Creating An Opportunity:

Groundwater Recharge through Winter Flooding of Agricultural Land In San Joaquin Valley

BSMAR 16 Symposium
Groundwater Resources Association

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March 2018

Purpose

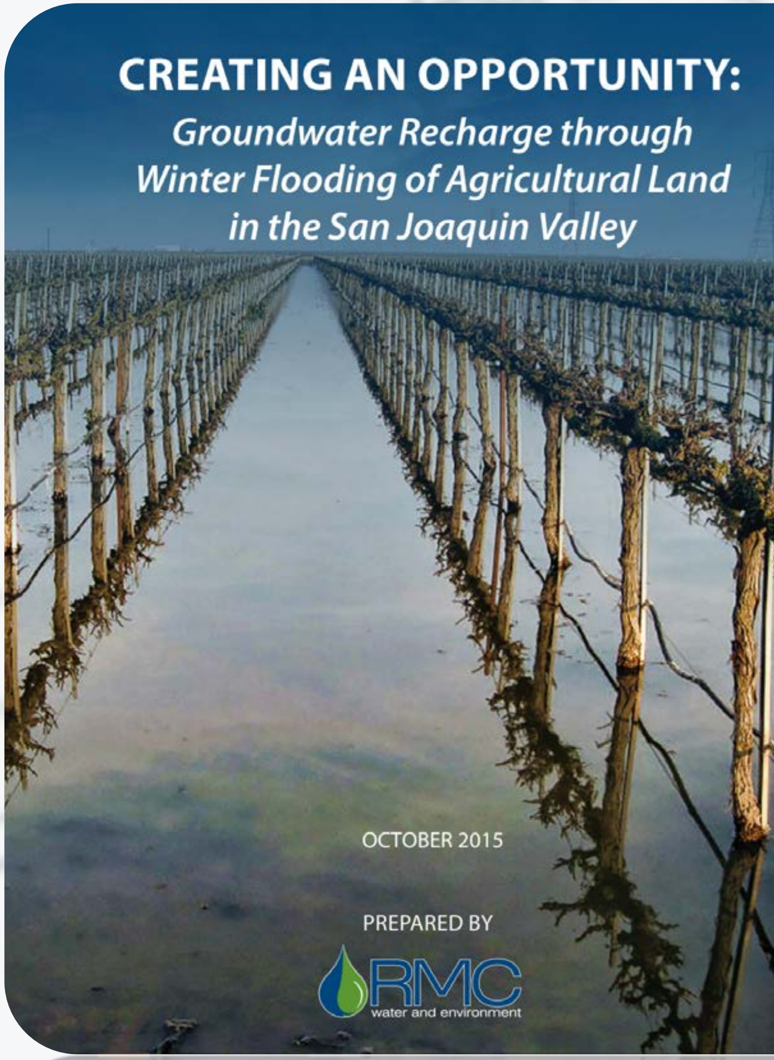
- Evaluation of potential opportunities for recharge of winter-time flows on agricultural areas
  - Water availability
  - Recharge areas
  - Efficiency of recharge
  - Economics

Acknowledgments

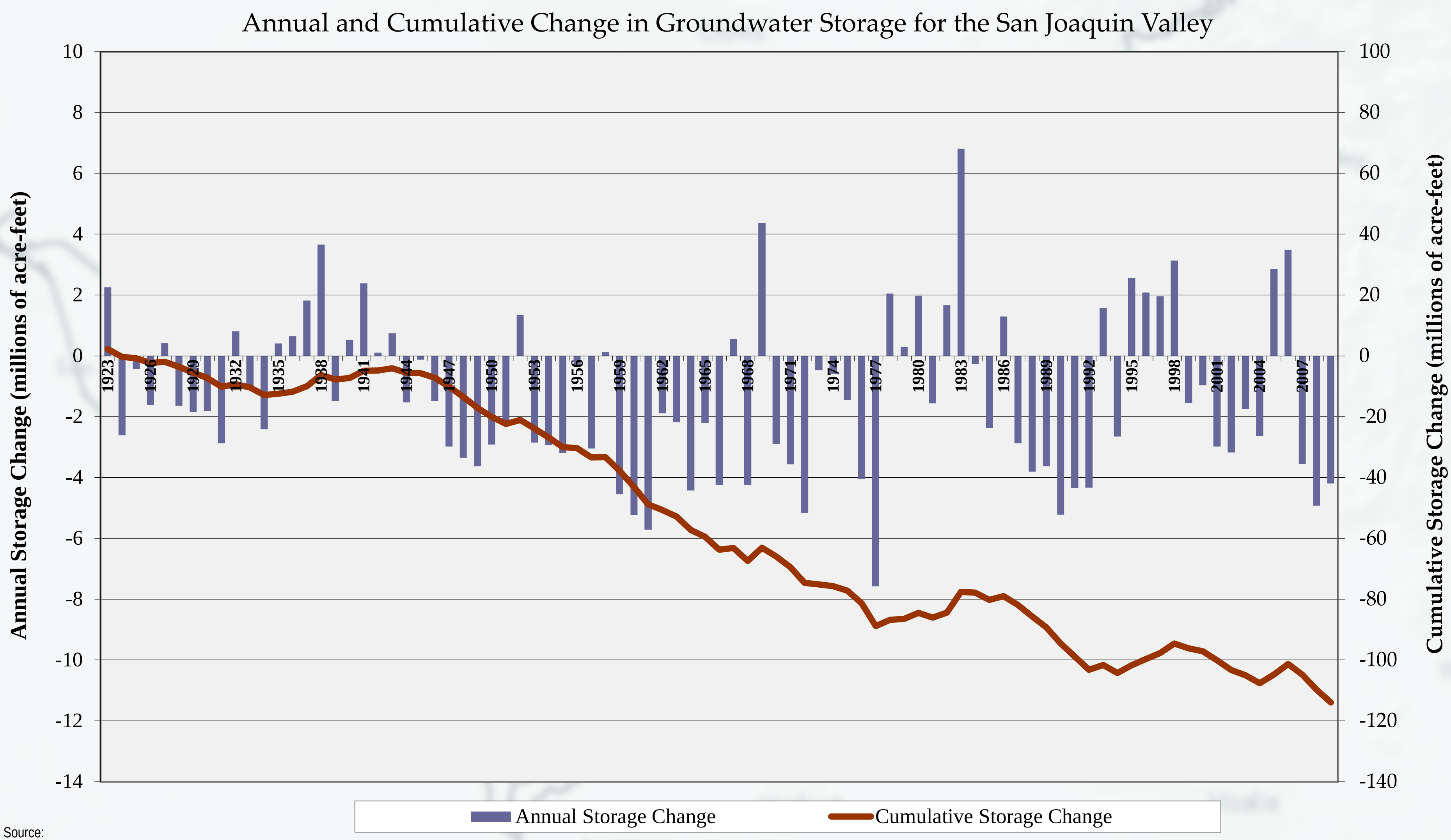
- **Study Participants:**
- Marco Bell, Merced Irrigation District
- Virginia Cahill, University of California, Davis
- Joe Choperena, Sustainable Conservation
- Hicham ElTal, Merced Irrigation District
- Daniel Mountjoy, Sustainable Conservation
- Toby O'Geen, University of California, Davis
- David Orth, formerly with Kings River Conservation District
- Eric Osterling, Kings River Conservation District
- Anthony Saracino, water consultant
- Bryan Thoreson, Davids Engineering
- Kathy Viatella, California Water Foundation
- Kate Williams, California Water Foundation

- **RMC Project Team:**
- Ali Taghavi, Project Principal
- Jim Blanke, Project Manager
- Mesut Cayar, Project Modeler

- **Funding:**
  California Water Foundation



The Need: Declining regional groundwater levels



Source:
RMC analysis of C2VSIM historical simulation results, 2012.

