GROUNDWATER SUSTAINABILITY PLANS (GSPs)
TURLOCK SUBBASIN AND MODESTO SUBBASIN

STANISLAUS COUNTY WATER ADVISORY COMMITTEE

SEPTEMBER 29, 2021

PRESENTATION OUTLINE

1. Overview of Both Subbasins Combined

2. Modesto Subbasin

3. Turlock Subbasin

- Basin Setting
- Sustainable Management Criteria
- GSP Projects

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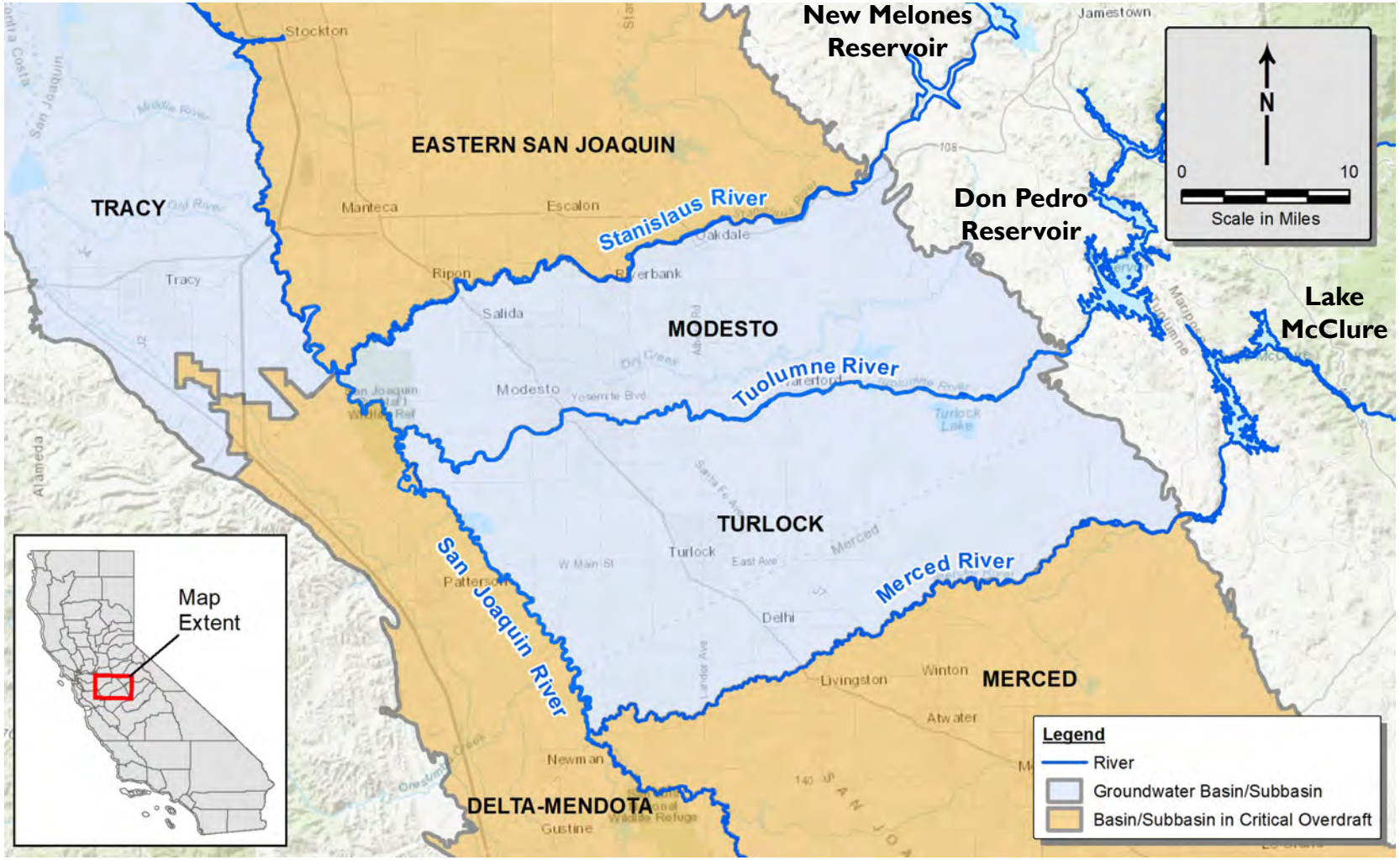
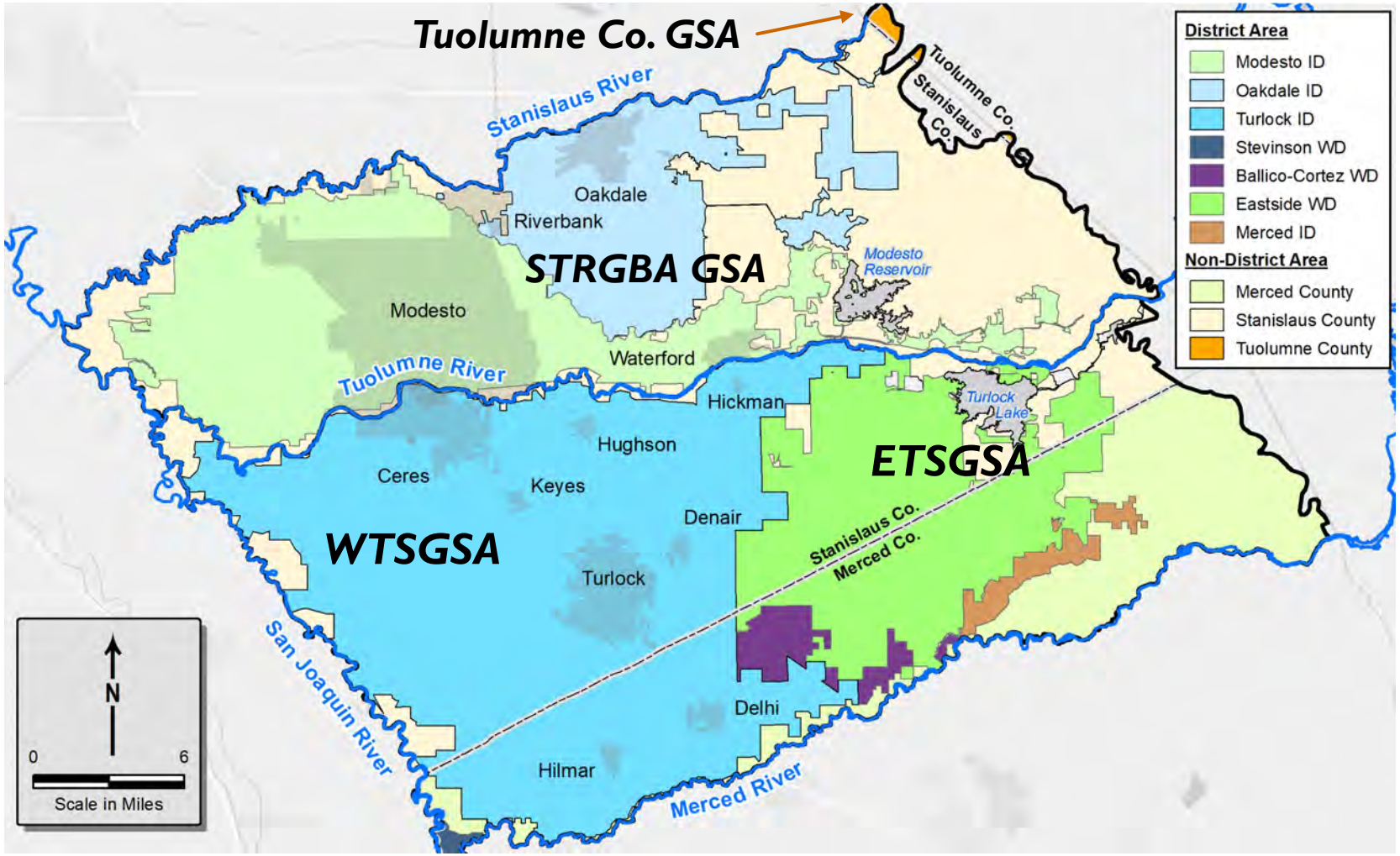
MODESTO AND TURLOCK SUBBASINS
SAN JOAQUIN VALLEY GROUNDWATER BASIN



- Modesto Subbasin
  - 245,000 acres
- Turlock Subbasin
  - 348,000 acres
- Surrounded by Critically Overdrafted Subbasins
- Modesto/Turlock:
  - Surface water supplies
  - No subsidence or streamflow impacts

TODD GROUNDWATER

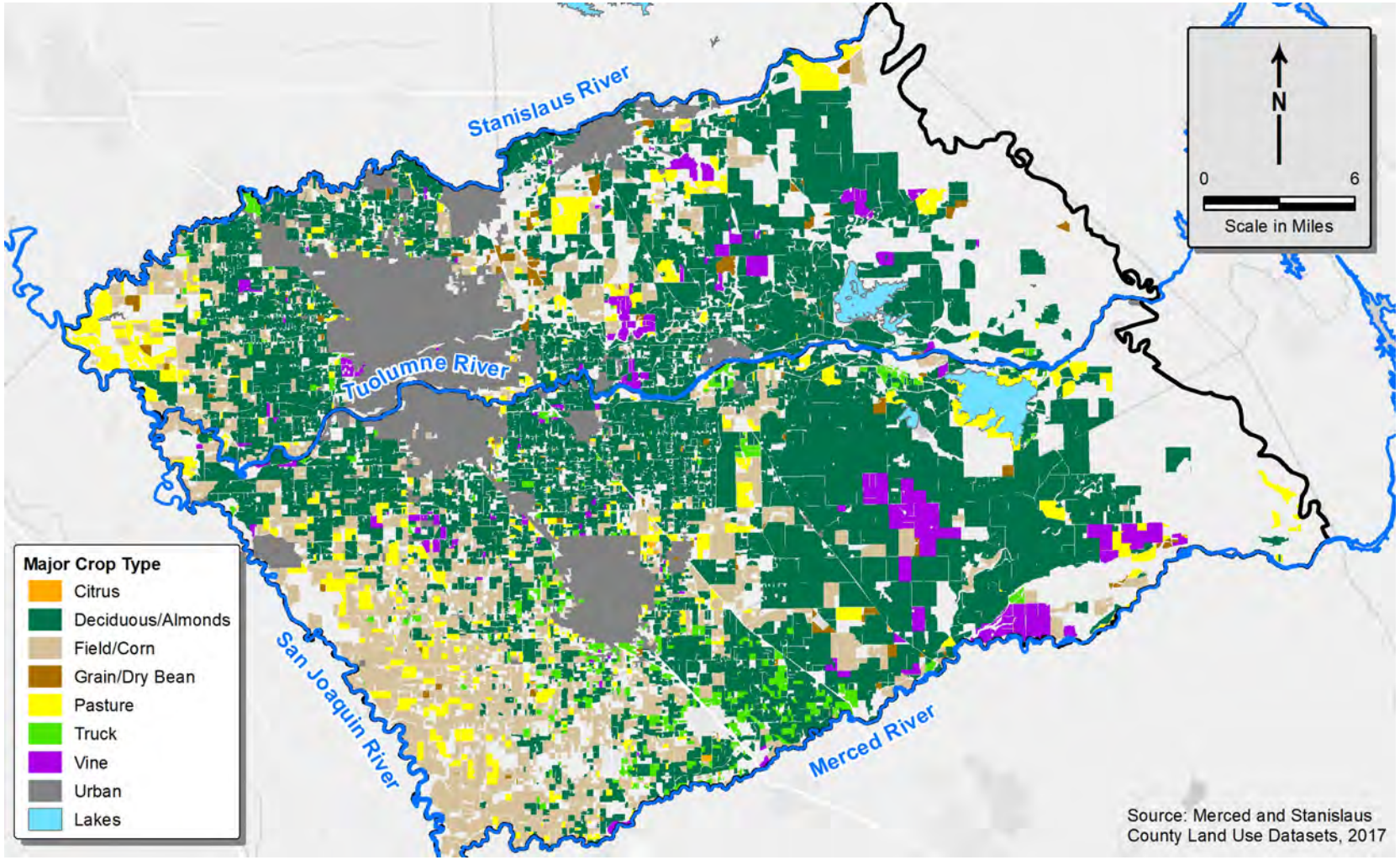
GROUNDWATER SUSTAINABILITY AGENCIES (GSAs) AND LOCAL AGENCIES / URBAN AREAS



- Two GSAs in each Subbasin
- Tuolumne Co. GSA participates through agreement with Stanislaus County
- Many agencies overlap both subbasins:
  - Stanislaus County
  - City of Modesto
  - Waterford/Hickman
- Shared water resources from the Tuolumne River

TODD GROUNDWATER

EXISTING LAND USE (2017)



Modesto Subbasin

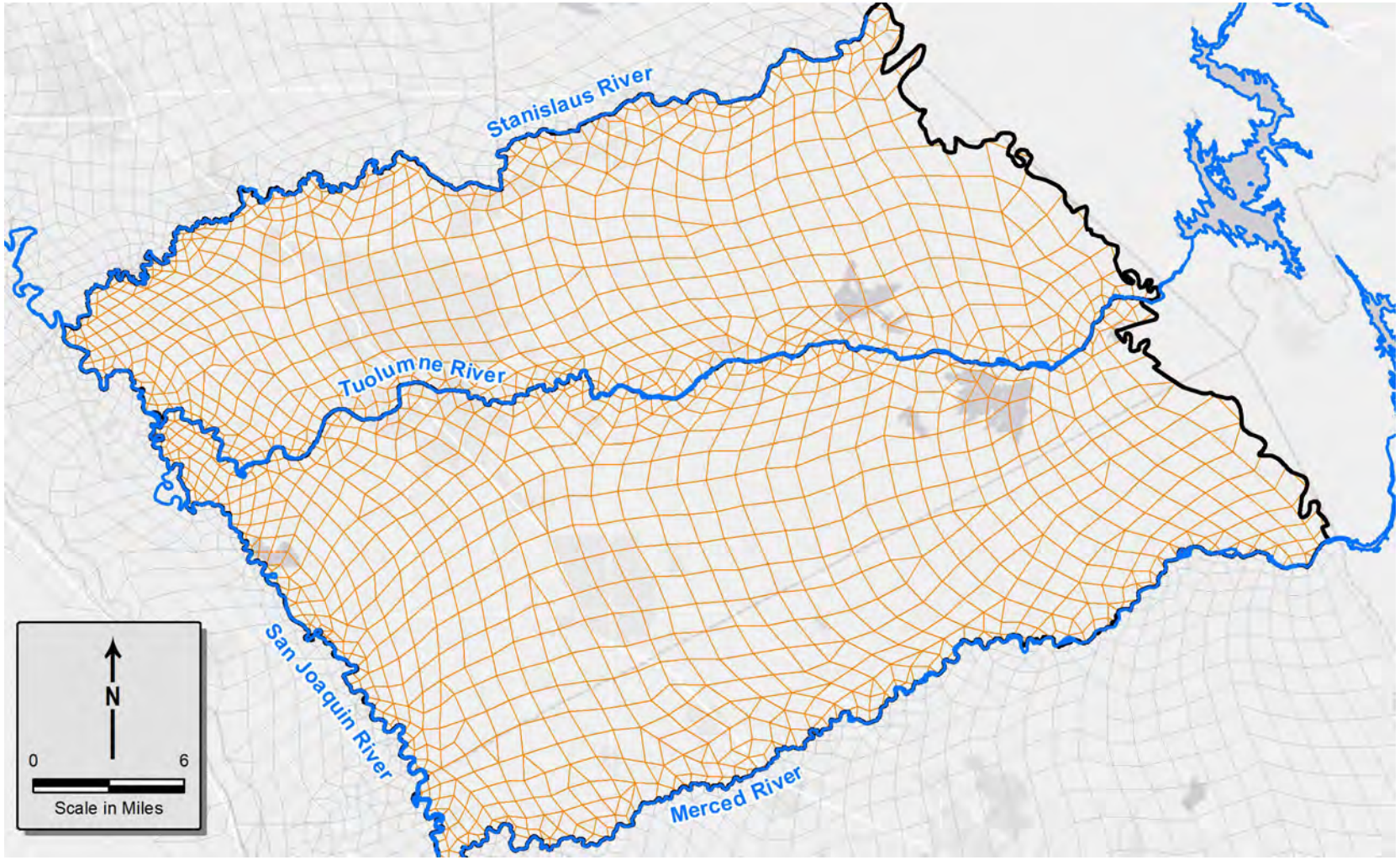
- 134,691 acres agriculture (55%)
- 36,391 acres urban (15%)
- 74,136 acres (30%) other/undeveloped

