

Source, Fate and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California

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Research Objectives

- **Assess the source and occurrence of a suite of endocrine disrupting compounds (EDCs), pharmaceuticals and personal care products (PPCPs)**
- **Fate and transport**
- **On a seasonal basis**
- **During selected wastewater spill events**
- **In three major drinking water sources in California.**

Significance of the Project

- **Occurrence data on EDCs and PPCPs in major watersheds supplying drinking water to California are limited**
 - **Impact of treated wastewater on drinking water supplies for emerging chemicals not fully understood**
- **Better characterization of EDCs and PPCPs in treated wastewater effluents used as source water for groundwater recharge**

Significance of the Project (cont'd)

- **Information is needed for:**
 - **source water characterization**
 - **public communication**
- **Opportunity for a collaborative effort among multiple agencies:**
 - **National Water Research Institute (NWRI)**
 - **Metropolitan Water District of Southern California (MWD)**
 - **Orange County Water District (OCWD)**
 - **California Department of Water Resources (DWR)**
 - **Southern Nevada Water Authority (SNWA)**
 - **Clean Water Coalition (CWC)**

EDCs and PPCPs

Endocrine Disrupting Compounds (EDCs)	Pharmaceuticals	Personal Care Products
	(PPCPs)	
Human, animal, and plant hormones	Prescription drugs	Disinfectants
Detergent residues	Over-the-counter drugs	Deodorants
Plasticizers	Illicit drugs	Fragrances
		Flavoring agents
		Insect repellants
		Sun screens

Occurrence of EDCs and PPCPs

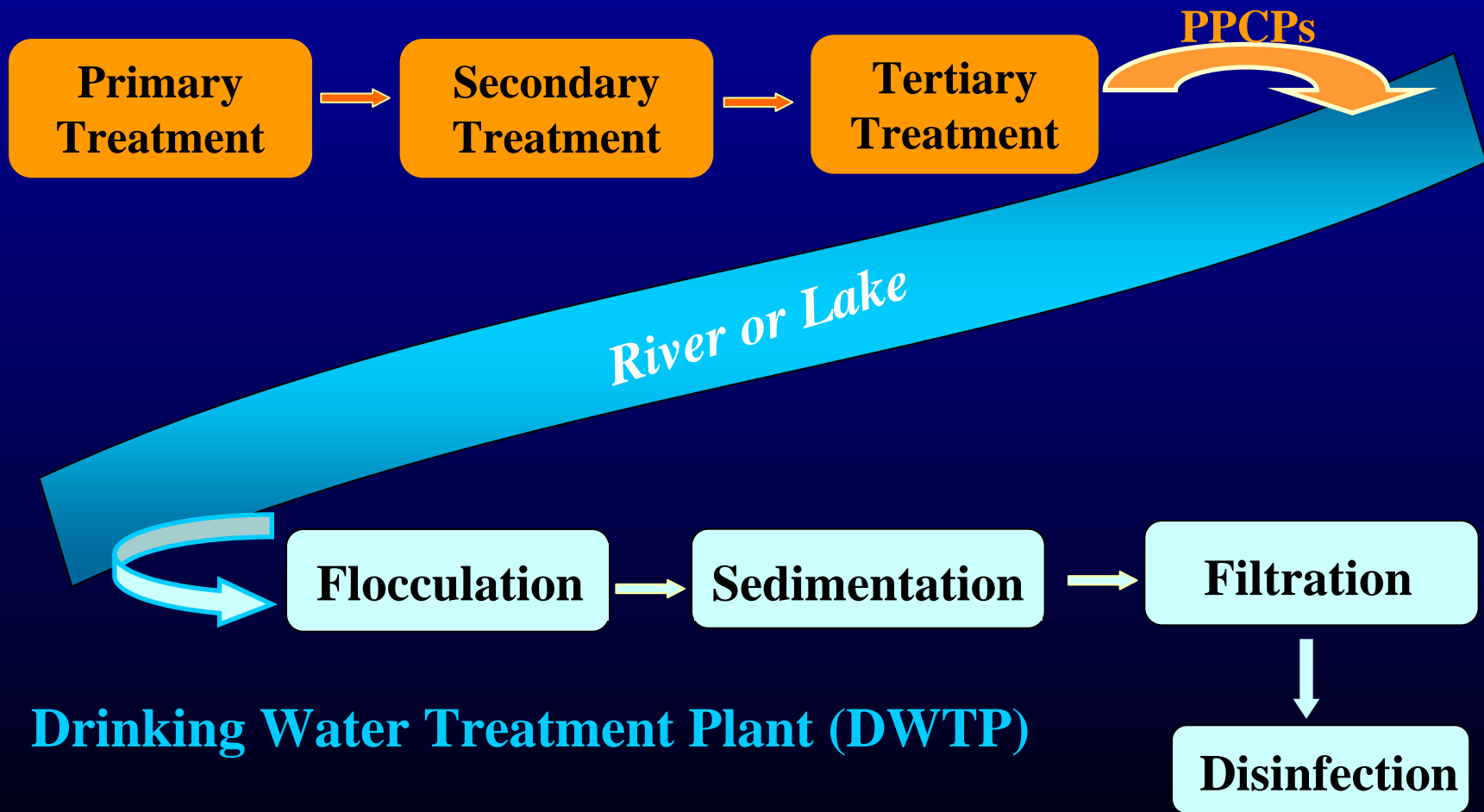
- **Many EDCs and PPCPs have been found across the U. S., as well as around the world, in:**
 - **surface water**
 - **ground water**
 - **finished drinking water**
 - **at ng/L to low ug/L levels**
 - **human health risks unknown**

