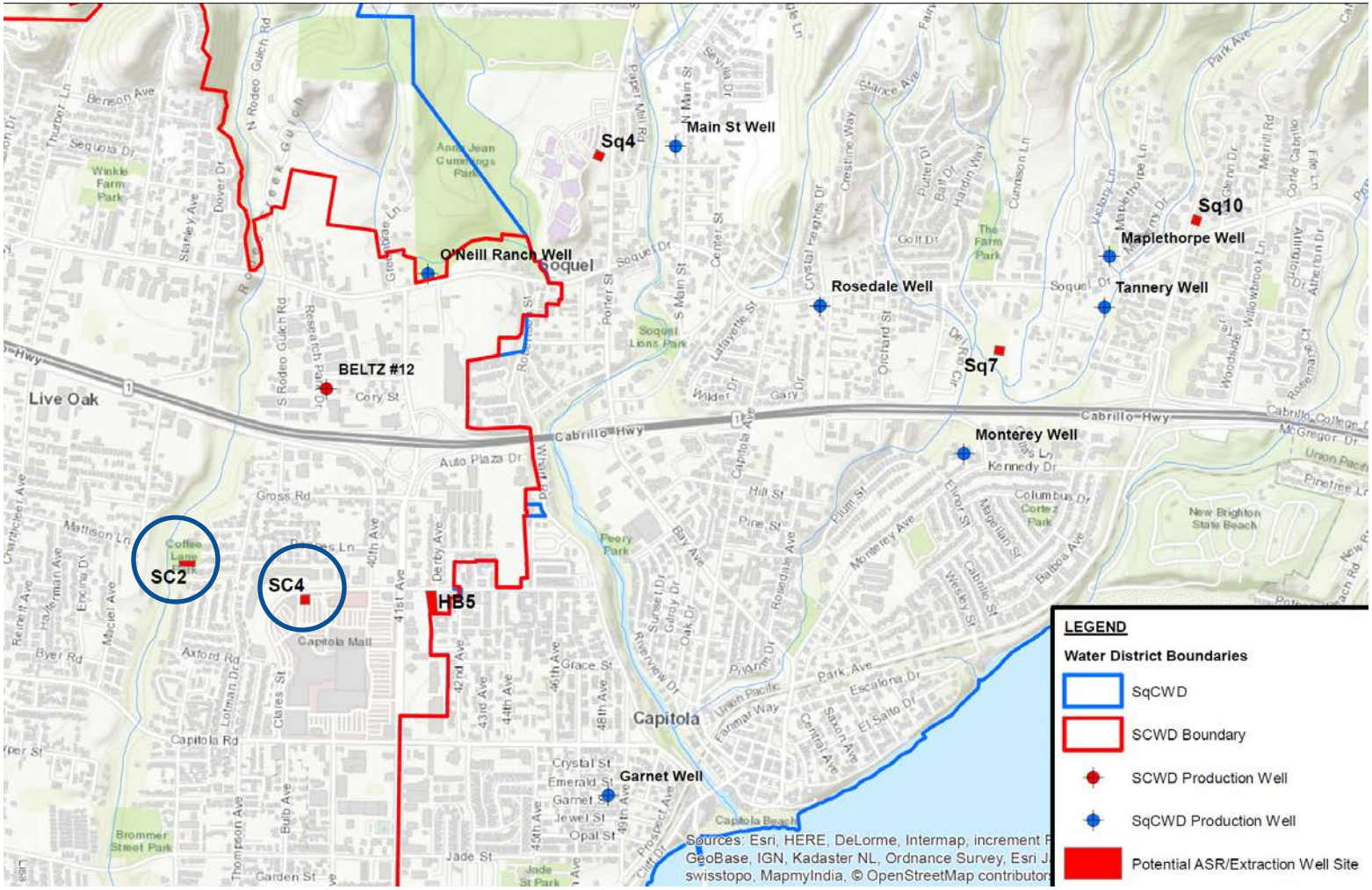
Scenario 6 – In-Lieu plus ASR Recharge – Recovery Flows



Scenario 6 – In-Lieu plus ASR
Simulated ASR Wells - SMGB



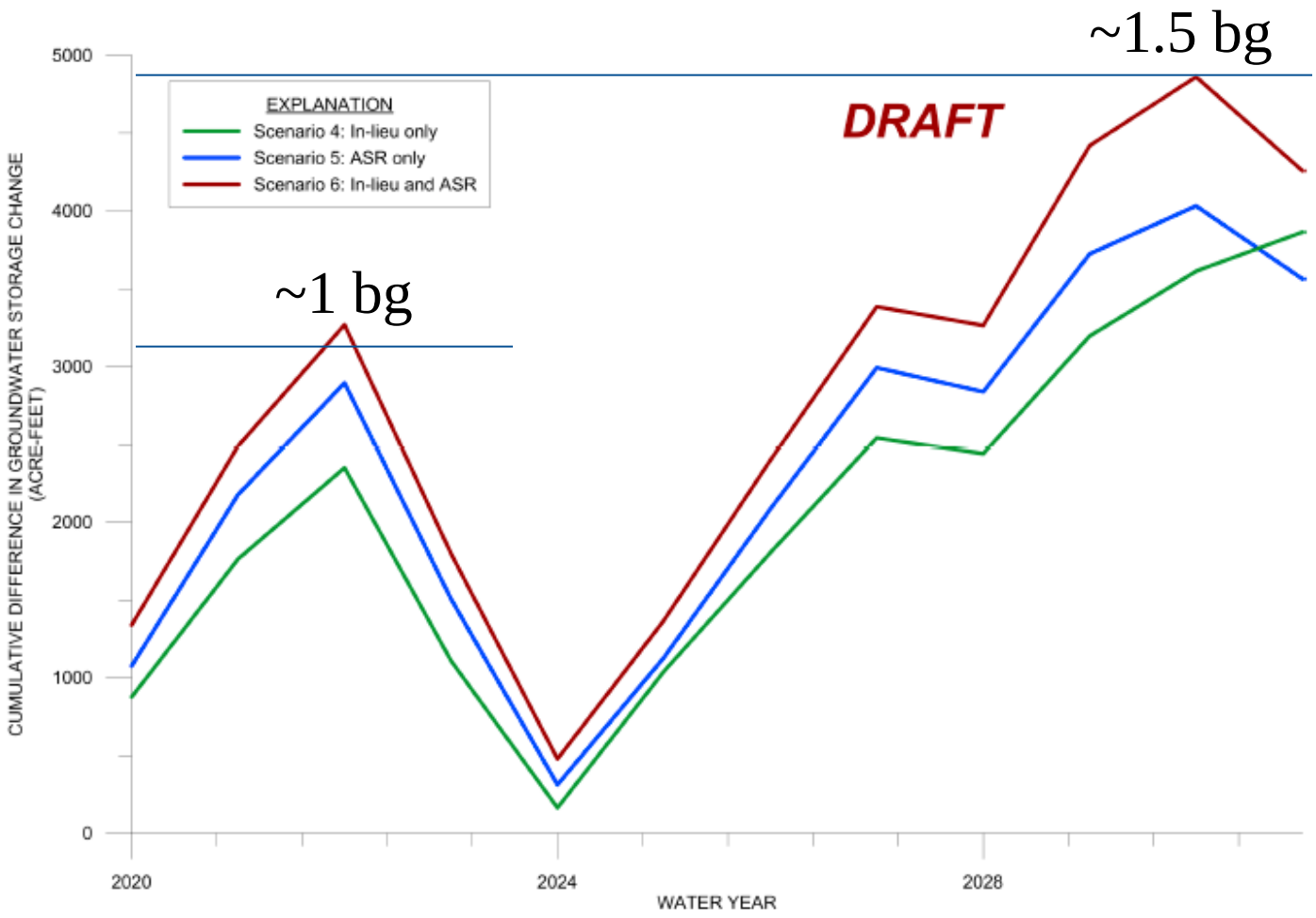
Scenario 6 – In-Lieu plus ASR Simulated ASR Wells - MCGB



