Water Reuse in Agriculture: Update on Current WE&RF Research

Wednesday November 8, 2017

1:00 – 2:30 p.m. EDT

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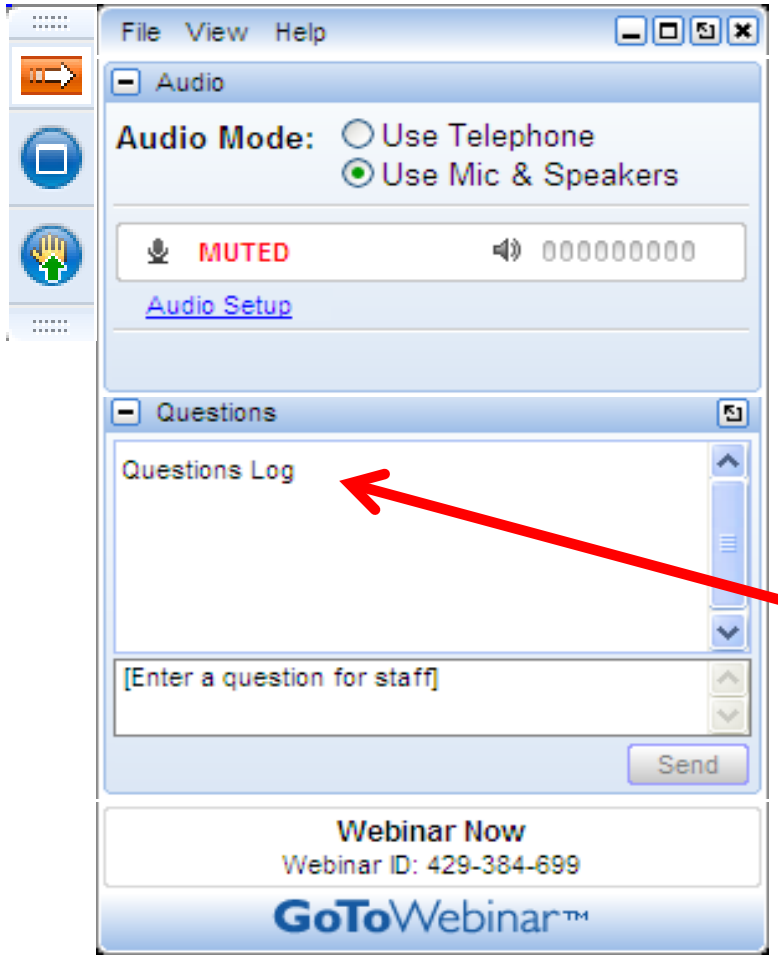
How to Participate Today



- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select "Use Telephone" and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this web seminar.**

Today's Moderator

Kristan VandenHeuvel
WE&RF Research Manager

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Agenda

A. Project Status/Background/Benefits
B. Potential Issues Overview
C. Potential Regulatory Issues
D. Next Steps

Today's Speakers

Kara Nelson, Ph.D.
UC Berkeley

Dave Richardson, P.E.
RMC

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WE&RF Project Reuse-15-08

State of Agricultural Water Reuse: Impediments and Incentives

Kara Nelson
Professor
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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

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- Water Environment & Reuse Foundation
- Pentair
- U.S. Bureau of Reclamation
- California State Water Resources Control Board

Global Coverage

- United States
  - California
  - Florida
  - Idaho
  - Arizona
  - Texas
- Australia
- Israel
- Japan
- Jordan
- Saudi Arabia
- Mexico
- Iran

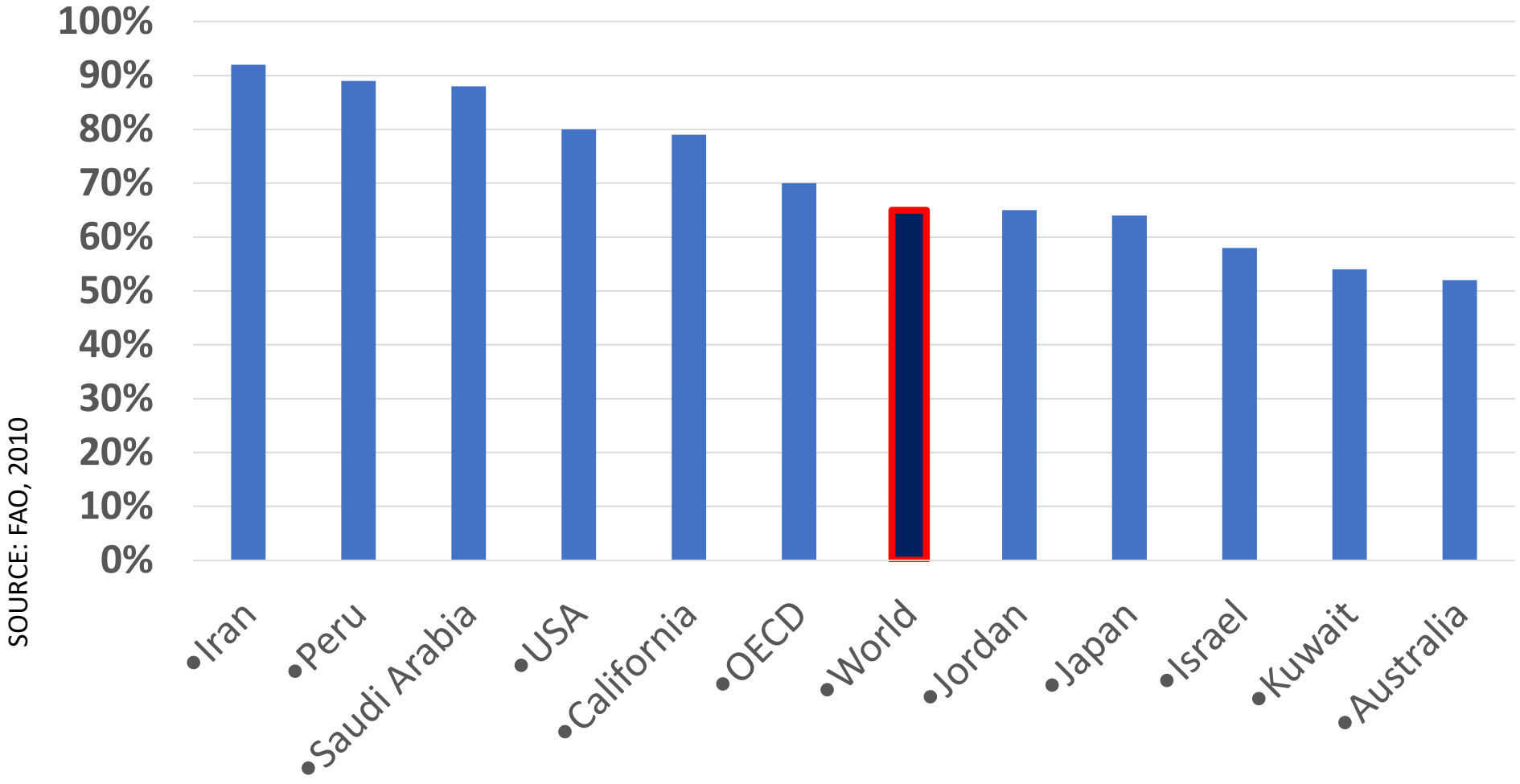
Project Objectives

- Review Recycled Water Use in Agriculture
- Identify Impediments and Incentives to Agricultural Reuse
- Characterize Opportunities to Increase Agricultural Reuse in U.S.
- Recommend Strategies to Increase Agricultural Reuse

Approach

- Literature Review
- Stakeholder Workshop, Break-outs, Review of Utility Documentation
- Interviews with Farmers, Utilities
- Geospatial Assessment across U.S.