Key Issues Associated with PPCPs

- PPCPs can enter the aquatic environment (surface and groundwater) through
 - Treated wastewater and industrial discharge
 - Run-off from agricultural operations
 - Leaching of municipal landfills
 - Urban run-off
 - Leaking septic systems
- Population growth, agricultural and industrial development increases potential for source water degradation
- Increase of water recycling and reuse

Impact of Treated Wastewater on Drinking Water Supplies

Wastewater Treatment Plant (WWTP)



Drinking Water Treatment Plant (DWTP)

Project Description

Project Timeline

- **2-year study (begin fall 2007)**
 - **6-month method development**
 - **1-year survey**
 - **Quarterly**
 - **Selected wastewater spill events**
 - **6-month data analysis and report preparation**

Sampling Locations

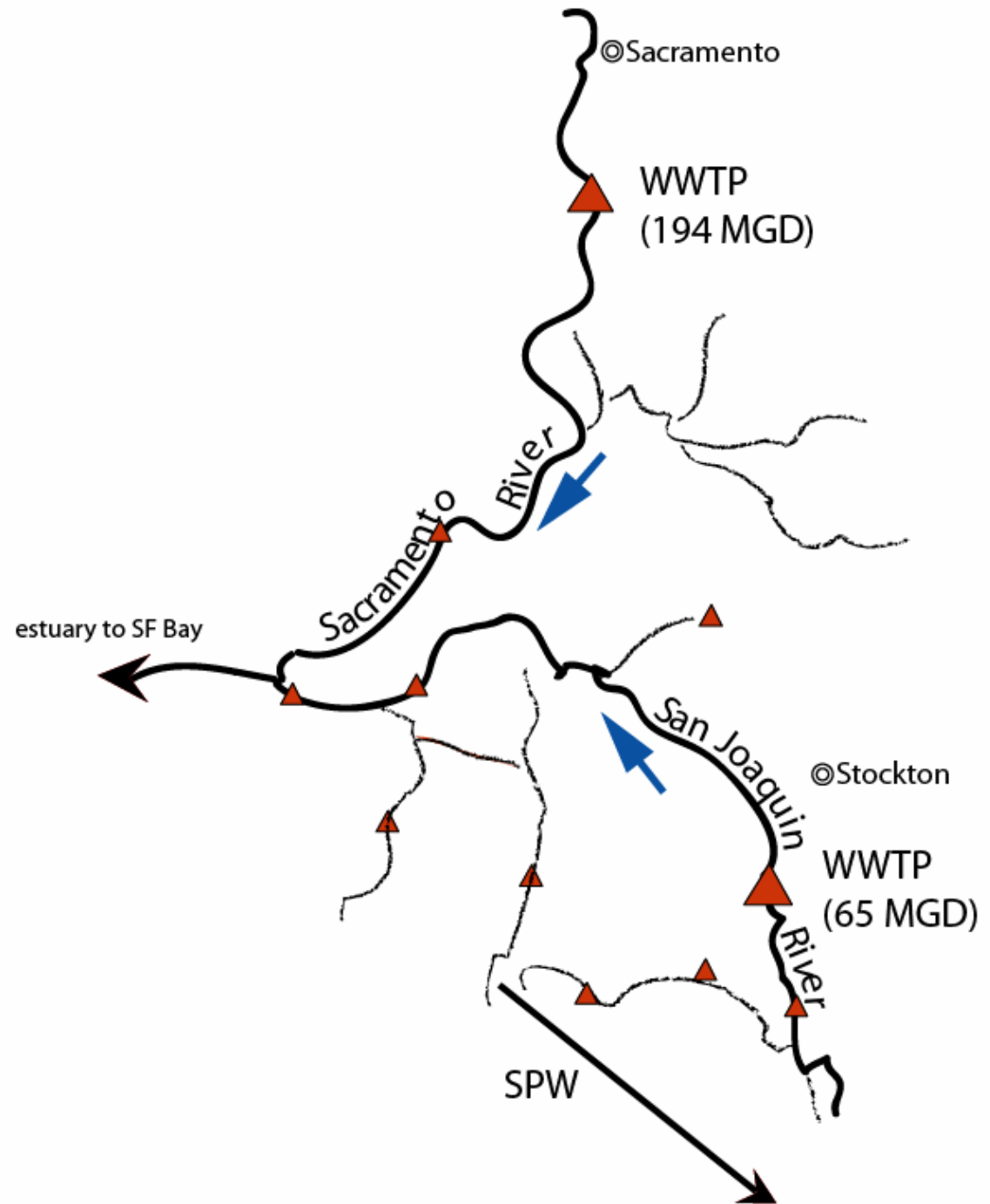
- **Upstream and downstream of wastewater discharges**
- **Selected WWTP effluents**
- **Selected points along the river/aqueduct and storage reservoirs**
- **Utilizing existing sampling stations**

Three Major Drinking Water Sources in California



The Delta (SPW)