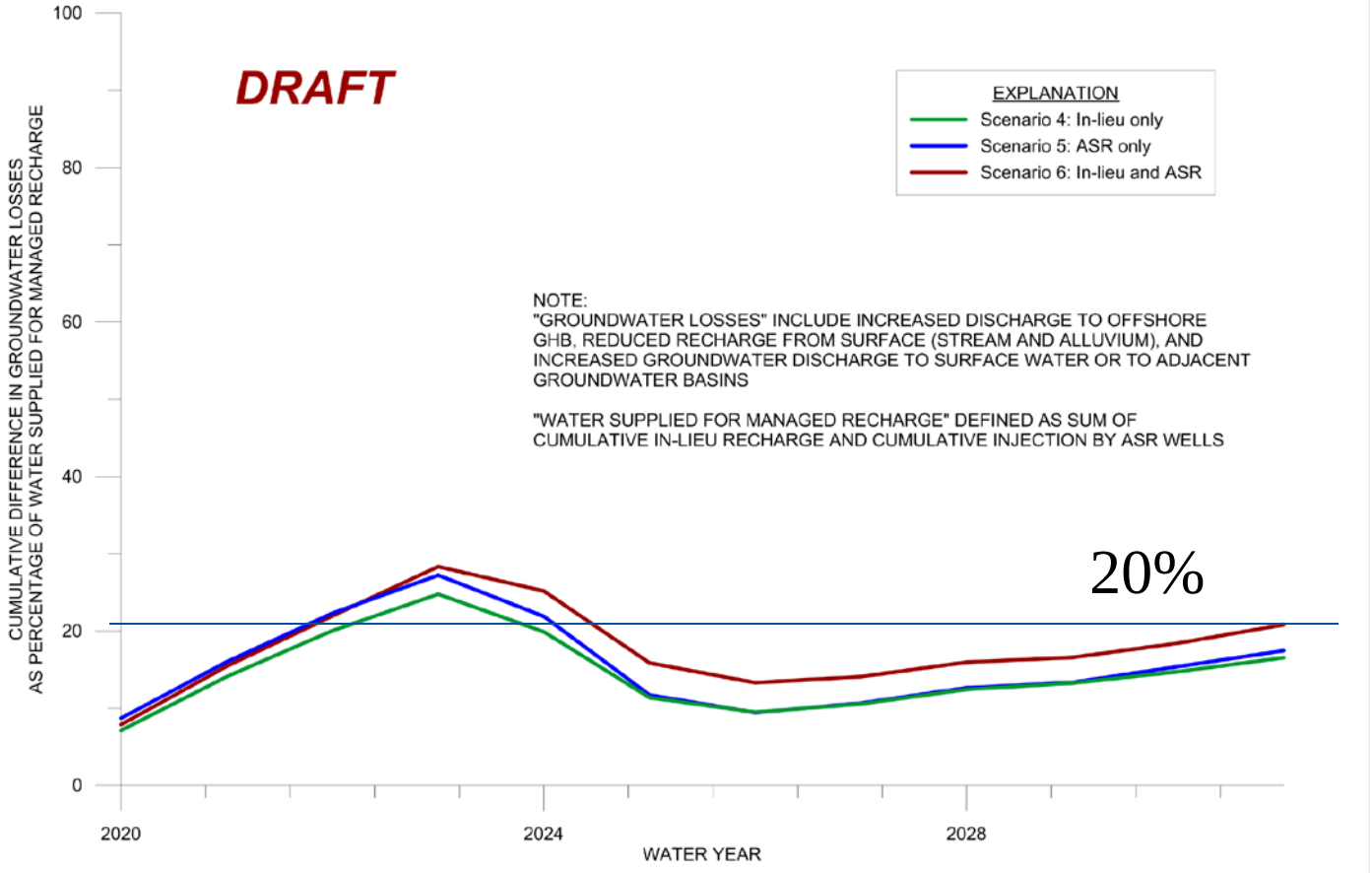
Groundwater Modeling Interpretation of Results

- Aquifer Storage Capacities – Water Budget Results
  - Maximum volumes of storage achieved
- Hydraulic Losses – Water Budget Results
  - Increases in outflow
  - Decreases in inflow
- Sustainable Injection Rates – Water Level Responses
  - Water levels remain below ground surface
- Basin Impacts – Water Budget & Water Levels
  - Net storage depletion
  - Depressed water levels
    - Other pumping wells
    - Coastal MWs

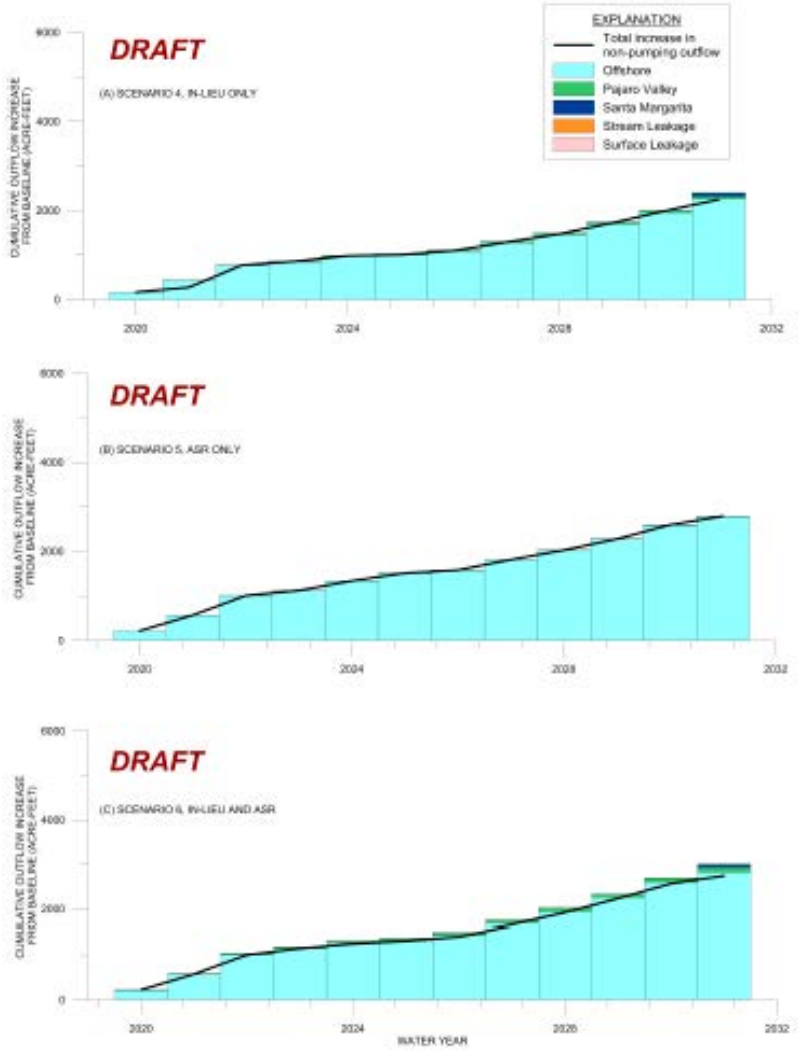
Scenarios 4 – 6 Results
Cumulative Storage Changes - MCGB



