

Identifying the amount of wastewater that is available and feasible to recycle in California

WRF 4962

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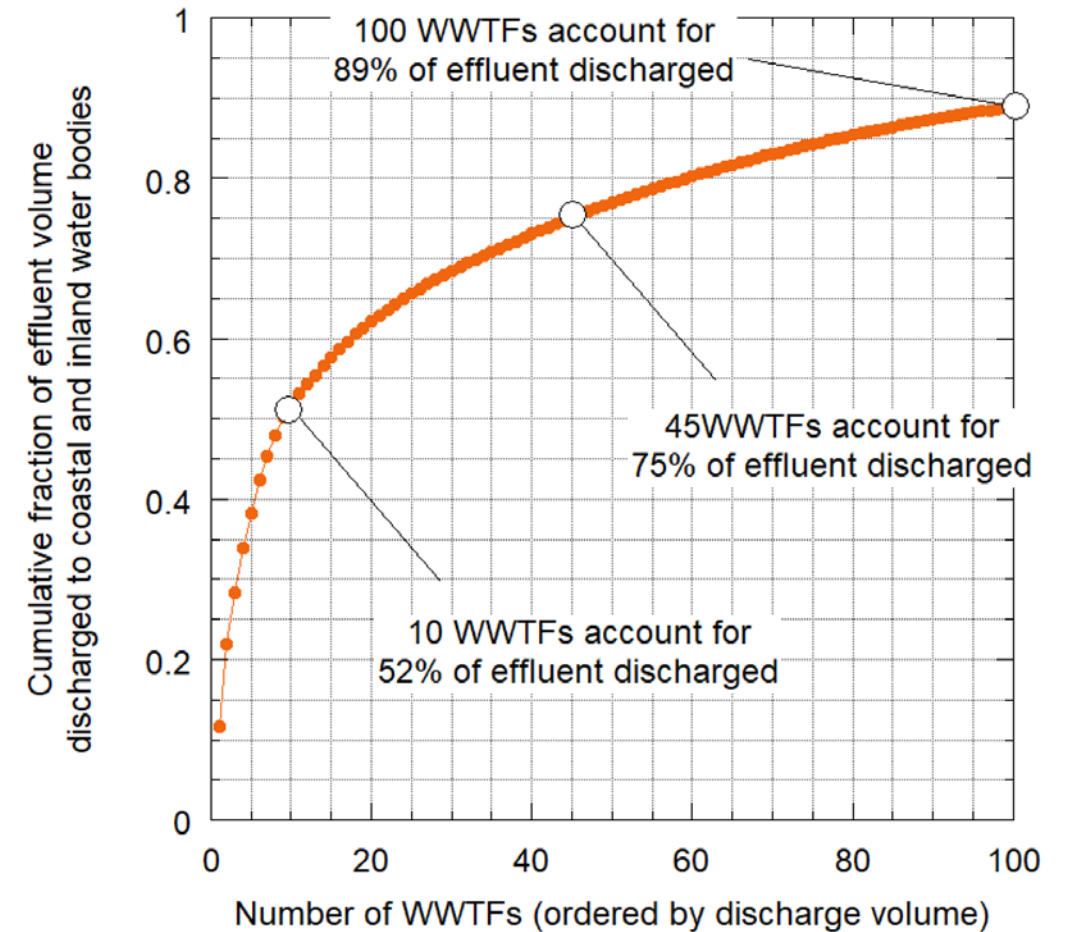
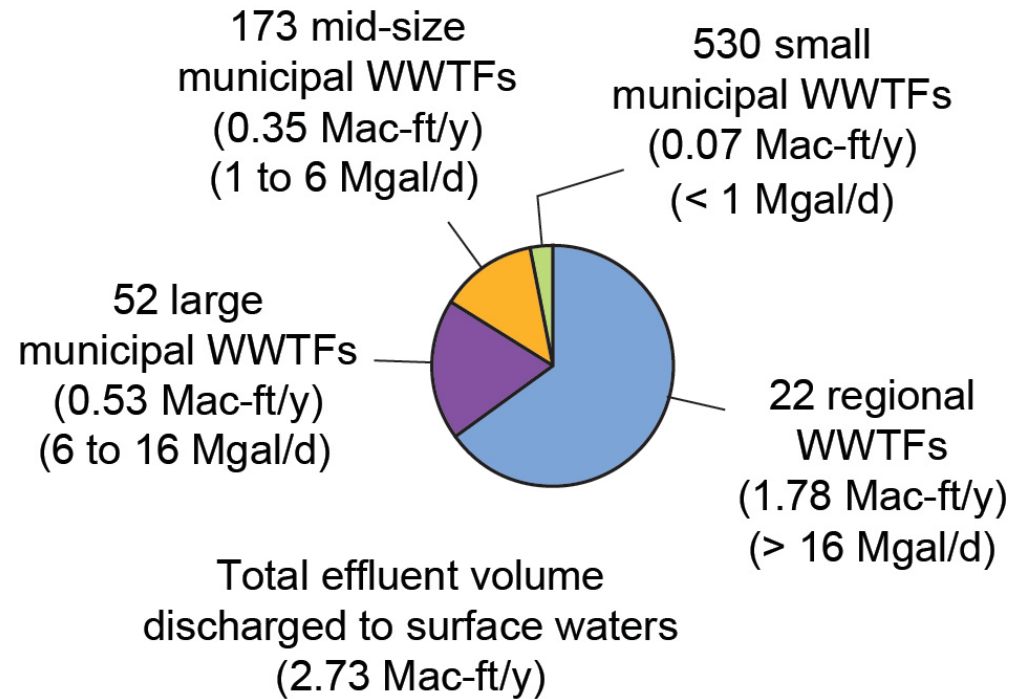
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Project Coordinator

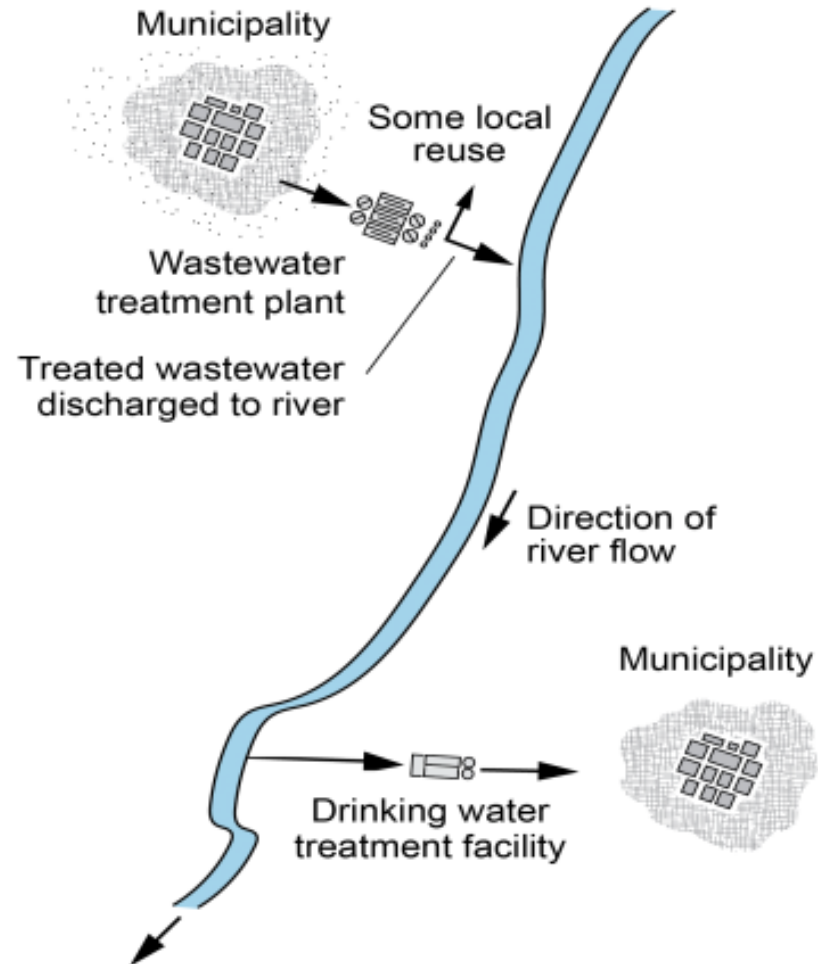
Topics

- Wastewater Management in CA
- Overview of Water Reuse in CA
- Views on Water Reuse in CA
- Obstacles to Water Reuse
- Approach for Modeling Feasibility of Expanded Water Reuse