Concept

- Divert “excess” flow in rivers
- Convey through existing canals
- Deliver to suitable ag lands for off-season recharge

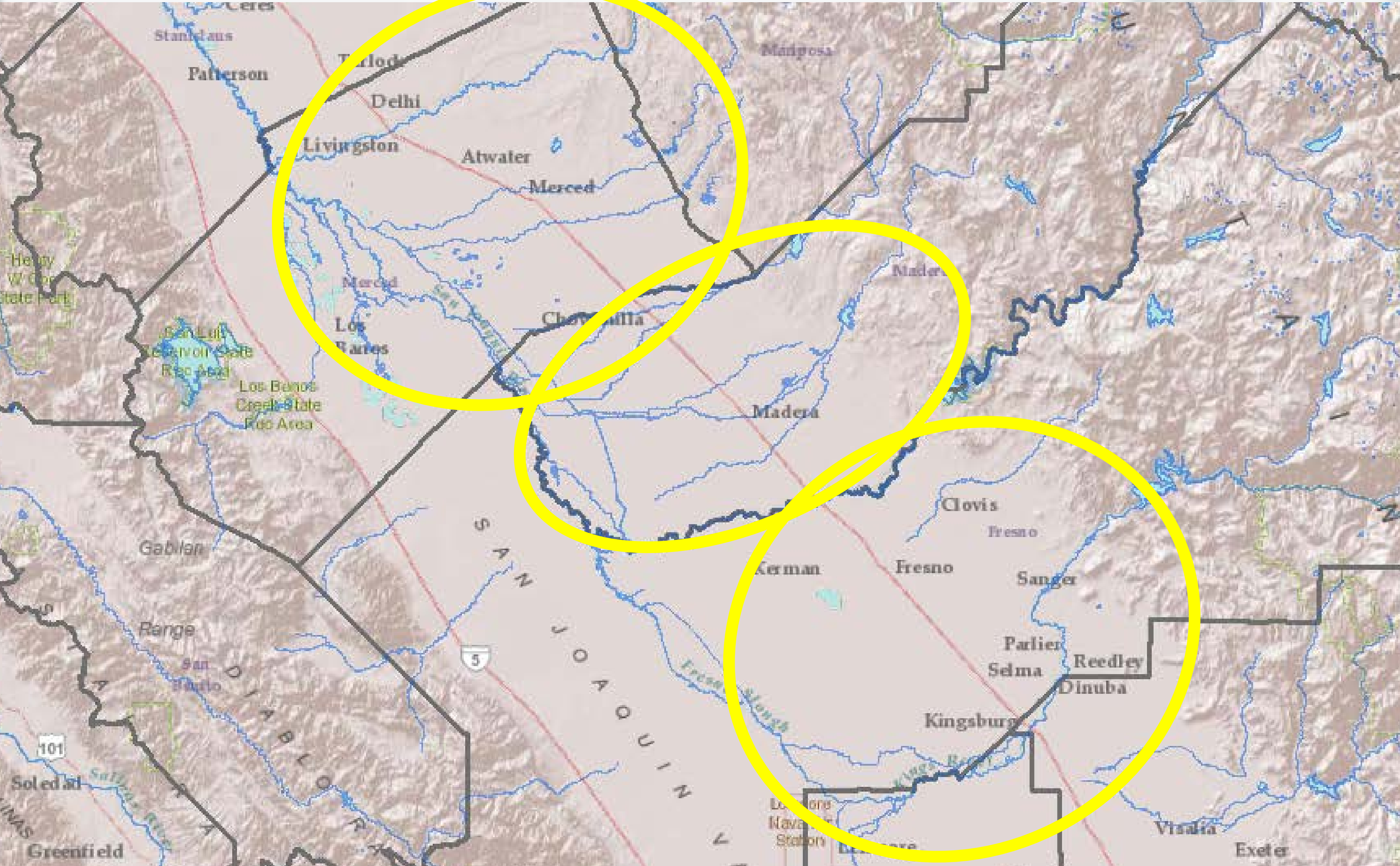
Key Assumptions

- Voluntary Grower Participation
- Honor Surface Water Rights
- Use Existing Storage and Conveyance
- Water is for Recharge, Not Banking

Pilot Project Area Features

- Pilot Project Area: Merced, Madera, and Fresno Area
- Significant GW issues exist
- Data and information is readily available
- Study team is intimately familiar with the systems operations
- Institutional issues and constraints are well known
- Analytical tools that cover the Pilot Project Area are readily available

Pilot Study Area



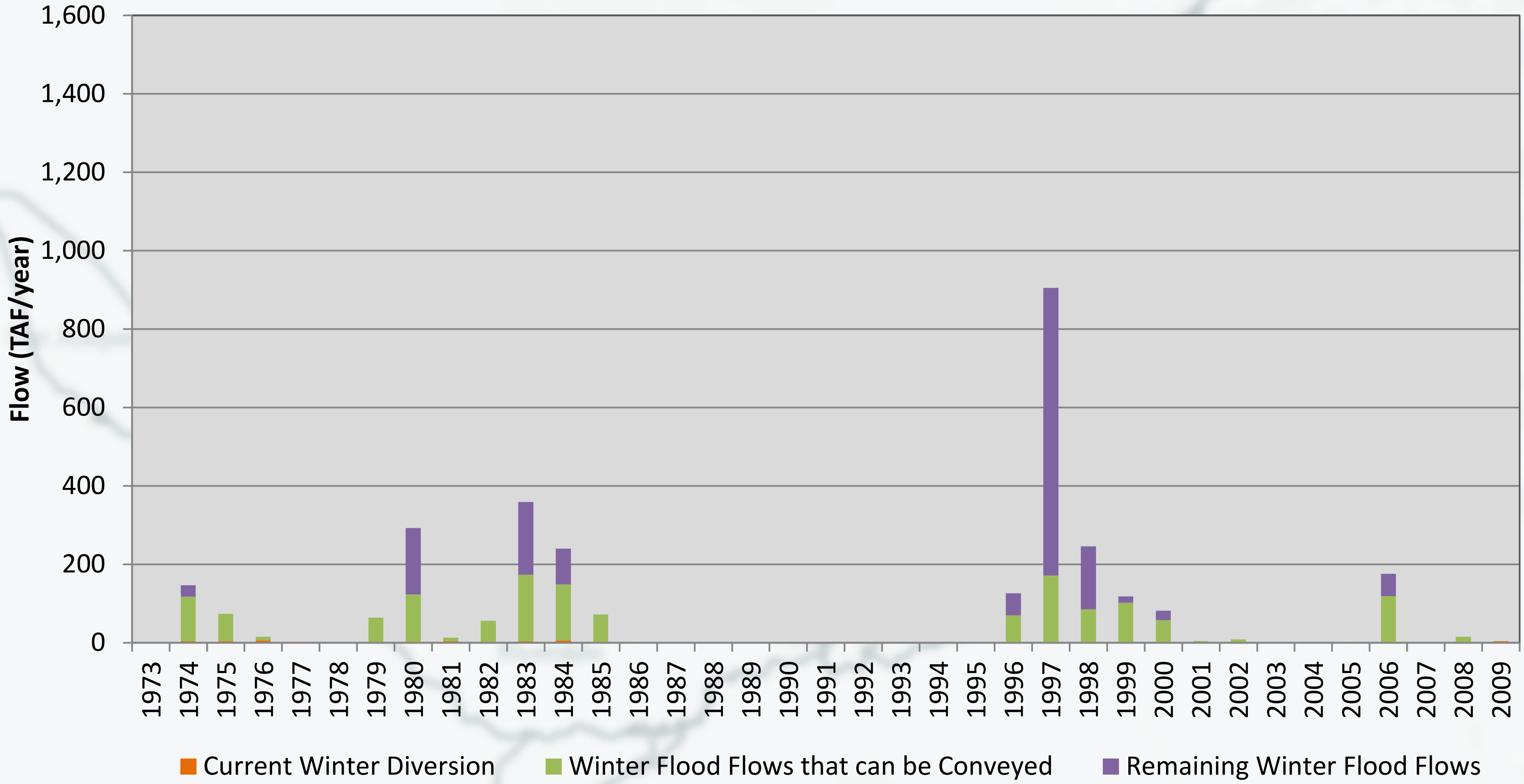
Surface Water Supply

- Considered Merced, Kings, Chowchilla and Fresno Rivers
- Analyzed two time periods:
  - Winter Recharge Period: December – February
  - Extended Winter Recharge Period: November - March