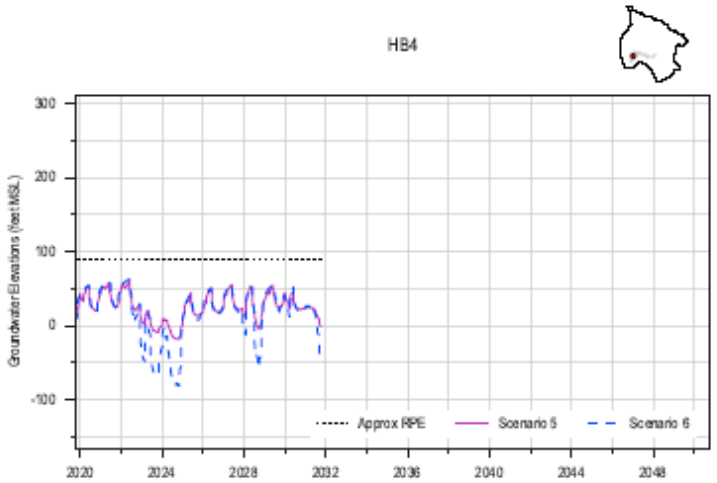
Scenarios 4 – 6 Results
Cumulative Storage Losses - MCGB

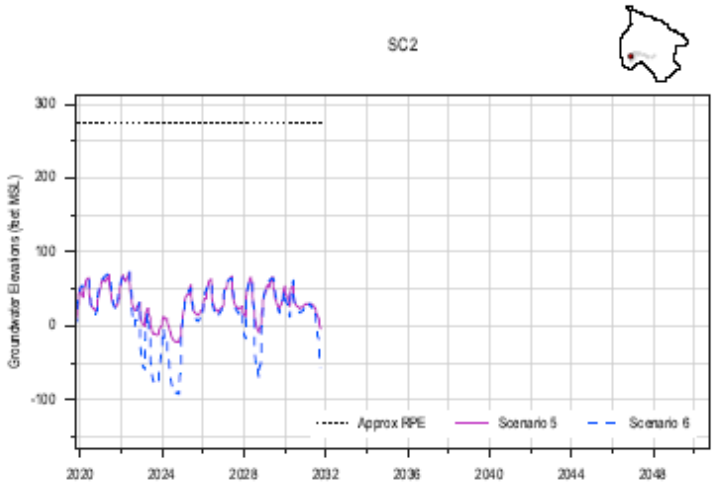


Scenarios 4 – 6 Results
Sources of Storage Losses - MCGB

