Indian Wells Valley
Groundwater Model Results Overview

April 4, 2019

Indian Wells Valley

BASELINE MODELING RESULTS 2017-2020

Baseline Pumping

FUTURE BASELINE (No Action) PUMPING 2020-2070

Owner	Estimated # of Wells	Est. Recent Pumping	Est 2016 Pumping	Estimated Baseline Pumping (AFY) 2020	2040	2070
Meadowbrook Dairy	10	9,640 2	6,387 2	12,303	12,303	12,303
Mohave Pistachio	8	3,655 1	3,040 1	6,054	6,891	6,891
Large Ag Subtotal	**18**			**18,357**	**19,194**	**19,194**
Simmons Farm	1	982 2	918 2	931	931	931
Quist Farms	7	750 2	516 4	674	685	685
Sierra Shadows	3	missing	missing	765	765	765
Amberglow	1	missing	missing	62	62	62
Terese Farms	2	missing	missing	310	410	410
Hickle	2	missing	missing	85	85	85
Blubaugh	1	missing	missing	1	1	1
Bellino	1	missing	missing	50	50	50
McGee	2	missing	missing	400	400	400
Other Small Ag	unk	732 3	1,260 3	0	0	0
Small Ag Subtotal	**20**			**3,278**	**3,389**	**3,389**
Kern County	1	missing	missing	18	18	18
City of Ridgecrest	5	388 2	373 2	407	407	407
Other Irrig, Dust Subtotal	**6**			**425**	**425**	**425**
IWVWD	11	7,704 2	6,412 1	6,518	7,346	8,791
Inyokern CSD (265)	2	110 2	102 2	191	191	191
Mutuals (491)	38	comb /	comb /	354	354	354
DOM (832)	832	2,120 2	1,100 2	832	832	832
MUN, DOM Subtotal	**883**			**7,894**	**8,723**	**10,167**
Searles Valley Minerals	5	2,576 2	2,377 2	2,907	2,907	2,907
Navy	6	1,633 1	1,595 1	2,041	2,041	2,041
TOTAL	**938**	*cannot calculate due to missing data*		**34,902**	**36,679**	**38,123**

historical data source

1 *data received from pumper*

2 *data from IWVCGWMG 1975-2017 pumping table; most recent years up to ten if available*

3 *data from IWVCGWMG 1975-2017 pumping table, difference of 'Orchards' and Mohave Pistachios*

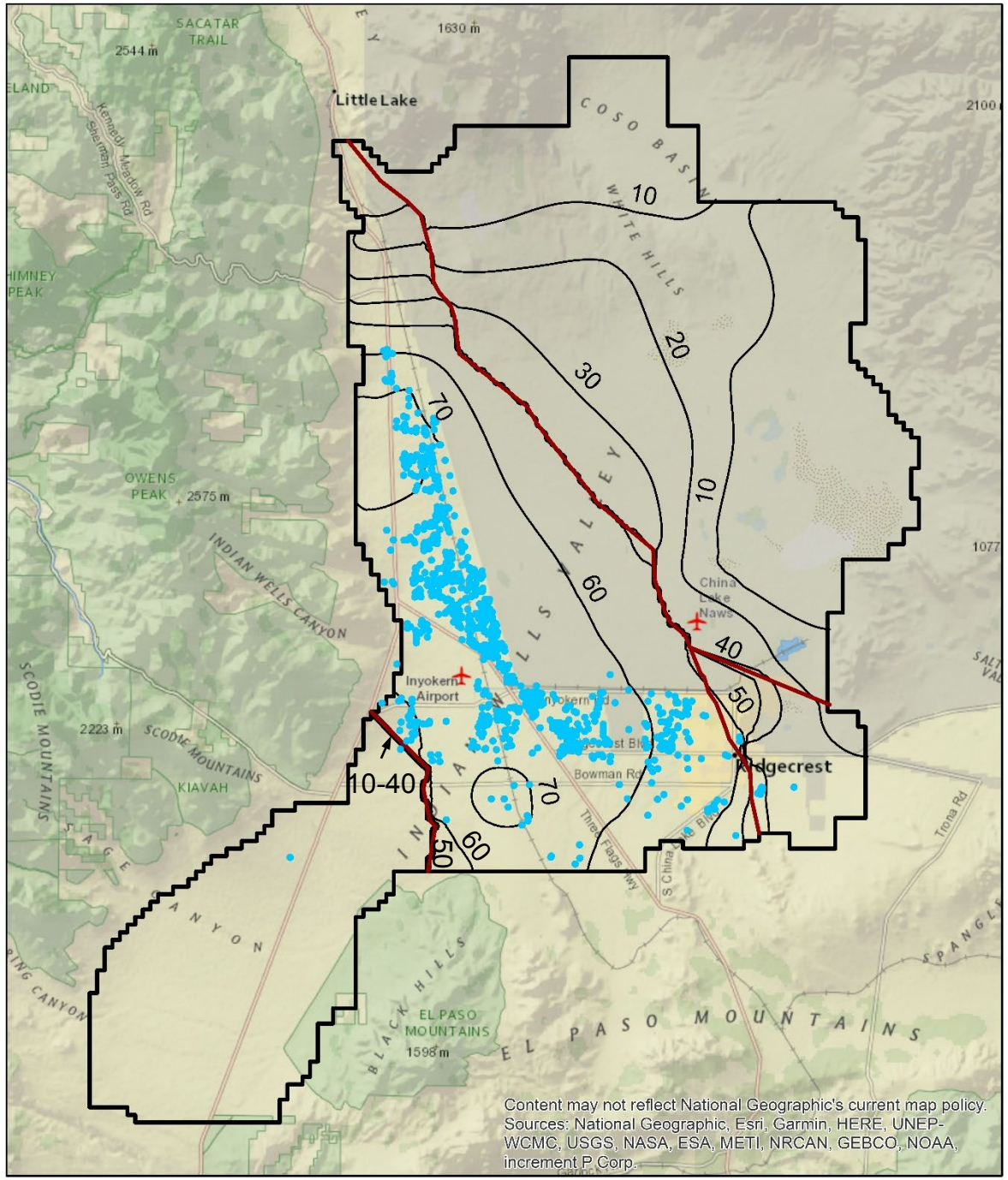
4 *2017 estimated pumping available from pumper*

Water Budget (average AF/Y)

		Calibration		Baseline
		1922-2016 (95 years)	2011-2015 (5 years)	2020-2070 (51 years)
Inflow		AF/Y	AF/Y	AF/Y
Natural Recharge		7,650	7,650	7,650
Recycled Water		--	--	--
Imported Water		--	--	--
	TOTAL:	7,650	7,650	7,650
Outflow				
Pumping		15,240	27,740	36,880
Evapotranspiration (ET)		6,580	4,850	1,610
Flow to Salt Wells		60	50	40
	TOTAL:	21,880	32,640	38,530
Change of Groundwater in Storage		-14,230	-24,990	-30,880

Drawdown Results

- Drawdown from 2020 to 2070



Legend

- Wells
- Geologic Faults
- Drawdown (2020-2070) ft
- Model Area

0 1.5 3 6 9 12 Miles

N

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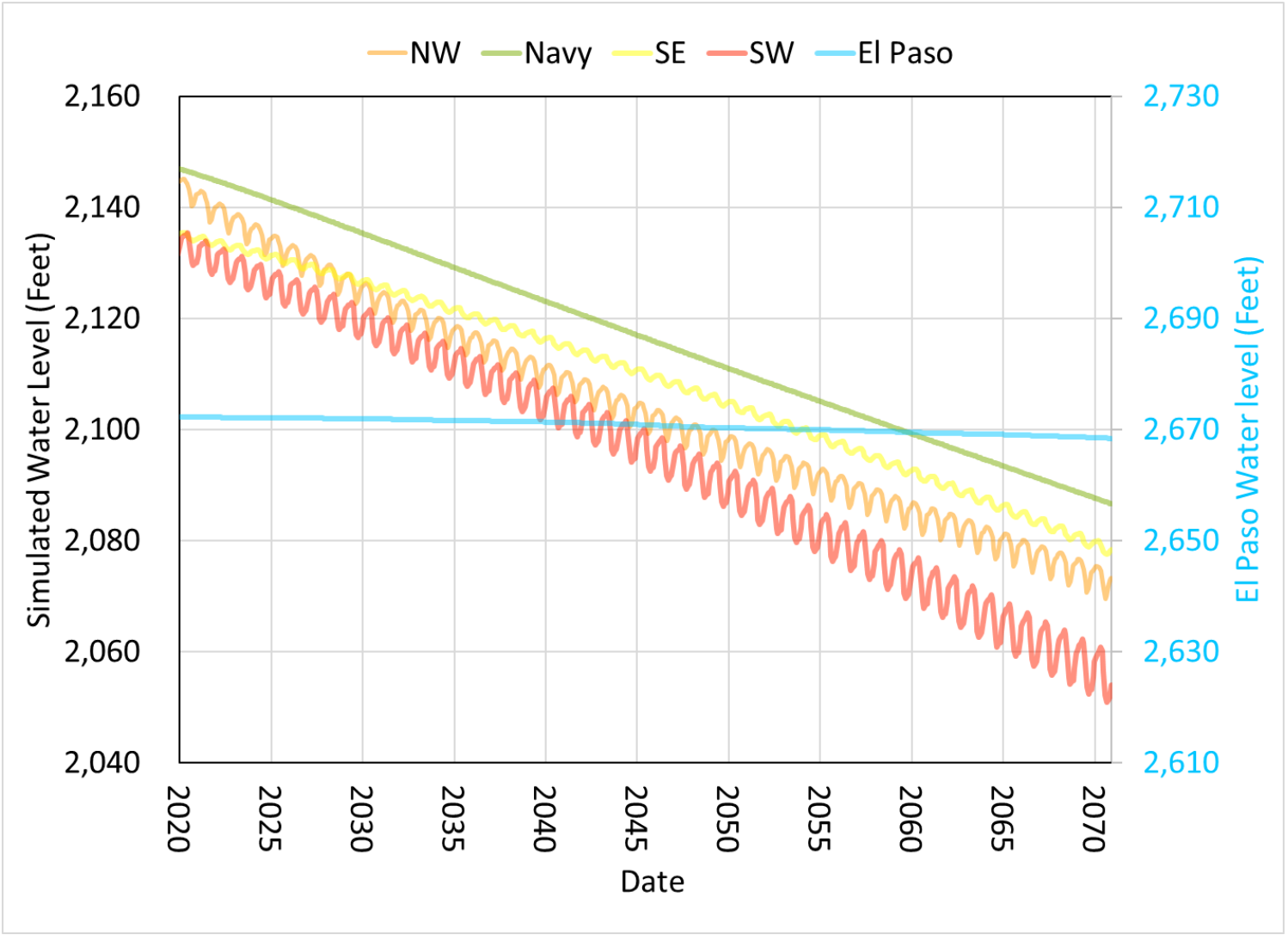
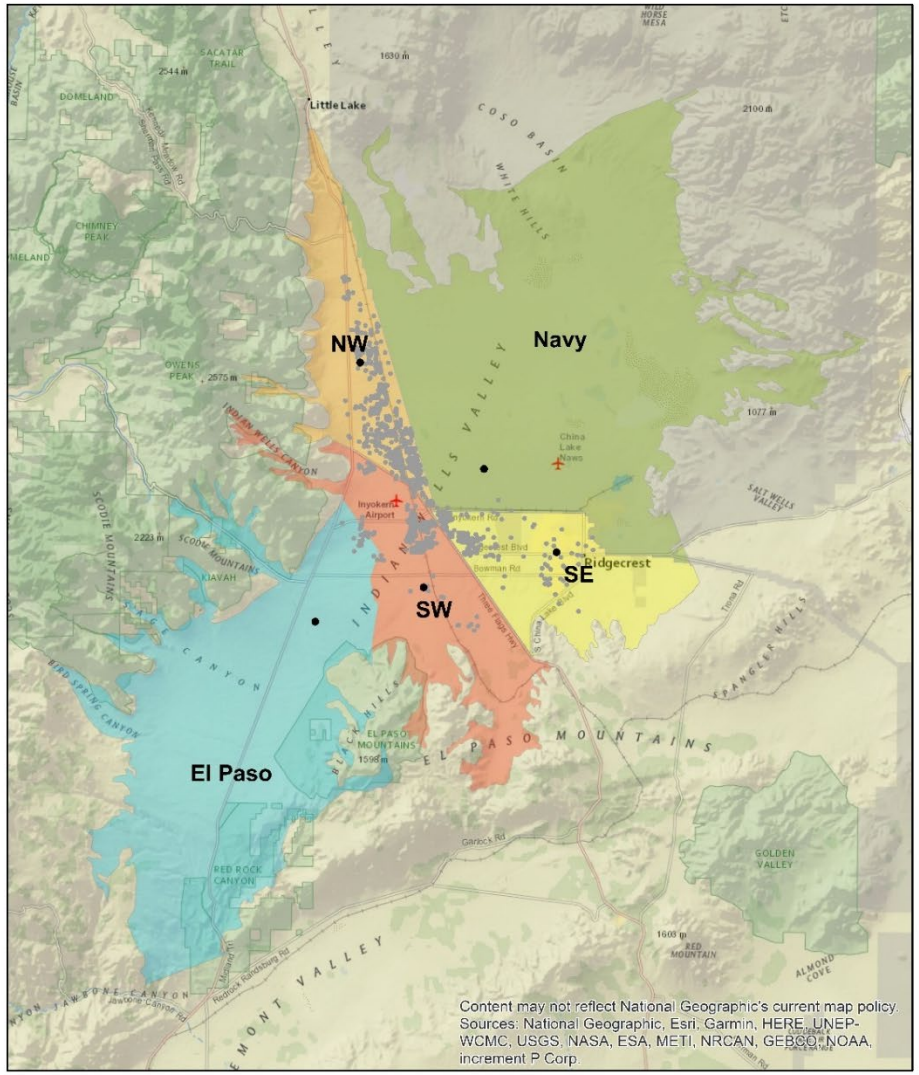
Simulated Water Levels by Model Analysis Zones





Legend

- Wells
- Water Level Location

0 2 4 8 12 16 Miles

N

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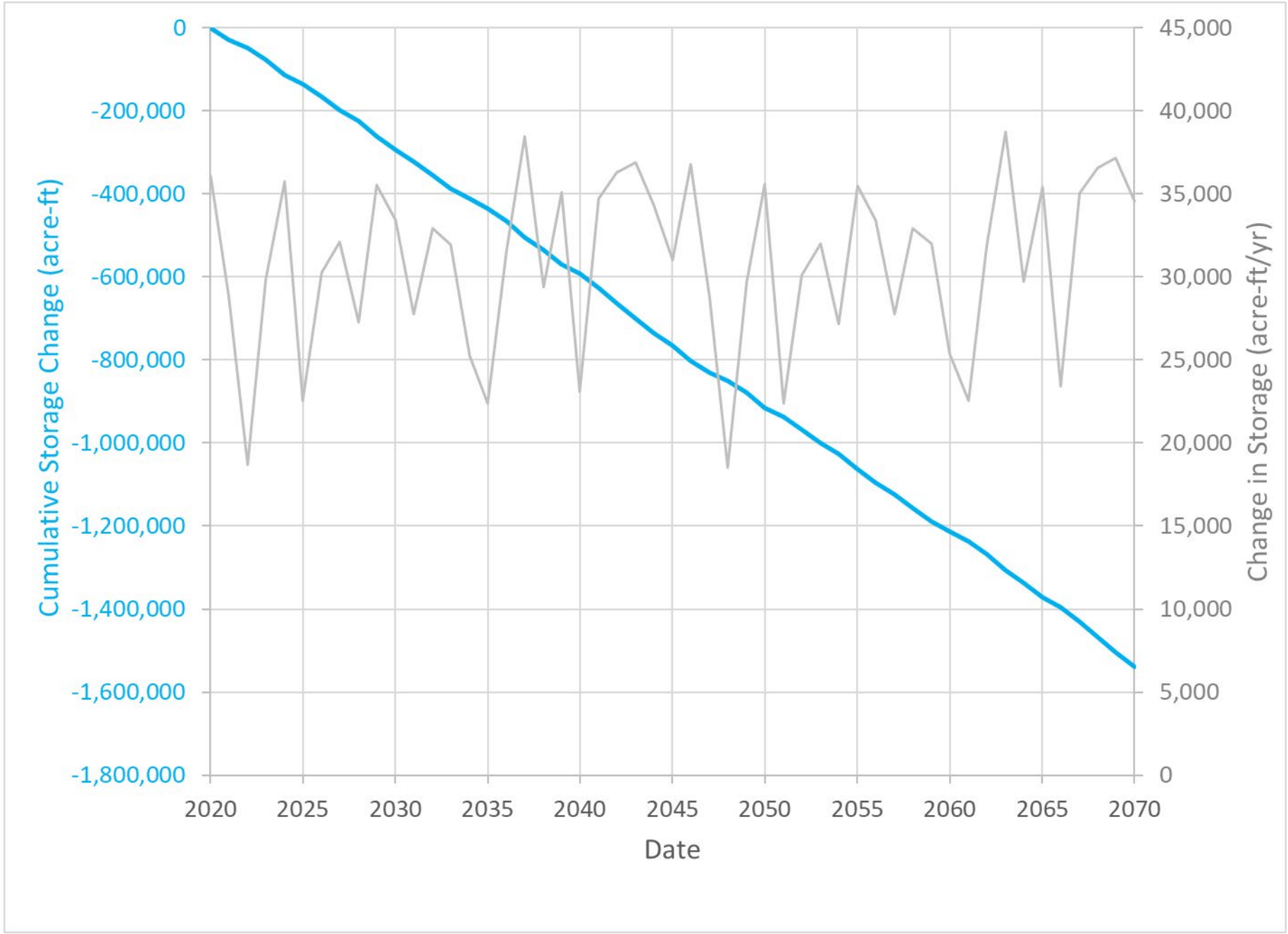
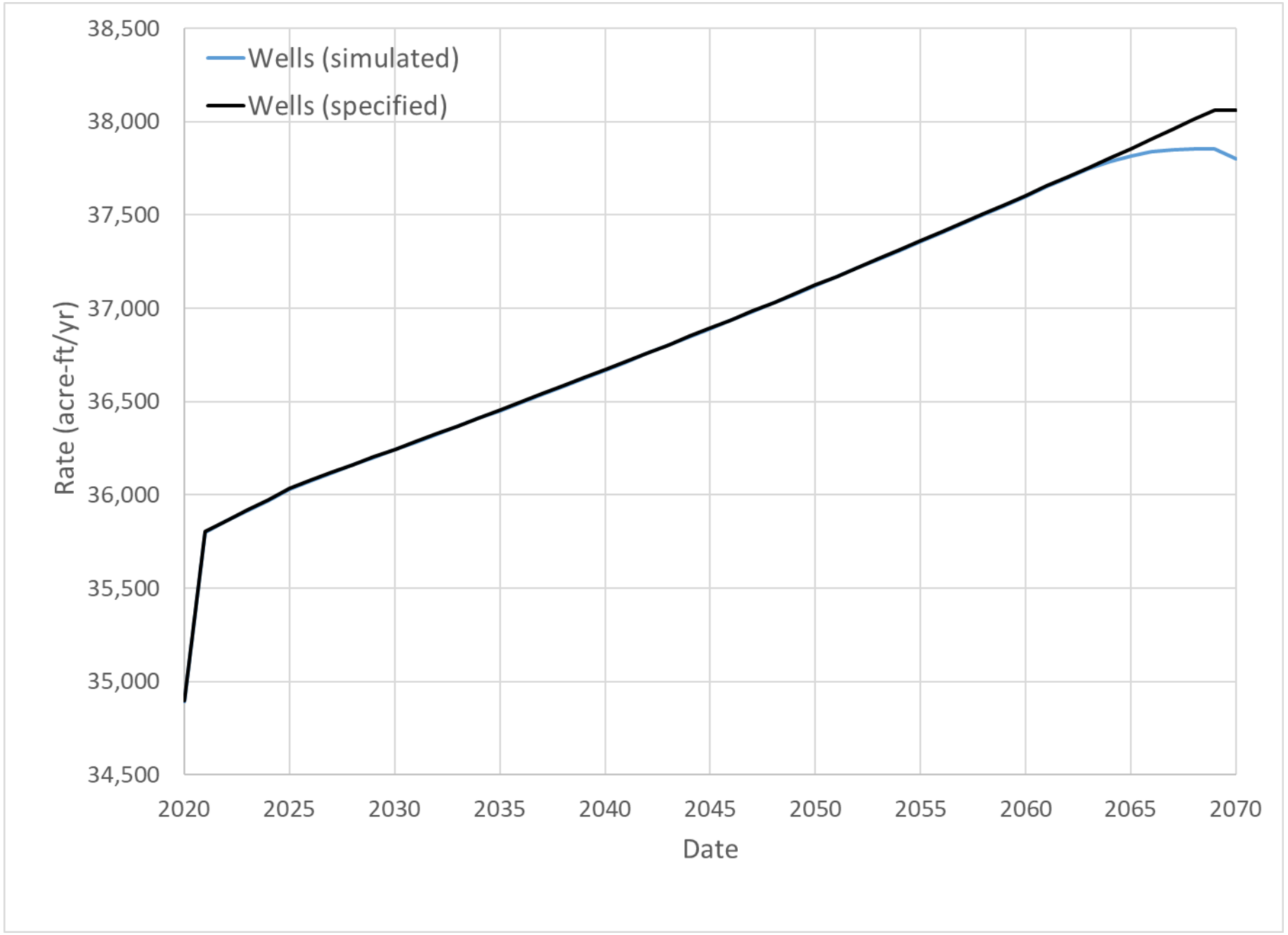
Change in Groundwater Storage

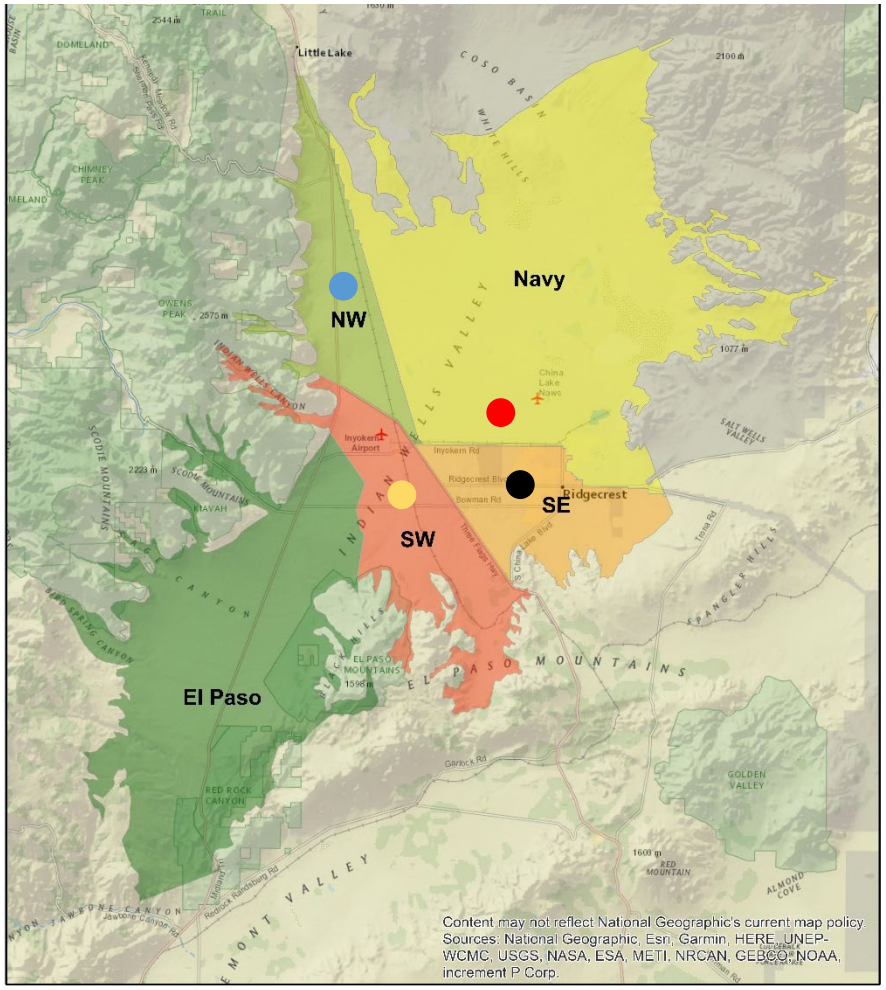


Simulated Outputs (Wells)



4/4/2019

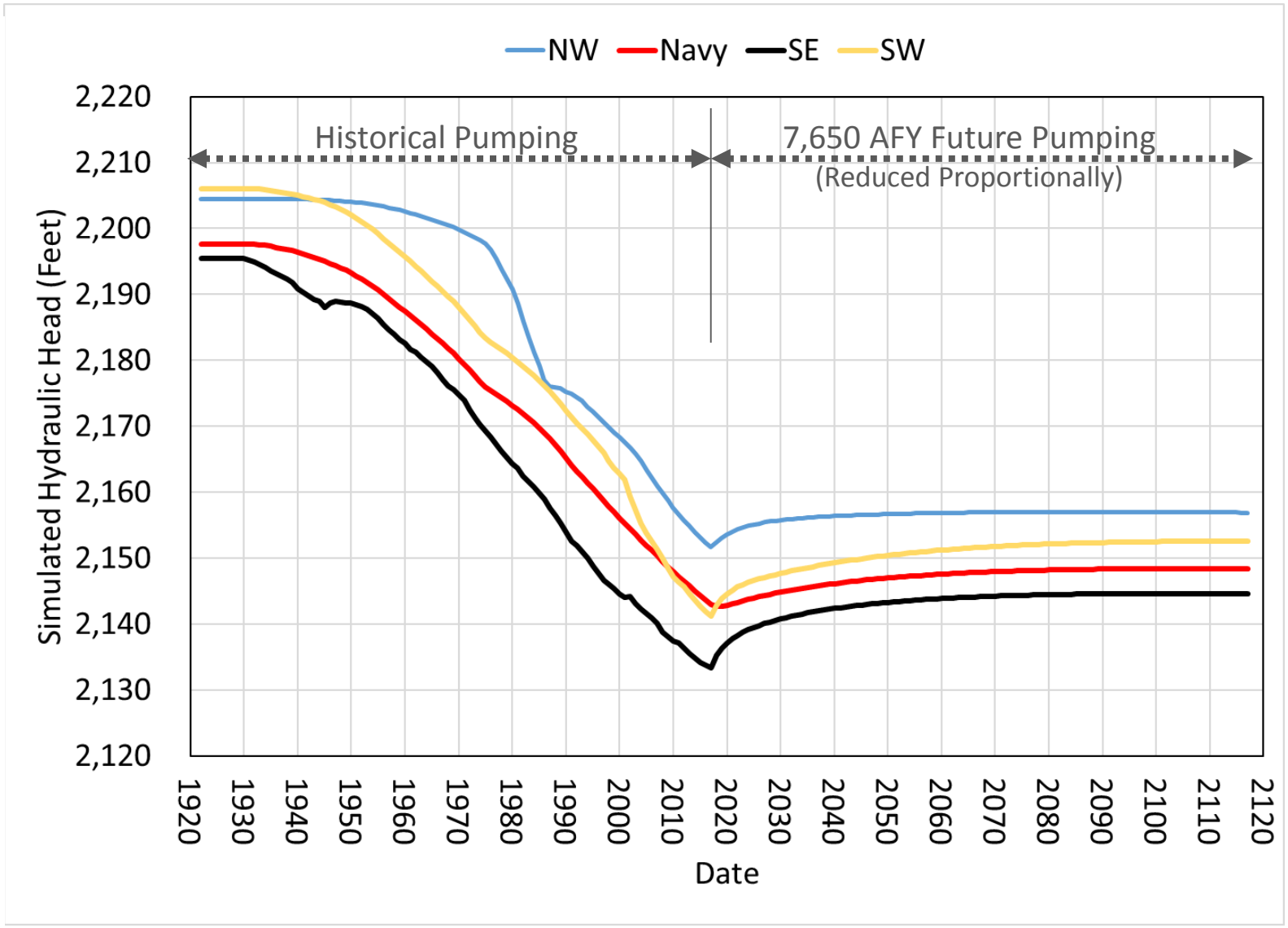
Predictive Simulation with Pumping Reduced to Basin Recharge