Turlock Subbasin

- 262,920 acres agriculture (75%)
- 23,220 acres urban (7%)
- 62,004 acres (18%) other/undeveloped

TODD GROUNDWATER

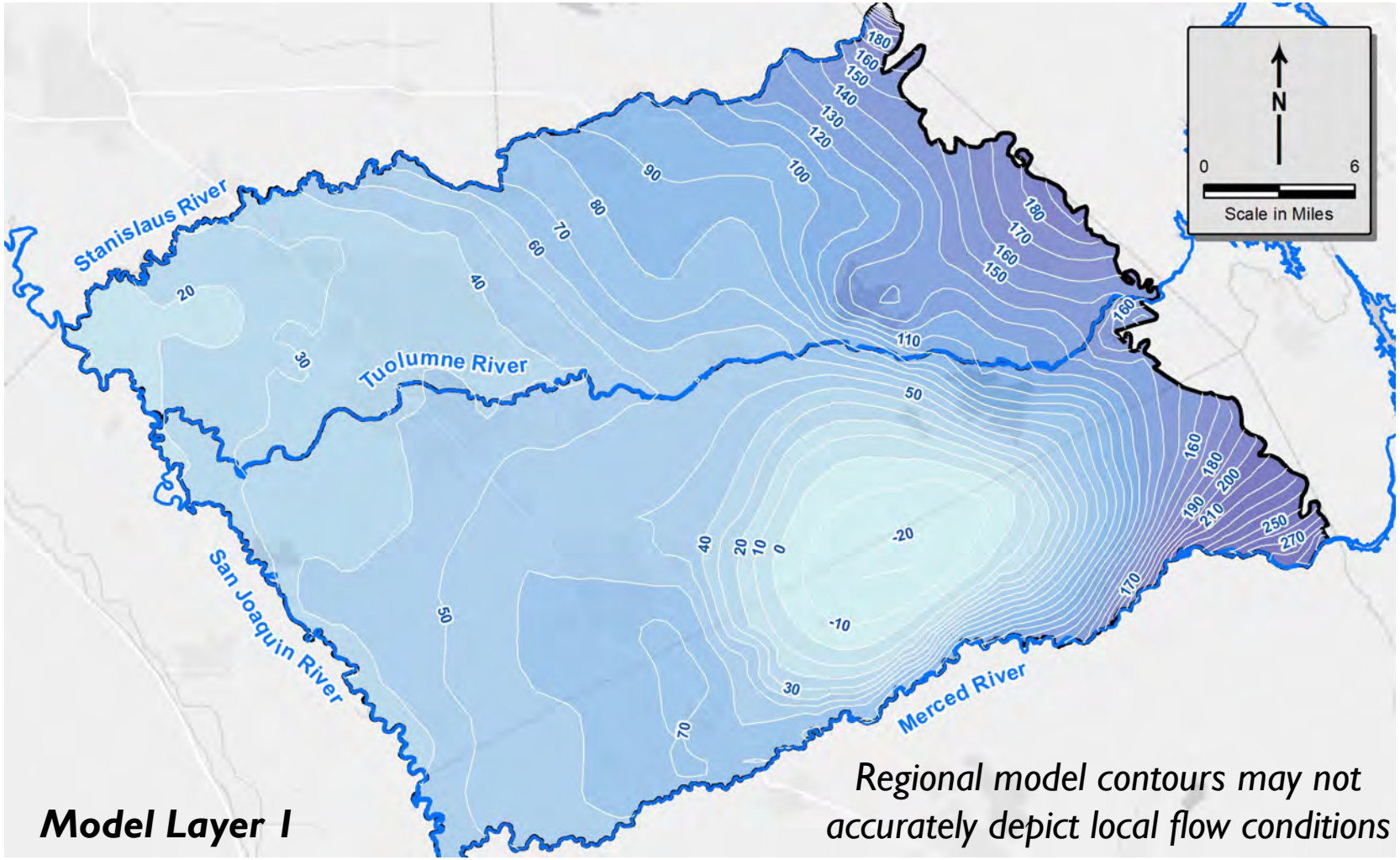
TURLOCK & MODESTO INTEGRATED SURFACE WATER-GROUNDWATER MODEL



- Based on C2VSim-FG regional DWR model
- Covers both subbasins
- Estimates boundary flows between subbasins
- Predicts dynamic interaction between groundwater and surface water along river boundaries

TODD GROUNDWATER

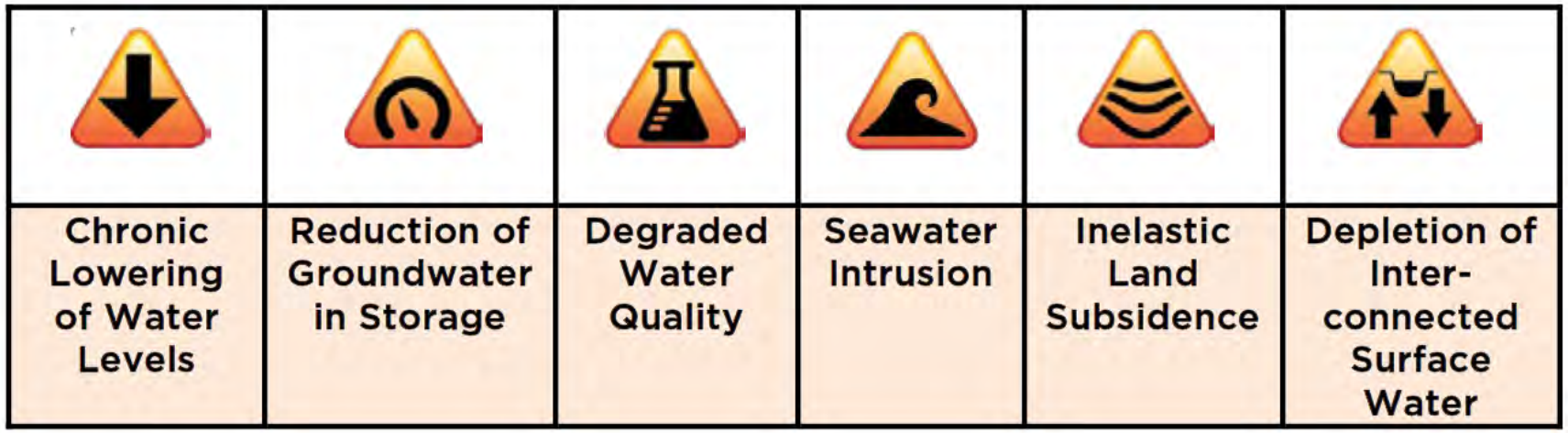
SIMULATED GROUNDWATER ELEVATIONS OCTOBER 2015



- Chronic water level declines in eastern areas solely reliant on groundwater
- Largest historical declines in Turlock Subbasin
- Lack of historical data in eastern portions of both subbasins

TODD GROUNDWATER

Sustainable Management Criteria



- 6 Sustainability Indicators – If conditions are determined to be significant and unreasonable, they are defined as undesirable results
- Minimum Thresholds / Measurable Objectives – to quantify undesirable results

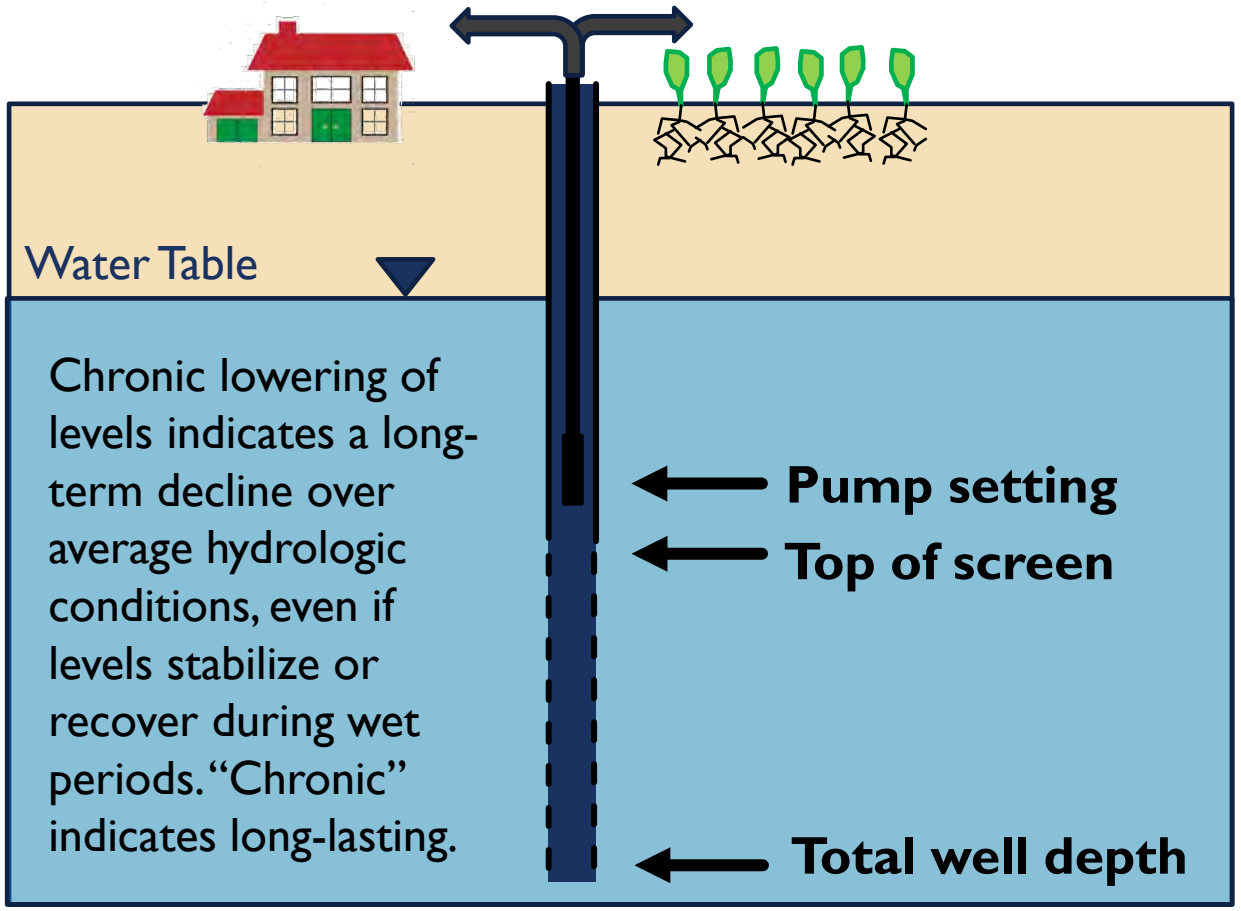
Sustainability Considerations

Sustainability Indicator	Modesto Subbasin	Turlock Subbasin
Chronic Lowering of Groundwater Levels	Adverse impacts to water supply wells; declines affect other indicators	Same as Modesto Subbasin
Reduction of GW in Storage	Overdraft conditions in eastern Subbasin	Same as Modesto Subbasin
Degraded Water Quality	Track 7 constituents of concern monitored by others; coordinate with other programs	Track 6 constituents of concern monitored by others; coordinate with other programs
Seawater Intrusion	Not applicable	Not applicable
Inelastic Land Subsidence	No documented impacts to date; potential for future impacts	Same as Modesto Subbasin
Interconnected Surface Water	Projected increase in streamflow depletion along river boundaries	Projected increase in streamflow depletion; disconnection may occur if declines continue

Sustainable Management Approach

- GSAs are not required to address undesirable results that occurred before, and have not been corrected by, January 1, 2015. (§10727.2 (b)(4))
- Focus GSP on eliminating any current or projected future undesirable results.
- Develop robust monitoring networks; improvements over time.
- Recognize the need for adaptive management:
  - Demonstrate GSP implementation progress through annual reporting
  - Re-assess sustainable management criteria and aquifer response to projects/actions at five-year evaluation of GSP.

Chronic Lowering of Water Levels



- Have water level declines affected beneficial uses of wells?
- During the recent drought of record, did we have:
  - Dry wells?
  - Operational issues?
  - Water quality concerns?
- Are these undesirable results?

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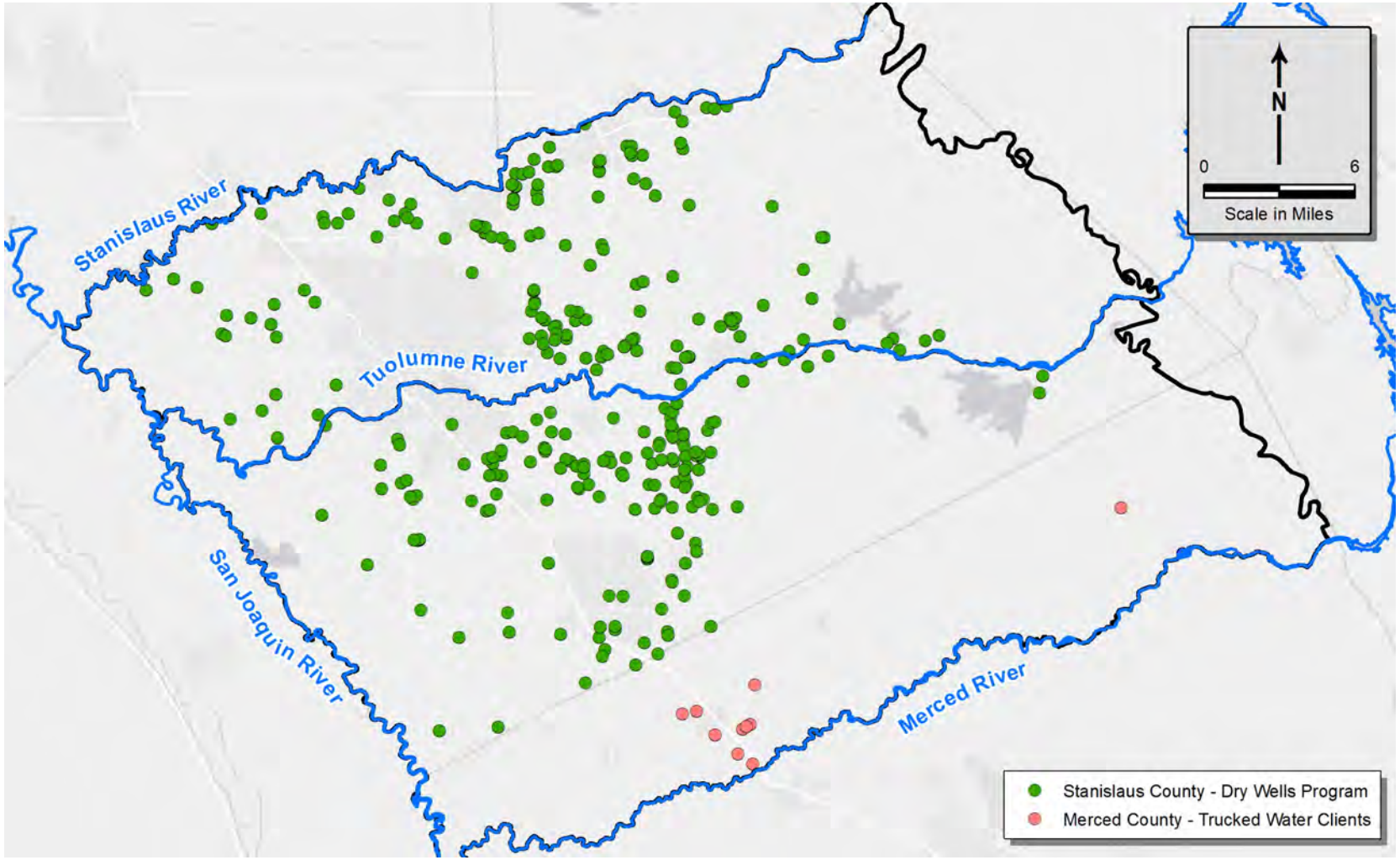
TODD GROUNDWATER

