



LAND IQ WORKSHOPS

KAWEAH SUBBASIN

VIRTUAL, MARCH 17, 2022
1:00 - 3:00 PM



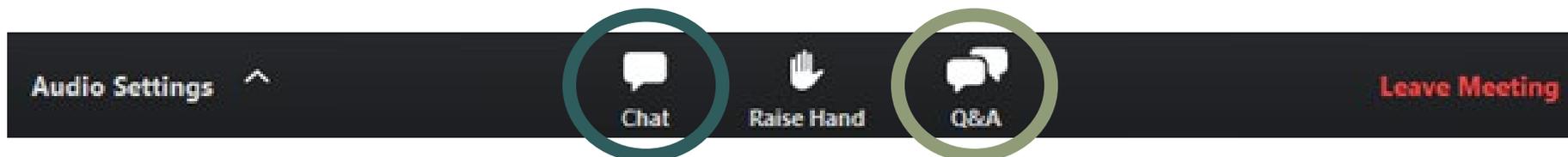


AGENDA

1. Logistics
2. Welcome & Introductions
3. SGMA and the Kaweah Subbasin
4. LandIQ: Monthly Field by Field ET, Precipitation, and Land Use for SGMA Compliance
5. Kaweah Water Dashboard Introduction
6. Q&A

ZOOM LOGISTICS

1. Microphone and video is turned OFF for all participants
2. **Q&A** – Questions can be submitted using the Q&A feature on your Zoom menu. We will pause and address questions periodically during the workshop.
3. **Technical difficulties** – If you have technical difficulties, use the Chat feature to ask questions and receive assistance



WELCOME & INTRODUCTIONS

Aaron Fukuda – Mid-Kaweah GSA, *Interim General Manager*

Eric Osterling – Greater Kaweah GSA, *General Manager*

Michael Hagman – Lindmore ID & East Kaweah GSA, *Executive Director*

Joel Kimmelshue – Land IQ, *Founding Partner and Principal Soil and Agricultural Scientist*

Savannah Tjaden – Provost & Pritchard Consulting Group, *Product Manager*

Trilby Barton – Provost & Pritchard Consulting Group, *External Affairs Specialist*

Rebecca Quist - Provost & Pritchard Consulting Group, *External Affairs Specialist*



LIVE POLL



SGMA 101

Eric Osterling – Greater Kaweah GSA,
General Manager

SGMA 101

SUSTAINABLE GROUNDWATER MANAGEMENT ACT



**CALIFORNIA LAW
SIGNED IN SEPTEMBER
2014**

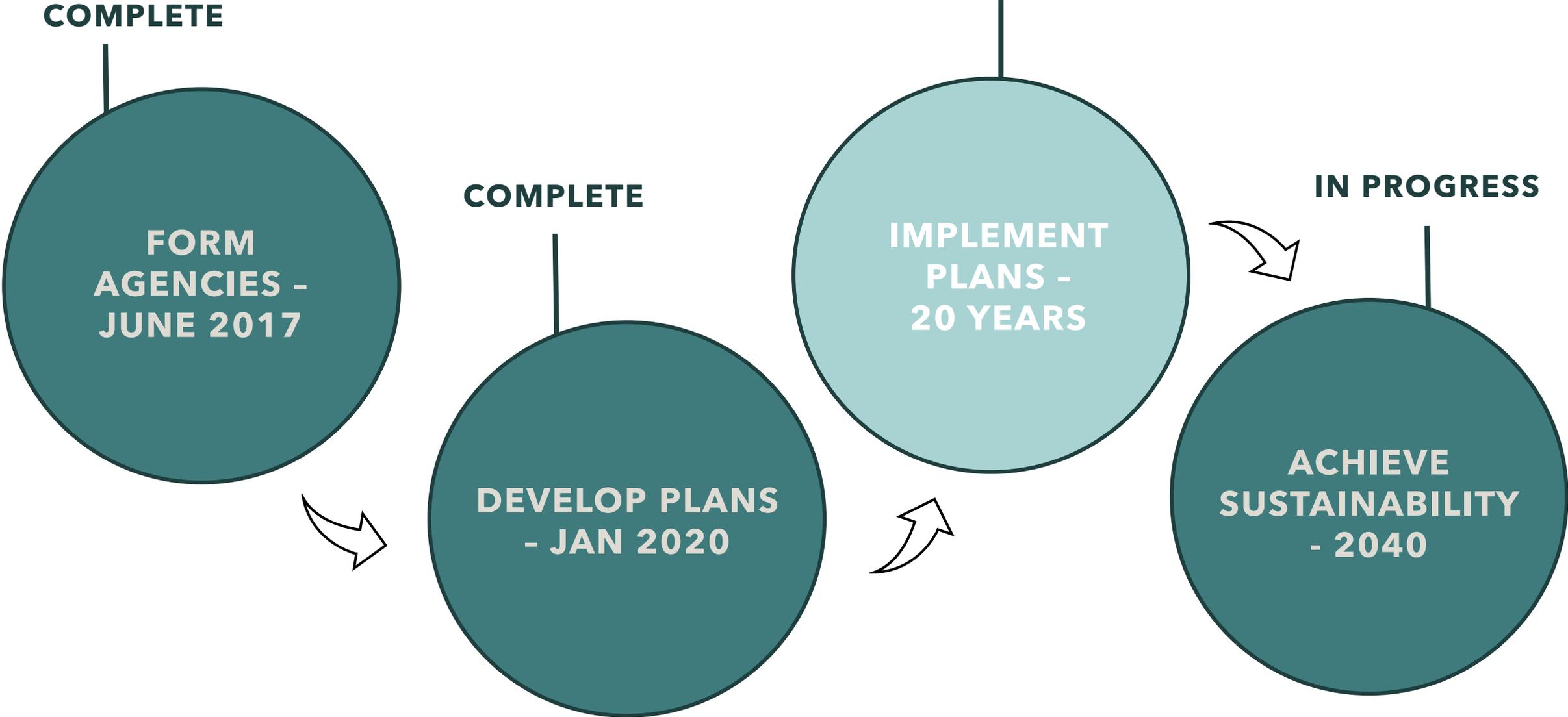


**SGMA MANDATES
GROUNDWATER
SUSTAINABILITY BY 2040**



**GRANTS LOCAL CONTROL
TO GROUNDWATER
SUSTAINABILITY AGENCIES**

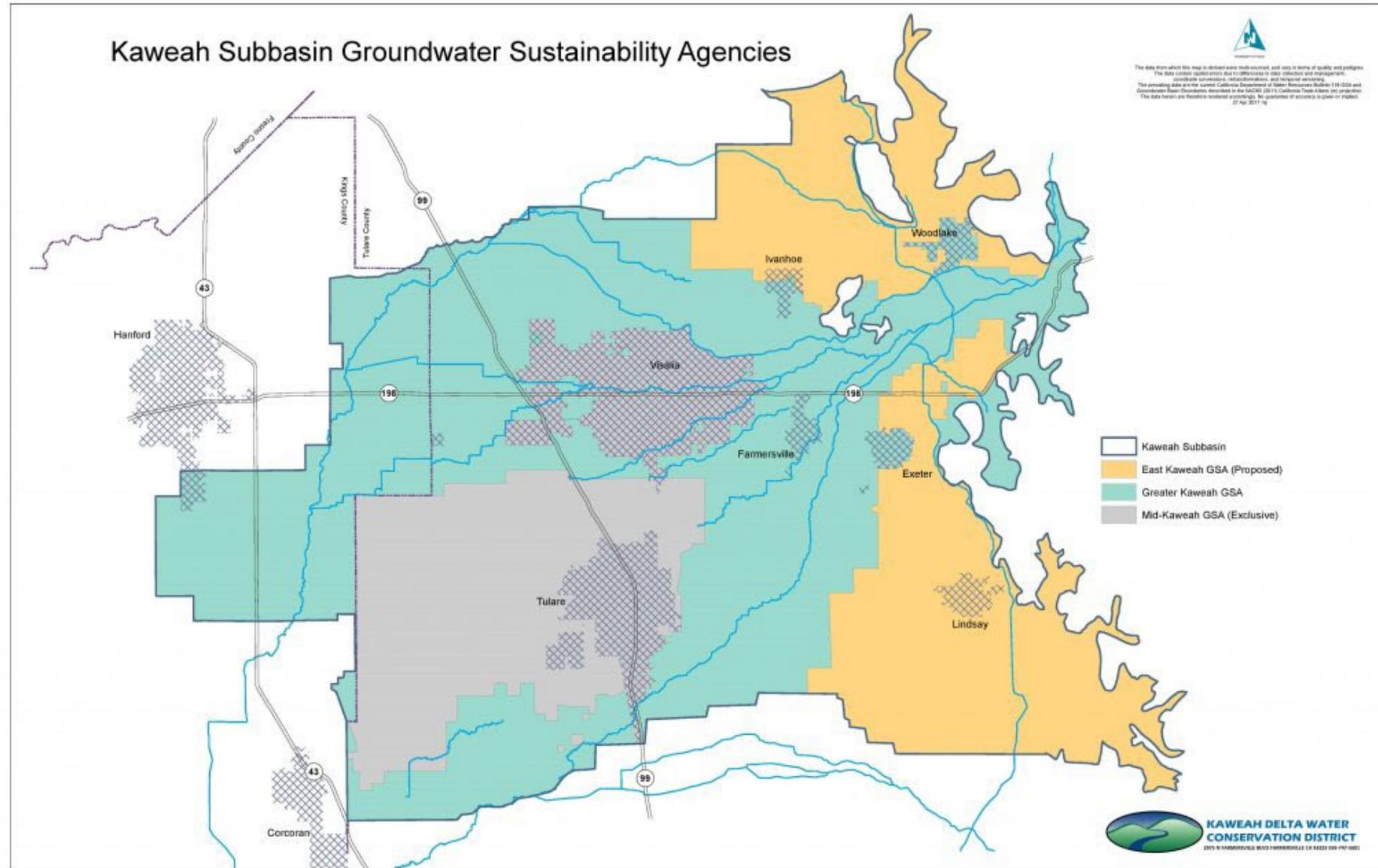
SGMA TIMELINE



KAWEAH SUBBASIN (PRIORITY BASIN)