Legend

Observation Points

0 2 4 8 12 16 Miles



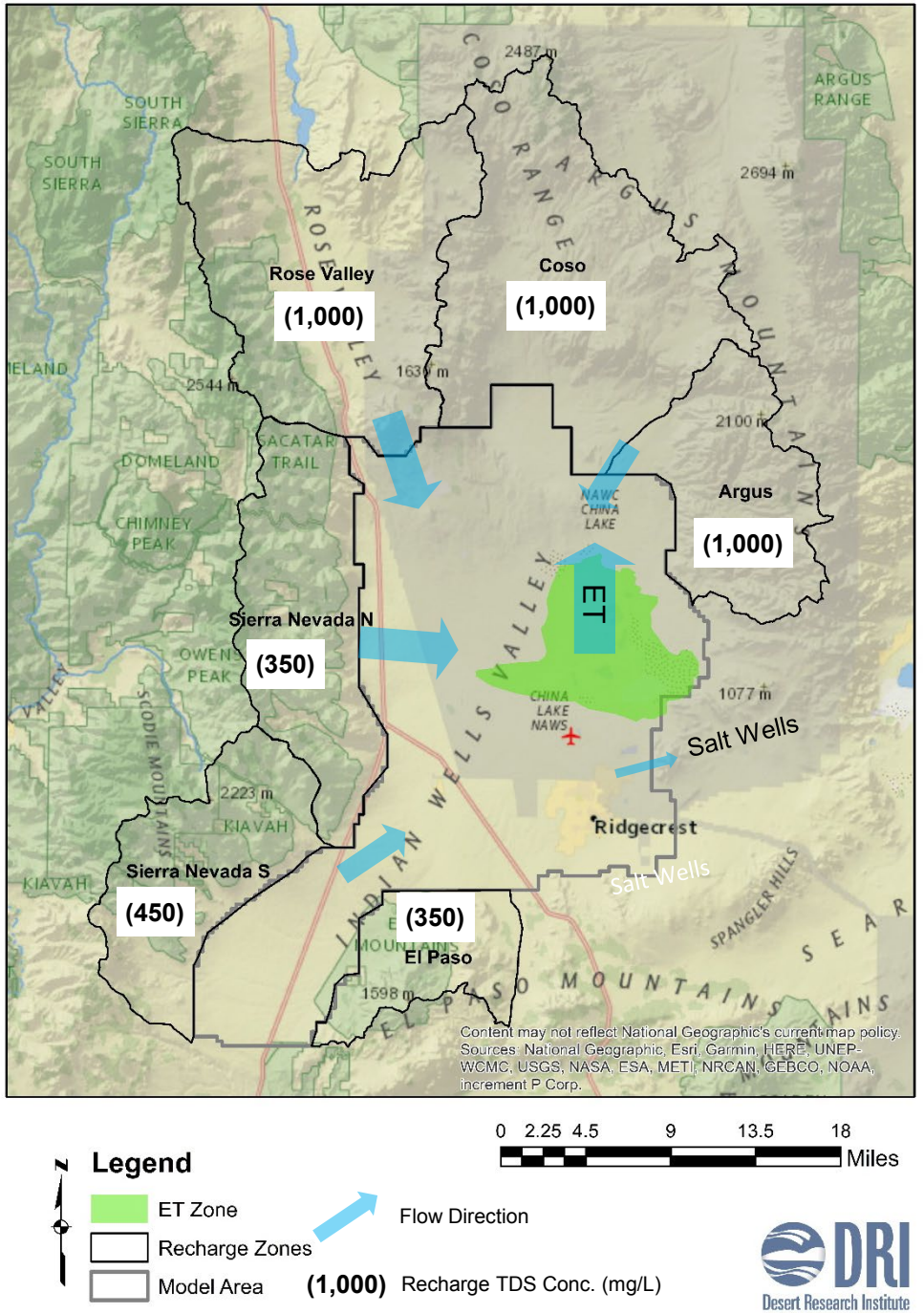
Indian Wells Valley

DRAFT WATER QUALITY (TOTAL DISSOLVED SOLIDS) MODELING RESULTS FOR BASELINE PUMPING CONDITIONS

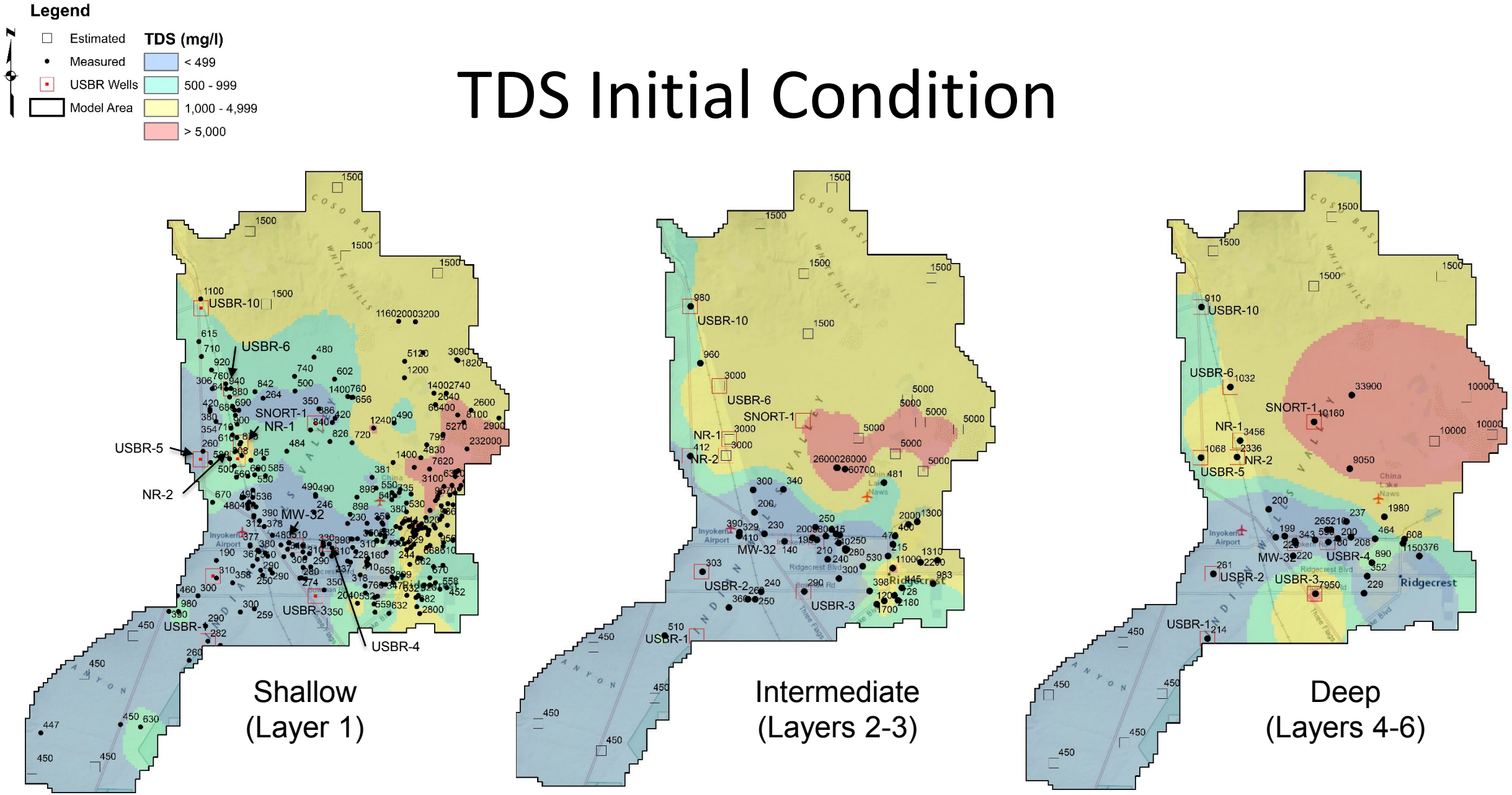
TDS Conceptual Model (mg/L)

- <u>Sources:</u>
  - Solutes in recharge
  - Dissolution of minerals in basin
  - Mixing with saltier groundwater
    - Remnant evaporative brines
    - Geothermal fluids
- Concentration by evaporation

- <u>Sinks:</u>
  - Solutes in discharge to Searles Valley
  - Precipitation of minerals

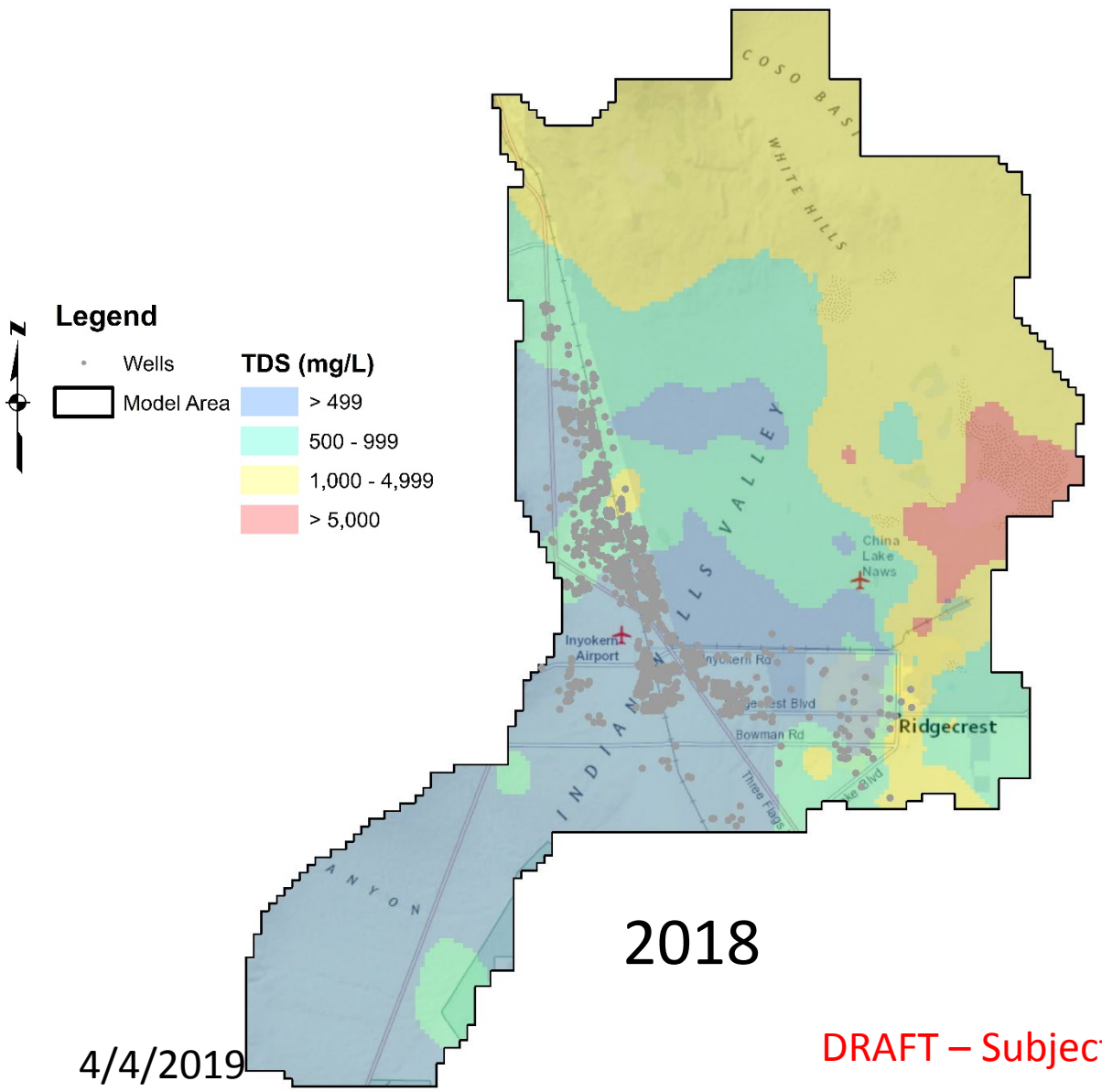


TDS Initial Condition

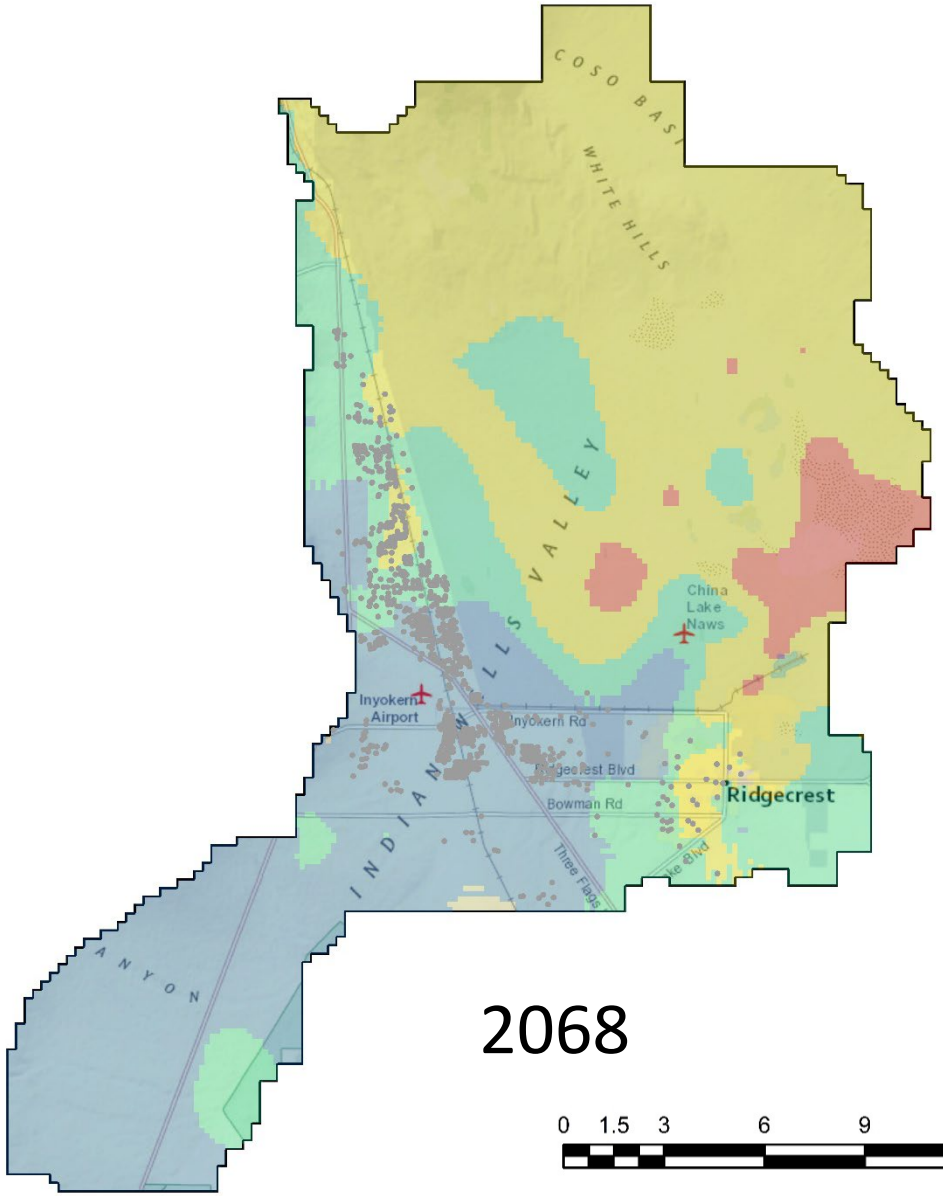


DRAFT – Subject to change

Simulated TDS Concentration - Shallow



2018



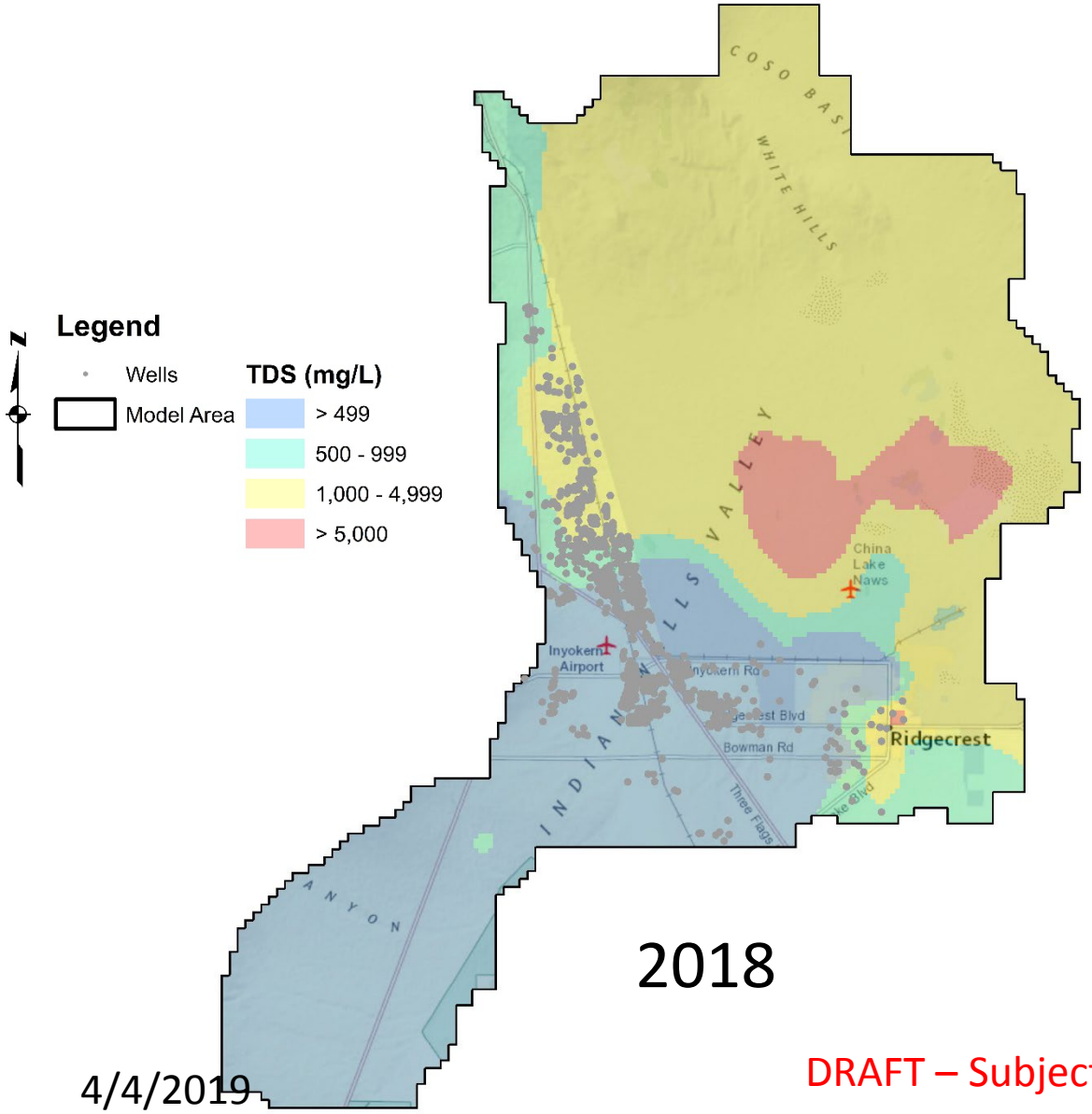
2068

4/4/2019

DRAFT – Subject to change

0 1.5 3 6 9 12 Miles

Simulated TDS Concentration - Intermediate



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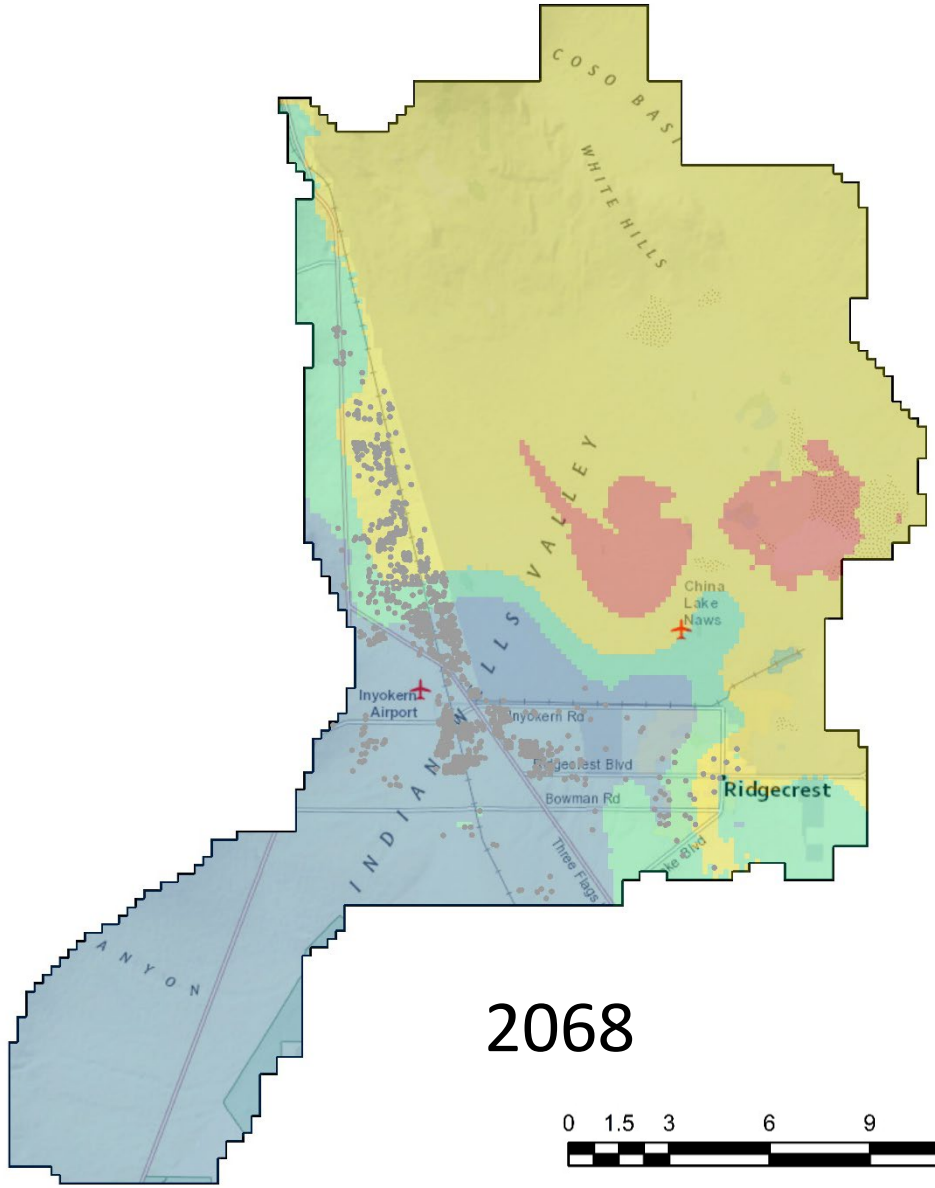