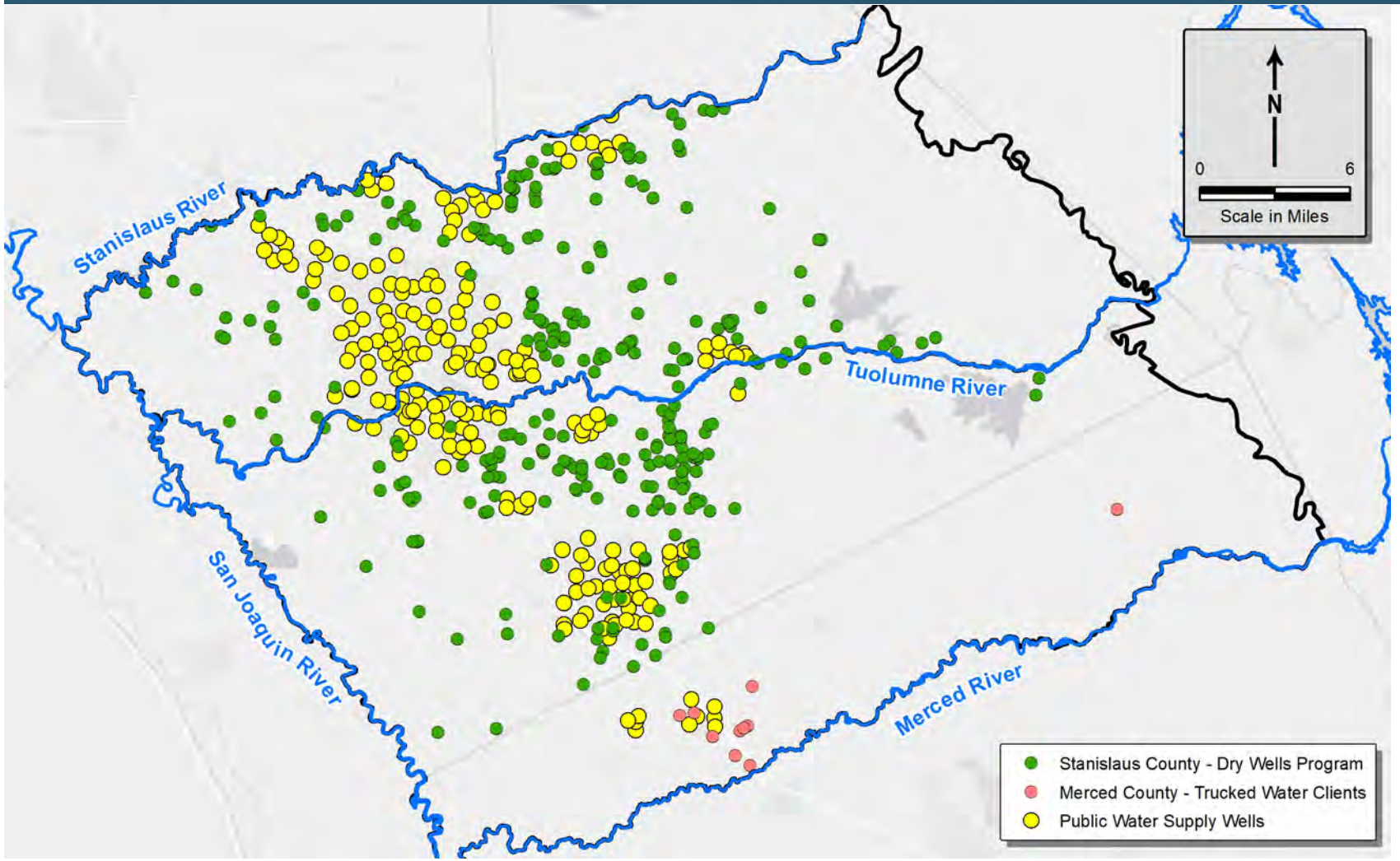
COUNTY PROGRAM FOR FAILED DOMESTIC WELLS DURING 2014 – 2017 DROUGHT



- Stanislaus and Merced counties assisted homeowners with failed domestic wells during 2014-2017 drought
  - 159 in Modesto Subbasin
  - 165 in Turlock Subbasin
- Most failed wells were older wells less than 100 feet deep
- Most domestic wells appear to have been replaced; 211 new domestic wells drilled since 2015

TODD GROUNDWATER

PUBLIC WATER SUPPLY WELLS IMPACTS DURING 2014 – 2017 DROUGHT



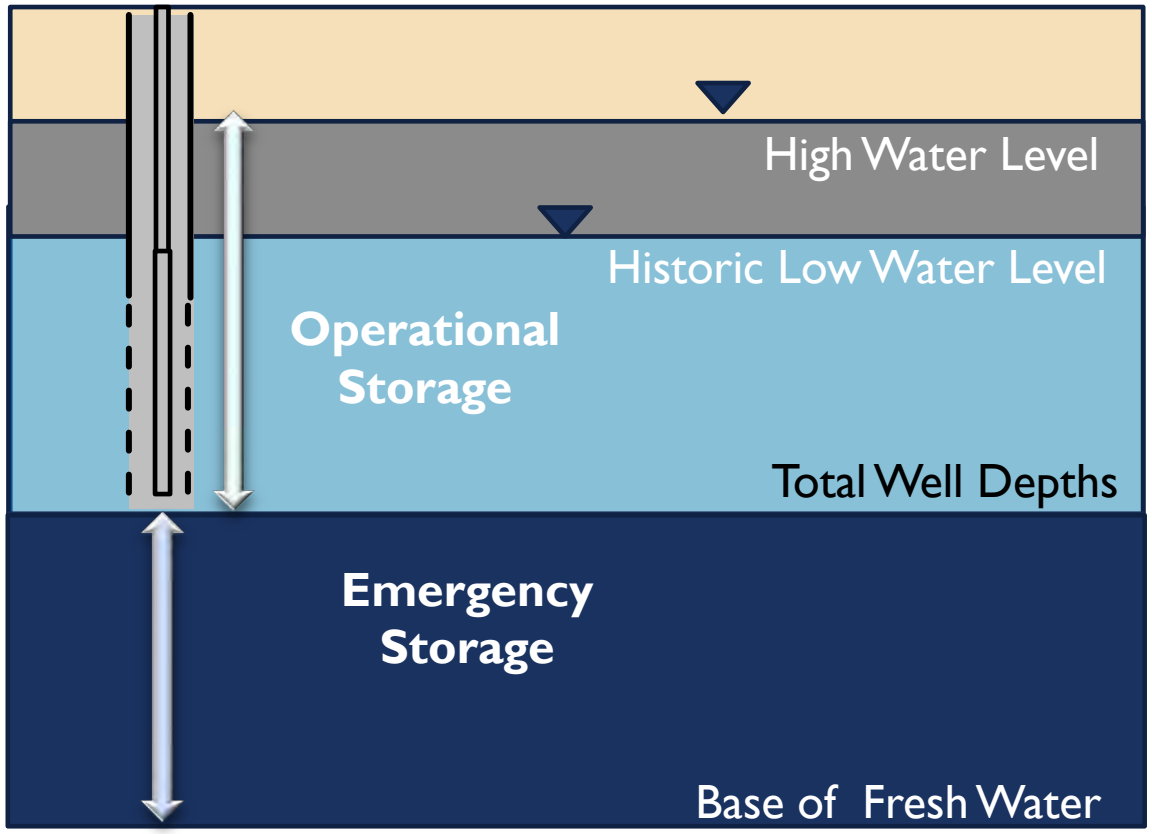
- Adverse impacts to some of the public water supply wells during drought
  - Collapsed casing
  - Replaced/lowered pumps
  - Loss of capacity
  - Water quality
- More wells at risk during future droughts

TODD GROUNDWATER

REDUCTION OF GROUNDWATER IN STORAGE

Considerations:

- Depletion of Supply
  - *Will we "run out of water"?*
- Overdraft Conditions
  - *Is the basin being managed within its sustainable yield?*



GSP Water Budgets

Historical Conditions

Historical
* Land use
* Water use
* Hydrology

WY 1991-2015

Projected Conditions

Projected
* Land use
* Water use

Historical
* Hydrology (1969-2018)

50-Year Forecast

Projected with Climate Change

Projected
* Land use
* Water use
* Hydrology

50-Year Forecast

Sustainable Yield

Projected Conditions

Draft Sustainable Management Criteria

Preliminary based only on demand reduction

50-Year Forecast

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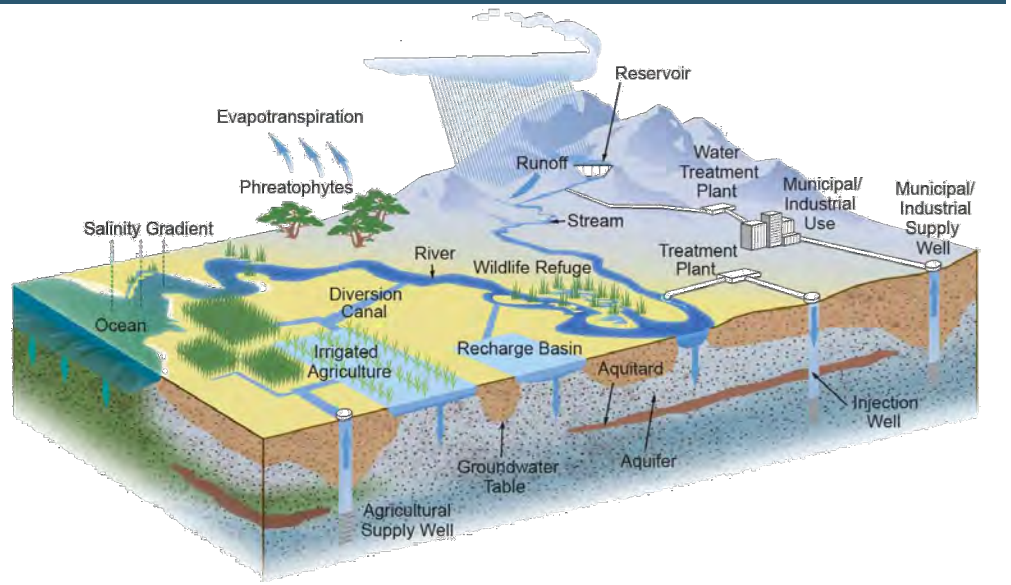
WOODARD & CURRAN

TODD GROUNDWATER

PROJECTED WATER BUDGETS

- Forecast future inflows and outflows over the planning and implementation horizon (50 years)
- Provide a *baseline* of future conditions <u>without projects or management actions</u>
- Assist with sustainable management criteria (undesirable results)
- Target projects and actions needed to achieve sustainability



Quantify natural and managed recharge, extractions/discharge, subsurface flows, and interactions between surface water and groundwater (interconnected surface water)

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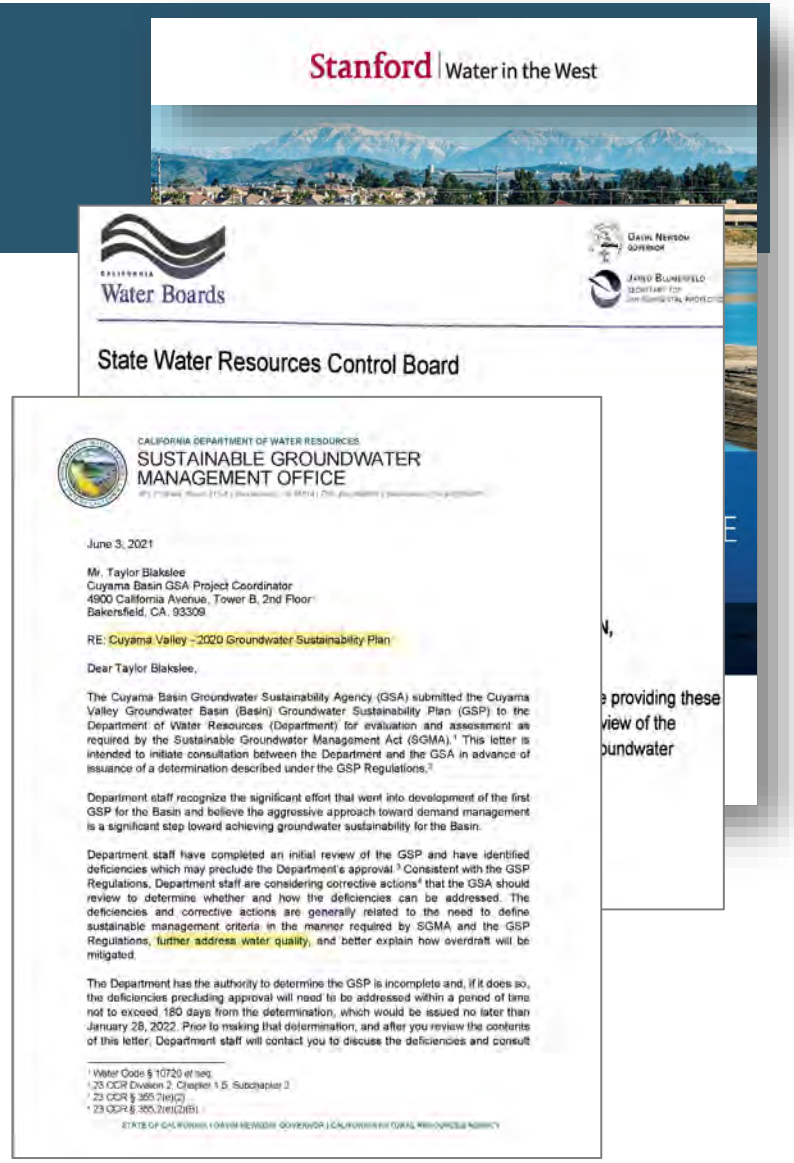
WOODARD & CURRAN TODD GROUNDWATER

DEGRADED WATER QUALITY

- GSAs are not required to take over regulatory roles assigned to agencies with primary responsibility for groundwater quality.
- GSAs are required to assess potential impacts on water quality from GSP projects or management actions.
- Recent DWR/SWRCB comment letters note that GSAs are also responsible for regulating water levels and extractions; therefore, GSAs are responsible for water quality impacts affected by water levels/pumping.
- GSAs are recommended to track all constituents of concern, determine if degradation is related to GSA actions, and then confer with other regulatory agencies on any water quality undesirable results.
- GSP should provide a "cross-walk" between GSAs and water quality regulatory agencies.