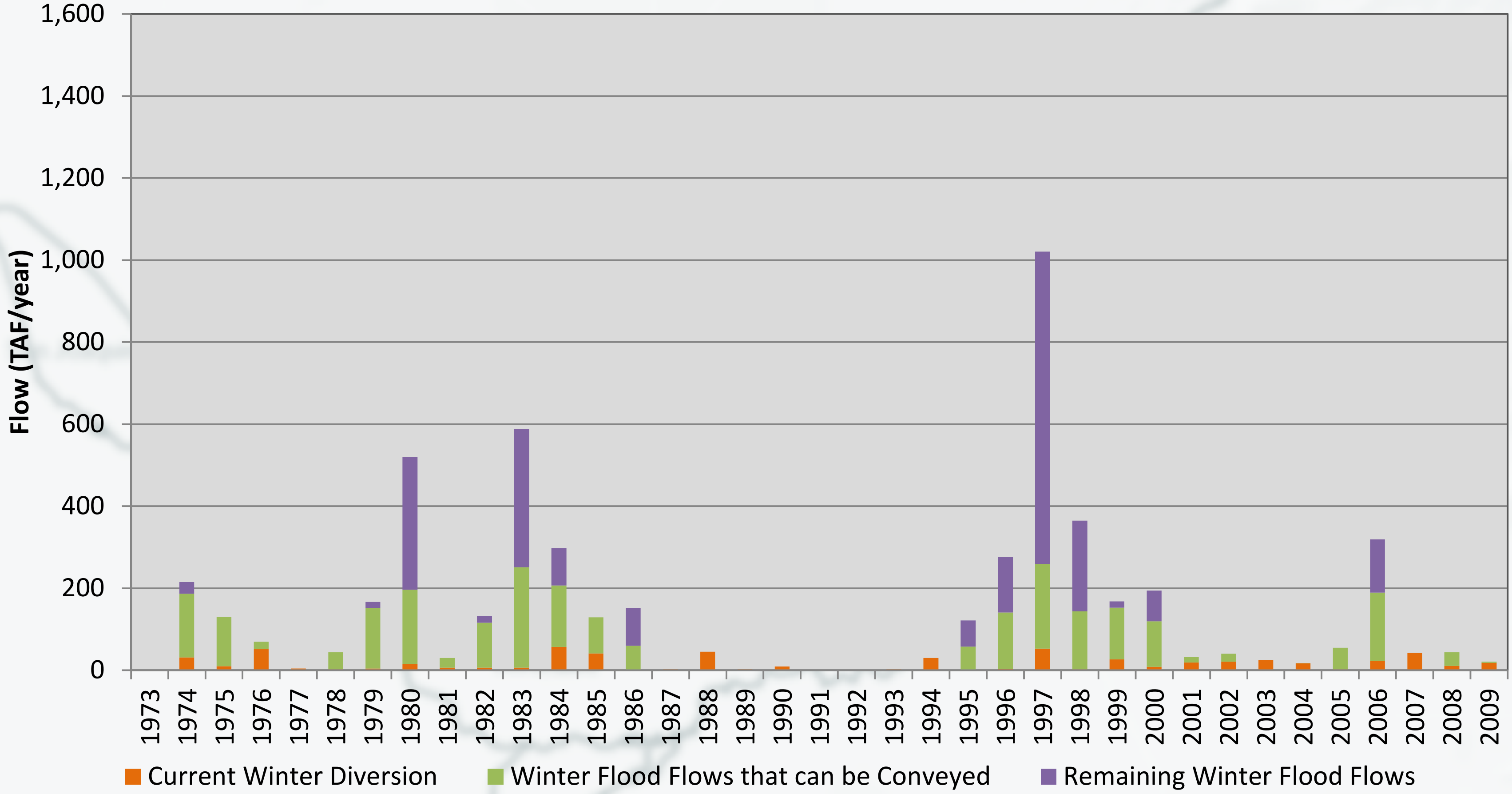
Summary of Data and Assumptions for Rivers in the Project Area

River	Historical Hydrology	Minimum Flow Requirements	Available Distribution Capacity[1]
Merced River	Based on flow below Crocker-Huffman Dam	Based on FERC license, Davis-Grunsky contract, and Cowell Agreement	Based on canal capacity and historical diversion data for Merced Irrigation District
Chowchilla River	Based on release data from Buchanan Dam	No minimum flow requirements. 10% of assumed distribution capacity assumed unavailable	Not available. Assumptions made based on summer releases from Buchanan Dam
Fresno River	Based on release data from Hidden Dam	No minimum flow requirements. 10% of assumed distribution capacity assumed unavailable	Not available. Assumptions made based on summer releases from Hidden Dam
Kings River	Based on flows at James Bypass	No minimum flow requirements	Based on canal capacity and historical diversion data for FID, CID, and AID

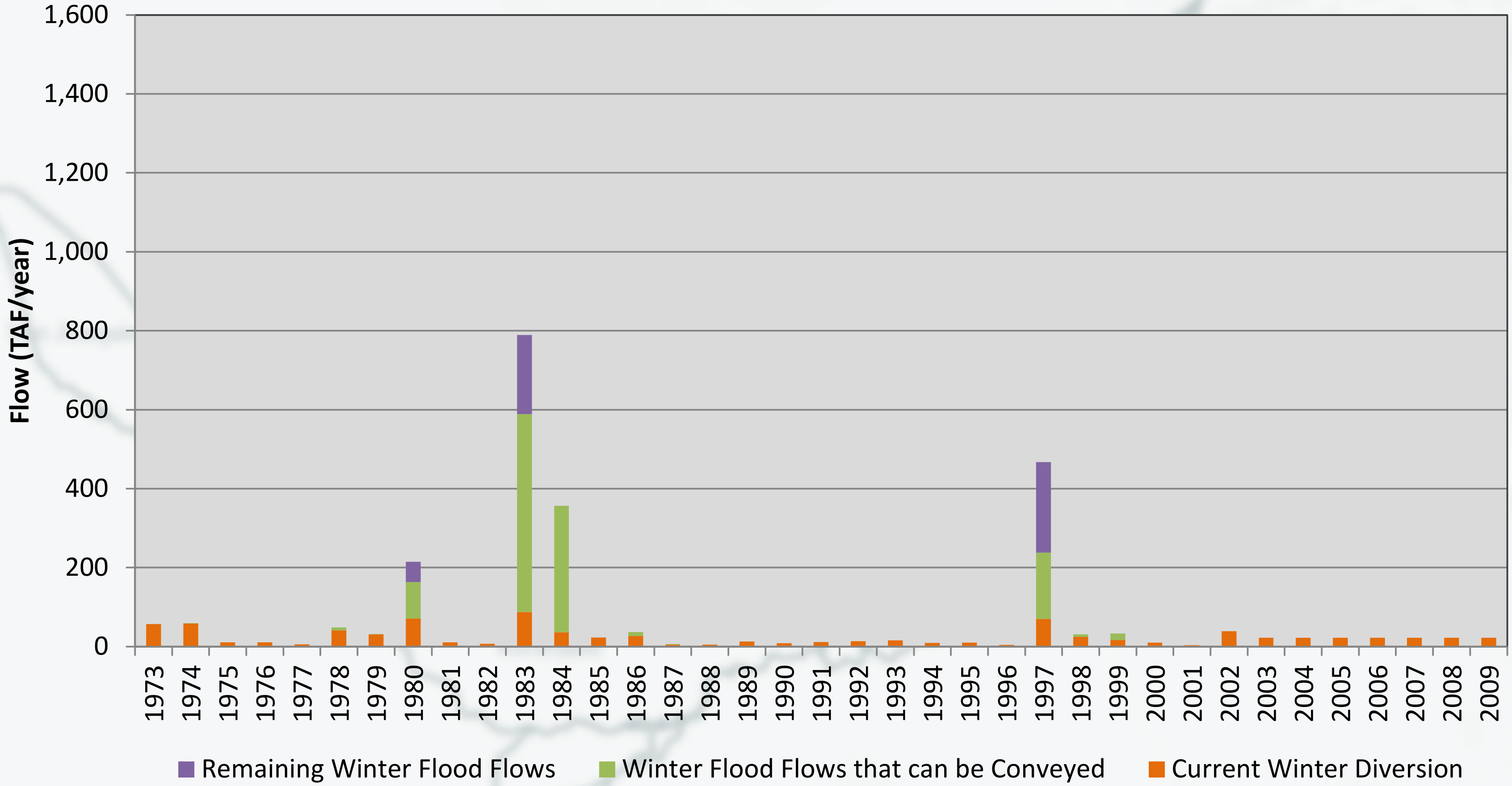
Merced River Flows
Winter Period (Dec-Feb)



