Agricultural Water Reuse: Impediments and Incentives

WRRF 15-08

Anne Thebo
Senior Research Associate
Pacific Institute

Kara Nelson
Professor
UC Berkeley

Bahman Sheikh
Water Reuse Consultant
Water Reuse Consulting

Co-Authors

- Ted Gardner
- Jim Kelly
- Brent Haddad
- Avner Adin
- Shannon Spurlock
- Ryujiro Tsuchihashi

Partners

- Monterey Regional Water Pollution Control Agency
- OceanMist Farms
- City of Santa Rosa
- Dublin San Ramon Services District
- Denver Water
- Denver Urban Gardens
- Idaho Department of Environmental Quality
- Water Environment and Reuse Foundation
  - Kristan VandenHeuvel, Project Officer

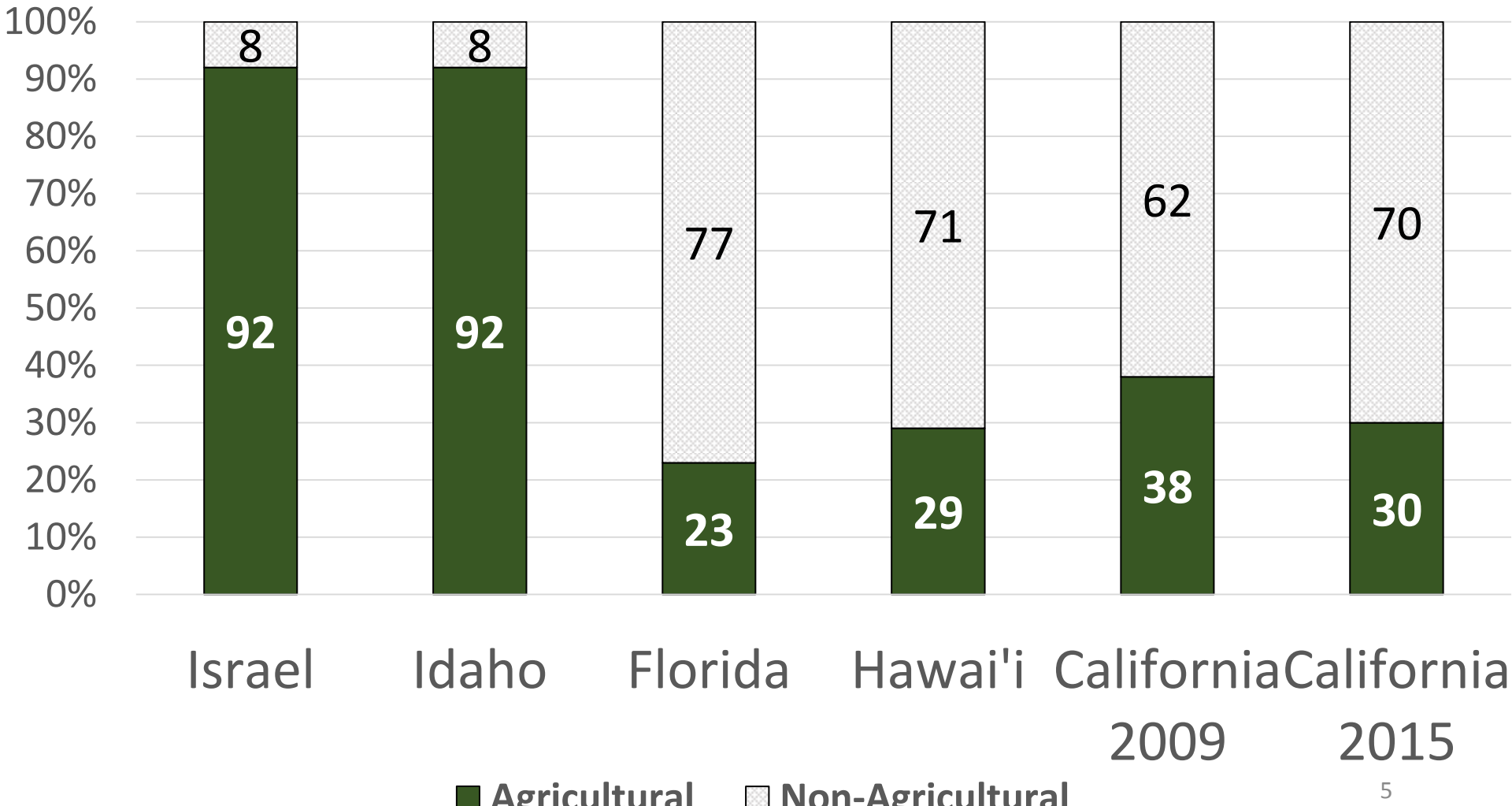
Technical Advisors: Prof. Takashi Asano, Prof. Rafael Mujeriego

Project Sponsors

Project Objectives

- Define Status of Use of Recycled Water in Agriculture
- Identify impediments and incentives to agricultural reuse
- Assess opportunities to increase agricultural reuse in US
- Recommend strategies to facilitate agricultural reuse

Agriculture Use of Recycled Water



Approach

Diverse Methods

- Literature Review
- Stakeholder workshop and break-out sessions
- Review of utility documentation
- Detailed interviews
- National geospatial assessment

Broad Geographic Scope

- United States
  - California
  - Idaho
  - Florida
- Australia
- Israel and Middle East
- Japan

Presentation Overview

- Status of Agricultural Use of Recycled Water
- Spatial Analysis (GIS)
- Case Studies
  - Impediments, Challenges, Obstacles
  - Incentives, Drivers, Subsidies, Encouragements
- Conclusions and Recommendations

