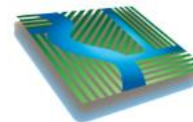




# Preliminary 2024 Verification Project Results

Madera County  
Participating Grower Workshop  
*January 27, 2025*

**DRAFT**



**DAVIDS**  
ENGINEERING, INC

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Western Water Since 1993

# 2024 Verification Project\*

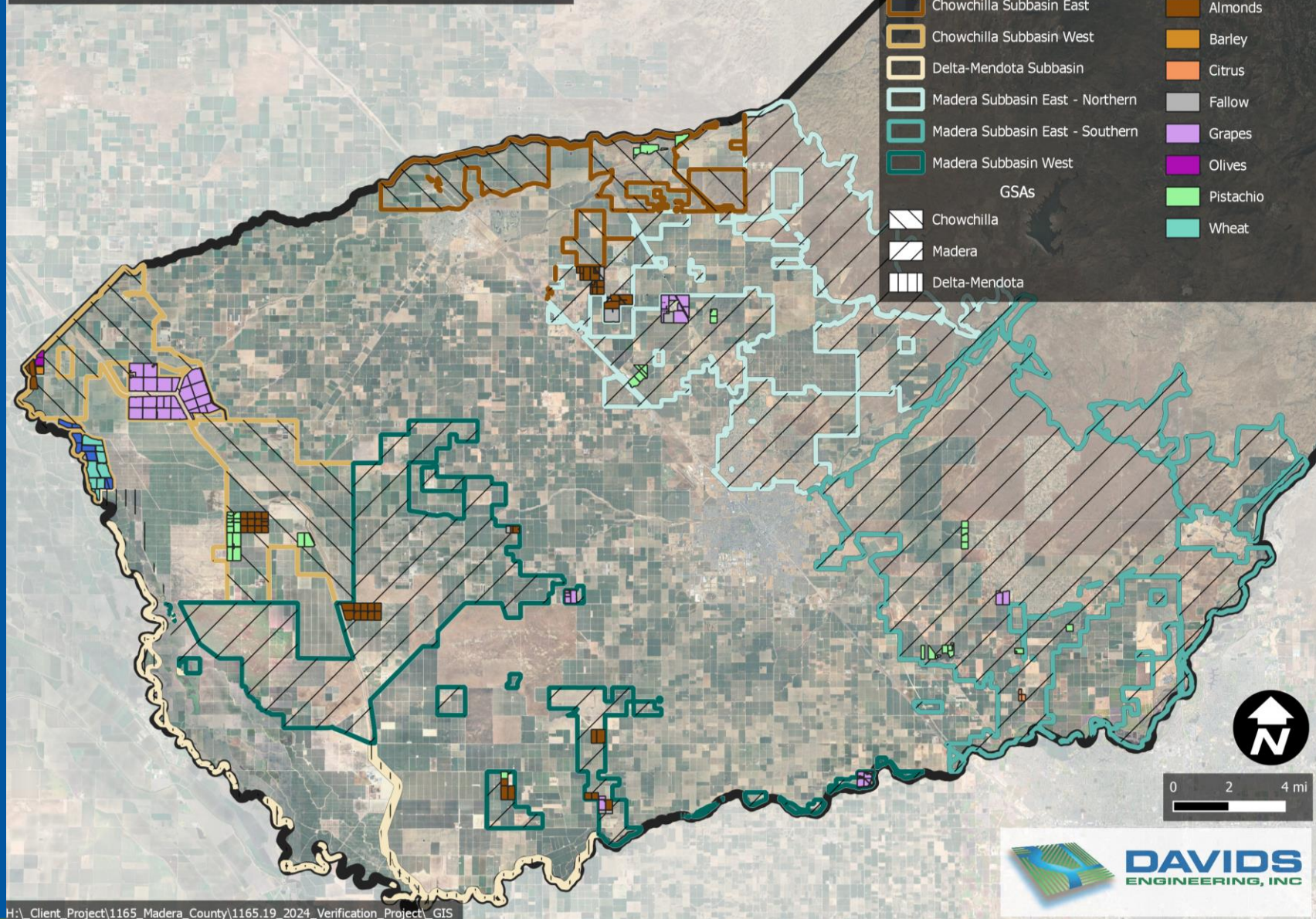
\*An in-depth review of quantification of ETAW across all groundwater allocation measurement options



Flowmeters



Madera County GSAs, Farm Unit Zones, and 2024 Verification Project Participants (VPPs)



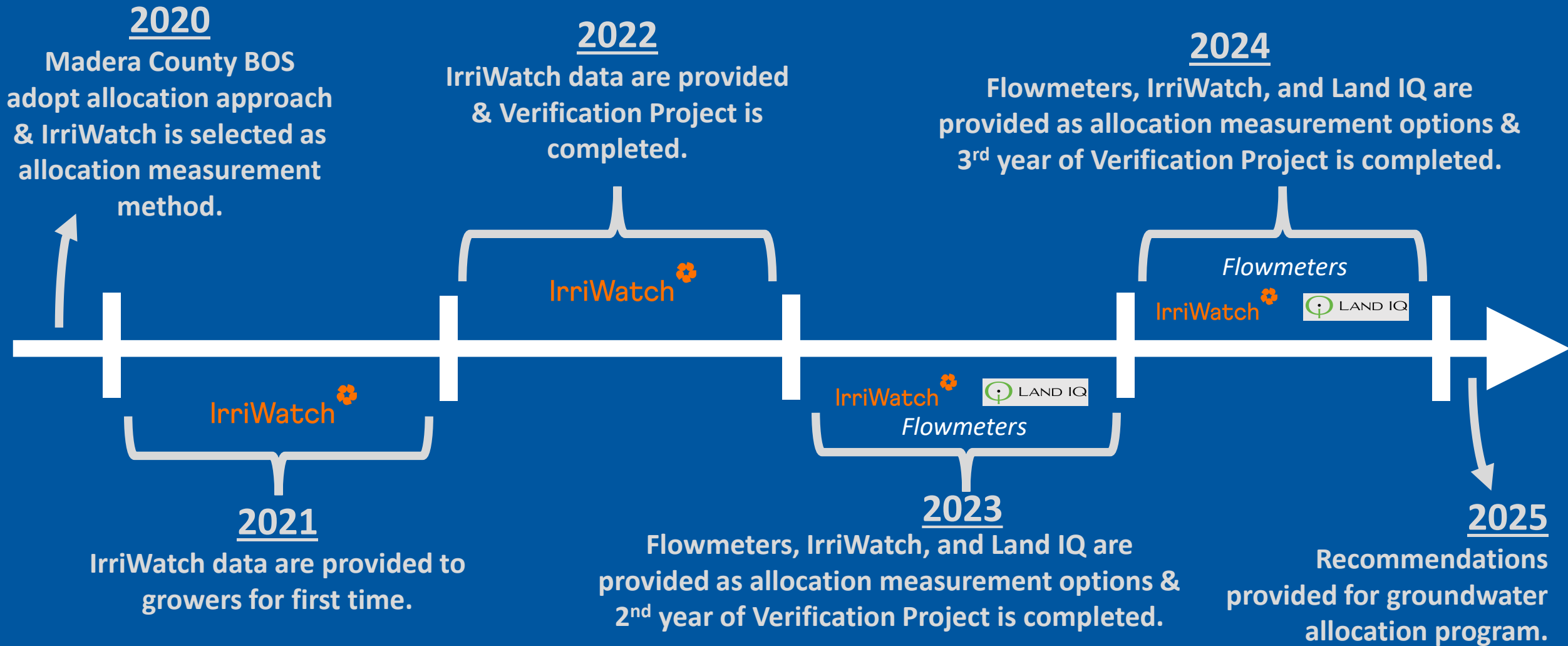
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# Agenda