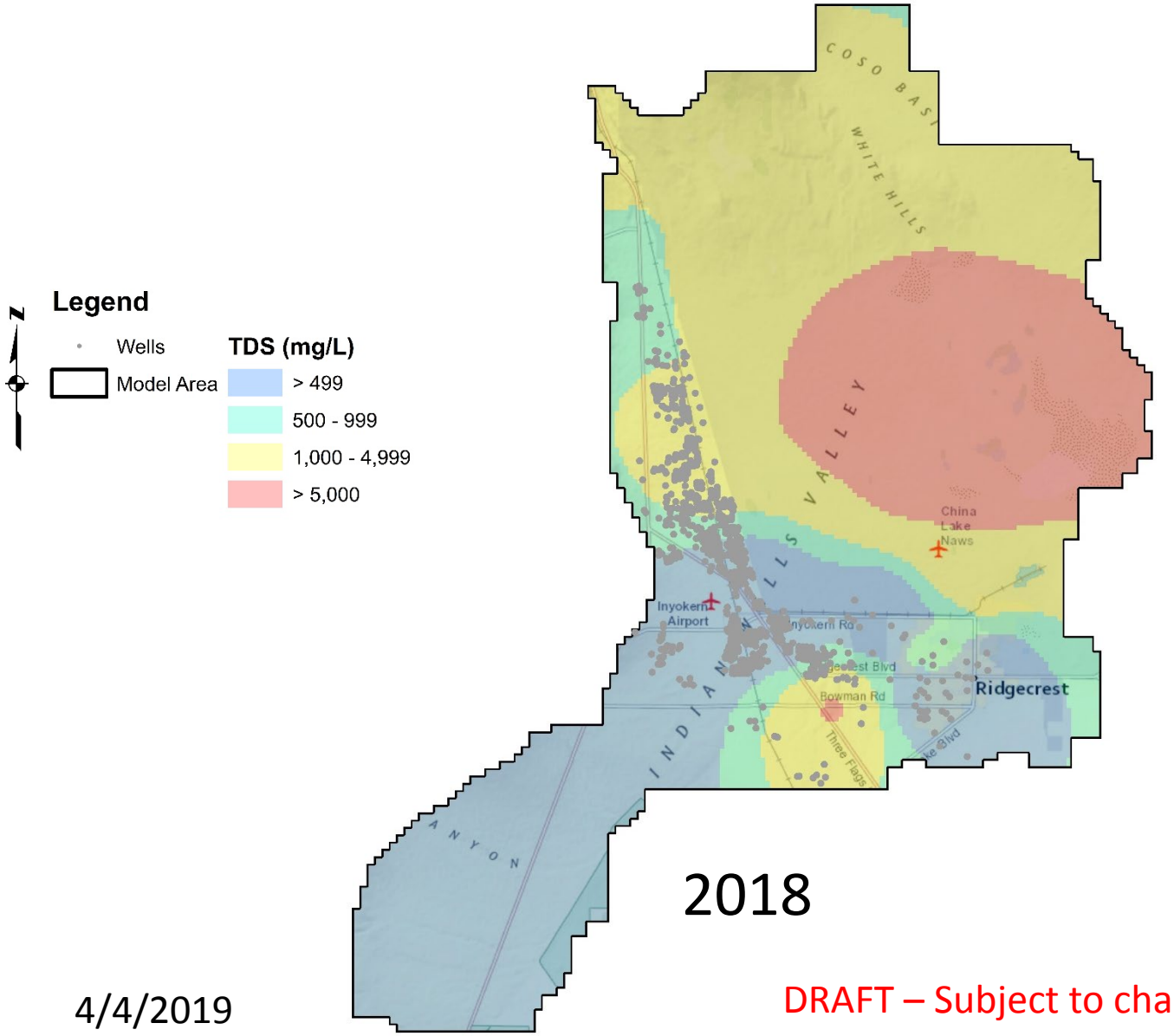
2068

DRAFT – Subject to change

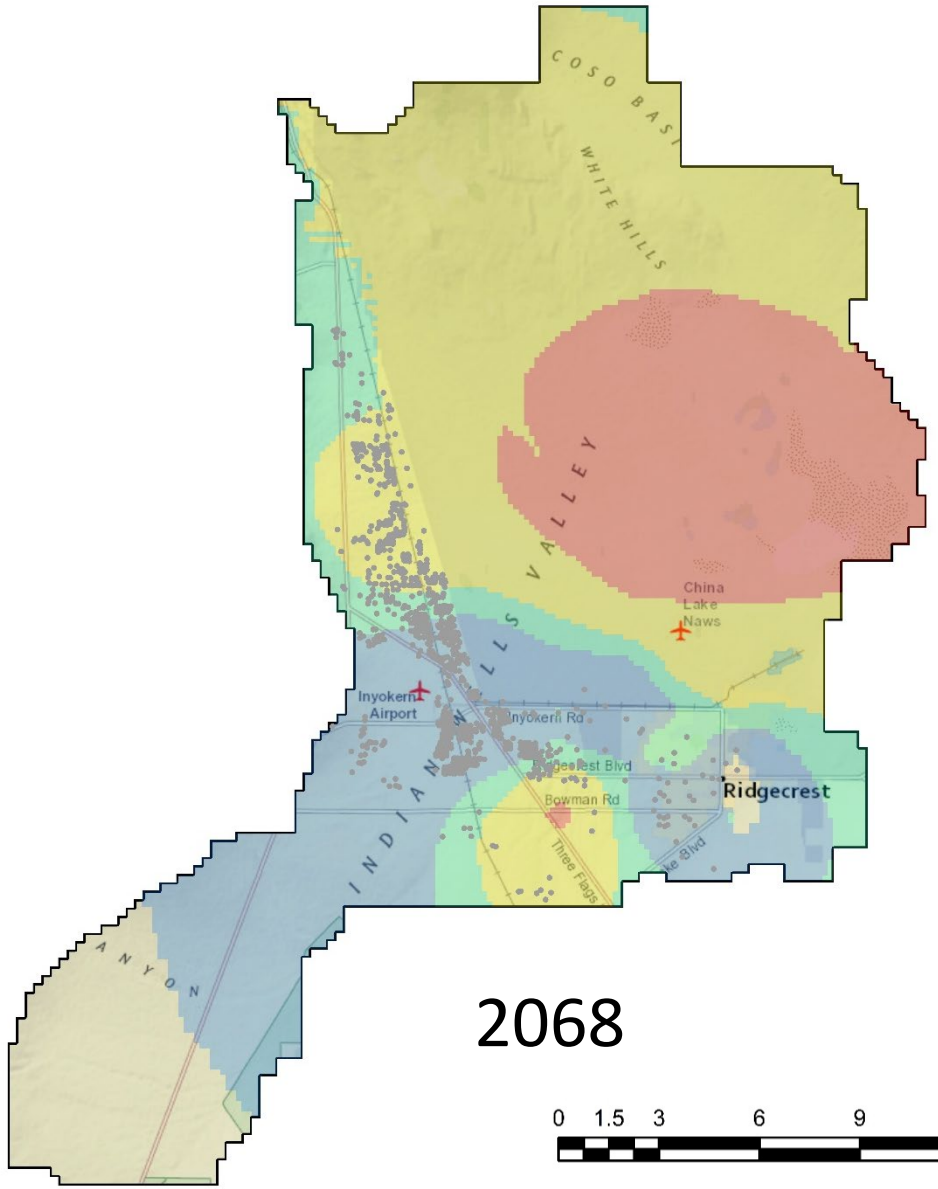
0 1.5 3 6 9 12 Miles

4/4/2019

Simulated TDS Concentration - Deep



2018



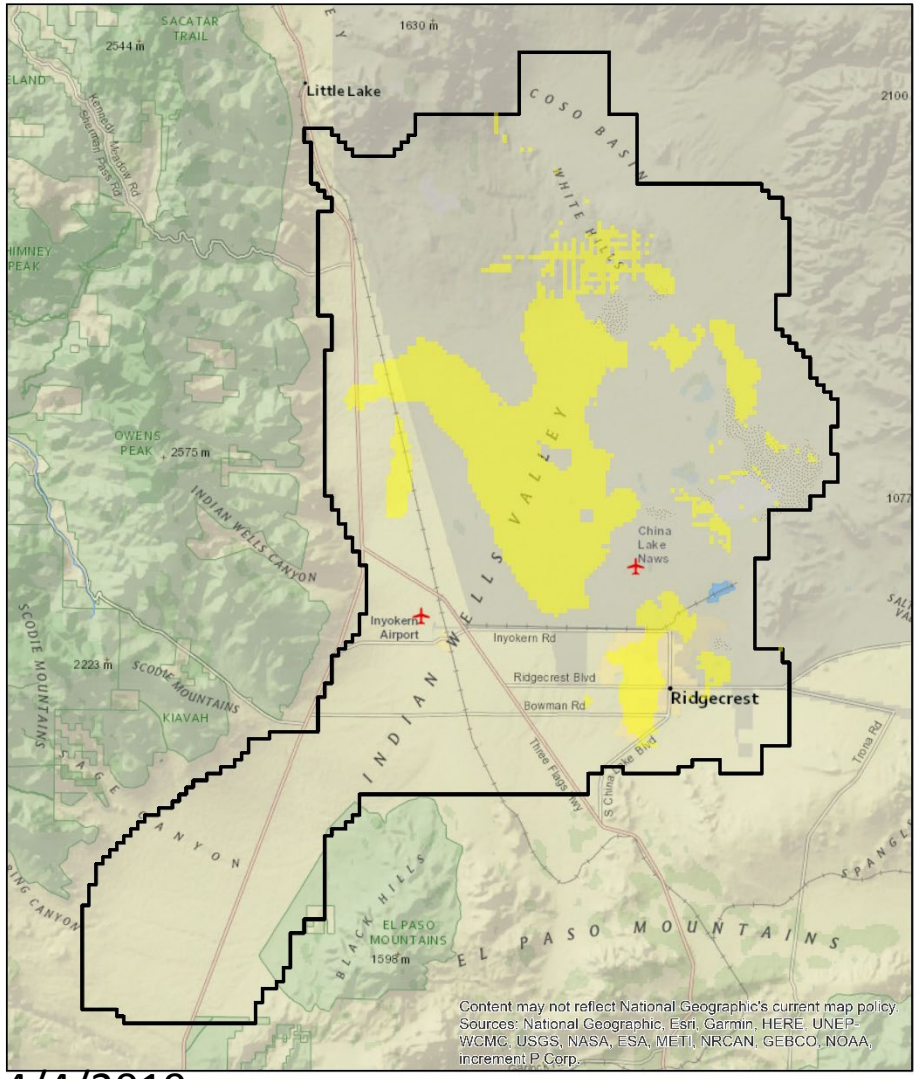
2068

0 1.5 3 6 9 12 Miles

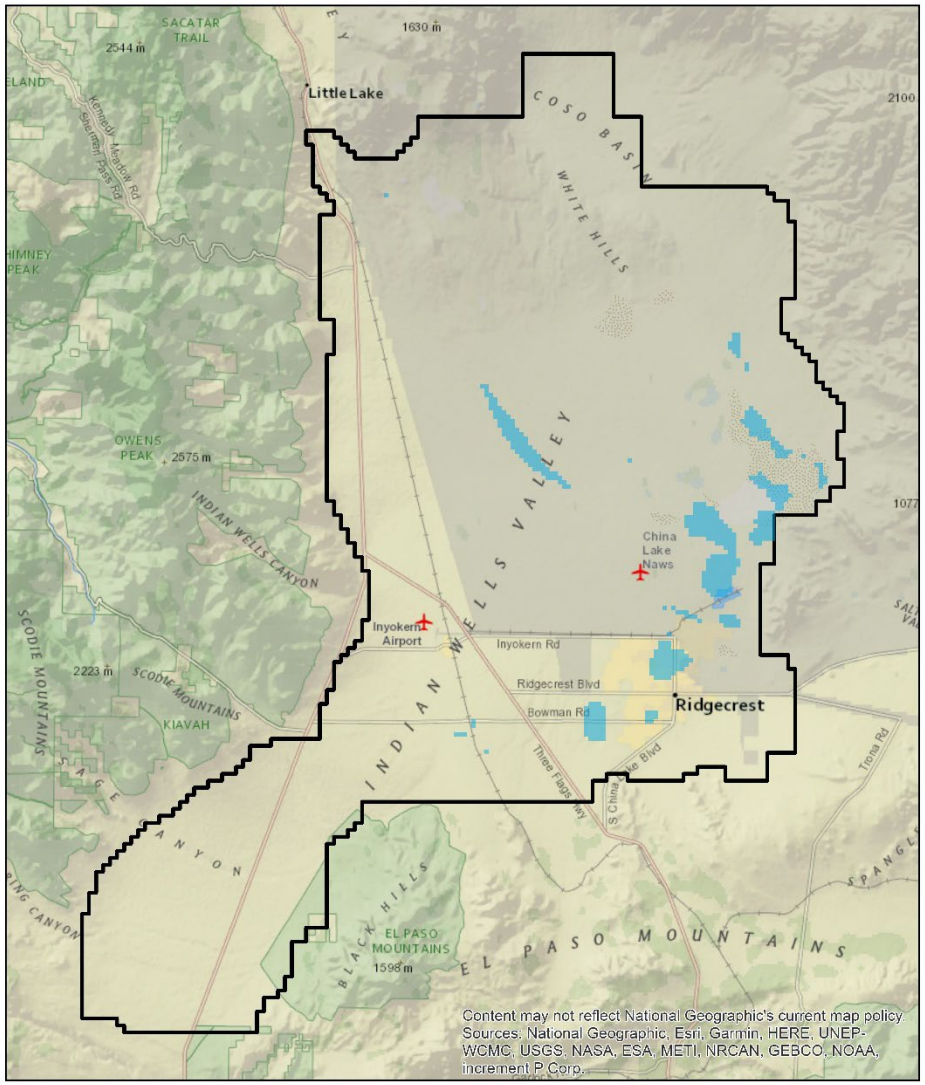
DRAFT – Subject to change

4/4/2019

Simulated TDS Trends (2020 – 2070)



Colored areas represent zones where rate > 5 mg/L/yr



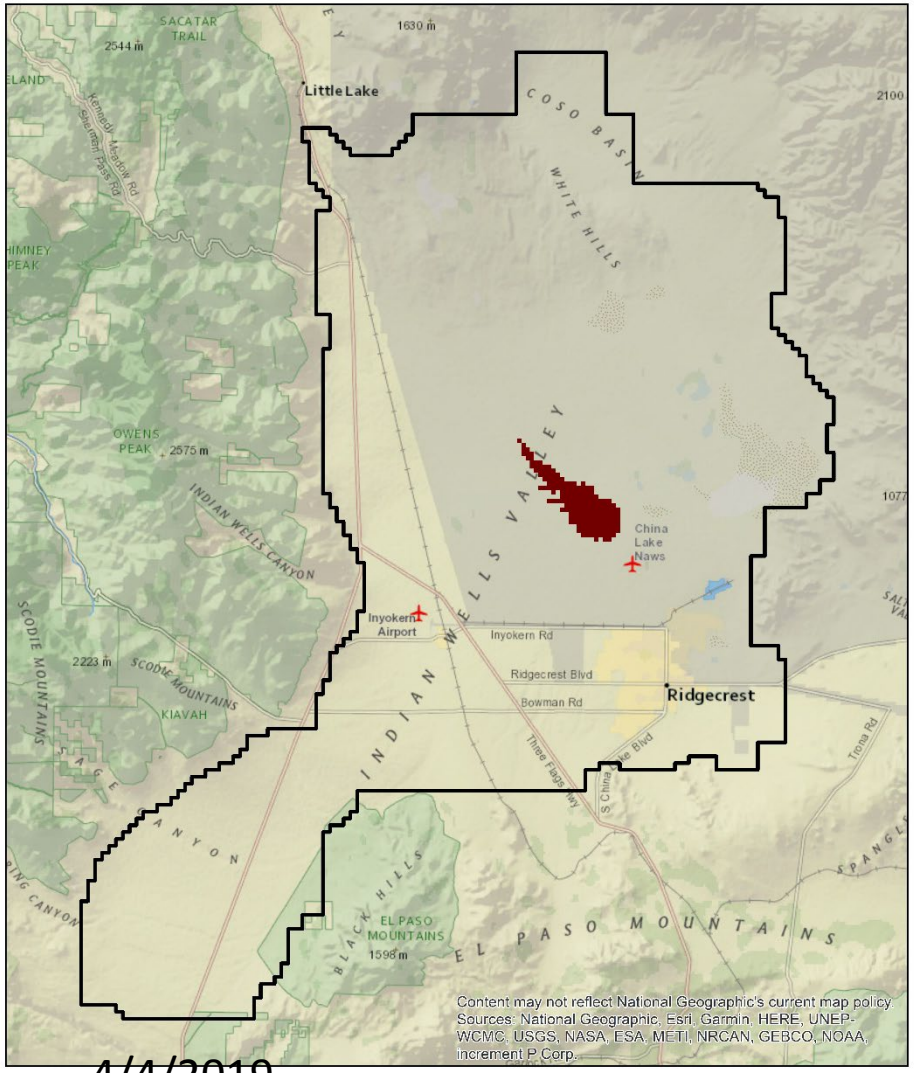
4/4/2019

Shallow

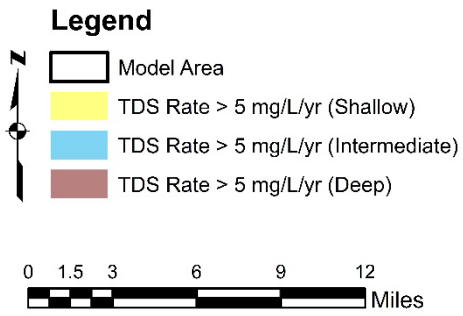
DRAFT – Subject to change

Intermediate

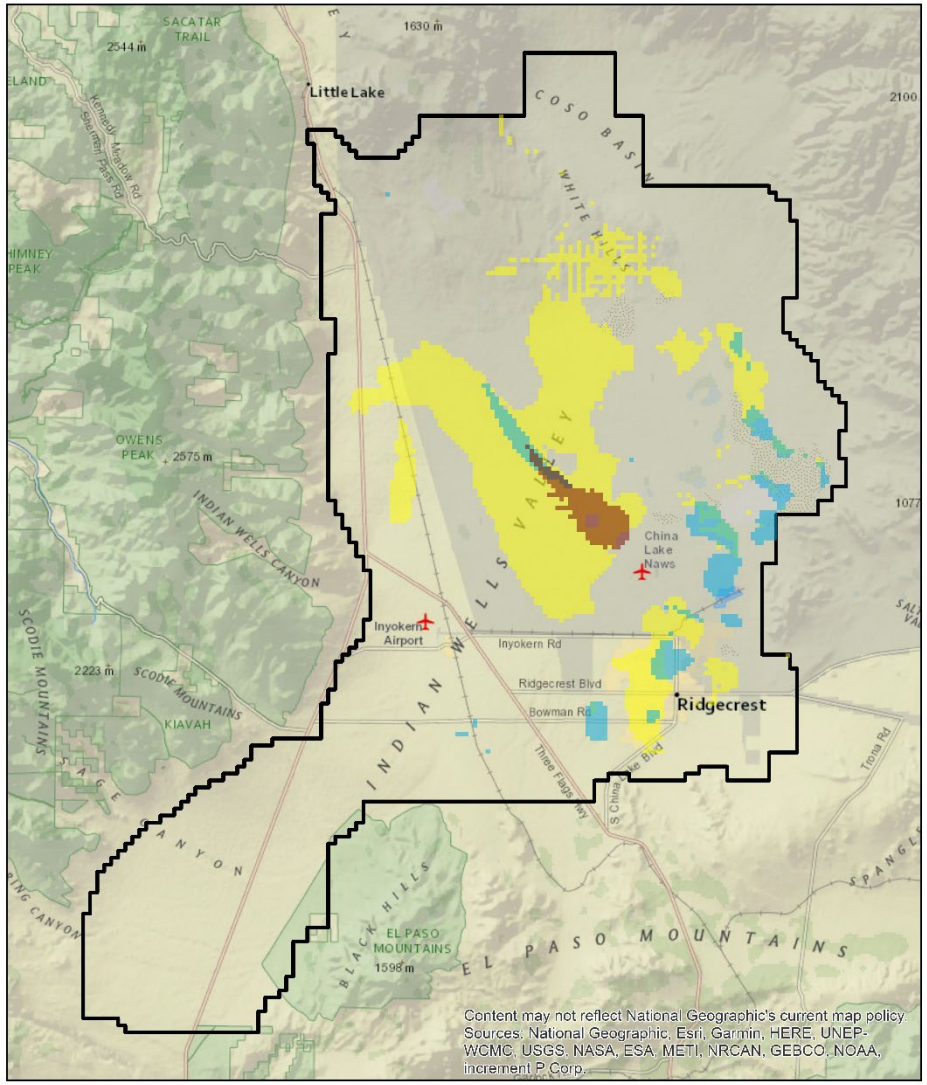
Simulated TDS Trends (2020 – 2070)



Deep



DRAFT – Subject to change



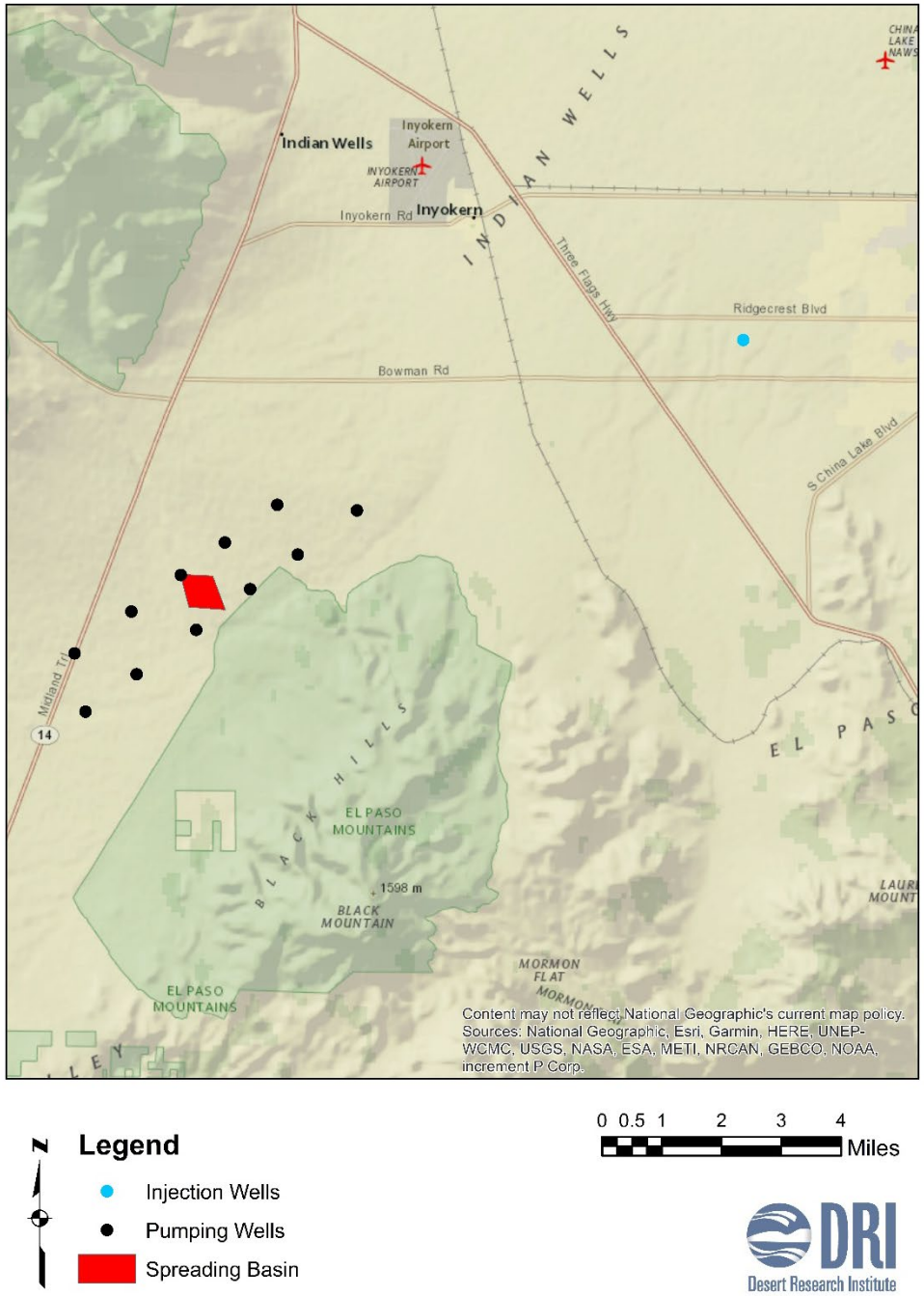
All Zones

Indian Wells Valley

MANAGEMENT SCENARIO NO. 1 MODELING RESULTS

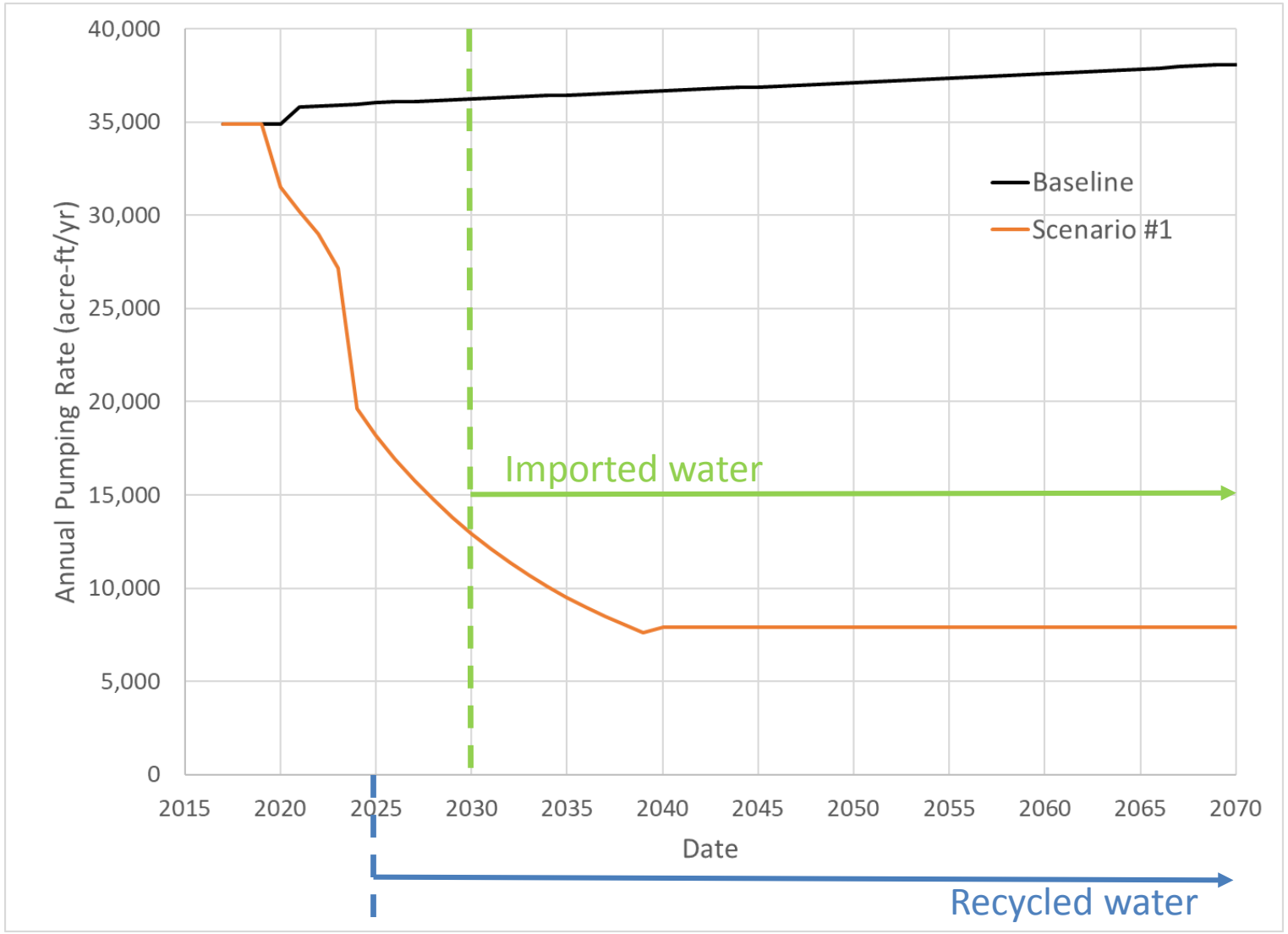
Management Scenario 1

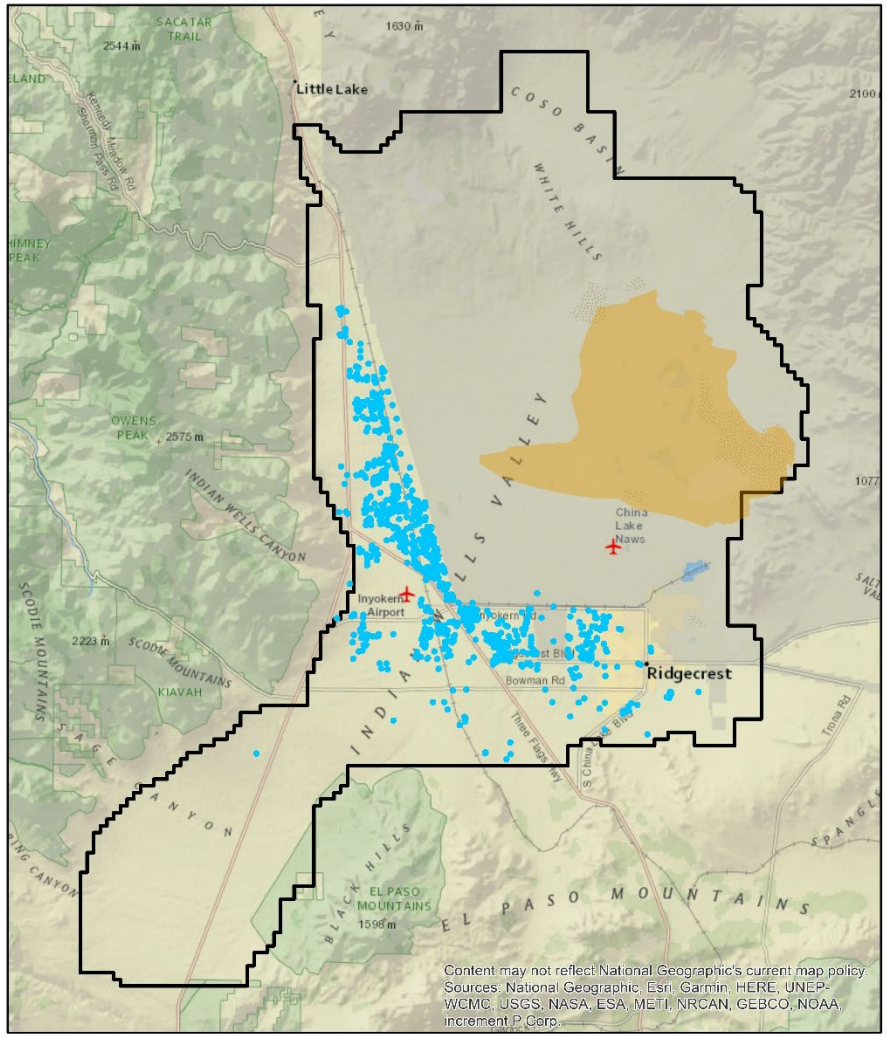
- Pumping
  - Cliff
  - Ramp Down
  - Leasing
- Imported Water
  - Begins 2030
  - Spreading basins: Dec – Apr (15,000 AFY)
  - Pumping: May – Nov (15,000 AFY)
- Recycled Water
  - Begins 2025
  - Injected (352 AFY)