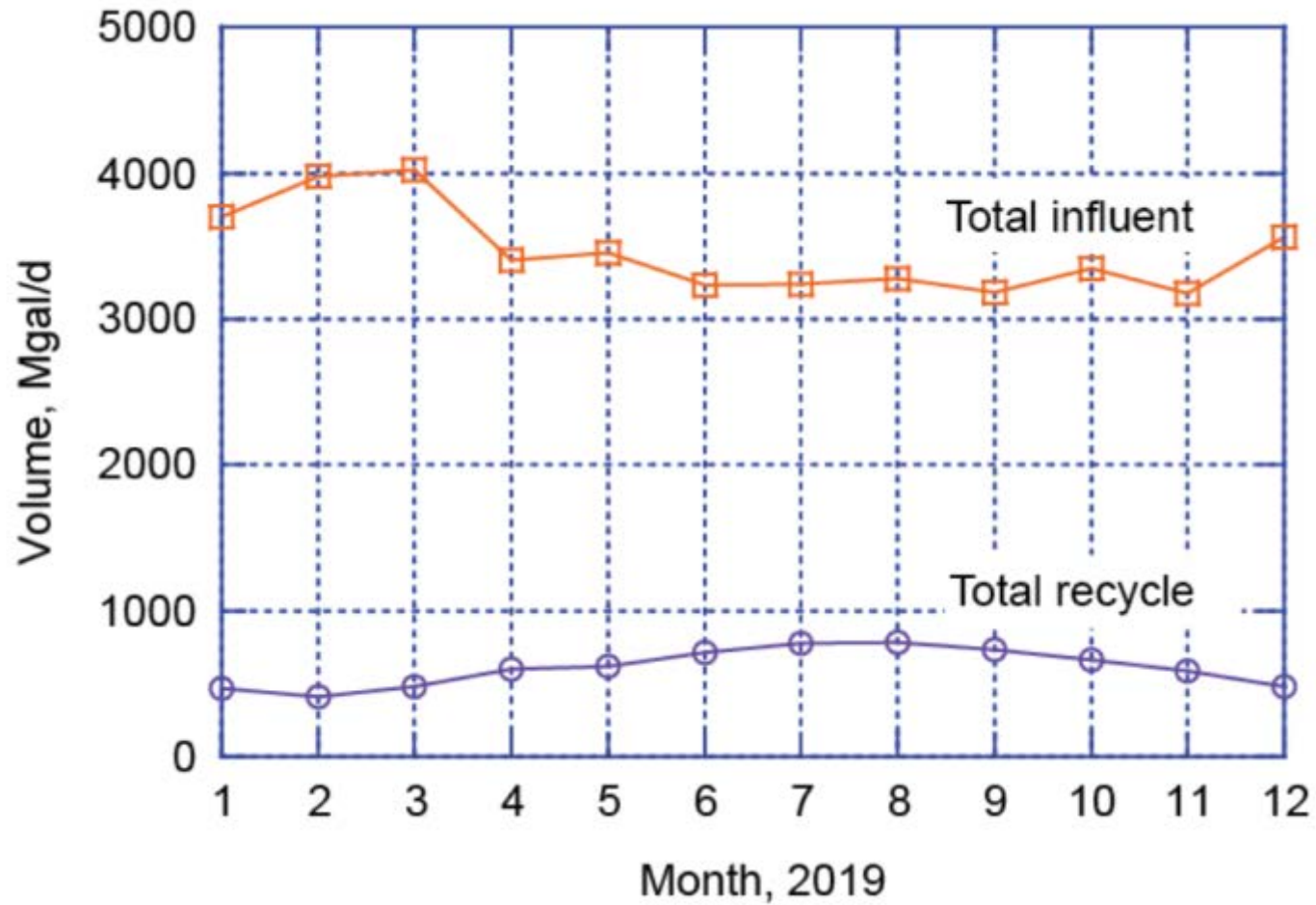
Wastewater Management in CA



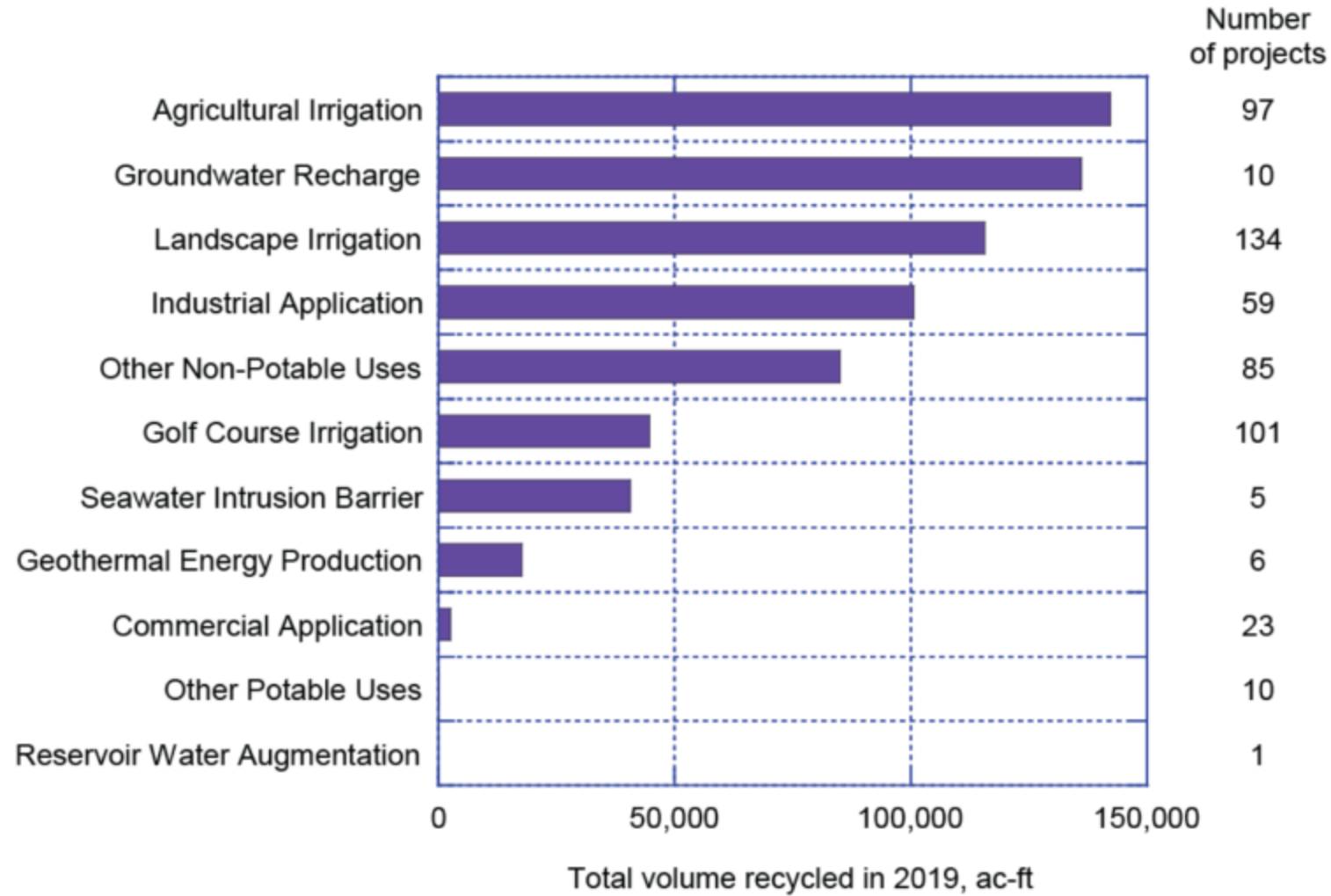
CURRENT [INLAND] EFFLUENT DISPERSAL PRACTICE: *de facto* indirect reuse