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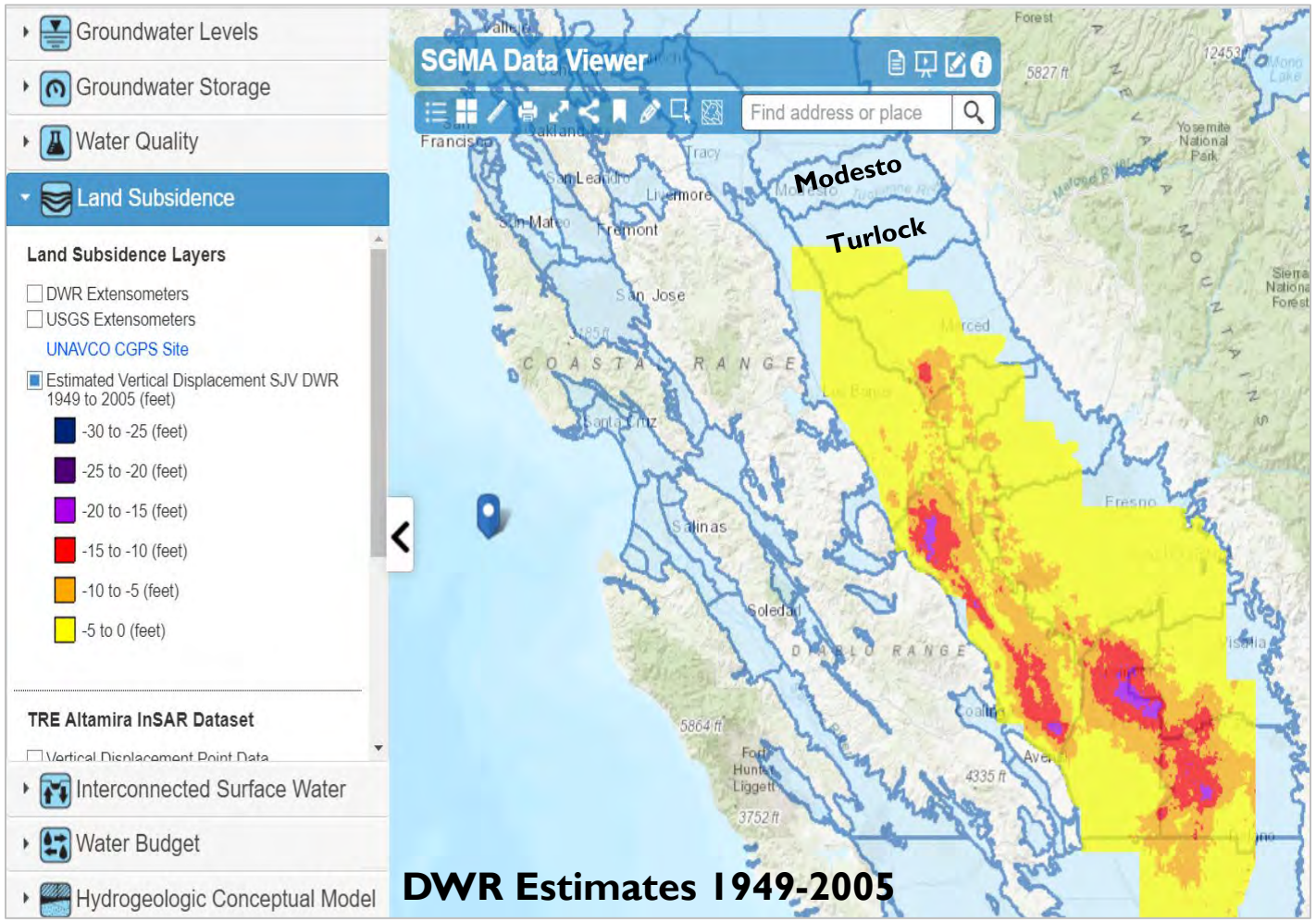
TODD GROUNDWATER

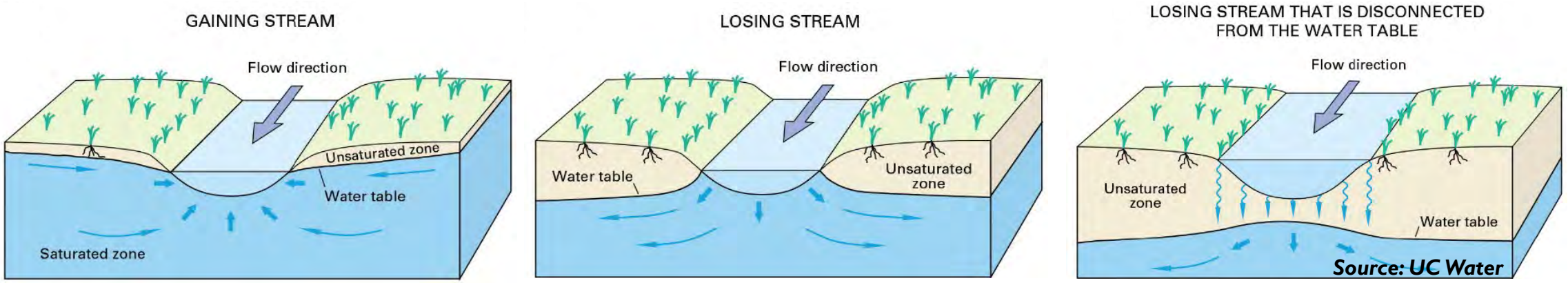
LAND SUBSIDENCE



- GSP requirements :
  - Minimum Threshold shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results (354.28(c)(5)
- Given the lack of impacts to date, it is difficult to determine an exact rate that would lead to undesirable results in Turlock/Modesto.
- Managing groundwater levels at or above historic low levels would be protective against future impacts from land subsidence.

TODD GROUNDWATER

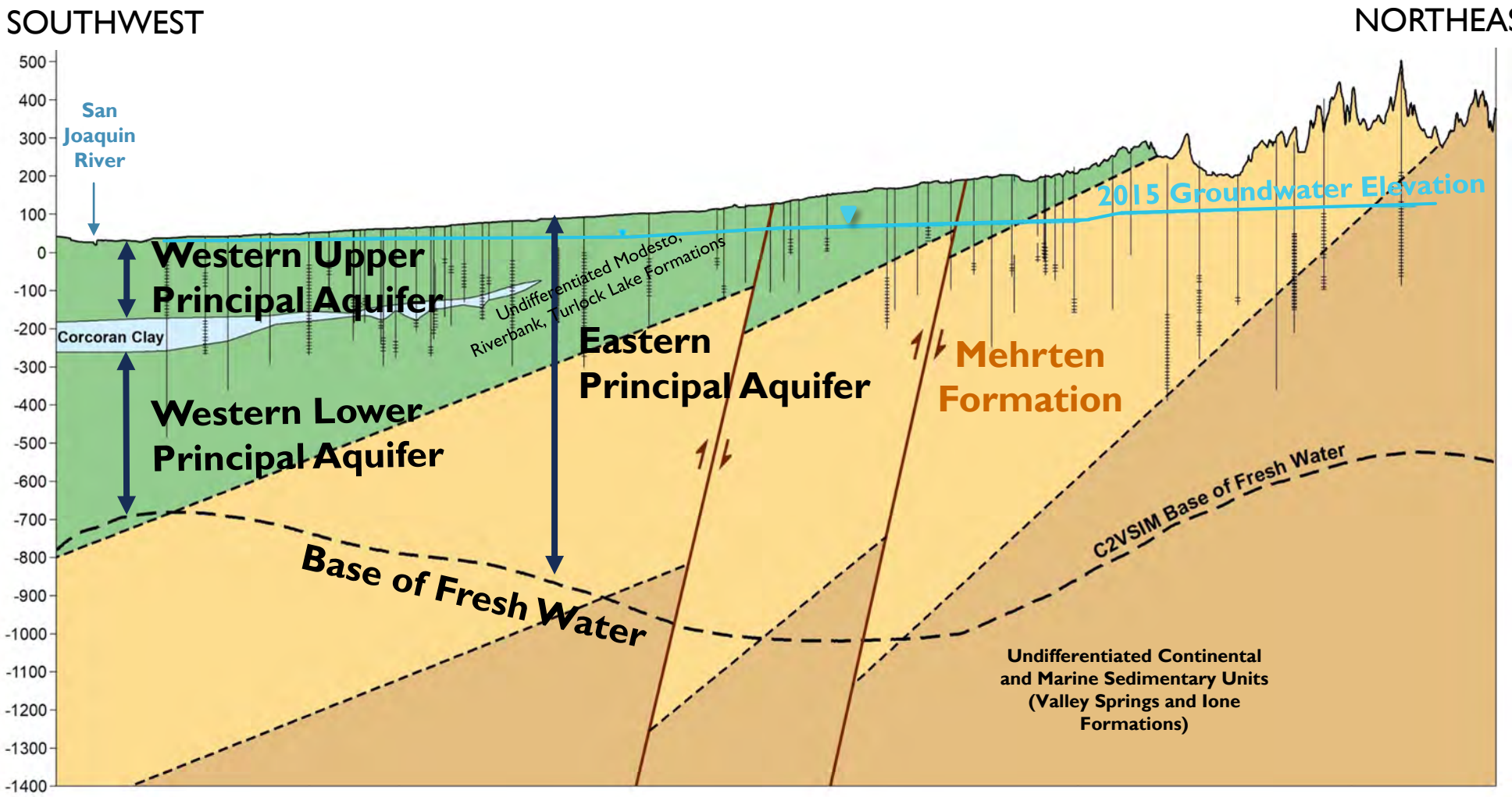
INTERCONNECTED SURFACE WATER



- Historical water budget – Stanislaus, Tuolumne, and San Joaquin rivers were net gaining streams; Merced River was a slightly net losing stream, on average.
- Projected future modeling suggests significant increases in streamflow depletion in all except San Joaquin River. Merced River may become disconnected.
- Streamflow depletion provides a benefit to groundwater supply but can adversely impact surface water rights and ecosystems (e.g., GDEs).

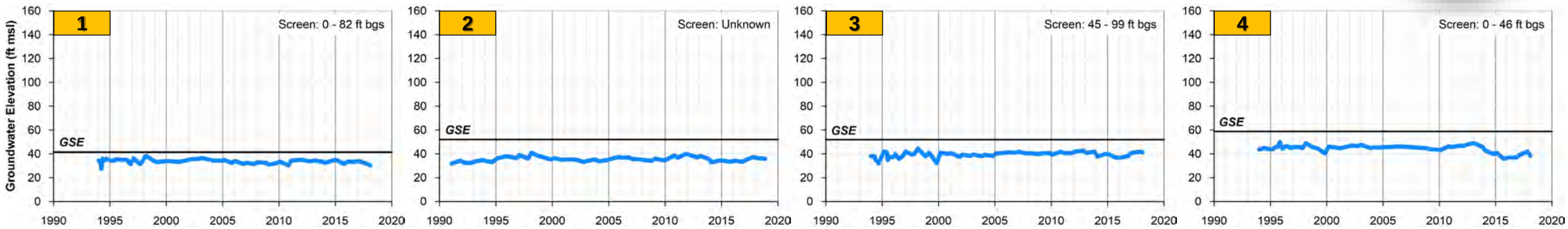
MODESTO SUBBASIN

BASIN SETTING – PRINCIPAL AQUIFERS AND HYDROGEOLOGIC FRAMEWORK

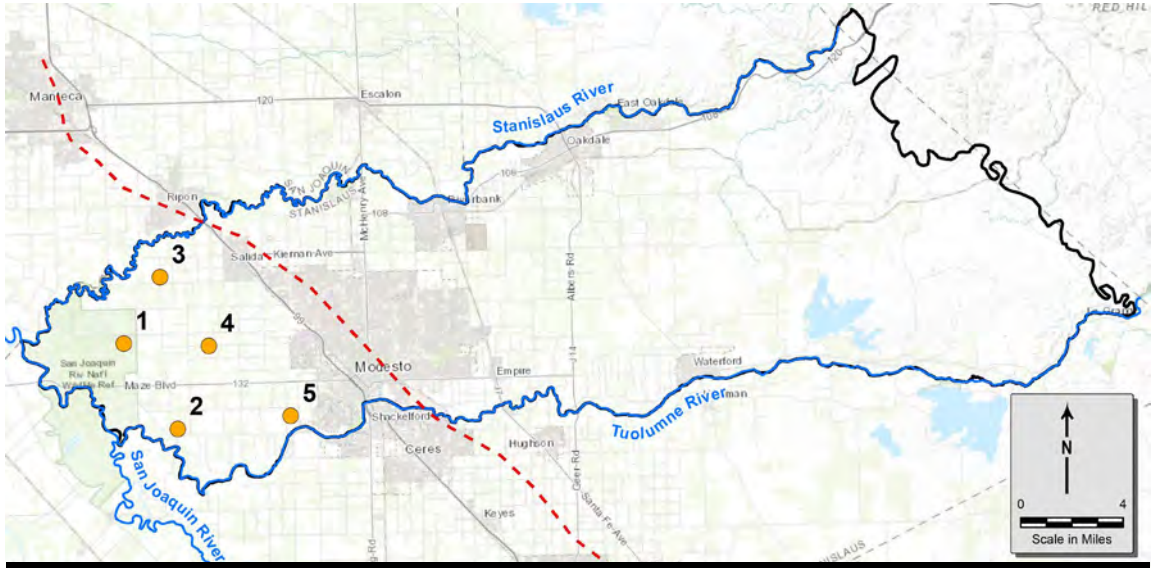


- 3 Principal Aquifers
- Defined by Corcoran Clay
- Basin Bottom (Base of Fresh Water) up to 1,200 feet thick

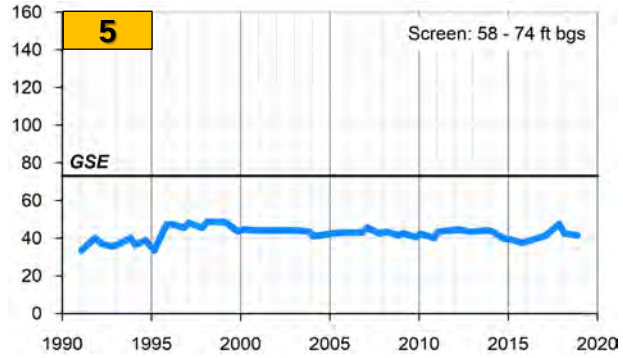
HISTORICAL GROUNDWATER LEVELS WESTERN UPPER PRINCIPAL AQUIFER



- No significant long-term declines (<15 ft)
- Water levels recover during wet periods



Western Upper Principal Aquifer Wells



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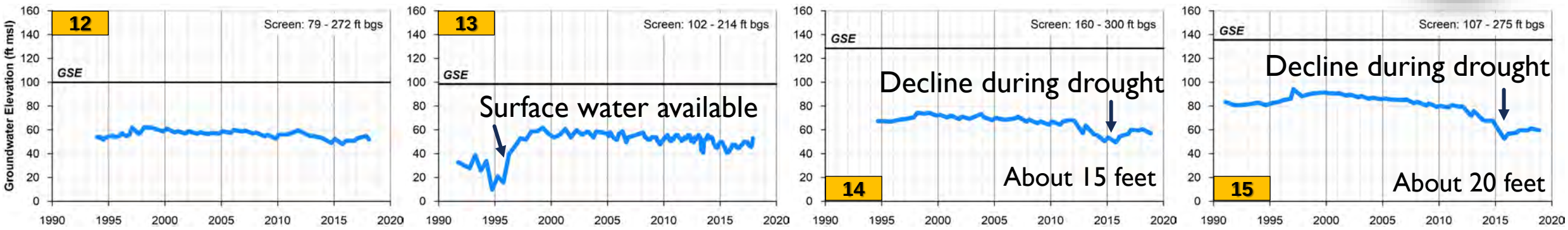
Historical Groundwater Levels
Eastern Principal Aquifer



- Overall drought declines of 15 ft to 20 ft
- City of Modesto Well (#13) rose when surface water became available
- Eastern-most wells have not recovered fully from drought (#14, 15, and 16)

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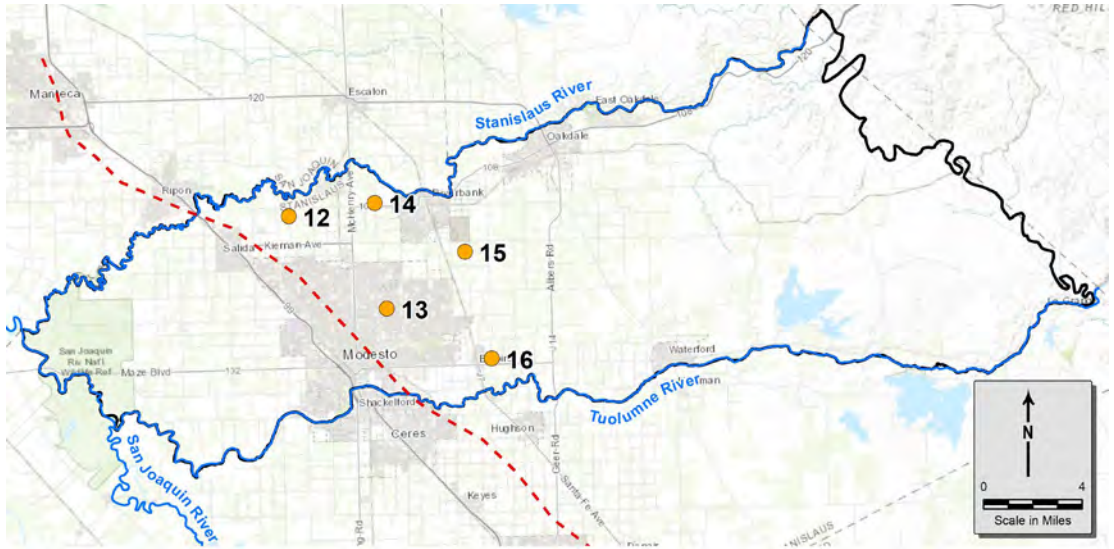
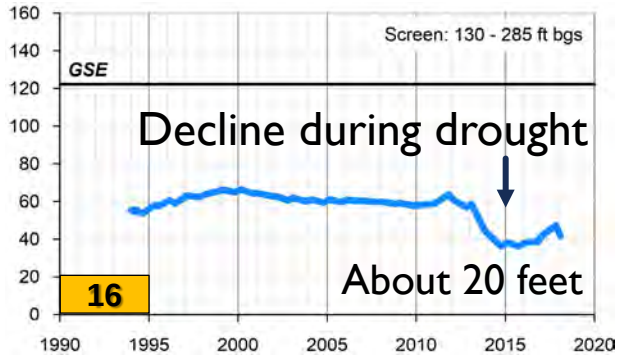
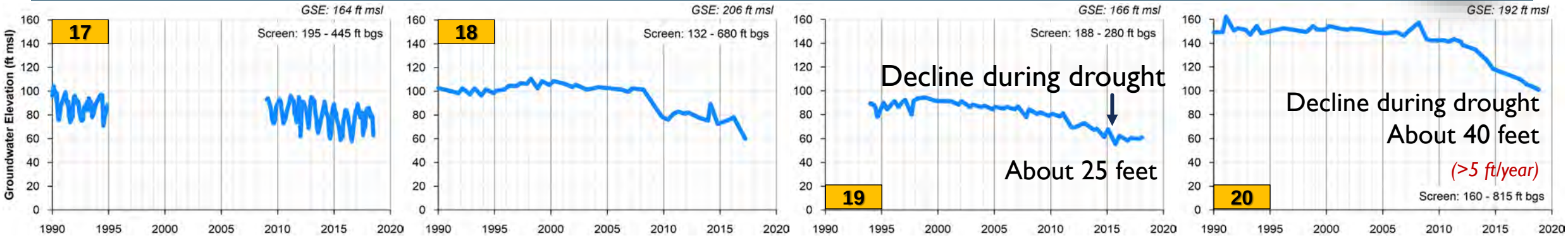