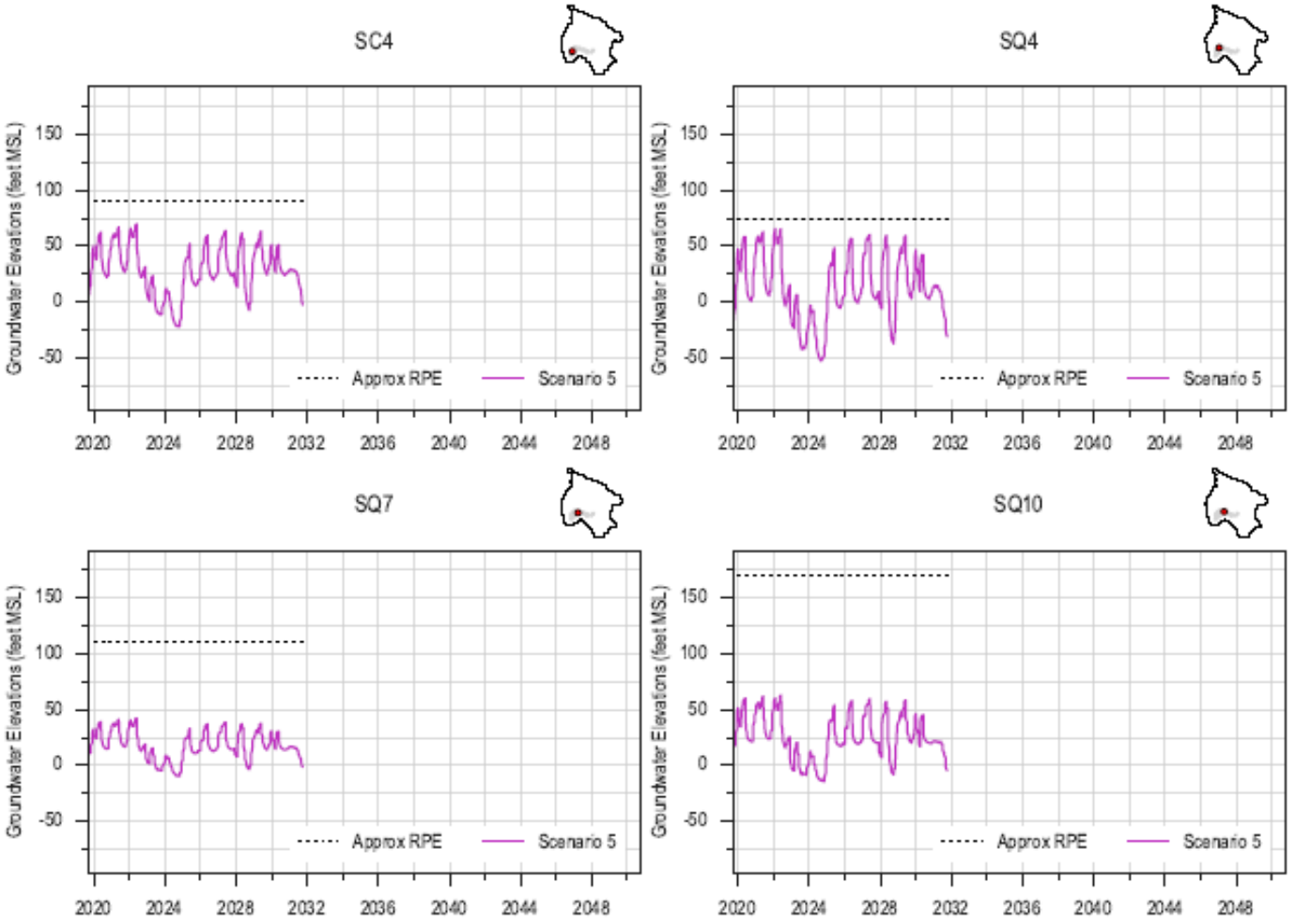


Scenarios 4 – 6 Results
ASR Well Water Levels - MCGB

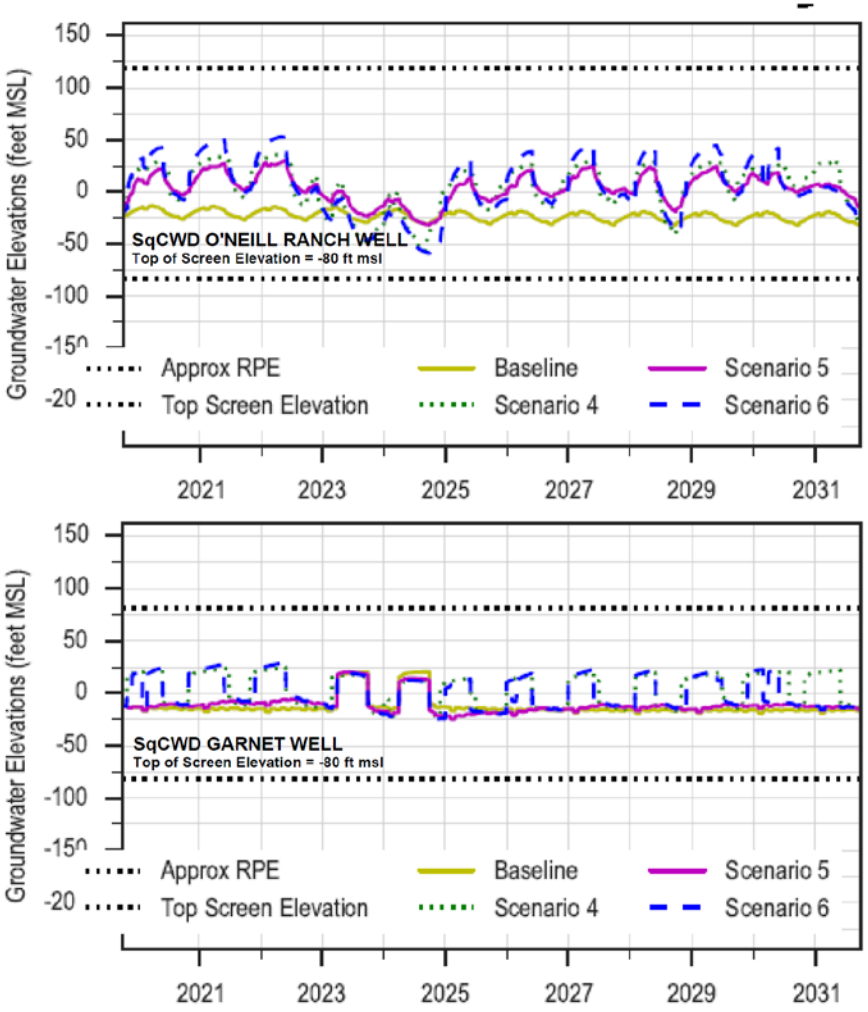




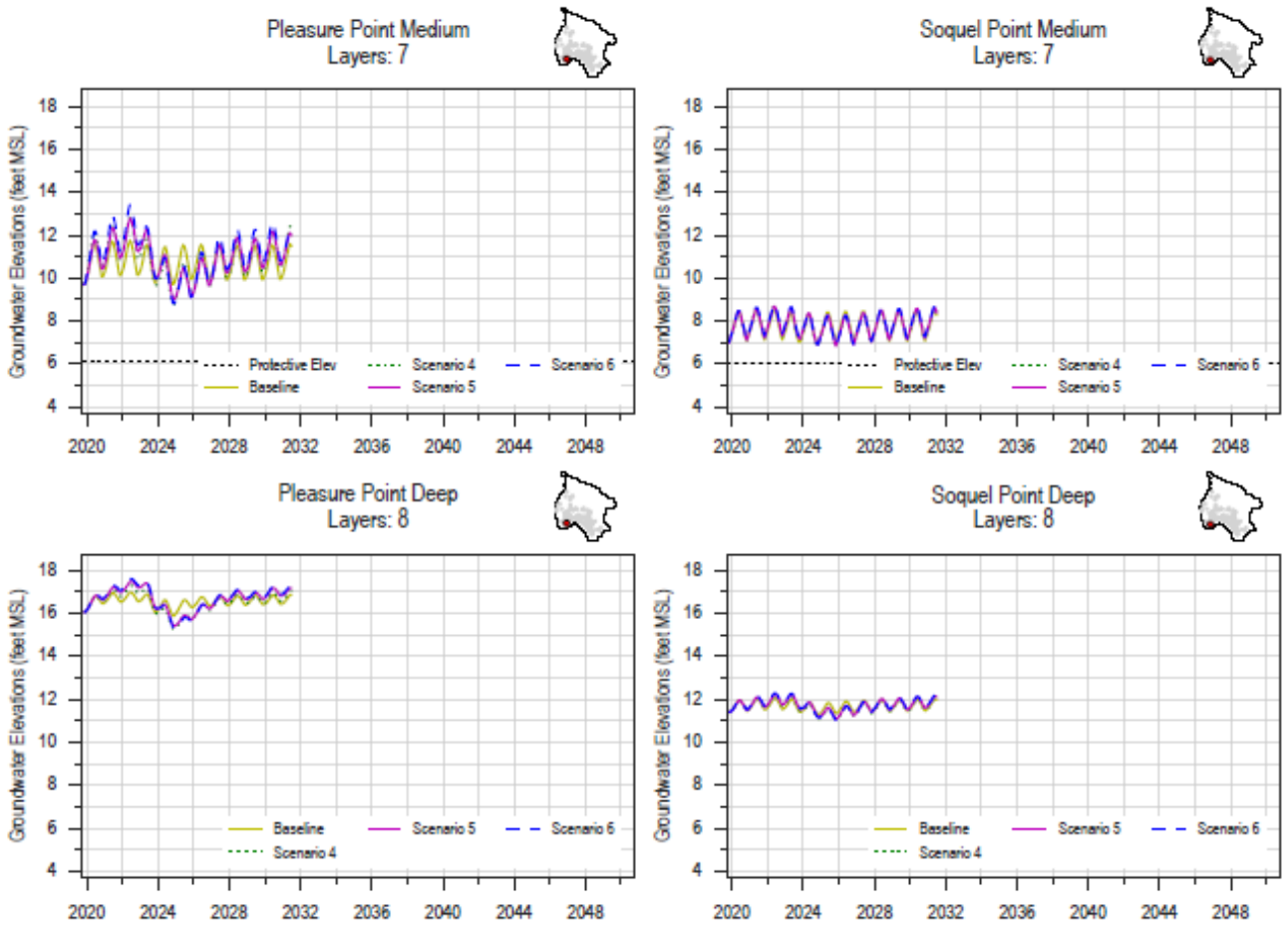
Scenarios 4 – 6 Results
ASR Well Water Levels - MCGB