DRAFT – Subject to change

Simulated Pumping





Legend

- Wells
- ET Zone
- Model Area

0 2 4 8 12 16 Miles

N

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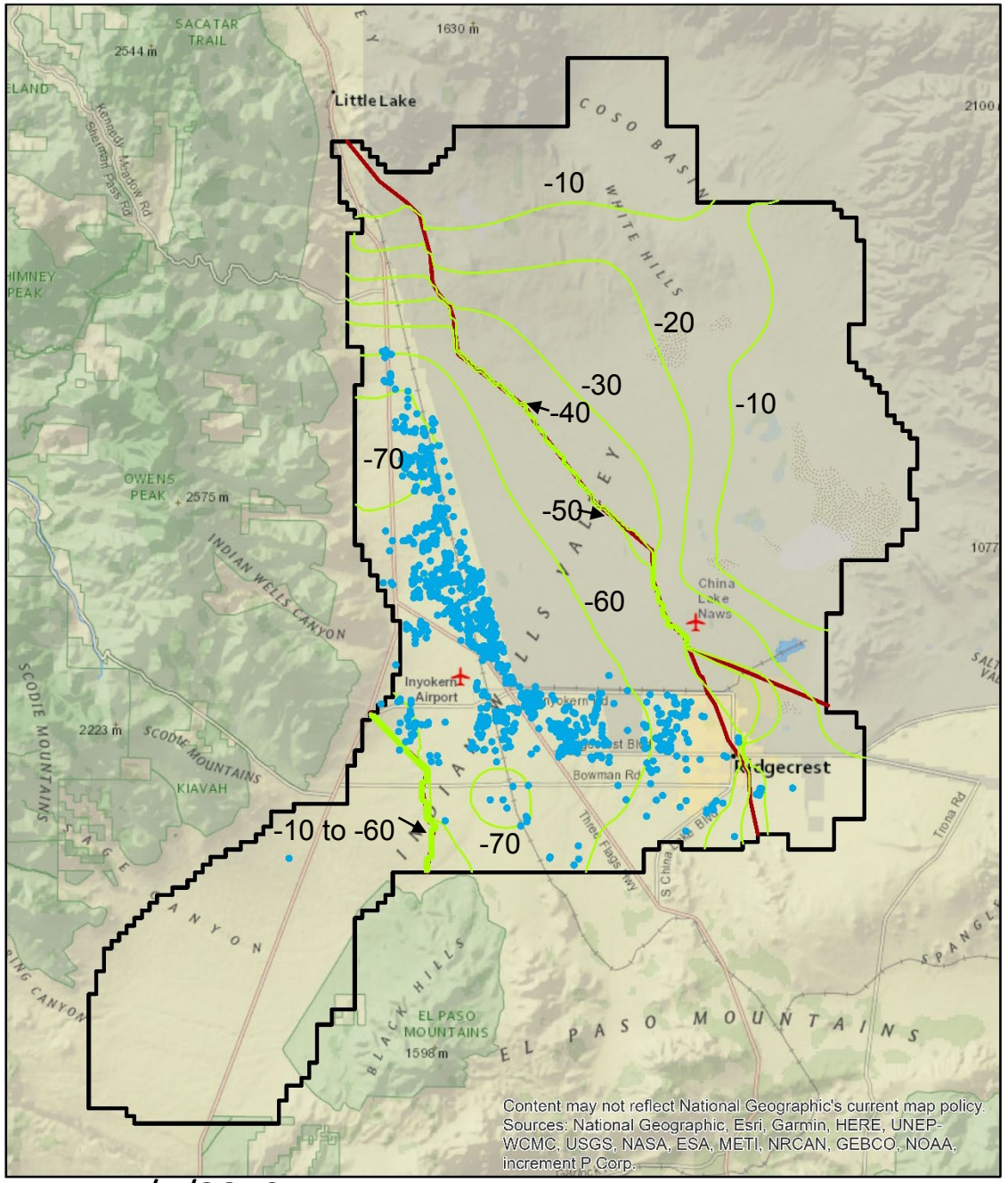
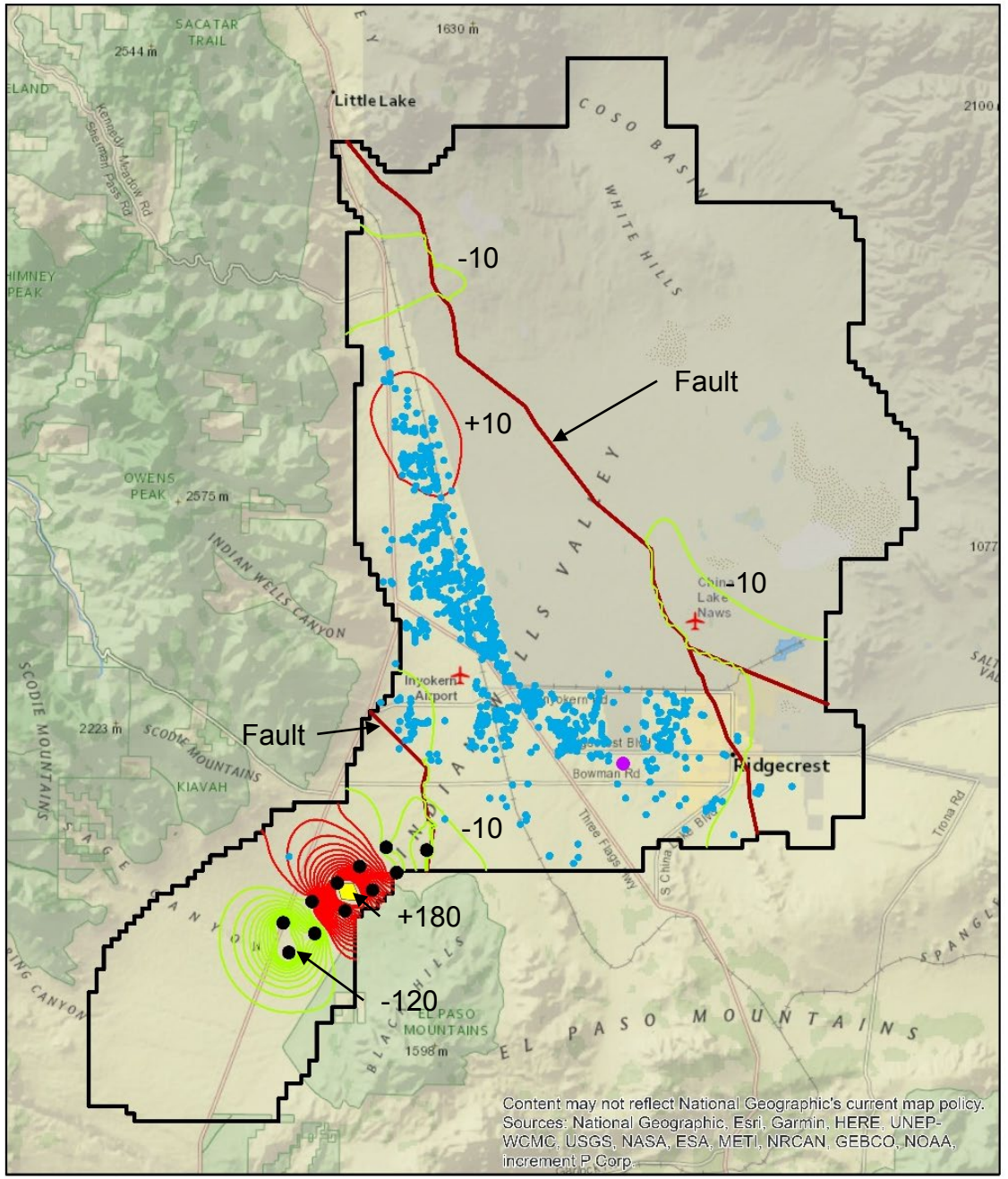
DRAFT – Subject to change

Water Level Change (2020-2070)



4/4/2019

Baseline



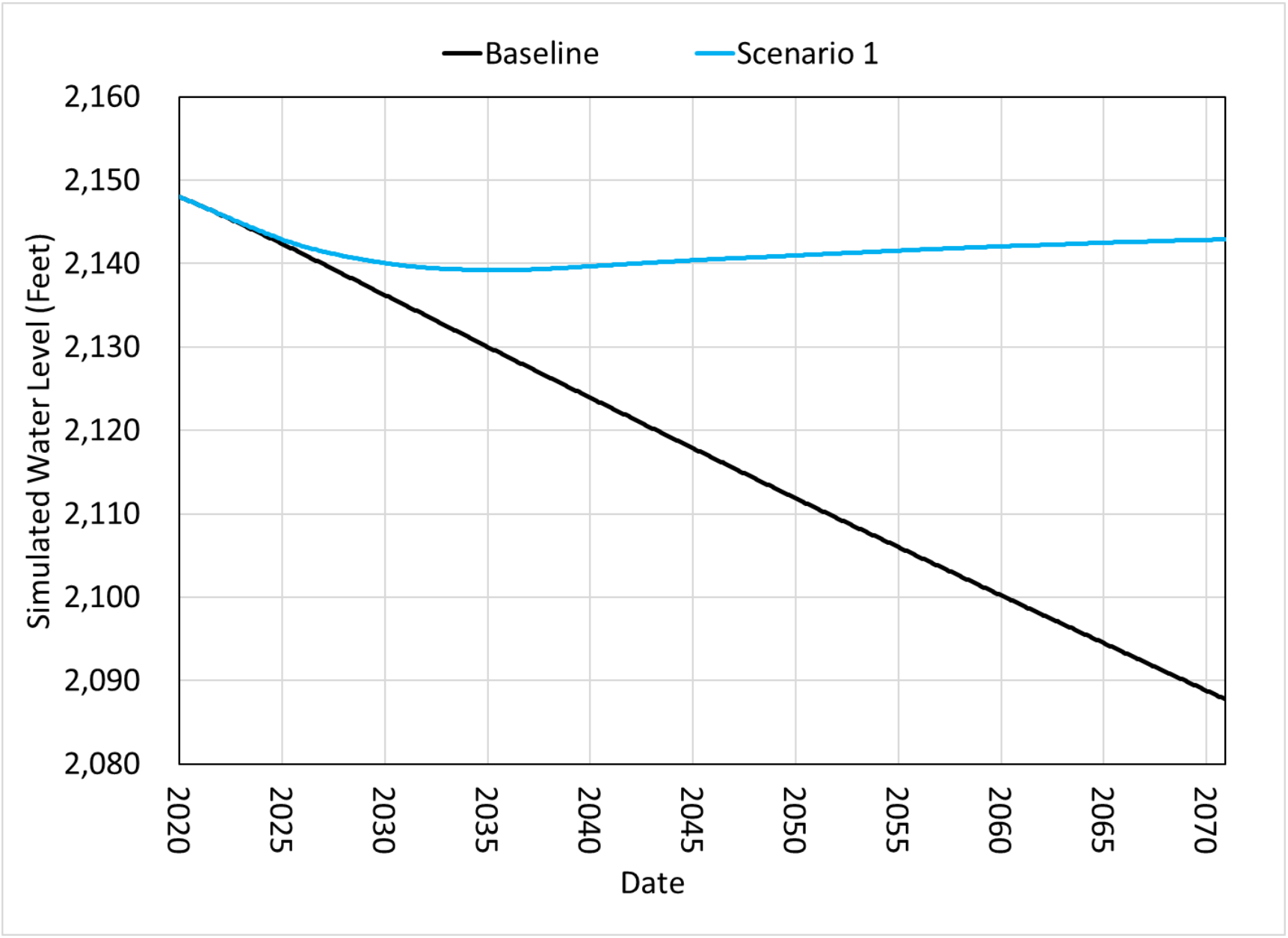
Rising

Falling

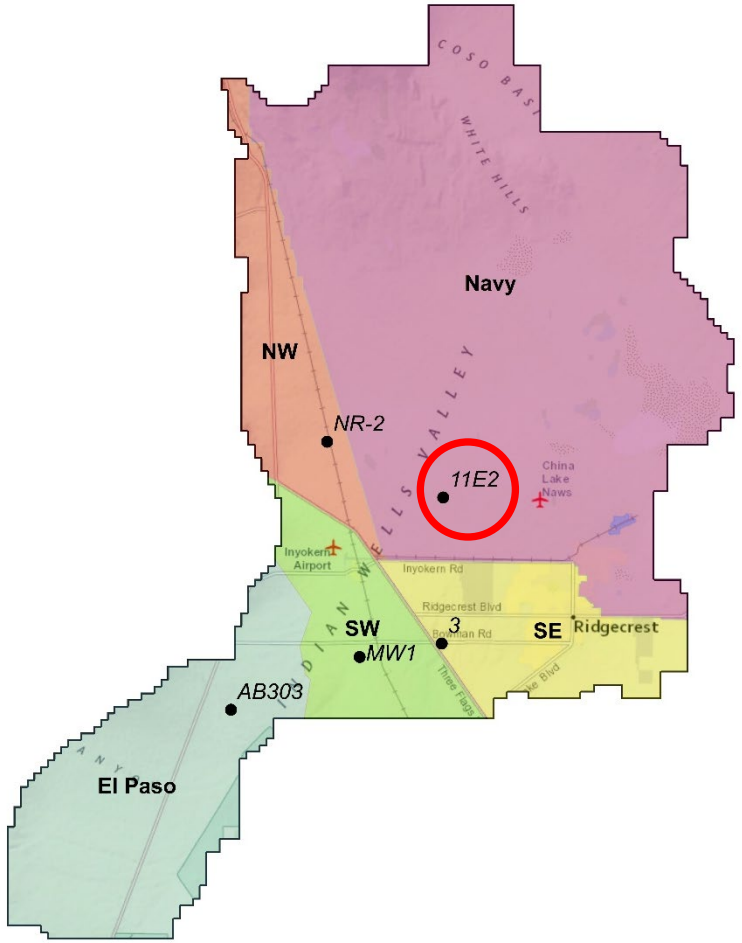
Scenario #1

DRAFT – Subject to change

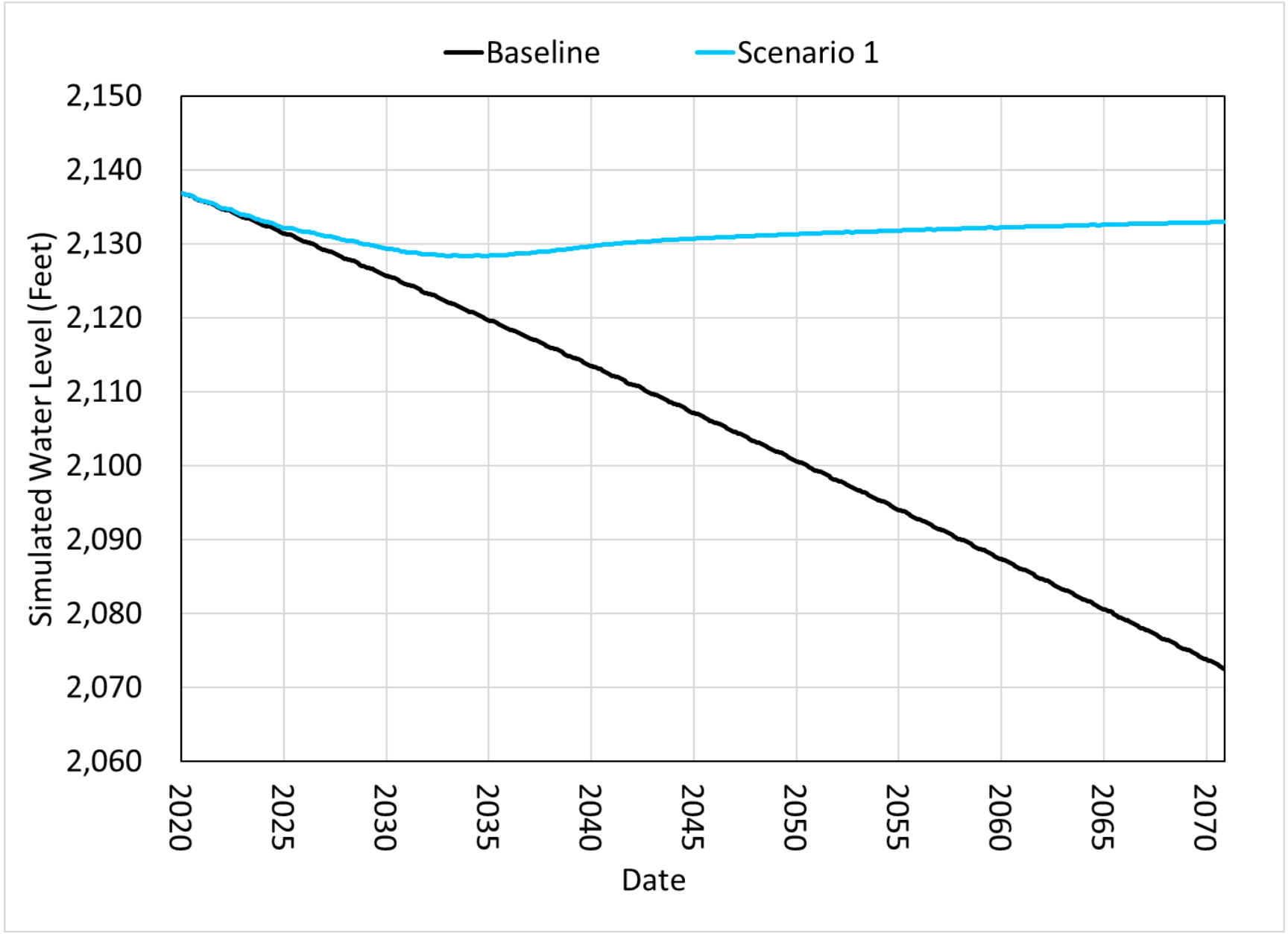
Units: feet



11E2



DRAFT – Subject to change



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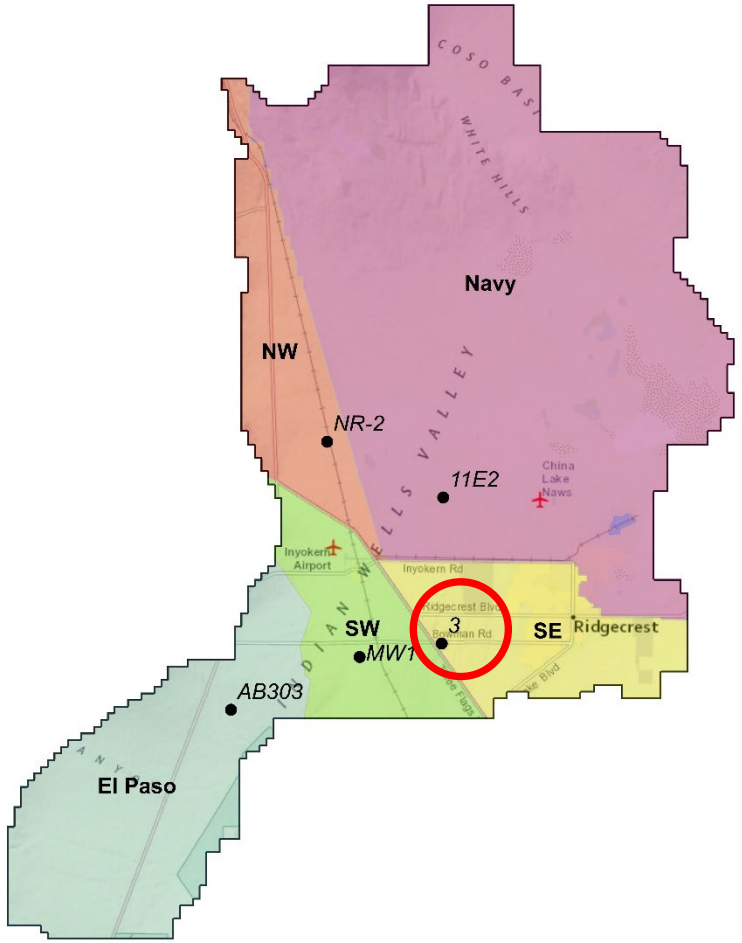
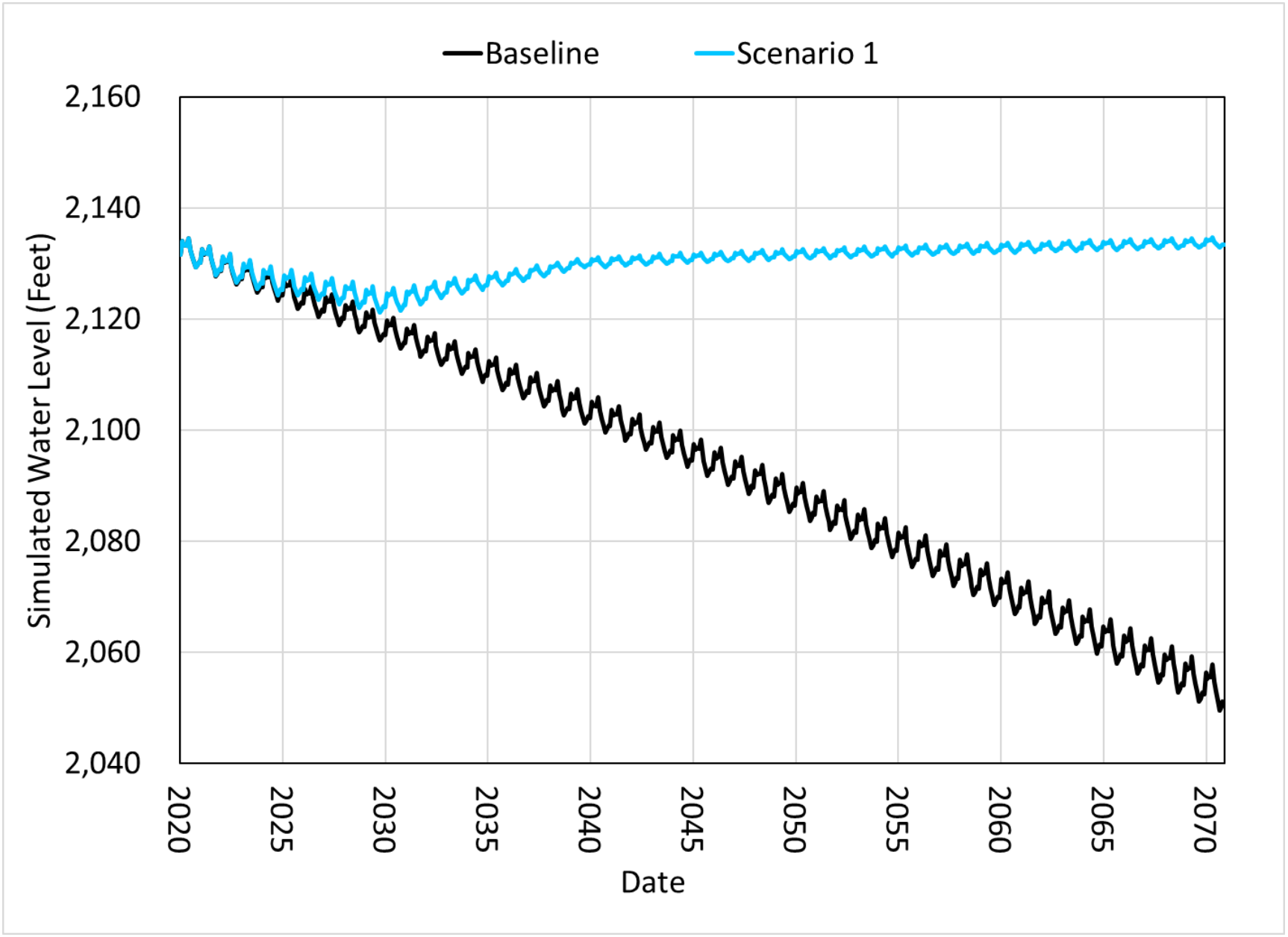
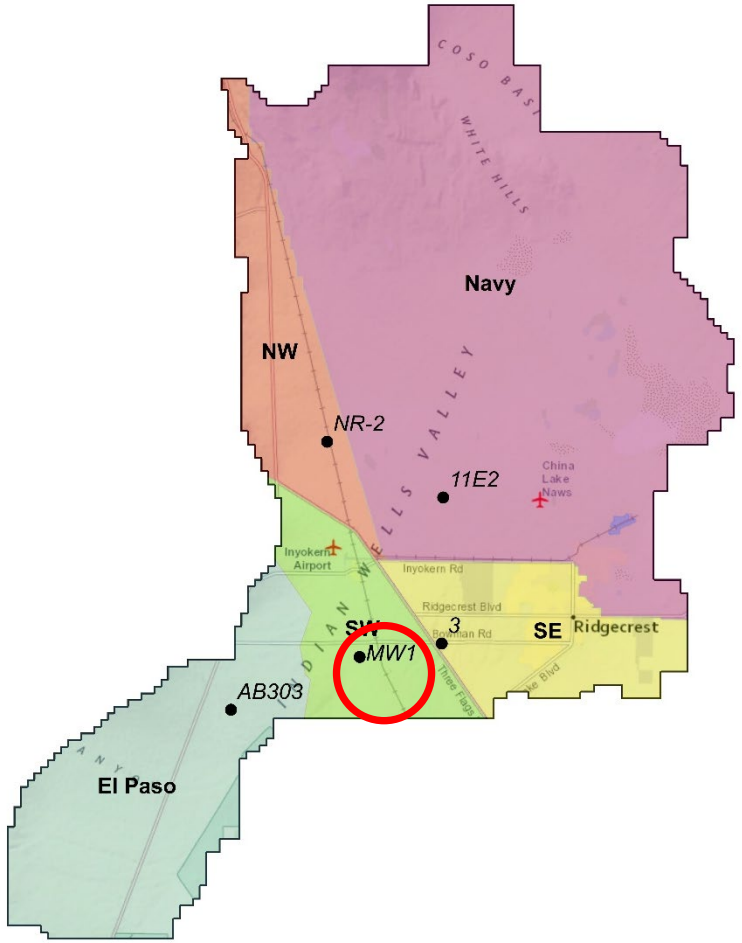