Eastern Principal Aquifer Wells



Historical Groundwater Levels
Eastern Principal Aquifer



- Largest water level declines in Non-District East area
- Declines of 25 ft to 40 ft during recent drought
- Rate of decline more than 5 feet/year for some eastern wells

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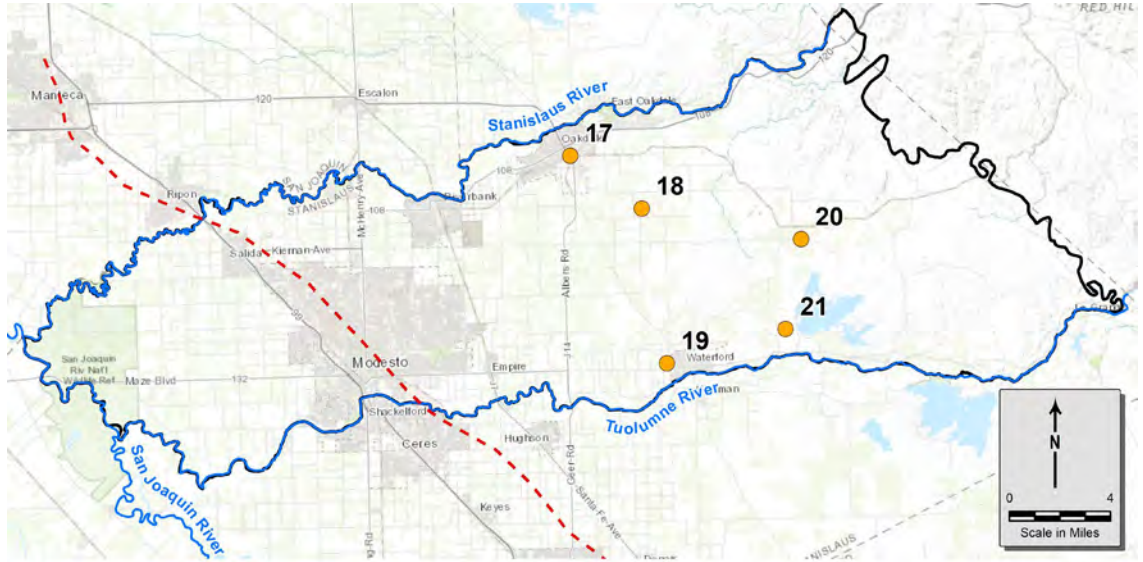
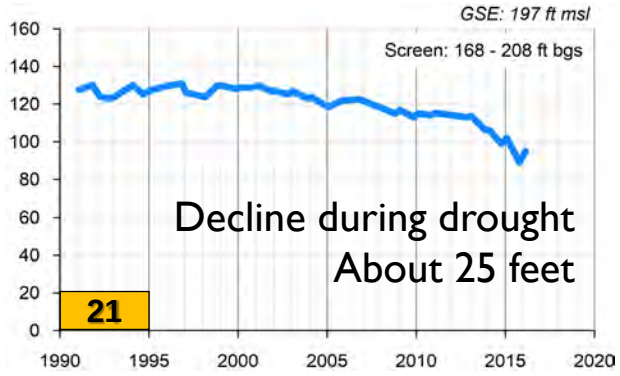
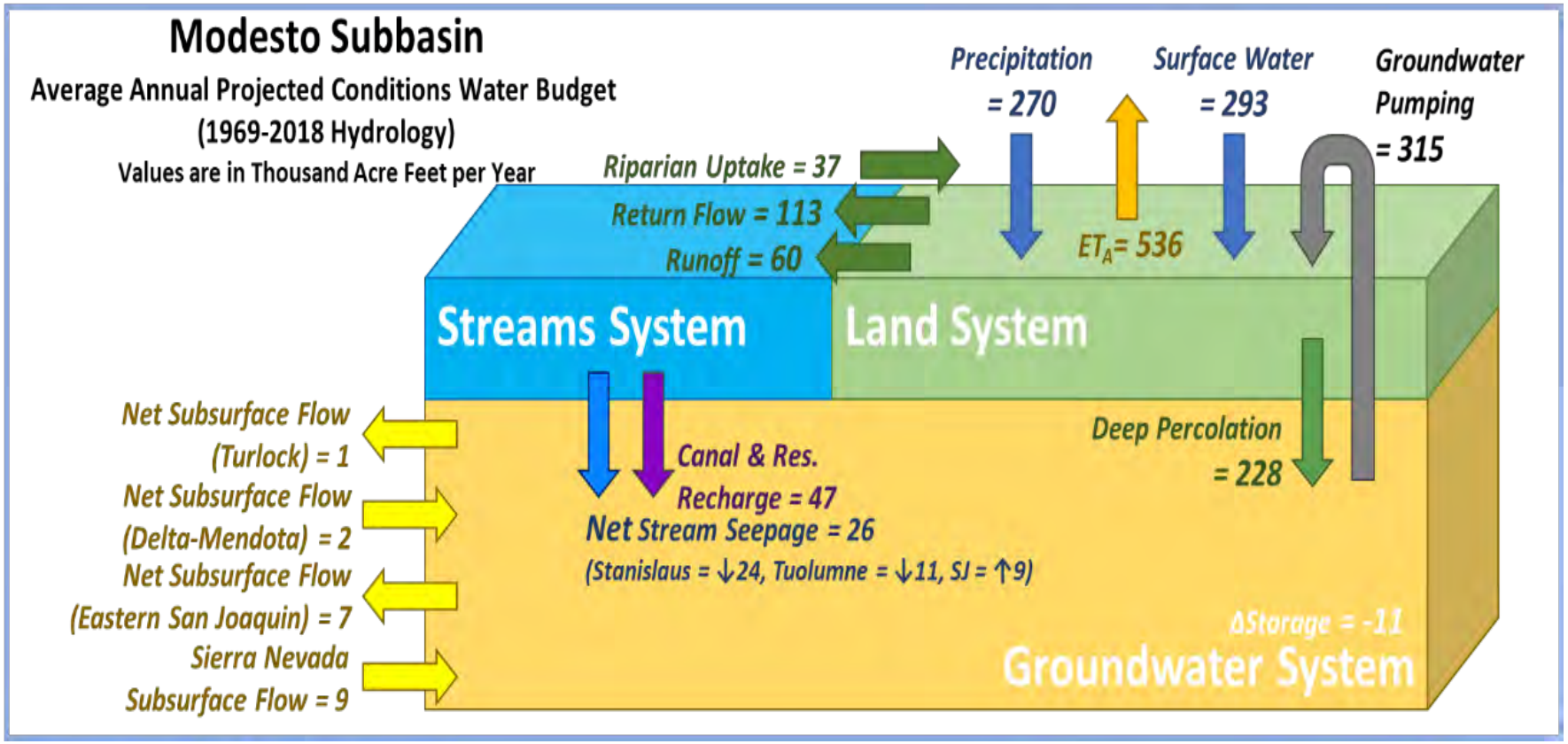


Eastern Principal Aquifer Wells



PROJECTED FUTURE WATER BUDGET MODESTO SUBBASIN



- Monthly inflows and outflows over 50 years
- Overdraft -11,000 AFY
- Improved from historical -43,000 AFY but at expense of increase in streamflow depletion

Most of the projected overdraft and increase in streamflow depletion are associated with areas using groundwater as the sole water supply.

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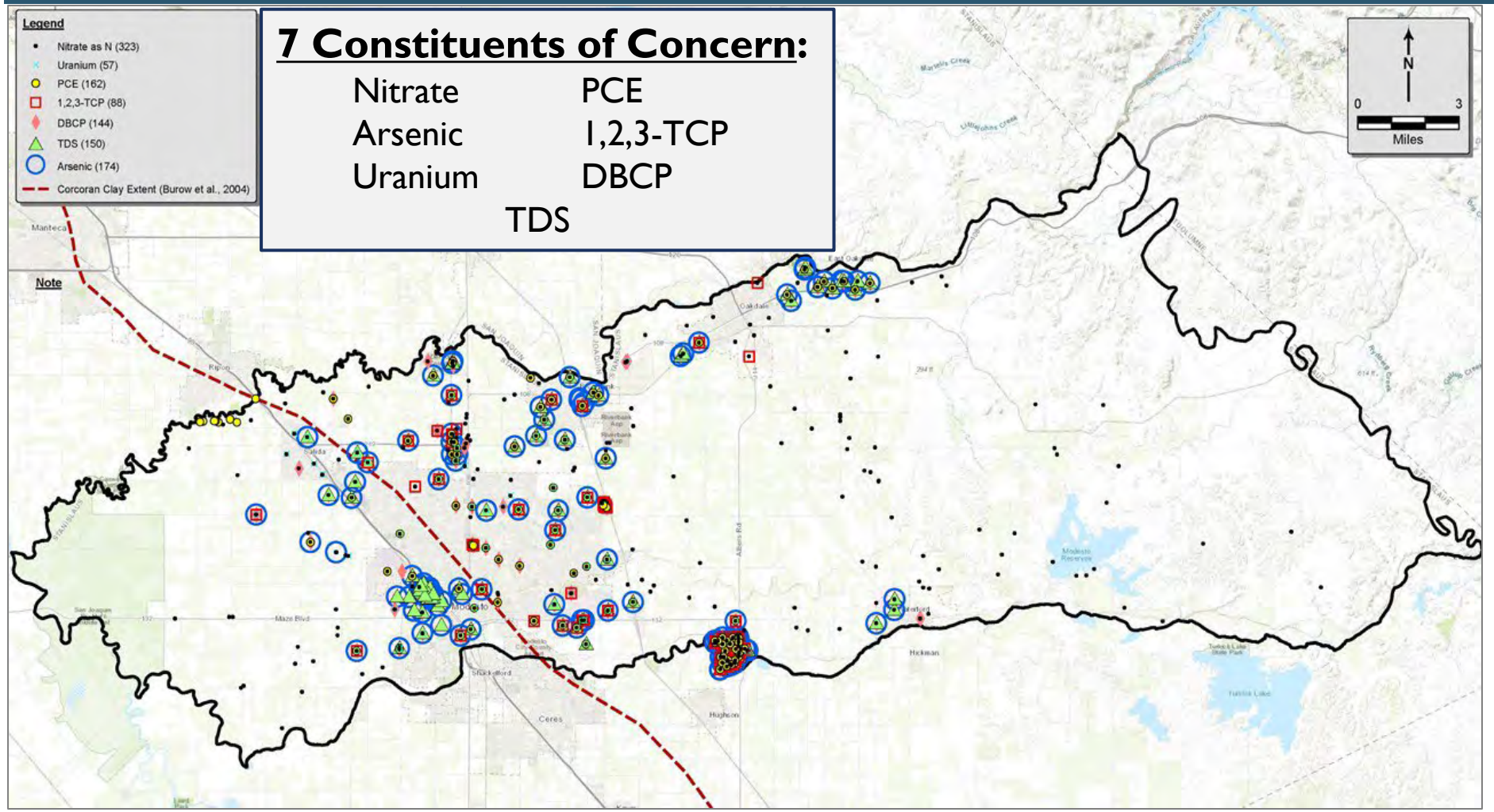
WOODARD & CURRAN TODD GROUNDWATER

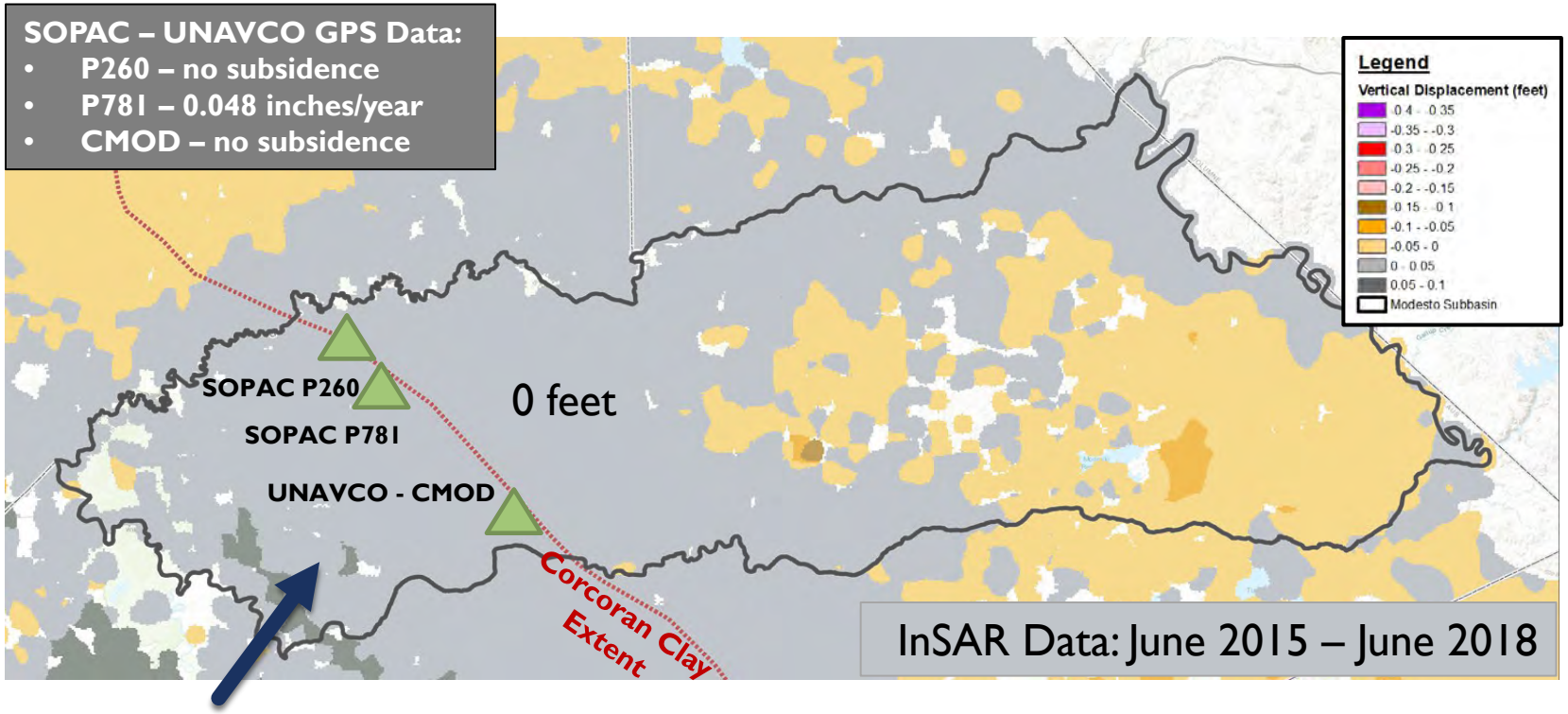
WATER QUALITY MONITORING SITES OCTOBER 2019 – SEPTEMBER 2020 (WY 2020)



- Over 300 wells sampled in WY 2020
- Leverage existing data
- Download annually from databases:
  - GeoTracker
  - GAMA
  - Water Quality Coalitions

TODD GROUNDWATER

InSAR Data and Existing GPS Stations for Future Tracking of Potential Land Subsidence



