California's Regulatory Process to Protect Public Health for Crop Irrigation Reuse and Potable Reuse

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Agricultural Irrigation Reuse

- Includes Food Crops Eaten Raw (Produce)
- 37% of California Total Reuse
- 300 hm^3/year
- 25,000 ha
- 52 crop types

Indirect Potable Reuse

- Regulation in 2014
- 7 Large Projects

  (approved pre Regulation)
- 19% of California Reuse
- 160 hm^3/year
- Surface Spreading and Injection

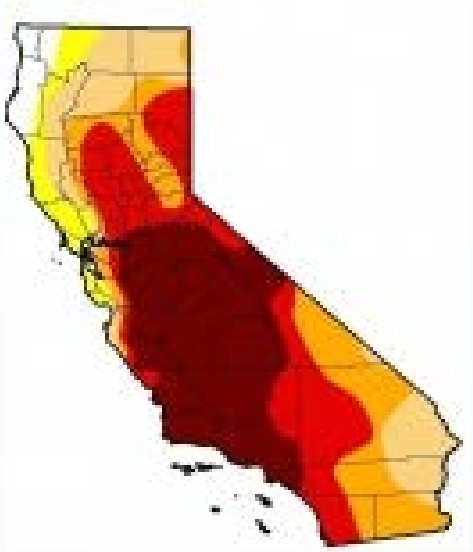
Groundwater Replenishment IPR Projects in the Los Angeles Area

Current Activities

- Recent California Legislation
  - Adopt Surface Water Augmentation regulation
  - Determine feasibility of developing Direct Potable Reuse regulation
- Proposition 1 provides $625 million (USD) in funding for recycled water projects.
  - Loans and grant for planning and construction activities
- Authorizing a surface water augmentation project
- Starting to develop direct potable reuse regulations

California Reuse Drivers

- Arid and less snow in Sierra Nevada
- Droughts
- Population growth
- Groundwater overuse
- California policy and legislation
  - Water Industry and Environmental Group influence
- Competition for water among agriculture, urban areas, and environmental needs

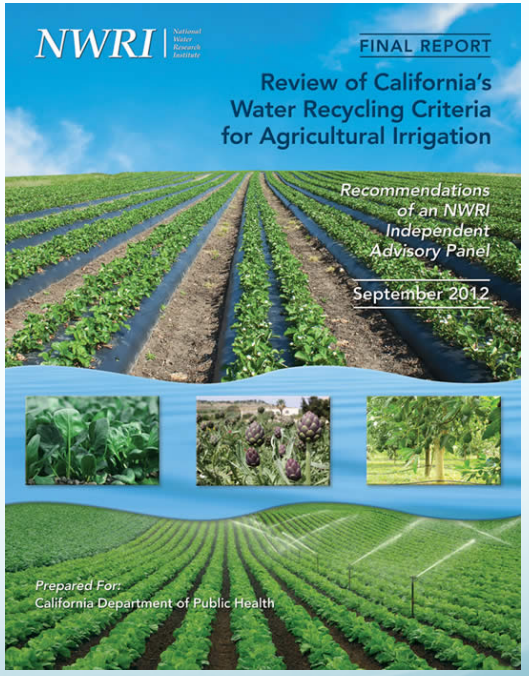


Agricultural Reuse Process

- Regulation (1978)
  - Treatment standard
- Monterey Study
  - Irrigation pumping was pulling sea water into an important aquifer
  - The State adopted a plan to consolidate wastewater into a reclamation plant for crop irrigation if long term reuse could be shown to be safe for the public, crops, groundwater, soil, and farm workers.
  - Safe ✓

Agricultural Reuse (2)

- Monterey area now the largest raw-eaten food crop area in the world irrigated with recycled water, growing strawberries, lettuce, broccoli, celery, and artichokes.