3 GSAs

- East Kaweah GSA
- Greater Kaweah GSA
- Mid-Kaweah GSA





GROUNDWATER CONDITIONS

Under SGMA, the Kaweah Subbasin is tasked with ensuring this groundwater supply is available for years to come. This means balancing the **estimated 80,000+ acre-feet of groundwater overdraft occurring on average every year.**

GROUNDWATER SUSTAINABILITY PLAN (GSP)

- Physical description of groundwater management area
- Water budget
- Monitoring program and projects
- Sustainability in 20 years
- Measurable objectives / thresholds
- Annual reporting
- State evaluations for compliance

IMMEDIATE GSP IMPLEMENTATION NEEDS

- Accurately and efficiently understand groundwater demand on an ongoing basis
- Refine water accounting mechanisms to implement GSA policies



Q&A



LAND IQ

Joel Kimmelshue – Land IQ, *Founding
Partner and Principal Soil and Agricultural
Scientist*



Monthly Field by Field Evapotranspiration,
Precipitation, and Land Use for SGMA Compliance

KAWEAH SUBBASIN

MARCH 15, 17, 25, 2022

LAND IQ TECHNICAL DISCIPLINES

Land-Based Sciences: Land and Water Resources

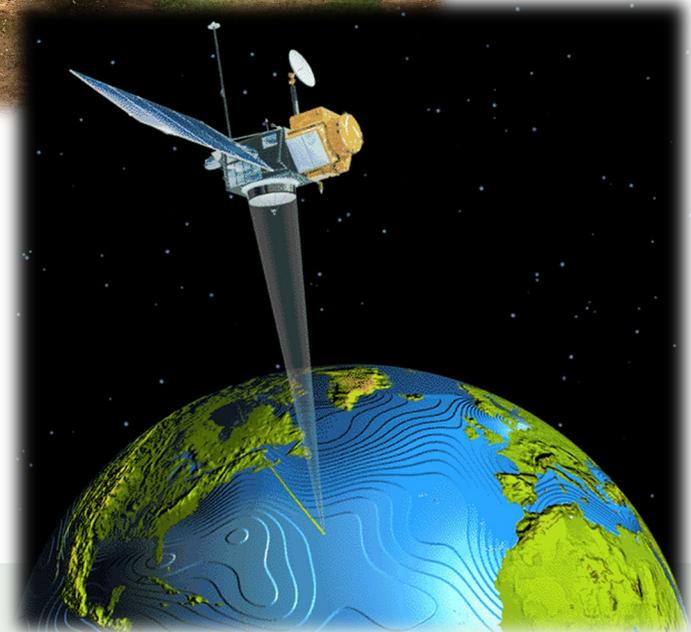
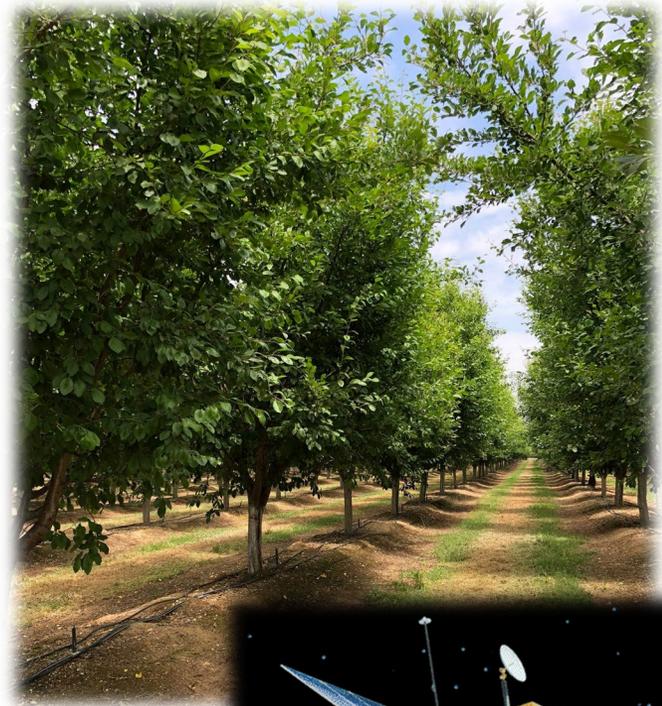
- Agronomic assessments/soil science
- Water quality and supply evaluations
- Salinity and nutrient management
- Agricultural reuse
- Land stabilization and erosion control
- Soil reclamation and irrigation/drainage

Spatial Sciences: Remote Sensing and GIS

- Consumptive use estimation and crop identification
- Large landscape evaluations
- Irrigation and drainage
- Production agriculture

Development

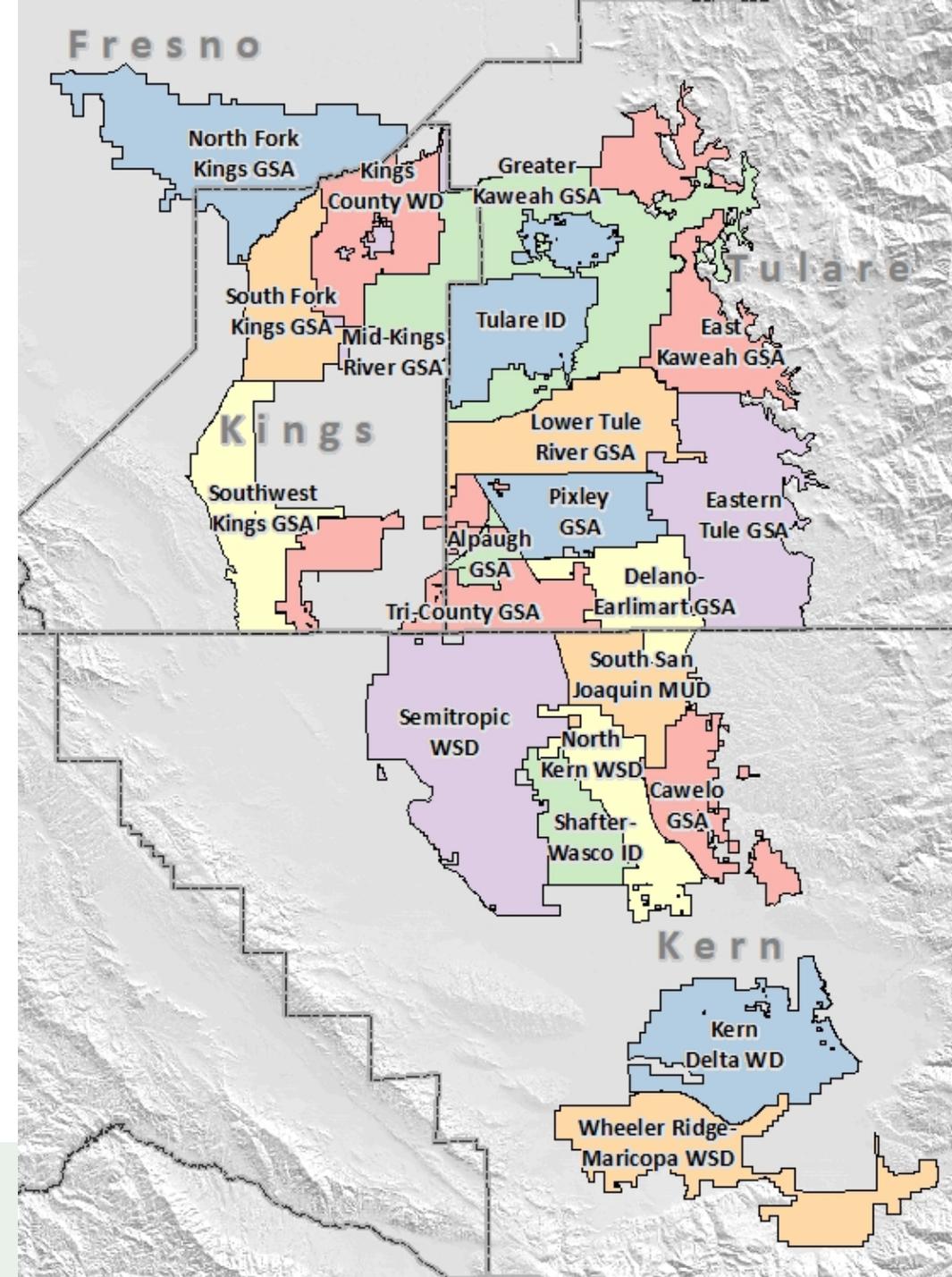
- Data management tools



LAND IQ CURRENT ET WORK EFFORTS

Land IQ currently provides monthly, field by field consumptive use, land use, and precipitation results for:

- 22 GSAs or Districts
- 35-40 different crops
- Multiple water sources
- Supports various allocation methods and water management strategies
- Monthly reports with accuracies
- Delivery within 25-30 days
- Integration to on-line platform results



STATEWIDE LAND USE

- Minimum field size of 2.0 acres – many times less
- Overall accuracy of 97.6% based on independent ground-truth validation dataset
- Approximately 50 crop legend categories, which represent 98% of all irrigated lands
- Over 15,000 miles of ground truthing each year
- Urban is approximately 50% of ag footprint (4.7 million acres versus 9.6)

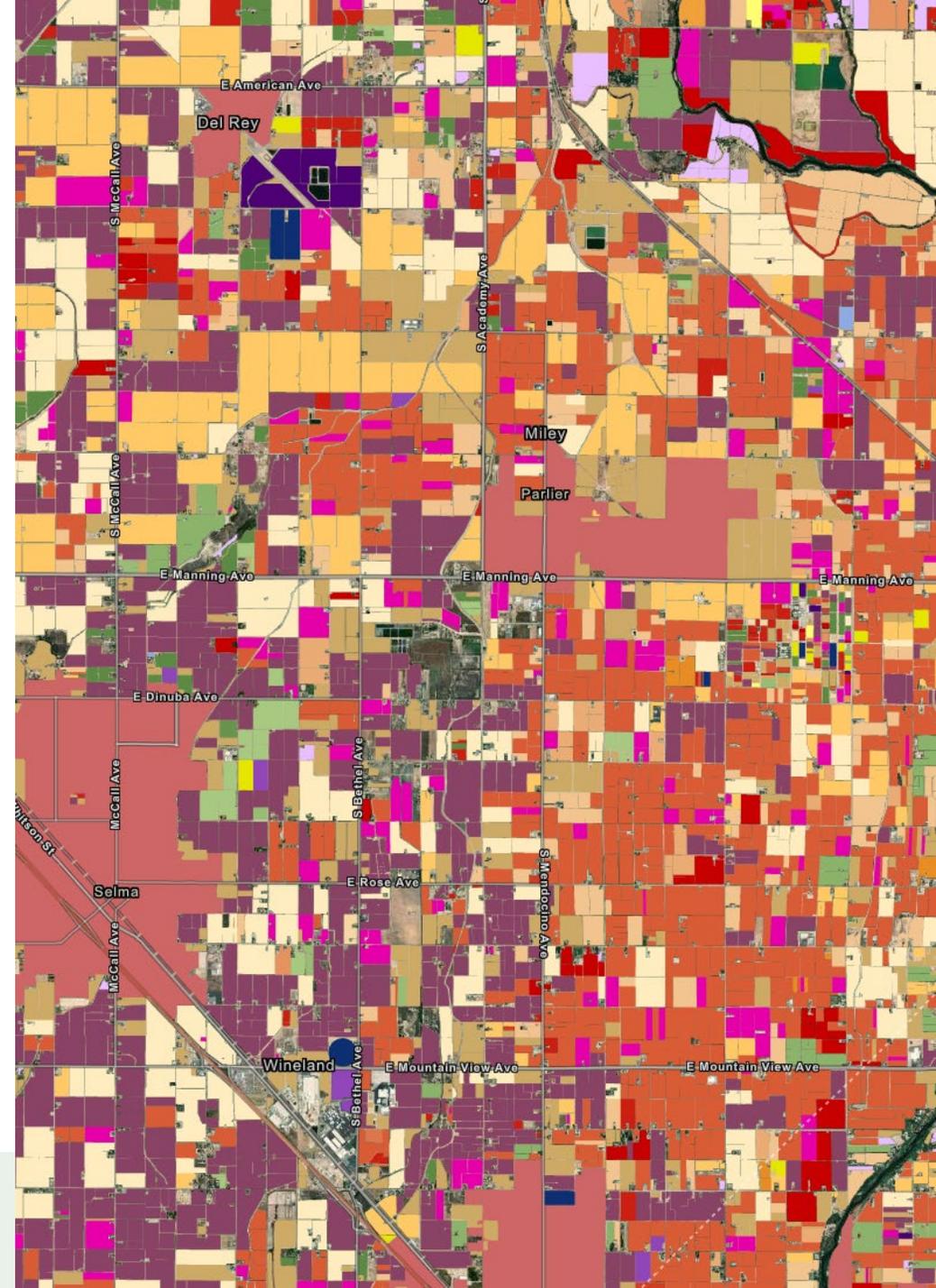


Table 9. WY 2018 Statewide Land Use Mapping Accuracy and Precision by Crop

Crop Class	User's Accuracy (Number of correctly classified acres/total acres)	Number of Groundtruth (Reference Sample Acres)	95% Two- tailed Confidence Interval
Almonds	100%	74,441	0%
Cherries	100%	10,940	0%
Dates	100%	12,575	0%
Kiwis	100%	183	0%
Olives	100%	2,886	0%
Pistachios	100%	16,243	0%
Rice	100%	862	0%
Young Perennials	100%	26,210	0%
Plums, Prunes and Apricots	100%	22,648	0%
Sunflowers	100%	29,491	0%
Walnuts	100%	40,315	0%
Pomegranates	100%	2,572	0%
Grapes	99%	3,635	0%
Citrus	99%	3,010	0%
Tomatoes	99%	35,209	0%
Cotton	99%	3,730	0%
Peaches/Nectarines	98%	12,478	0%
Mixed Pasture	97%	27,851	0%
Corn, Sorghum and Sudan	97%	37,381	0%
Potatoes or Sweet Potatoes	97%	1,416	0%
Alfalfa and Alfalfa Mixtures	96%	393	0%
Miscellaneous Field Crops	96%	1,760	0%
Avocados	96%	2,565	0%
Unclassified Fallow	96%	4,052	0%
Carrots	96%	606	0%
Beans (Dry)	95%	2,580	0%
Bush Berries	95%	5,847	0%
Onions and Garlic	95%	2,716	0%
Pears	94%	4,128	0%
Melons, Squash and Cucumbers	92%	1,998	0%
Miscellaneous Grain and Hay	92%	2,617	0%
Safflower	91%	12,429	0%
Strawberries	91%	7,179	0%
Apples	89%	11,615	0%
Lettuce/Leafy Greens	85%	4,297	0%
Peppers	82%	6,713	0%
Flowers, Nursery and Christmas Tree Farms	80%	265	0%
Cole Crops	79%	766	0%
Miscellaneous Truck Crops	71%	622	0%
Miscellaneous Grasses	67%	1,469	0%
Miscellaneous Deciduous	58%	333	0%
Miscellaneous Subtropical Fruits	48%	32	0%

LAND USE ACCURACY

- Overall accuracy of 97.1% based on independent ground-truth validation dataset for specific crop type.
- Overall accuracy of 98.1% based on independent ground-truth validation dataset for grouped crop type.
- Mapping completed for 2014, 2016, 2018, 2019, 2020, 2021
- Publicly available for 2014, 2016, 2018

Reference	Predicted											Total Acres	Correct Acres	Incorrect Acres	% Correct	Commission Error
		Citrus and Subtropical	Deciduous Fruits and Nuts	Field Crops	Grain and Hay Crops	Pasture	Rice	Truck, Nursery and Berry Crops	Unclassified	Vineyard	Young Perennial					
Citrus and Subtropical	16,000	1	-	-	-	-	8	65	-	-	16,074	16,000	74	99.5%	0.5%	
Deciduous Fruits and Nuts	9	122,914	-	-	-	-	-	214	3	35	123,175	122,914	261	99.8%	0.2%	
Field Crops	-	5	57,185	-	560	-	668	21	-	-	58,439	57,185	1,254	97.9%	2.1%	
Grain and Hay Crops	-	-	258	37,201	159	-	683	1,456	-	-	39,757	37,201	2,556	93.6%	6.4%	
Pasture	-	-	393	309	38,115	-	7	317	-	-	39,141	38,115	1,026	97.4%	2.6%	
Rice	-	-	-	-	-	26,210	-	-	-	-	26,210	26,210	-	100.0%	0.0%	
Truck, Nursery and Berry Crops	3	-	335	118	176	-	62,335	19	23	1	63,010	62,335	675	98.9%	1.1%	
Unclassified	-	46	-	-	1,070	-	7	35,873	188	196	37,380	35,873	1,507	96.0%	4.0%	
Vineyard	-	-	-	-	5	-	-	80	29,320	74	29,479	29,320	159	99.5%	0.5%	
Young Perennial	-	-	-	-	-	-	-	-	-	4,128	4,128	4,128	-	100.0%	0.0%	
Total Acres	16,012	122,966	58,171	37,628	40,085	26,210	63,708	38,045	29,534	4,434	436,793					
Correct Acres	16,000	122,914	57,185	37,201	38,115	26,210	62,335	35,873	29,320	4,128		429,281				
Incorrect Acres	12	52	986	427	1,970	-	1,373	2,172	214	306			7,512			
% Correct	99.9%	100.0%	98.3%	98.9%	95.1%	100.0%	97.8%	94.3%	99.3%	93.1%				98.3%		
Commission Error	0.1%	0.0%	1.7%	1.1%	4.9%	0.0%	2.2%	5.7%	0.7%	6.9%						