1. Overview of Groundwater Allocations and Verification Project
2. 2024 Project Goals and Objectives
3. Preliminary Results
4. Preliminary Conclusions and Recommendations
5. Questions and Discussion / Next Steps

# Overview of Groundwater Allocations & Verification Project

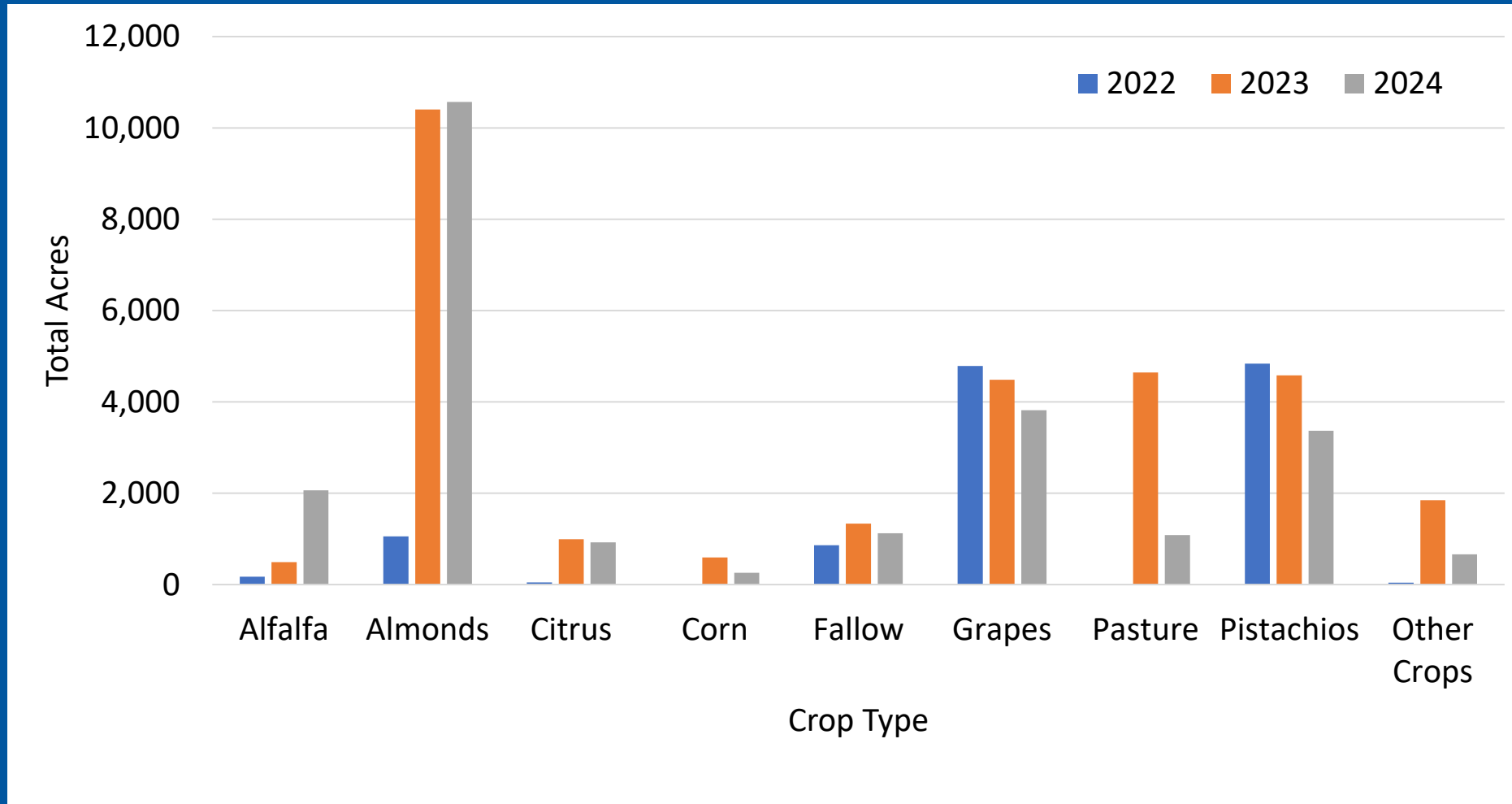


# 2024 Project Goals and Objectives

1. Continue grower engagement, education, and outreach.
2. Implement and refine methods for collecting and/or developing the required input data and associated computations for totalizing flowmeters or remote sensing with IrriWatch or Land IQ.
3. Collect, analyze and compare results from the three allocation measurement methodologies across Verification Project lands and all available years.
4. Provide recommendations for the groundwater allocation program.
5. Enable Madera County staff to lead future variations of the Verification Project, to the largest extent possible<sup>1</sup>.

1. New goal and objective for 2025 Verification Project.

# Crop Types Represented in Verification Project (VPP and FMA Lands<sup>1</sup>)



Year	Total Acres
2022	11,800
2023	29,400
2024	23,900

- In 2022, majority of acreage was Grapes and Pistachios.
- In subsequent years, Almonds have been primary included crop (also most common in GSAs).

1. VPP are Verification Project Participants and FMA are Flowmeter Accounts.

# All Verification Project Lands: 2024

Crop	2024 Madera Verification Project (VPP and FMA lands <sup>1</sup> )			Madera County GSAs			Acreage % Difference (Verification Project - GSAs)
	Parcel-Field <sup>2</sup> Count	Acreage	Acreage %	Parcel-Field <sup>2</sup> Count	Acreage	Acreage %	
Alfalfa	33	2,066	8.7%	141	6,665	6.1%	2.6%
Almonds	214	10,568	44.3%	950	38,115	34.7%	9.6%
Citrus	42	926	3.9%	95	1,889	1.7%	2.2%
Corn	5	257	1.1%	58	2,075	1.9%	-0.8%
Fallow	28	1,121	4.7%	712	10,979	10.0%	-5.3%
Grapes	63	3,816	16.0%	337	13,697	12.5%	3.5%
Pasture	15	459	1.9%	50	1,263	1.1%	0.8%
Pistachios	105	3,369	14.1%	631	21,764	19.8%	-5.7%
Wheat	11	624	2.6%	142	6,352	5.8%	-3.2%
Other Crops <sup>3</sup>	24	664	2.8%	210	7,093	6.5%	-3.7%
<b>Totals</b>	<b>540</b>	<b>23,869</b>	<b>100.0%</b>	<b>3,326</b>	<b>109,893</b>	<b>100.0%</b>	<b>-</b>

Notes:

- VPP are Verification Project Participants (who are voluntarily participating in the Project) and FMA are Flowmeter Accounts (who have elected to use flowmeters as their 2024 groundwater allocation measurement method).
- A parcel-field is the union of legal parcel boundaries, from the Madera County Assessor's Office, and 2023 California statewide irrigated and urban lands coverage, from the California Department of Water Resources (DWR).
- The other crop classification includes small area crops such as cotton, olives, tomatoes, other deciduous, walnuts, and grasses. In addition, this classification includes land uses/crop classes that make up the rest of the Parcel-Fields in the Madera County GSAs. These include cherries, figs, kiwis, undeveloped areas, urban areas, unknown land types, and variety of other tree crops. Although crop type was field verified and accurate for lands participating in the 2024 Verification Project, there were some corrections required from the original crop shown in IrriWatch at the outset of the Project. For cropping in the overall Madera County GSAs, the coverage is generally representative but not expected to be completely accurate. Improving land use coverage is a recommendation resulting from the Project.