Scenarios 4 – 6 Results
Production Well Water Levels - MCGB



Scenarios 4 – 6 Results
Coastal MW Water Levels - MCGB



Groundwater Modeling

Summary of Key Findings from Scenarios 4-6

1. Aquifer Storage Capacities
   - SMGB ~1.5 bg
   - MCGB ~1.5 bg
   - Combined ~3.0 bg
2. Hydraulic Losses
   - SMGB ~15% – 20%
   - MCGB ~25% - 30%
   - Greater losses for In-Lieu vs ASR

Groundwater Modeling

Summary of Key Findings from Scenarios 4 – 6 (con't)

3. Sustainable Well Injection Rates
   - SMGB ~0.35 mgd per well avg (3.0 mgd total)
   - MCGB ~0.50 mgd per well avg (3.0 mgd total)
   - Combined total for both basins ~6.0 mgd
4. Basin Impacts
   - Beneficial in both basins on Net Basis
   - Potential for negative impacts at nearest prod. wells during City recovery pumping in both basins
   - Potential for coastal water levels to transiently exceed Protective Elevations

Groundwater Modeling
Potential Future Scenarios

- Additional In-Lieu Recovery Wells
- ASR Only on City-Owned Properties
- Longer "Fill Period" Assumption (e.g. 7 yrs)
- Additional Recharge Volumes Beyond City Needs
- ASR plus Pure Water Soquel
- Additional modeling using different Climate Change scenario
- Others?

WSAC ASR Performance Measures Phase 1 Status

Task	Potential Performance Measures	Findings To Date
1.1 - Existing Wells Screening	Suitable Existing Wells for Pilot Testing in Target Aquifers do not exist	**Satisfied**
1.2 - Site-Specific Injection Capacity Analysis	Results show that avg. Injection Capacity of 250 gpm (+/- 10%) is unrealistic	**Satisfied**
1.3 - Geochemical Interaction Modeling	Results show that undesirable geochemical interactions are likely	**Satisfied**
1.5 - Groundwater Modeling	Results show that target aquifers cannot sustain needed injection or recovery rates or unacceptable hydraulic losses occur	**SATISFIED**

Current Status Summary

- Phase 1 Investigation is Essentially Complete. Ongoing Tasks Include:
  - SMGB Test Well Site Identification – Work Plan
  - Climate Change Evaluation
  - Additional Groundwater Modeling Scenarios/Iterations
- WSAC Performance Measures for Phase 1 Satisfied
- No Fatal Flaws Identified
- Phase 2 is Advancing in the MCGB with Beltz 12 Pilot Test

Next Steps

- Beltz 12 ASR Pilot Test (Phase 2)
- Test Well Site in SMGB (Phase 2)
- Climate Change Scenario Evaluation
- Infrastructure Evaluation
- Additional Modeling

Phase 2 ASR Pilot Testing
Beltz 12 (Tu/AA/A Aquifers of MCBG)

Phase 2 ASR Pilot Testing
Beltz 12 (Tu/AA/A Aquifers of MCBG)

- Primary Purposes:
  - Determination of sustainable injection/recovery pumping rates
  - Evaluation of well plugging rates/backflushing requirements
  - Determination of local aquifer response to injection/recovery pumping
  - Evaluation of water-quality changes during storage and recovery (focus on DBPs and Mn)

Phase 2 ASR Pilot Testing
Beltz 12 (Tu/AA/A Aquifers of MCBG)

- ASR Cycle Test Program:

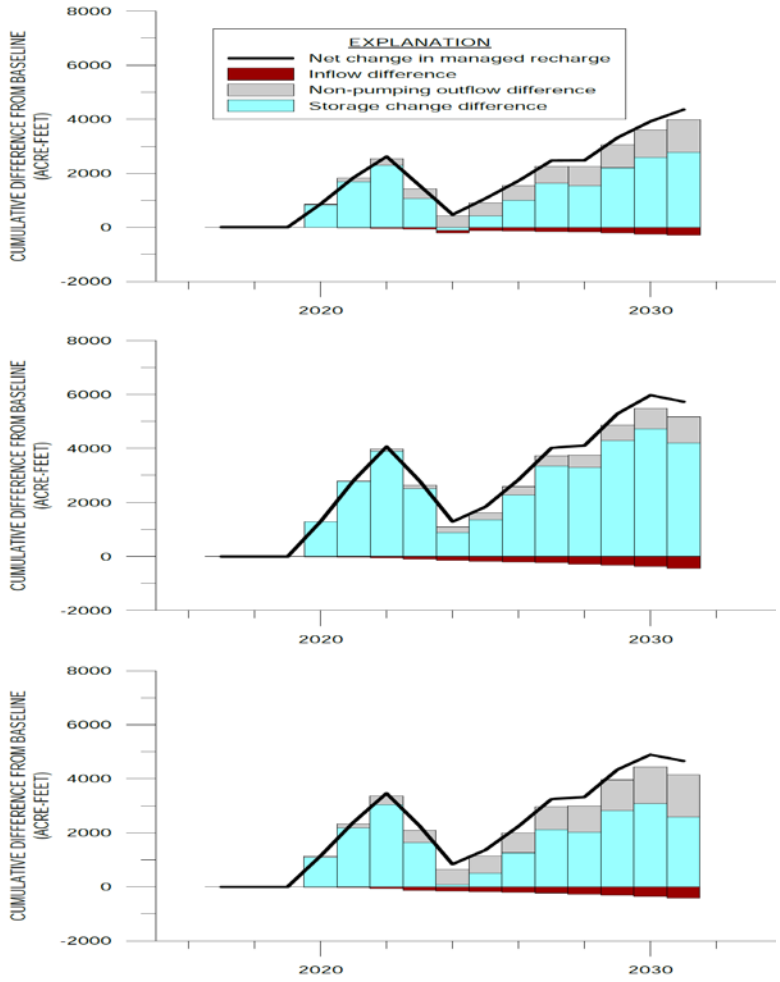
ASR Cycle No.	Injection					Storage	Recovery				
	Period (days)	Rate (gpm)	Total Volume (mg)	Total Volume (af)	Radius (ft)	Period (days)	Period (days)	Rate (gpm)	Volume (mg)	Volume (af)	Discharge Location
1	1	400	0.58	1.77	18	2	1	700	1.01	3.09	Storm Drain
2	7	400	4.03	12.4	46	14	6	700	6.05	18.6	Storm Drain
3	30	400	17.3	53.0	96	60	30	400	17.3	53.0	Distribution
Total Duration (days):				151							
Total Injection Volume (mg):				21.9							
Total Recovery Volume (mg):				24.3							