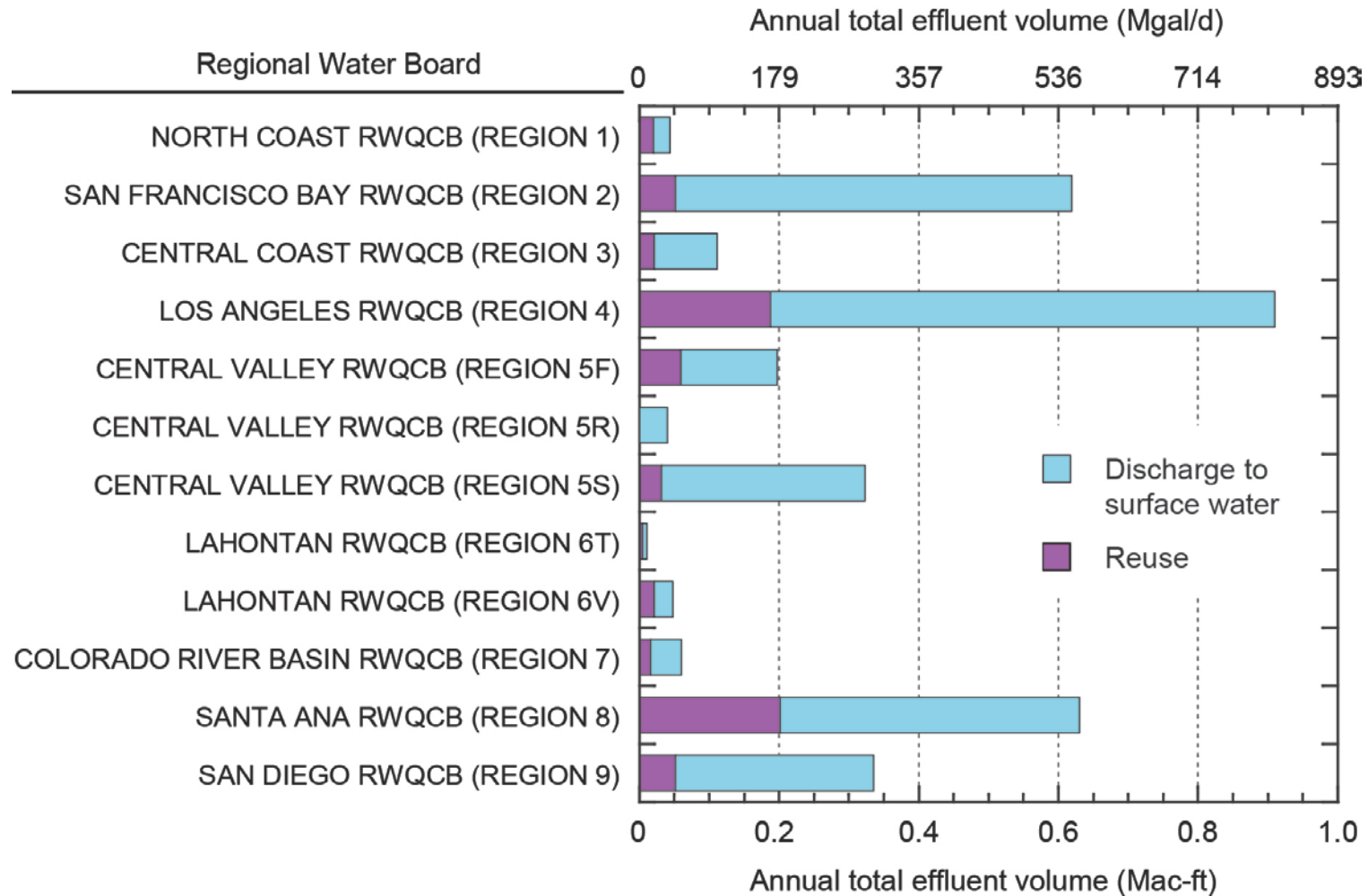
Overview of Water Reuse in CA



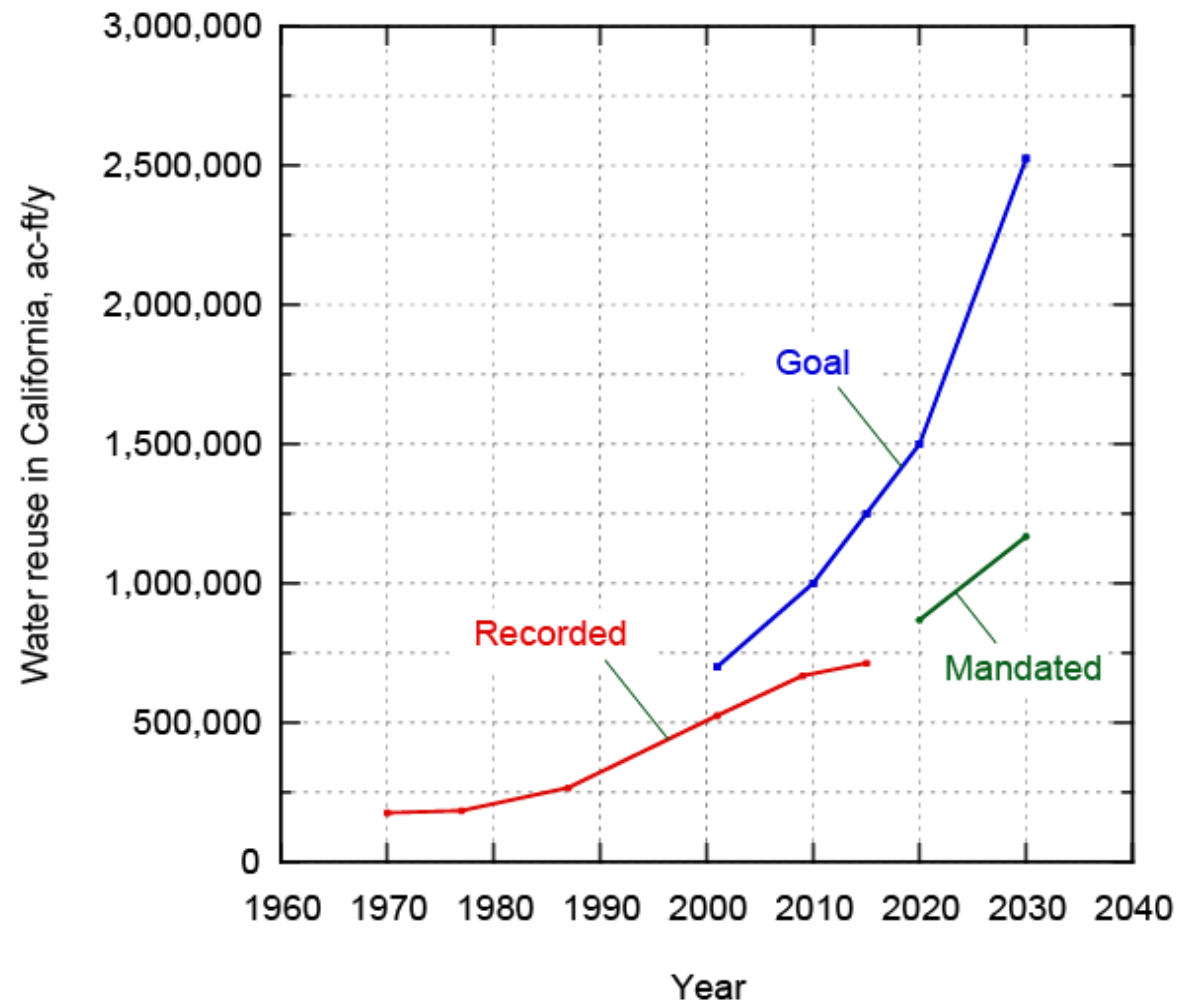
Overview of Water Reuse in CA



Overview of Water Reuse in CA



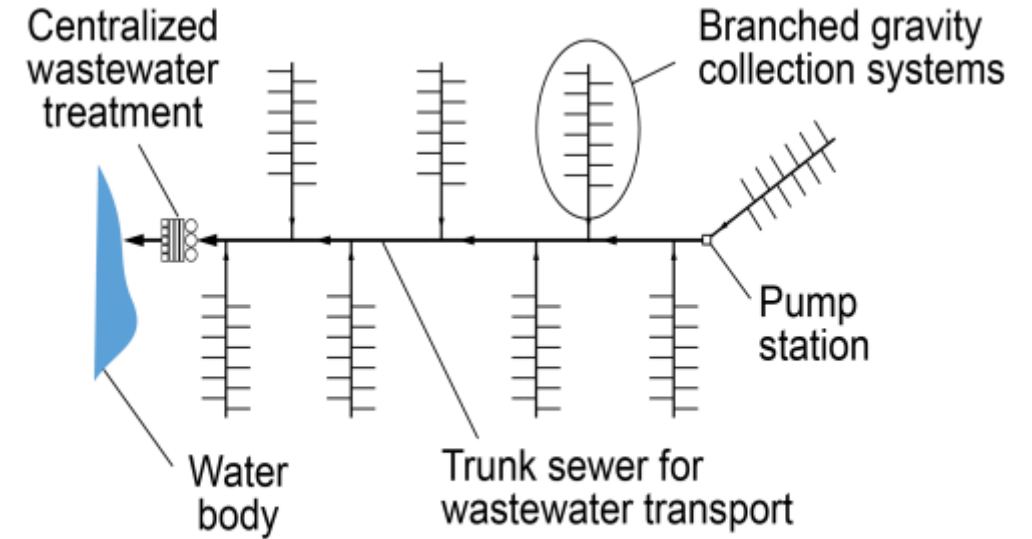
Views on Water Reuse in CA



Some Obstacles to Water Reuse

- Unintended consequences of past decisions
 - 20th century infrastructure
- Dynamic conditions
 - Impacts on water supply from drought
 - Changes in population
 - Changes in how we use water
- Cost
 - Capital, operations, and permit compliance
- No perceived threat to existing water supply

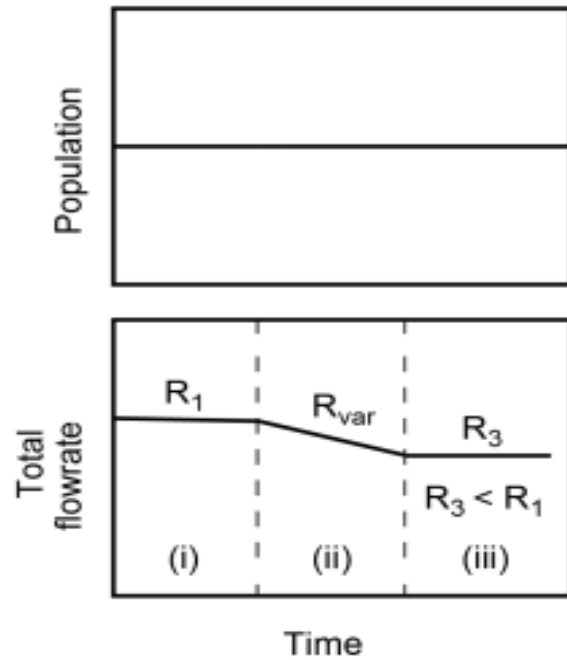
20th Century Infrastructure



Conventional wastewater infrastructure

- Conventional wastewater infrastructure