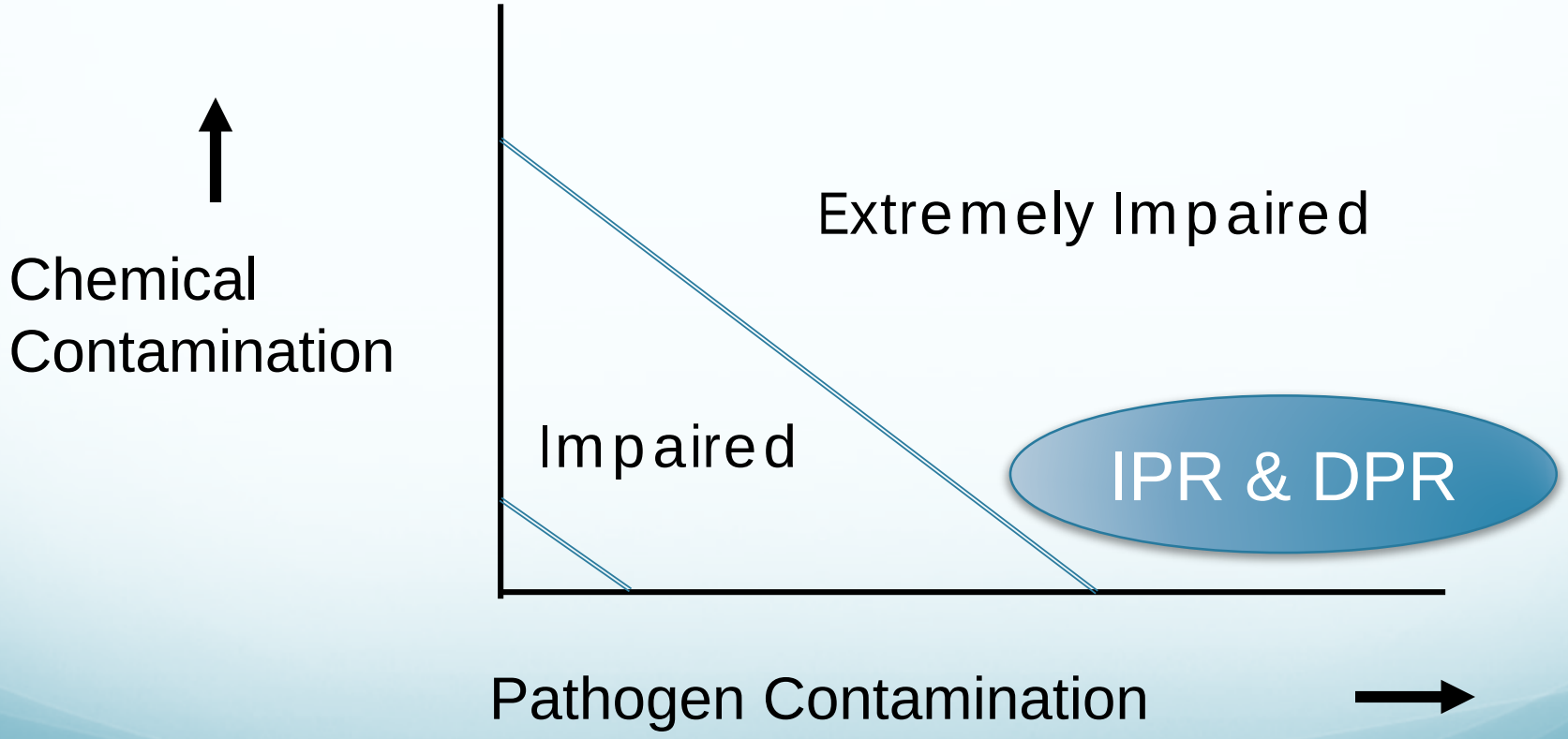


- Regulation risk reviewed (2012)
  - Achieves 1 in 10,000 annual risk of infection public health goal

Types of Potable Reuse

- The use of a river with a wastewater discharge as a source of drinking water is called incidental, ***de facto,*** or unplanned potable reuse
- Indirect potable reuse (IPR) – the planned delivery or recycled wastewater to a groundwater or surface drinking water source
  - IPR is characterized by a substantial environmental separation between wastewater treatment and water use
    - Barrier to contaminants
    - Time to react to a treatment failure
- Direct Potable Reuse dispenses with the substantial environmental component