- Project Tasks and Schedule:

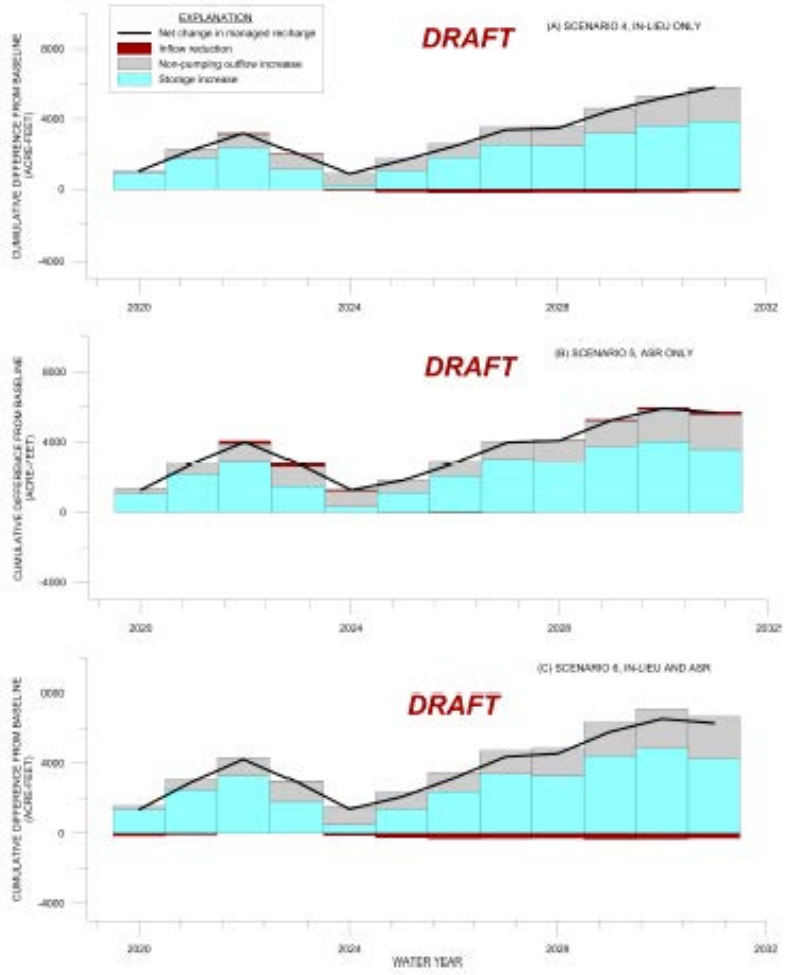
Task / Activity	Time Period	Duration (months)
CEQA and Permitting	Sep 2018 - Nov 2018	3
Site Preparation	Nov 2018	1
ASR Cycles	Dec 2018 - May 2019	6
Data Analysis and Reporting	Jun 2019 - Jul 2019	2
	Total:	**12**

Questions / Discussion

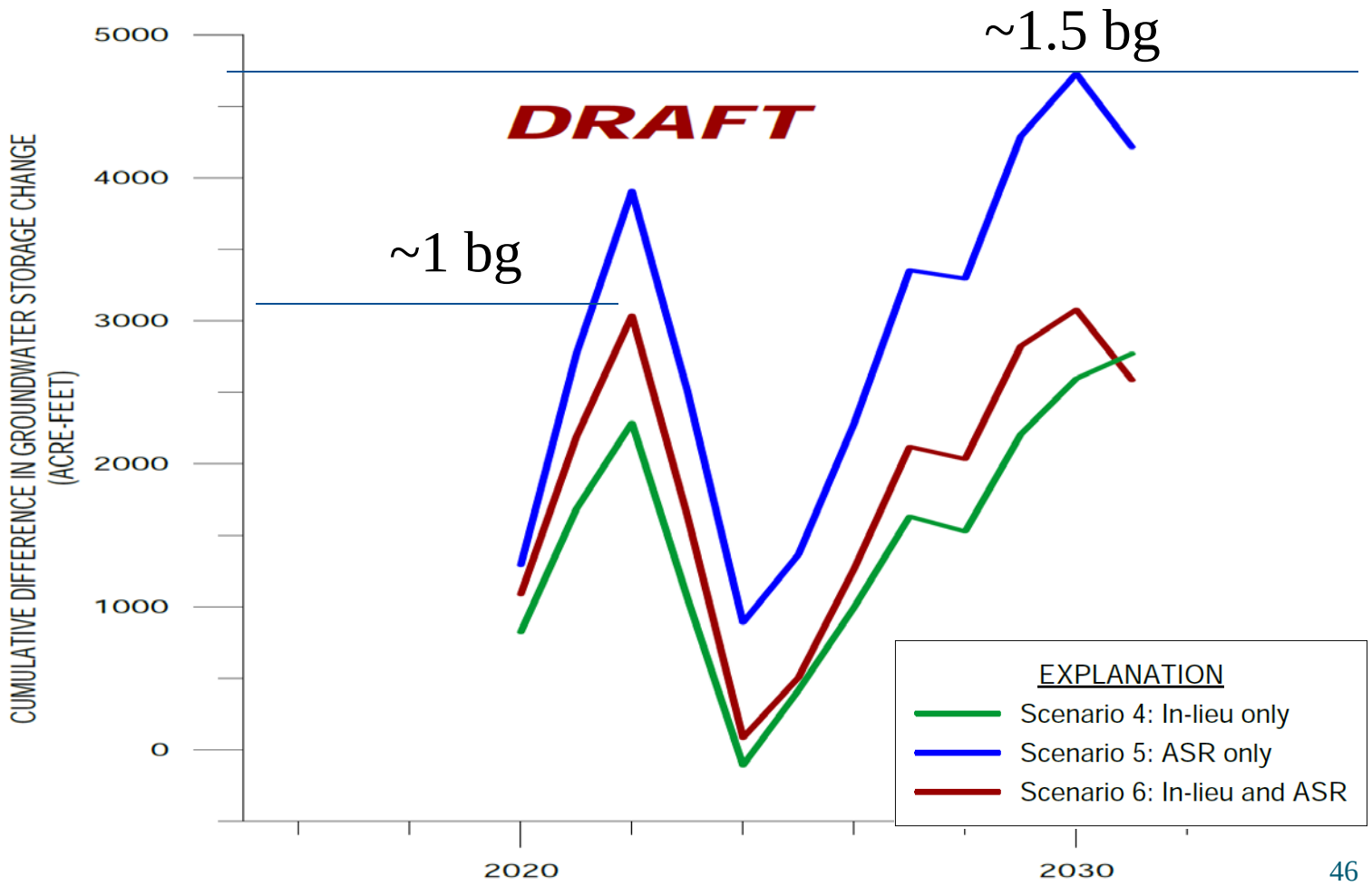
Scenarios 4 – 6 Results
Annual Storage Changes - SMGB