- Not well adapted to low flow scenarios
 - Vulnerabilities with climate change
 - Limits some water reuse opportunities

Changing Patterns in Water Use



(i) Pre-1992

(ii) Improved water conservation

(iii) Maximum water conservation

Use	Flow, gal/capita•d					
	2015		2020		2030	
	Range	Typical	Range	Typical	Range	Typical
Domestic						
Indoor use	40 - 80	60	35 - 65	55 (50)	30 - 60	40 (35)
Outdoor use	16 - 50	35	16 - 50	35	16 - 50	35
Commercial	10 - 75	40	10 - 70	35	10 - 65	30
Public	15 - 25	20	15 - 25	18	15 - 25	15
Loss and waste	15 - 25	20	15 - 25	18	15 - 25	15
Total	96 - 255	175		161		135

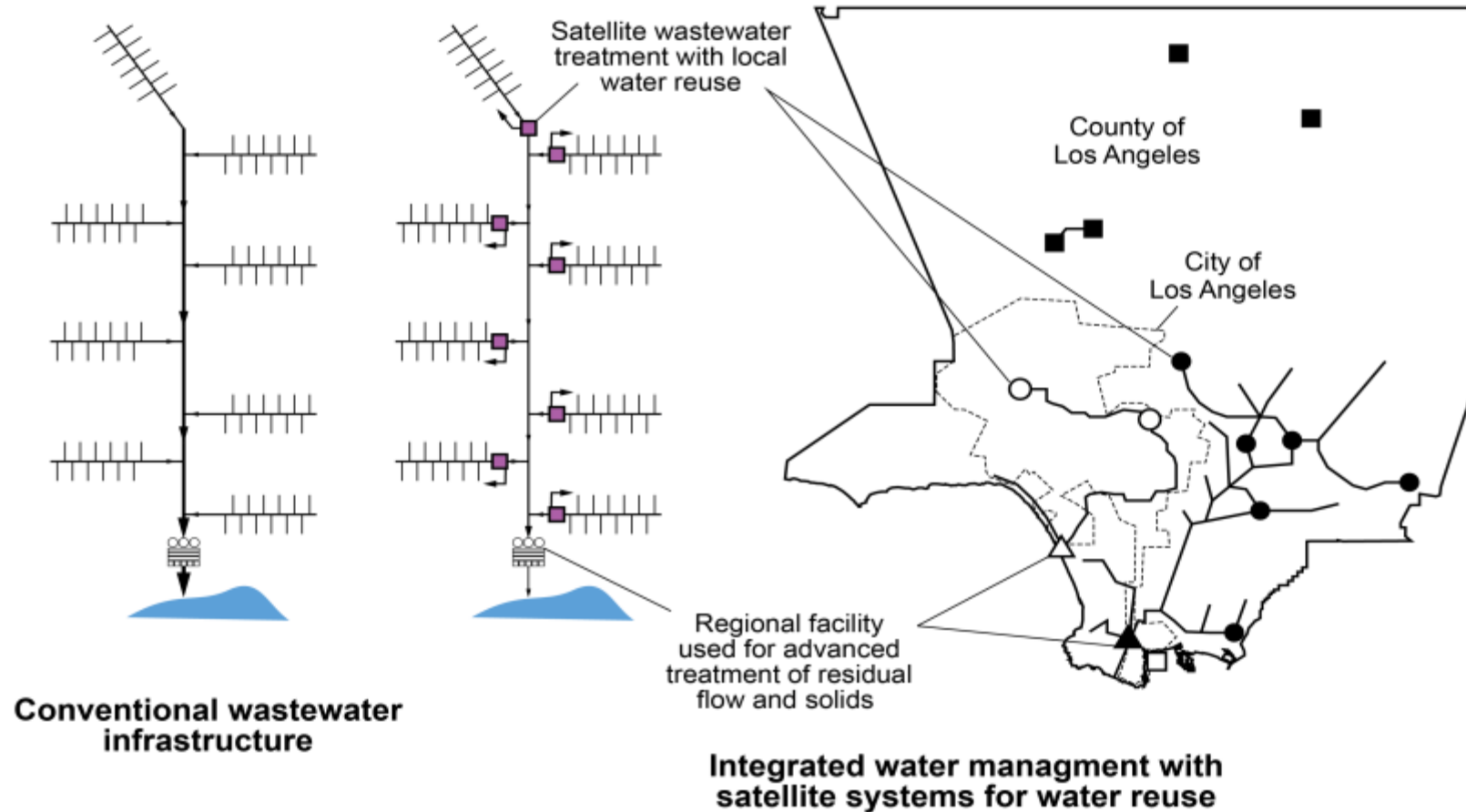
Changing Wastewater Constituent Concentrations