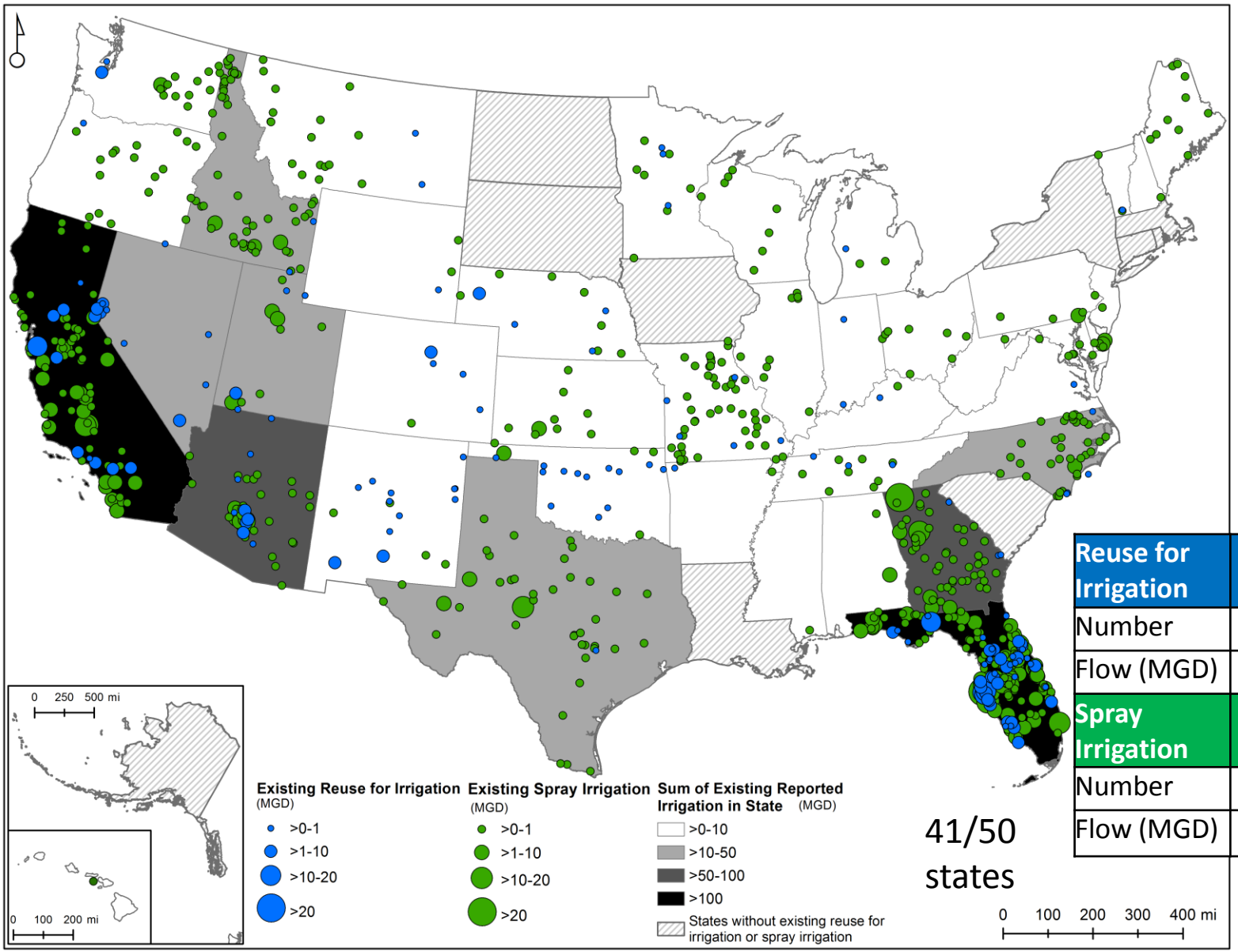
Motivation for a National Assessment of Agricultural Reuse

- Water reuse is an important component of the sustainable management of:

  Water Quantity AND Water Quality

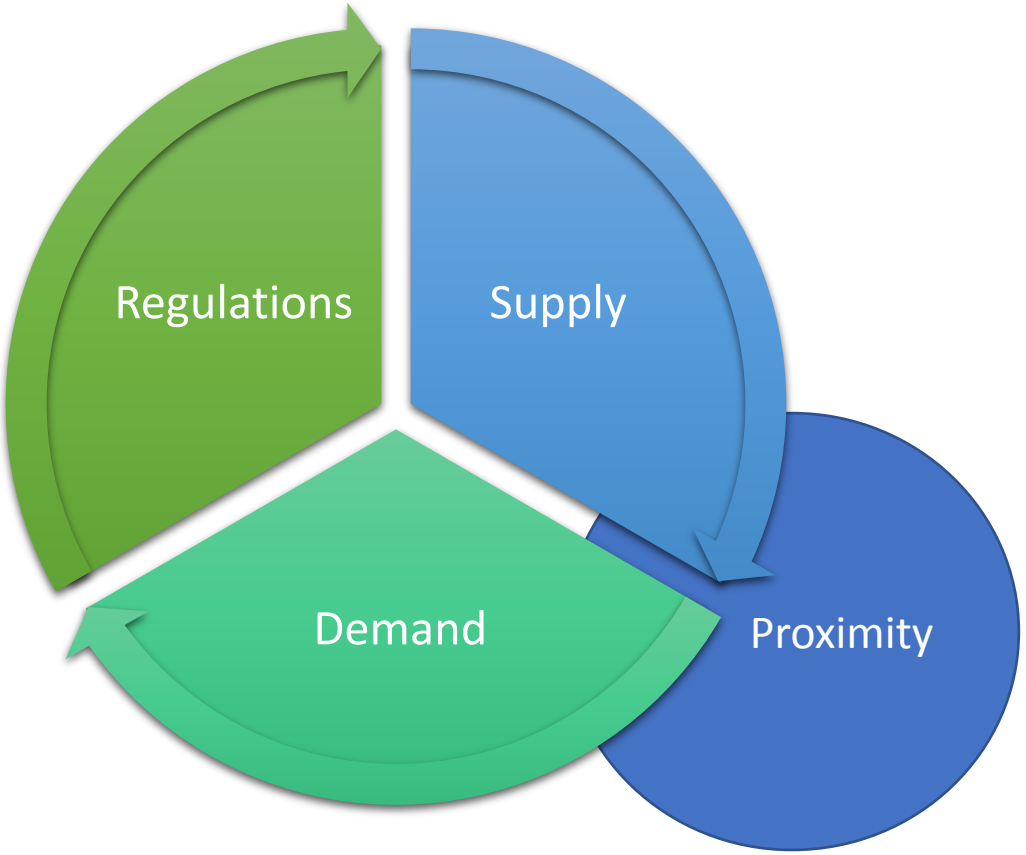
- Drivers and impediments spatially heterogeneous
- No nationally consistent inventory of water reuse
  - A few high quality state inventories (CA, AZ, FL)
- Agriculture is a major of consumptive use

What is the current extent of reuse for irrigation in the US?



Reuse for Irrigation	Existing (1-yr Avg)	Projected Design
Number	153	210
Flow (MGD)	234	652
Spray Irrigation	**Existing (1-yr Avg)**	**Projected Design**
Number	638	712
Flow (MGD)	587	1212

What is the potential for agricultural use of recycled water?