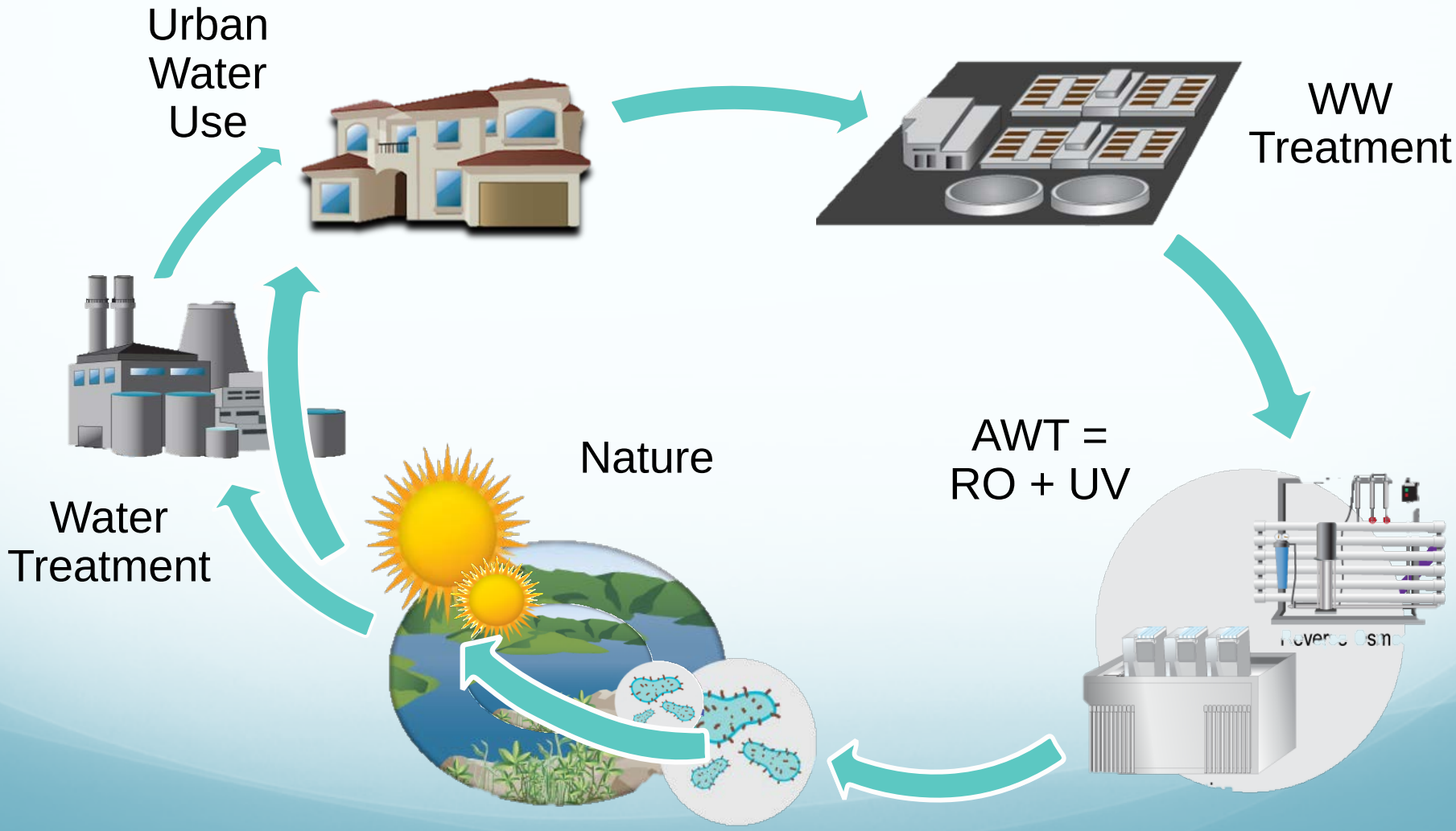
Drinking Water Source Quality



Public Health Goals

- Pathogens – all reuse
  - 1 in 10,000 annual risk of infection
- Potable Reuse pathogens
  - 12, 10 and 10 are California $\log_{10}$ reduction targets for enteric virus, *Giardia*, and *Cryptosporidium*
    - Raw wastewater to drinking water
    - Based on worst case wastewater levels
- Potable Reuse Chemicals
  - Drinking Water Standards
  - Notification Levels
  - Unregulated chemicals (CECs) at or below levels in good conventional sources

Planned Indirect Potable Reuse



Calif. Indirect Potable Reuse via Groundwater Recharge

- Montebello Forebay (1960's)
  - Primary, secondary, filtration, disinfection, soil-aquifer treatment (spreading), dilution, travel time
- Water Factory 21 (1976)
  - WW treatment + lime clarification + reverse osmosis (RO) or activated carbon
  - Injection for seawater intrusion barrier
- Projects demonstrated the need, ability, and community determination to do groundwater recharge IPR