Constituent	Unit	Typical value	Concentration, mg/L	
			Volume, L/capita•d (gal/capita•d)	
			380 (100)	190 (50)
BOD ₅	g/capita•d	76	199	400
COD	g/capita•d	193	507	1016
TSS	g/capita•d	74	195	389
TKN as N	g/capita•d	13.2	35	70
Total P as P	g/capita•d	2.1	5.6	11
Potassium	g/capita•d	6.1	16	32
Oil and grease	g/capita•d	29	76	153

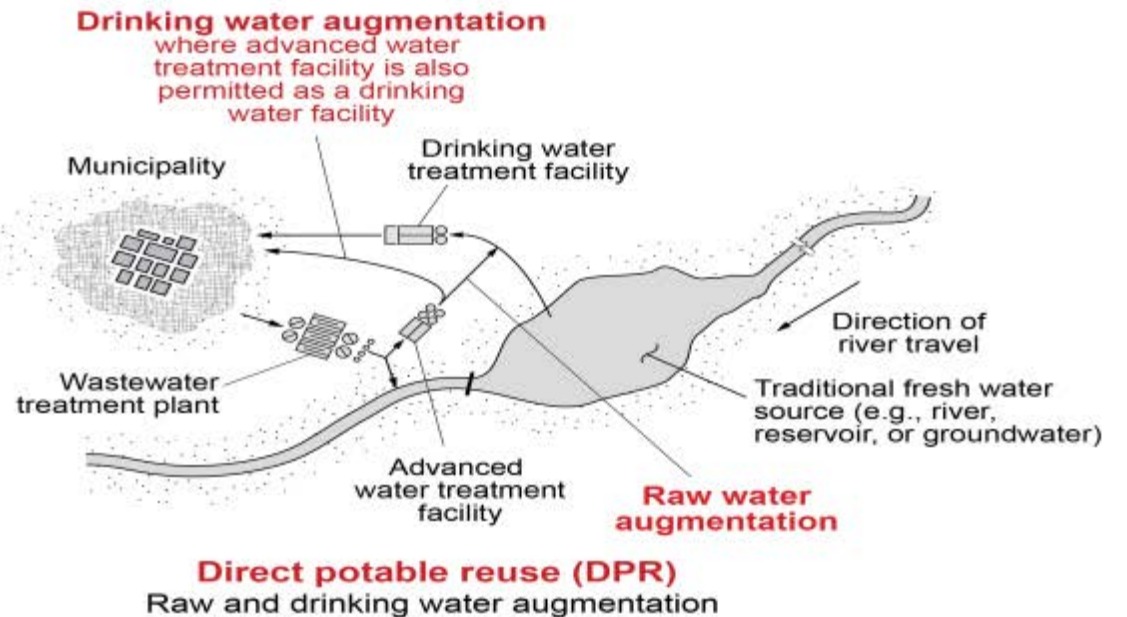
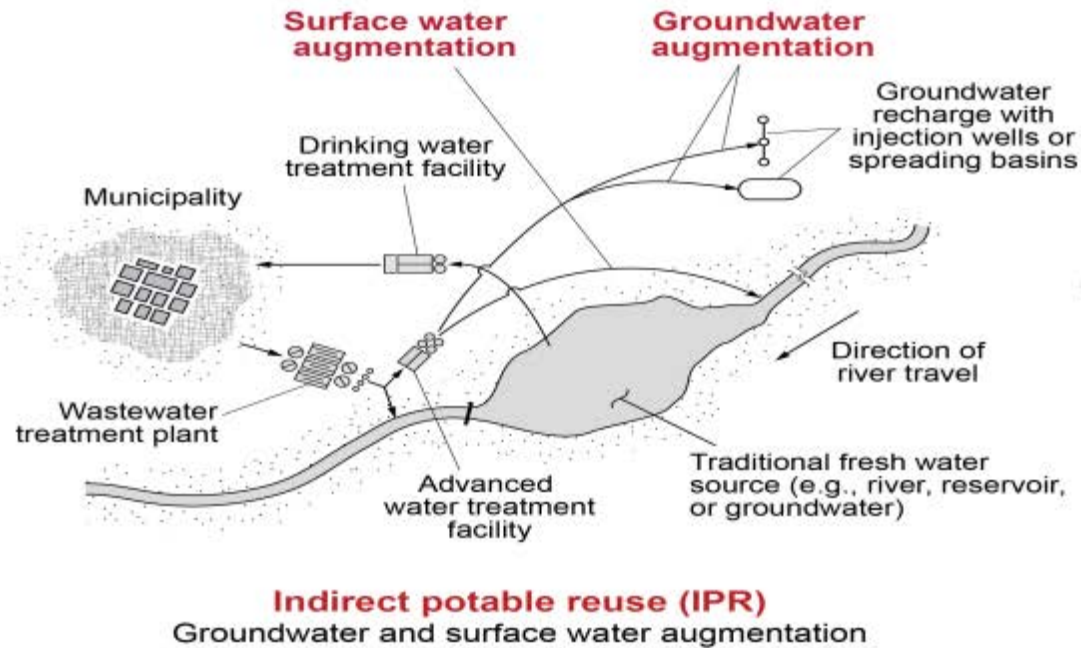
Some considerations for Water Reuse