Defining Metrics for Evaluating Potential for Agricultural Reuse

Utilities

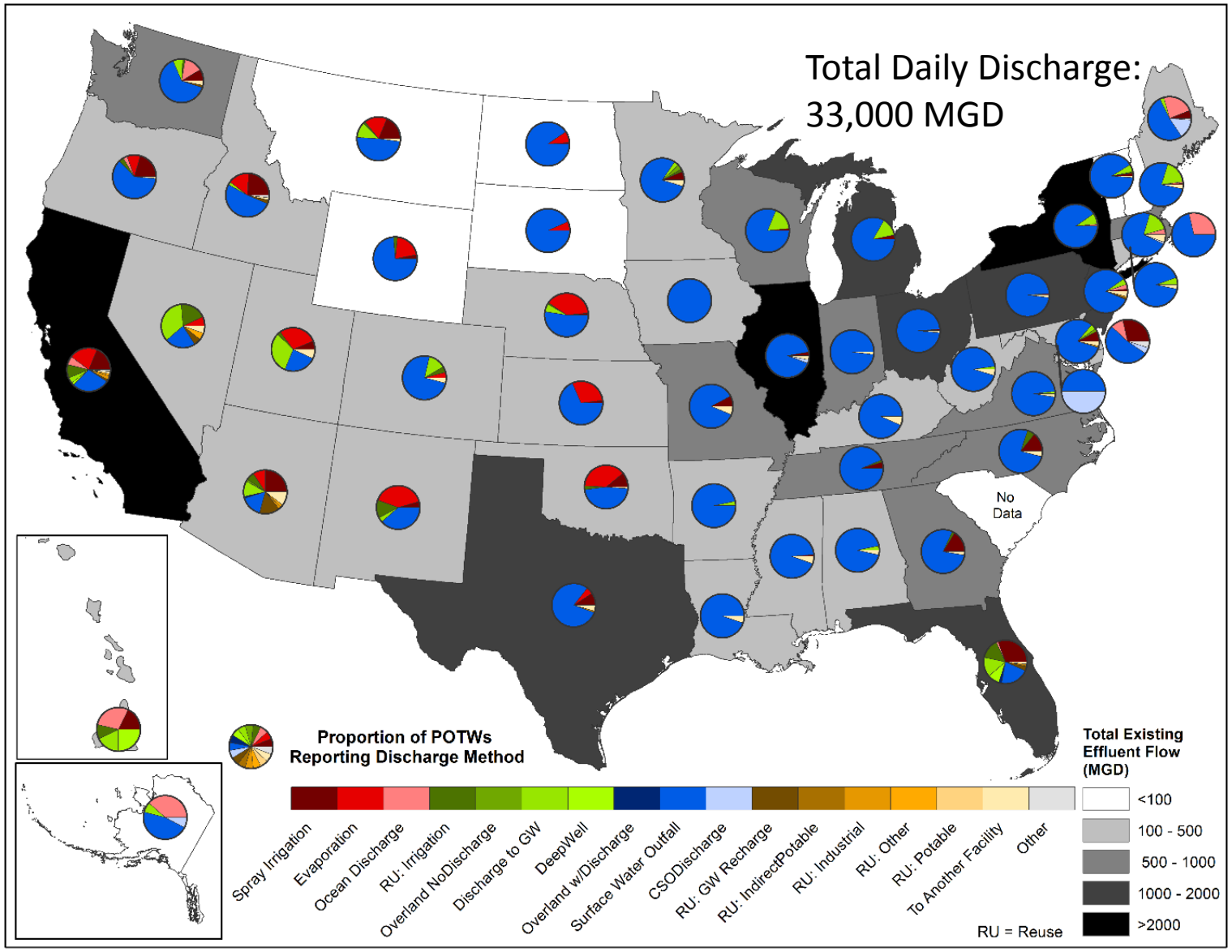
- Is there demand for recycled water in local agriculture?
- What is the distance to potential customers? (cost of distribution)
- Can installed technology meet WQ needs/regulations?
- What financing is available for infrastructure?

Growers

- How much recycled water can be supplied?
- What crops can be grown with recycled water?
- What is the cost and reliability of recycled water?
- What is the quality of recycled water relative to existing sources?

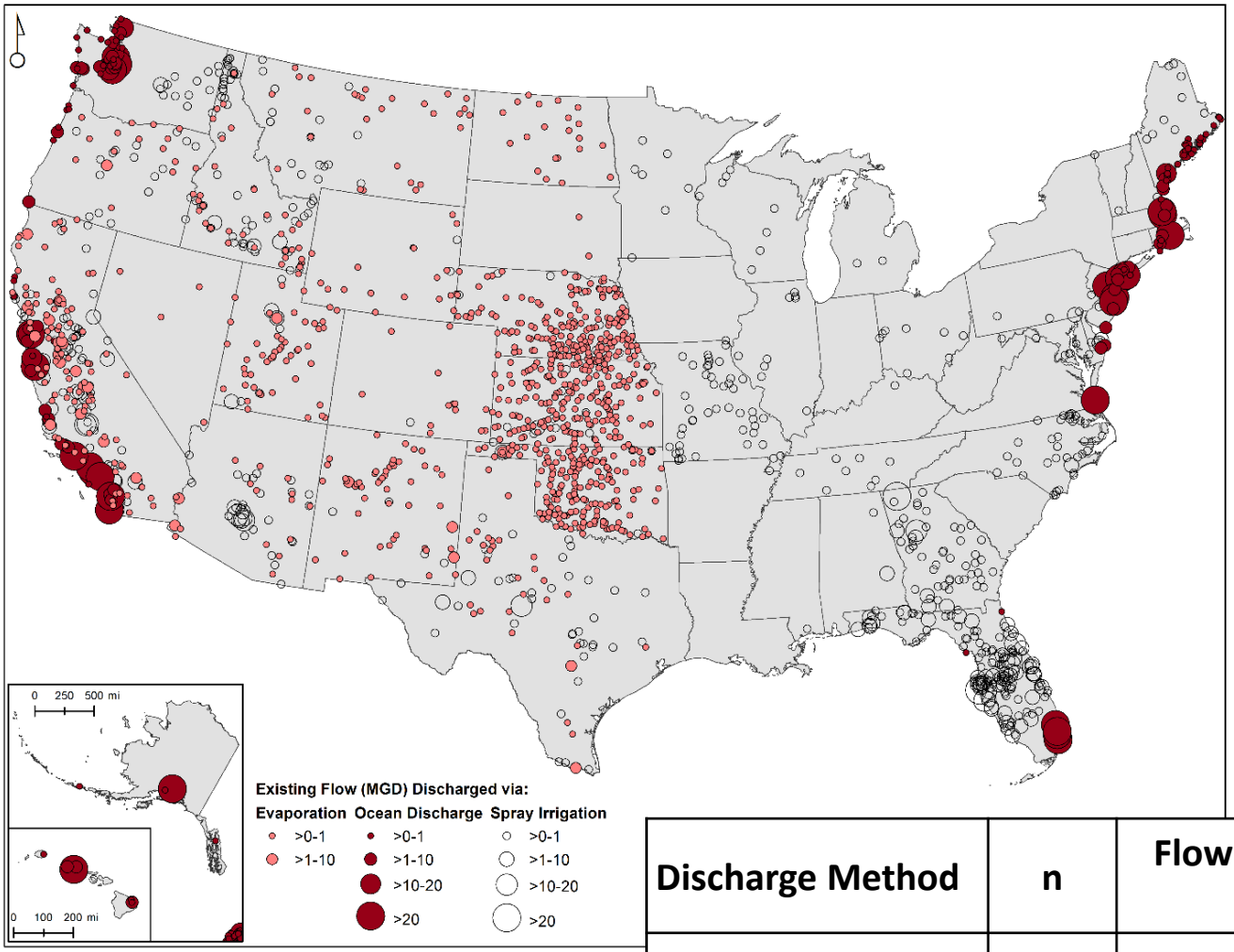
What are the state regulations governing agricultural reuse?

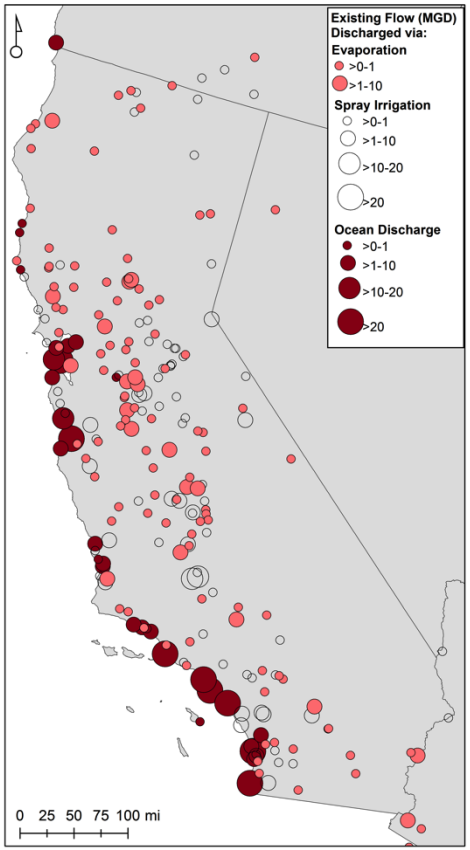
Where is treated wastewater discharged across the United States?