- InSAR data published annually by DWR
- 3 GPS stations monitored by others for land subsidence
- Track data for future indications of subsidence outside of extent of the Corcoran Clay
- Manage water levels at or above historic lows protective against future land subsidence impacts

Zero to low rates of vertical displacement in areas most likely to be susceptible to land subsidence (extent of the Corcoran Clay)

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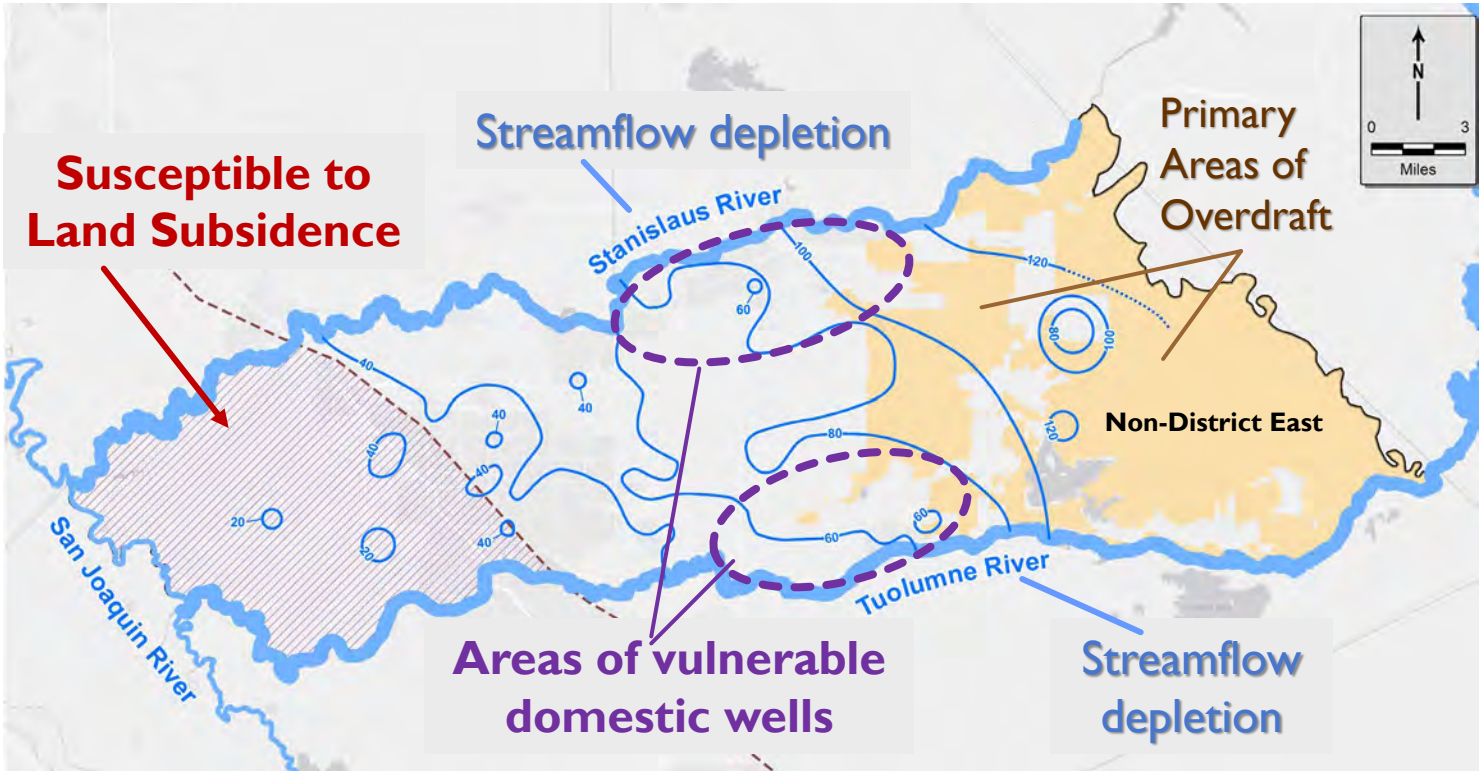
TODD GROUNDWATER

SUSTAINABILITY CONSIDERATIONS MODESTO SUBBASIN



- Declining groundwater levels and overdraft
- Water supply well impacts
- Streamflow depletion on Tuolumne and Stanislaus Rivers
- Corcoran Clay and associated compressible clay layers susceptible to land subsidence

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TODD GROUNDWATER

Sustainable Management Criteria
Modesto Subbasin

Sustainability Indicator	Undesirable Results (narrative)	Minimum Thresholds
Chronic Lowering of Groundwater Levels	Adverse impacts to water supply wells from over-pumping	Historical low water level WY 1991–2020 (typically 2015, 1991, or current)
Reduction of GW in Storage	Long-term overdraft conditions based on projected water use and average hydrology	As above; linked to sustainable yield volume
Degraded Water Quality	Degradation caused by GSA projects/actions or management of water levels/extractions	MCLs of 7 constituents of concern
Seawater Intrusion	Not applicable	Not applicable
Inelastic Land Subsidence	Inelastic land subsidence that adversely impacts land use/infrastructure	Historical low water level WY 1991–2020 (typically 2015, 1991, or current)
Interconnected Surface Water	Adverse impacts on beneficial uses of surface water caused by groundwater extraction	Fall 2015 water levels (in coordination with adjacent subbasins)

Sustainable management criteria above are summarized/shortened for space; please refer to the GSPs for complete descriptions of criteria.

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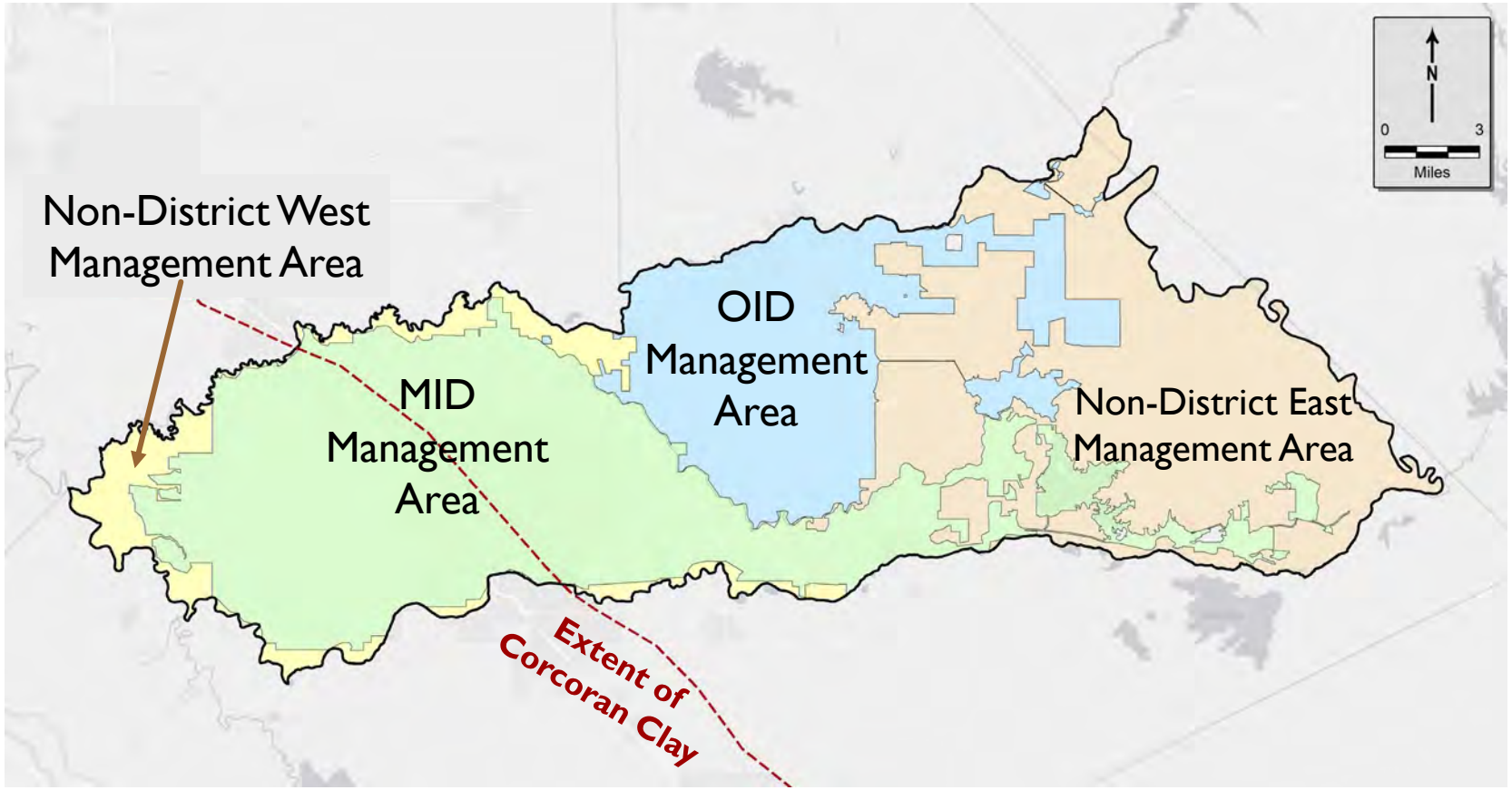
TODD GROUNDWATER

GSP MANAGEMENT AREAS
MODESTO SUBBASIN



- Management Areas established to facilitate Projects and Management Actions
- Supports current agency management and responsibilities
- Promotes coordination for surface water projects

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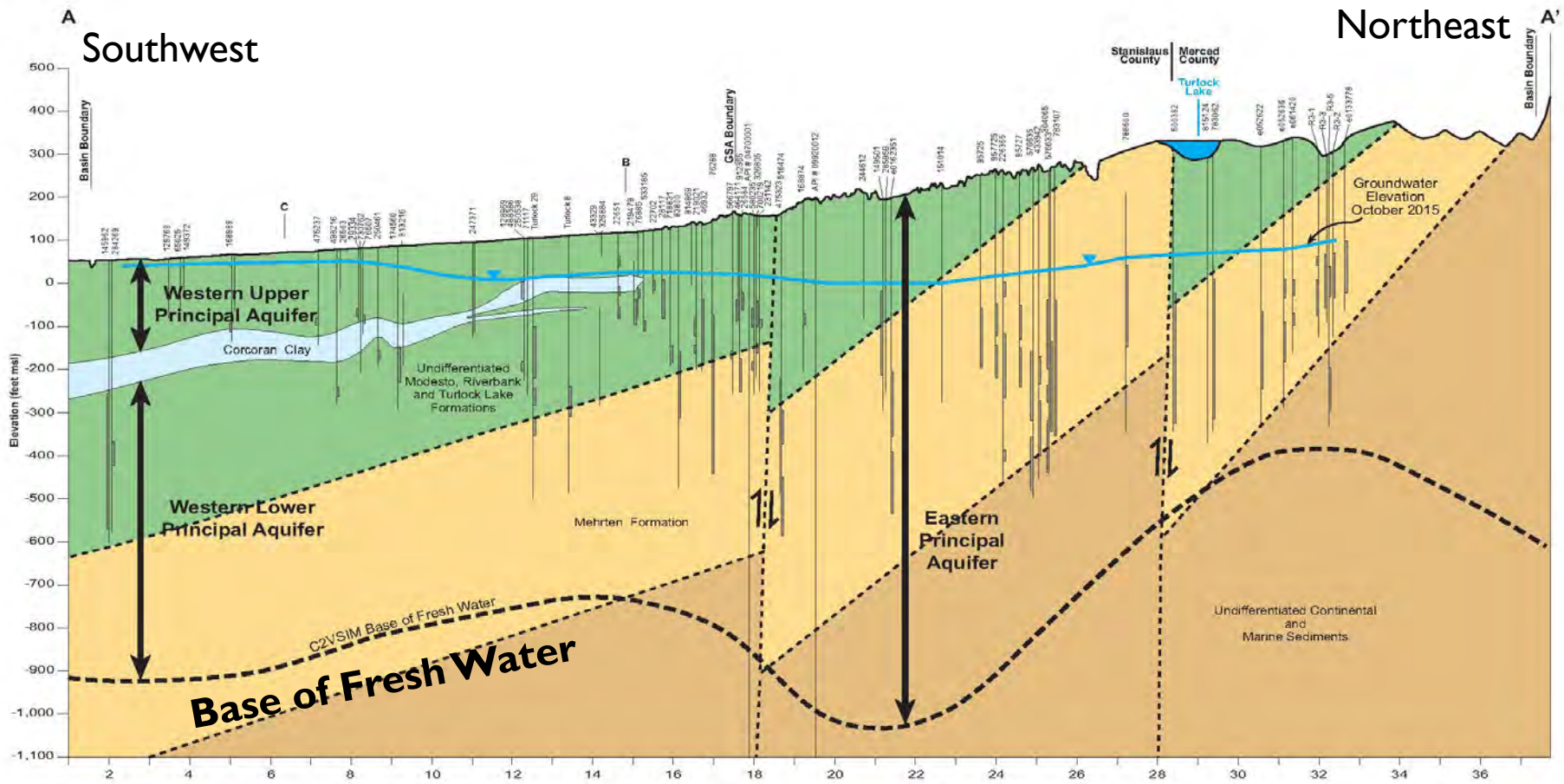
TODD GROUNDWATER

MODESTO SUBBASIN GSP PROJECTS

Draft: Work in Progress Projects	Direct Recharge (AFY)	In-Lieu Recharge (AFY)	Demand Reduction (AFY)
City of Modesto Municipal Conservation Projects			18,700
Waterford/Hickman Surface Water Supply Project		900	
Storm Drain Cross Connection Removal Project	248		
MID to Out-of-District Lands In-lieu or Direct Recharge Project		28,800	
OID to Out-of-District Lands In-lieu or Direct Recharge Project		9,600	
Tuolumne River Flood Mitigation Direct Recharge Project	9,600		
Dry Creek Flood Mitigation Direct Recharge Project	5,400		
All Projects	***15,248***	***39,300***	**18,700**

TURLOCK SUBBASIN

BASIN SETTING – PRINCIPAL AQUIFERS AND HYDROGEOLOGIC FRAMEWORK



- Regional cross sections with geologic formations and structure
- Delineated Principal Aquifers same as in Modesto Subbasin
- Bottom of basin – Base of fresh water