- Decentralized Water Reuse
- Potable Reuse
- Integrated Water Management

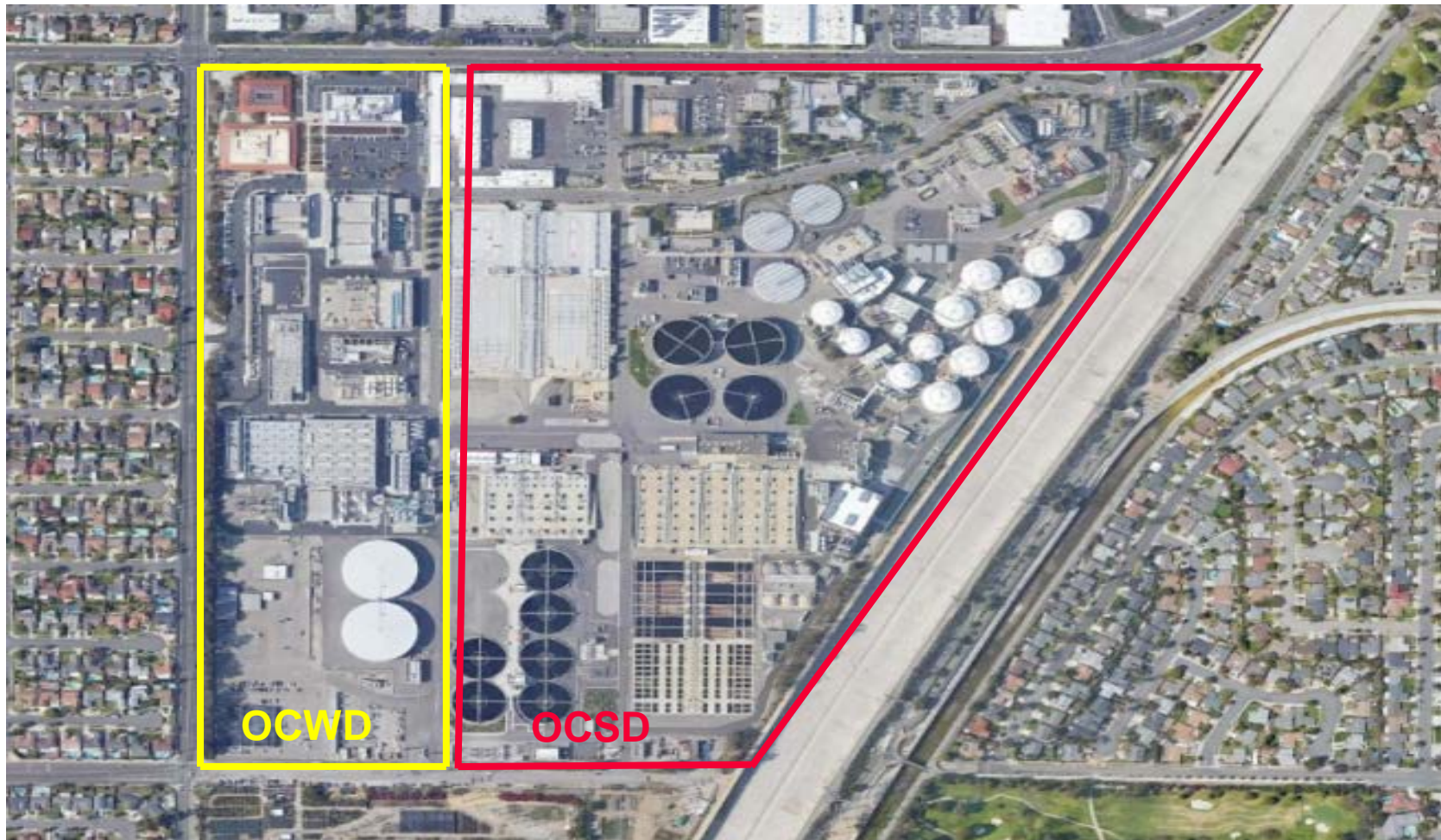
Decentralized Water Reuse



Potable Reuse



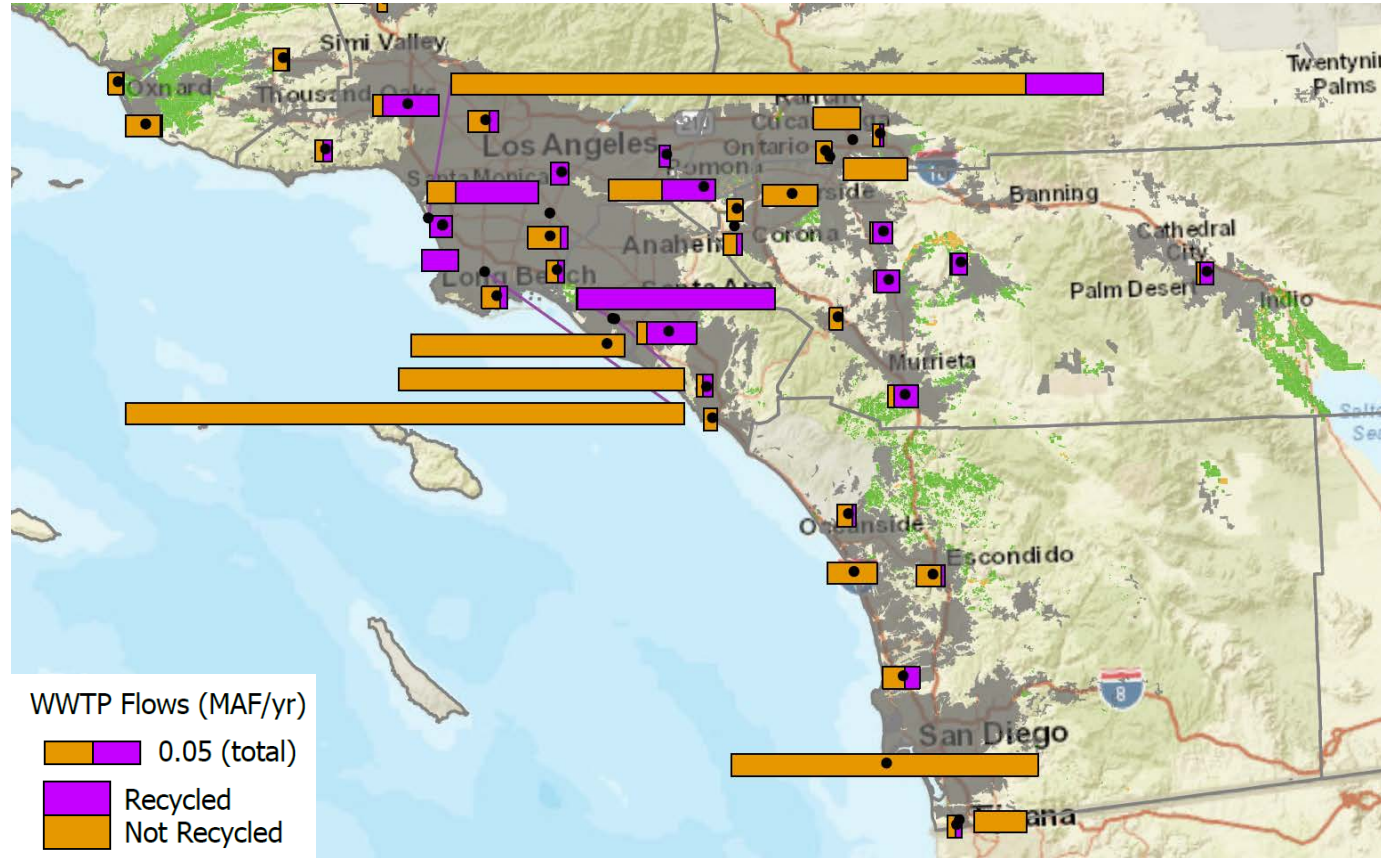
Integrated Water Management



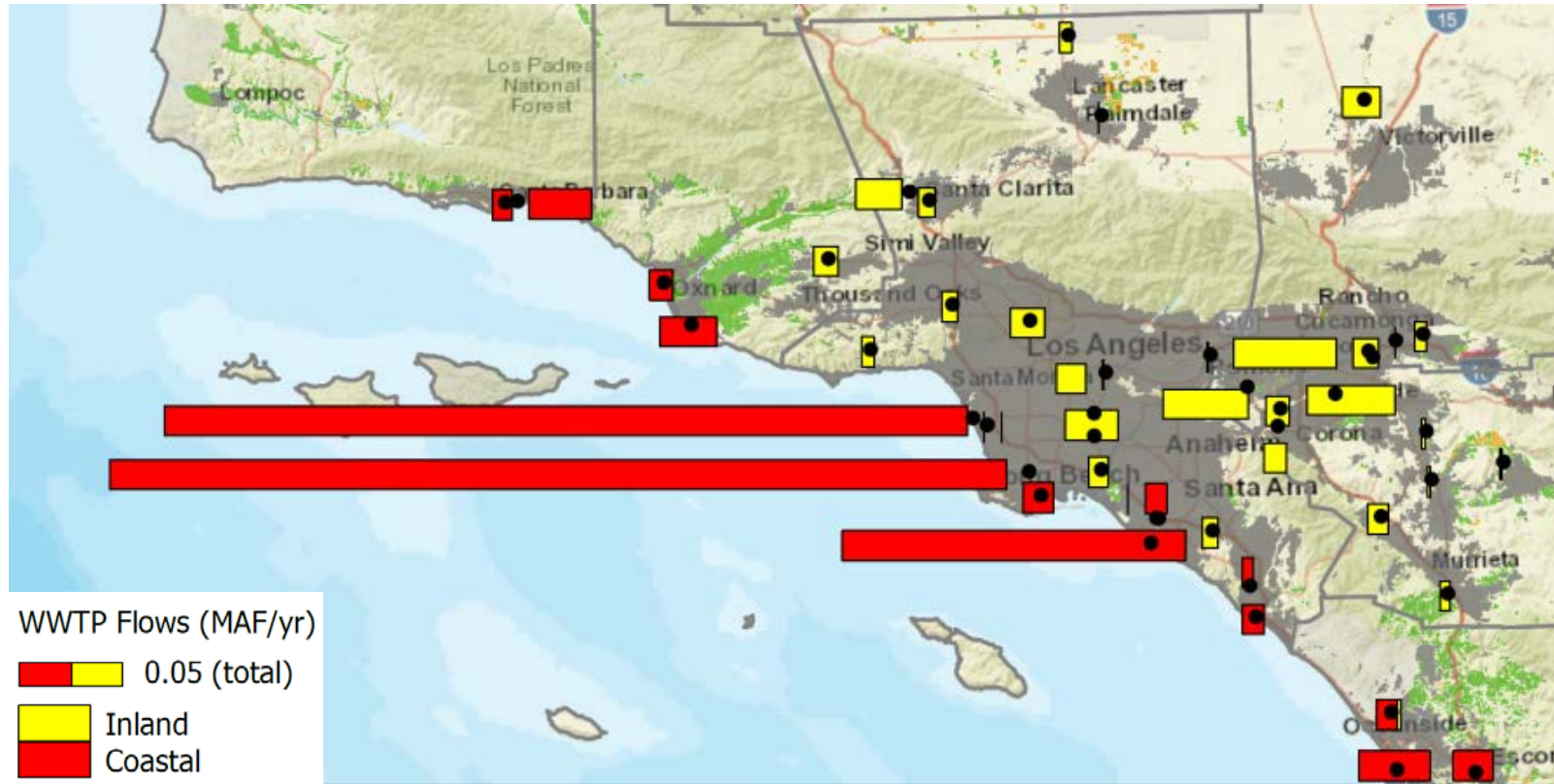
Approach for Modeling Feasibility of Expanded Water Reuse