Data: 2012 EPA Clean Watersheds Needs Survey

What quantities of effluent are discharged via methods with a high potential for reuse?

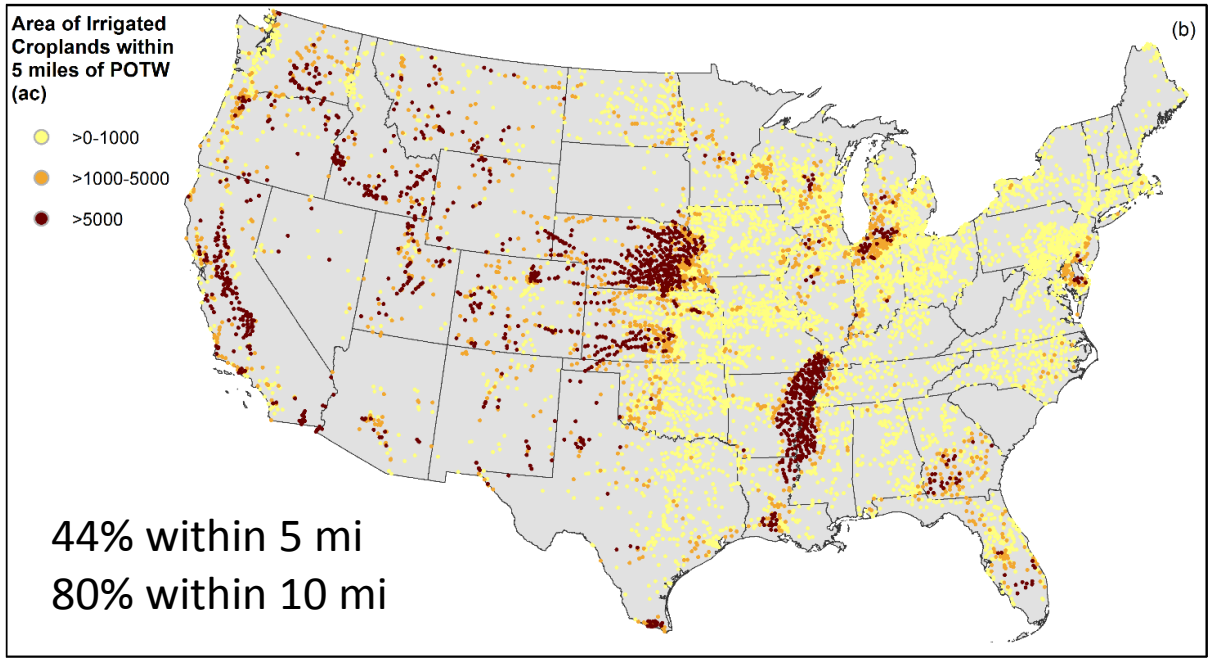




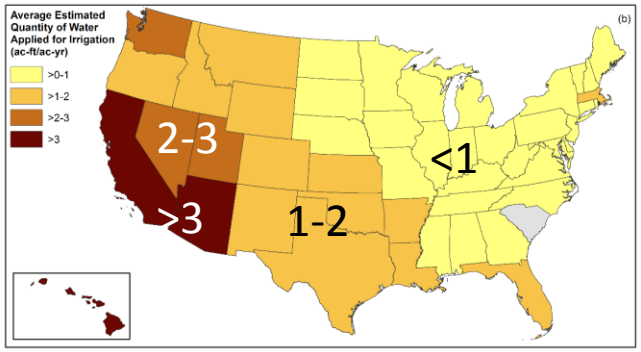
1 MGD =
3785 m^3/d =
1120.1 AFY

Discharge Method	n	Flow Discharged (MGD)
Evaporation	939	166
Ocean Discharge	183	3104
Spray Irrigation	638	586

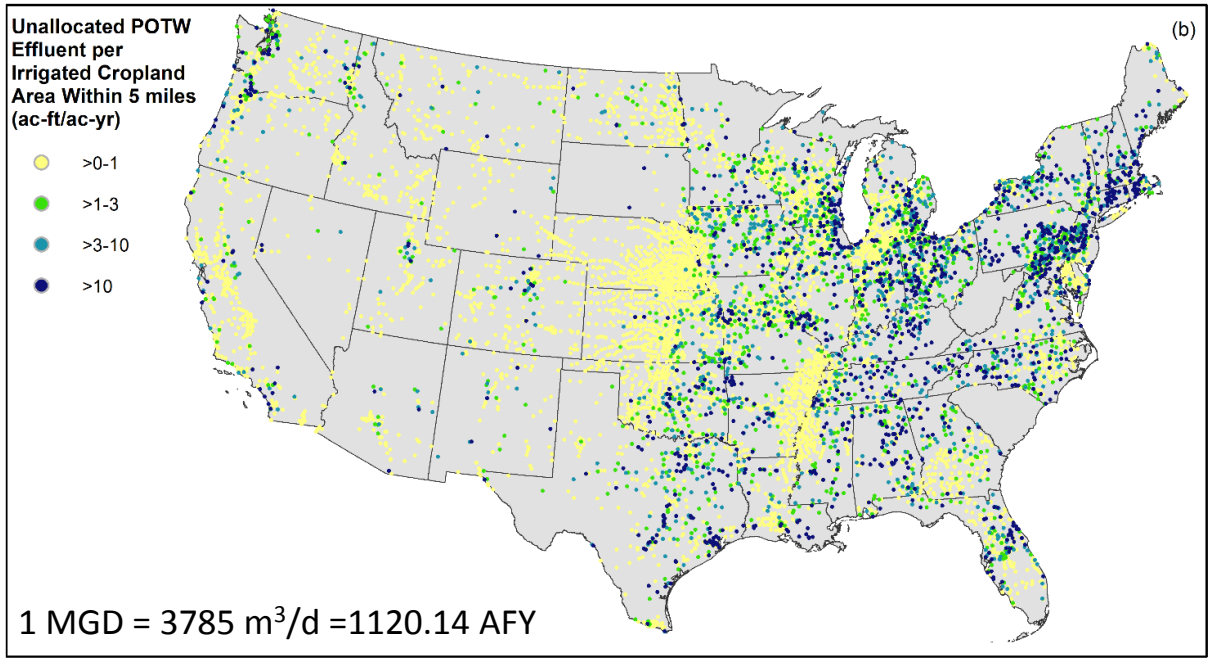
Where are irrigated croplands located relative to POTWs?