Agricultural Use of Water



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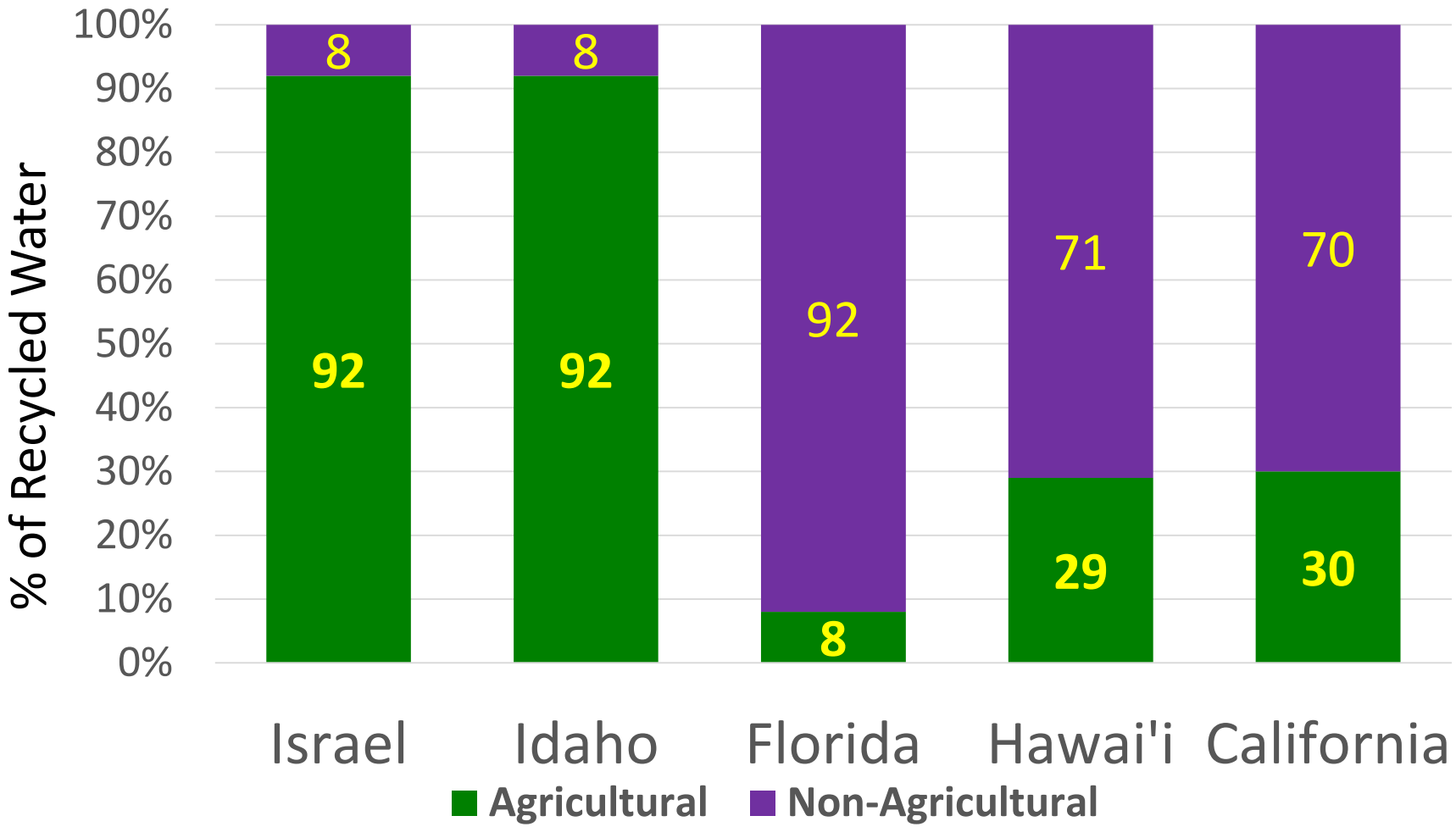
Agricultural Use of Recycled Water



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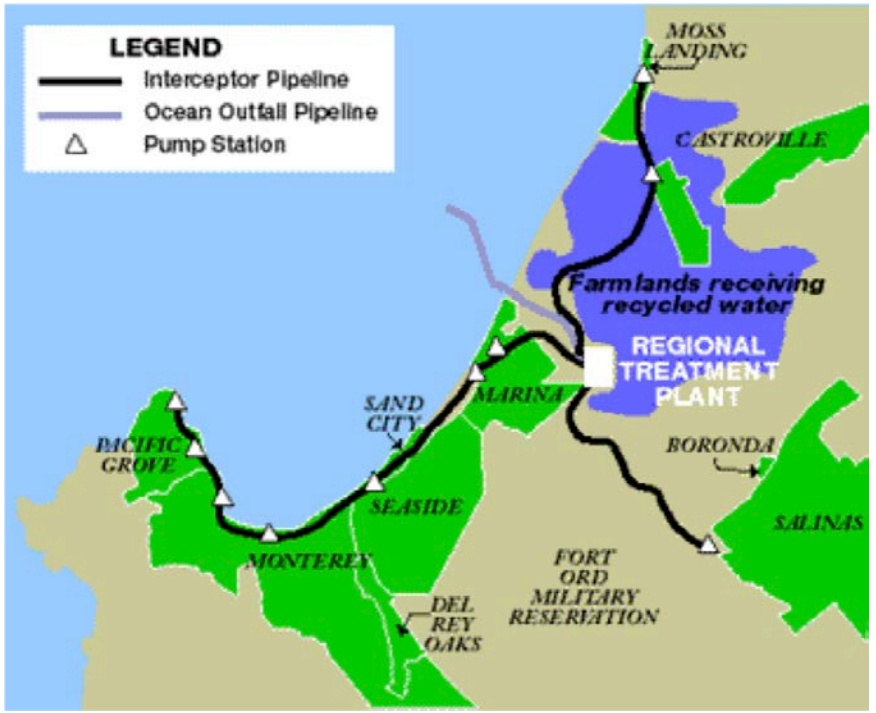
Case Studies

Monterey, CA	Modesto, CA	Hayden, ID
Oxnard, CA	Escondido, CA	Virginia Pipeline, AU

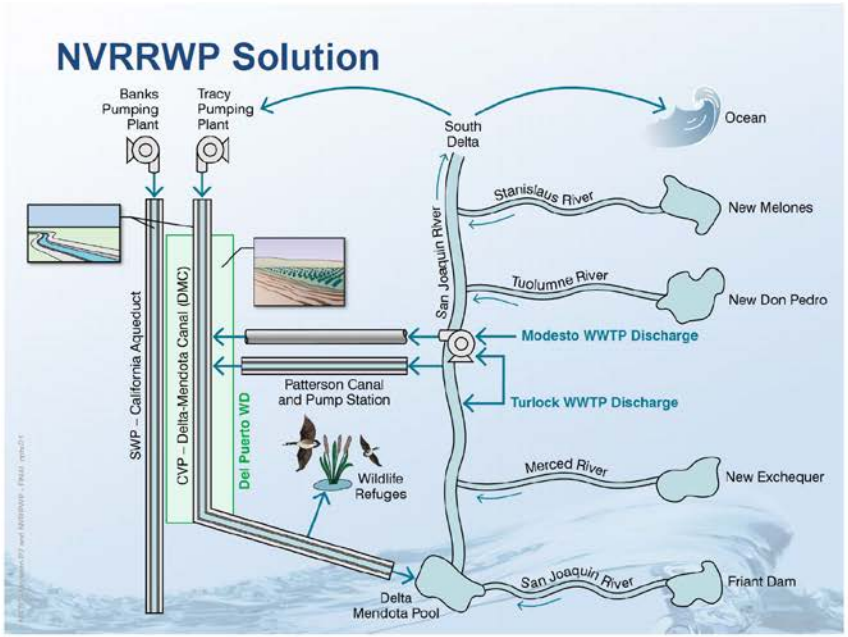
Case Study: Monterey, CA

- **Drivers:**
  - Overdrafted Groundwater
  - Seawater Intrusion
  - Saline Groundwater
- **Impediments:**
  - Safety Perceptions
  - Concerns about Soil/Crop Health
  - Potential Impact on Sales
- **Incentives:** Pilot Project, CWA Grant Funding
- **Treatment:** Tertiary filtration, chlorine disinfection (450 CT)
- **Crops:** Cauliflower, Broccoli, Lettuce, Celery, Artichokes, Strawberries