APPLIED/RECEIVED VERSUS CONSUMED

- Applied/Received Water
 - Irrigated Fields/Orchards/Groves
 - Surface Water
 - Groundwater
 - Precipitation
 - Non-Irrigated Fields/Orchards/Groves
 - Precipitation
- Consumed Water
 - Occurs in both irrigated and non-irrigated environments



EVAPOTRANSPIRATION

- Evapotranspiration = Evaporation + Transpiration
- Evaporation: Water evolved into the atmosphere from soil and plant surfaces after precipitation or irrigation (never goes through the plant)
- Transpiration: Water evolved into the atmosphere from translocation through the plant (goes from roots to leaves)

EXAMPLE ON NON-IRRIGATED FIELD

- Only water the field “sees/receives” is precipitation
- So, what happens to that precipitation? – ET happens!
 - Recently disked field – Evaporation – occurs from the soil surface
 - Rangeland – Evaporation AND Transpiration
- So, how much is left after ET?
 - Usually not much because of how and when it rains
 - Land IQ measures the ET (consumed water)
 - Received Water > Consumed Water



EXAMPLE ON NON-IRRIGATED FIELD

- Givens:
 - 20-acre field
 - Rainfall only = 1.20 inches – From Land IQ rain gauges
 - 1.75 acre-ft consumed – From Land IQ monthly analyses
- Results:
 - $1.75 \text{ acre feet} / 20 \text{ acres} = .0875 \text{ feet}$ (or 1.05 inches)
 - $1.05 / 1.20 = 88\%$ of the water was consumed = gone
 - 12% of the water was not consumed: (0.15 inches, 0.0125 feet, 0.21 acre feet)
 - Stored in the root zone for future use, OR
 - Passed the root zone to groundwater

EXAMPLE ON NON-IRRIGATED FIELD

- Conclusion:
 - Just because you have 1.20 inches of rainfall on a non-irrigated field, does not mean you can pump 1.20 inches for irrigation somewhere else.

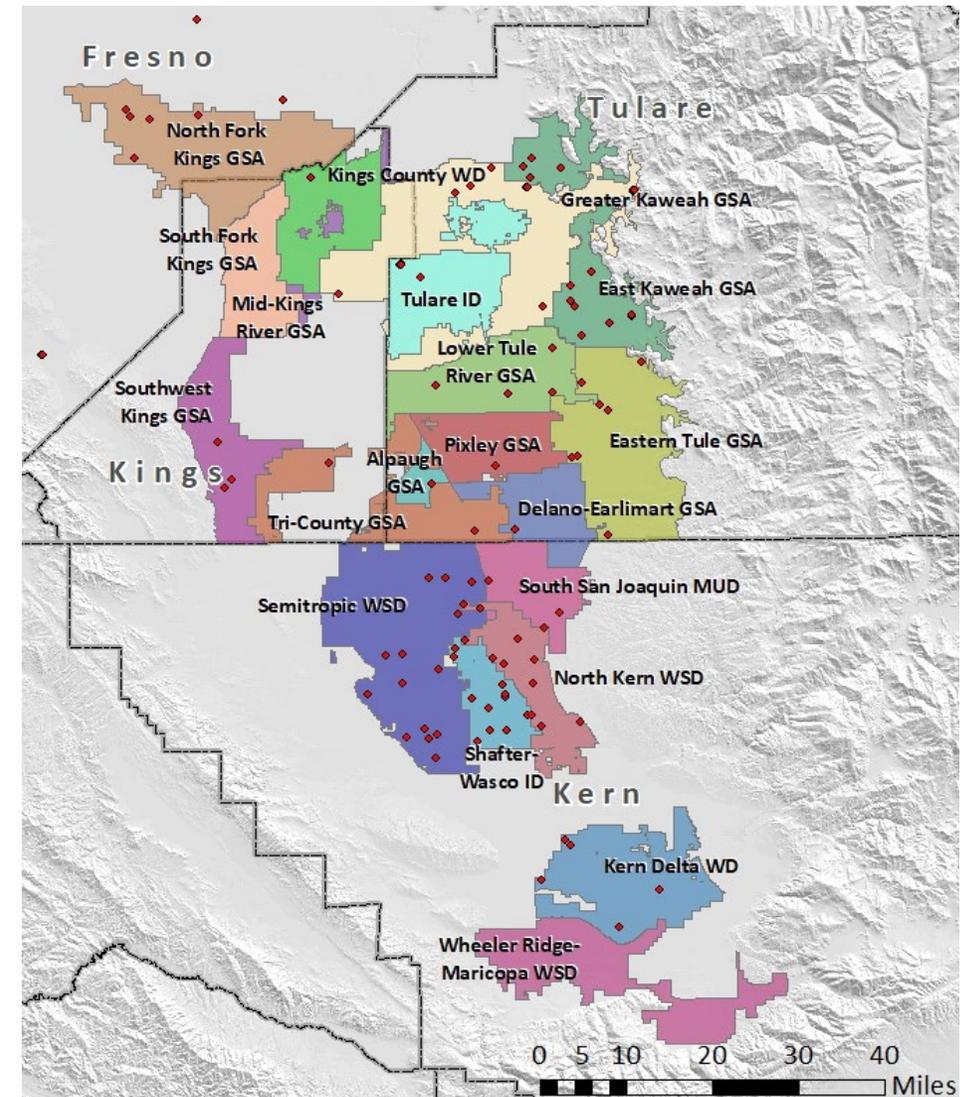
GROUND TRUTHING FOR CALIBRATION – WHY?

- Defensible
- Independent validation
- Calibration to actual conditions
- Avoiding interpolation during cloud and smoke cover
- Understanding specific field conditions and management
- Allows for continual improvement of models
- Allows for crop-specific modeling
- Stations used are a combination of eddy covariance and surface renewal approaches developed through collaboration with DWR (Delta) and UC Davis researchers
- A “ground up” approach



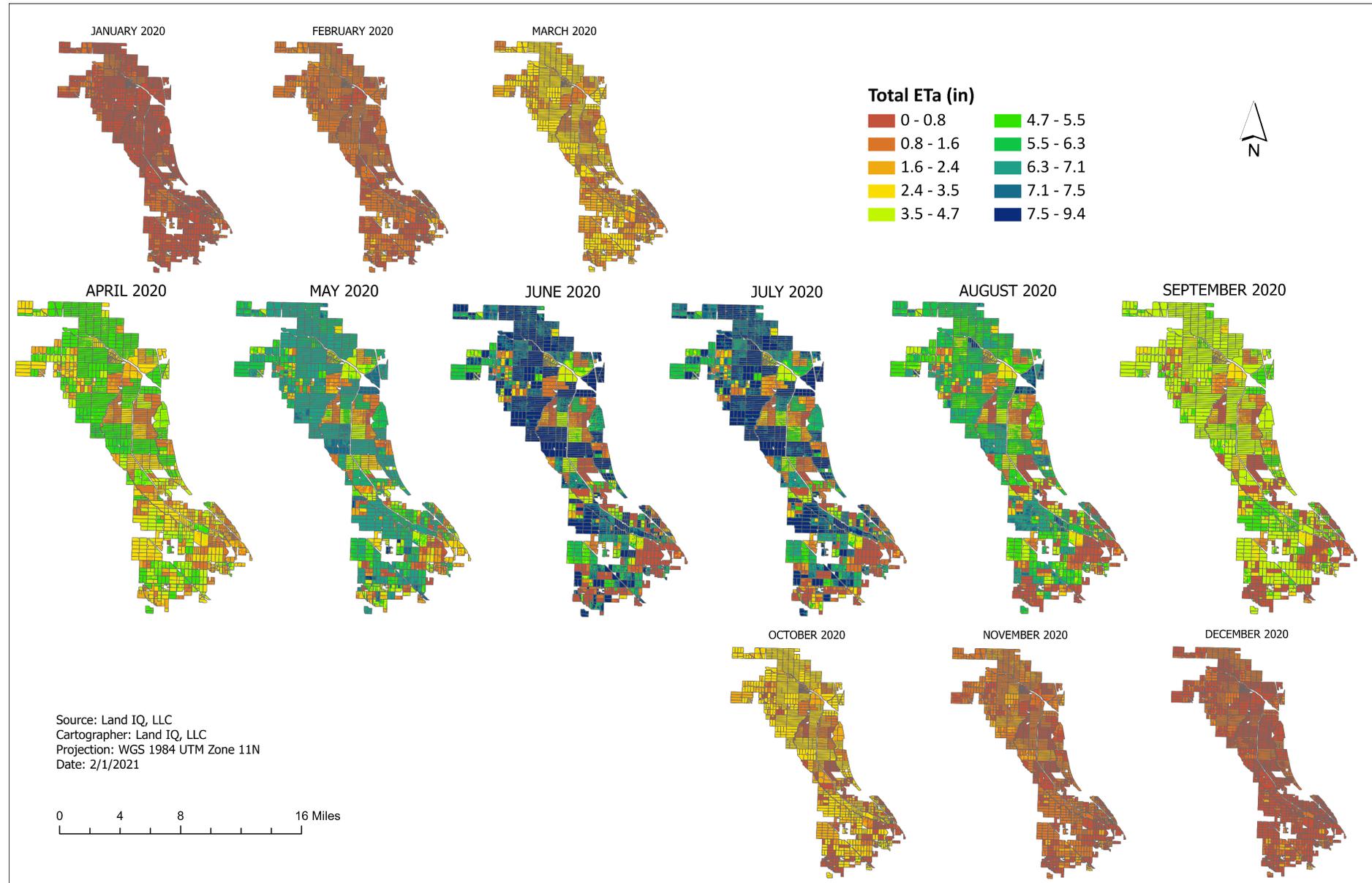
GROUND TRUTHING FOR CALIBRATION – WHERE?