- Spatial distribution of volume and quality for current discharges (AcrGIS)
- Focus on top 100 largest facilities
- Economic model
 - Cost to upgrade effluent quality
 - Cost to reach reuse sites (cost-path analysis)
- Flow balance corrections
 - Current dry weather flow
 - Population change
 - Water loss with solids
 - Correction for reductions in indoor water use
 - Correction for water loss with concentrate management

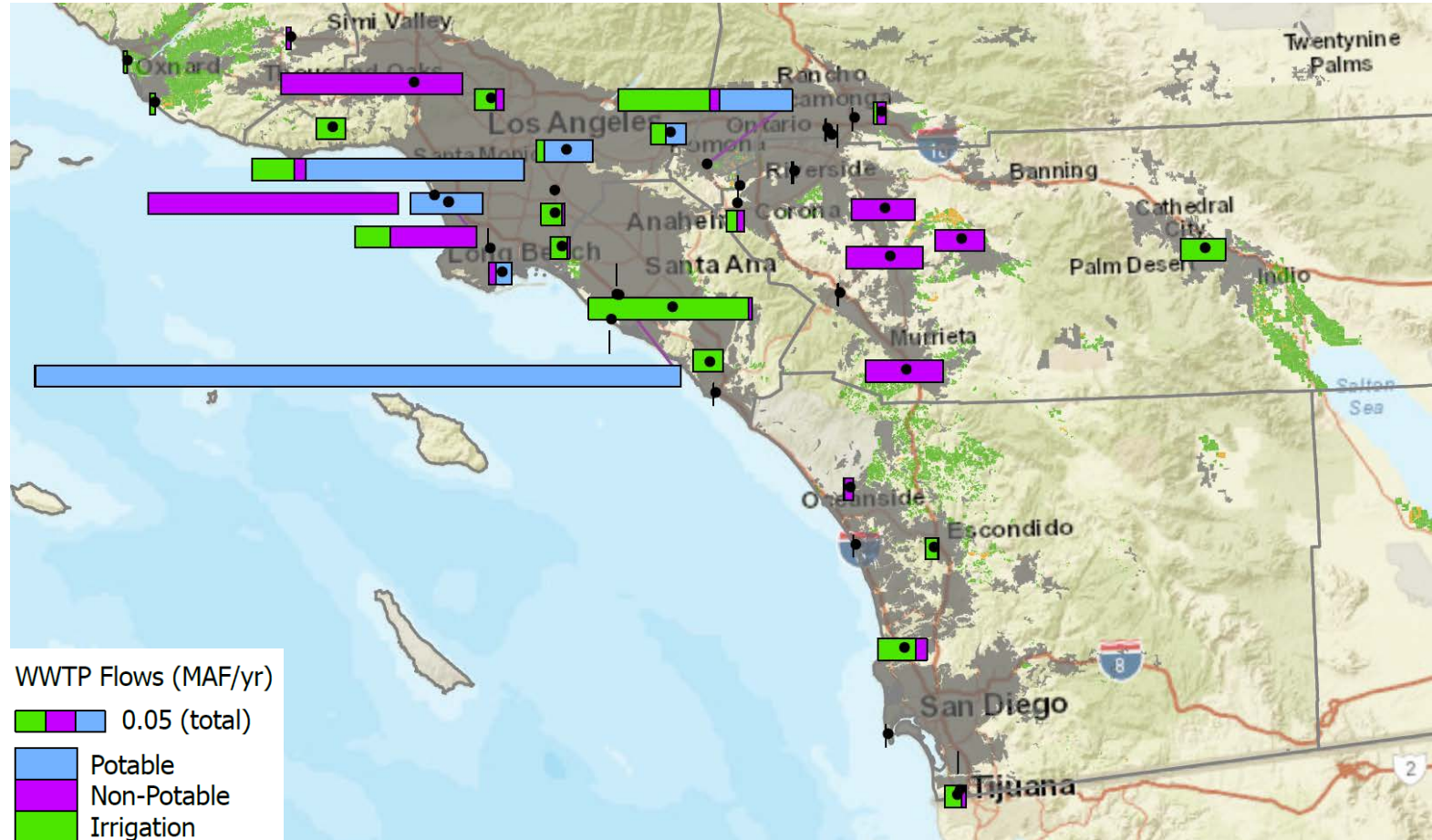
Spatial Distribution of Effluent and Reuse Areas