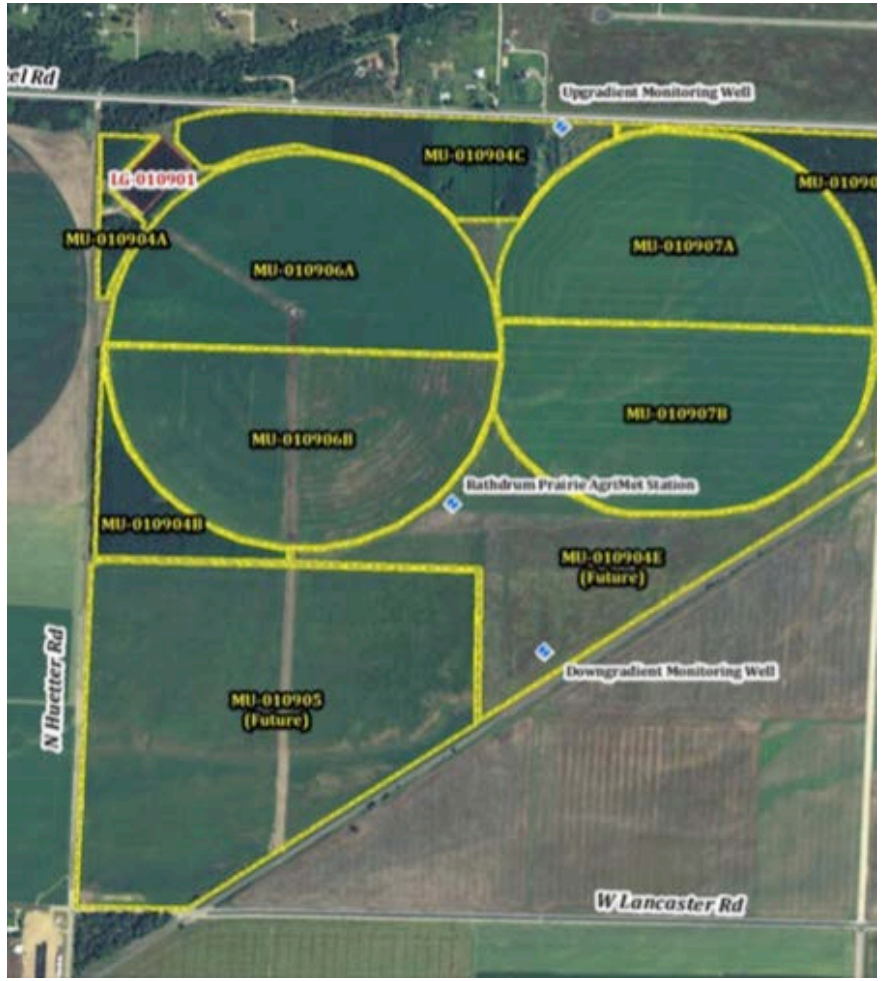
Case Study: Modesto, CA

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



Case Study: Hayden, ID

- **Drivers:**
  - Discharge Limits to Spokane River
  - Nitrate pollution of groundwater
- **Impediments:**
  - Separate Permits for Reuse
- **Incentives:**
  - Farmer Pays $55/Acre
- **Treatment:**
  - Oxid. Ditch, BNR, UF, Chlorination
- **Crops:**
  - Alfalfa, Poplar Trees
- **Unique Features:**
  - City-Owned Farmland
  - Nitrogen mass balance to limit application rate



Case Study: Oxnard, CA

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

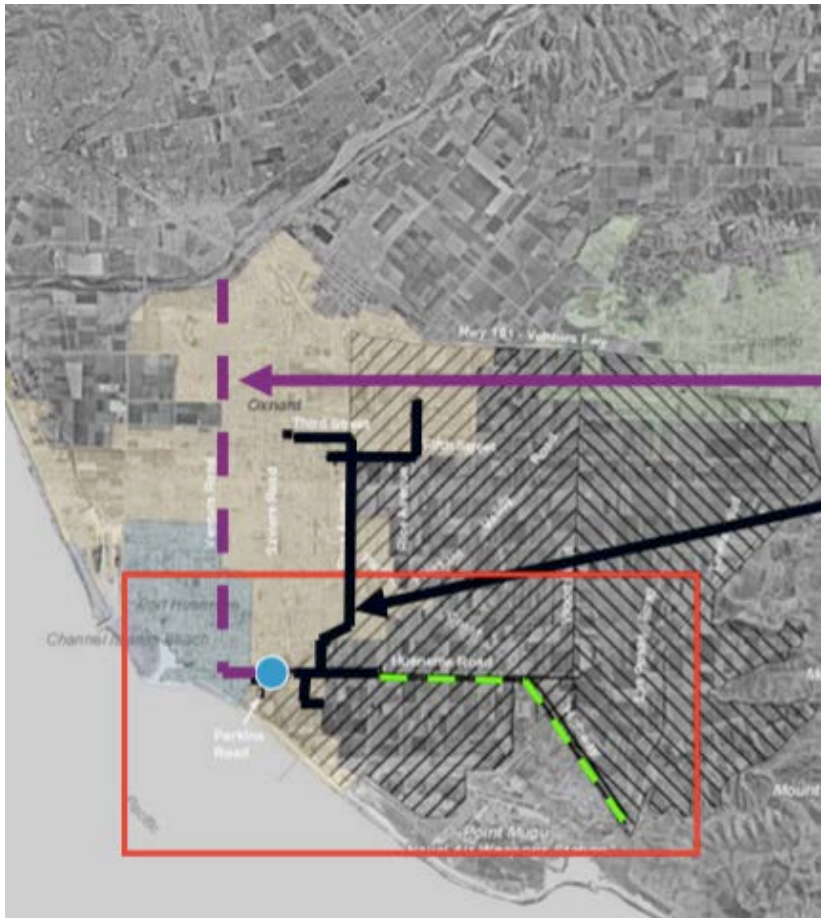


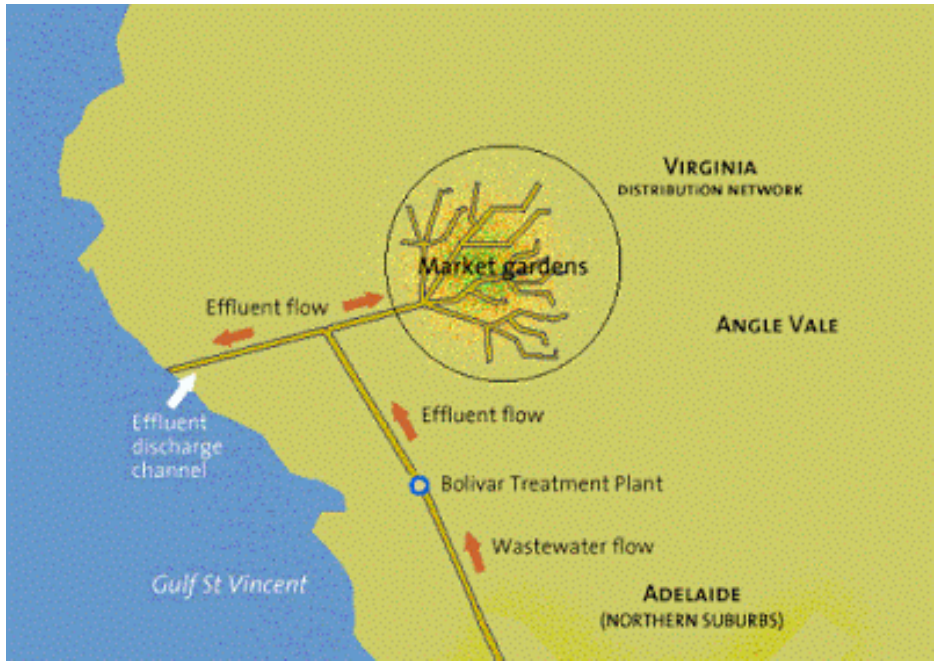
Image credit: Vorissis, 2013 Idaho Reuse Conference

Case Study: Escondido, CA

- **Driver:**
  - $0.5 Billion Outfall Cost
  - Water Scarcity
- **Impediments:**
  - Recycled Water Salinity
  - Avocado’s are Salt Sensitive
- **Incentives:**
  - $0.25 Billion Cost Savings
- **Crops:**
  - Avocados (Salt-Sensitive)
- **Treatment:** Some RO
- **Unique Features:**
  - Proximity of Farms to Utility

Case Study: Virginia Pipeline, AU

- **Driver:**
  - Algae Blooms in Gulf St Vincent
  - Groundwater Overdraft
  - Seawater Intrusion
- **Impediments:**
  - Private Co. Risk Aversion
  - Cost to Upgrade & Distribute Recycled Water
- **Incentive (for Expansion):**
  - $1.0 Billion Government Subsidy
  - Monterey Case
- **Crops:**
  - High-Value Raw-Eaten Vegetables
- **Treatment:** Class A + Some RO
- **Unique Features:**
  - Large WWTP Close to Large Agricultural Area
  - Create Agricultural Employment



Role of Technology

- Technology issues were not perceived as barriers
  - Treatment train primarily driven by regulations
  - Some agencies are providing more treatment than necessary → flexibility
- Opportunities to reduce treatment requirements
  - Free chlorine disinfection (< 450 CT)
  - Virus credit for MBRs (reduce disinfection requirements)
  - Tertiary granular media filtration – 50% higher loading rates via waiver (CA)