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1. New goal and objective for 2025 Verification Project.



## Objective 2

# Implement and Refine Methods: Evaluate Flowmeter Accuracy

1. Completed an inspection of flowmeter installation on all permanent flowmeters included in study<sup>1</sup>.
2. Completed independent flow measurements with a portable transit time flowmeter for direct comparison to permanently installed flowmeters.

1. These inspections were for use related to the 2024 Verification Project only and do not constitute an official meter inspection, pursuant to Resolution 2021-113.

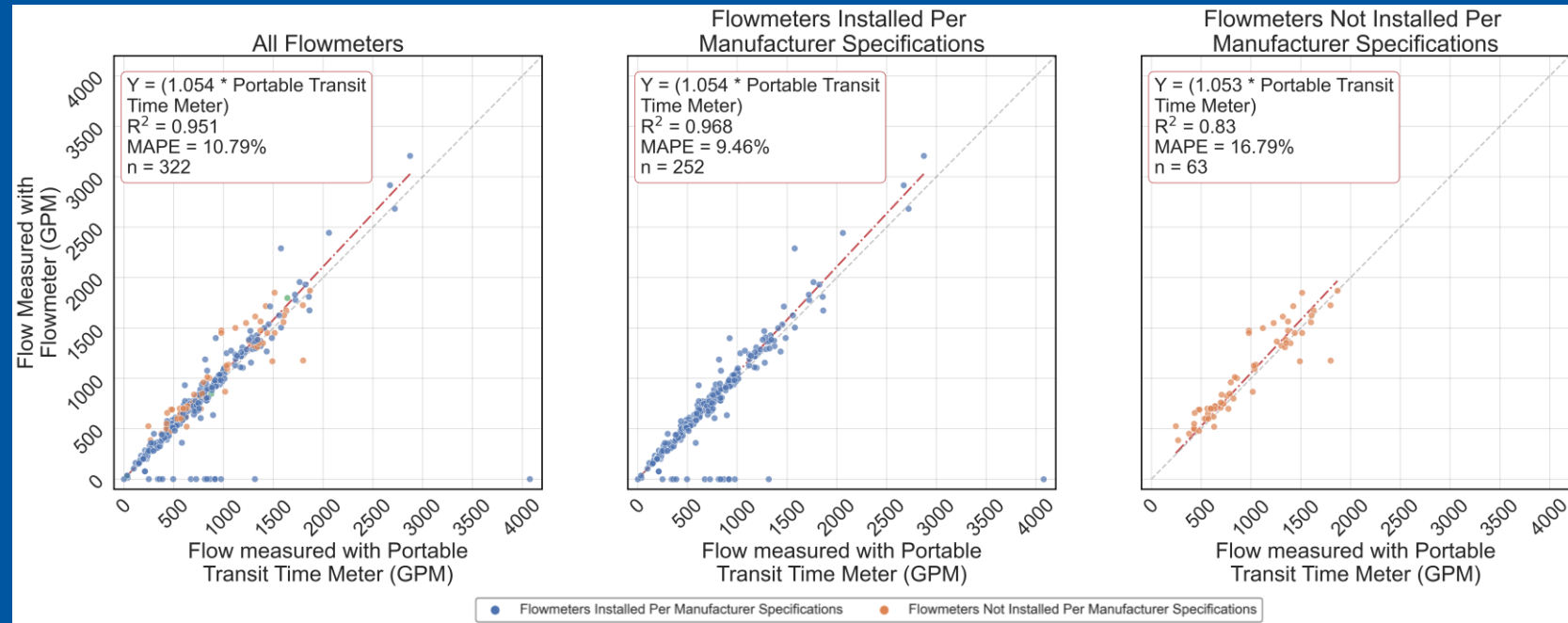
# All Flowmeter Comparison Results (2022 – 2024)

- 210 permanent flowmeters
  - 169 (80%) installed per manufacturer specifications
  - 41 (20%) were not
- 322 comparison measurements
- Mean Absolute Percent Error (MAPE):
  - All measurements = **10.8%**
  - Installed per Manufacturer Specs = **9.5%**
  - Not Installed per Manufacturer Specs = **16.8%**
- **Correct installation substantially improves flowmeter accuracy.**

(1) Flowmeter



(2) Portable Transit Time Meter



## Objective 2

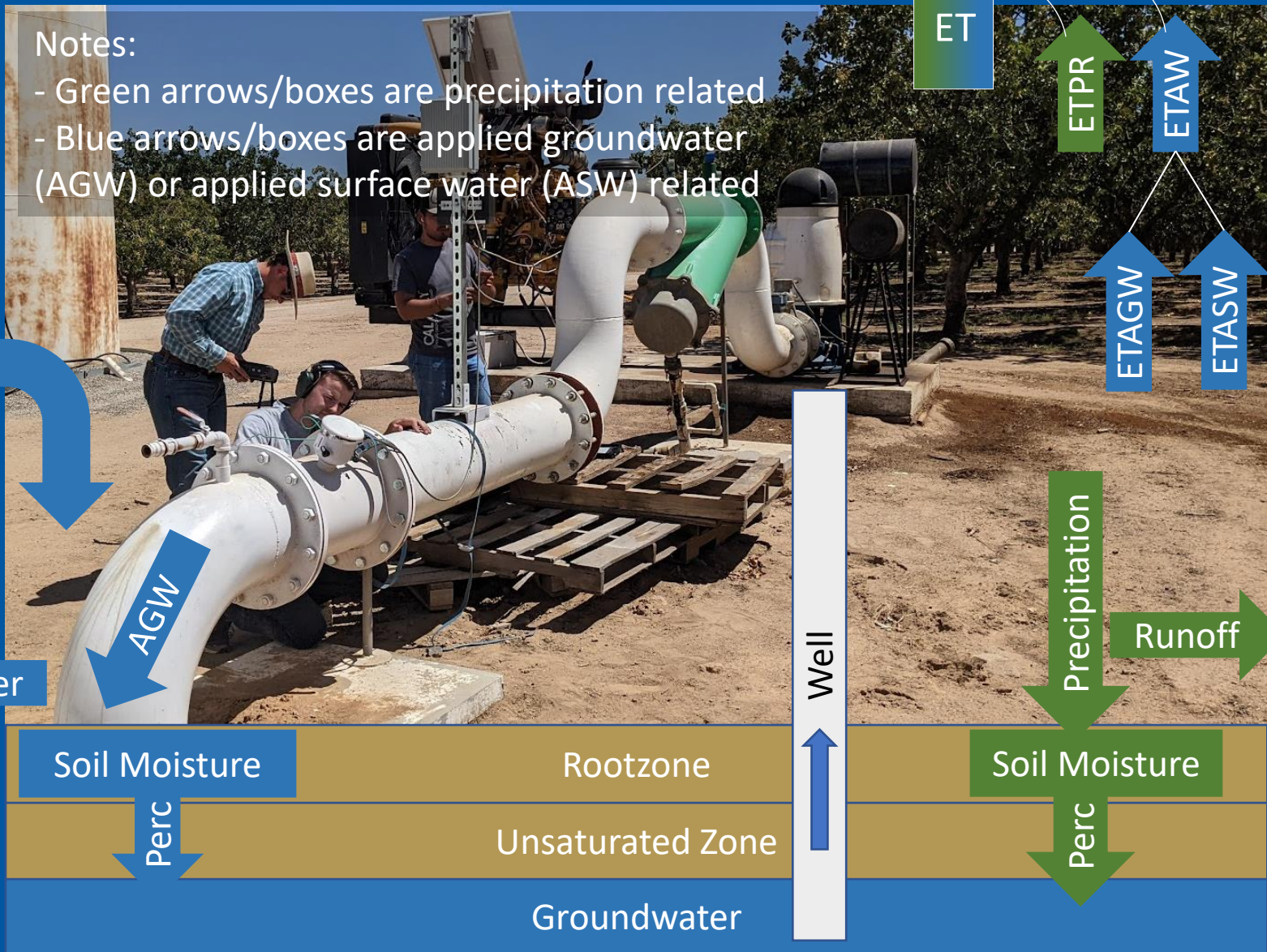
# Implement and Refine Methods: Data Inputs, Management, and Quantification of ETAW

1. Three Methods: Flowmeters, IrriWatch, and Land IQ.
2. For each, we'll present:
  1. Overview of measurement method.
  2. Source data and calculations.
  3. Benefits and drawbacks.