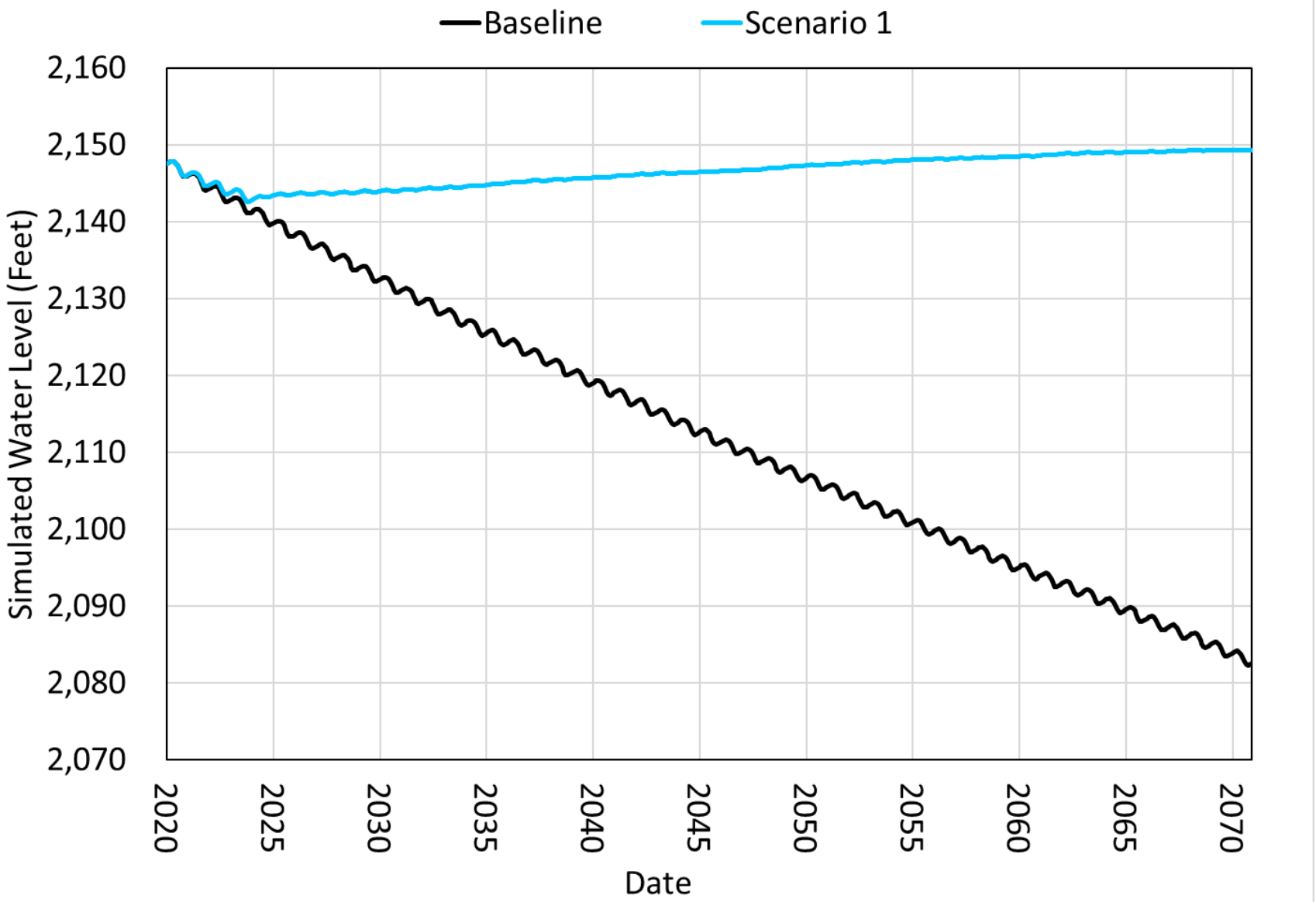
DRAFT – Subject to change



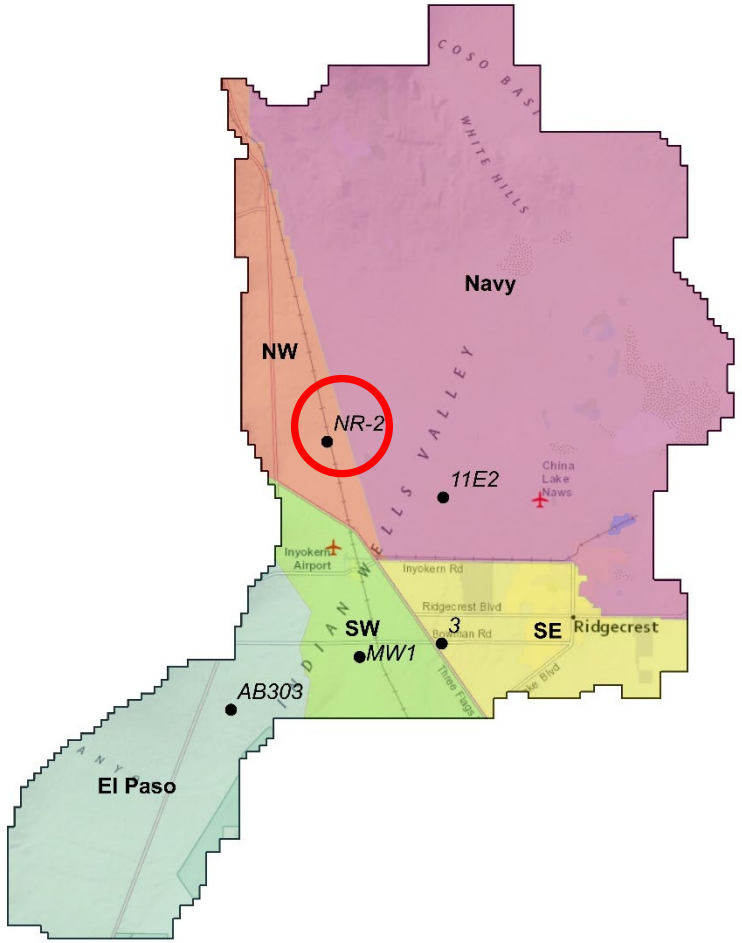
MW-1



DRAFT – Subject to change

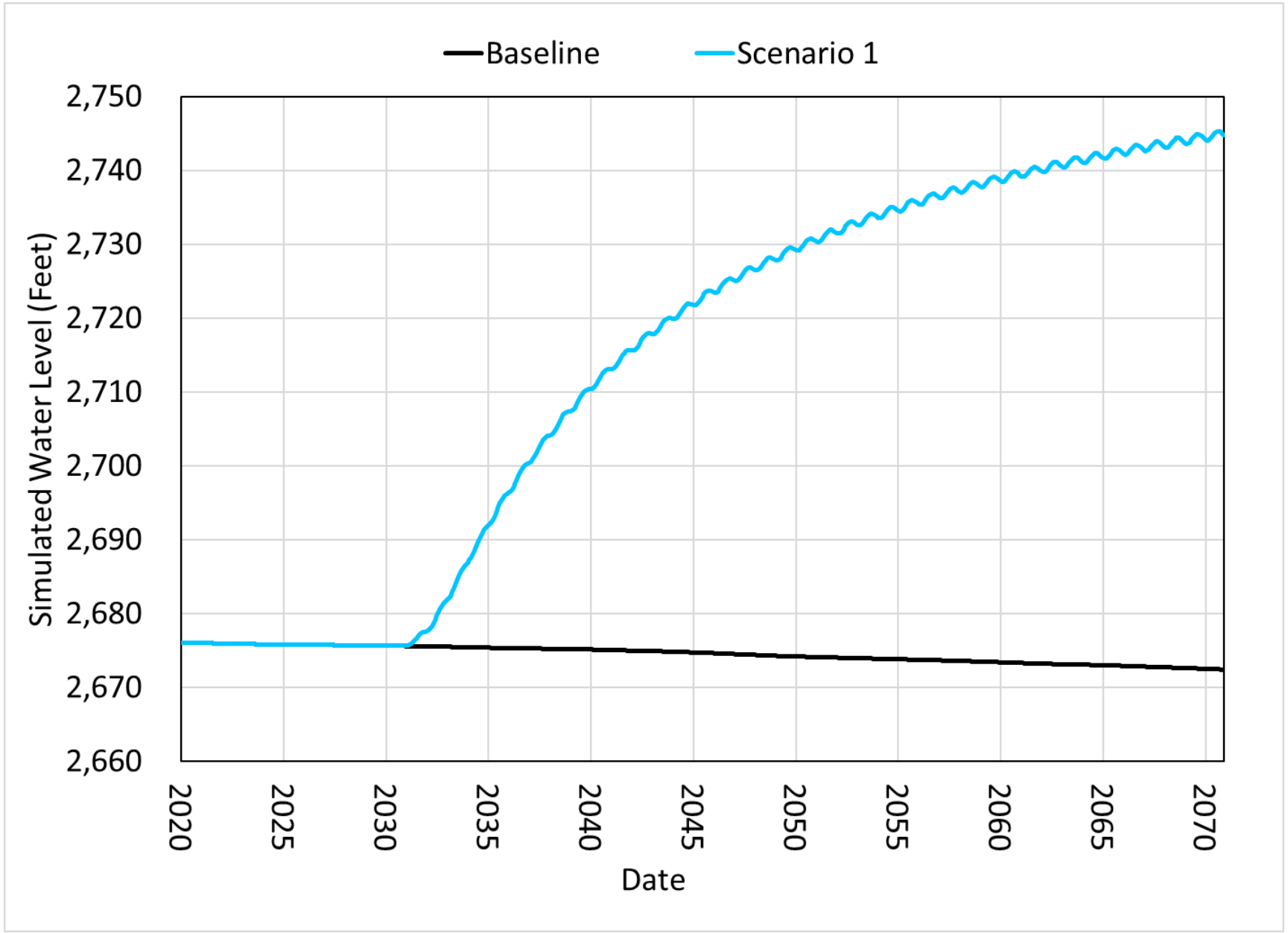


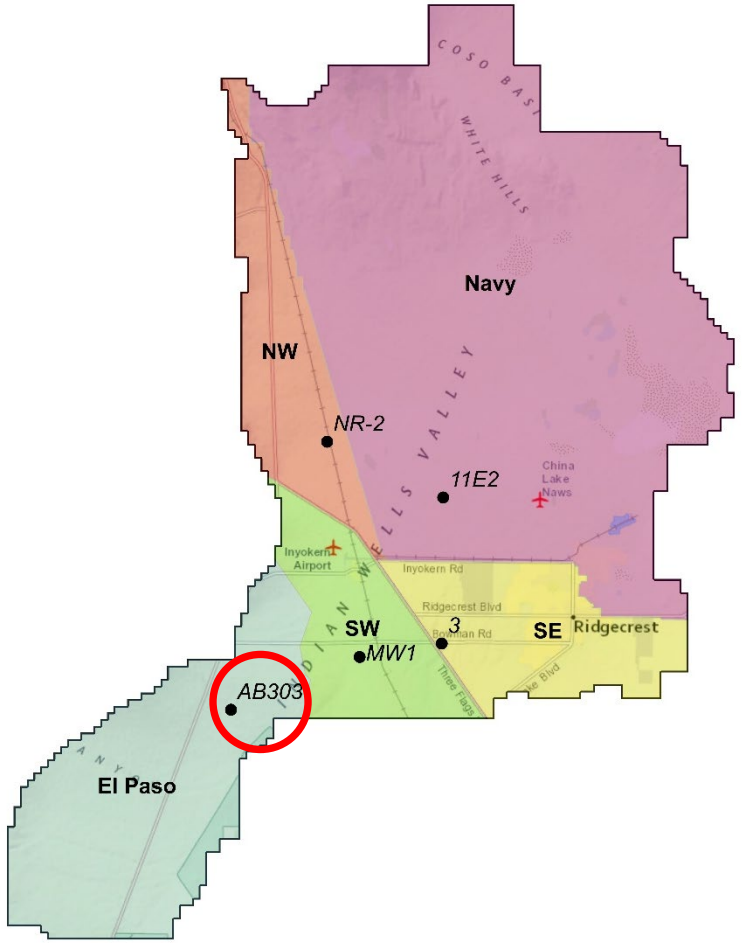
NR-2



DRAFT – Subject to change

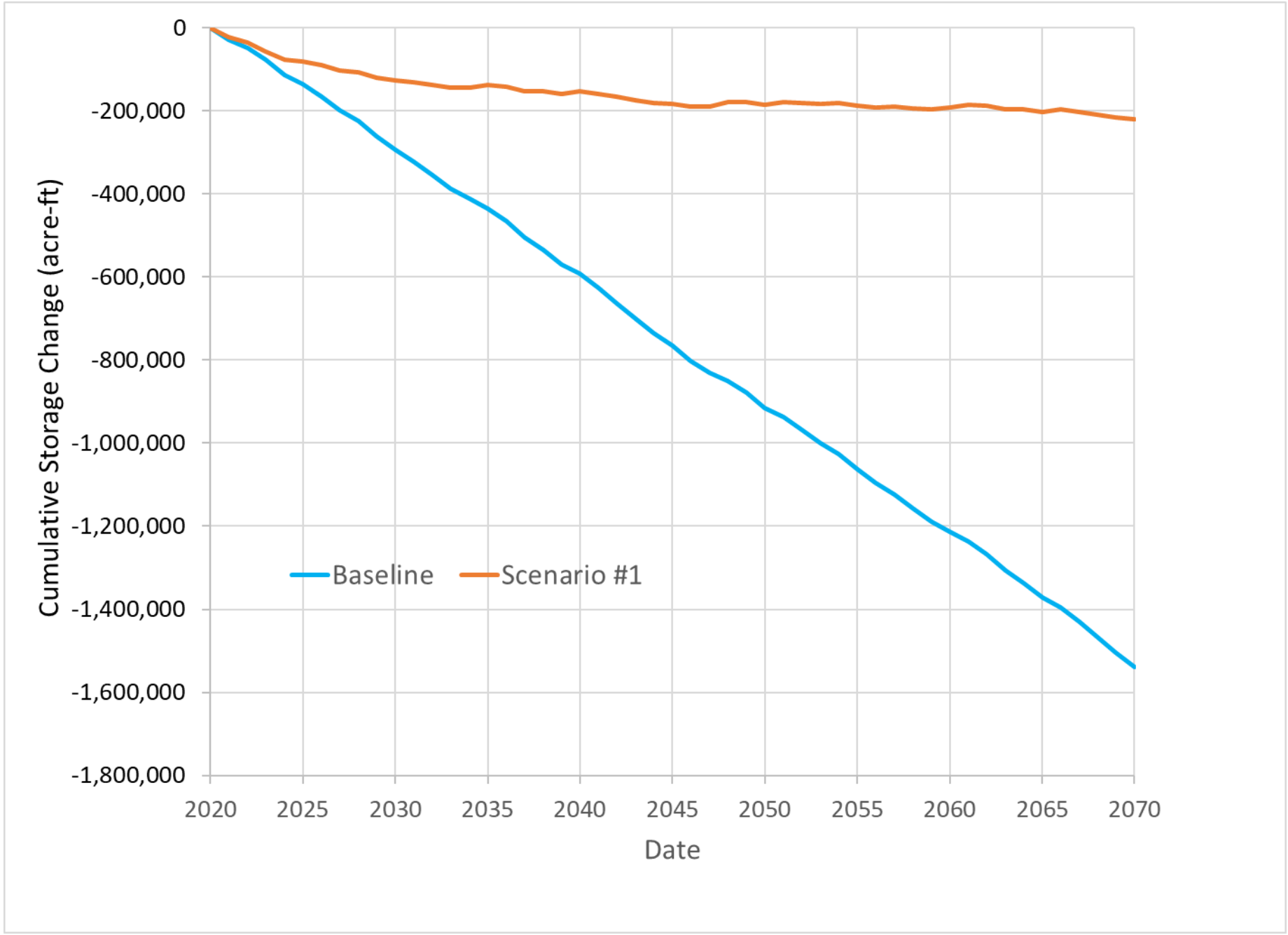
AB303(6)





DRAFT – Subject to change

Scenario #1 Change in Groundwater Storage



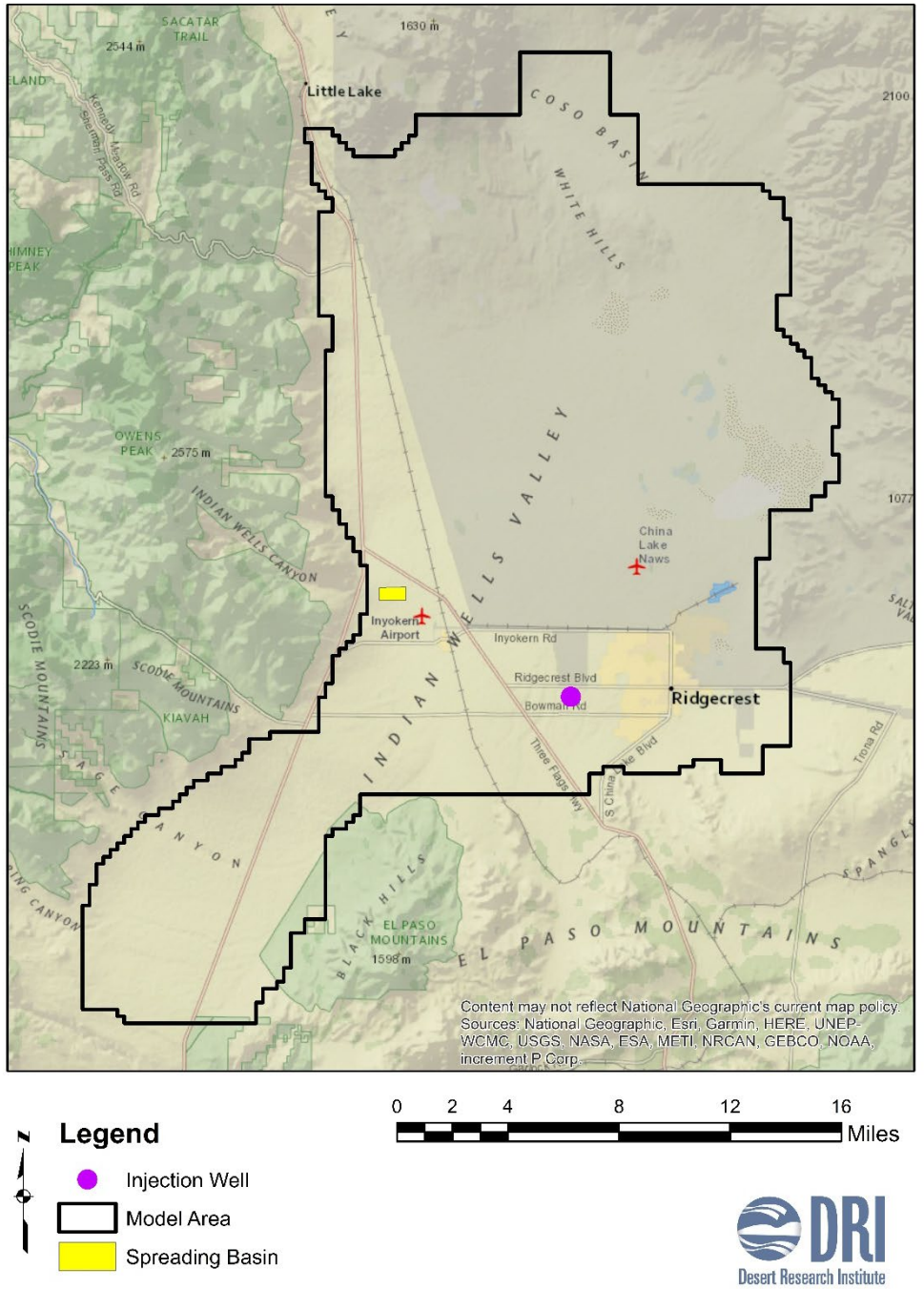
DRAFT – Subject to change

Indian Wells Valley

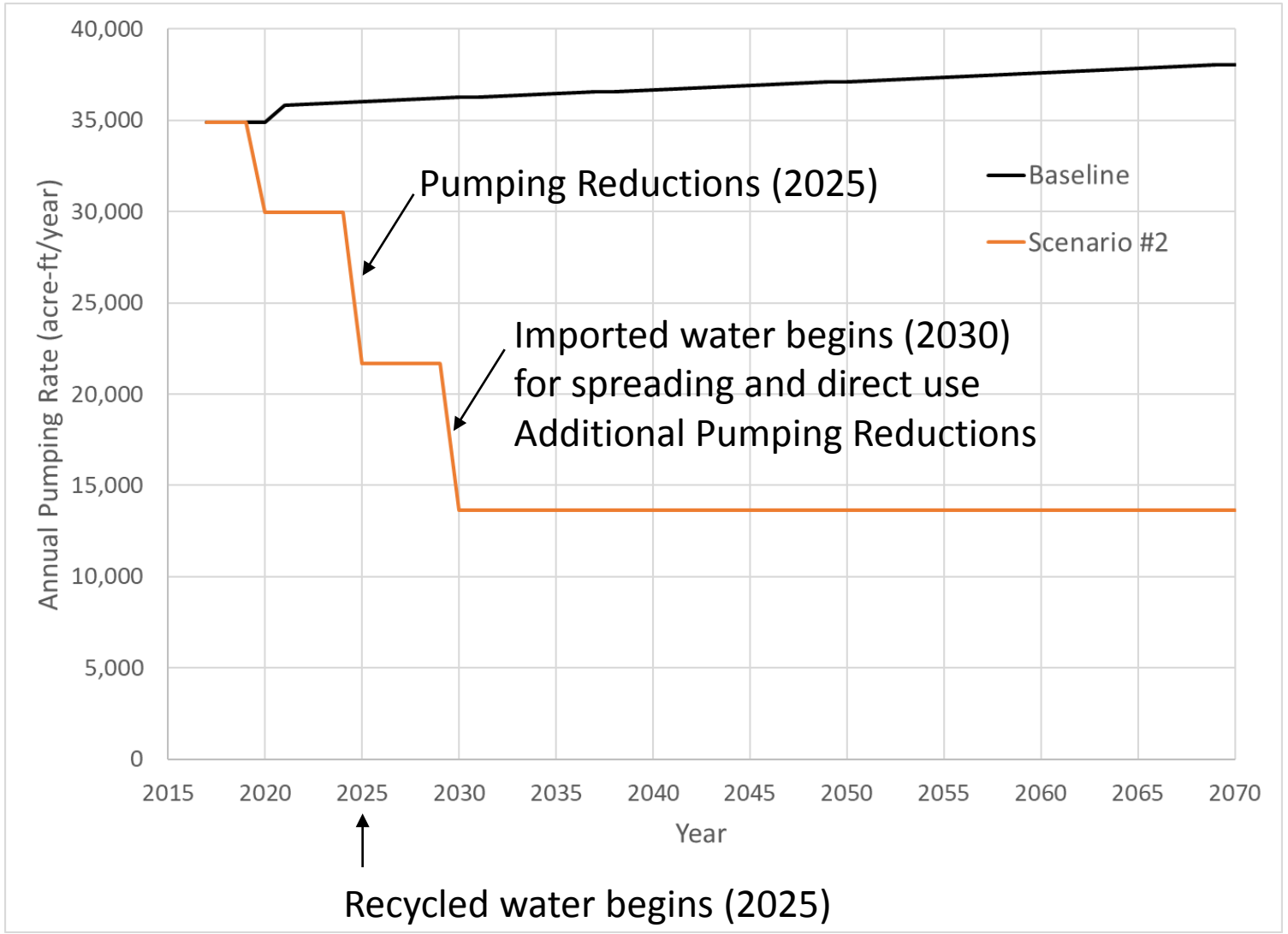
MANAGEMENT SCENARIO NO. 2 MODELING RESULTS

Management Scenario 2

- Pumping
  - Step Down in 2025 and 2030
- Imported Water
  - Begins 2030
  - Spreading and Direct Use
- Recycled Water
  - Begins 2025
  - Injected (352 AFY)



Simulated Pumping



2020 Pumping = 29,940 AF

2025 Pumping = 21,680 AF

No Reduction	Navy
No Reduction	Domestic
No Reduction	SVM
10% Reduction	IWVWD
10% Reduction	Mutuals, CSD
30% Reduction	Kern County
40% Reduction	Agriculture
No Pumping	City (Recycled Water)

2030 Pumping = 13,650 AF

No Reduction	Navy
No Reduction	Domestic
No Pumping	SVM (Direct Use)
No Pumping	IWVWD (Direct Use)
No Addtnl Reduction	Mutuals, CSD
No Addtnl Reduction	Kern County
No Addtnl Reduction	Agriculture
No Pumping	City (Recycled Water)

2030 through 2070 Pumping = 13,650 AFY

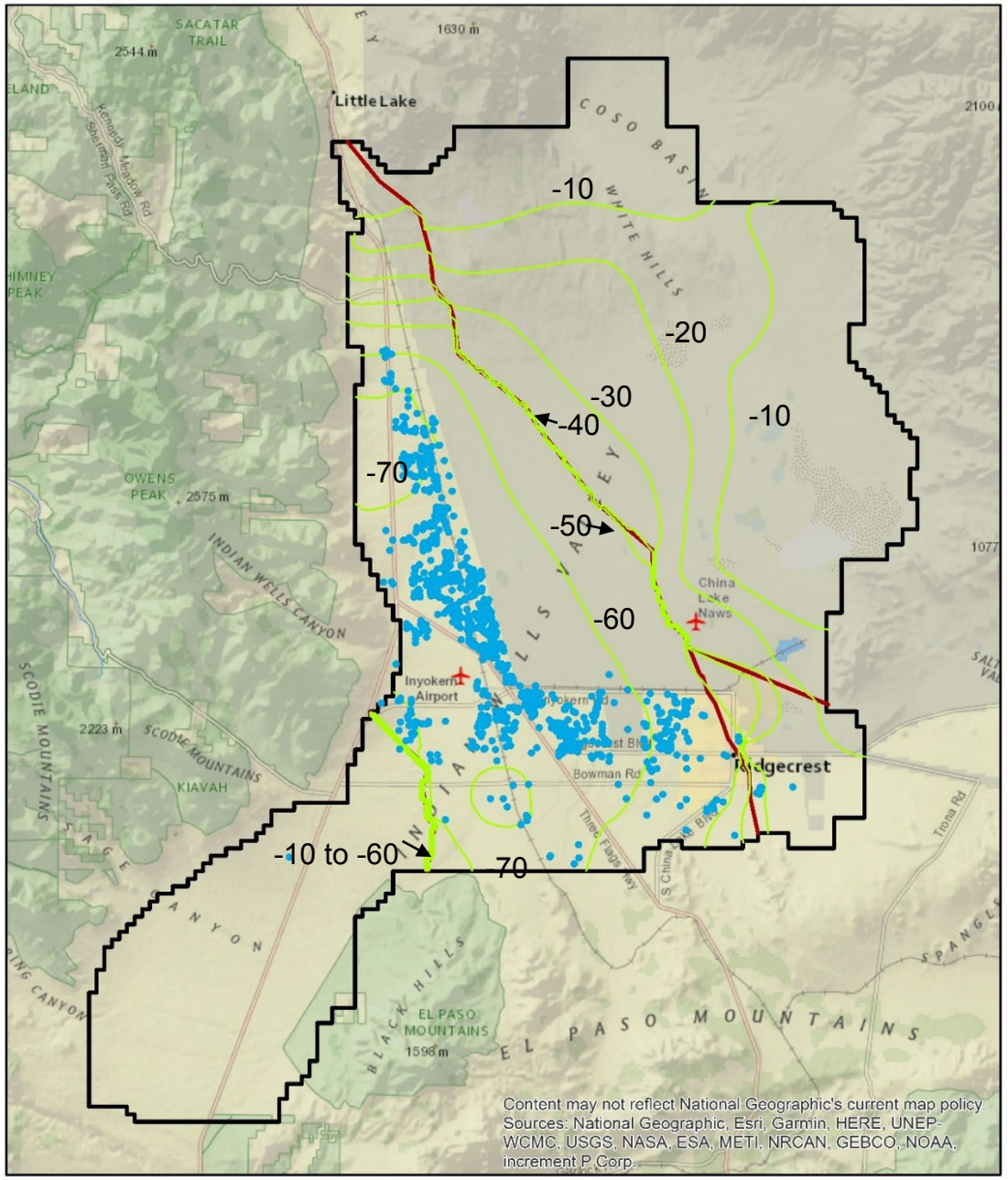
DRAFT – Subject to change

Groundwater Basin Budget

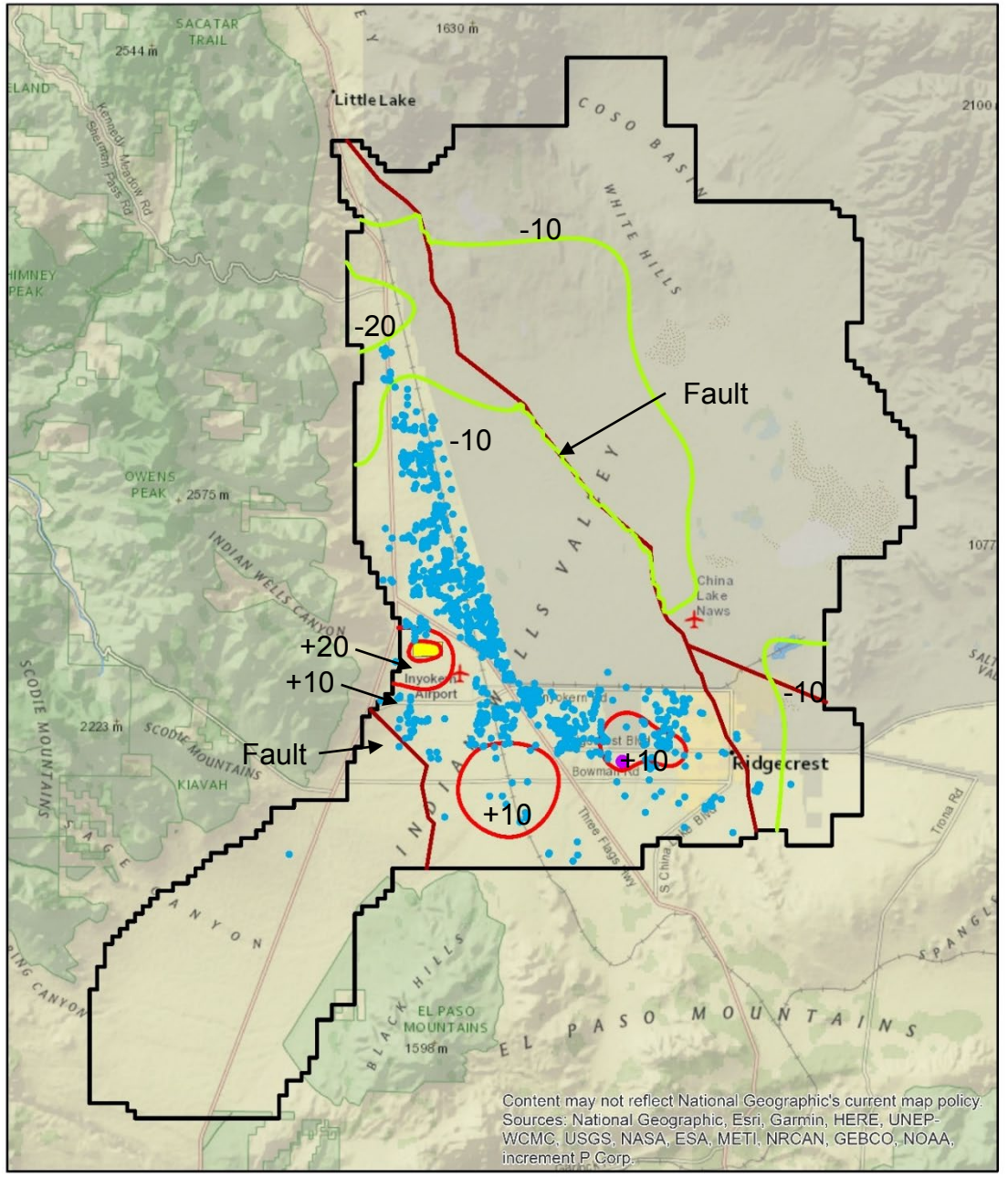
	BASELINE (2020 - 2070)	SCENARIO #2 (2020 - 2025)	SCENARIO #2 (2035 - 2040)	SCENARIO #2 (2065 - 2070)
INFLOW				
Natural Recharge	7,650	7,650*	7,650*	7,650*
Imported Water Recharge	-	-	5,640	5,640
Recyled Water Recharge	-	-	350	350
TOTAL	7,650	-	13,640	13,640
OUTFLOW				
Pumping	36,880	29,940	13,650	13,650
Evapotranspiration	1,610	2,634	1,950	1,230
Flow to Salt Wells Valley	40	65	46	16
TOTAL	38,530	32,639	15,645	14,896
CHANGE IN GW STORAGE	-30,880	-21,383	-1,221	-3,890

*Averaged over 2020 - 2070

DRAFT – Subject to change



50-Year Groundwater Level Change (2020-2070)