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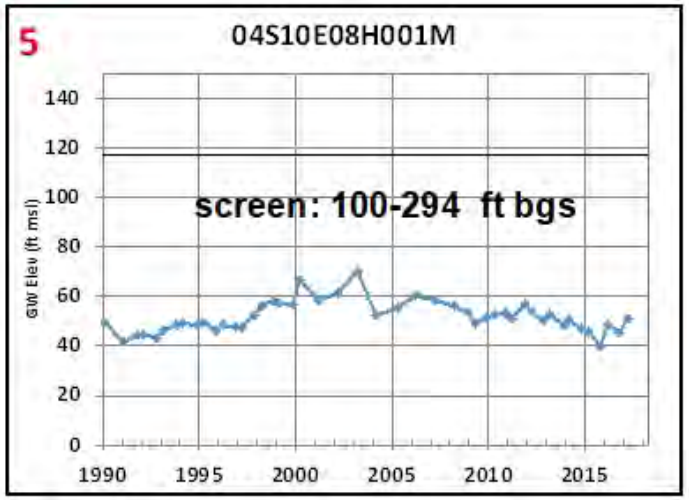
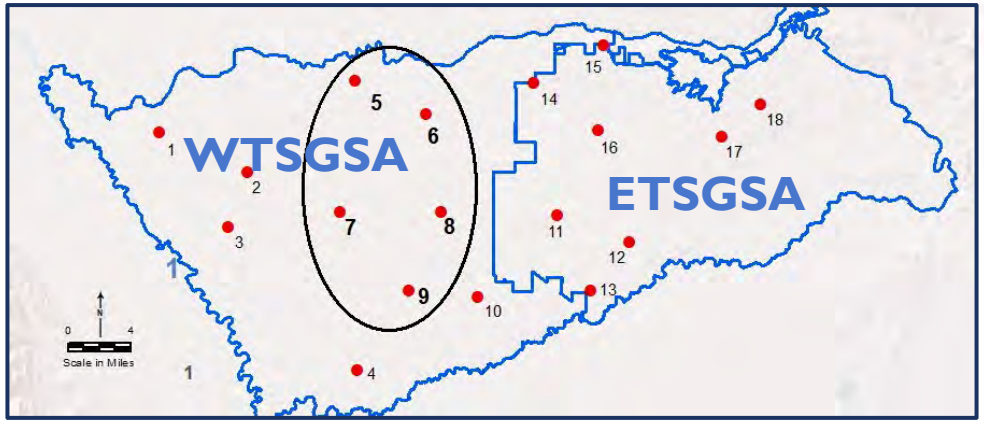
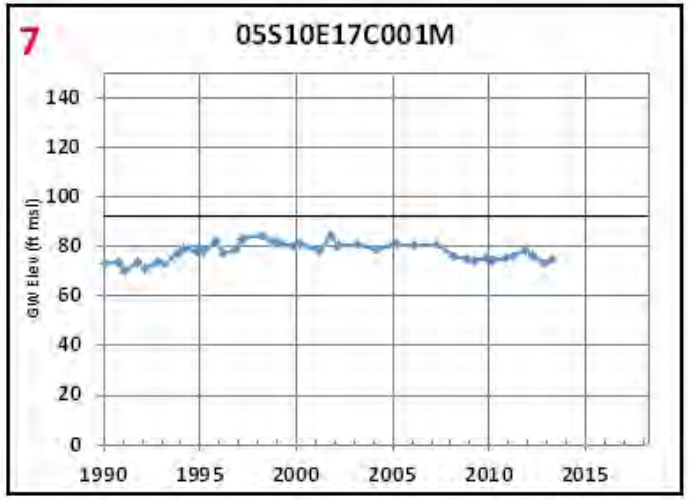
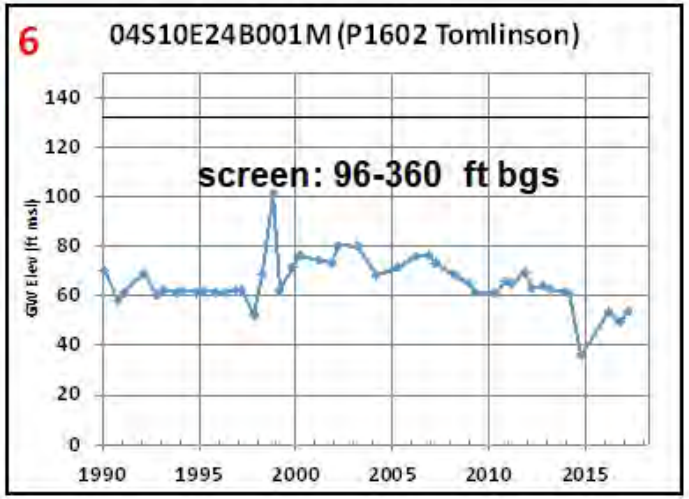
Wood Rodgers, 2019

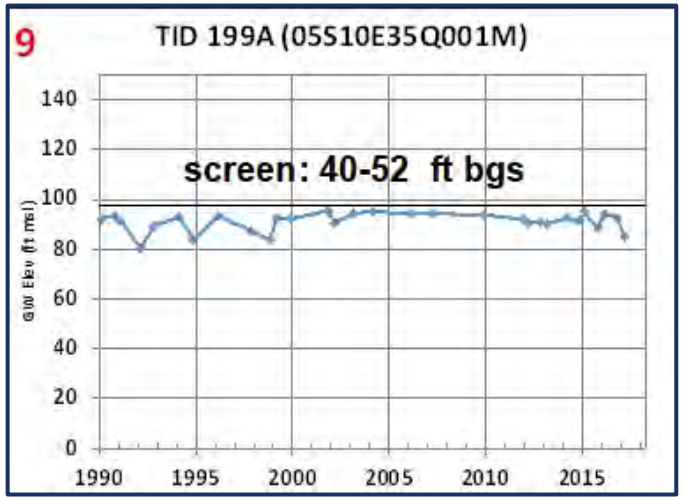
HISTORICAL GROUNDWATER LEVELS
WEST TURLOCK SUBBASIN GSA (WTSGSA)

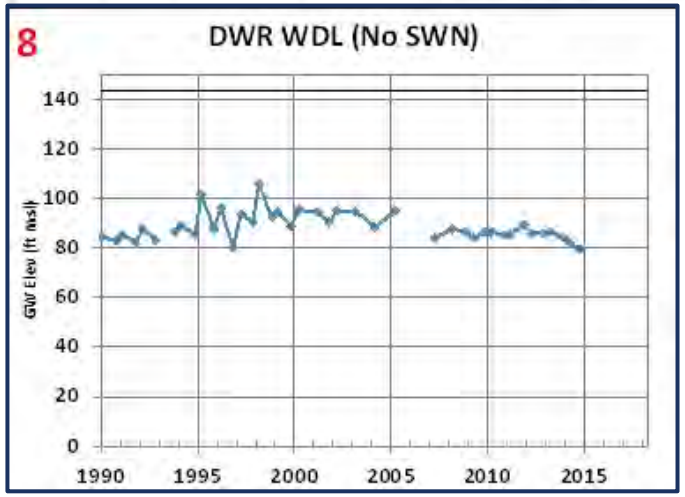




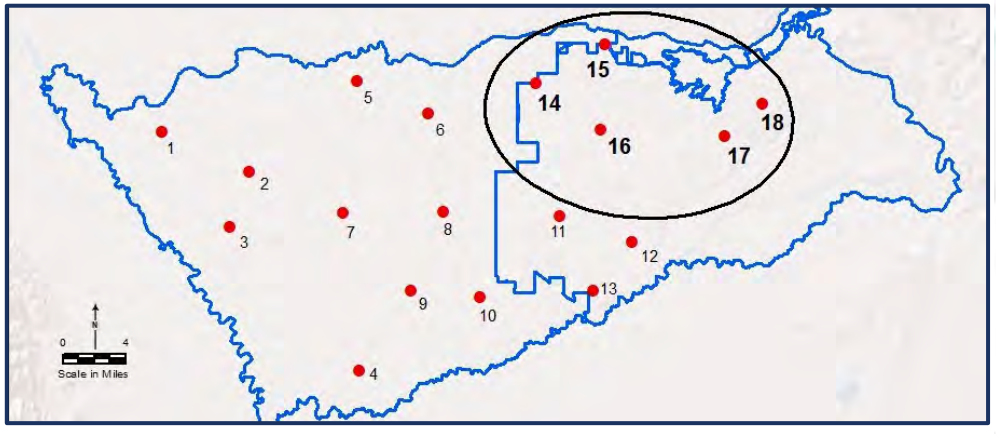


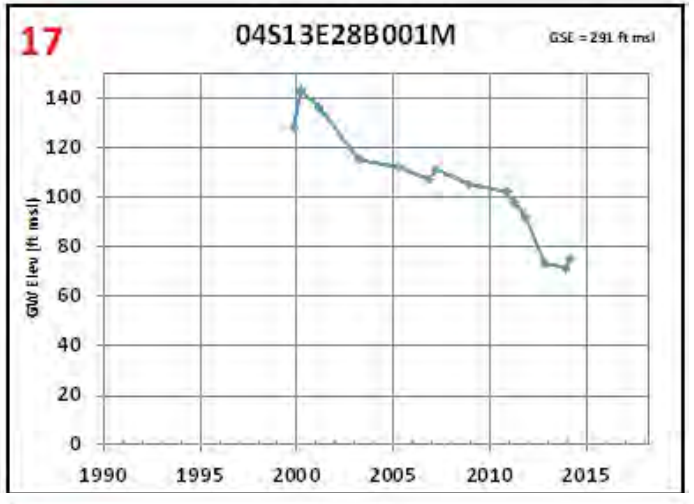


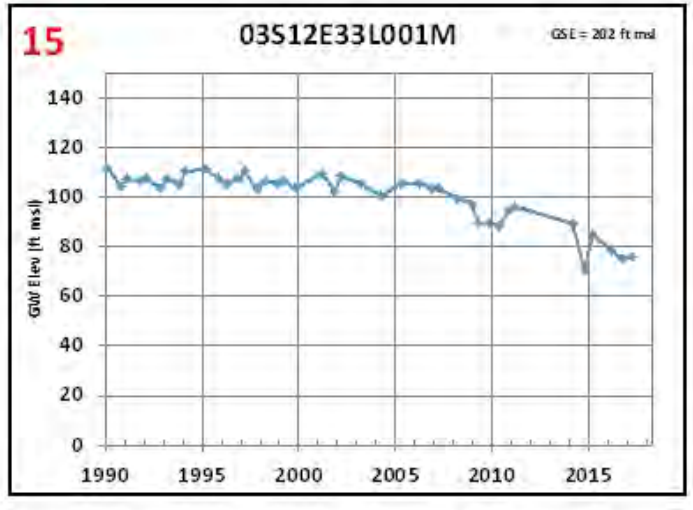


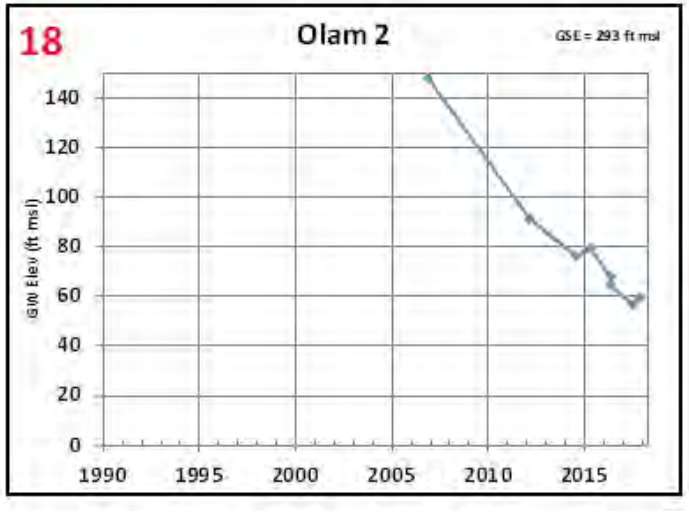


HISTORICAL GROUNDWATER LEVELS EAST TURLOCK SUBBASIN GSA (ETSGSA)

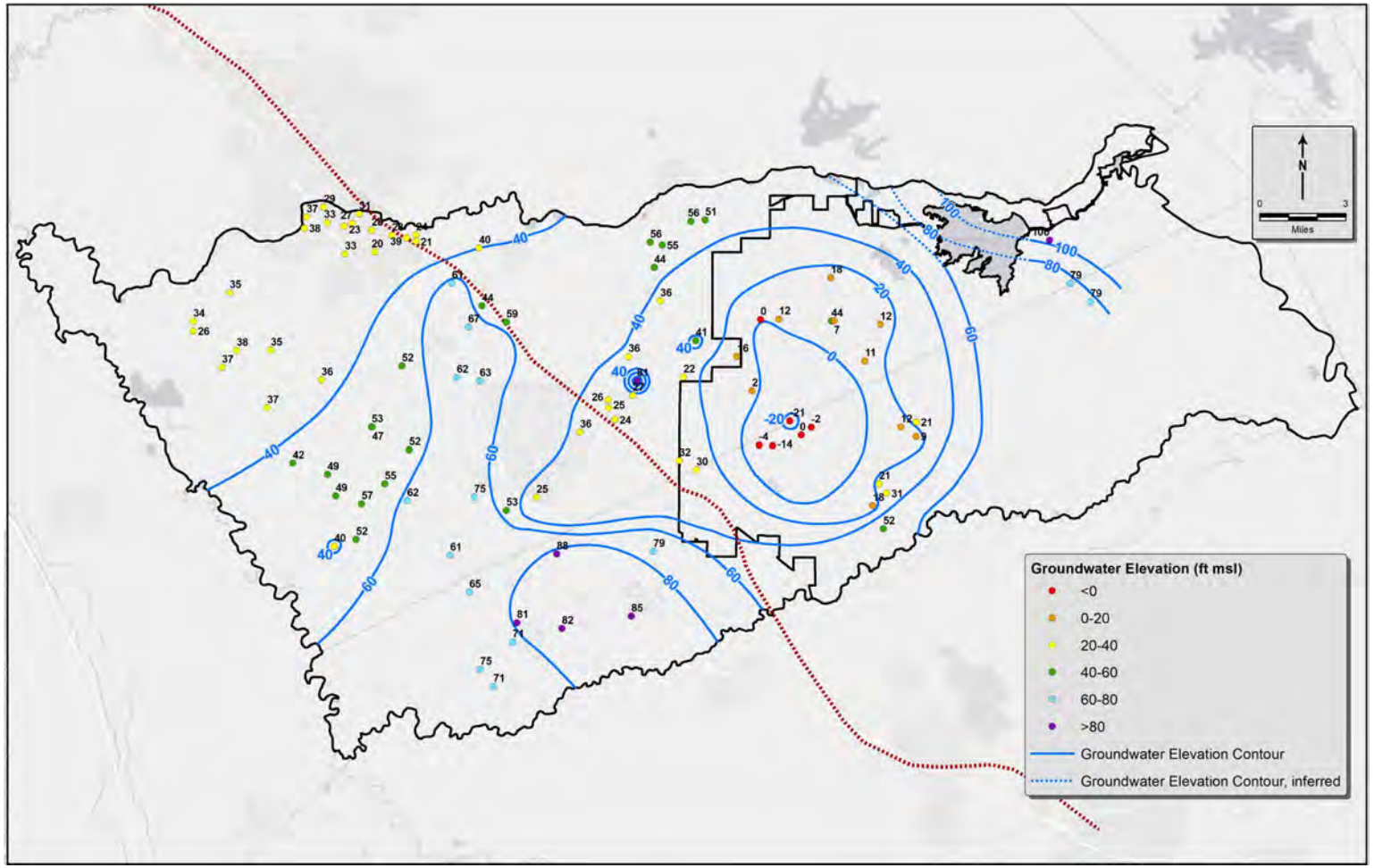






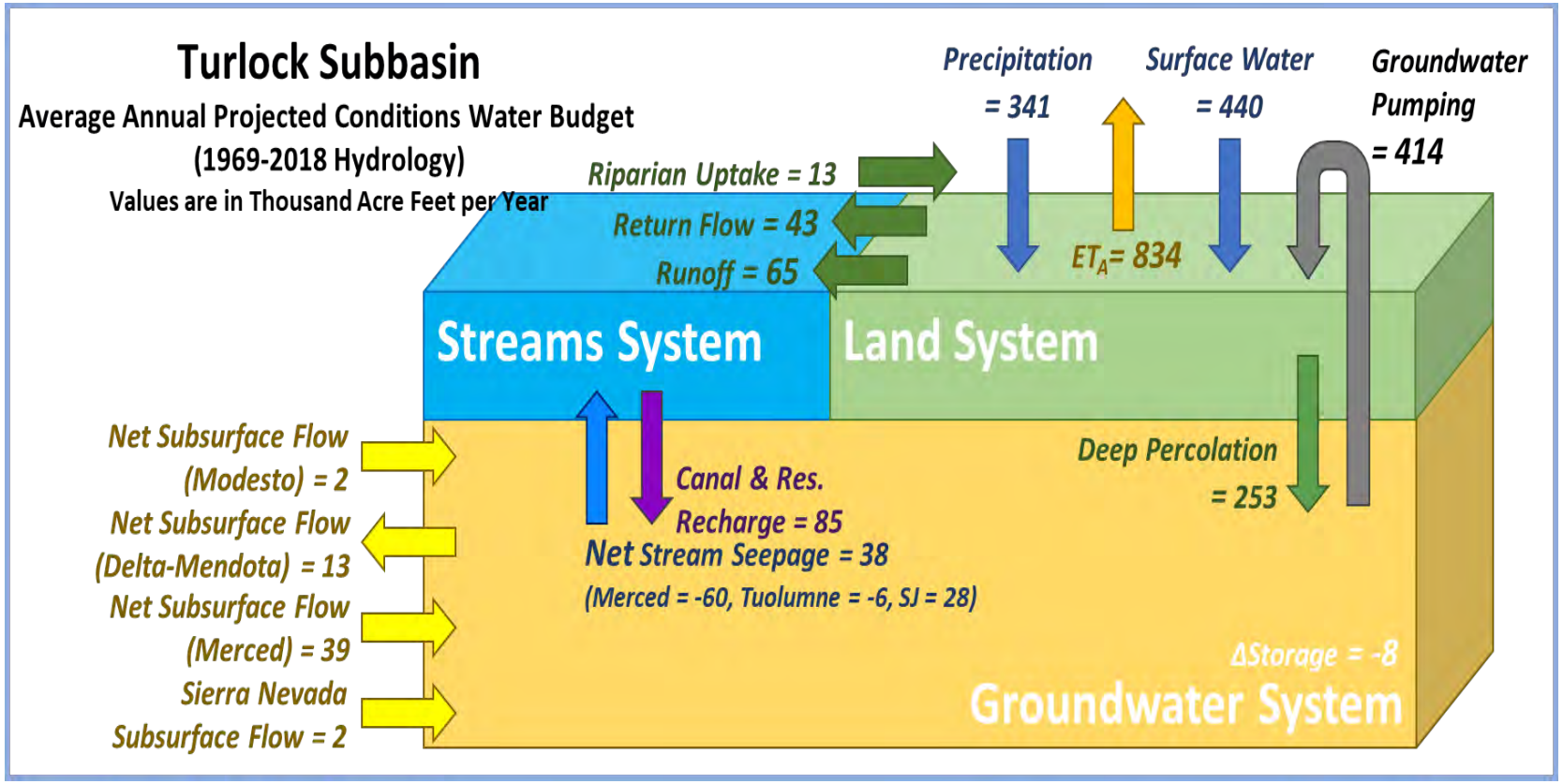


2015 GROUNDWATER CONDITIONS



- Historical overdraft and declining water levels in east-central Subbasin
- Expansion of cone of depression radially around historical pumping centers, extending north and south to rivers
- Data gaps in areas of eastern Subbasin pumping

FUTURE PROJECTED WATER BUDGET TURLOCK SUBBASIN



- Monthly inflows/outflows over 50-year period
- Projected future overdraft of -8,000 AFY
- Historical overdraft of -63,900 AFY
- Improvement in overdraft results from increase in streamflow depletion – an undesirable result.