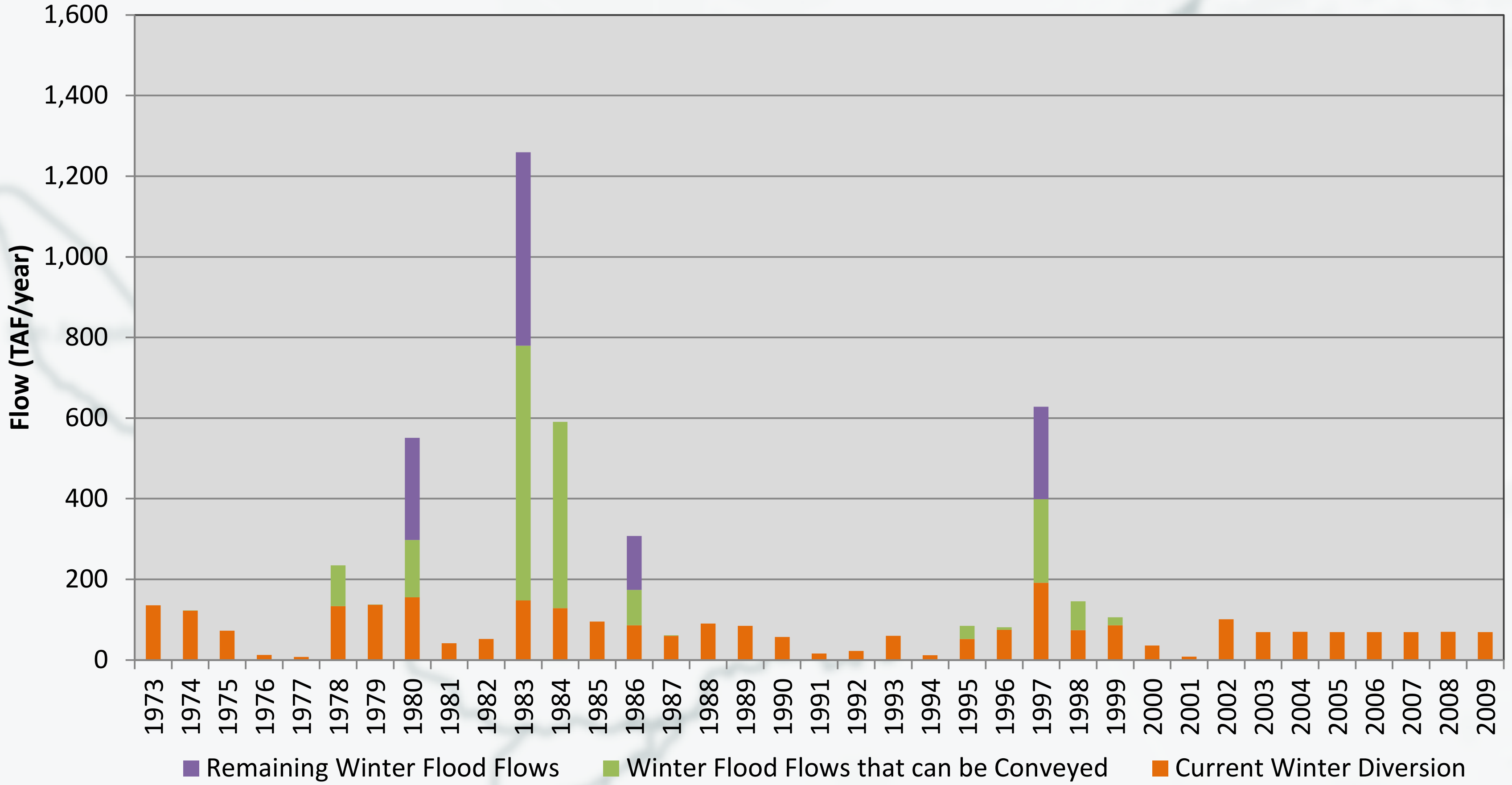
Merced River Flows
Extended Winter Period (Nov-Mar)



Kings River Flows
Winter Period (Dec-Feb)



Kings River Flows
Extended Winter Period (Nov-Mar)



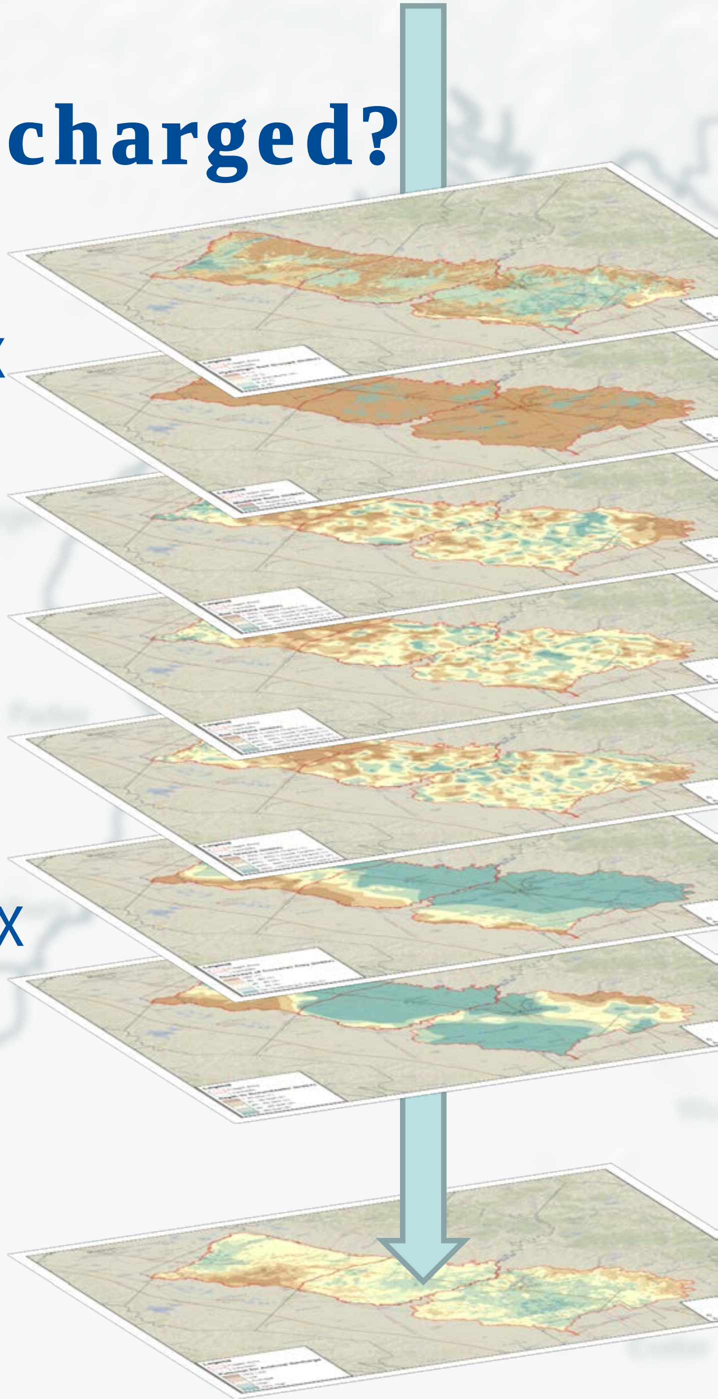
Water Supply Availability

Water Source	Recharge Period	Total Flood Flows	Diversions	Flood Flows that can be Conveyed	Remaining Flood Flows beyond Conveyance Capacity
Merced River	Winter	81,650	1,250	39,200	41,200
	Extended Winter	143,300	16,000	65,000	62,300
Chowchilla River	Winter	13,800	N/A[2]	3,600	10,200
	Extended Winter	20,700	N/A	6,700	14,000
Fresno River	Winter	17,800	N/A	6,200	11,600
	Extended Winter	28,100	N/A	10,700	17,400
Kings River	Winter	67,300	24,100	30,200	13,000
	Extended Winter	154,100	76,800	47,600	29,700
Total	Winter	168,130	23,350	79,200	76,000
	Extended Winter	346,200	92,800	130,000	123,400