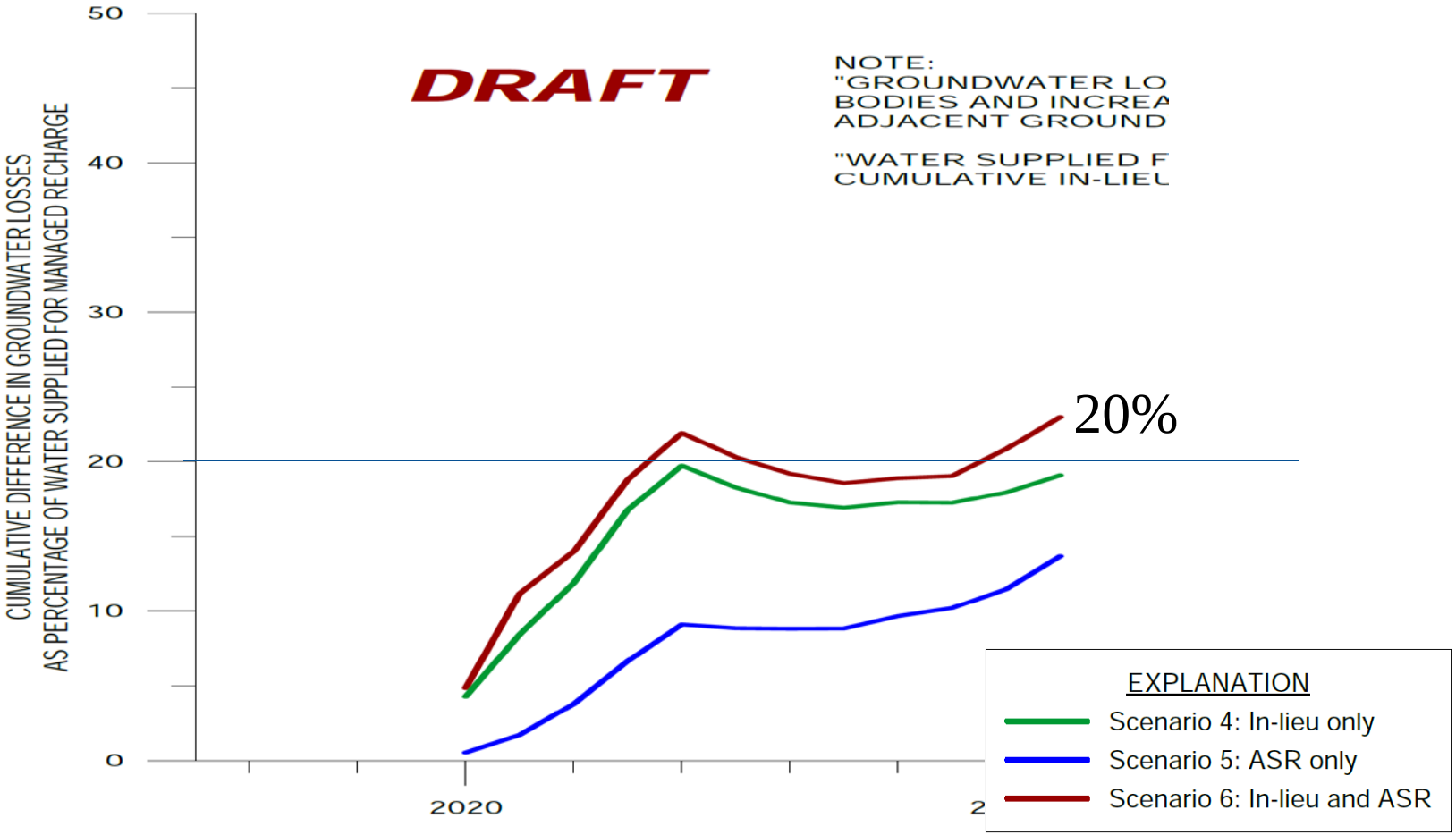
Scenarios 4 – 6 Results
Annual Storage Changes - MCGB



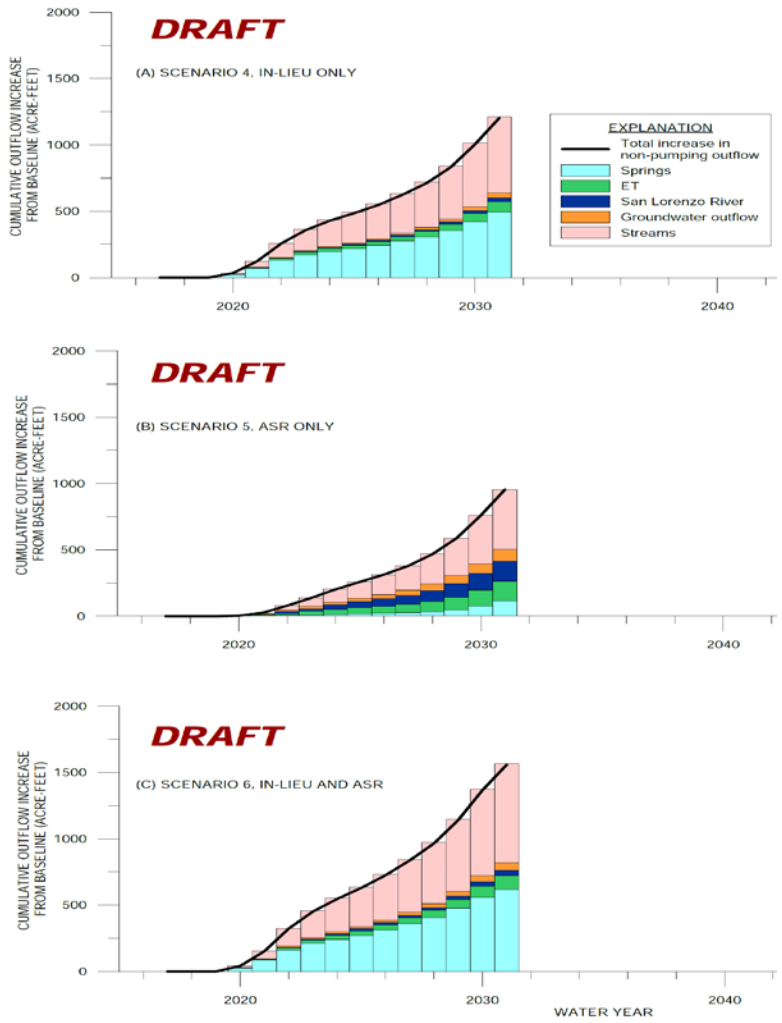
Scenarios 4 – 6 Results
Cumulative Storage Changes - SMGB