Most of the projected overdraft and increase in streamflow depletion are associated with areas using groundwater as the sole water supply.

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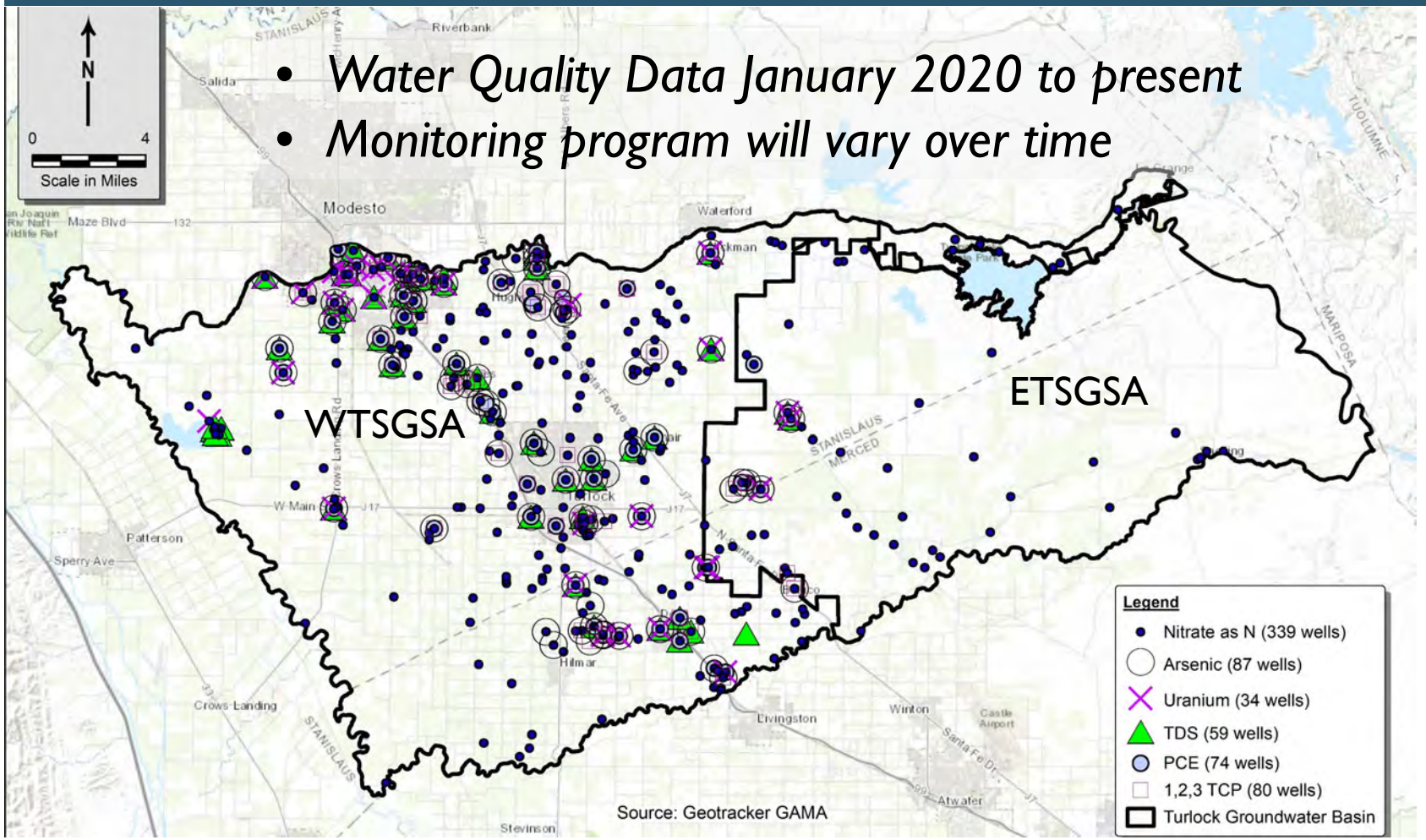
TODD GROUNDWATER

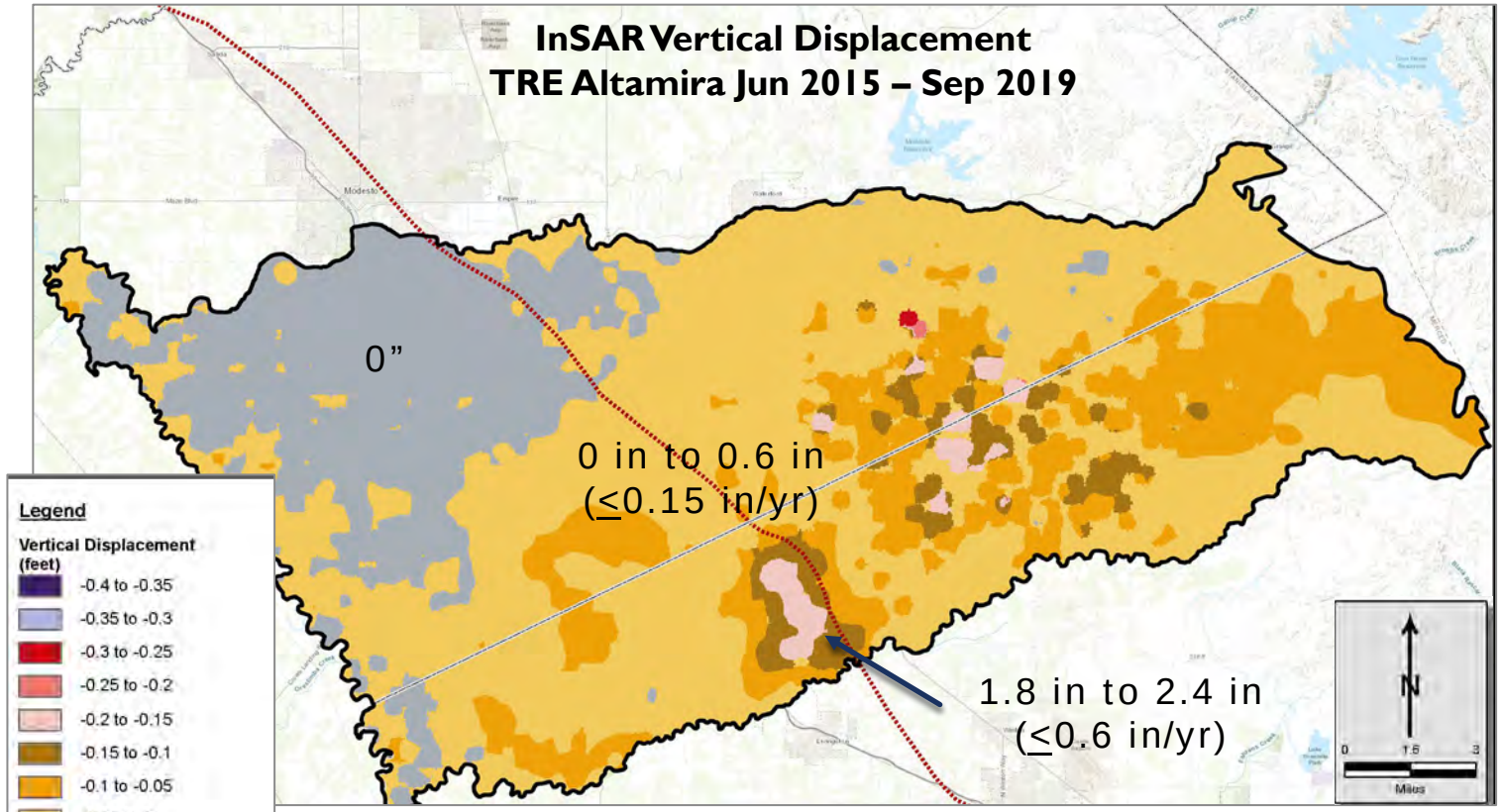
WATER QUALITY DATA MONITORED BY OTHERS
SWRCB DATA ONLINE – GEOTRACKER-GAMA



- *Water Quality Data January 2020 to present*
- *Monitoring program will vary over time*

- Data compiled from numerous programs on GeoTracker website
- Number of wells sampled for each potential COC:
  - Arsenic – 87 wells
  - Nitrate – 339 wells
  - TDS – 59 wells
  - Uranium – 34 wells
  - 1,2,3-TCP – 80 wells
  - PCE – 74 wells
- Data focused in areas of drinking water supply

RECENT INSAR DATA FOR LAND SUBSIDENCE



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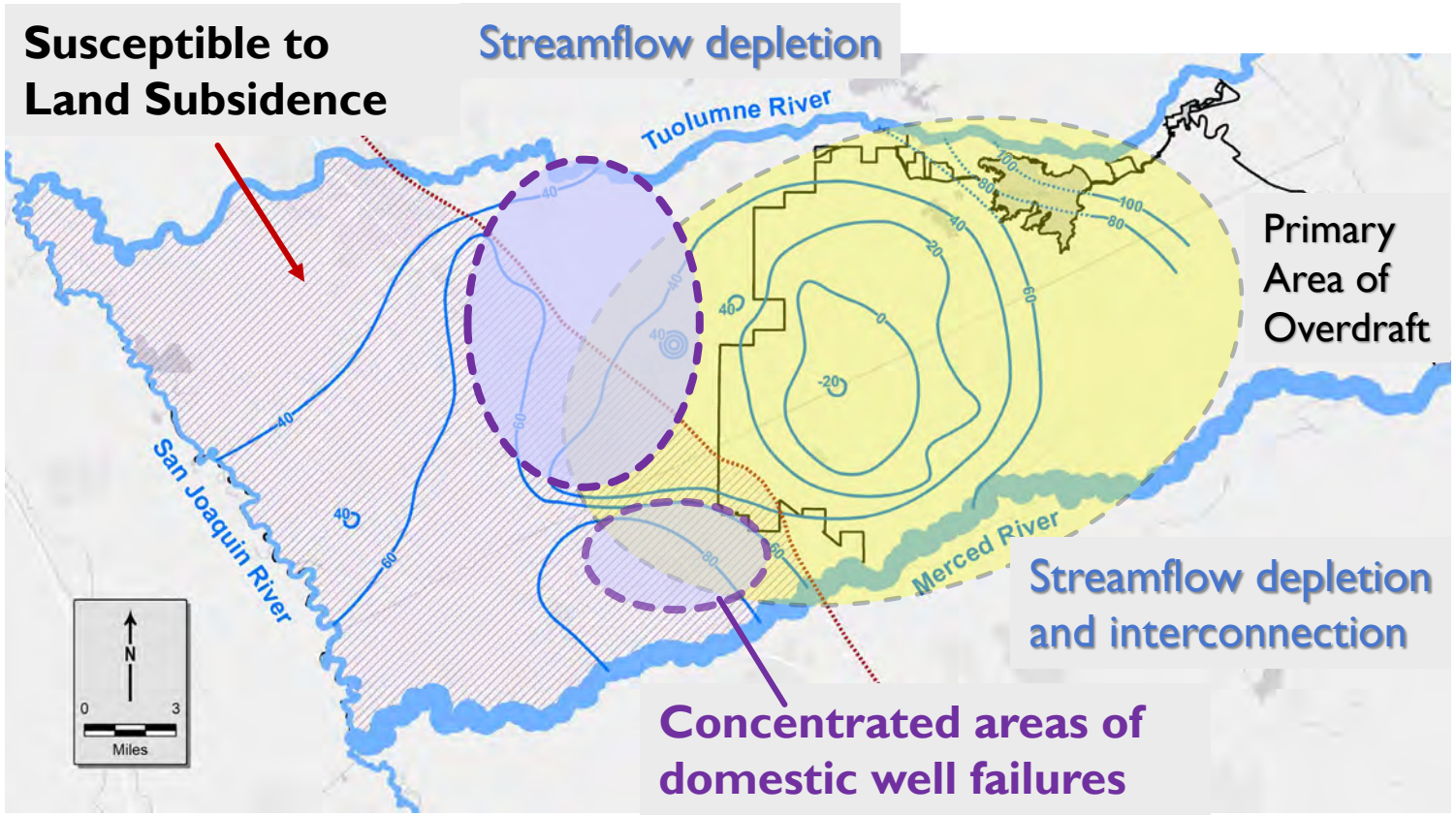
- InSAR data published by DWR in April 2021
- Useful for annual screening
- June 2015 to Sept 2019:
  - Most of Turlock Subbasin < 0.6 inches (<0.15 inches/year)
  - Maximum 1.8 to 2.4 inches (up to 0.6 inches/year)
  - For comparison, Merced Subbasin had 9.0 inches/year or15x the rate in the Turlock Subbasin

SUSTAINABILITY CONSIDERATIONS



- Declining groundwater levels and overdraft
- Water supply well impacts
- Streamflow depletion and possible disconnection along the Merced River
- Streamflow depletion on Tuolumne River
- Corcoran Clay and associated compressible clay layers susceptible to land subsidence

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Sustainable Management Criteria
Turlock Subbasin

Sustainability Indicator	Undesirable Results (narrative)	Minimum Thresholds
Chronic Lowering of Groundwater Levels	Adverse impacts to water supply wells during multi-year droughts	Fall 2015 groundwater levels
Reduction of GW in Storage	Long-term overdraft conditions based on projected water use and average hydrology	Fall 2015 groundwater levels; linked to sustainable yield volume
Degraded Water Quality	Degradation caused by GSA projects/actions or management of water levels/extractions	MCLs of 6 constituents of concern
Seawater Intrusion	Not applicable	Not applicable
Inelastic Land Subsidence	Inelastic land subsidence that adversely impacts land use/infrastructure	Fall 2015 groundwater levels
Interconnected Surface Water	Adverse impacts on beneficial uses of surface water caused by groundwater extraction	Tuolumne/SJ rivers: Fall 2015 water levels Merced River: Spring 2014 water levels

Sustainable management criteria above are summarized/shortened for space; please refer to the GSPs for complete descriptions of criteria.

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TURLOCK SUBBASIN GSP PROJECTS

Draft: Work in Progress Projects	Direct Recharge (AFY)	In-Lieu Recharge (AFY)	Demand Reduction (AFY)
Regional Surface Water Supply Project		17,600	
Stanislaus State Stormwater Recharge	460		
Dianne Storm Basin	23		
TID On-Farm Recharge	5,200		
Recycled water from TUR		2,000	
Ceres Main Regulating Reservoir	400		600
WTSGSA Projects	5,683	19,600	600
ETSGSA Agricultural Recharge	1,600	3,400	
Mustang Creek Flood Control Recharge	600		
Upland/Waterford Pipeline Recharge	1,100		
ETSGSA Projects	3,300	3,400	0
All Projects	***8,983***	***23,000***	***600***

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Next Steps:

- Complete modeling of GSP Projects
- Finalize Management Actions
- Complete GSP draft chapters – TAC review
- Publish remaining draft GSP chapters for public review