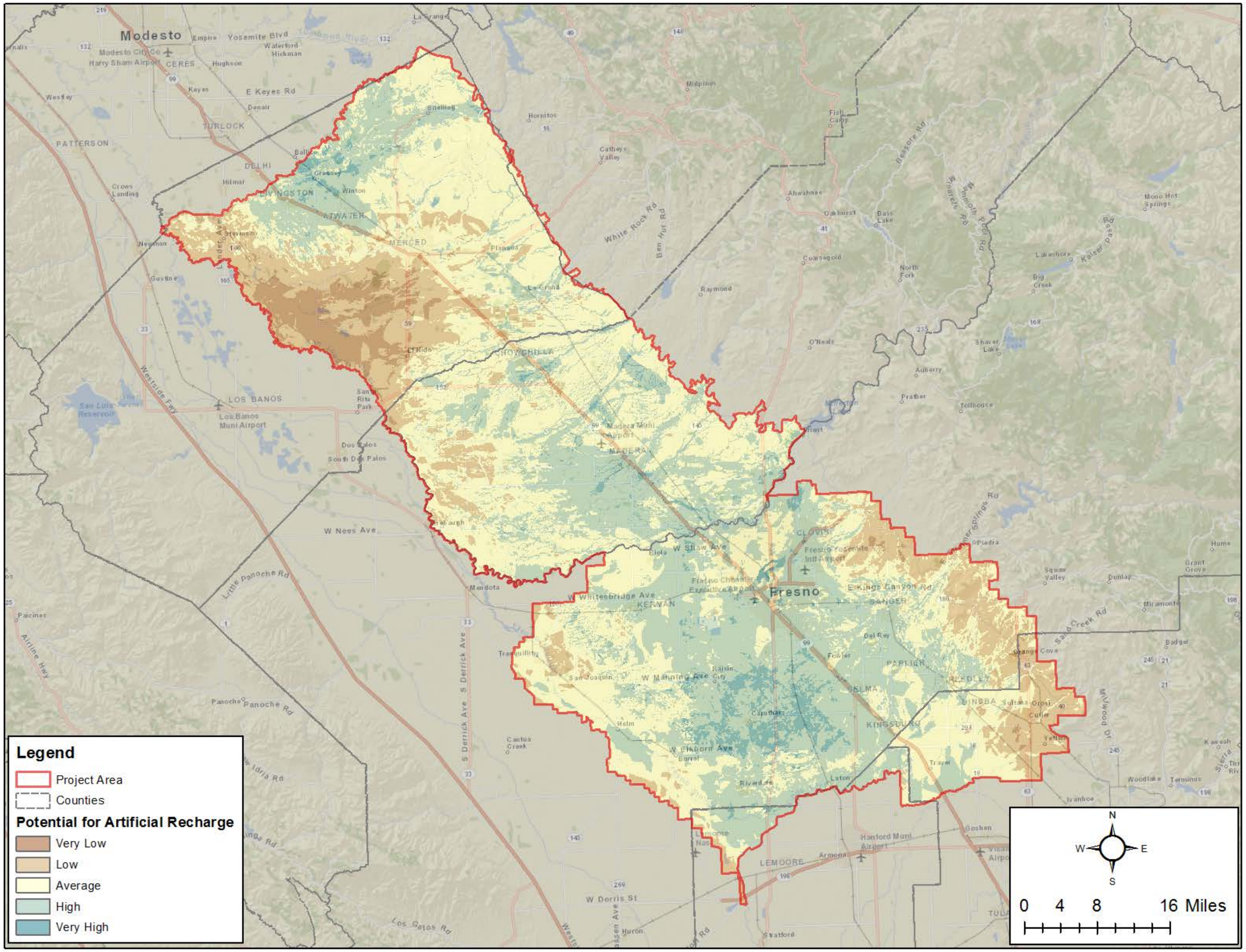
[1] The hydrologic record used for this analysis is water years 1973 to 2009.
[2] N/A: Not available, assumed to be zero for this study.

Where can that water be recharged?

- GIS-based Recharge Suitability Index
  - Soil type
  - Deep ripping
  - Subsurface materials
  - Corcoran Clay thickness
  - Depth to water
- Weighted and combined for final index



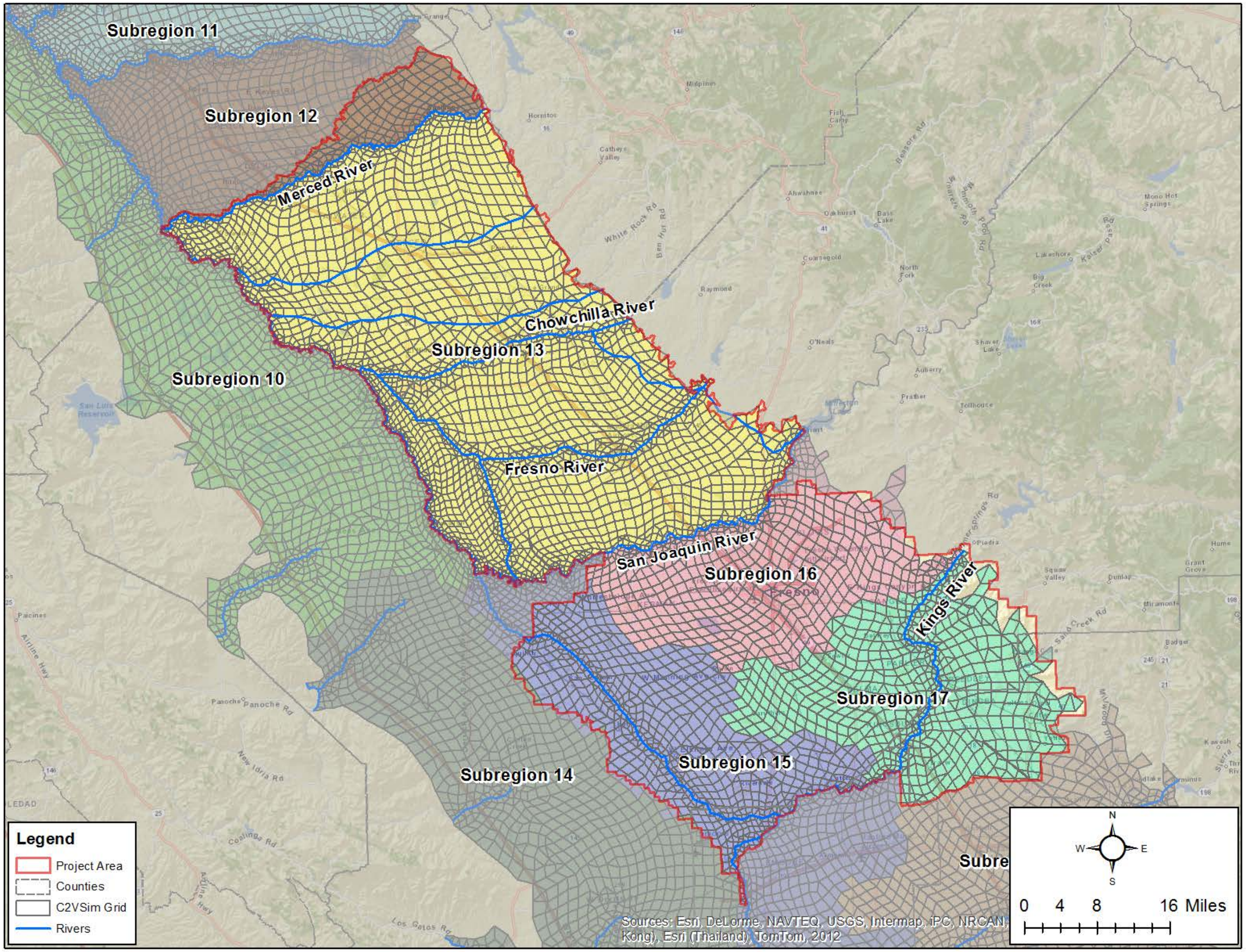
Recharge Suitability Index



C2VSim- Fine Grid Version is a Suitable Tool

- Developed by DWR
- Average grid size 0.6 mi
- Finer grid along rivers
- Currently under enhancement for SGMA implementation