- Within the next 6 months will have nearly 100 stations installed in the South Valley
- Collaboration with UC Davis, UC Cooperative Extension and USDA Agricultural Research Service
- Native/non-irrigated areas included
- Establishment of spatial precipitation with multiple rain gauges
- For the purpose of understanding crop specific and repeated measurements
- Necessary for more accurate estimation of consumed water in any water allocation/market approach



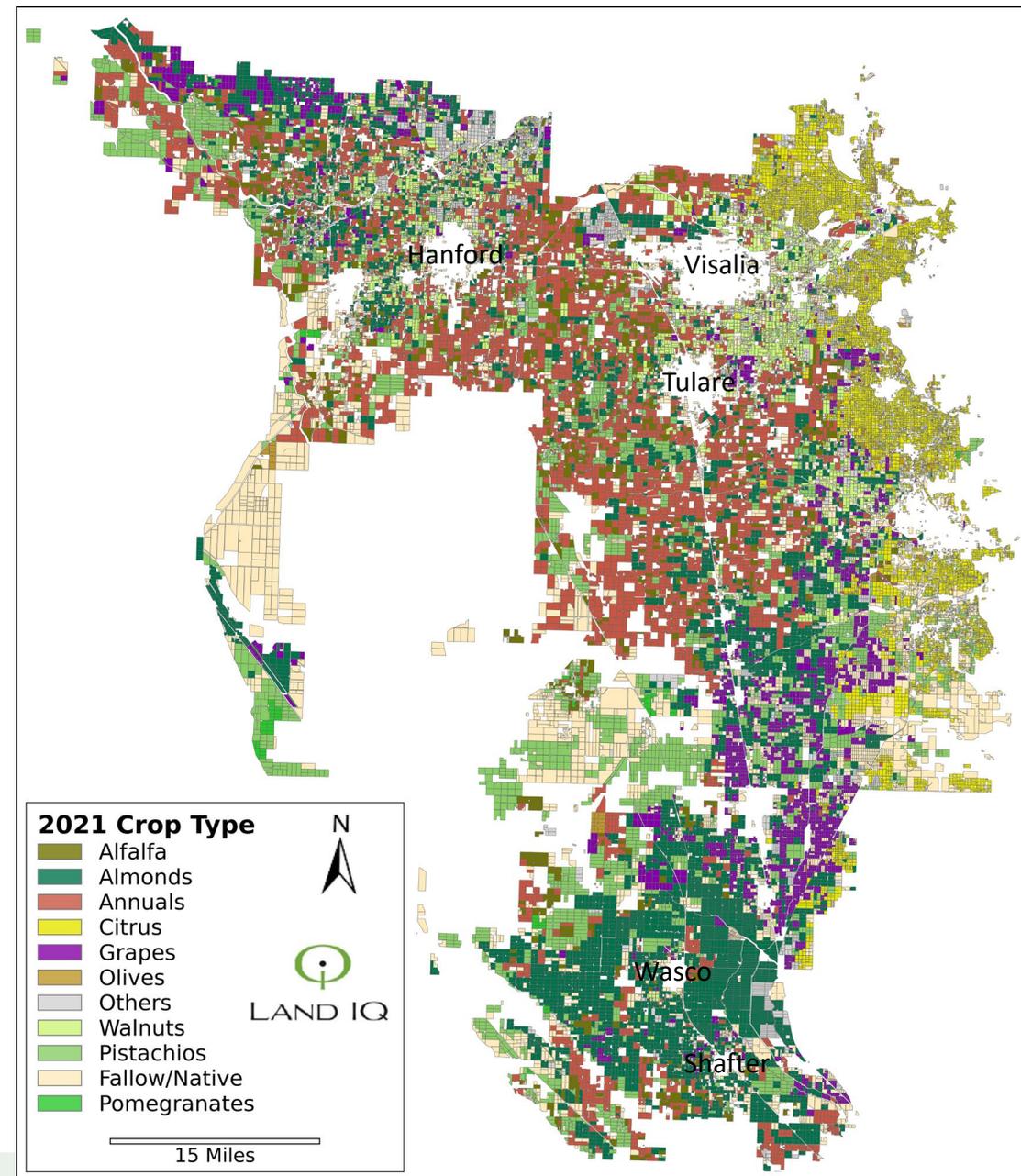
DELIVERABLE – FIELD BY FIELD ET

- Monthly results delivered within 25 days of the previous month
- Calibrated and validated by ground truthing climatic stations
- Reviewed by independent advisors
- Used for tracking water use, water management, reporting, allocations, water markets, etc.



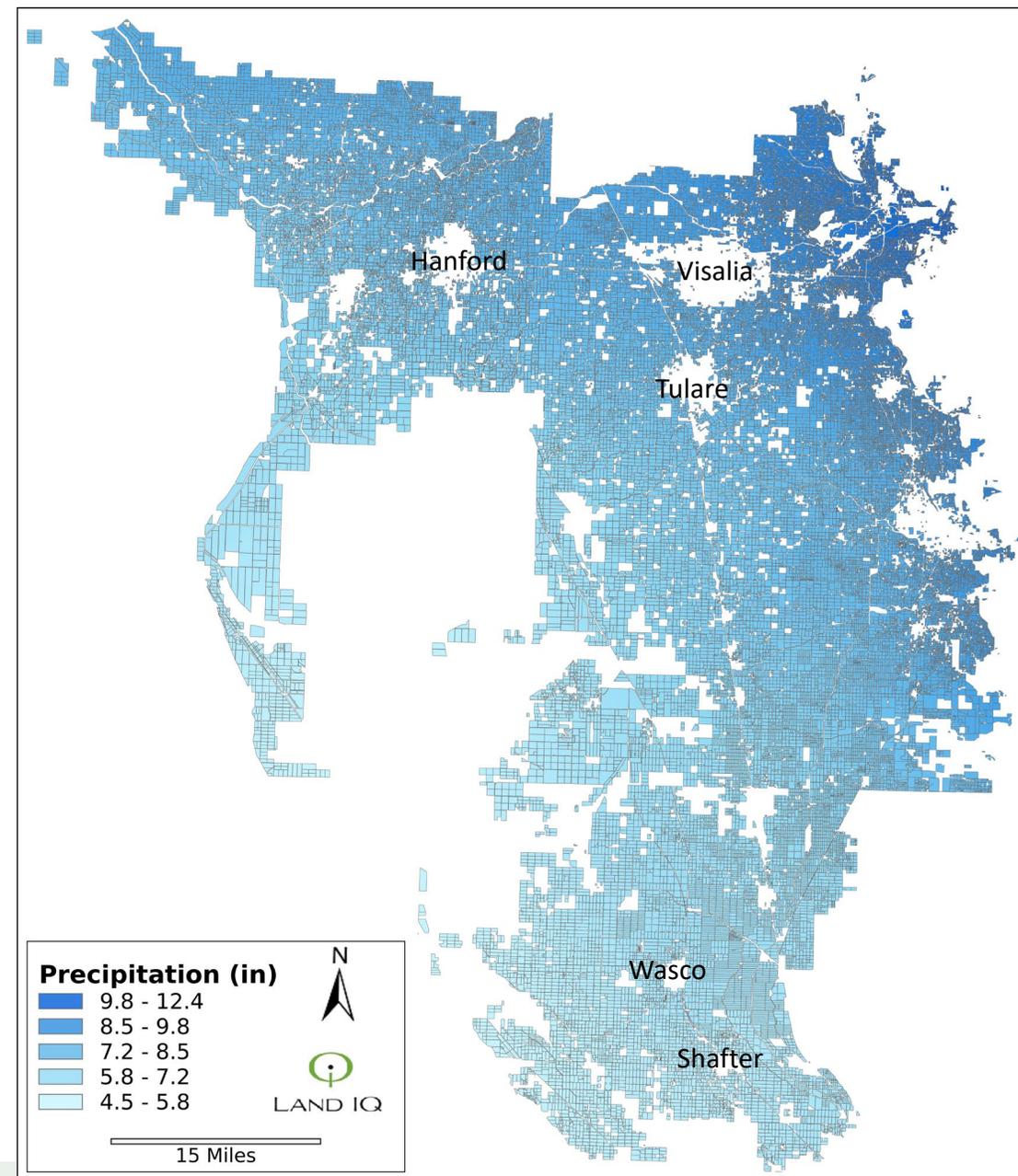
DELIVERABLE – FIELD BY FIELD CROP TYPE

- Same methodology used to provide crop type to CA Dept of Water Resources as a requirement of SGMA
- Consistent with results for DWR
- Essentially real-time crop type for inclusion in modeling
- Can be used by GSAs/Districts for tracking irrigated acreage, customer base, in-season water planning and management