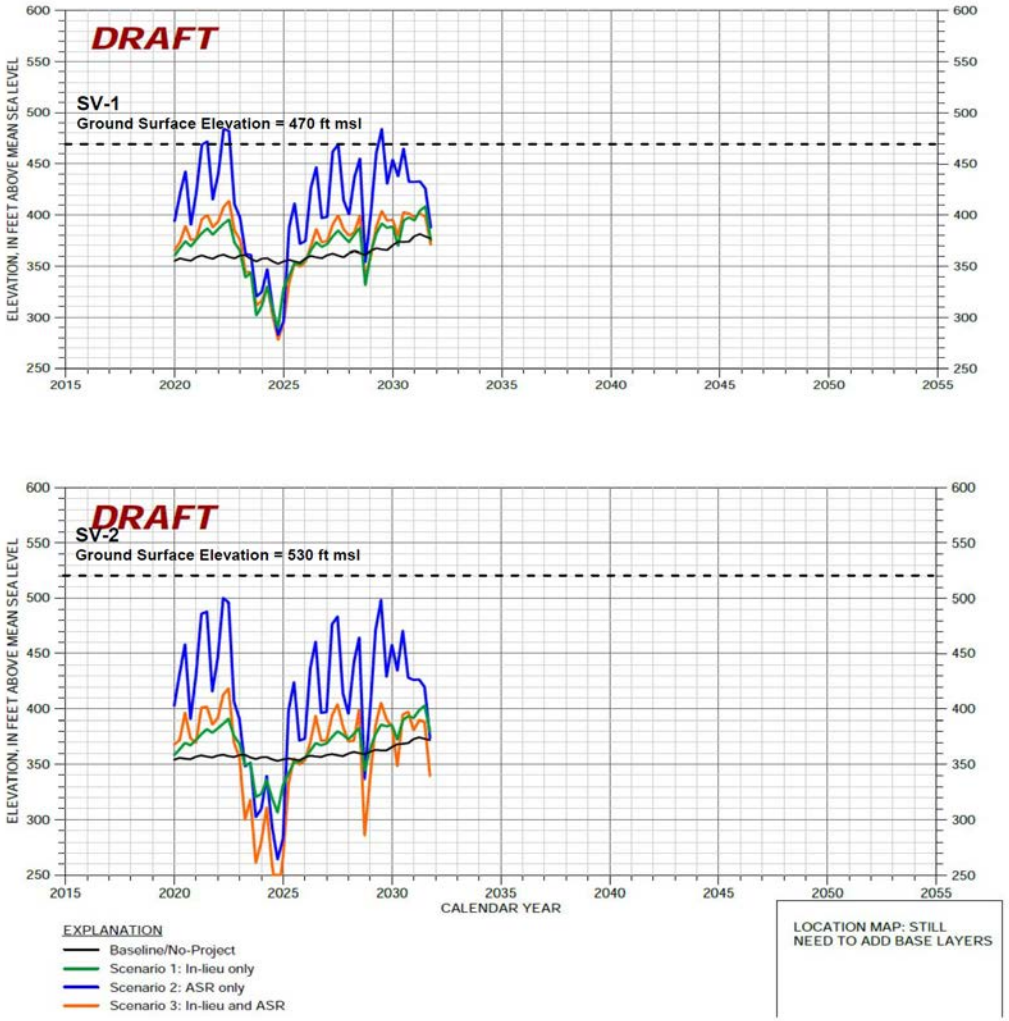
Scenarios 4 – 6 Results
Cumulative Storage Losses - SMGB



Scenarios 4 – 6 Results
Sources of Storage Losses - SMGB



Scenarios 4 – 6 Results
ASR Well Water Levels - SMGB



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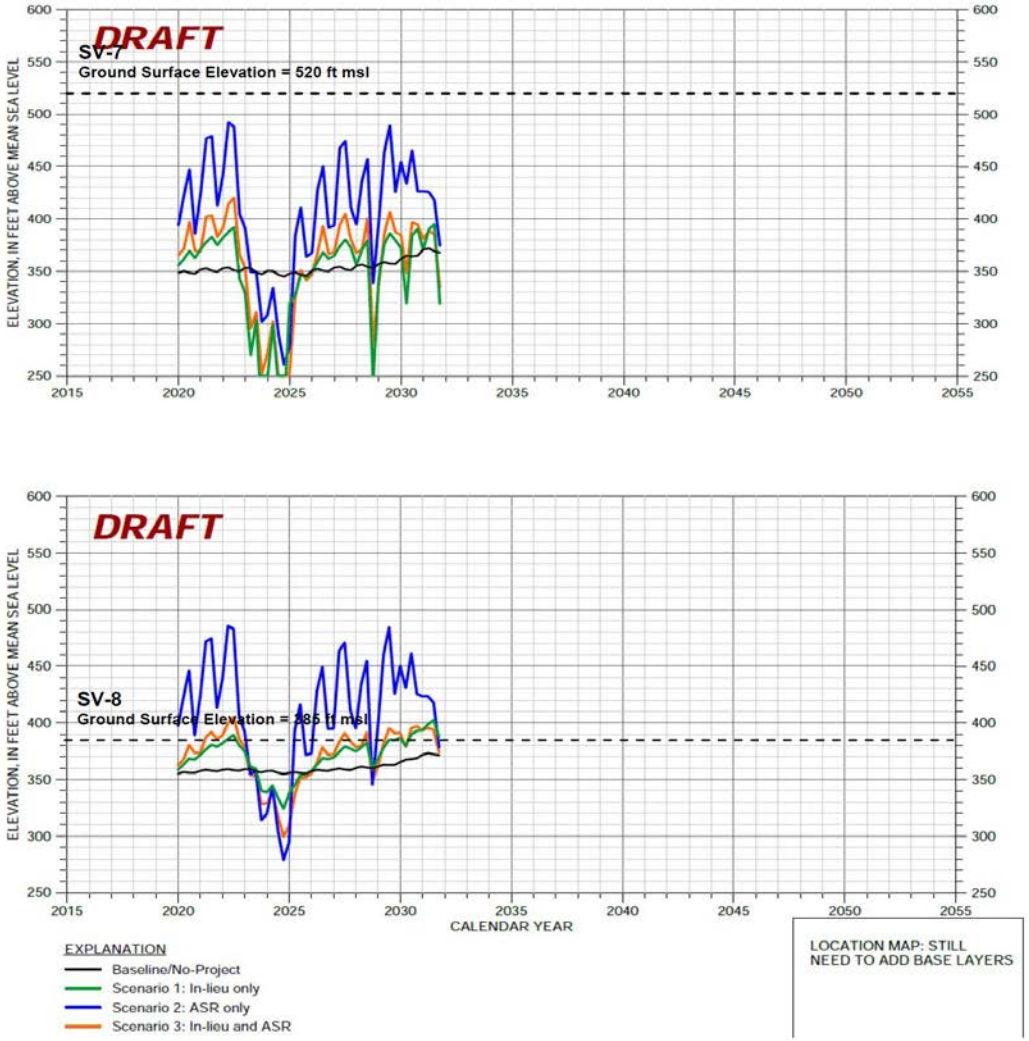

Scenarios 4 – 6 Results
Production Well Water Levels - SMGB