C2VSim Grid in the Pilot Study Area



Potential Recharge Periods for Annual Crops Based on Cultural Practices and Growth Periods

Crop	Typical Plant Date[1]	Typical Harvest Date[1]	Potential Recharge Period[2]	Source
Grain/Hay				
Oats	October - January	May - June	June - September	UC Division of Agriculture a Natural Resources, 2006
Wheat	Mid November - January	May - June	June - October	
Barley	Mid November - February	May - June	June - October	
Corn				
Silage	Late May	September	October - April	Frate, Marsh, Klonsky, & De Moura, 2012
Sweet	February - July	June - October	July - January	Smith, Aguiar, & Caprile, 19
Cotton	April - May	October - November	November - March	Hutmacher, et al., 2012
Tomatoes				
Fresh Market	March - July	June - October	July - February	Strange, Schrader, & Hartz,
Processing	Late January - Early June	June - October	July - December	Hartz, et al., 2008

[1] Plant and harvest dates were reported for the region of interest, where provided by the listed source.

[2] Potential recharge periods are based solely on the timing of critical cultural practices and crop growth periods. Other factors may further impact potential recharge pe Presence of double cropping would further reduce the potential recharge period for the indicated crop. Local experience (Bachand, et al., 2012) suggests recharge per may be longer for local conditions considered as part of this project.

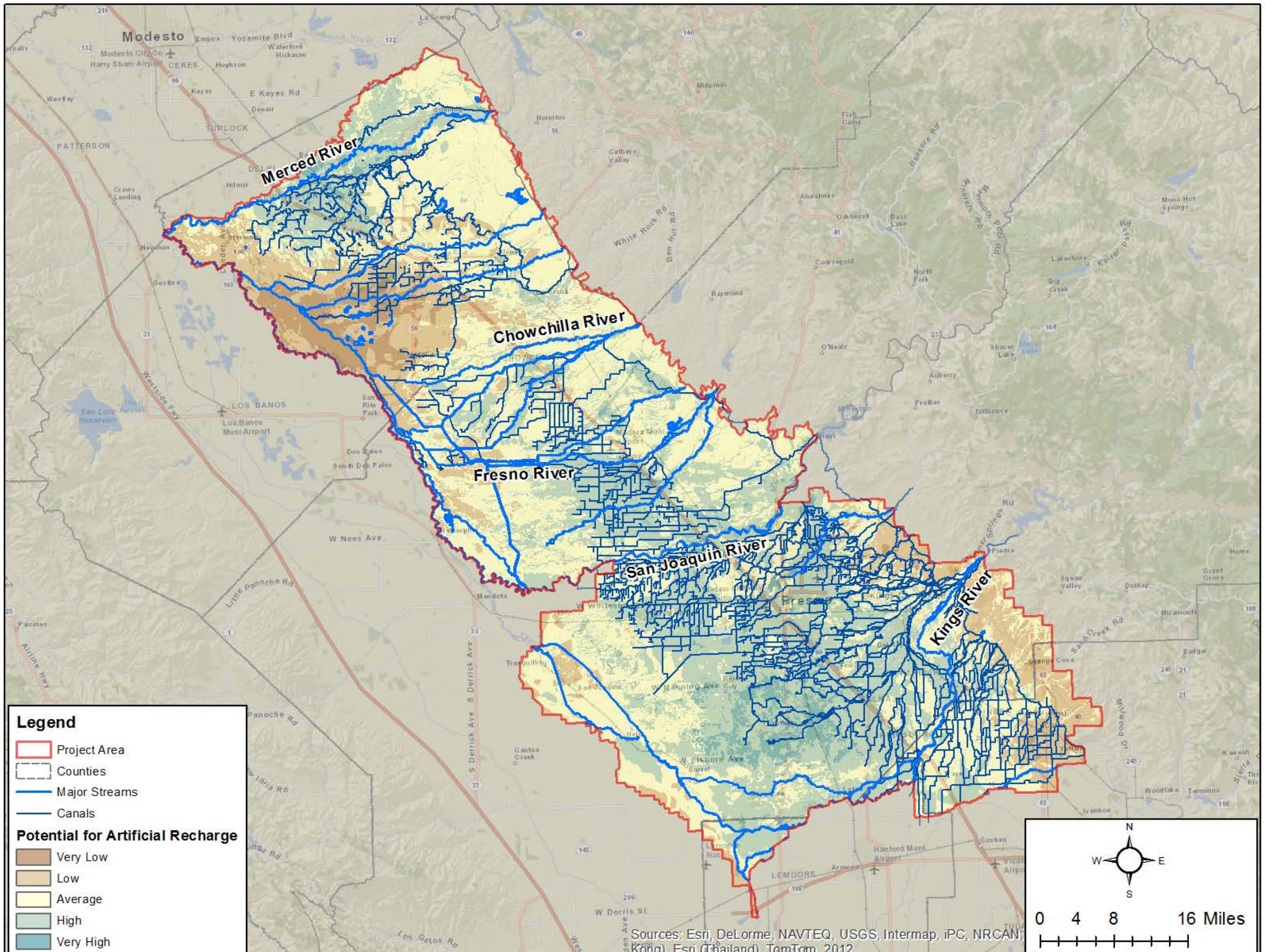
Potential Recharge Periods for Perennial Crops based on Cultural Practices and Growth Periods

Crop	Bud Break	Typical Harvest Date[1]	Leaf Fall	Potential Recharge Period[2]	Sourc
Almonds	Late February	August - October	November	December - January	Blue Diam
Vineyards	Mid February	Late August - Early October	Early November	December - January	Geisel, Farr & Vossen,
Pistachios	Late March	September	Late November	December - February	UC Davis,
Pasture		November - December		December - February	
Alfalfa		November - December		December - February	Orloff & Put 2007