Impediments, Drivers, Incentives*

- Water scarcity was a most frequently cited driver
- Costs are impediments; Grants and loans can be incentives
- Perception issues of safety were often cited as impediments
- Regulations:
  - Cited as Impediments, “Unclear”, “Inconsistent”, “Outdated”, “Which Water Quality Is Needed For Which Crops”, “Prohibitions”
  - Government Targets and Mandates to Increase Use of Recycled Water Are Significant Incentives
- Salinity of water source can be either driver or impediment
- Technical issues were not cited significant as driver or incentive

* Based on interviews, workshop, and review of documents

Evaluating the Potential for Increased Agricultural Reuse

Objectives:

1) Quantify volumes of effluent discharged via methods with a high potential for reuse

2) Identify locations where there is unallocated flow available in close proximity to irrigated croplands

3) Compile list of priority POTWs on the basis of available effluent and irrigated croplands

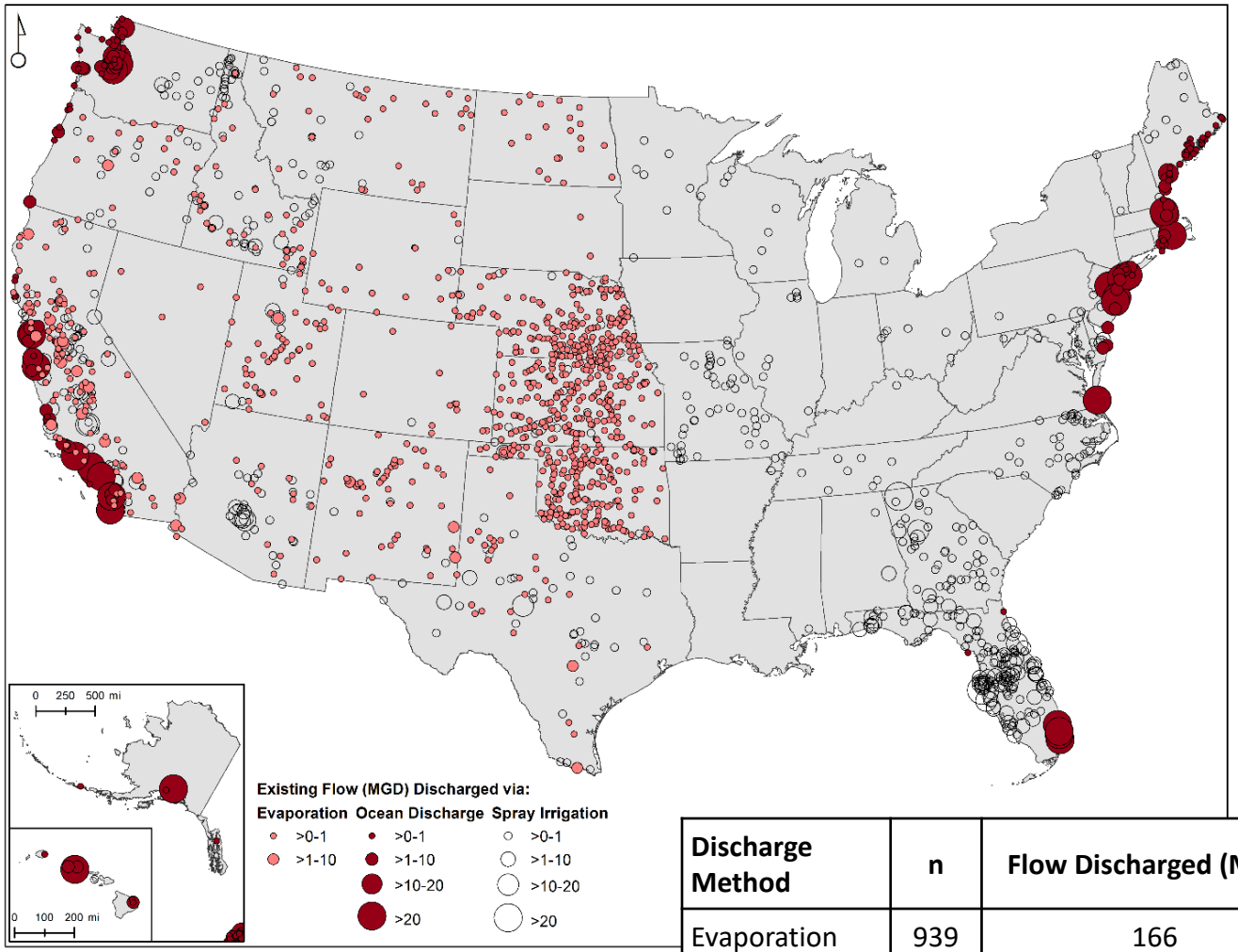
Approach:

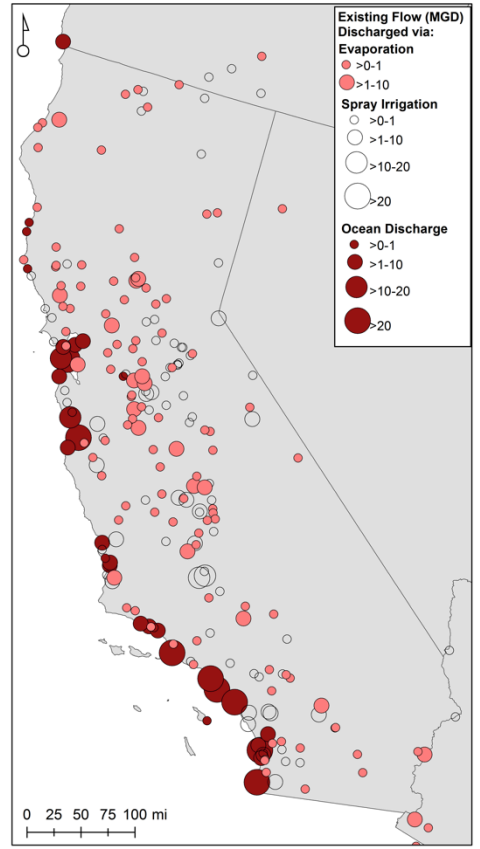
Geospatial Analysis (GIS)

Major Data Sources:

EPA Clean Watersheds Needs Survey (CWNS)
Irrigated Croplands (MiRAD)

Quantity of Flow Discharged with “High Potential”





Discharge Method	n	Flow Discharged (MGD)
Evaporation	939	166
Ocean Discharge	183	3,104
Spray Irrigation	638	586