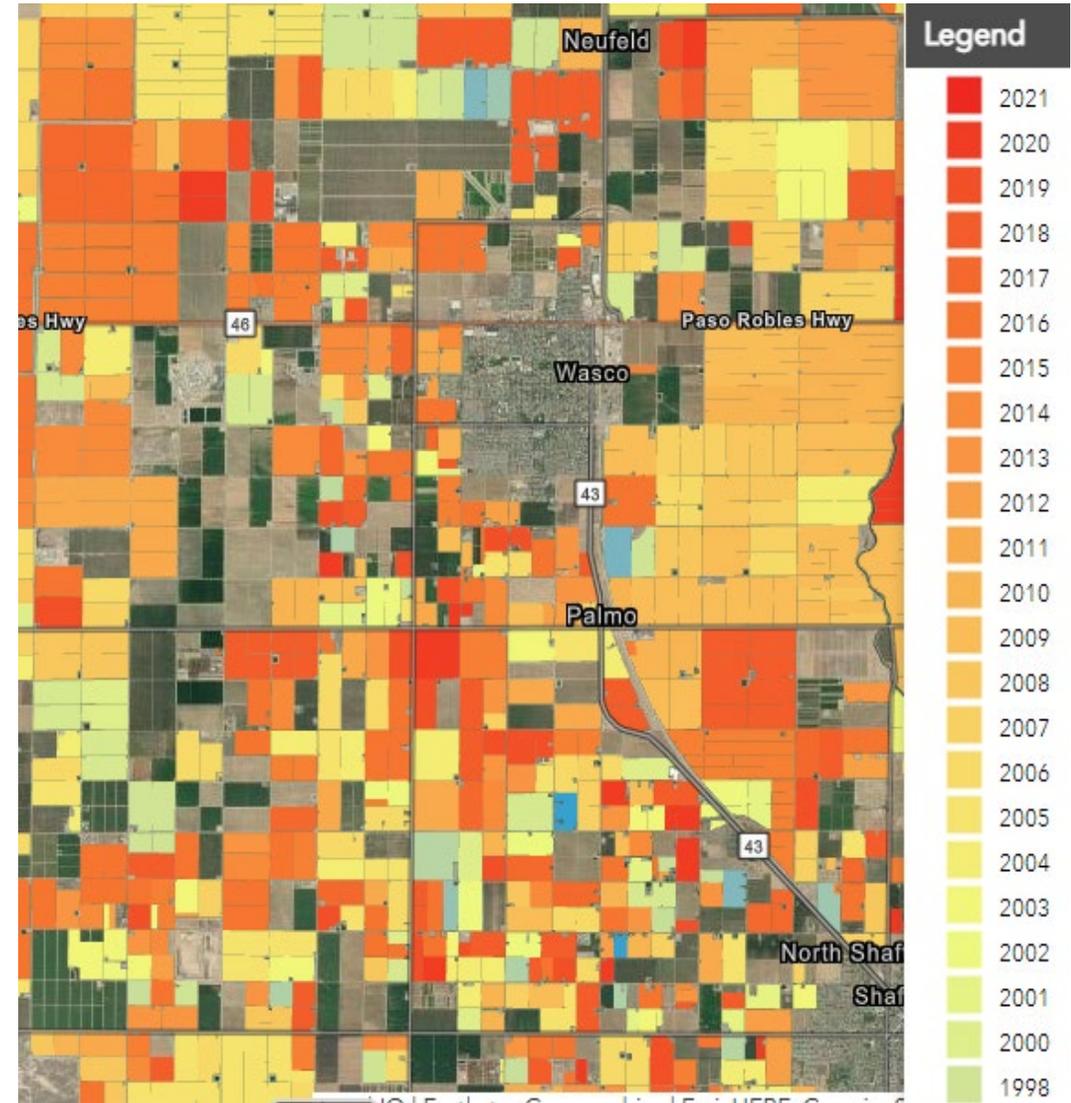
DELIVERABLE – FIELD BY FIELD PRECIPITATION

- Results collected by rain gauges at ground truthing stations
- Incorporation of other public rain gauge results (e.g. CIMIS, airports, cities, etc.)
- Conversion of point data into a spatial precipitation map by month and by year
- Assignment of a field-by-field precipitation for rainfall contribution to ET, water budget tracking, allocations, modeling, etc.

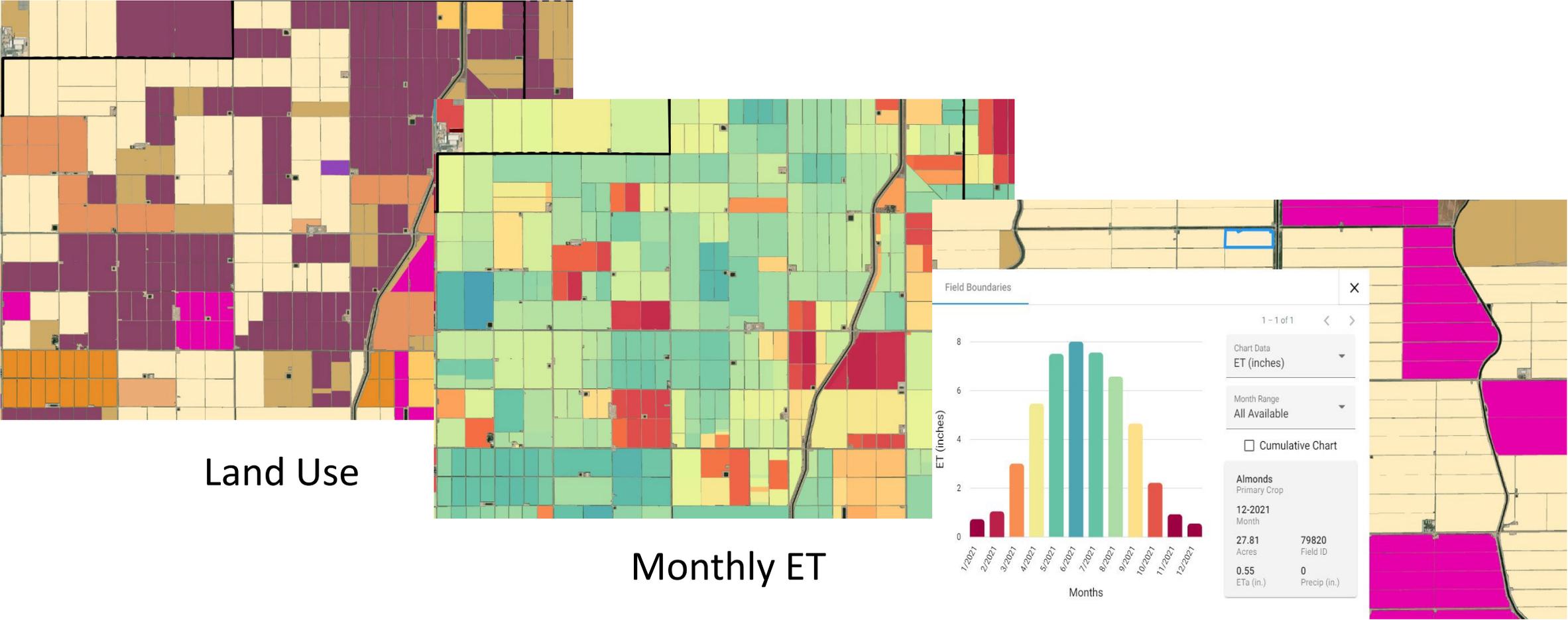


DELIVERABLE – FIELD BY FIELD PERMANENT CROP AGE

- Same methodology used to provide crop type to CA Dept of Water Resources as a requirement of SGMA
- Consistent with results for DWR
- Highly correlated to consumed water
- Yet another line of evidence that people can use to refine their water management allocations and forecasting



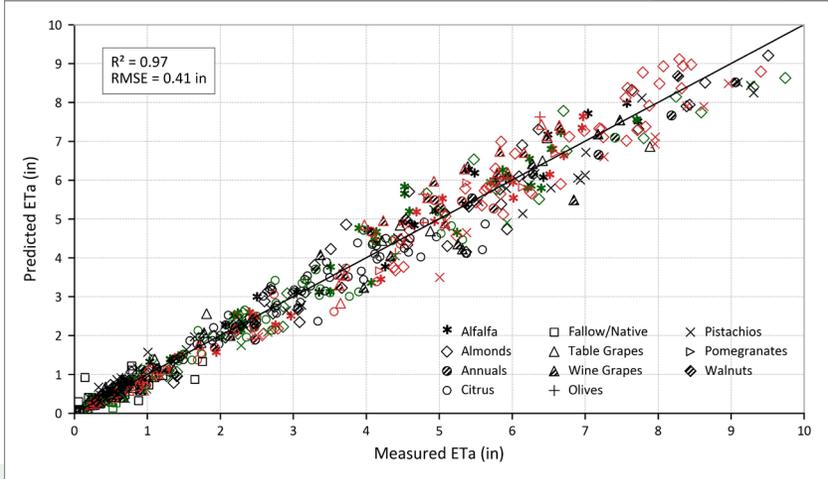
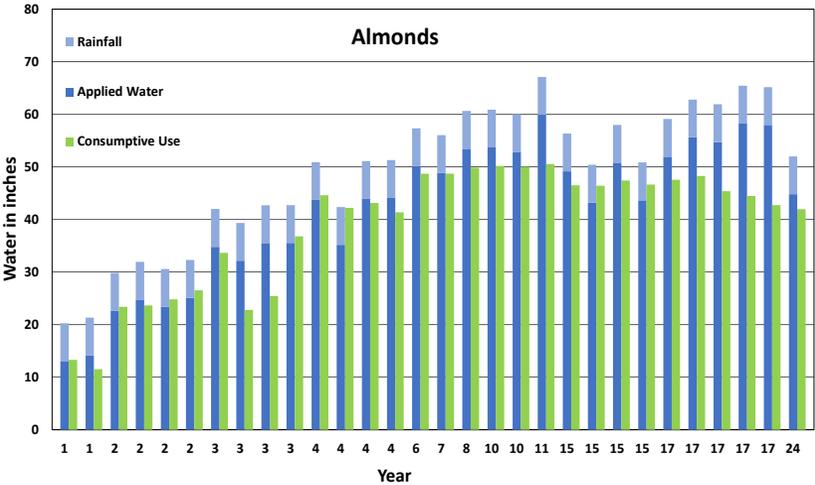
ONLINE FIELD-BY-FIELD RESULTS AND DELIVERY