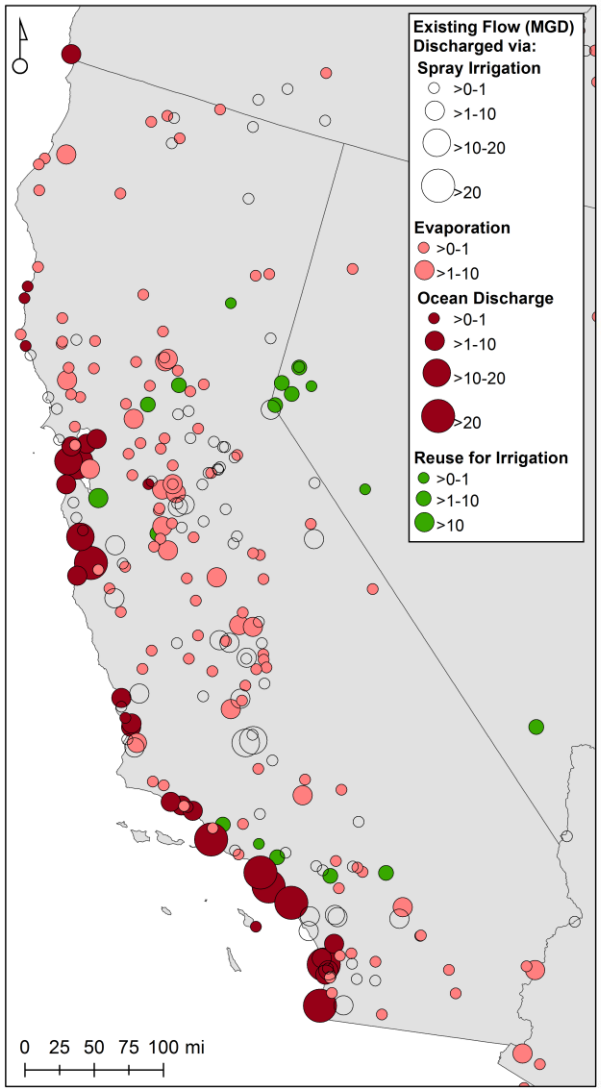
Avg Quantity of Water Applied (AFY/ac)