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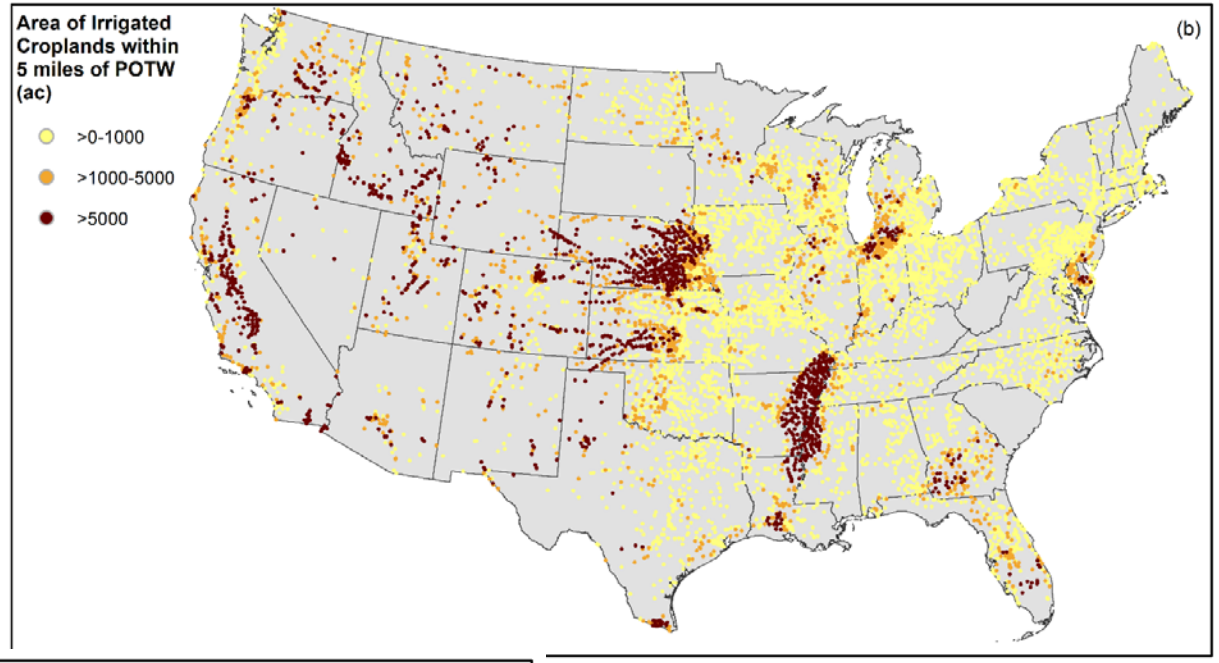
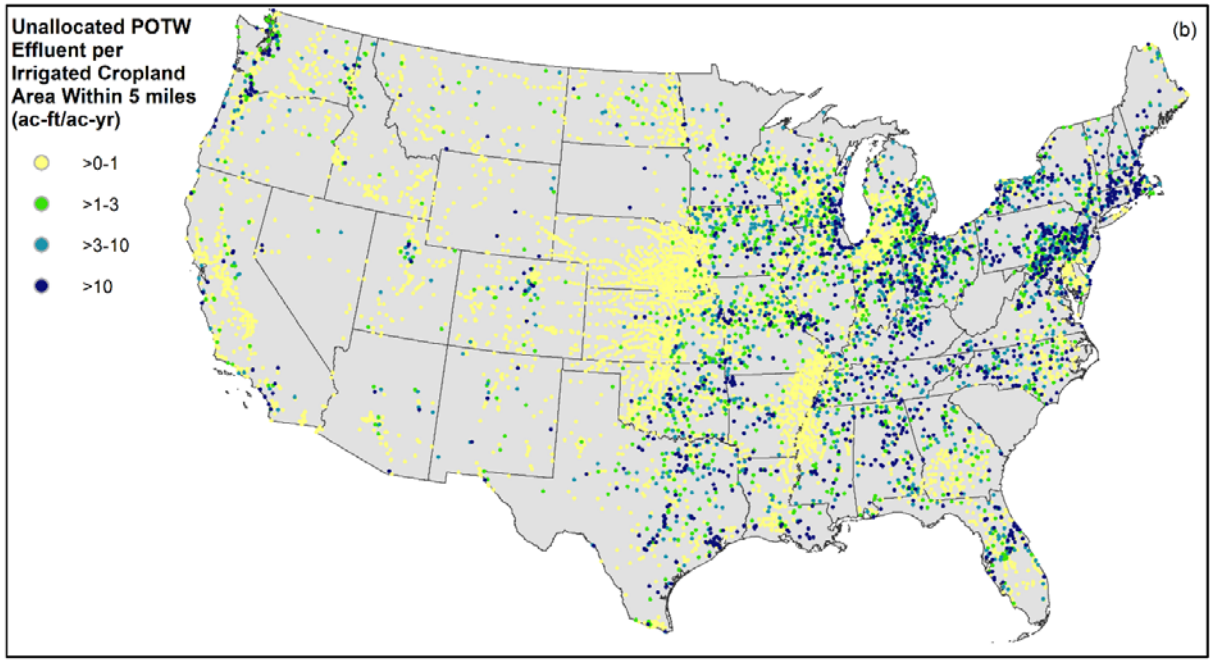
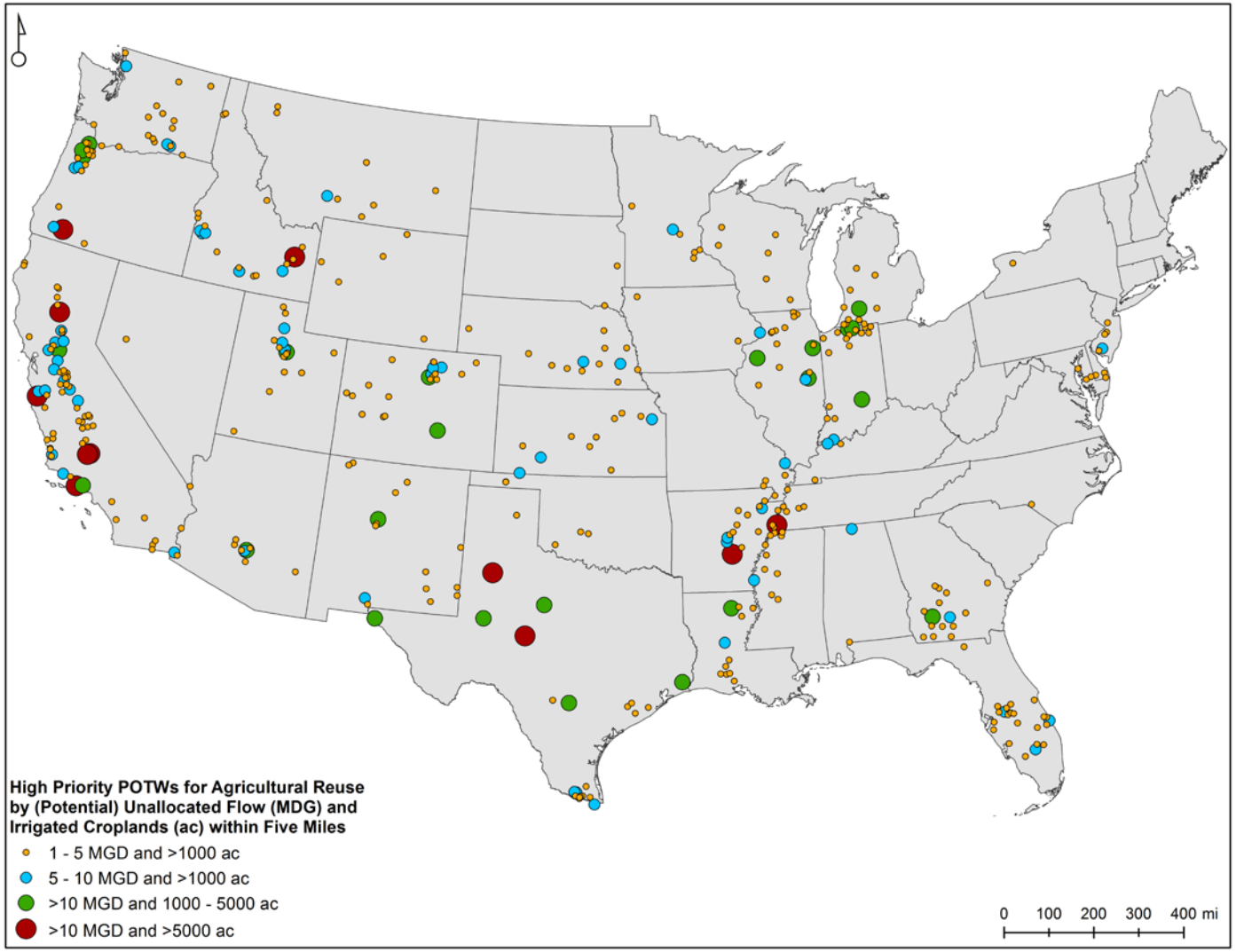
Irrigated Cropland Area within 5 mi of POTWs





Ratio of Unallocated Flow or Irrigated Cropland Area within 5 mi of POTWs

POTWs with High Potential for Ag Reuse



35 largest sites:
~ 1000 MGD
200,000 acres

Conveyance:

- Piping costs can be significant
- Pumping costs are not significant

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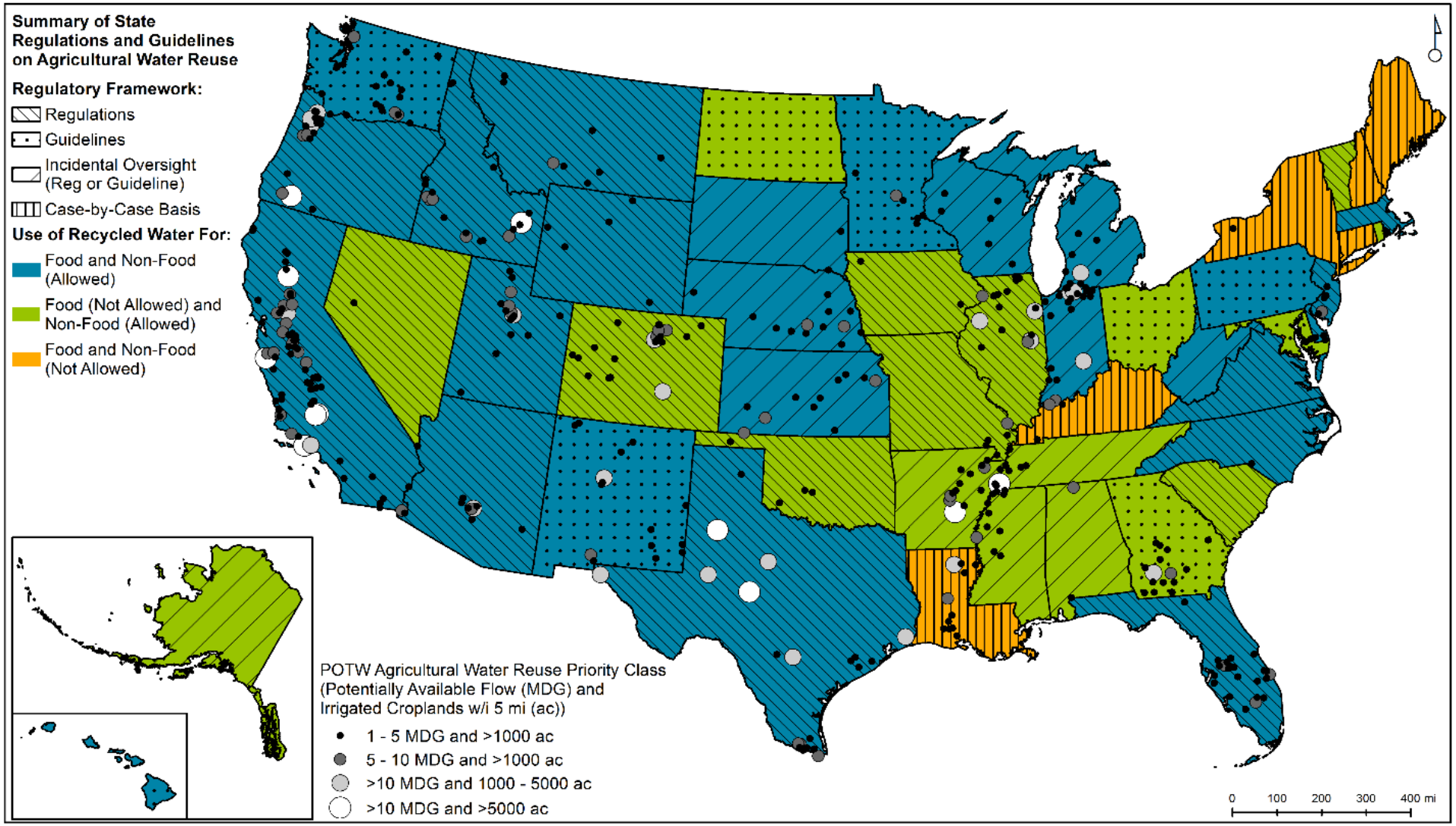
Regulatory Impediments to Reuse



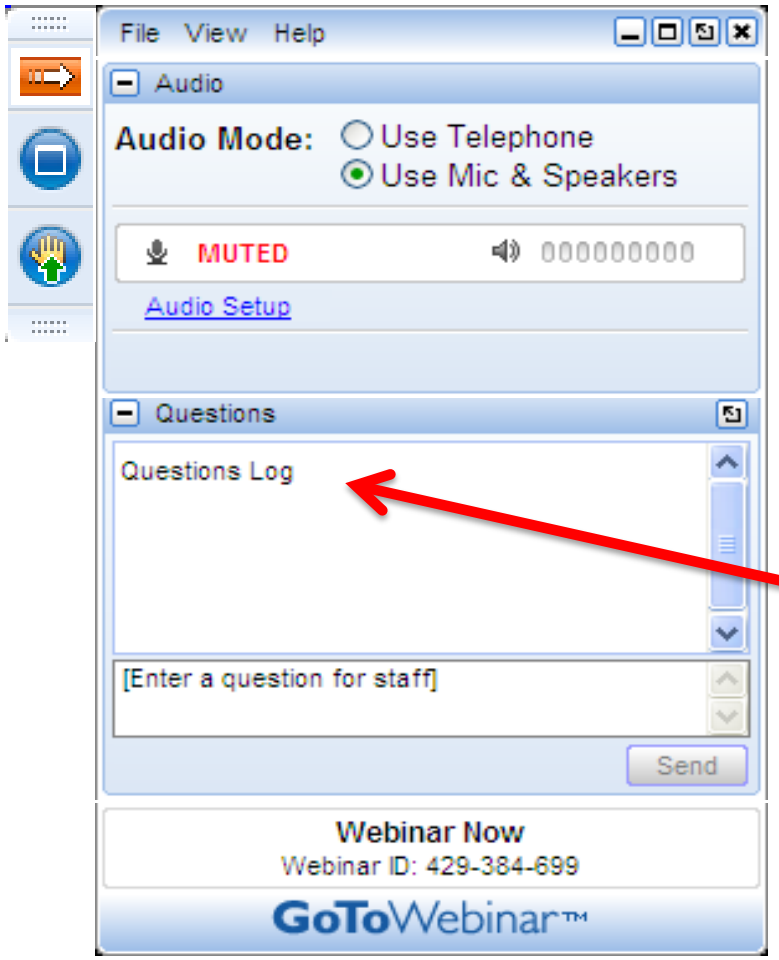
Conclusions

- The potential to increase agricultural reuse is large (> 1000 MGD)
- > 1500 POTW practice spray irrigation and evaporation
- Drivers vary depending on local context (water scarcity, discharge limitations, infrastructure upgrades)
- Nutrient content of recycled water is not an incentive to farmers, but lower salinity can be
- There are many benefits, but they are fragmented
- Future drivers/incentives: NPDES limits on nutrients or temperature, FSMA (US), and SGMA (CA)
- Incentives can overcome impediments—**It Takes A Champion**

Recommendations

- Continued research to characterize POTW identified as high potential for agricultural reuse
- Explore incentives for converting POTW practicing evaporation and spray irrigation to agricultural reuse
- Encourage collaboration among regulators (especially between states)
- Develop partnerships between utilities and farmers
- Charge farmers for recycled water
- Seeing is believing – encourage visits to existing projects

Questions for Our Speakers?



- **Submit your questions using the Questions Pane.**

Groundwater Recharge with Recycled Water on Agricultural Lands in California (WE&RF Reuse-16-03)

November 8, 2017

Dave Richardson, P.E.
RMC, a Woodard & Curran Company

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Technical Advisory Committee

- Sacramento County Farm Bureau
- California Farm Bureau Federation
- Sustainable Conservation
- The Nature Conservancy
- U.C. Davis
- Regional San (Sacramento County)
- North San Joaquin Water Cons. District
- Constellation Brands, Woodbridge Winery

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- Kristan VandenHeuvel

WE&RF Project Subcommittee

- Chris Impellitteri, USEPA
- Bob Holden, MRWPCA
- Monica Gasca, LACSD
- Katharine Dahm, USBR
- Sally McCraven, Todd

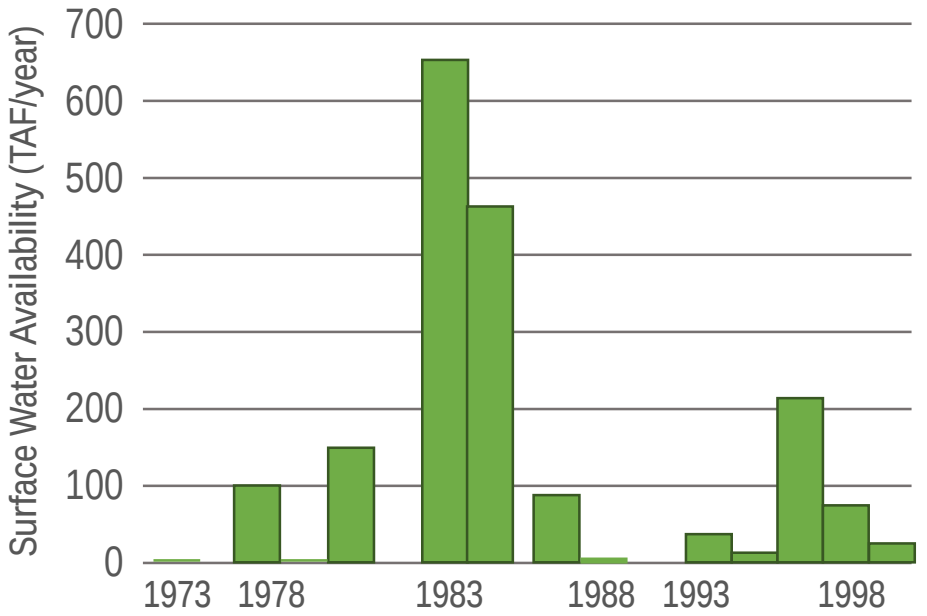
Regulators

- California State Water Resources Control Board
  - Division of Drinking Water
  - Division of Water Quality
- Regional Water Quality Control Boards