Rising

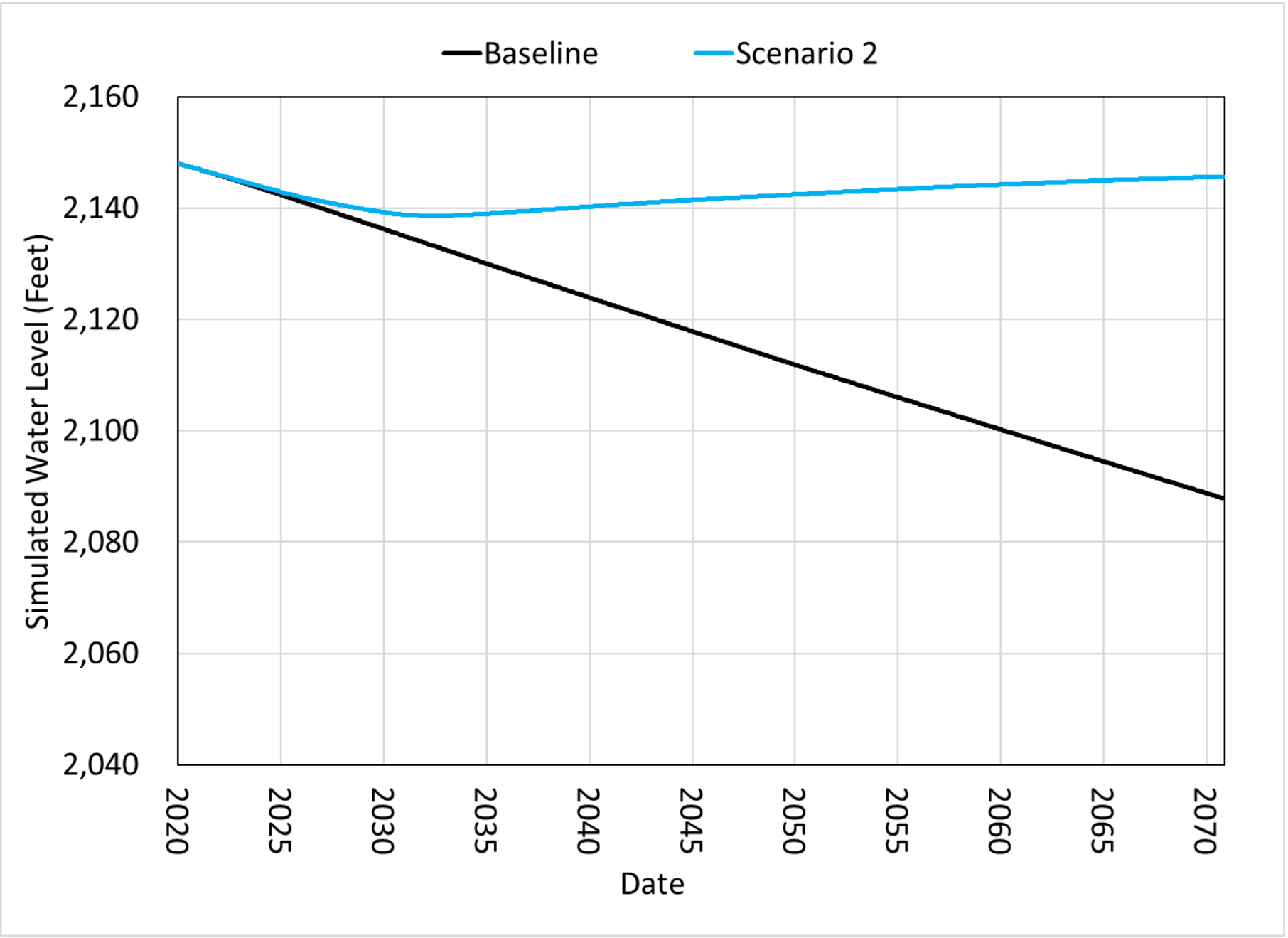
Falling

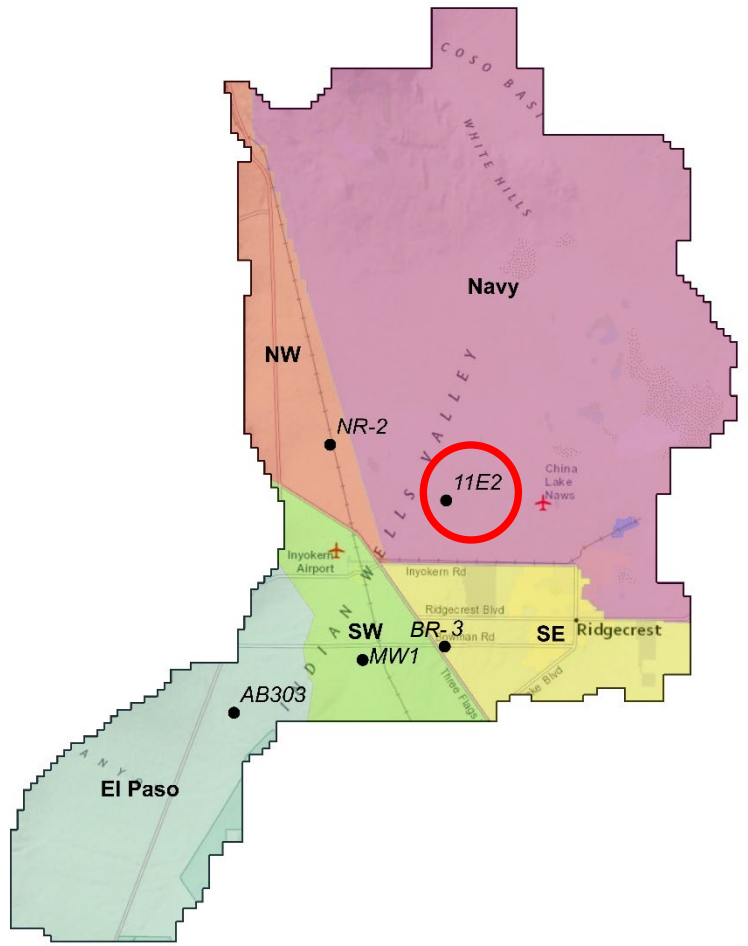
Baseline

From DRI March 7, 2019 TAC Presentation

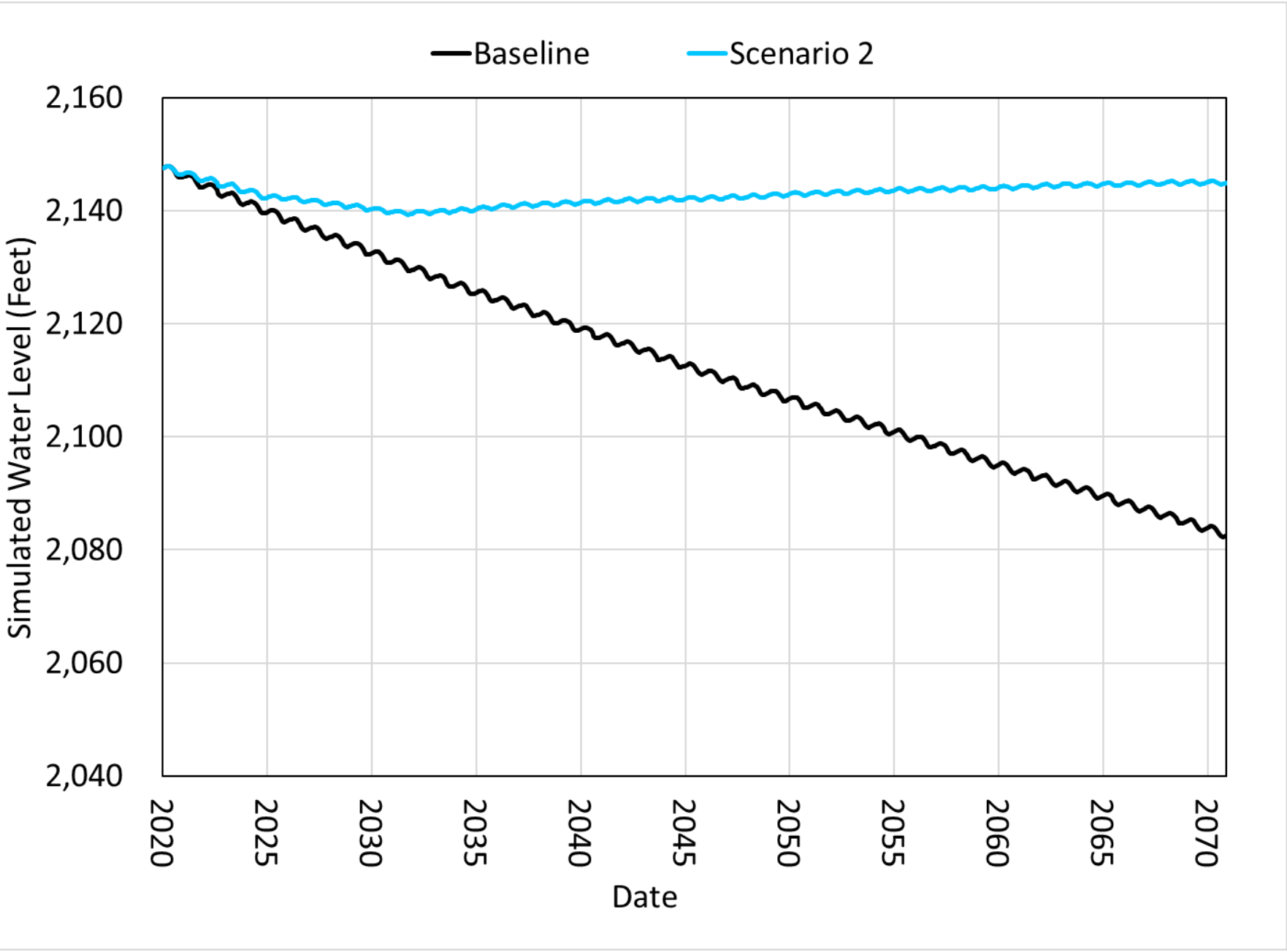
Scenario #2

Units: feet

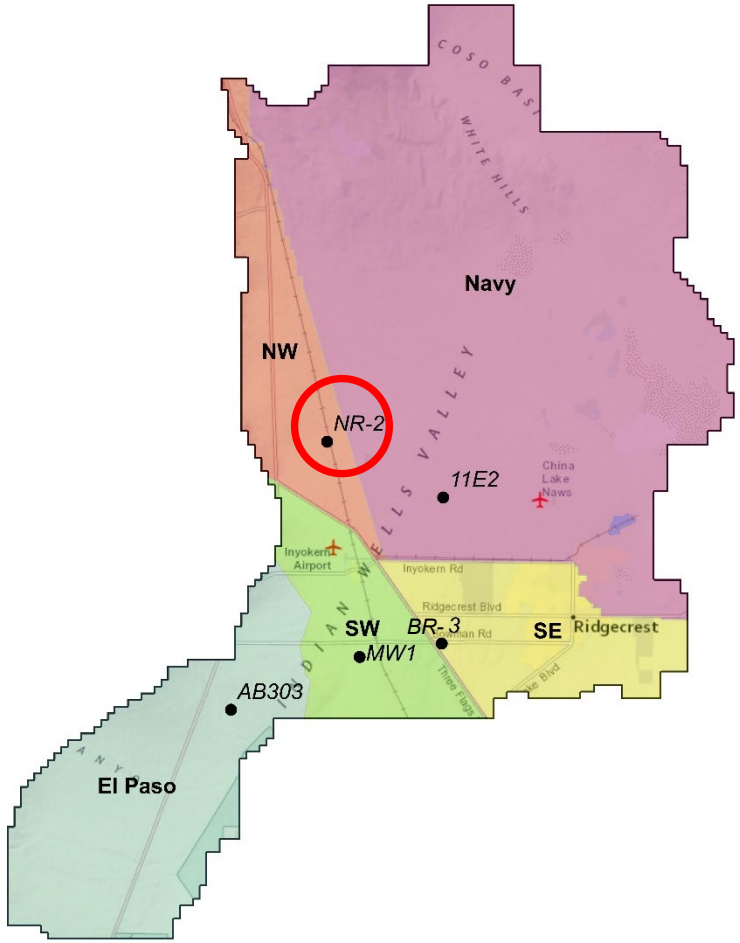




DRAFT – Subject to change



NR-2



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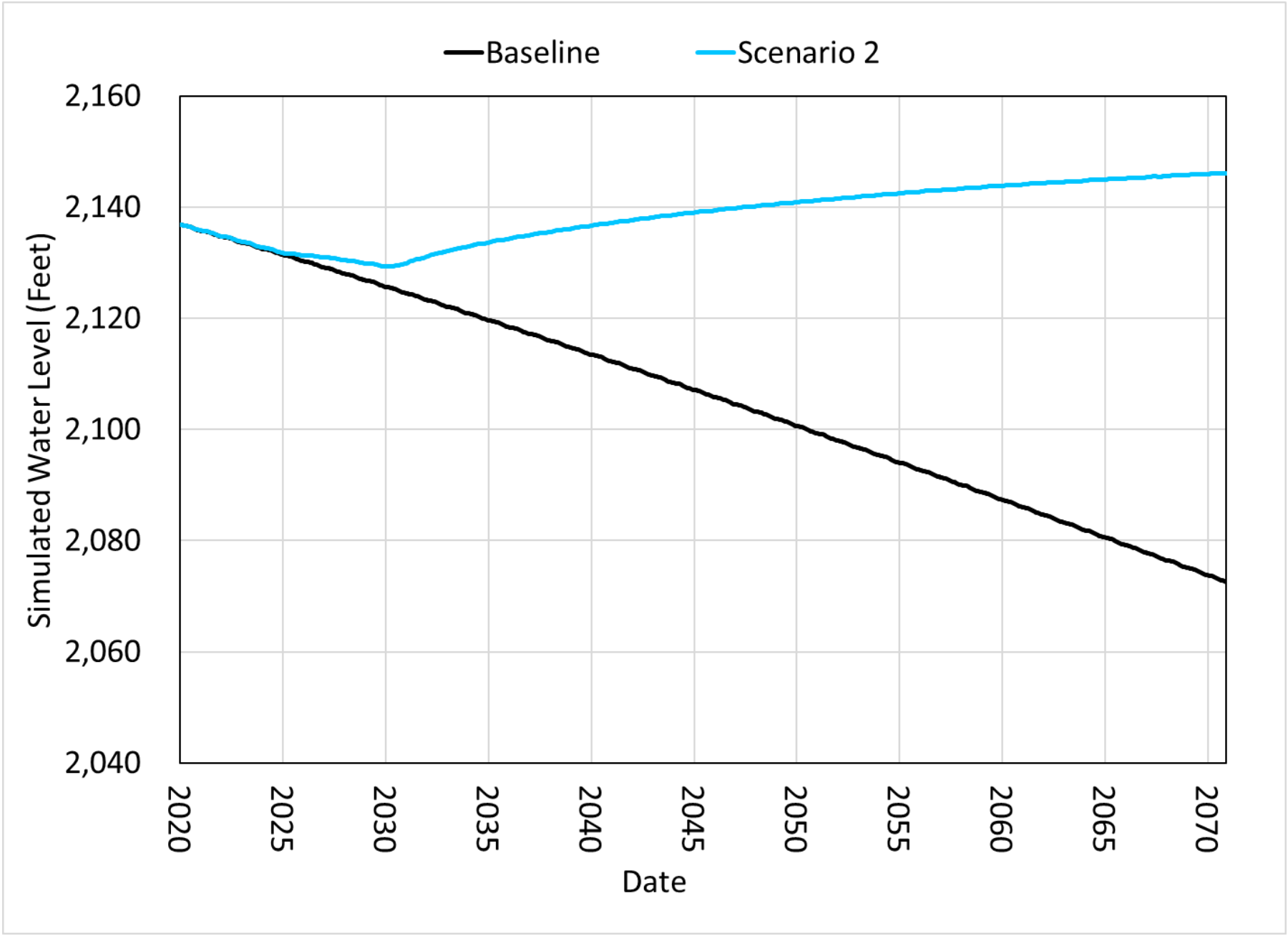

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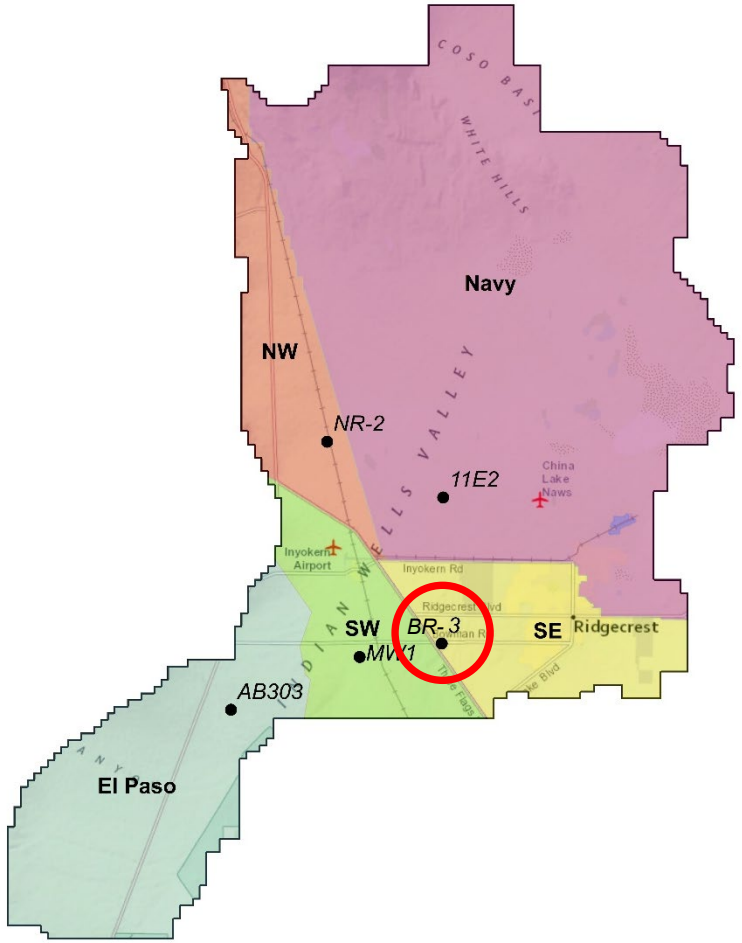

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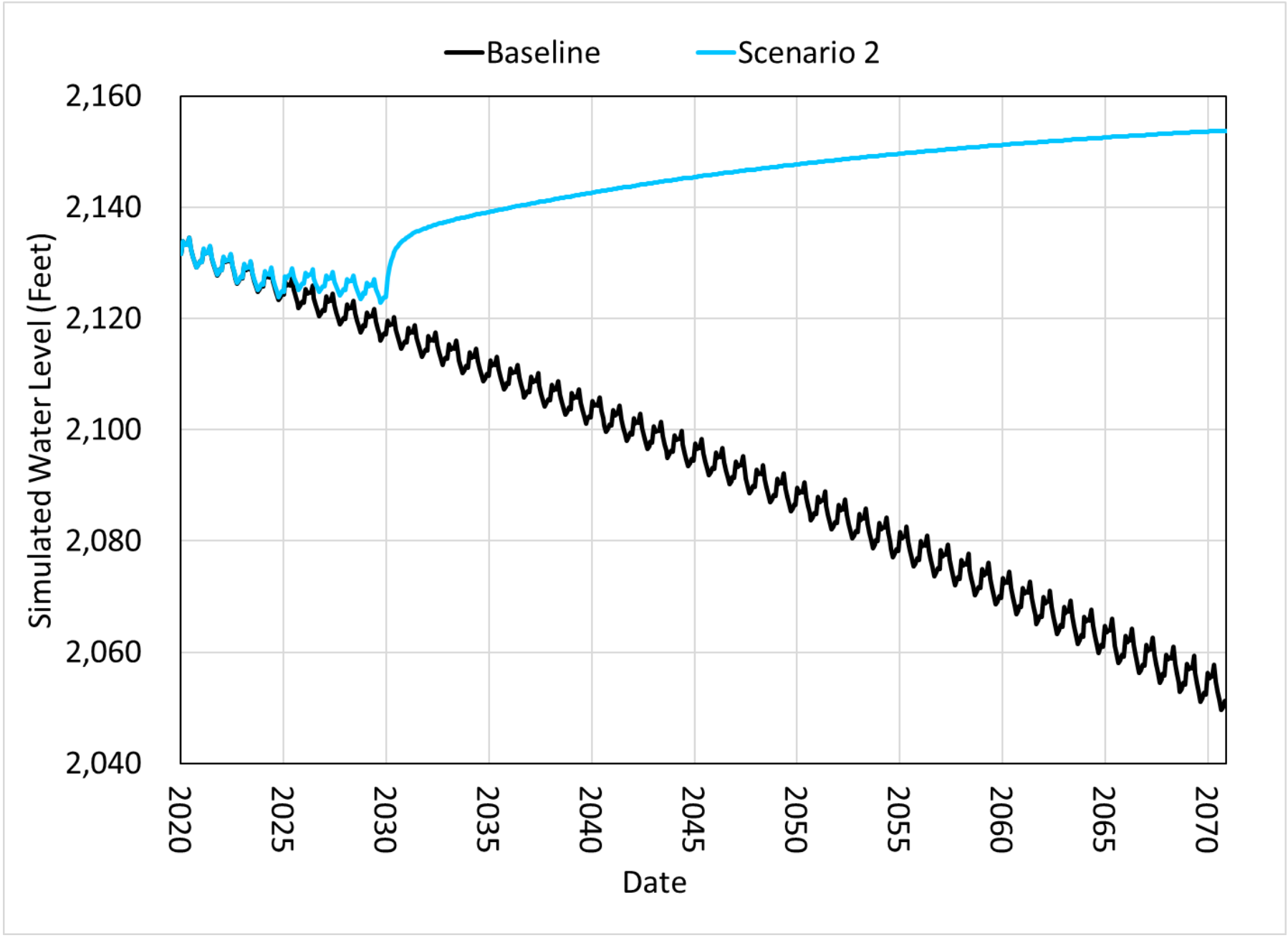

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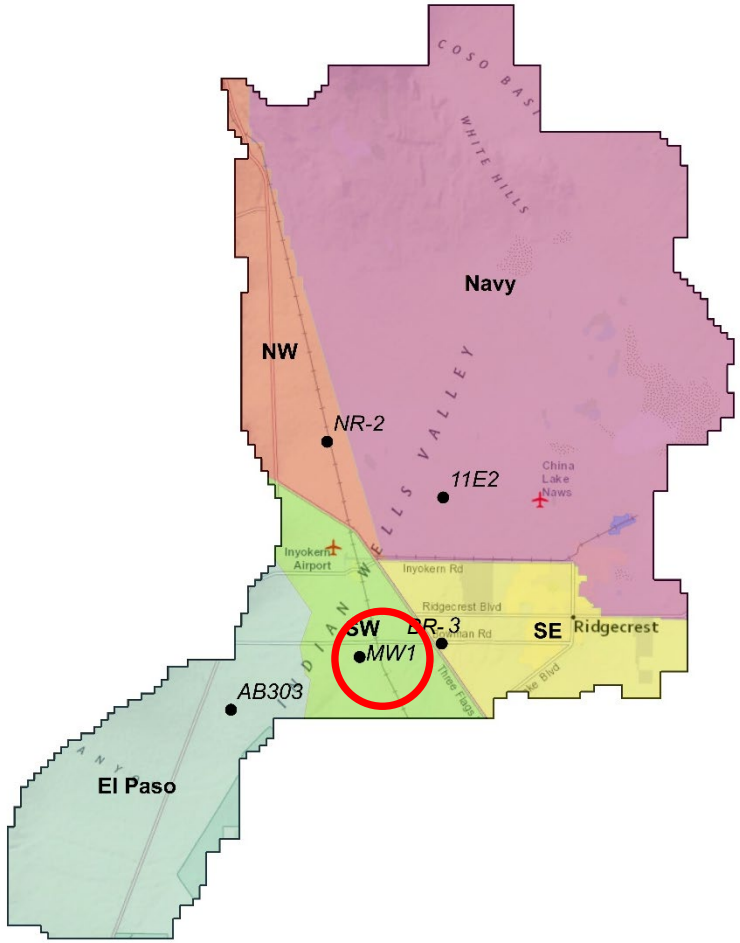

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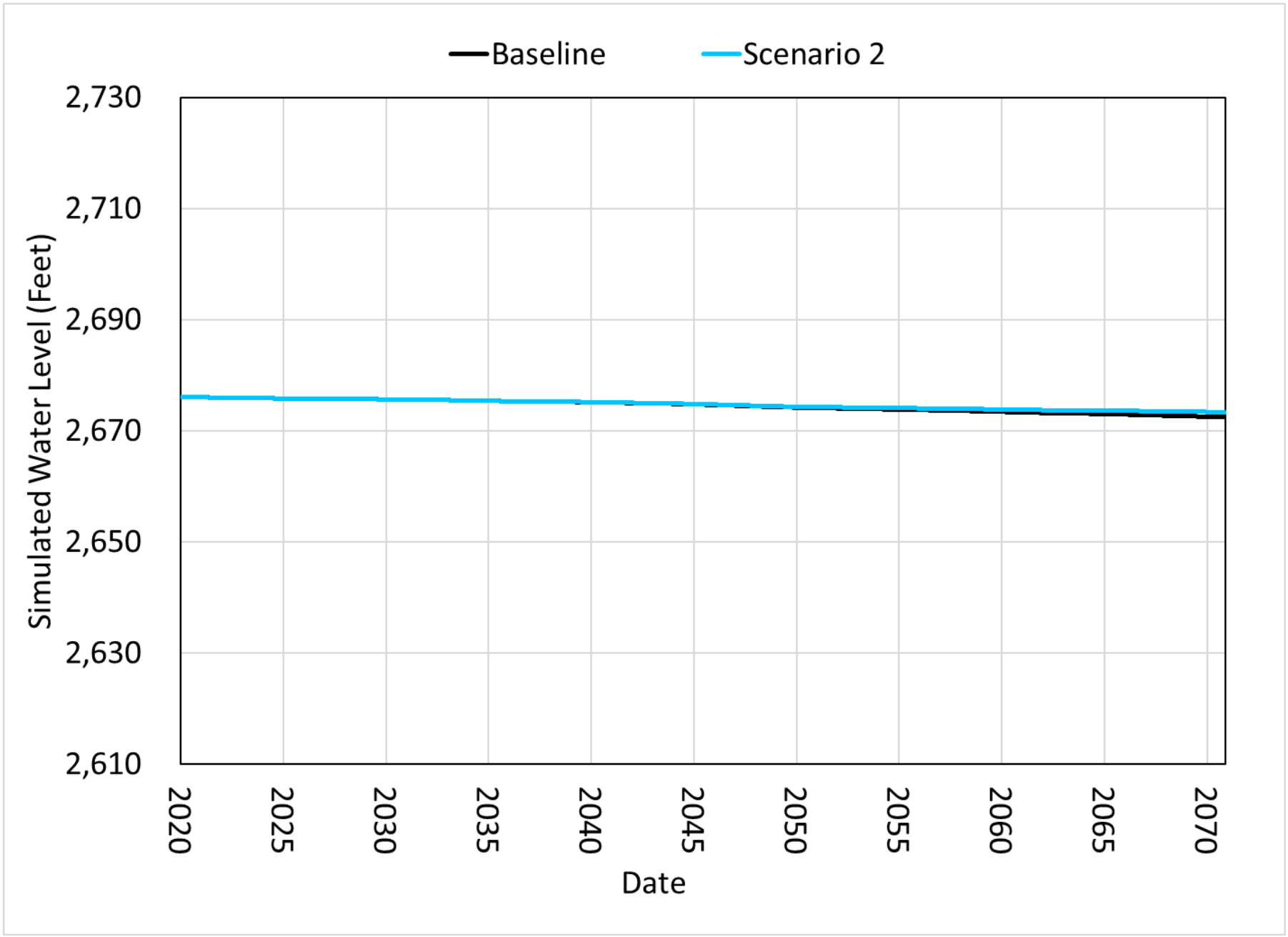

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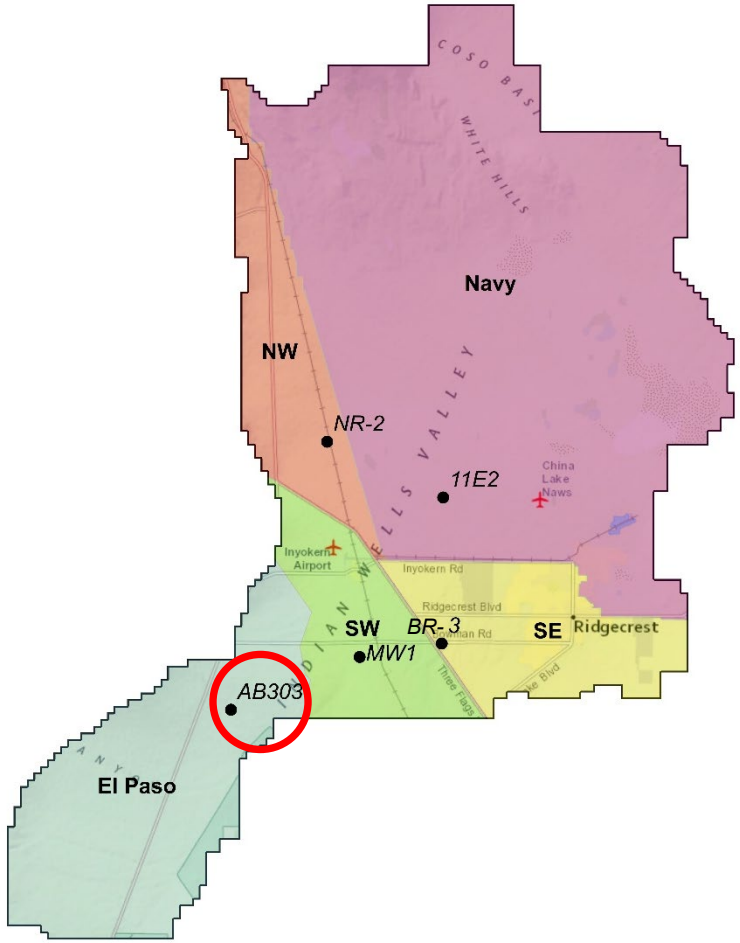