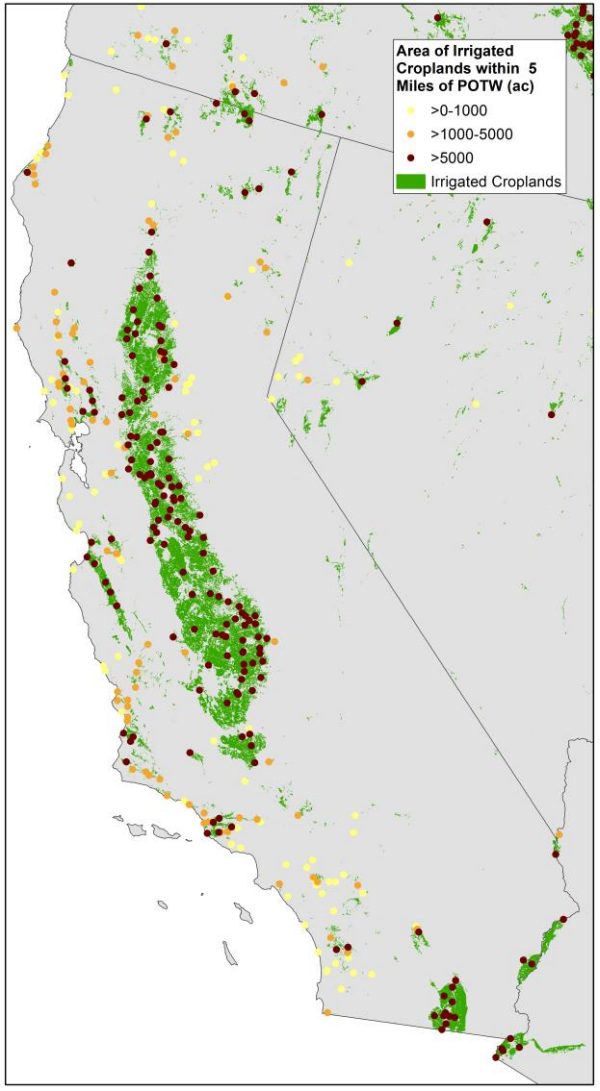


Ratio of Unallocated Flow to Irrigated Cropland Area



Potential for Increased Agricultural Reuse in California





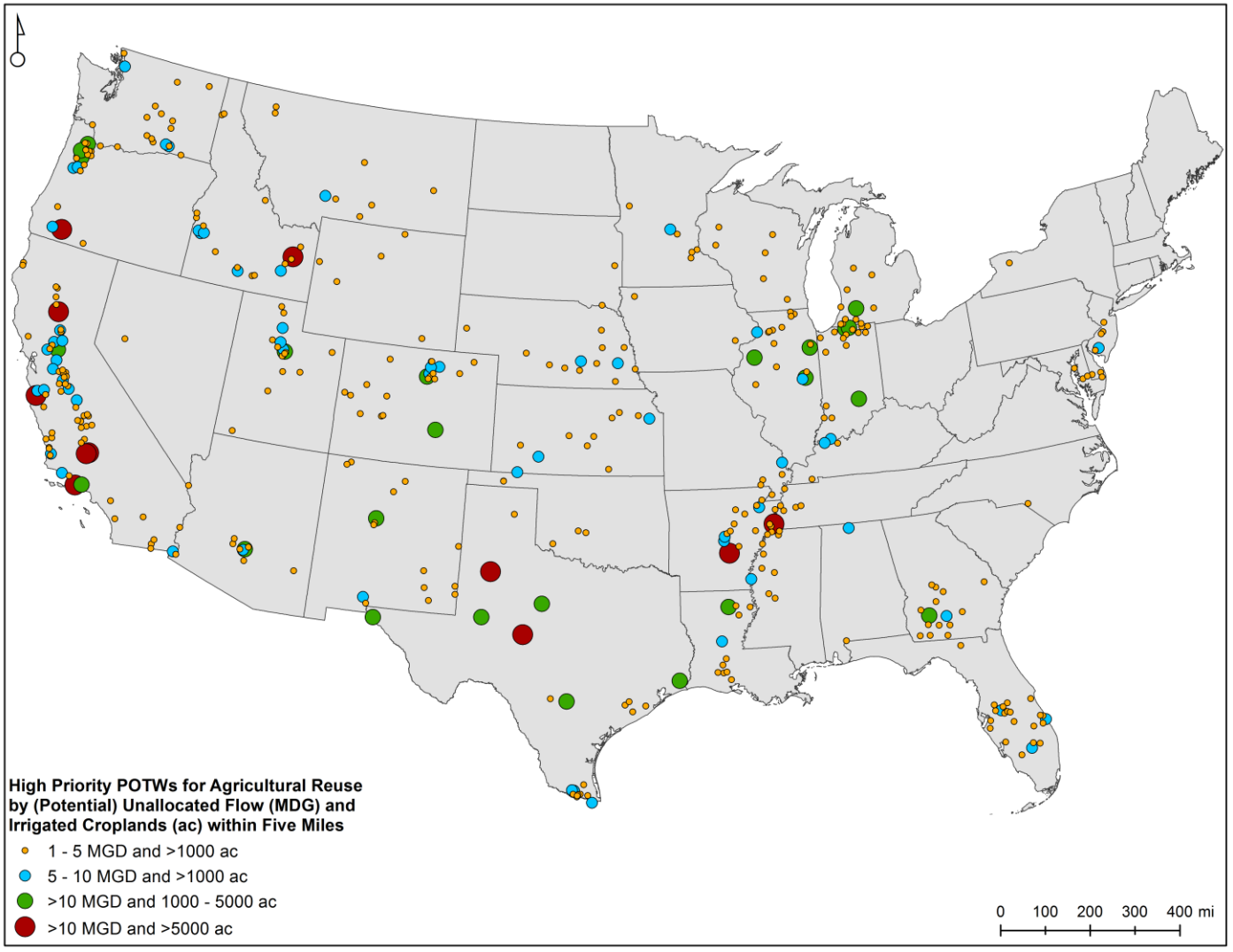
SWRCB Recycled Water Mandates

2020: 1.169 MAF

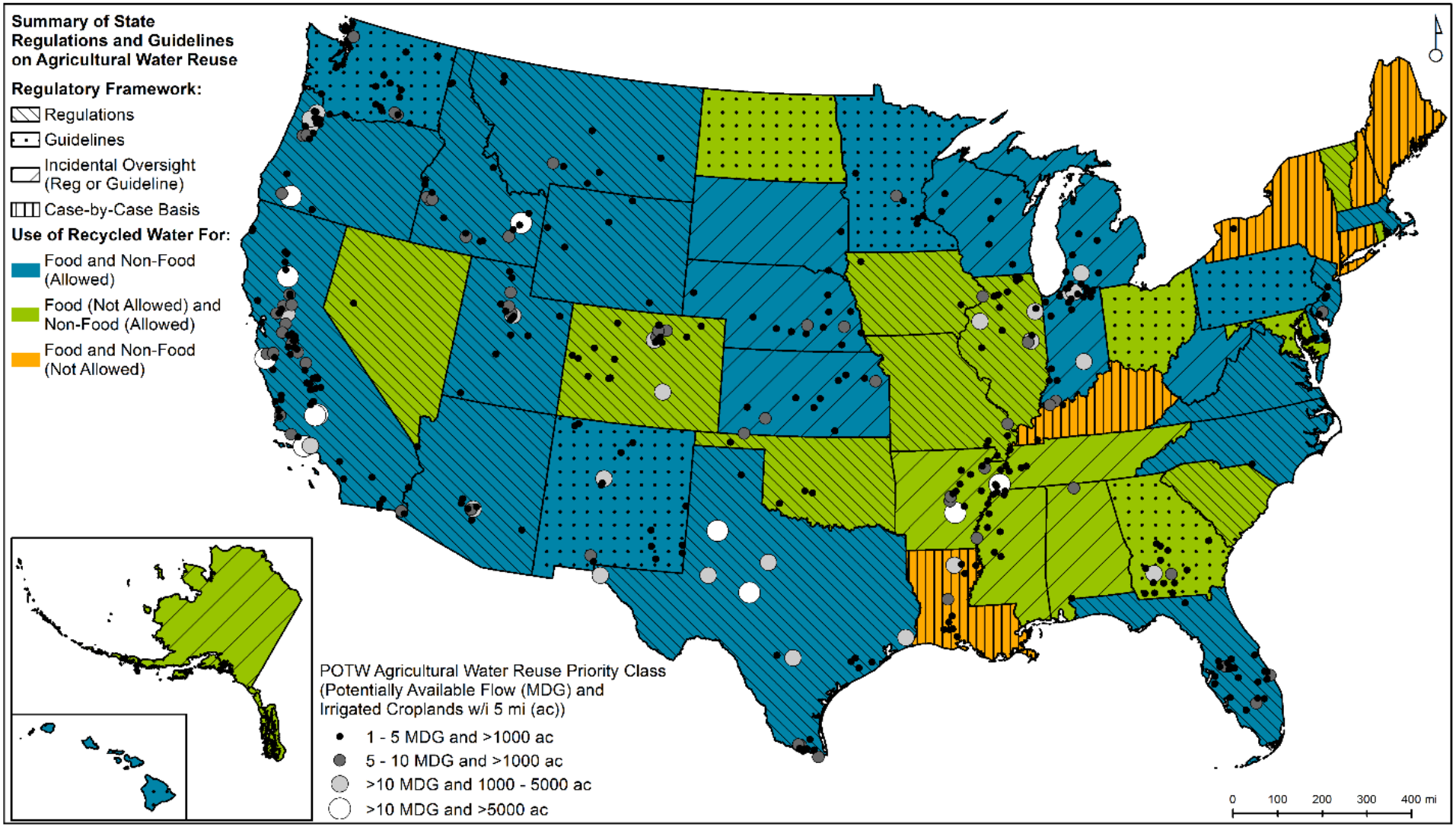
2030: 2.525 MAF

Discharge Method	n	Existing Flow (MGD)	Existing Flow (MAFY)	% RW Mandate	
				2020	2030
Evaporation	117	71	0.08	9.1	6.8
Ocean Discharge	35	1,330	1.50	171.5	127.5
Spray Irrigation	80	110	0.12	14.2	10.5
Surface Water	104	744	0.83	95.9	71.3
Potentially Unallocated	376	2,315	2.60	298.4	221.8
All Existing Effluent	499	3,516	3.94	453.2	336.9

POTWs with a High Potential for Agricultural Reuse



US Agricultural Reuse Regulations



Number of States and Territories by Allowable Uses:

Food + Non-Food: 26; Non-Food: 19; Not Allowed: 7

Regulation of Agricultural Reuse in California

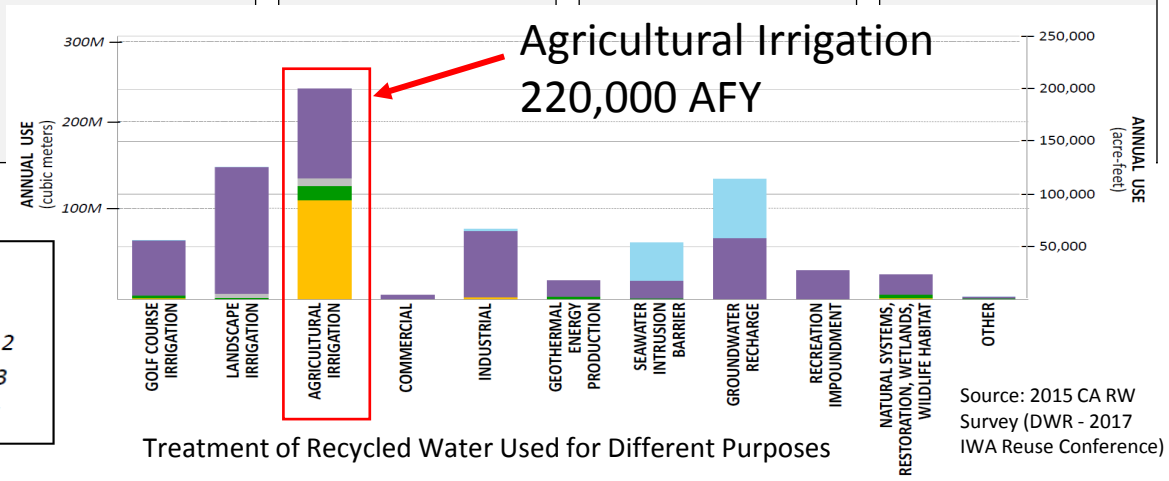
Agricultural Uses of Recycled Water	Treatment Level: Disinfected Tertiary Recycled Water	Disinfected Secondary 2.2 Recycled Water	Disinfected Secondary 23 Recycled Water	Undisinfected Secondary Recycled Water
Food crops where recycled water contacts the edible portion of the crop, including all root crops	Allowed	Not Allowed	Not Allowed	Not Allowed
Food crops, surface-irrigated, above-ground edible portion, not contacted by recycled water		Allowed		
Ornamental nursery stock and sod farms with unrestricted public access			Allowed	
Pasture for milk animals for human consumption				
Orchards and vineyards with no contact between edible portion and recycled water				Allowed
Non food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest				
Fodder and fiber crops and pasture for animals not producing milk for human consumption				
Seed crops not eaten by humans				
Food crops undergoing commercial pathogen-destroying processing before consumption by humans				
Ornamental nursery stock, sod farms not irrigated less than 14 days before harvest				