Recharge of surface water on agricultural lands is limited by available and reliable supplies

Surface Water Recharge on Agricultural Lands

Example (Kings River, CA)
Surplus Surface Water Supply



Groundwater recharge with recycled water maximizes reuse but requires dedicated land for recharge

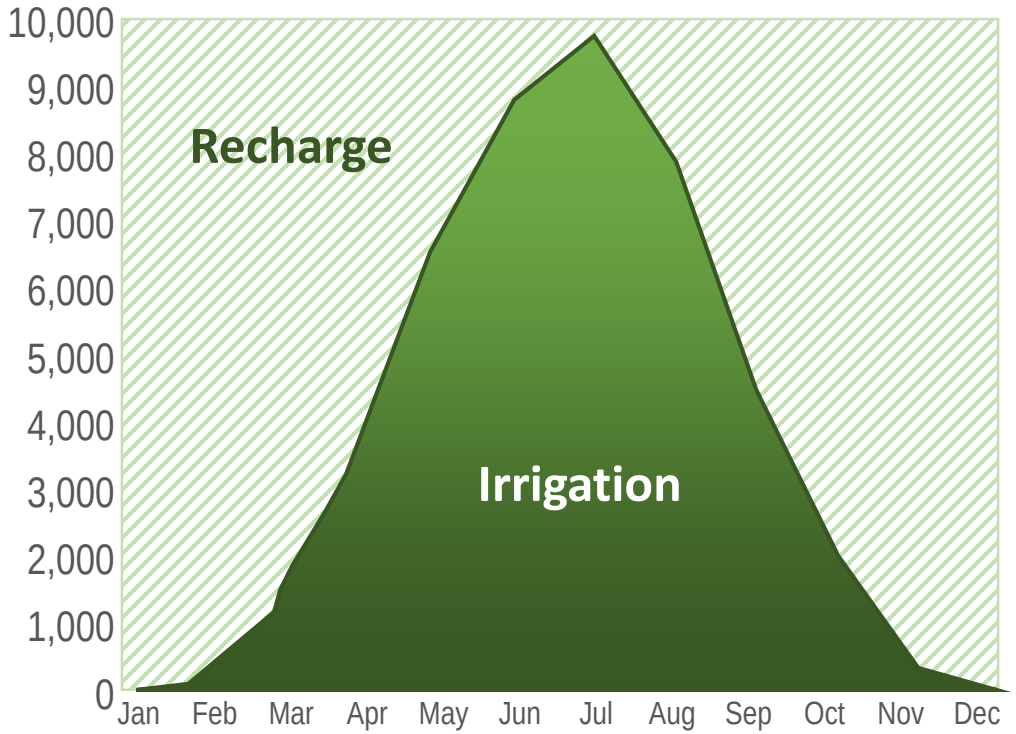
Source: Sanitation Districts of Los Angeles County

Agricultural irrigation with recycled water can on use only about half of available RW annually

Agricultural Irrigation with Recycled Water

Source: Bob Holden, MRWPCA

GWR opportunities during low irrigation demand



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Benefits of Groundwater Recharge with Recycled Water on Agricultural Lands (Ag-GWR-RW)

- Beneficial use of surplus winter recycled water
- Beneficial use of compatible agricultural land (dormant / between crops)
- Minimal new infrastructure (when combined with ag reuse projects)
- Environmental benefits (higher GW tables, conserve habitat)

Purpose of Ag-GWR-RW White Paper

- Assimilate relevant current knowledge
- Define on-site operational challenges and propose ways to resolve or mitigate those challenges
- Investigate existing regulatory frameworks and consider an approach to meet the intent of those regulations
- Identify additional research needs and potential demonstration project

Translating Ag Reuse to Ag-GWR-RW

- Distribution systems supports GWR with limited investment

Ag-GWR-RW Candidates

- Suitable crops and cropping pattern
- Suitable hydrogeological setting
- No tile drains
- Available RW in winter
- Salt/Nutrient management

Translating Recharge with Surface Water to to Ag-GWR-RW

- Increased salt and nutrient loading
- Increased pathogen / organics potential
- Introduces additional regulations
- Higher level of oversight / monitoring

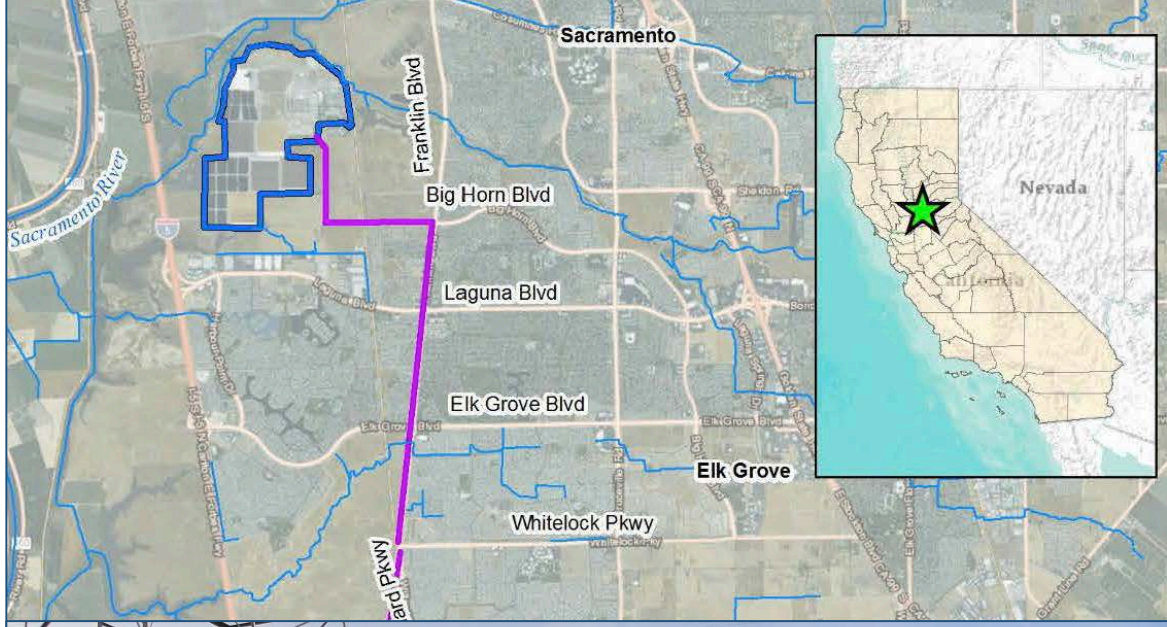
South Sacramento Co. Ag Reuse Program

Recycled Water for Ag Irrigation

- 16,000 acres
- ~33,000 AFY
- ~$250M

Recycled Water for Recharge

- Up to 17,000 AFY of recycled water
- 500+ acres



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Potential Issues Overview

Participant Considerations

- Cost Considerations
- Crop Health Risk
- Regulatory Risk

Recycled Water Supply Considerations

- Availability of Recycled Water
- Proximity of Recycled Water
- Recycled Water Quality
- Application Method
- Surface Water Supplies

Water Quality Protection

- Salt and Nutrients
- Pathogens
- Chemicals of Emerging Concern
- Pesticides
- Heavy metals

GW Basin Setting Considerations

- Hydrogeological Characteristics
- Assimilative Capacity
- Potable Wells
- Institutional Structures