# Objective 2

## Methods

- Groundwater Allocation is based off of ETAW.
- Flowmeters measure AW (AGW and ASW).
- IrriWatch measures ET and calculates ETPR and ETAW.
- Land IQ measures ET and Precipitation.



# Summary of Allocation Measurement Methods

Allocation Msmt Method	Description <sup>1</sup>	Benefits	Drawbacks
Flowmeters	Direct measurement of AW; Conversion to ETAW (CUF * AW)	1. On-the-ground measurement of water (primarily groundwater) use	1. Grower requirements <sup>2</sup> 2. Substantial work to complete QA/QC and convert from AW to ETAW 3. Flowmeter malfunctions
IrriWatch	Remote sensing measurement of ET; Conversion to and provision of ETAW (ET – ETPR)	1. No grower requirements 2. Direct provision of ETAW on a daily basis through online Grower Portal	1. Coordination with IrriWatch staff required 2. Adjustments were required in 2022 and 2023 3. Need to account for ASW
Land IQ	Remote sensing and ground-based measurement of ET and P; Conversion to ETAW (ET – ETPR)	1. No grower requirements 2. Less substantial work to complete QA/QC and convert to ETAW <sup>3</sup>	1. Provision of ET and P on monthly basis and convert from ET to ETAW 2. Data latency 3. Need to account for ASW

1. AW = Applied Water [Applied Groundwater (AGW)+ Applied Surface Water (ASW)], ETAW = Evapotranspiration of Applied Water, P = Precipitation, ETPR = ET from Precipitation.
2. Grower requirements include cost of purchase, installation and maintenance of flowmeters; annual submittal of initial information to County; and submittal of monthly flowmeter readings between 1st and 10th of the month.
3. Although the initial development of procedures was labor intensive, completing QA/QC and conversion to ETAW using existing procedures is less data intensive relative to other two accounting methodologies.

# 2024 Project Goals and Objectives

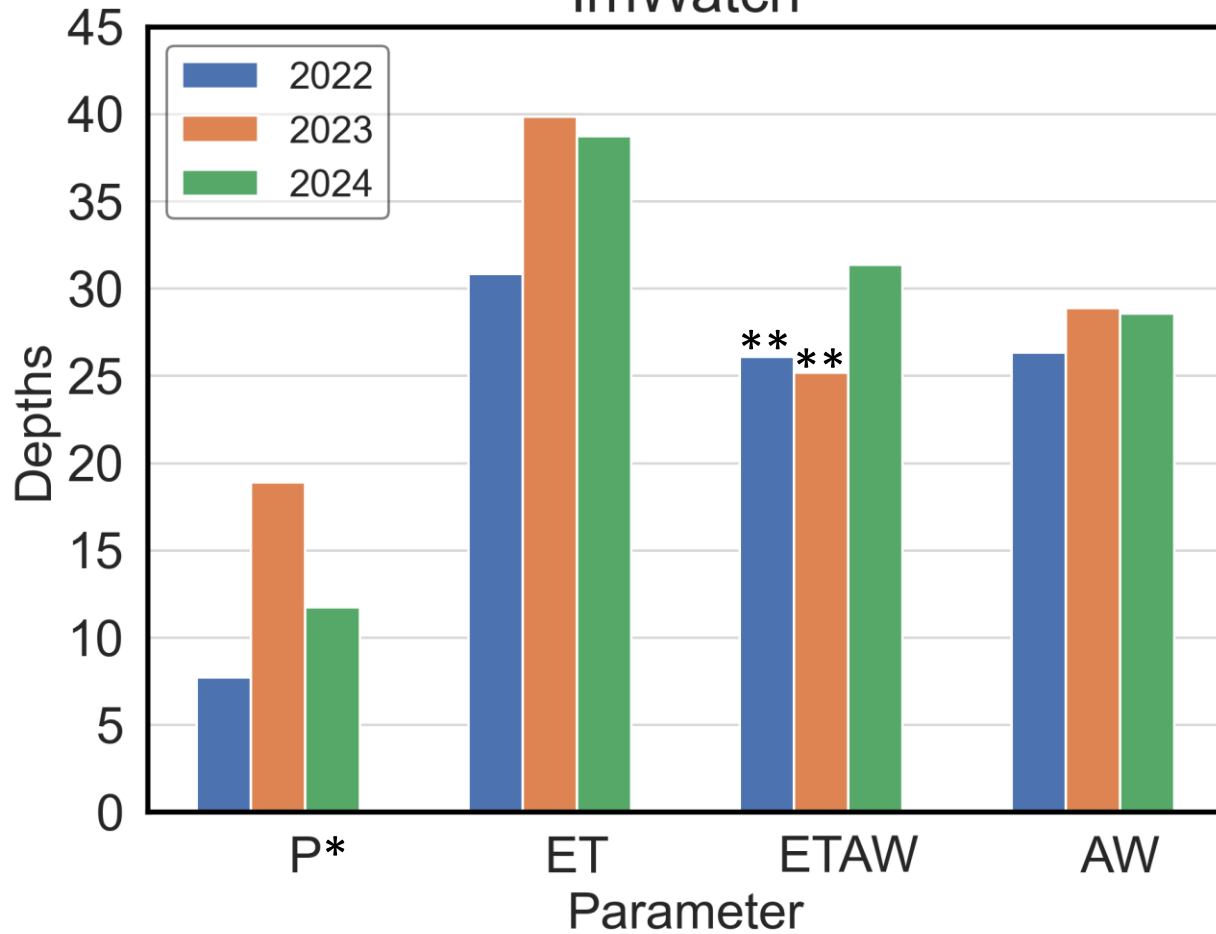
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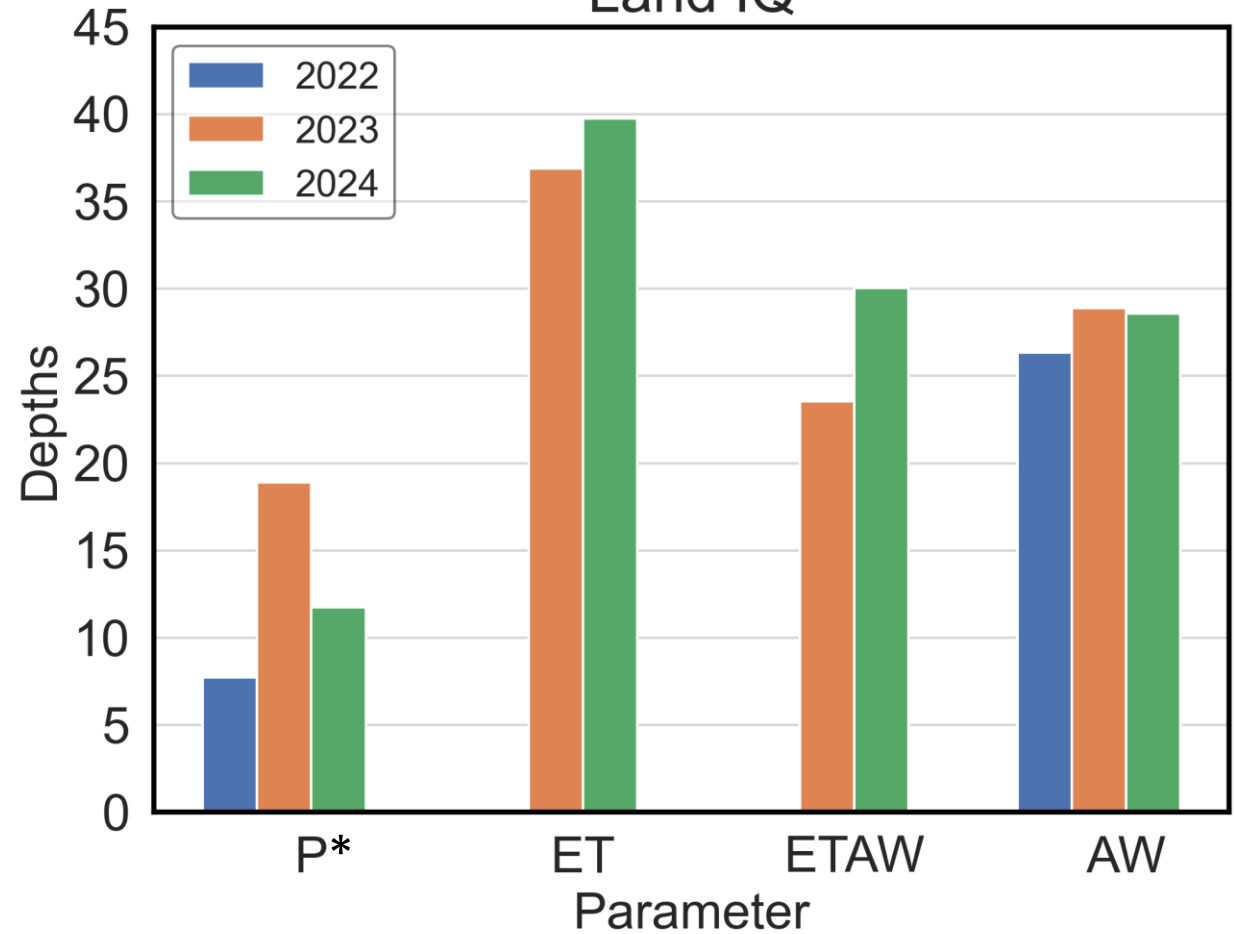
# Objective 3: Compare ETAW and AW Results