1980s and 90s Scientific Basis and Regulation Development

- Science Advisory Panel report and the charge to draft comprehensive regulation (1986)
  - report said provided basis for new project approvals
    - limited exposure, time, and low organic carbon level
- Extensive studies at Montebello Forebay and Water Factory-21 by the utilities
- Draft criteria developed

Gaining Experience with the Draft Criteria

- Numerous groundwater recharge IPR proposals
  - West Basin West Coast Barrier – 1995
  - Dominguez Gap, Los Alamitos, Inland Empire
  - Orange County Groundwater Replenishment project in 2008
- Every project advanced the science and understanding of potable reuse

Case-By-Case Process

- Independent Advisory Panel (IAP) for proposals
  - Membership approved by State
  - Science and technology experts
  - Advisors to the project proponent, their consultants, and the State regulators
- IAP required whenever the State has technical questions about the proposal
- Numerous meetings during project development to discuss Permit issues and studies requested by the IAP or State

Draft Criteria Improved With Case-By-Case use

- Each proposal had new conditions, approaches or requests for alternatives to criteria they could not meet
- The project proponent was responsible for providing the research justifying criteria modifications
- Criteria changed
  - More flexible: additional treatment and monitoring schemes were approved
  - Changed unworkable criteria
  - Deleted unnecessary criteria

CEC Criteria Reassessment

- Contamination with NDMA and 1,4-dioxane
- The project operator was very responsive to the State and well owners, and provided the necessary additional treatment
- Project response saved potable reuse in California
- Criteria inadequate
  - Tighten the TOC objective, thus requires an improved type of RO
  - added UV/hydrogen peroxide (AOP) (2001-2)

Pushing the Limit to 100% (2001-2)

- Important because dilution water increasingly difficult or impossible to obtain
- Up until 2000 draft criteria only allowed 50% recycled water at a drinking water well
- West Basin requested 100% -
  - required to form an IAP to advise on the issue
- Regulation changed to allowed 100% based on West Basin research and IAP recommendations for additional treatment

Regulation Drafting and Adoption Process

- Review the literature
- Consult experts on the science and technology
- Consult water utilities for their experience and insights
- Draft criteria and request comments
- Draft and submit a regulation
  - Legal review and other reviews
  - Public comment
  - Response to comments
  - Final approval (?)

Groundwater Replenishment Regulation - 2014

- Pathogens
  - Rational approach (Australian) that fosters confidence
    - Regulators, scientists, public, policy makers
  - Risk based organism log reductions
    - 12-log virus, 10-log each for *Giardia* & *Cryptosporidium*
  - Based on very protective assumptions
  - Multi barrier treatment