- 11 WWTPs (▲)
- Total 339 MGD
- Agricultural operations throughout the area



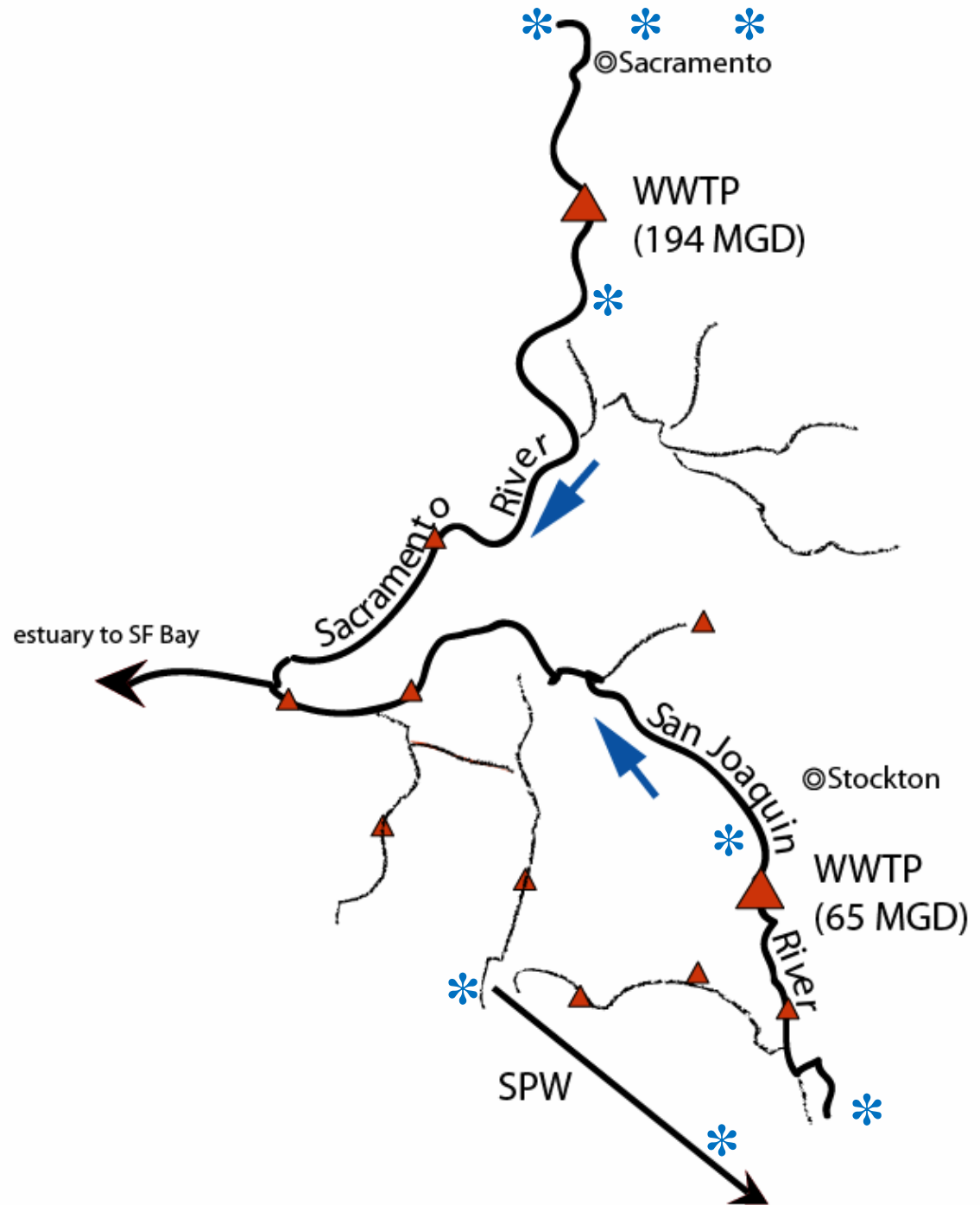
Sampling Locations in the SPW System

Sampling Location	Significance of the Location
Natomas East Main Drainage Canal	Urban Drainage
American River at E.A. Fairbairn DWTP	---
Sacramento River at West Sacramento DWTP Intake	Upstream of WWTP
Effluent of WWTP in Delta Region (tentative)	WWTP Effluent
Sacramento River at Hood	Downstream of WWTP
San Joaquin River near Vernalis	Upstream of WWTP
San Joaquin River at Stockton	Downstream of WWTP
H. O. Banks Pumping Plant	Intake from Delta
O'Neill Forebay (Check 13)	Integration Point of Delta Output
Check 41	Entry Point to Southern California; Agricultural Runoff from Central Valley
East Branch SPW at Devil Canyon	---
West Branch SPW at Foothill PCS	---