Spatial Distribution of Effluent and Reuse Areas



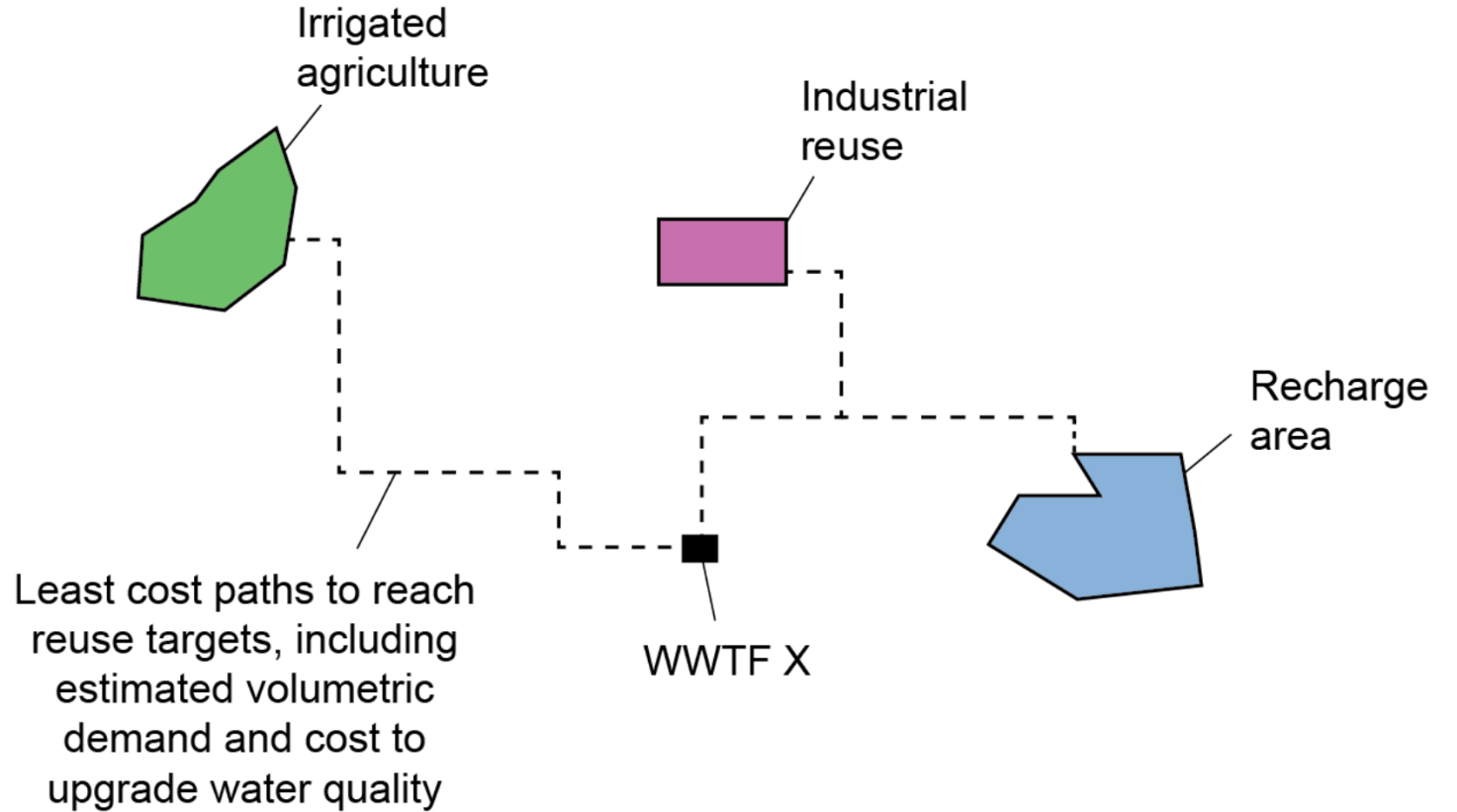
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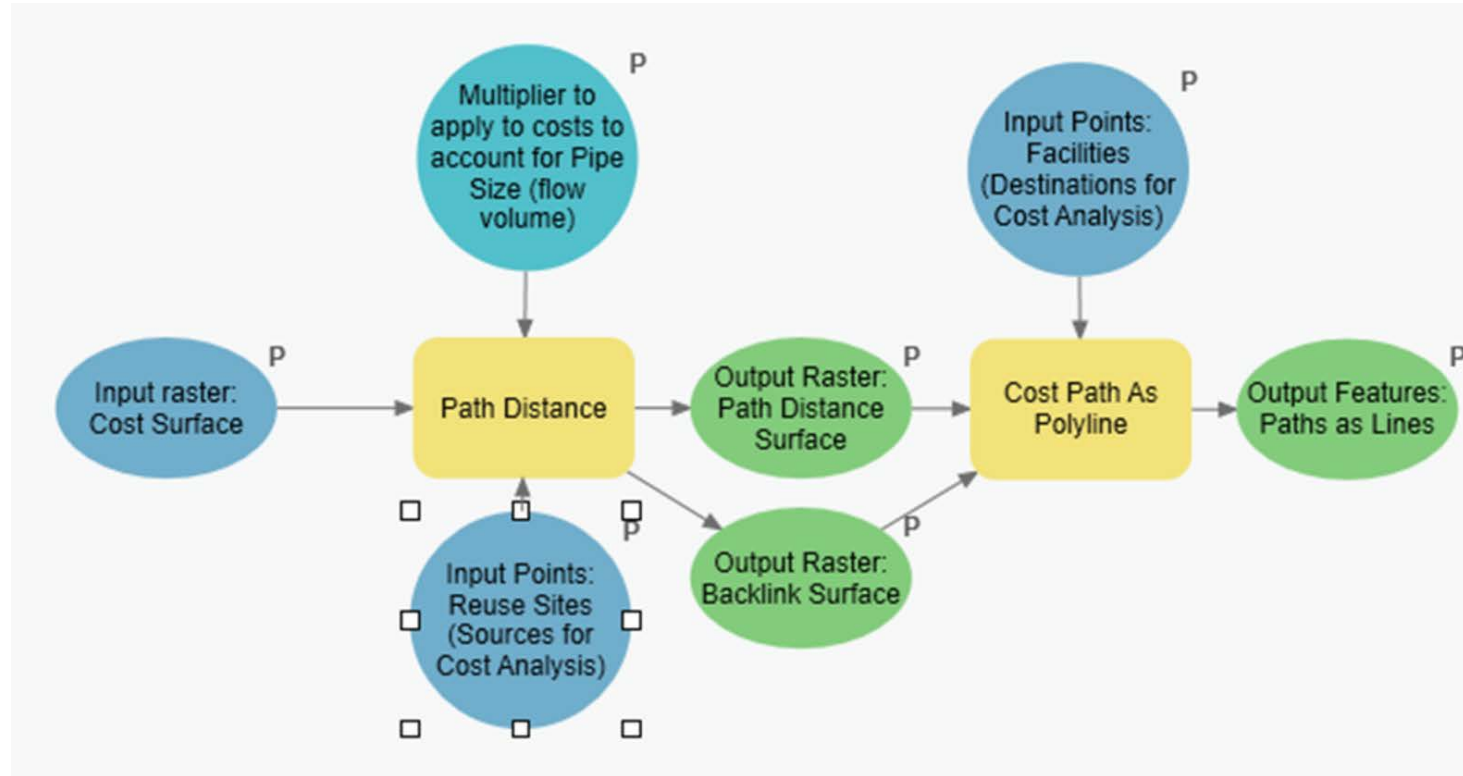
Locating Targets for Water Reuse

Potential reuse site databases:

- Agricultural reuse
- Commercial and industrial non-potable sites
- Groundwater recharge (surface infiltration)
- Groundwater recharge (injection)
- Water supply reservoir locations
- Direct raw water and potable water augmentation



Calculation of cost to reach reuse sites



Recycled Water Production Cost Matrix

Establish a simplified matrix for a magnitude-of-order estimate

- Treatment levels associated with end use categories
 - A. Restricted, non-potable reuse: Secondary + Disinfection
 - B. Unrestricted, non-potable reuse: Secondary + Tertiary filtration + Enhanced disinfection
 - C. Potable Reuse: Secondary + Advanced Treatment + Enhanced disinfection + Multi barrier/ Engineered buffer

Existing Treatment Plant	A. Restricted Non-potable Reuse	B. Unrestricted Non-potable Reuse	C. Potable Reuse
Secondary + Disinfection	No modification	Filtration + Enhanced disinfection	Advanced treatment + Enhanced disinfection + Multi-barrier/ Engineered buffer
Secondary + Tertiary filtration + Enhanced disinfection	No modification	No modification	Advanced treatment + Enhanced disinfection + Multi-barrier/ Engineered buffer
Secondary + Advanced treatment + Enhanced disinfection + Multi-barrier/ Engineered buffer	No modification	No modification	No modification

Recycled Water Production Cost Matrix

Existing Treatment Plant	A. Restricted Non-potable Reuse	B. Unrestricted Non-potable Reuse	C. Potable Reuse
	\$/AF treated, 30-yr project period		
A	0	100	700
B	0	0	700
C	0	0	0

Reference: Tchobanoglous et al. 2017

Recycled Water Production O&M Cost Matrix

Existing Treatment Plant	A. Restricted Non-potable Reuse	B. Unrestricted Non-potable Reuse	C. Potable Reuse
	Additional cost on top of existing facility		
A	20	60	450
B	10	60	450
C	0	0	0

Reference: Tchobanoglous et al. 2017

Preliminary Output

					Cost based on available flow							
	Available Q MGD	Available Q AFY	Existing process	Target process	30-yr Project Cost	Annual O&M cost	Target process	30-yr Project Cost	Annual O&M cost	Target process	30-yr Project Cost	Annual O&M cost
Plant 1	50	56005	A	A	\$0	\$1,120,100	B	\$561,792,012	\$3,360,300	C	\$3,932,544,082	\$25,202,250
Plant 2	5	5601	A	A	\$0	\$112,010	B	\$9,990,232	\$336,030	C	\$69,931,622	\$2,520,225
Plant 3	10	11201	A	A	\$0	\$224,020	B	\$33,603,000	\$672,060	C	\$235,221,000	\$5,040,450
Plant 4	20	22402	A	A	\$0	\$448,040	B	\$113,026,569	\$1,344,120	C	\$791,185,983	\$10,080,900
Plant 5	30	33603	A	A	\$0	\$672,060	B	\$229,794,827	\$2,016,180	C	\$1,608,563,788	\$15,121,350
Plant 6	100	112010	A	A	\$0	\$2,240,200	B	\$1,889,635,555	\$6,720,600	C	\$13,227,448,885	\$50,404,500
Plant 7	65	72807	A	A	\$0	\$1,456,130	B	\$889,152,852	\$4,368,390	C	\$6,224,069,967	\$32,762,925

Refinement:

- Calibration of overall cost using actual project cost data
- Inclusion of Available Volume (counting loss through treatment, e.g., RO concentrate)
- Integration with GIS-based end-use model (conveyance cost, potential demand/seasonality)

Data and Input Needs for Model Calibration

- Cases where there could be challenges diverting effluent from an existing discharge
- For facilities greater than 6 Mgal/d, details for known or potential significant reuse projects:
 - Coordinates
 - Type of reuse
 - Volume required
 - Cost

Questions or contributions?

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