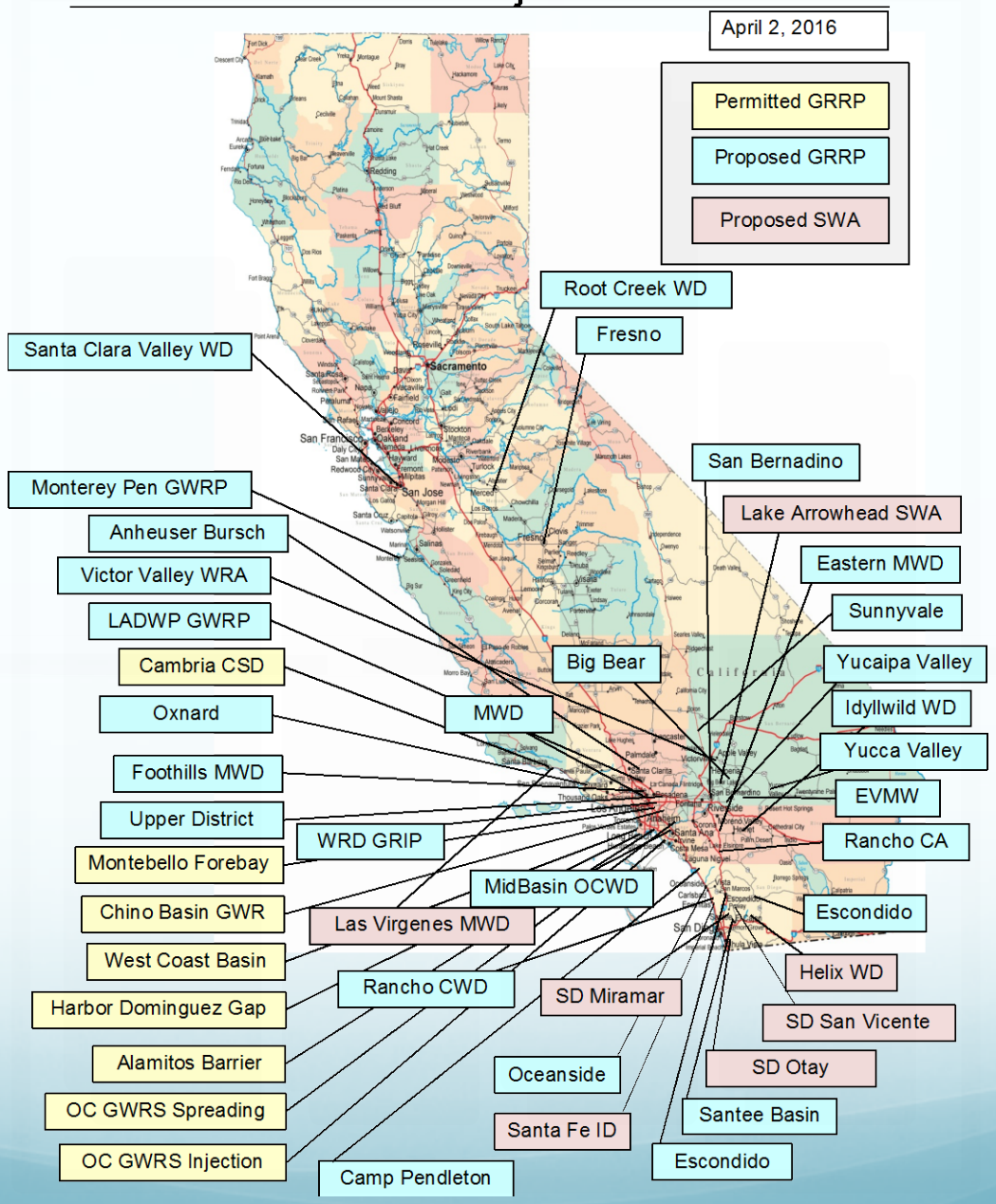
2014 Regulation (continued)

- Chemicals
  - Drinking Water Standards
  - Notification Levels
  - CECs
    - Source control
    - Multi-barrier treatment
      - Soil-aquifer + dilution or RO/AOP
- Time underground to identify and respond to any “situation”

Surface Water Augmentation Indirect Potable Reuse

- Environmental barrier –
  - Reservoir storage rather than aquifer
  - Mixing more important than time
  - Mix to attenuate a brief treatment failure
- Build on groundwater replenishment IPR experience
- Study by San Diego demonstrated the benefit of the reservoir
- Draft completed (?)

Indirect Potable Reuse Projects Across California



Direct Potable Reuse (DPR)

- Legislation required Expert Panel to study feasibility of developing regulations for DPR
- Both groups met with the State over two years
  - Briefed on our thinking, needs, and questions
    - Need objective criteria
    - Need to specify the necessary reliability
- “Evaluation of the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse”
- Criteria Feasible ✓

Moving Toward DPR Criteria

- Expert Panel, Advisory Group, WateReuse DPR research initiative, other research products, and experience with IPR have provided an understanding of how DPR might be done safely
- Our experience with the development of IPR criteria has shown that it is a sizable step, however,

  from being confident that something can be safe

  to producing criteria that assure that it will be accomplished safely, in every case, all the time.

Criteria Objectives

- When the Expert Panel embarked we offered several objectives for criteria. The criteria:
  - Must be enforceable (enable an objective compliance determination);
  - Must be unambiguous regarding the critical protective features; and
  - Must assure that any proposal that can comply, will actually produce safe water continuously.

Knowledge Gaps Remain

- Key Expert Panel findings on DPR performance and reliability lead to further questions.
- Workshops with experts needed to resolve.
- For example: Extra Organism Log reduction Capacity

  > "Use a treatment train … with multiple, independent treatment barriers … that meet performance criteria greater than the goals … for microorganisms"

  - How much additional LRV capacity is necessary?

Knowledge Gap: Chemical Peak Attenuation

- Regarding short-term discharges of chemicals into the wastewater collection system -
- "… incorporating a final treatment process … after the advanced water treatment train may result in some "averaging" of these potential chemical peaks."
  - How much "averaging" is necessary and how do we specify it?

Finally …

- Draft DPR criteria and then invite the water industry to challenge them with all imaginable proposals to make sure they will always assure safe DPR projects