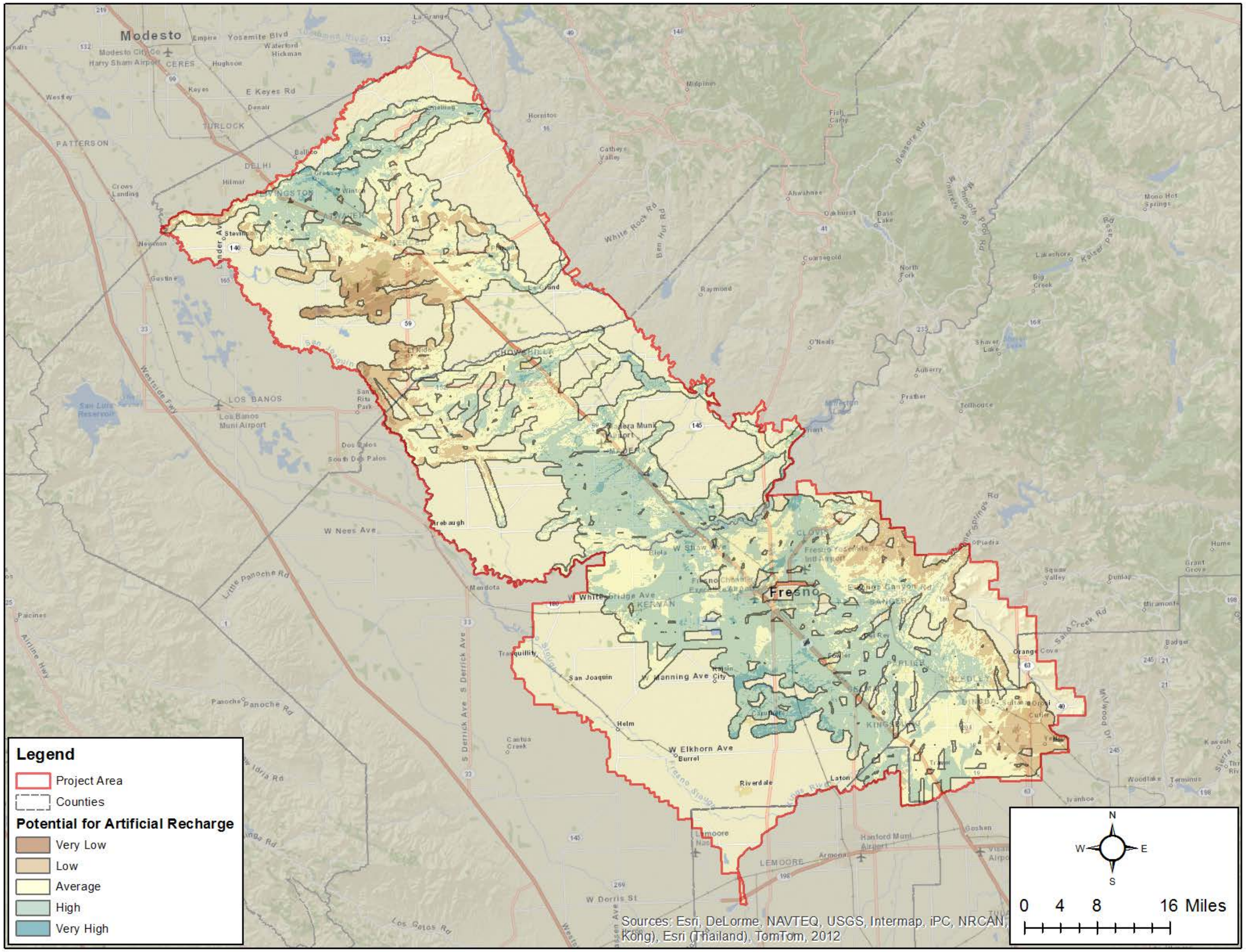
[1] For alfalfa and pasture, harvest dates apply to the last cutting of the calendar year.

[2] Potential recharge periods are based solely on the timing of critical cultural practices and crop growth periods. Other factors may further impact potent recharge period. Local experience (Bachand, et al., 2012) suggests recharge periods may be longer for local conditions considered as part of this proje

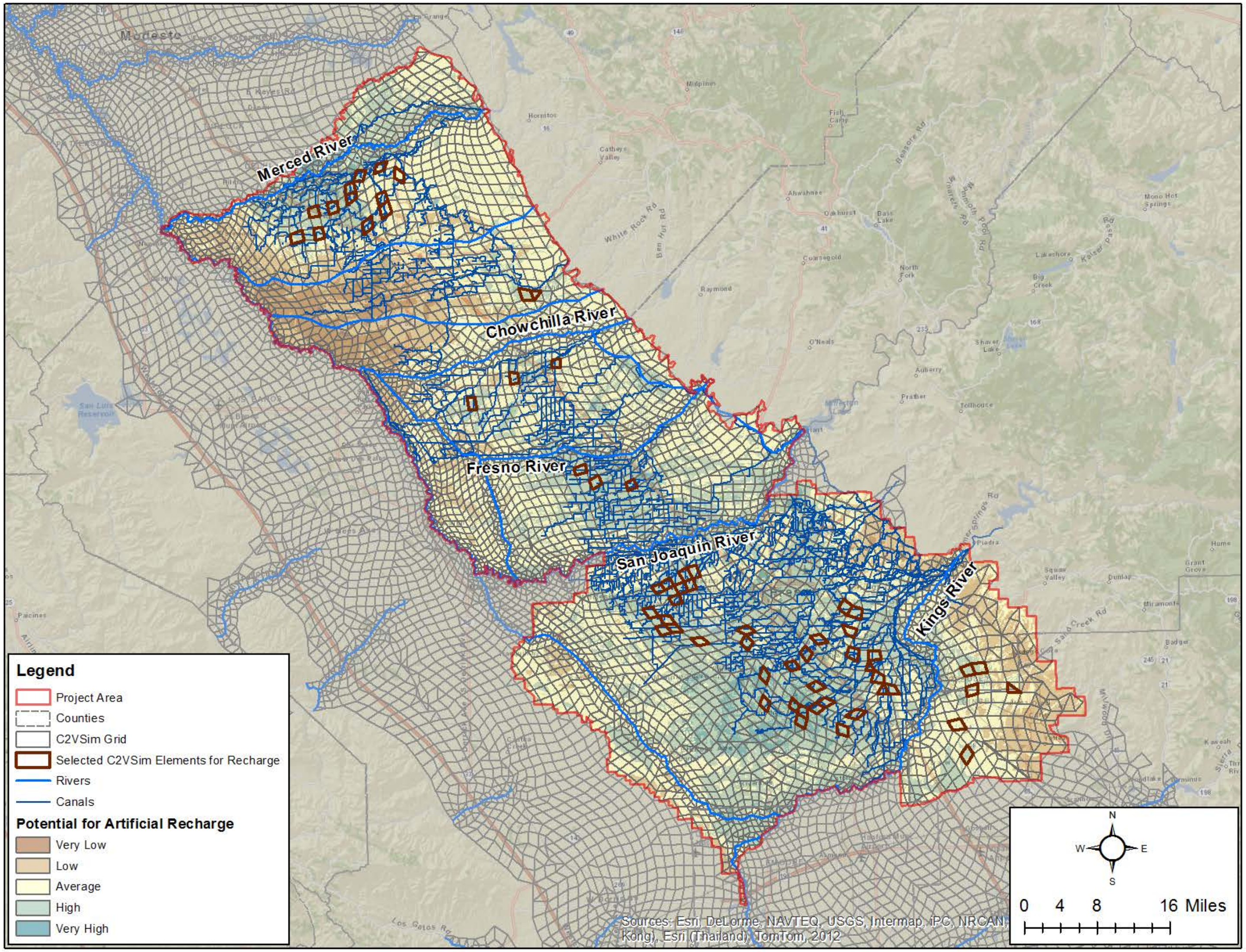
Major Surface Water Conveyance Systems used to ID Recharge Sites