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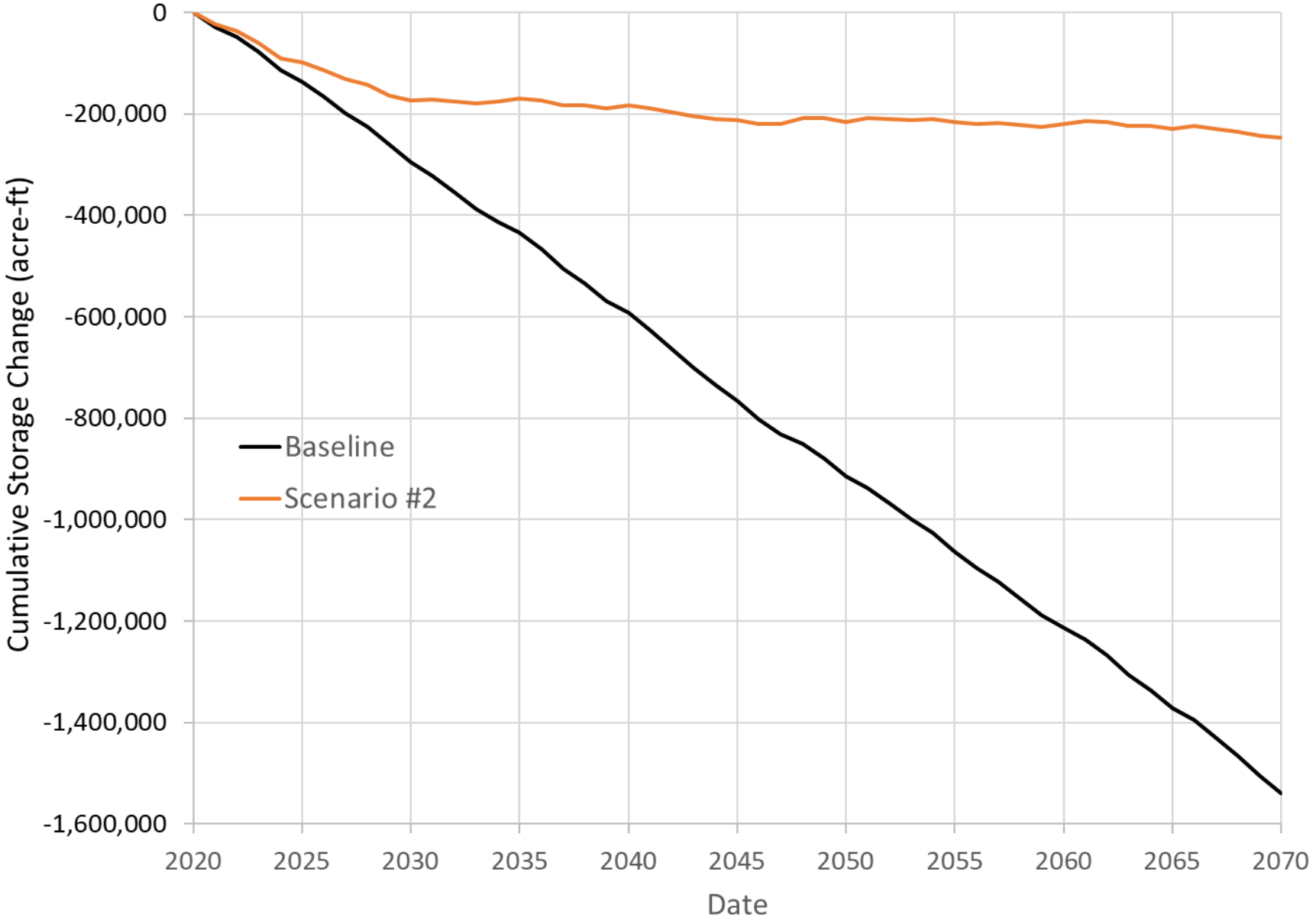
Scenario #2 Change in Basin Groundwater Storage



From DRI March 7, 2019 TAC Presentation

(Agenda item 3aii) Estimated Shallow Well Impact Analysis

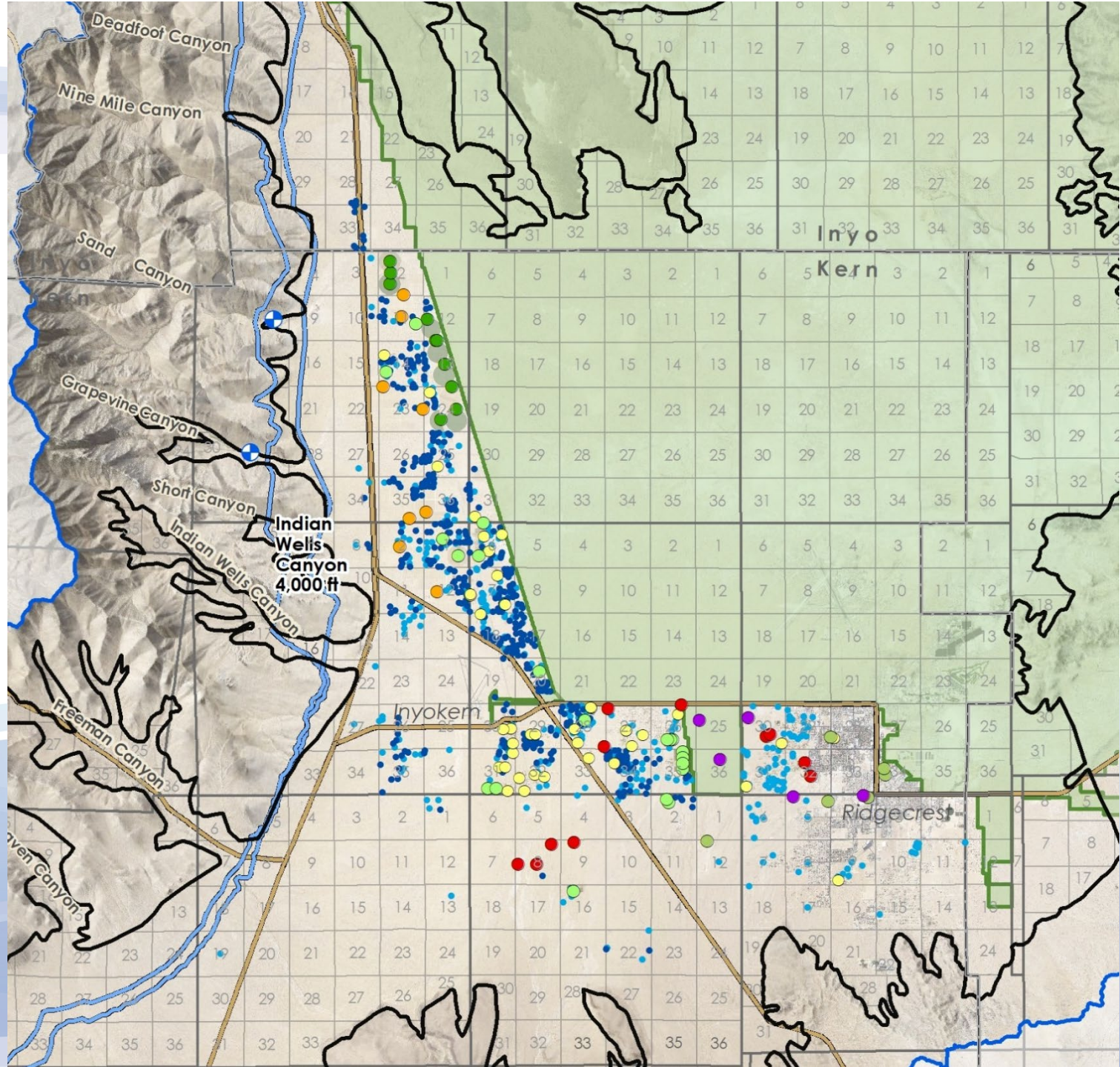
Estimated Shallow Well Inventory

- 377 DOM Wells from Well Permits (Kern County Health Department)
- 455 Other private wells estimated from # Rural Domestic
- 2 Coop Wells representing 265 Hookups
- 38 Municipal Wells representing 491 Hookups

872 Shallow Wells (1,588 residences)

Production Well Location Map

66 Larger Production Wells
40 Mutual and CSD Wells
832 Domestic/Private Wells
938 Production Wells



Production Wells
- Large Ag Alfalfa
- Large Ag Pistachio
- Small Ag
- Parks/Dust
- Searles Valley Minerals
- IWVWD
- CSD & Mutuals

Aqueduct
Indian Wells Valley GSA
Watershed Boundary
County Boundary

Estimated Domestic Well Location
- Permit Database
- Other Private

NOTE: Navy production wells are not shown on this map.

Shallow Well Impact Analysis:
Rate of Drawdown (DDN) by Section

Methodology to Develop Annual Rate of Groundwater Table Drawdown

HISTORICAL (KCWA Groundwater Level (GWL) Contour Maps and GIS)

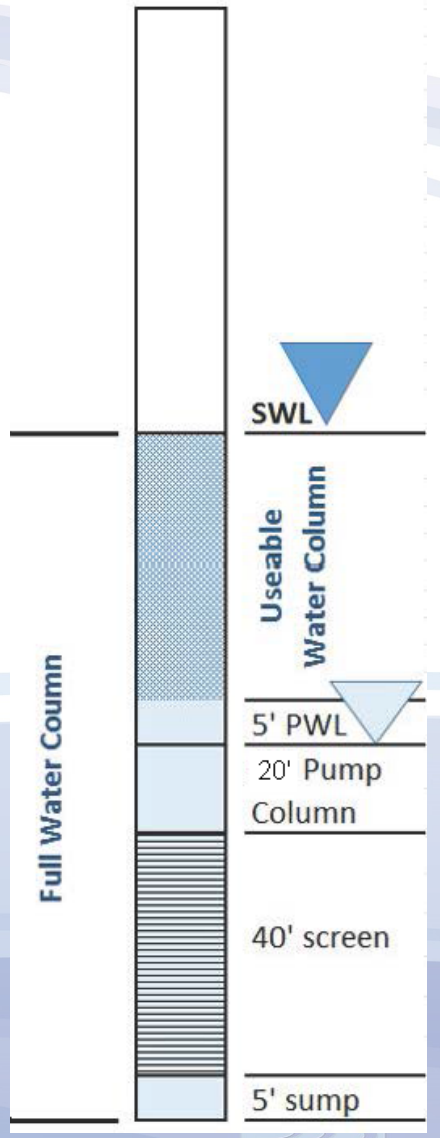
- Digitize 2010 & 2015 contours into GIS
- Develop GIS raster of average change in GWL/year by Section
- Apply 2010-2015 average annual DDN rate to historical conditions

FUTURE BASELINE AND MANAGEMENT SCENARIOS (Model Output and GIS)

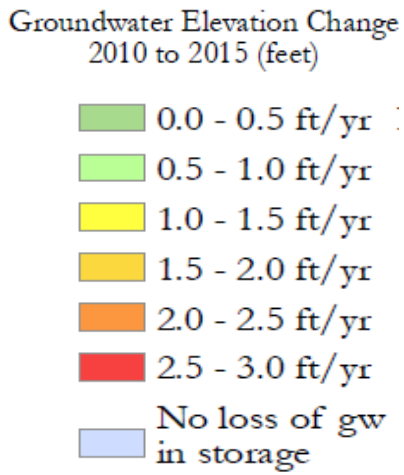
- Develop annual DDN rate from simulated 2020-2070 GWL
- GIS analysis to apply DDN Rates from model cells to Sections
- Develop GIS maps of average change in GWL/year by Section
- Apply changing DDN Rate to Shallow Well Impact Analysis
  (2020, 2025, 2030, 2040, 2070)

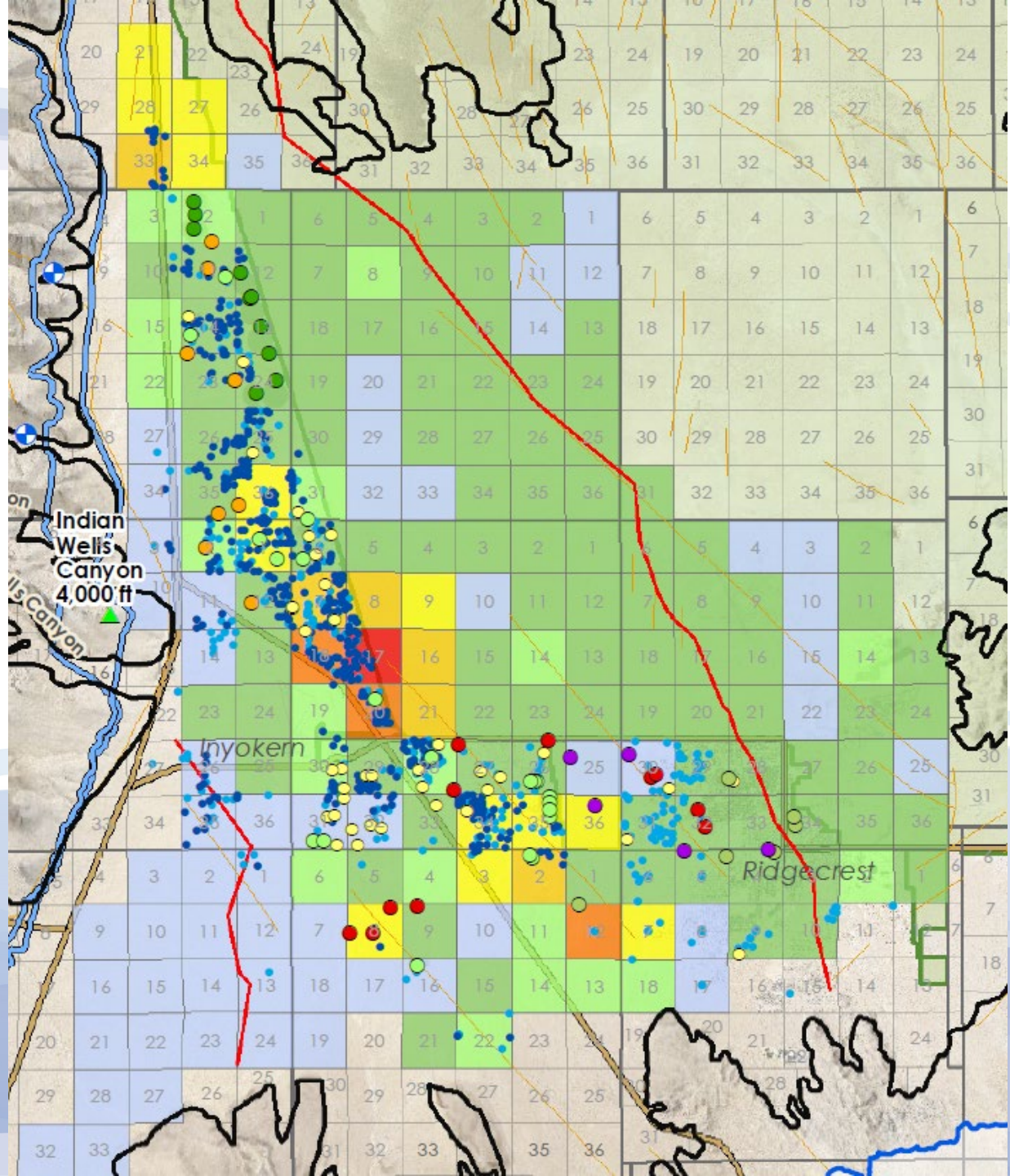
Methodology (useable water column within a well)

1. Establish Construction Dates for Each Shallow Well
   - 377 with earliest permit date
   - 495 randomized construction dates
2. Determine initial Water Column when Well Drilled
   - 118 feet (median of permitted wells)
3. Estimate Well Construction:
   - 5’ sump + 40’ screen + 20’ pump column + 5’ PWL = 70’ minimum water column
4. Estimate Usable Water Column at time of initial construction
   - TD – SWL – 70’ = useable water column (assumed 48 feet historically)
5. Estimate # years until impacted by aquifer drawdown
   - Useable Water Column (feet) / rate of drawdown per year (feet/year) = # years left of well operation

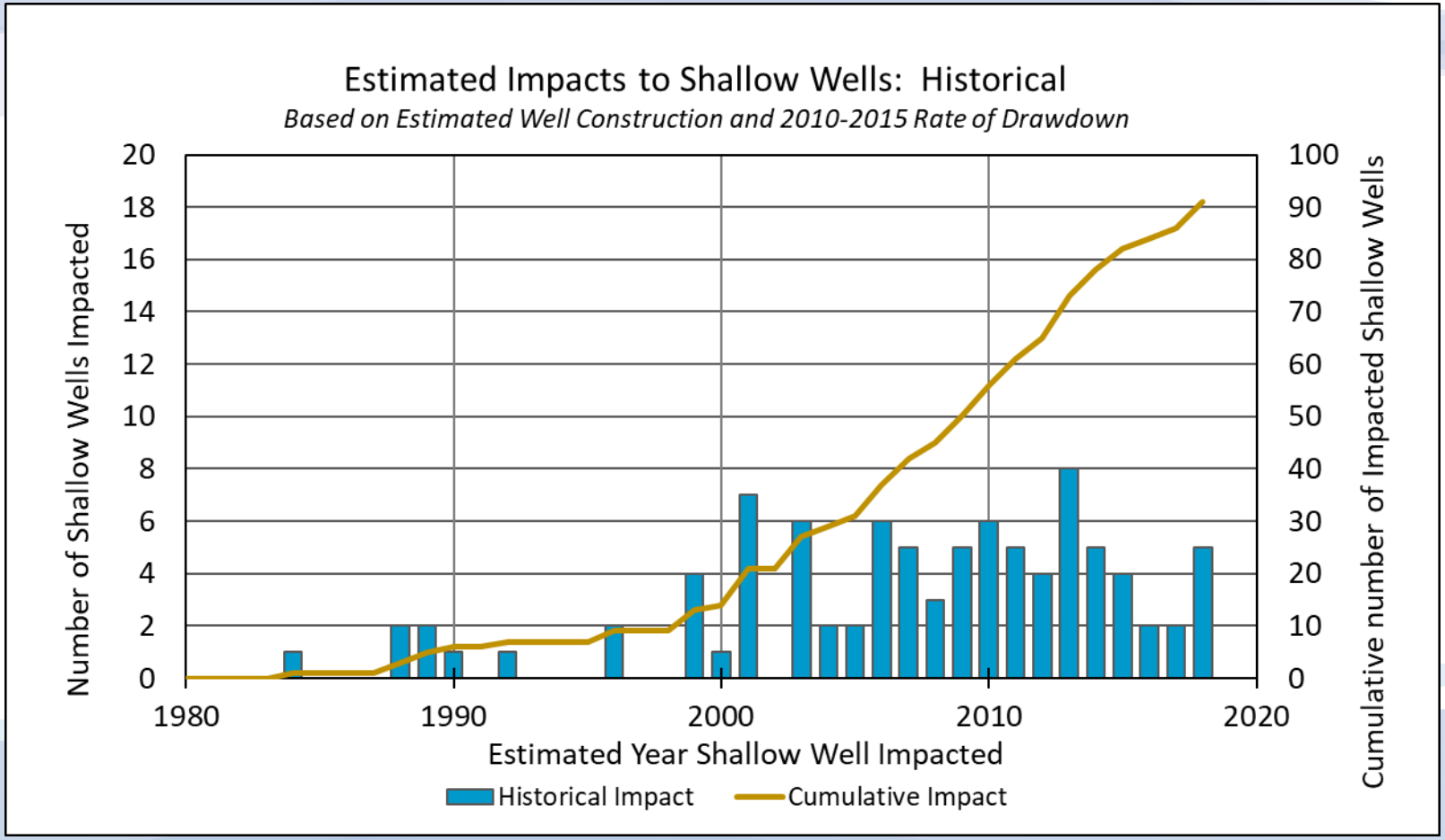


Historical Rate of Drawdown 2010 to 2015





Estimated Historical Impact to Shallow Wells



Wells Impacted Prior to 2019:
91

Cumulative # Impacted Wells

2000	14
2010	56
2019	91

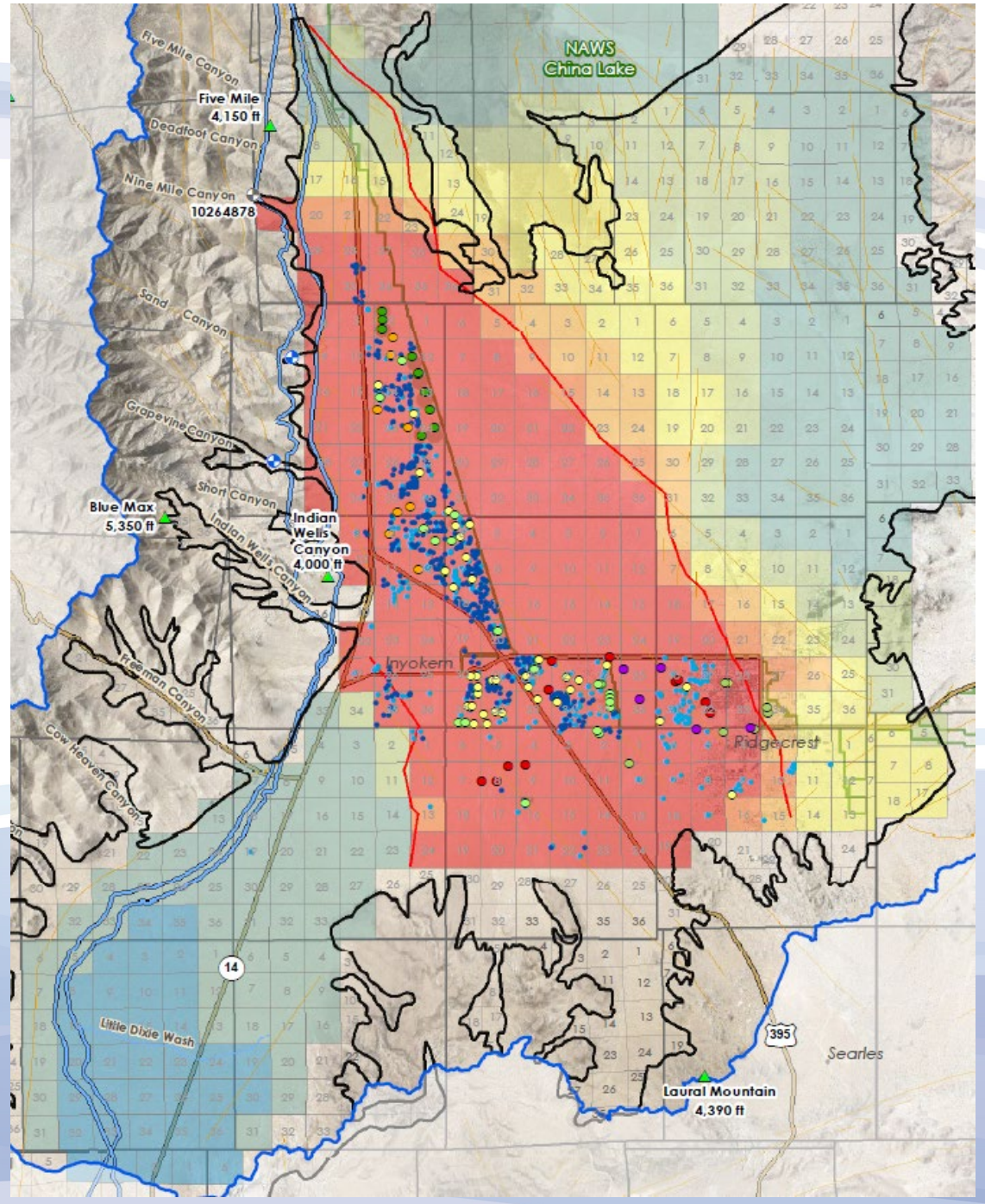
- Assumptions:
  1. 118 feet of total water column (median) when drilled
  2. Date drilled is earliest permit date for 377 wells (KCHD)
  3. Average rate of drawdown from 2010 to 2015 is representative since well drilled

Baseline
50-Year Predicted DDN

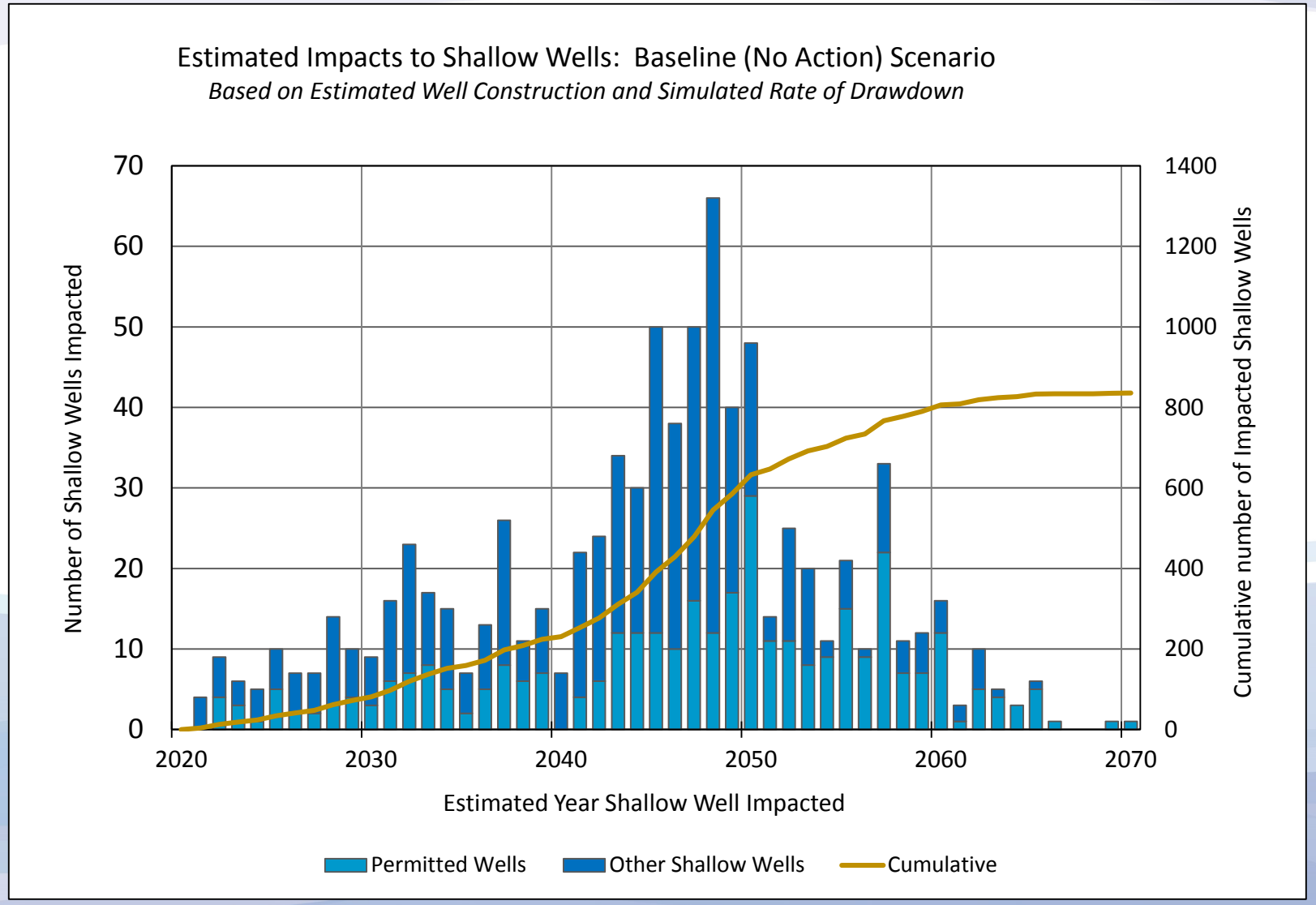
Large Ag	19,190
Small Ag	3,800
Municipal	7,600
Navy	2,040
Mining	2,910
Mutual, CSD	540
Domestic	830
50-yr Avg TOTAL	36,910

50-yr Simulated Predicted GWL Change 2020 to 2070

- No DDN
- 0 to -10 feet
- -10 to -20 feet
- -20 to -30 feet
- -30 to -40 feet
- -40 to -50 feet
- More than -50 feet



Estimated Baseline (No Action) Impact to Shallow Wells



Wells Impacted Prior to 2040:
231

Cumulative # Impacted Wells

2030	81
2040	231
2050	633

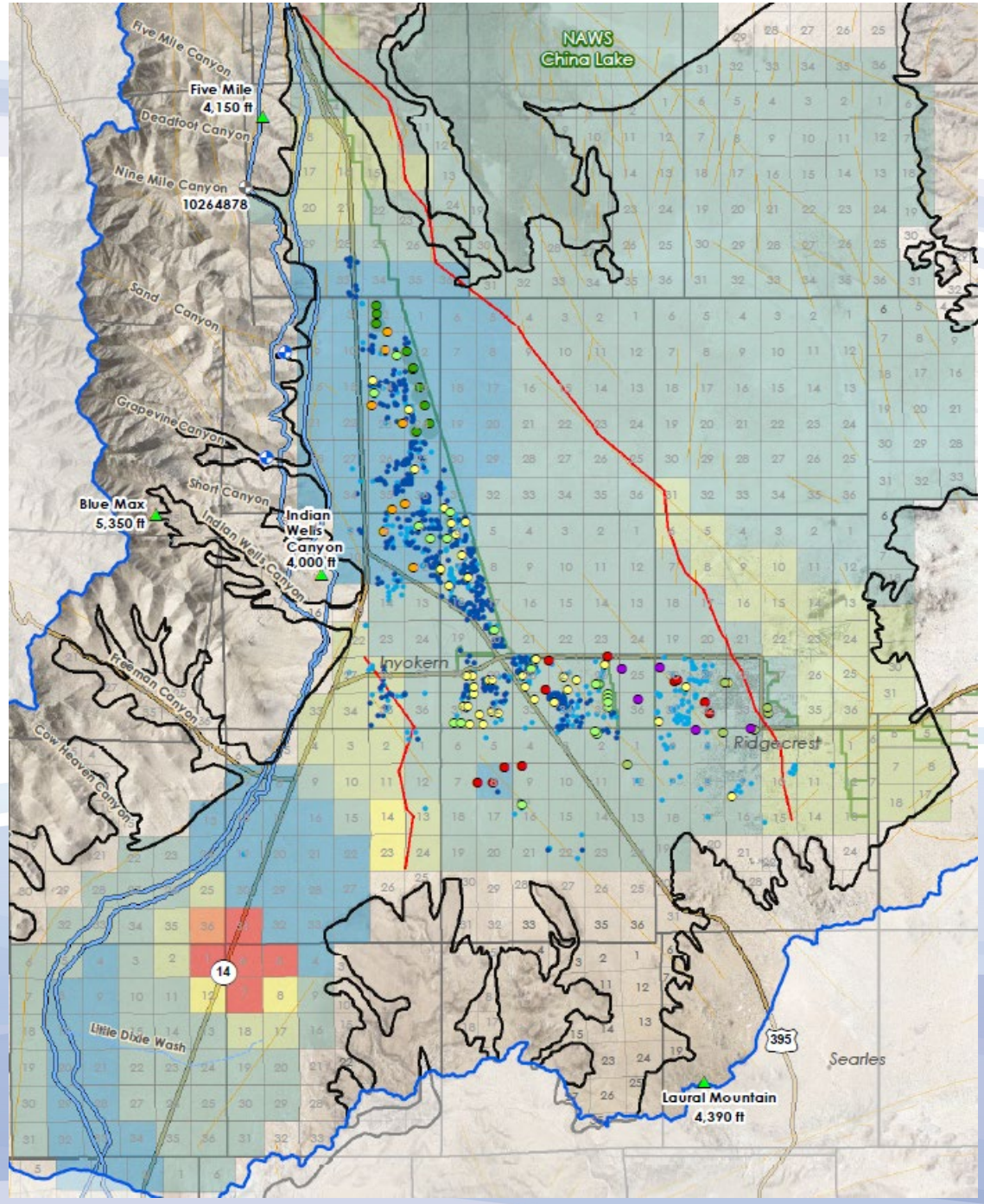
Assumption: well is deepened by 100 feet when re-drilled.