1. Developed bar charts, cumulative timeseries plots, and scatter plots to visualize ET/AW trends over time.
2. Utilized the Consumptive Use Fraction (CUF) to directly compare ETAW and AW:  $CUF = ETAW / AW$ .
3. Evaluated preliminary results by crop, irrigation method, and year.
4. Some caveats:
  1. All results are in DRAFT form and subject to change (edits are anticipated).
  2. Results shown are for January through November 2024.
  3. For some irrigation units, flowmeter readings from early 2024 still need to be incorporated into the dataset, surface water was available and used in 2024, and updates to flowmeter-field linkages may be necessary

### Cumulative Depths Across Project Years IrriWatch



### Cumulative Depths Across Project Years Land IQ

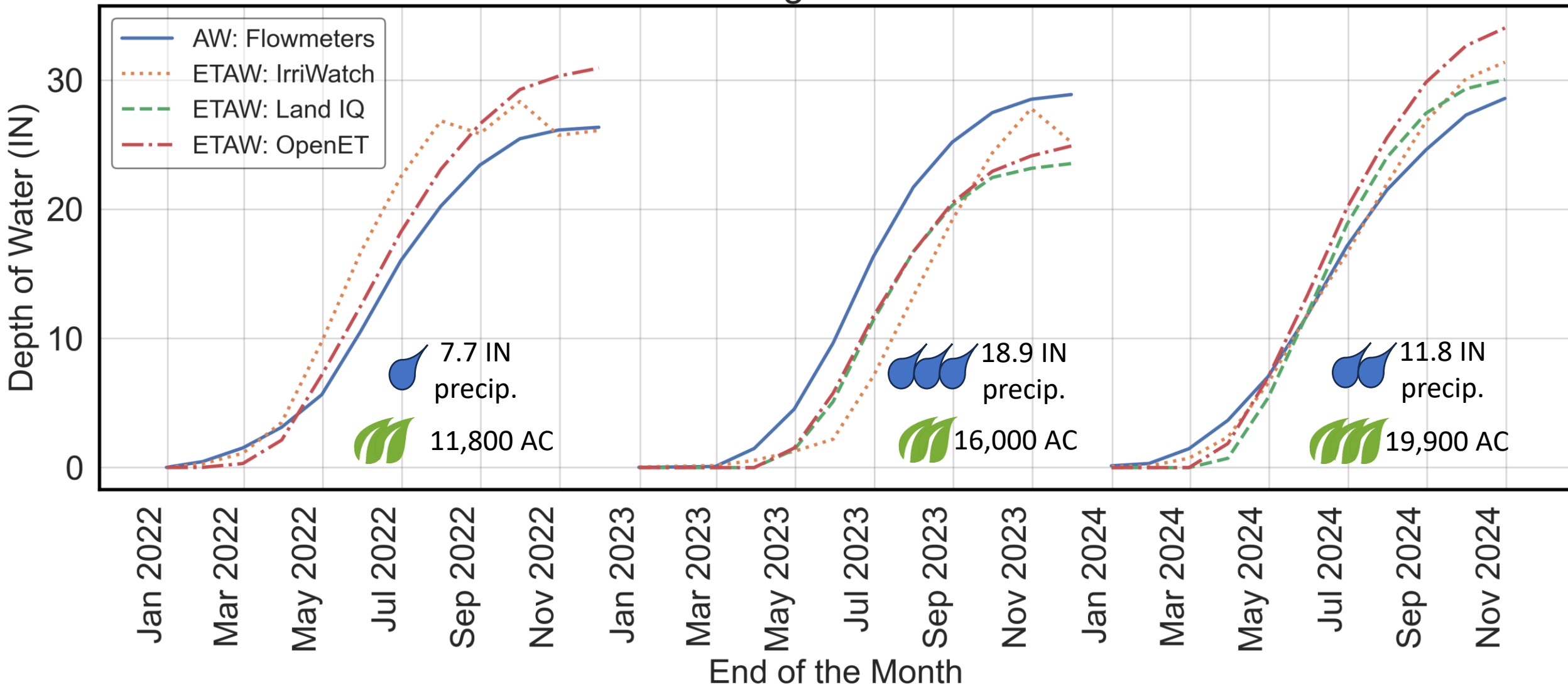


\* P = Water year precipitation

\*\*IrriWatch ETAW correction years: 2022 and 2023

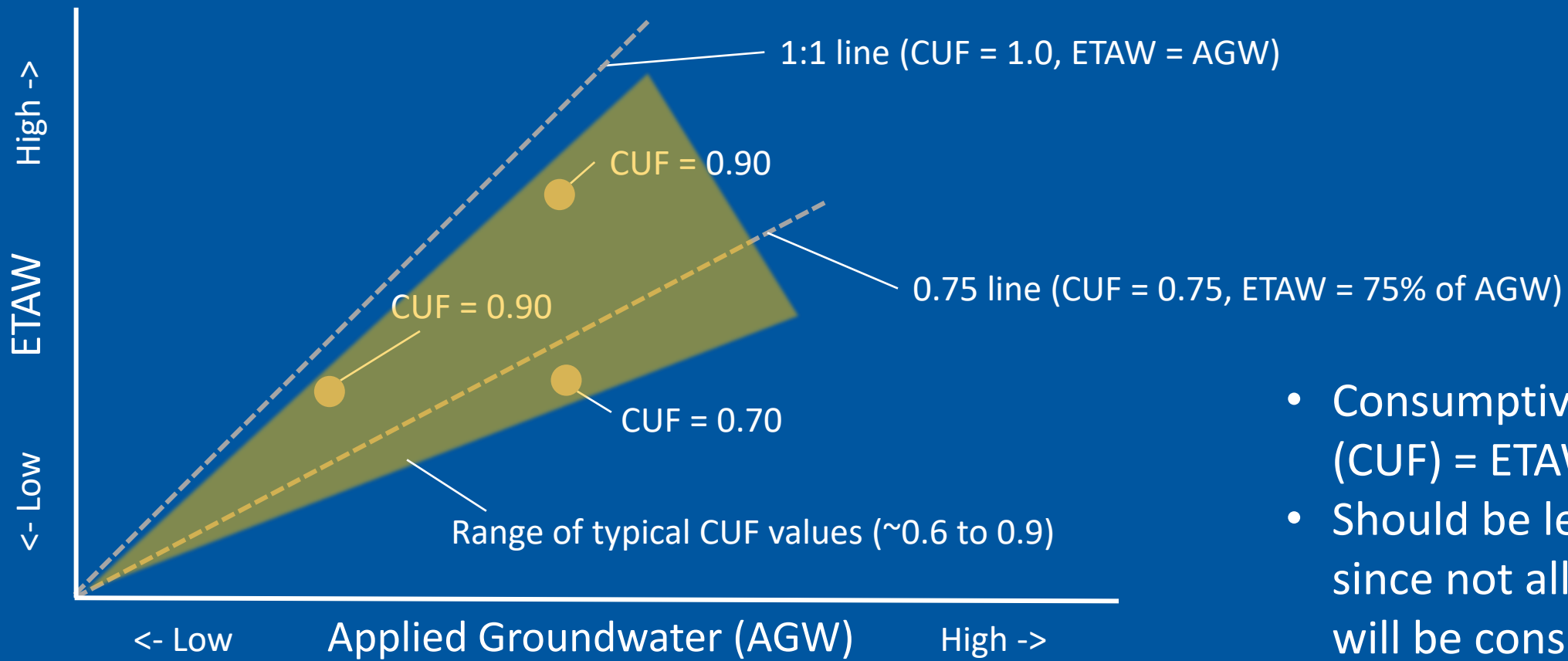


# Cumulative Timeseries (All Years) All Irrigation Units



# Objective 3

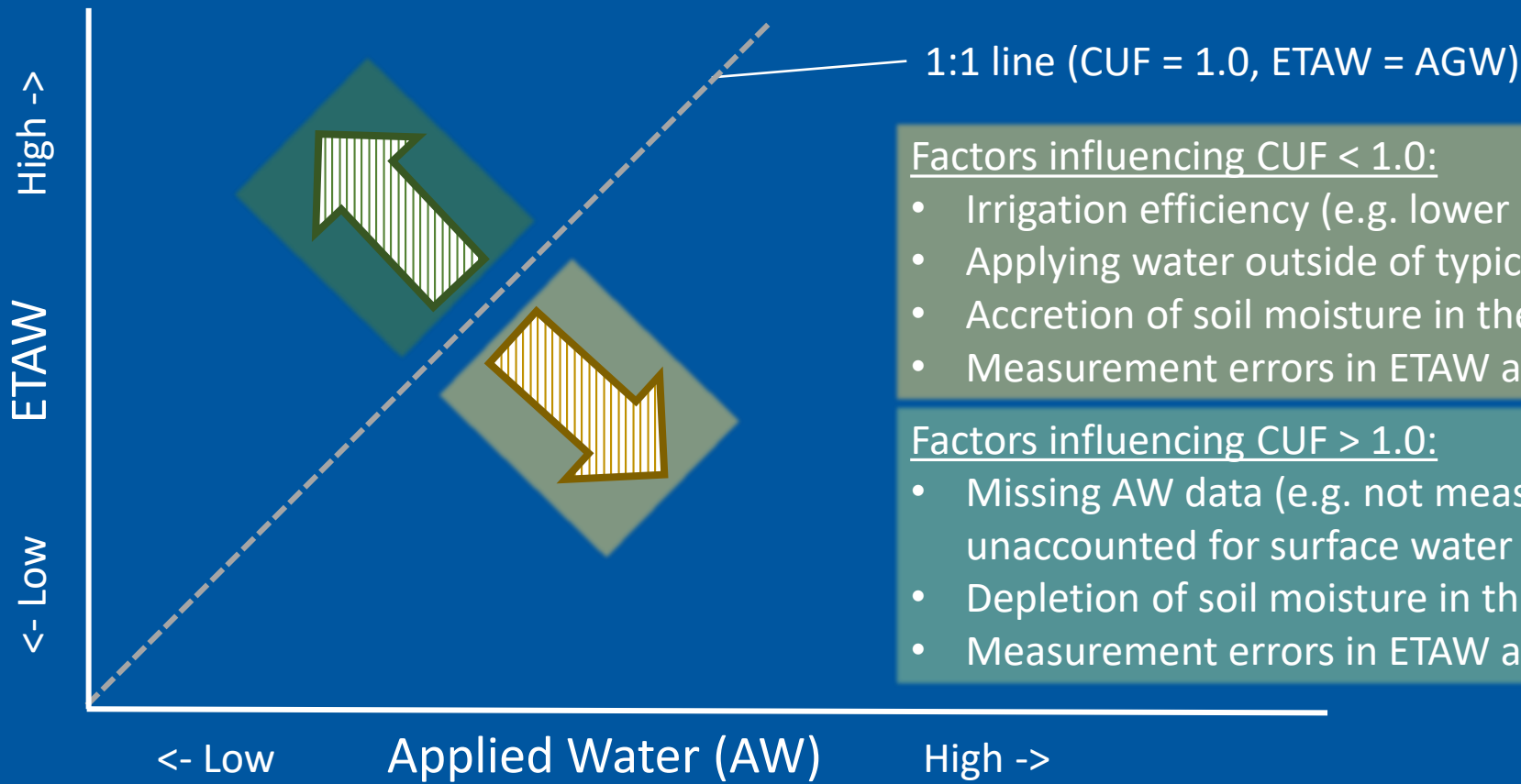
## Compare ETAW and AW Results



- Consumptive Use Fraction (CUF) =  $ETAW / AW$ .
- Should be less than one since not all water applied will be consumed.