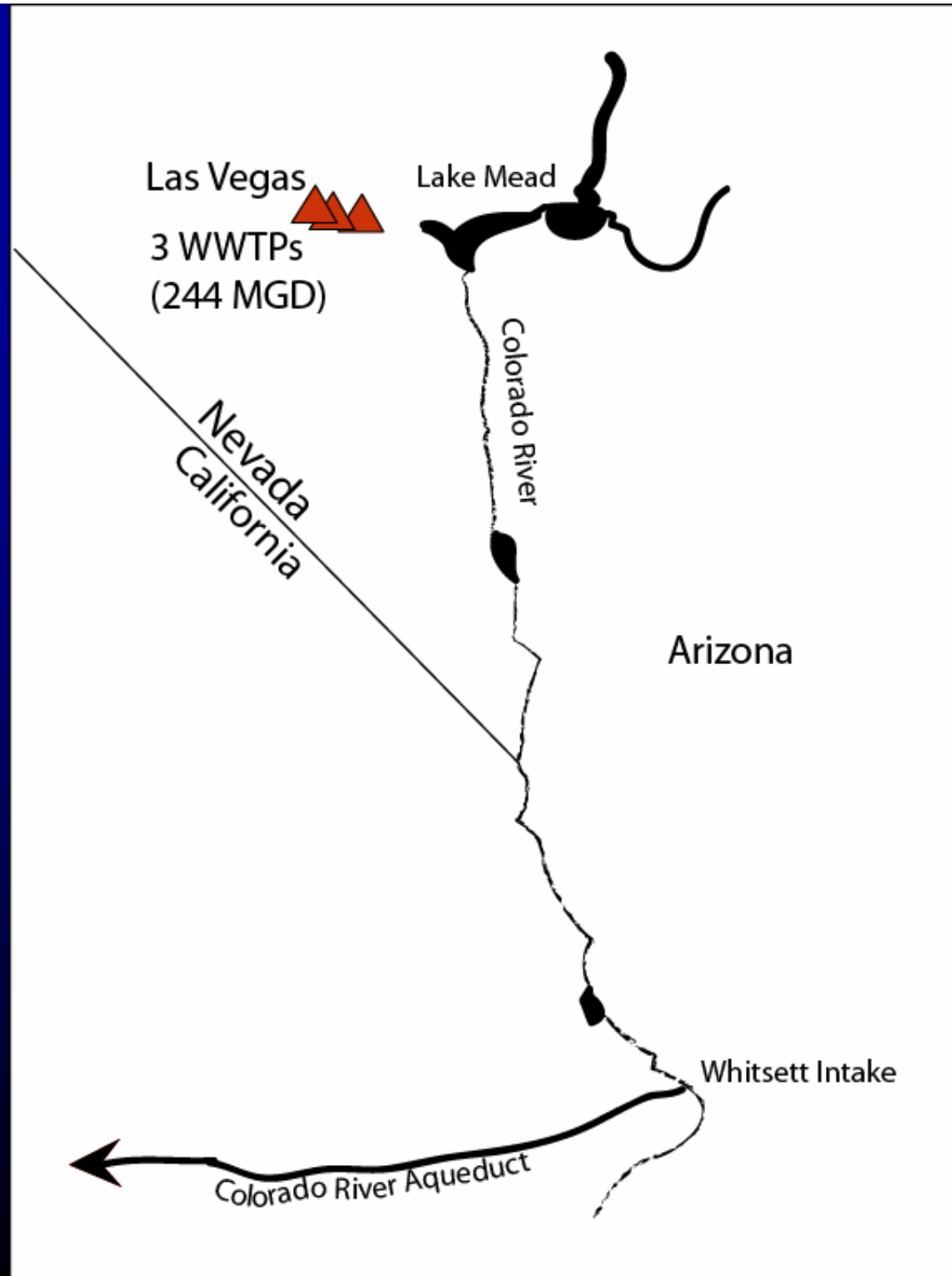
The Delta (SPW)

- 11 WWTPs (▲)
- Total 339 MGD
- Agricultural operations in the area

*Sampling locations



Colorado River Water (CRW)