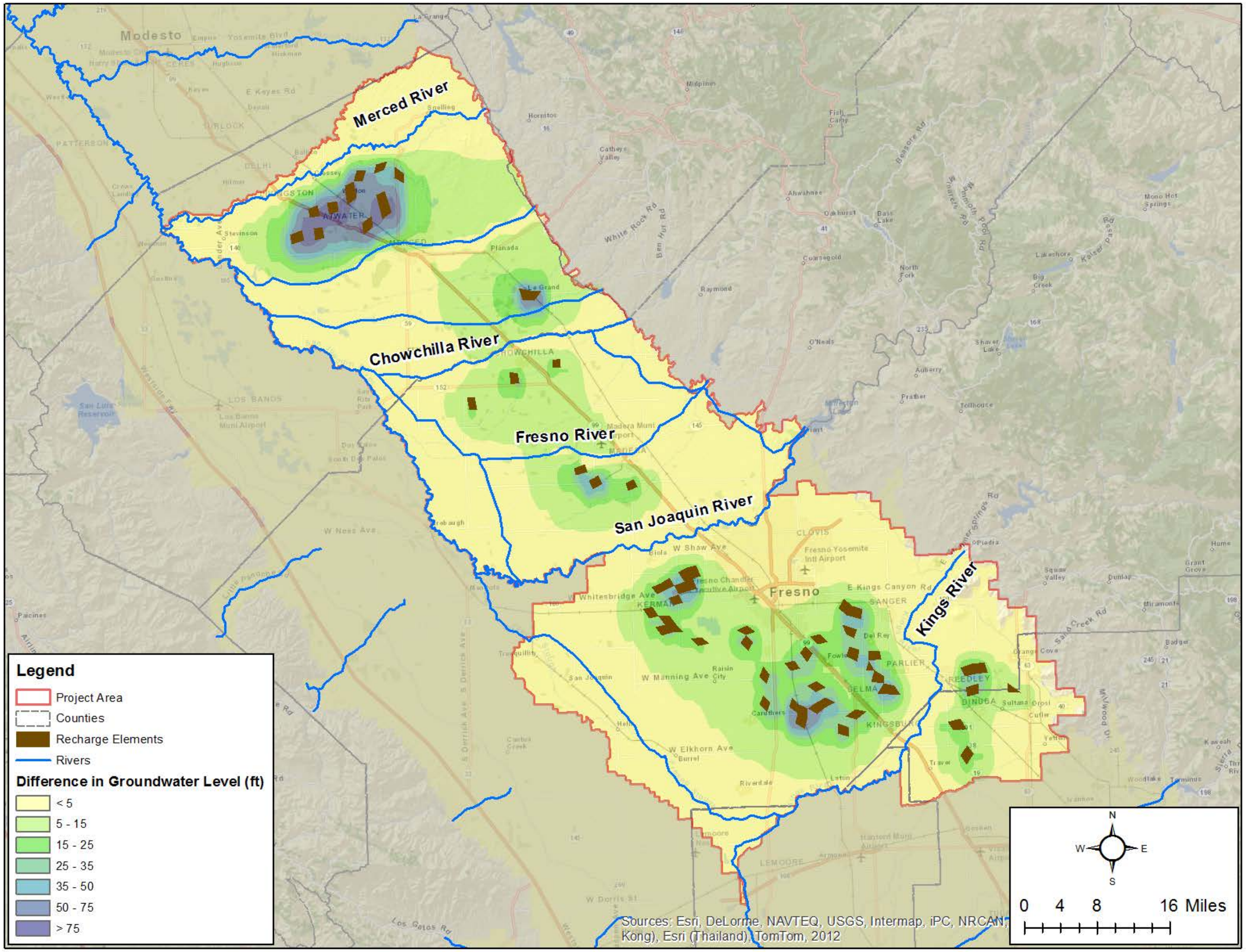
Recharge Suitability Index with 0.5 Mile of Conveyance Canals



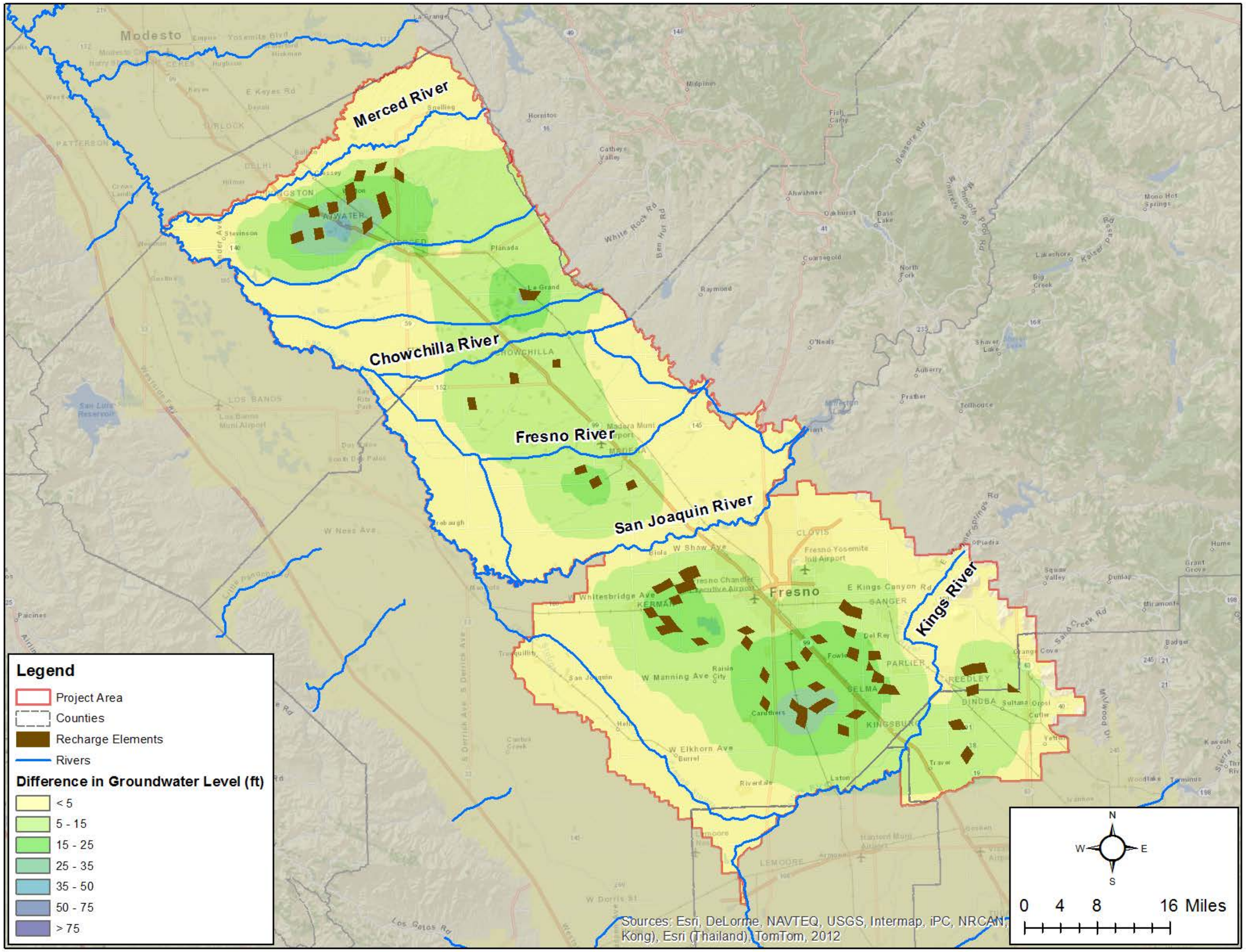
C2VSim Elements Selected for Recharge Scenarios



Extent of Recharge Water in Wet Year
Extended Winter Recharge



Extent of Recharge Water in Dry Year Extended Winter Recharge



Average Annual Groundwater Budget (Scenario vs. Baseline)

Item	Winter		Extended Winter	
	(AF/year)	% of Recharge	(AF/year)	% of Recharge
Recharge	79,200	-	130,000	-
Stream Capture	-34,200	43%	-55,500	43%
Subsurface Flow to Adjacent Areas	-14,000	18%	-22,700	17%
Change in GW Storage	31,000	39%	51,800	40%

Conclusions

1. Concept has promising outcome to capture and recharge excess water
2. Concept can be extended to the FloodMAR program
3. Overdraft can be reduced by approx. 10-12%
4. Dry year streamflow enhancement benefits ecosystem
5. Program can be cost effective using existing facilities
6. Existing modeling tools can assist fine-tune program

Recommendations for Further Work

1. Pilot Studies for:
   - Crop Suitability
   - Water Quality
   - Economic Implications
   - Water Rights Implications
2. Improved Understanding of Grower Needs and Incentives
3. Integrate with reservoir re-operation & FloodMAR
4. Include take cycle for the long-term operation
5. Include in GSP sustainability portfolio
6. Develop additional tools and maps for recharge suitability indices for the locals
7. Develop benefit packages and incentives for the GSAs
8. Develop modeling schemes, methodology, and BMPs
9. Evaluate the effectiveness at regional and multi-subbasin scale
10. Develop operational guidelines for local entities for implementation

References

- Reference to Report:
  - http://californiawaterfoundation.org
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