Food

Types of crops that can be irrigated

Non-Food

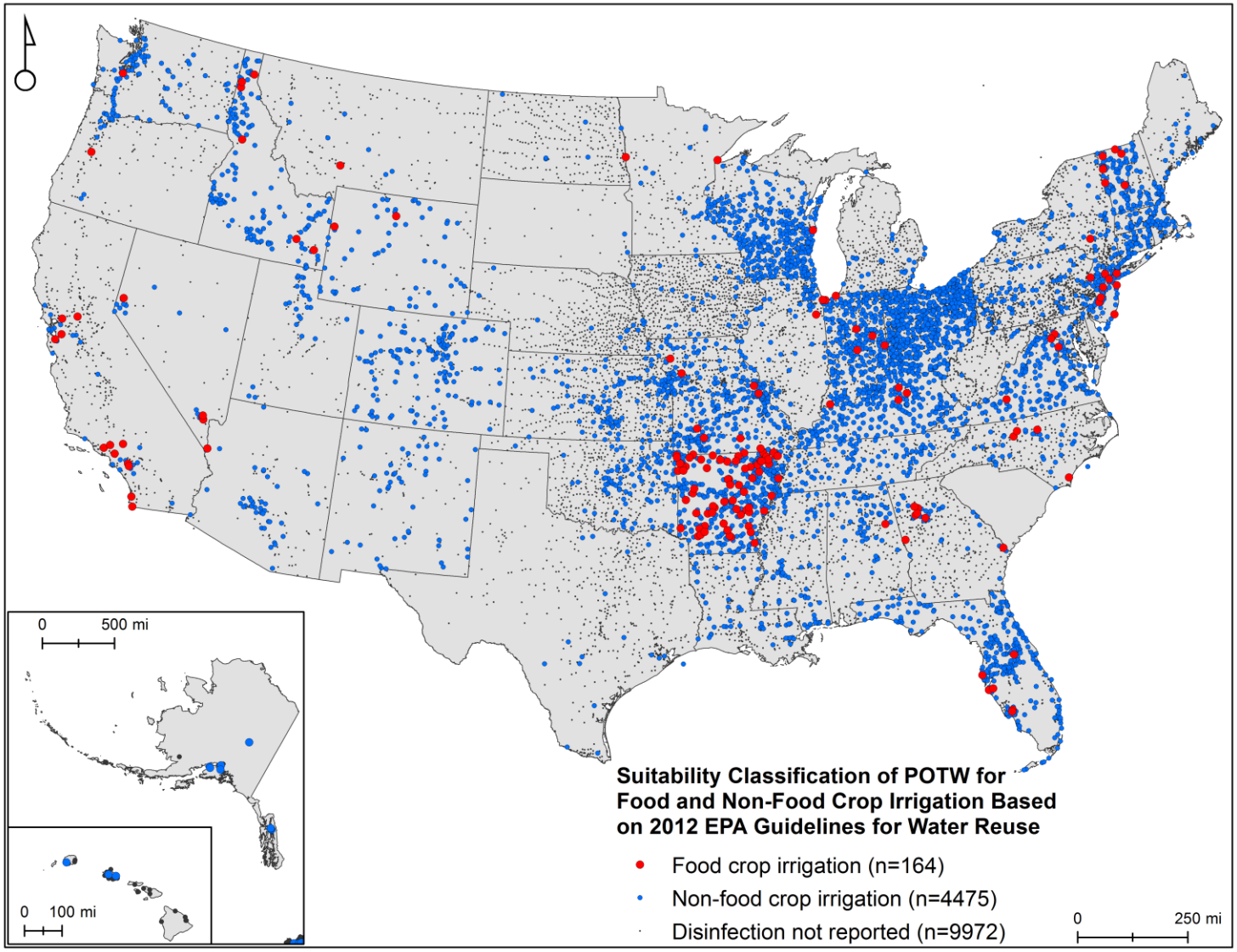
Increasing Levels of Treatment (and Energy Requirements)



Treatment of Recycled Water Used for Different Purposes

Source: 2015 CA RW Survey (DWR - 2017 IWA Reuse Conference)

Types of Crops that Could be Irrigated with Existing WW Treatment Infrastructure



2012 EPA Treatment Guidelines for Ag Reuse:

Food = Filtration + Secondary + Disinfection

Non-Food = Secondary + Disinfection

Note: 2012 EPA Guidelines for Water Reuse were used to define acceptable combinations of unit processes for irrigation of food or non-food crops. Not all POTWs reported details on unit processes.

Summary Statistics

- 41/50 states report some reuse for irrigation
- 33,000 MG of wastewater produced daily
- ~2% of wastewater currently used for irrigation
- 80% of irrigated croplands within 10 mi of POTW
- Existing unallocated flows in CA could meet RW targets several times over

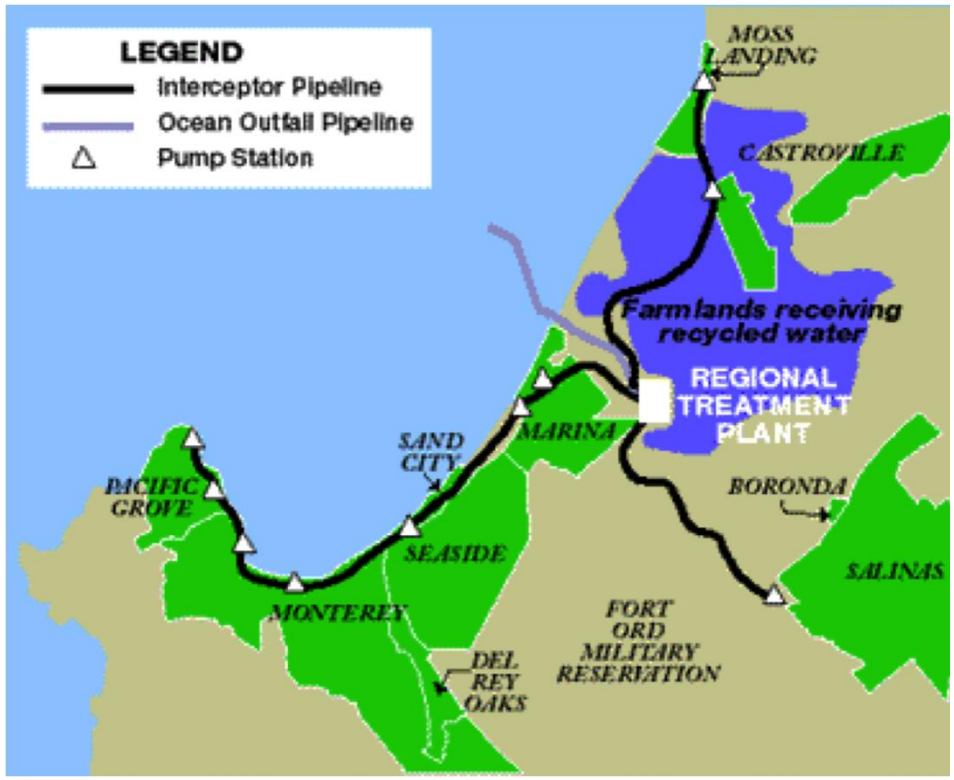



What causes potential to become a project in the ground?