Scenario #1
50-Year Predicted DDN

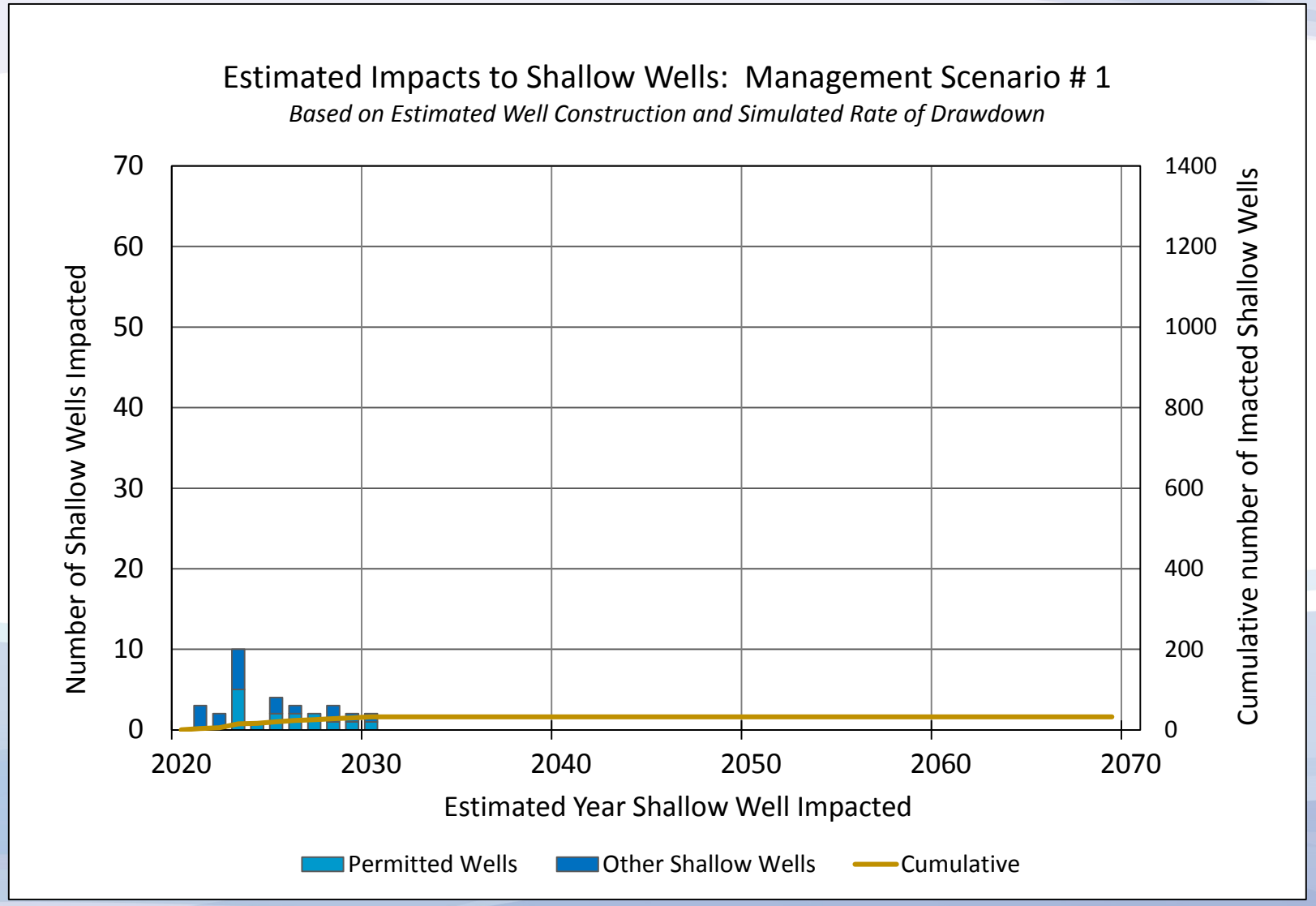
Pumping Ramp Down for 20 years
Imported Water Recharge & Recovery
Recycled Water Use
Management Concepts:
Cliff Pumping
Leasing

Simulated Predicted
Groundwater Level Change
2020 to 2070

- No DDN
- 0 to -10 feet
- -10 to -20 feet
- -20 to -30 feet
- -30 to -40 feet
- -40 to -50 feet
- More than -50 feet



Estimated Management Scenario #1 Impact to Shallow Wells



Wells Impacted Prior to 2040:

32

Cumulative # Impacted Wells

2025	20
2030	32
2040	32
2050	32

Assumption: well is deepened by 100 feet when re-drilled.

Scenario #2
50-Year Predicted DDN

Reduced Pumping
- by 38% in 2025 to 21,680 AFY
- by 54% in 2030 to 13,650 AFY

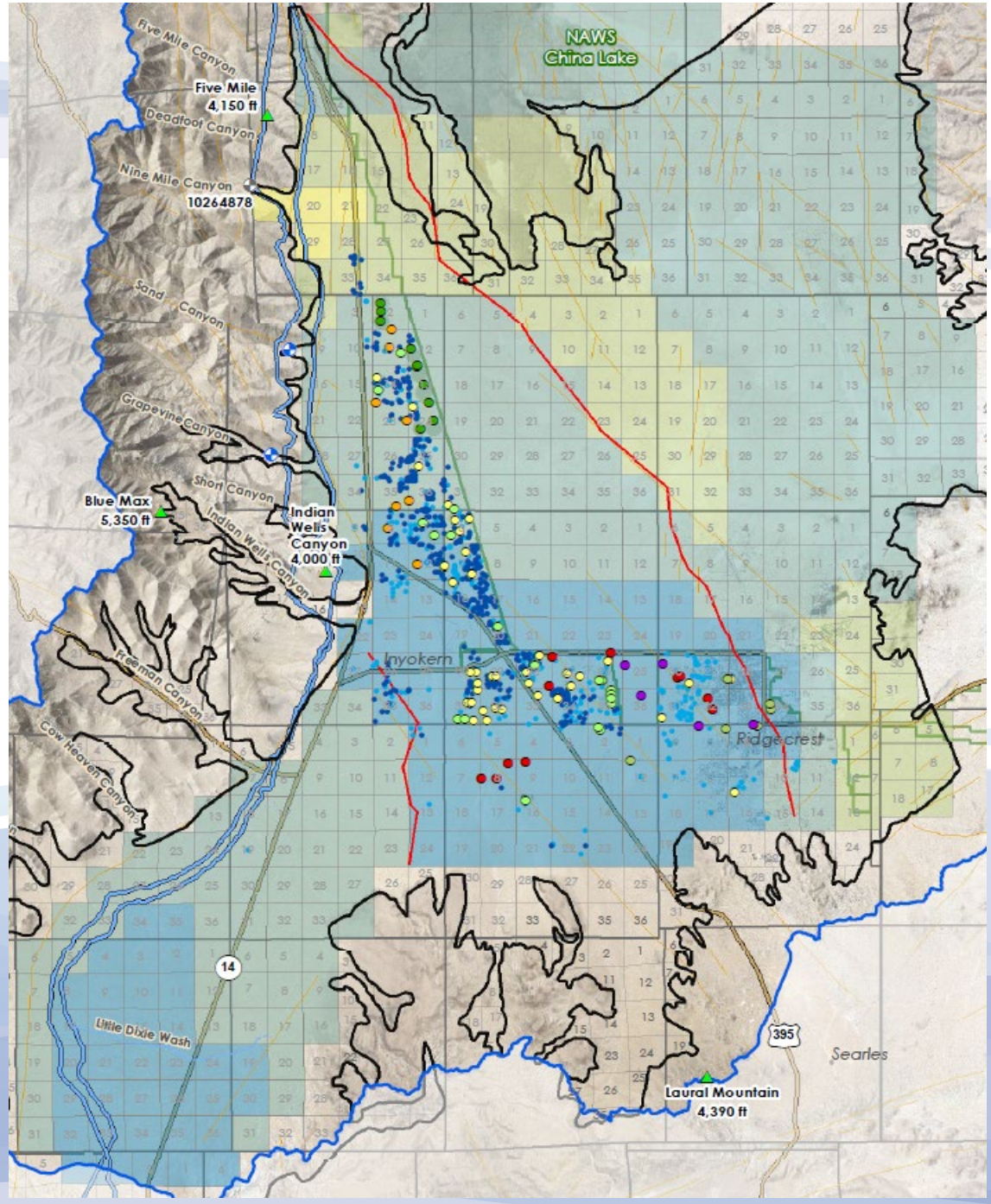
Recycled Water Use

Imported Water Recharged in 2030

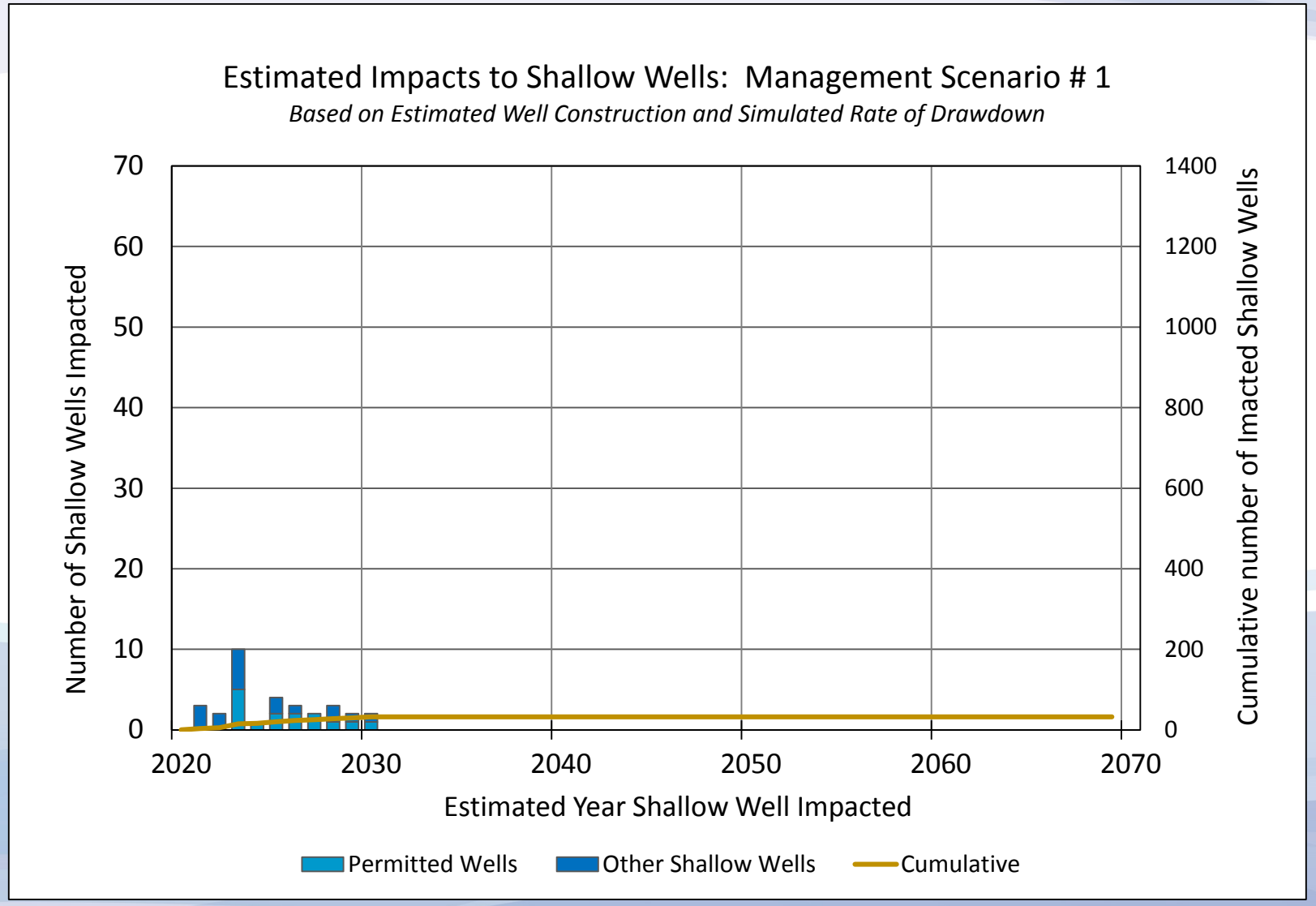
Direct Use of Imported Water in 2030

Simulated Predicted
Groundwater Level Change
2020 to 2070

- No DDN
- 0 to -10 feet
- -10 to -20 feet
- -20 to -30 feet
- -30 to -40 feet
- -40 to -50 feet
- More than -50 feet



Estimated Management Scenario #1 Impact to Shallow Wells



Wells Impacted Prior to 2040:

33

Cumulative # Impacted Wells

2025	20
2030	33
2040	33
2050	33

Assumption: well is deepened by 100 feet when re-drilled.

Future Recommendations

- Confirm the location of shallow rural domestic and mutual wells within the basin.
- Canvas all available resources for well logs (RCD, DWR, County Agencies, Well Owners)
- Develop a comprehensive database of well construction data, history of well deepening and/or replacement.

3b i
Sampling and Aquifer Testing

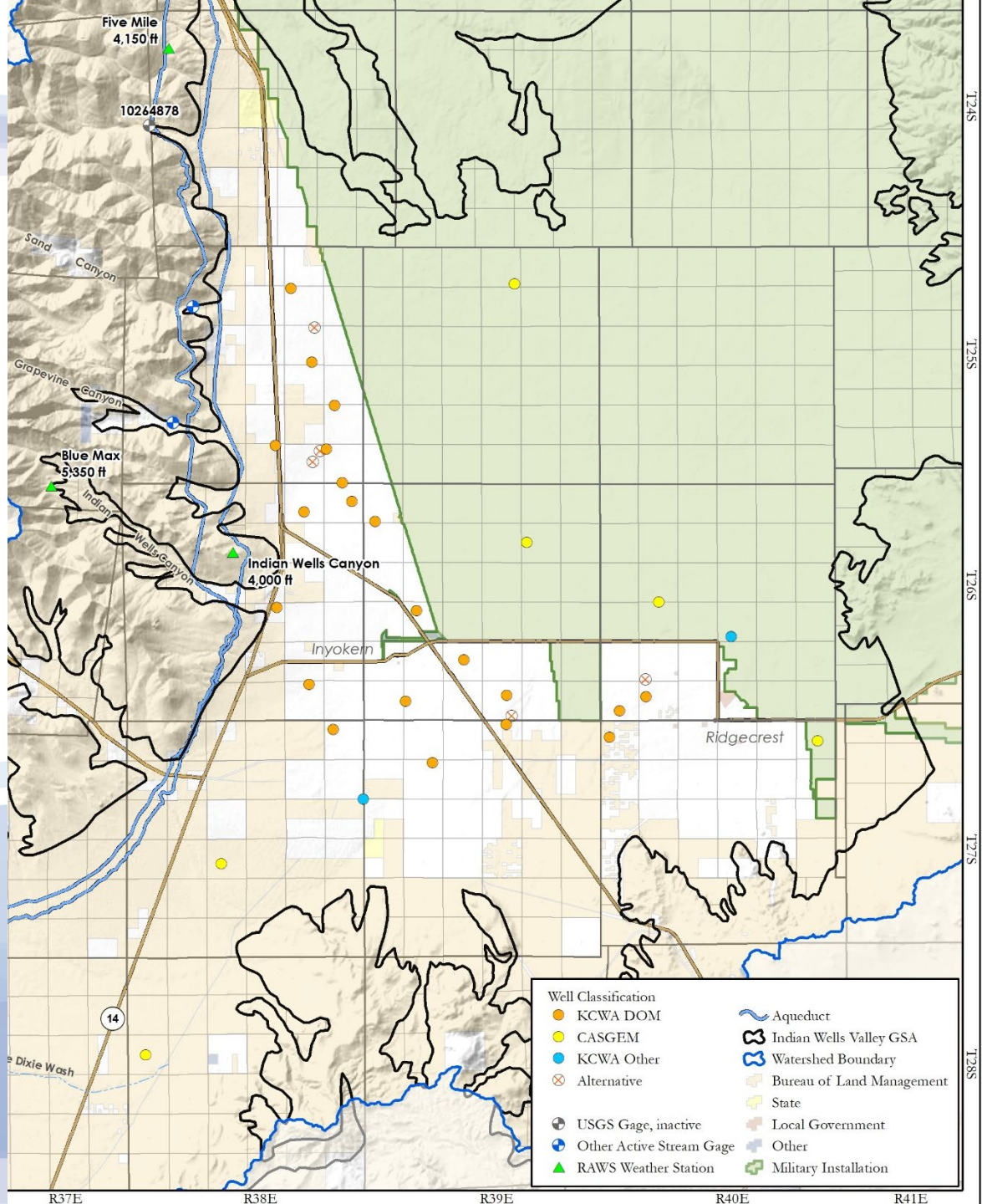
Developing work plans for Prop 1 Funding for Sampling and Aquifer Testing

- TDS and General Chemistry at Wells, Springs, and Streams
  Phase 1:
  - KCWA has contacted 5 DOM well owners for sampling
  - 10 samples with sampling rig
  - Spring and stream sampling

  Phase 2:
  - Outreach for other DOM well sampling

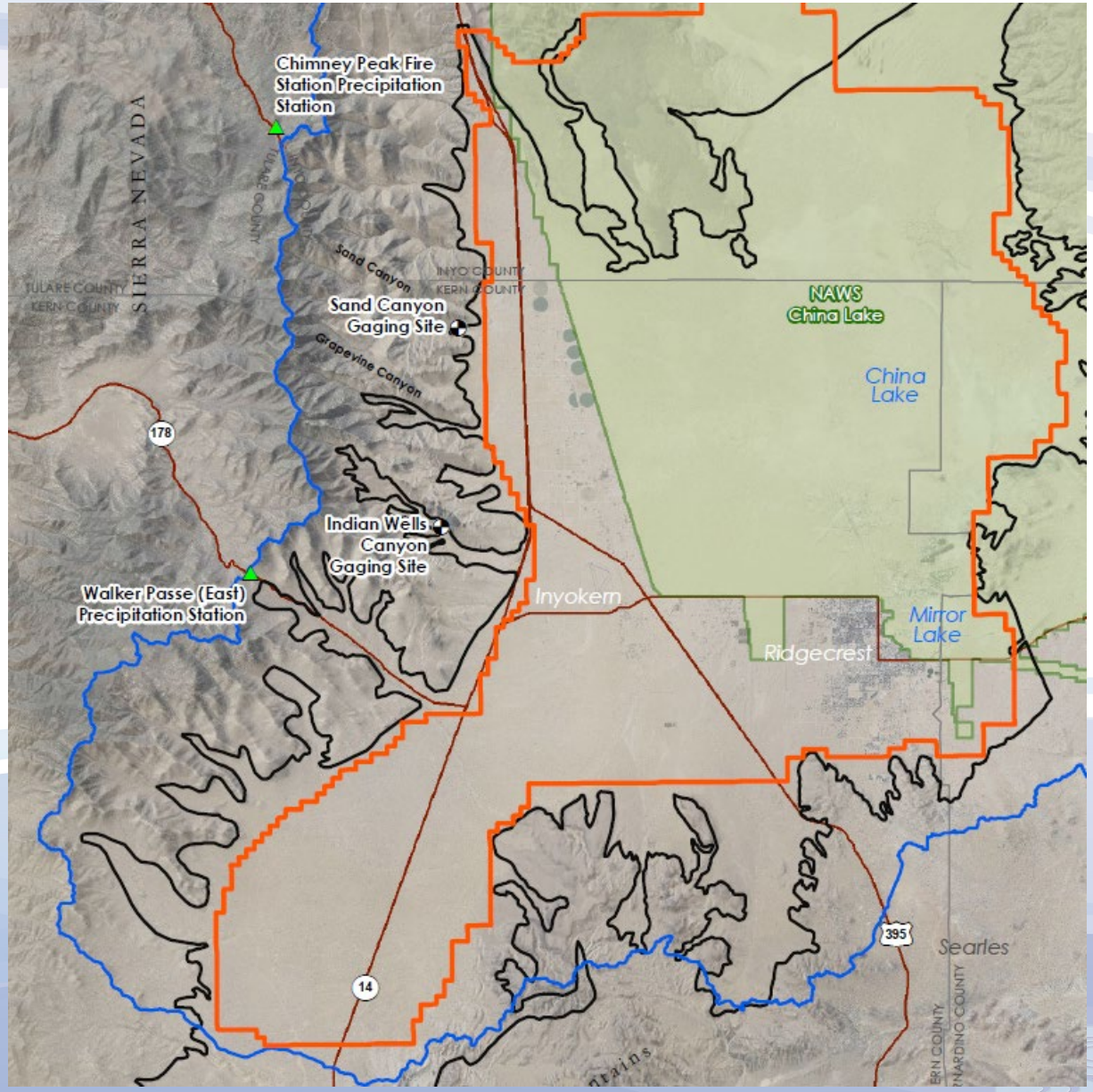
- Isotope Sampling
  - Subcontract with DRI

- Aquifer Testing
  - Developing work plan



Stream Gages / Weather Stations

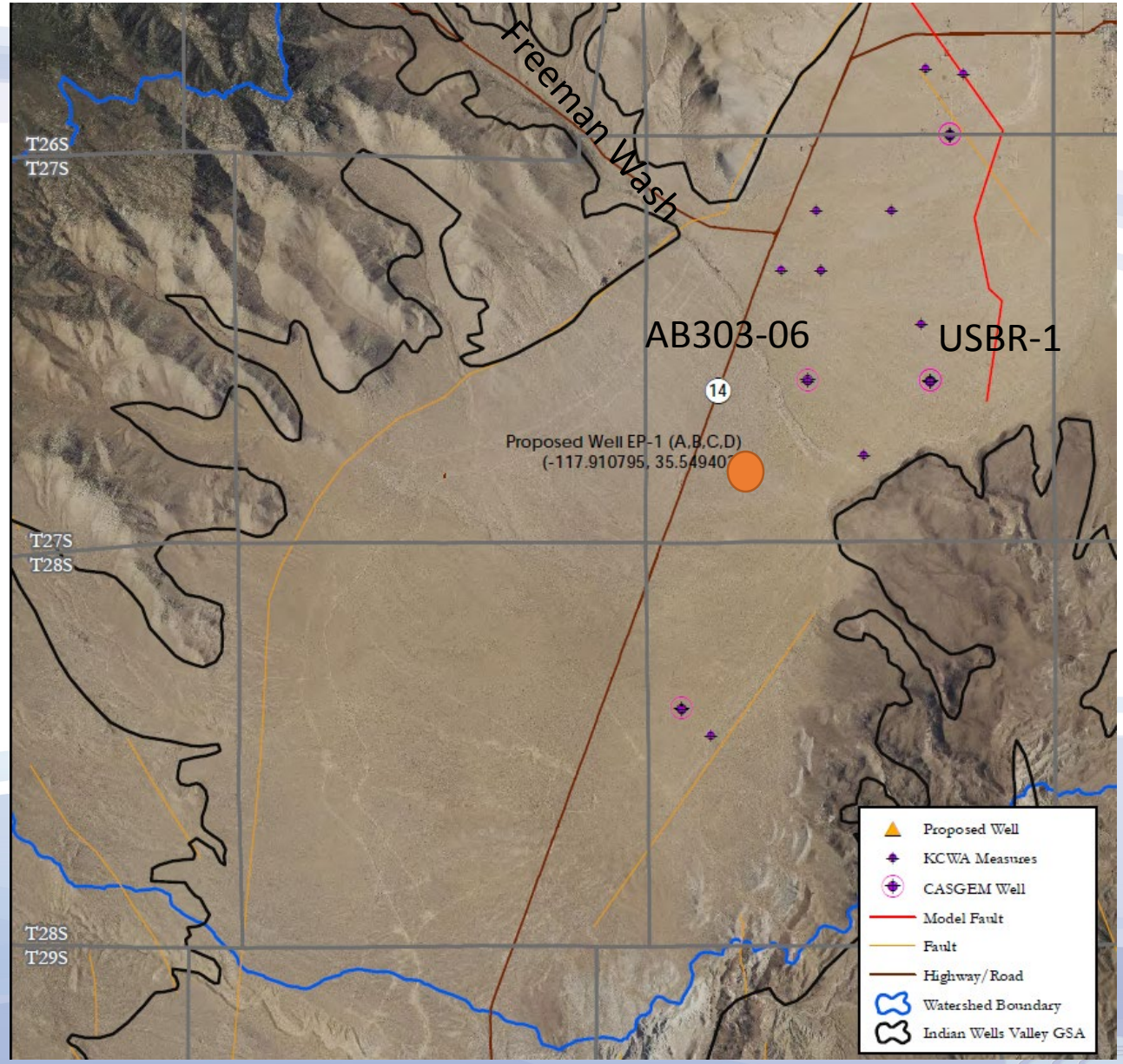
- Access/Permit Discussions with Ridgecrest BLM staff for:
  - Sand Canyon Gaging Site
  - Indian Wells Canyon Gaging Site
  - Walker Passe (east) Precipitation Station
- Access/Permit Coordination with Bakersfield BLM staff for:
  - Chimney Peak Fire Station Precipitation Station



DWR Technical Support Service

El Paso Multi-Level Well Project

- TSS Application Accepted by DWR on 3/21
- Coordinating with DWR (Jack Tung, PG) who is coordinating with driller (Gregg Drilling)
- Processing Category Exclusion with Ridgecrest BLM staff



Draft IWVGA GSP Section Release Schedule

Ver. 2

4/2/2019

GSP Section	POAM Line Number [1]	Tentative Release Date
Section 1: Introduction	*98*	*12/14/2018*
Section 1: Introduction (Redraft)	*98*	*3/15/2019*
Section 2: Plan Area	99	4/17/2019
Section 3: Basin Setting	99	4/26/2019
Section 4: Project and Management Actions [2]	100	6/28/2019
Section 5: Sustainable Criteria [2]	101	6/28/2019
Section 6: Implementation [2]	104	7/26/2019
Section 7: References [2]	105	7/26/2019
Review Draft (Compiled Draft with Figures, Appendices, etc.) [2]	109	8/26/2019
Public Review Draft (Submitted to DWR for 90 day review period) [2]	113	9/20/2019

[1] The next version of the POAM will be updated with the section release dates shown here.

[2] As reported to the IWVGA Board on 3/21/2019, based on the status of the allocation discussions, the TAC is is not on schedule to discuss critical GSP materials. Accordingly, the tentative release dates for certain GSP Sections have been delayed by approximately one month.