# Objective 3

## Compare ETAW and AW Results



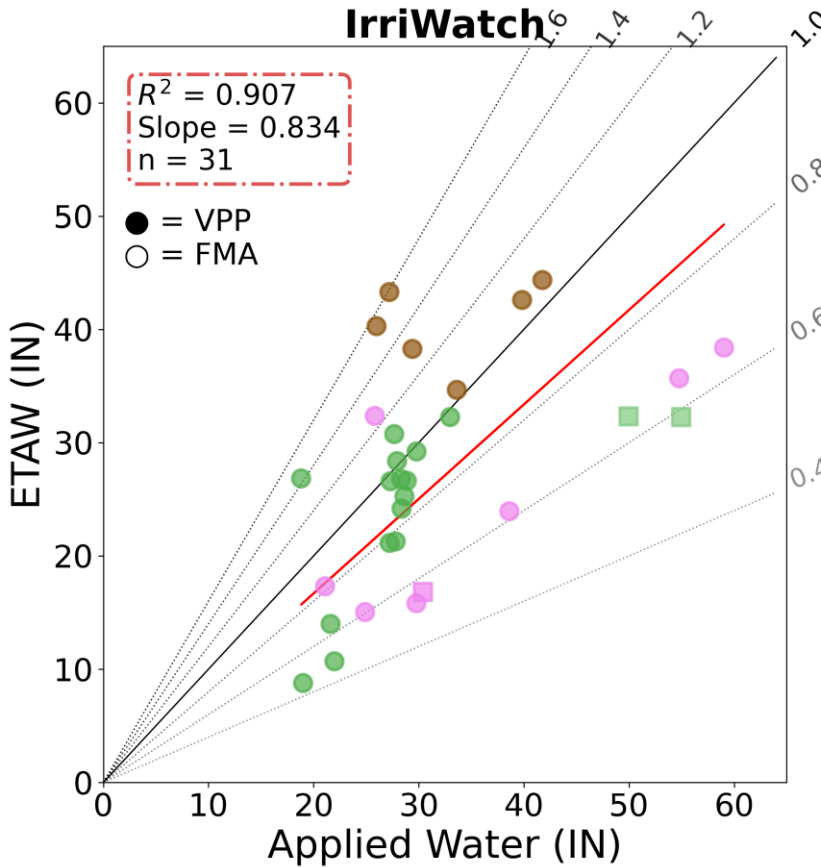
### Factors influencing CUF < 1.0:

- Irrigation efficiency (e.g. lower efficiency -> lower CUF)
- Applying water outside of typical irrigation season (e.g. low ETAW)
- Accretion of soil moisture in the root zone
- Measurement errors in ETAW and AW / IU configuration errors

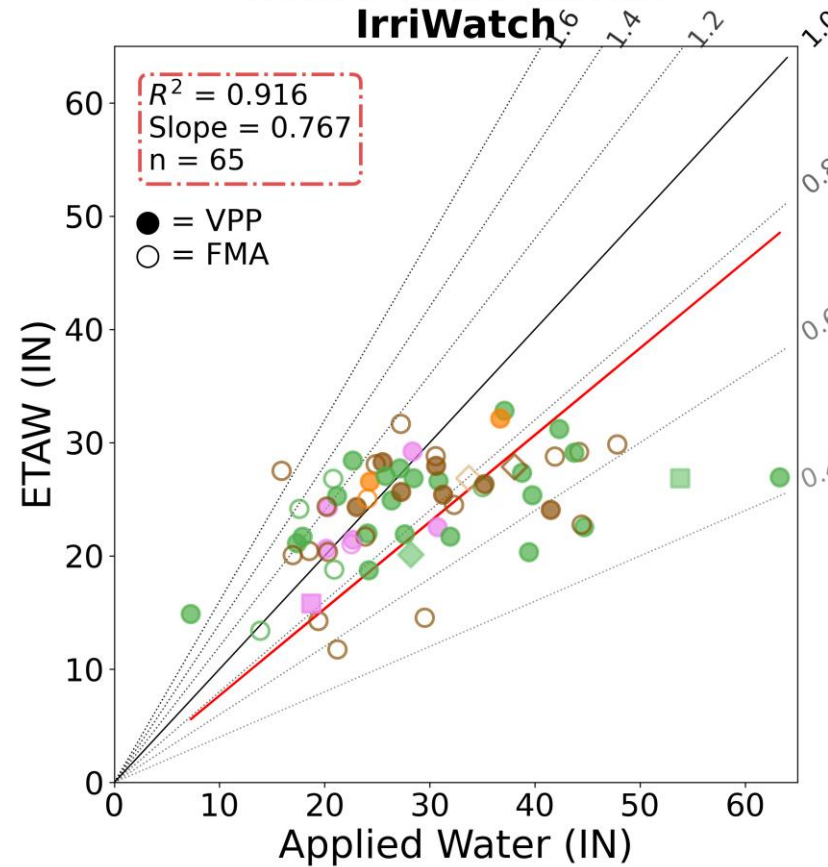
### Factors influencing CUF > 1.0:

- Missing AW data (e.g. not measuring all irrigation wells, unaccounted for surface water usage)
- Depletion of soil moisture in the root zone
- Measurement errors in ETAW and AW / IU configuration errors

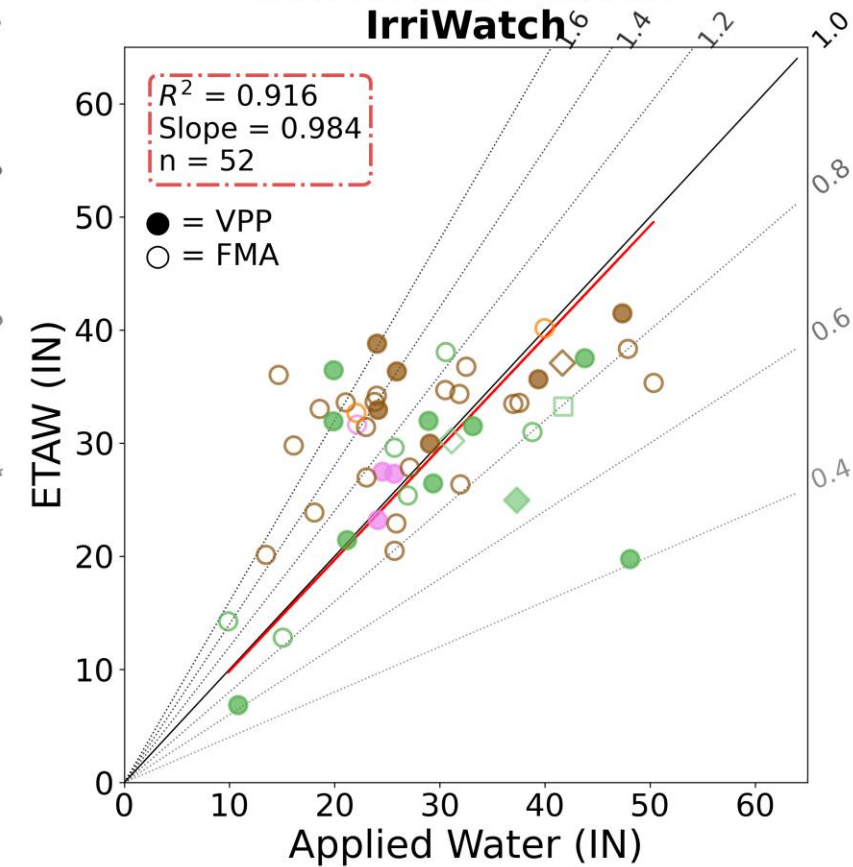
### 2022: ETAW vs. AW IrriWatch



### 2023: ETAW vs. AW IrriWatch



### 2024: ETAW vs. AW IrriWatch



- Primary Crop: ● Alfalfa ● Almonds ● Citrus ● Grapes ● Pistachios ● Wheat  
 Primary Irrigation Method: ◆ Border ● Drip/Micro-Spr. ■ Flood/Furrow