Case Studies

Case study: Monterey, CA

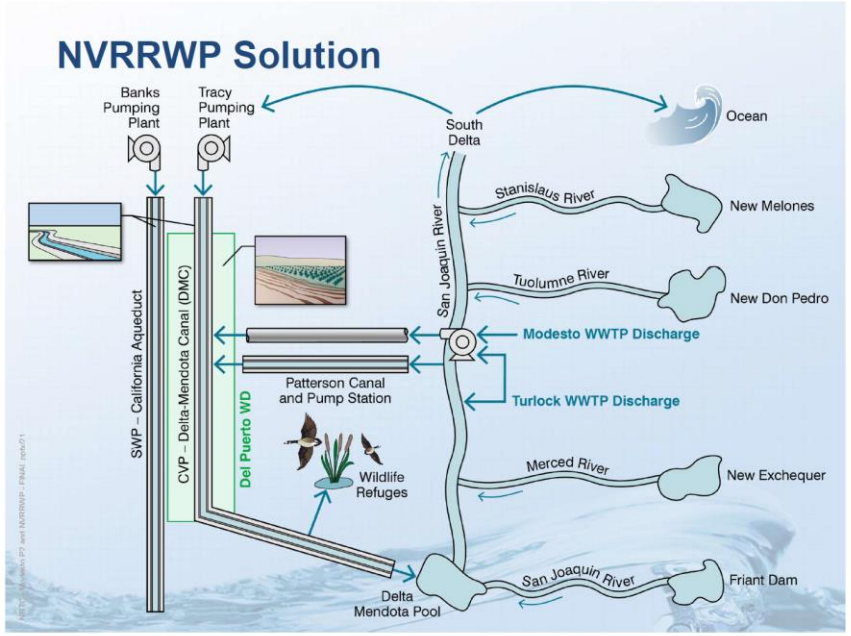
- **Impediments:**
  - Safety Perceptions
  - Soil/Crop Health
  - Sales Impact Concerns
- **Drivers:**
  - Over-drafted Groundwater
  - Seawater Intrusion
  - Saline Well-Water



- **Incentives:** Pilot Project, CWA Grant Funding
- **Crops:** Cauliflower, Broccoli, Lettuce, Celery, Artichokes, Strawberries

Case study: Modesto, CA

- **Impediments:**
  - Local Farmers' Senior Water Rights
- **Drivers:**
  - N Discharge To San Joaquin River
  - Water Scarcity
- **Incentive:**
  - Financing From Prop 1, SRF
- **Crops:** Nuts, Stone Fruit, Citrus
- **Treatment:** BNR, MBR, UV
- **Unique Features:**
  - Delta Mendota Canal to Convey RW (Reduces Purple Pipe) (CVP)

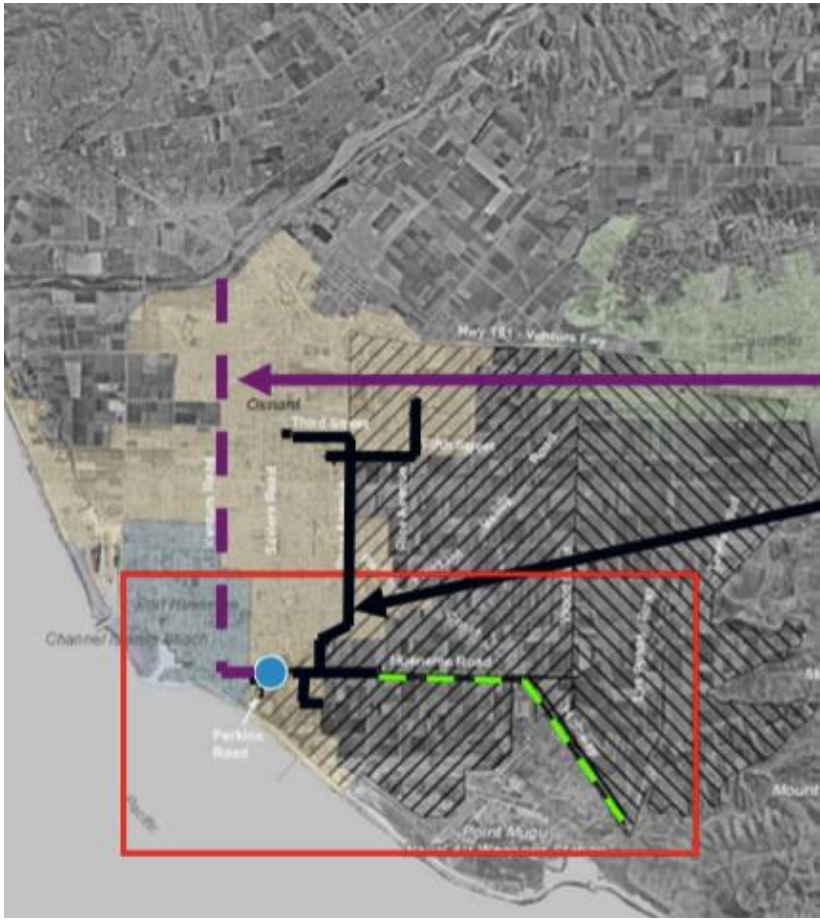


Case study: Hayden, ID

- **Impediments:**
  - Separate Permits for Reuse
- **Driver:**
  - Discharge Limits to Spokane River
  - Nitrogen Management
- **Incentives:**
  - Farmer Pays $55/Acre
- **Treatment:**
  - Oxid. Ditch, BNR, UF, Chlorination
- **Crops:**
  - Alfalfa, Poplar Trees
- **Unique Features:**
  - City-Owned Farmland

Case study: Oxnard, CA

- **Impediments:**
  - Resistance from Farmers
- **Drivers:**
  - Reduce Dependence on Imported Water
- **Incentives:**
  - Lowered Salinity of Recycled Water
- **Treatment:** MF-RO-AOP
- **Crops:**
  - Lettuce, Broccoli, Strawberries…
- **Unique Features:**
  - IPR + Ag Irrigation



Recommendations and Conclusions

- Peer utility and grower example
- Water quality (nutrient limits) are becoming a major driver for reuse
- Significant potential to expand agricultural reuse in CA and non-traditional regions
- Many opportunities for reuse are located in small or disadvantaged communities
  - Need for funding assistance, consolidation, and/or economically sustainable treatment technologies
- Conjunctive management with groundwater recharge can help manage seasonal demand for RW in agriculture
- Better matching of recycled water quality to agronomic conditions is needed




Thank You!

Questions?

Anne Thebo
athebo@pacinst.org