Online Viewer and Data Download Tool

MULTIPLE APPROACHES TO CALIBRATION AND VALIDATION

- Ground Truthing
 - Eddy Covariance
 - Surface Renewal
- Measured versus Predicted
- Literature
- Applied Versus Consumed
- Agronomic Knowledge and Experience
- Groundwater Pumping Allocations
- Grower Acceptance



UPDATED CONSUMPTIVE USE ESTIMATES OF ALMOND, WALNUT, PISTACHIO AND CITRUS IN CALIFORNIA

TO: Joel Kimmelshue
 FROM: Stephanie Tillman
 DATE: November 23, 2021

SUMMARY



... increased in many crops
 ... high value crops that have not
 ... them for less time compared to
 ... tented to improve yields.
 ... ically (in some cases, doubled)
 ... crop nutrition, pest phenology,
 ... gy and soil quality and
 ... as likely increased as yields
 ... some of these crops successfully

... almond, which have increased
 ... year on average, ranging up to
 ... tal development, cultural
 ... gement. Almond consumptive
 ... ct the increase in yield and

... ublished values; however, there
 ... ond. Most literature suggests
 ... es per year. Current crop
 ... om 39.8 to 53.2 (and averaging

... wing season in the San Joaquin
 ... ear.

... monly referenced guidance
 ... y different cropping systems

DEVELOPMENT OF INDEPENDENT ADVISORY GROUP

- Retired UC Cooperative Extension Agents and Farm Advisors:
 - Blake Sanden, MS – 26 years in Kern County
 - Allan Fulton, MS – 35 years in Kings, and Northern CA counties
 - Review results every month beginning in 2021 and offer suggestions for improvements
- 2-3x per year Advisory Group:
 - Blake Sanden, MS - Retired
 - Allan Fulton, MS - Retired
 - Daniele Zaccaria, PhD – UC Davis
 - Rick Snyder, PhD – UC Davis, Emeritus
 - Dan Howes, PhD – Cal Poly ITRC
 - Khaled Bali, PhD – UC ANR
 - Pasquale Steduto, PhD – UN-FAO





Questions
jkimmelshue@landiq.com
916.517.2482

KAWEAH SUBBASIN

MARCH 15, 17, 25, 2022





KAWEAH WATER DASHBOARD

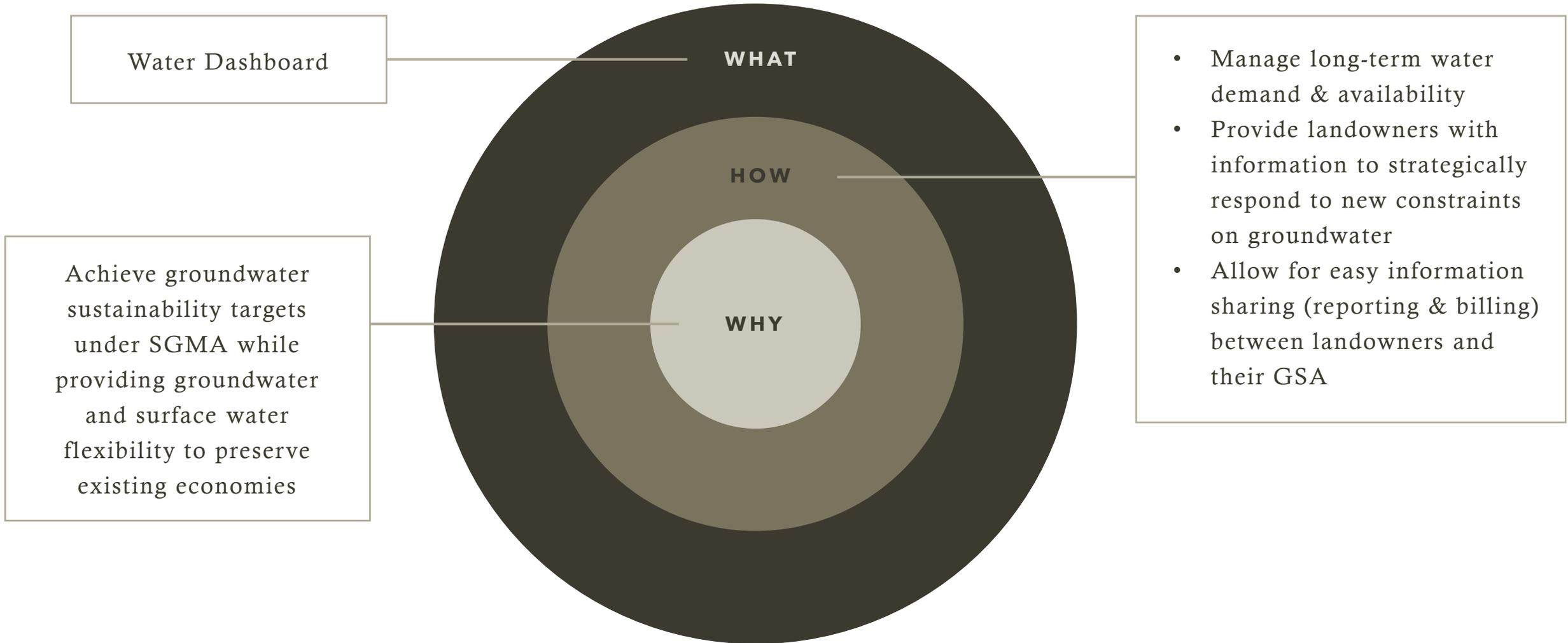
Savannah Tjaden – Provost & Pritchard
Consulting Group, *Product Manager*



NEED

Currently, no tool exists for landowners and the Kaweah Subbasin GSAs to easily share up-to-date water use information within the context of SGMA. This makes quantifying and efficiently responding to groundwater use difficult.

PURPOSE & INTRODUCTION



VALUE FOR GROWERS

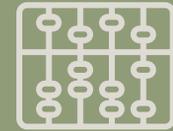
AN ONLINE WATER BANK ACCOUNT THAT...



**EMPOWERS KAWEAH
SUBBASIN LANDOWNERS
TO STRATEGICALLY
RESPOND TO SGMA**



**DELIVERS KEY WATER
USE INSIGHTS AT THE
FARM LEVEL**



**TRACKS OWNER-SPECIFIC
WATER ACCOUNTING &
INVOICING ASSOCIATED
WITH SGMA COMPLIANCE**



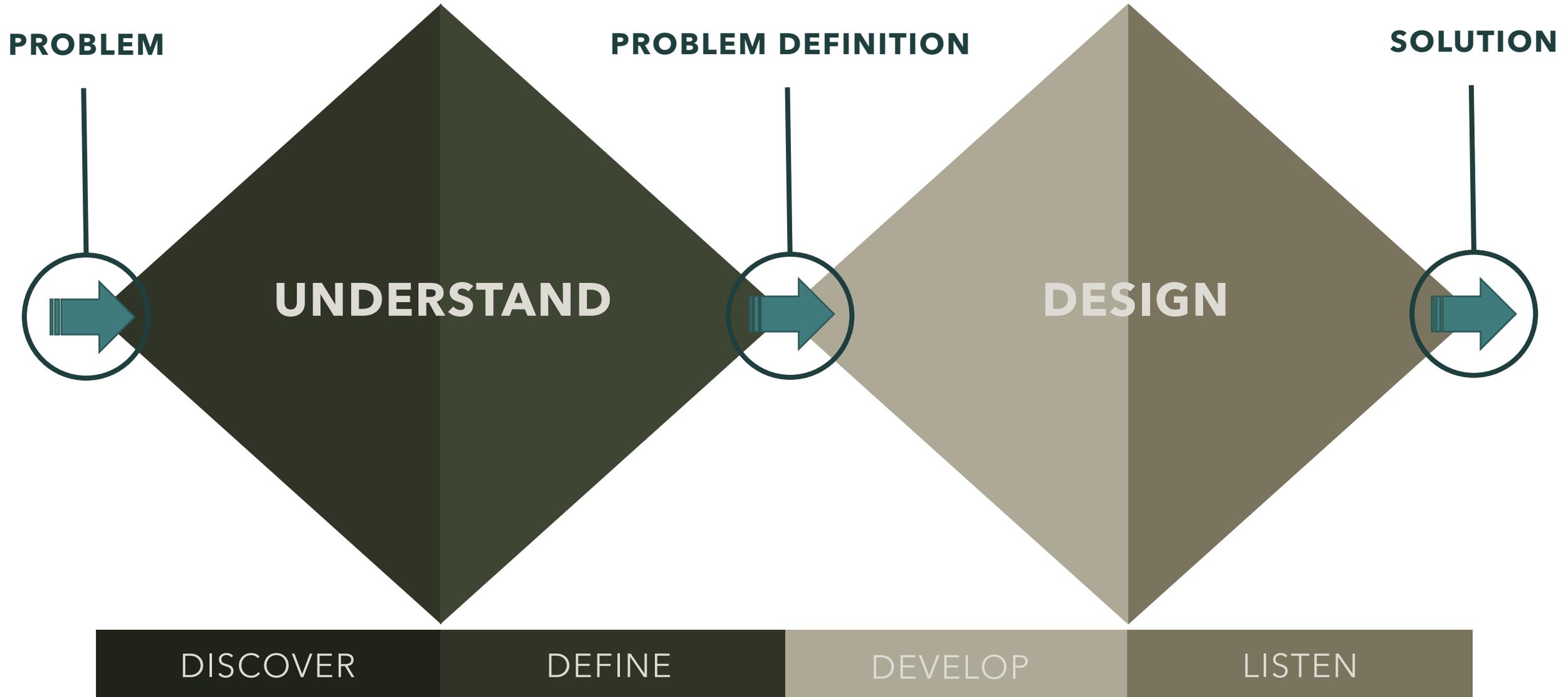
DEVELOPMENT PRINCIPLES

- ◆ Phased development, ongoing process.
- ◆ Landowner engagement is primary focus of development, ensuring features best suit the needs of local landowners.
- ◆ Diverse farm company structures are in mind to ensure account set-up and information sharing is as easy as possible.