2022: Critically Dry Year

2023: Wet Year

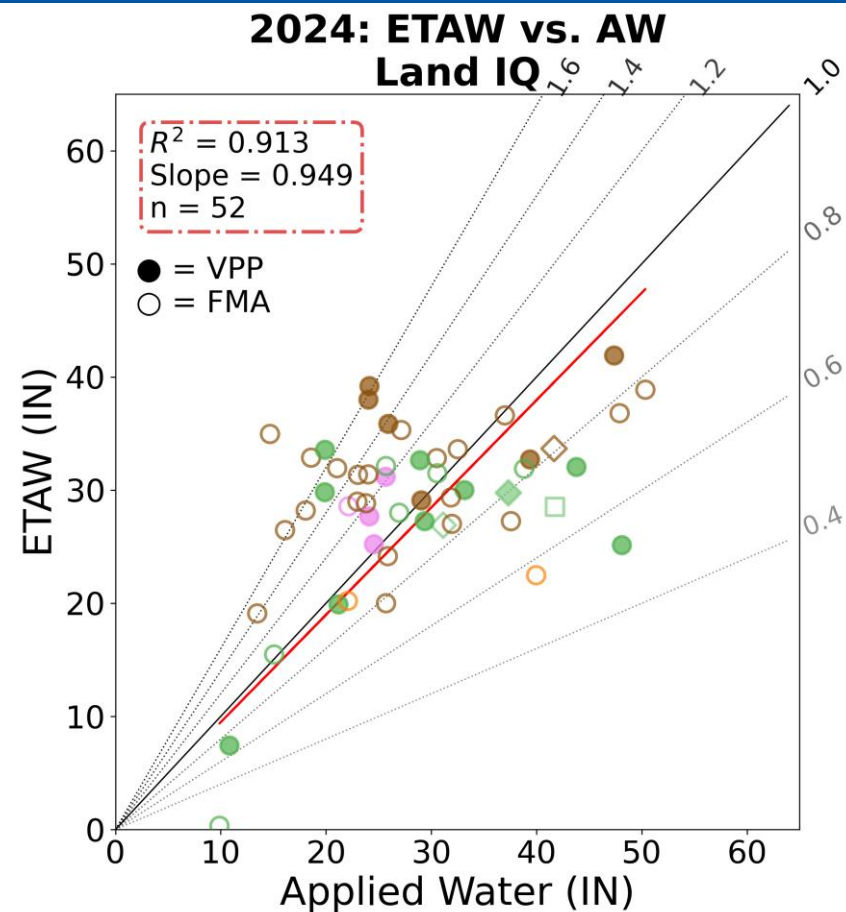
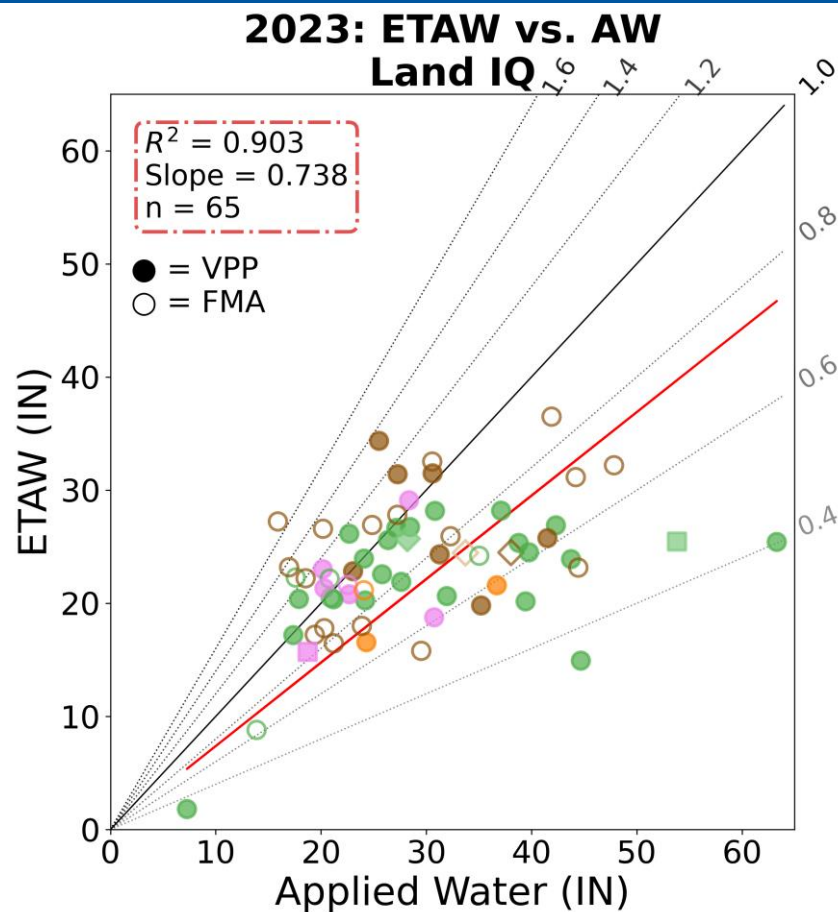
2024: "Normal" Year

VPP = Verification Project Participant

FMA = Flowmeter Account

CUF = ETAW / AGW

No Land IQ data available for 2022



Primary Crop



Alfalfa



Almonds



Citrus



Grapes



Pistachios



Wheat

Primary Irrigation Method



Border



Drip/Micro-Spr.



Flood/Furrow

2022: Critically Dry Year

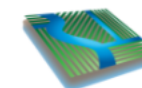
2023: Wet Year

2024: "Normal" Year

VPP = Verification Project Participant

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1. New goal and objective for 2025 Verification Project.

# 2024 Verification Project Conclusions and Recommendations

1. Hiring of Water Resource Specialists (WRS) has improved grower engagement, education and outreach; WRS contributions to the 2024 Verification Project substantially reduced costs relative to prior years (*Objectives 1 and 5*).
2. Flowmeters remain accurate for measurement of AGW if installed and maintained correctly. However, every year flowmeters in the project have malfunctioned and inaccurately quantified AGW volumes (*Objective 2*).
3. Remote sensing provides spatially-explicit data on a large spatial scale, but requires conversion from ET to ETAW<sup>1</sup> and has variability that should be further studied to improve understanding of influencing factors (*Objective 2*).

1. This also requires accounting for ETAW from groundwater and surface water (i.e., ETAGW and ETASW).

# 2024 Verification Project Conclusions and Recommendations continued

1. There continues to be substantial variability when comparing remotely-sensed ETAW from IrriWatch and Land IQ (and Open ET) to flowmeter measurements of AGW across cropping, irrigation unit size, and years (*Objective 3*).
2. The 2024 results for remote sensing showed an increase in ETAW over 2022-2023 (across all methods) that requires more investigation<sup>1</sup> to be fully understood. Volumes measured through flowmeters have been consistent, relative to remote sensing results (*Objective 3*).
3. Accounting for groundwater use is of statewide importance; Madera County should look for opportunities for regional and/or statewide participation in any emerging Groundwater Demand Management (GDM) networks (*Objective 4*).
4. Training of WRS to support the groundwater allocation program should continue, including increasing responsibilities in any potential future variations of the Verification Project (*Objective 5*).

1. Additional investigations include evaluating soil moisture storage over time, effective precipitation (ETPR), and ground-based evapotranspiration measurements.





# Questions & Discussion