Regulatory Overlap / Conflicts

California GWR-RW Regulations

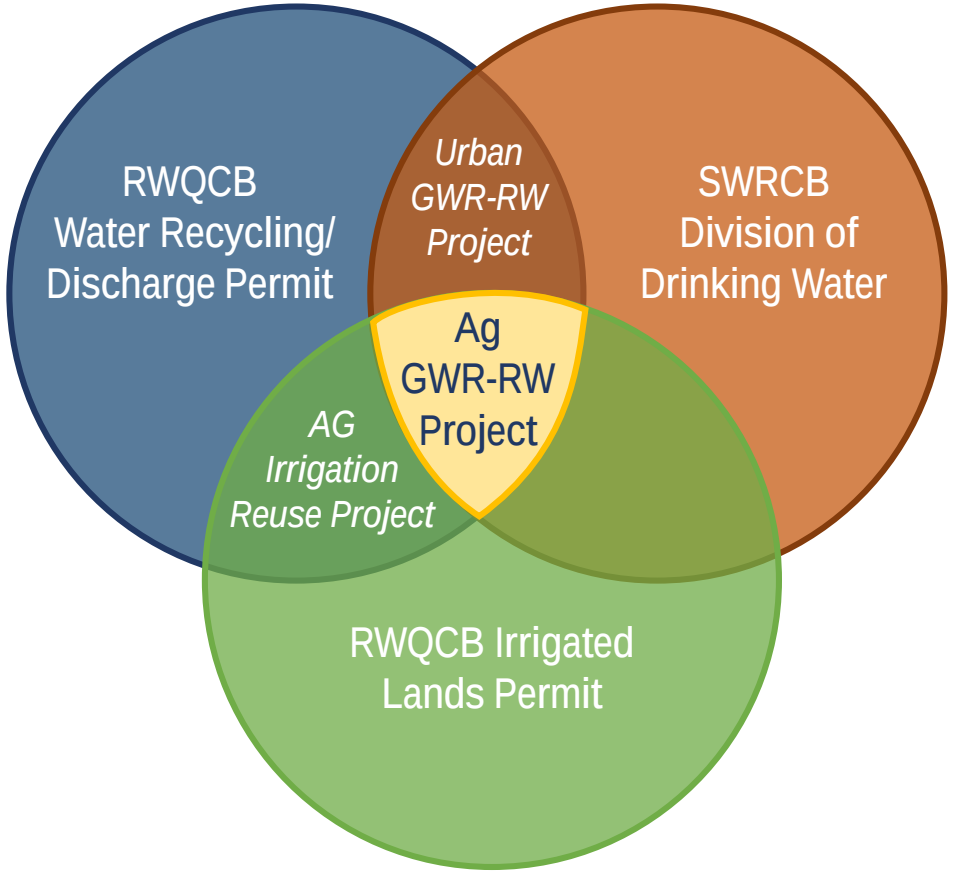
- Pathogens (travel time)
- Chemicals of Emerging Concern (TOC, blending)

California Anti-Degradation

- Salt / Nutrient Management

California Irrigated Lands Program

- Additional loading
- Landowner liability



Ag-GWR-RW Considerations

- Intermittent (~3 months) operations
- Large aerial extent
- Native soil with high biological activity
- Potable wells – typically small, shallow for residences within ag land

Components of a Successful Ag-GWR-RW Project

Recharge supply

- Surface water
- Recycled water

Agricultural land

- Suitable land
- Suitable crops
- Potable well locations

Hydrogeological

- Suitable soil
- Suitable groundwater

Economics

- Owner risks and benefits balanced
- Multiple benefits considered
- Costs borne by beneficiaries
- Willing owner / farmer

Implementation

- Clear regulatory pathway
- Institutional structures in place or to be developed

Top Ag-GWR-RW Issues

Assuming recycled water, hydrogeological conditions, and crop types/patterns are conducive to Ag-GWR-RW

- Crop Impacts
- Soil Impacts
- Groundwater Protection - Salt & Nutrients
- Public Health Protection - Pathogens

THANK YOU!

Groundwater Recharge with Recycled Water on Agricultural Lands in California (WE&RF 16-03)

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Regulatory Issues: GWR-RW Permit (DDW, RWQCB)

Pathogens

- Issues
  - Minimum travel time
- Management Measures
  - Disinfected tertiary treatment
  - Soil aquifer treatment
  - Prevent on-site sources
  - Groundwater monitoring

Chemicals of Emerging Concern

- Issues
  - Lack of large blend water supply
- Management Measures
  - Soil aquifer treatment
  - Wastewater-derived TOC
  - Monitoring per SWRCB CEC Expert Panel

Regulatory Issues: Anti-Degradation

Salts

- Issues
  - Existing assimilative capacity
  - Legacy salts / nutrients
  - Relatively high in recycled water
- Management Measures
  - Consider loading in context of overall GW basin management
  - Source control
  - Blend water, where feasible

Nutrients

- Issues
  - Same as salts
- Management Measures
  - Nitrification / denitrification @ WWTP
  - Soil aquifer treatment
  - Wet / dry soil cycles
  - Winter cover crops
  - Blend water, where feasible

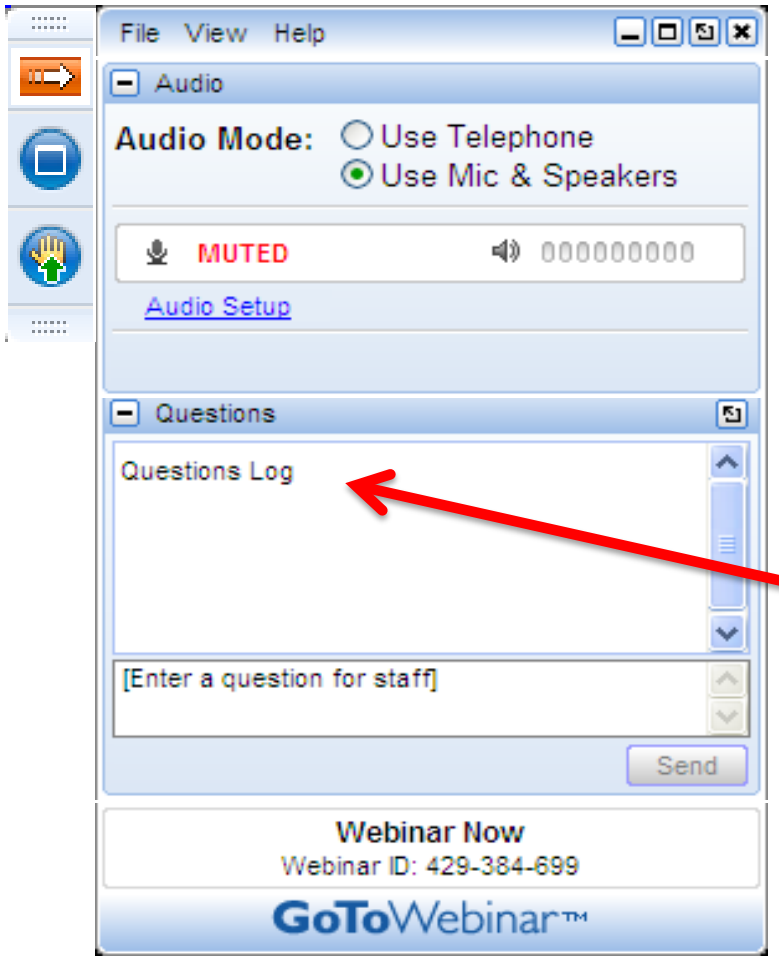
Research Recommendations (1 of 2)

Research Category	Research Topic
Crop Impacts	Understand the timing and duration of drying cycles; additional nutrient or amendment needs; and rootstock or variety selection
Soil Impacts	Analyze the effects of alternating water supplies with elevated SAR from recycled water and lower SAR from rainfall and surface water to build an understanding of potential impacts of Ag-GWR-RW on soil structure and permeability.
Nutrients	Develop an understanding of how cover crops can limit nutrient loading from winter application of recycled water, including on fallow fields as well as on vineyards and nut tree orchards.
Pathogens	Quantify the removal efficiency of pathogens during travel through the vadose zone for land with Ag-GWR-RW. These findings could be used to justify minimum retention time appropriate for Ag-GWR-RW setting.

Research Recommendations (2 of 2)

Research Category	Research Topic
Chemicals of Emerging Concern	Identify the remobilization potential of organic matter on ag land and potential impacts on TOC concentrations in the underlying groundwater and redox conditions in the subsurface affecting CEC removal.
Pesticides	Determine pesticides with highest contamination risk through use of tools such as the CA Dpt of Pesticide Regulation's Ground Water Protection Program and the UC Cooperative Extension
	Determine period prior to recharge operations for no pesticide application through use of tools such as the Windows Pesticide Screening Tool (WIN-PST)
Heavy Metals	Developing an understanding of the risks to heavy metal mobilization and how the timing, volume, and quality of recharged recycled water can be altered to minimize the risk.

Questions for Our Speakers?



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Thank You