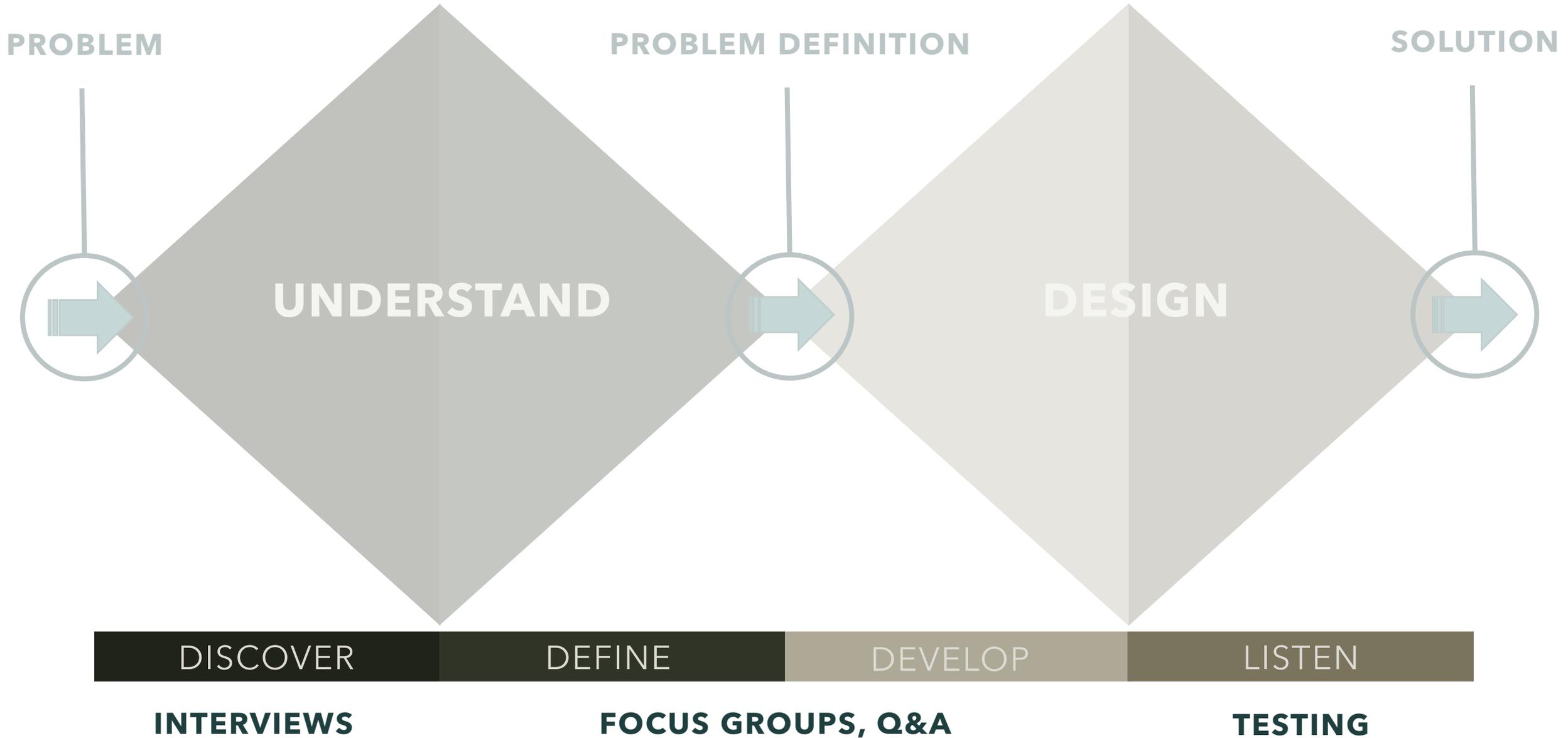
PRODUCT ROADMAP

	PHASE 1 View Historical ET	PHASE 2 Landowner Water Bank Account	PHASE 3 Water Trading
G O A L S	Landowners		
	UNDERSTAND ET DATA IN THE CONTEXT OF MY FARM OPERATIONS AND GROUNDWATER PUMPING	ACTIVELY AND EFFICIENTLY MANAGE GROUNDWATER AND SURFACE WATER SUPPLIES WITHIN THE CONTEXT OF SGMA	MAXIMIZE PROFITABILITY & OPTIMIZE LONG-TERM ASSET PLANNING
	GSA_s		
	REGISTER GSA MEMBERS	FULL ACCOUNTING OF WATER IN THE SUBBASIN & GROUNDWATER BILLING	PROVIDE MAXIMUM FLEXIBILITY TO LANDOWNERS WHILE ACHIEVING SUSTAINABLE GROUNDWATER USAGE

DEVELOPMENT PROCESS



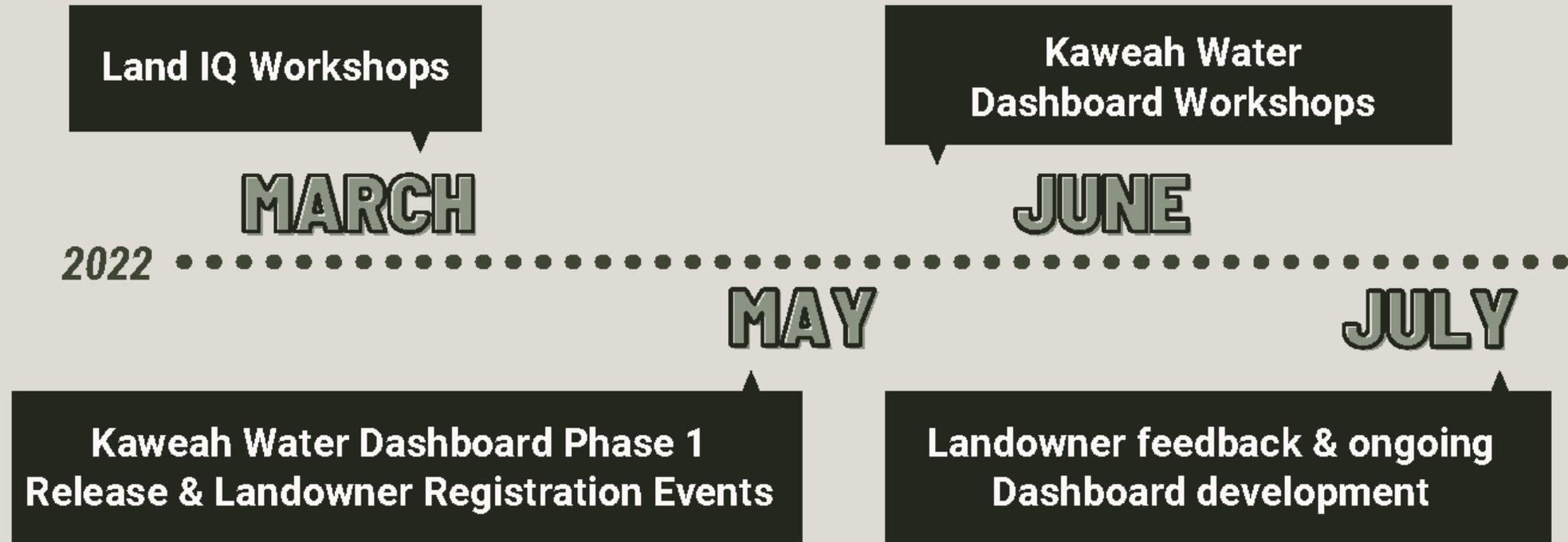
DEVELOPMENT PROCESS INCLUDES LANDOWNERS





LIVE POLL

WATER DASHBOARD PHASE 1 LAUNCH



WATER DASHBOARD MAY RELEASE

- Create a user profile to view your data from all 3 GSAs in a single location
- View historical Land IQ data
 - Average ET by crop type
 - Total annual and monthly usage for all land under your control
 - Annual and monthly usage for individual parcels under your control
- View your groundwater allocation for each GSA (based on proposed or approved rules and regulations for each GSA)



Q&A

THANK YOU!



Eric Osterling - Greater Kaweah GSA, *General Manager*

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www.greaterkaweahgsa.org



EAST KAWEAH
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