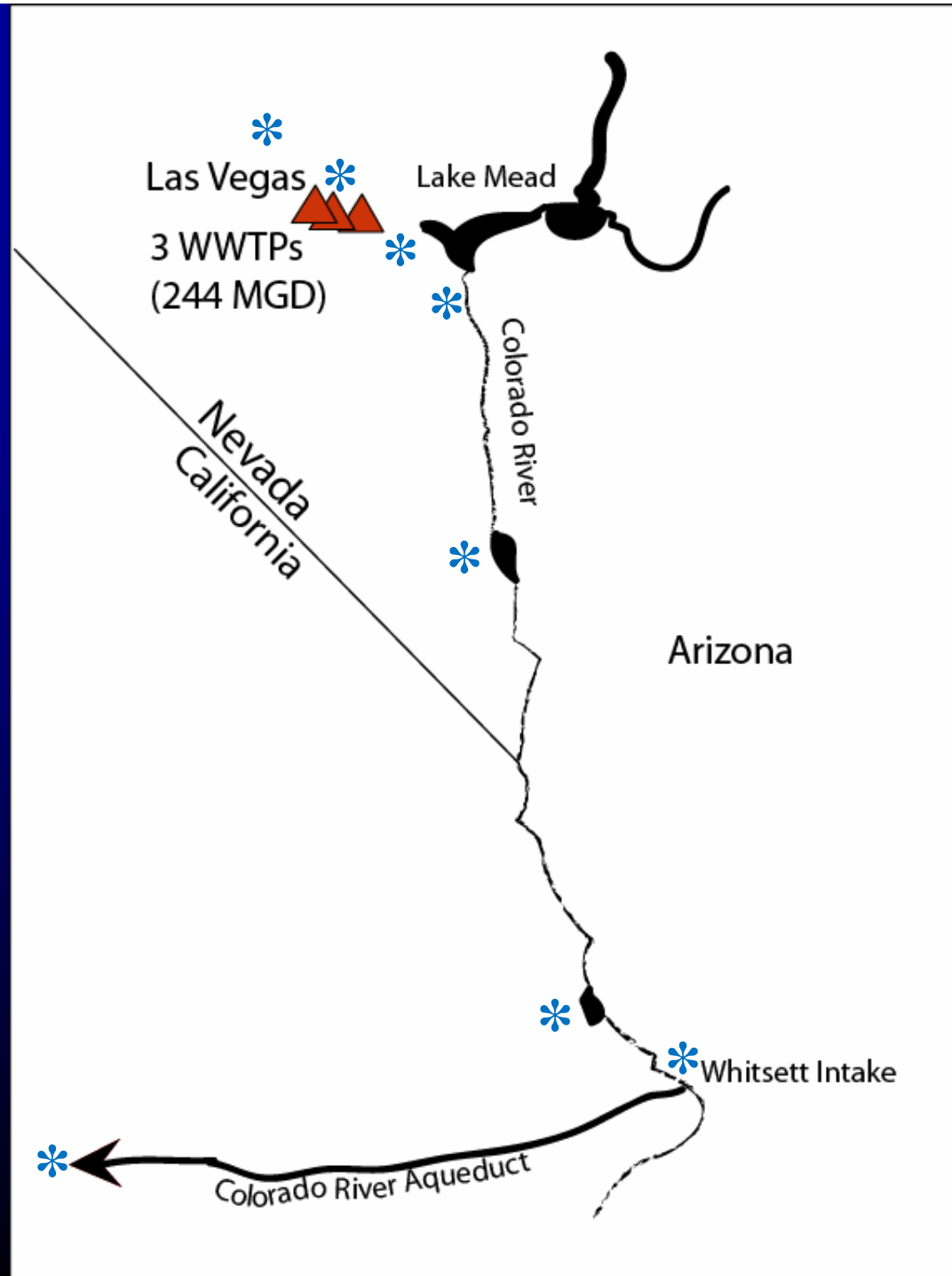


Sampling Locations in the CRW System

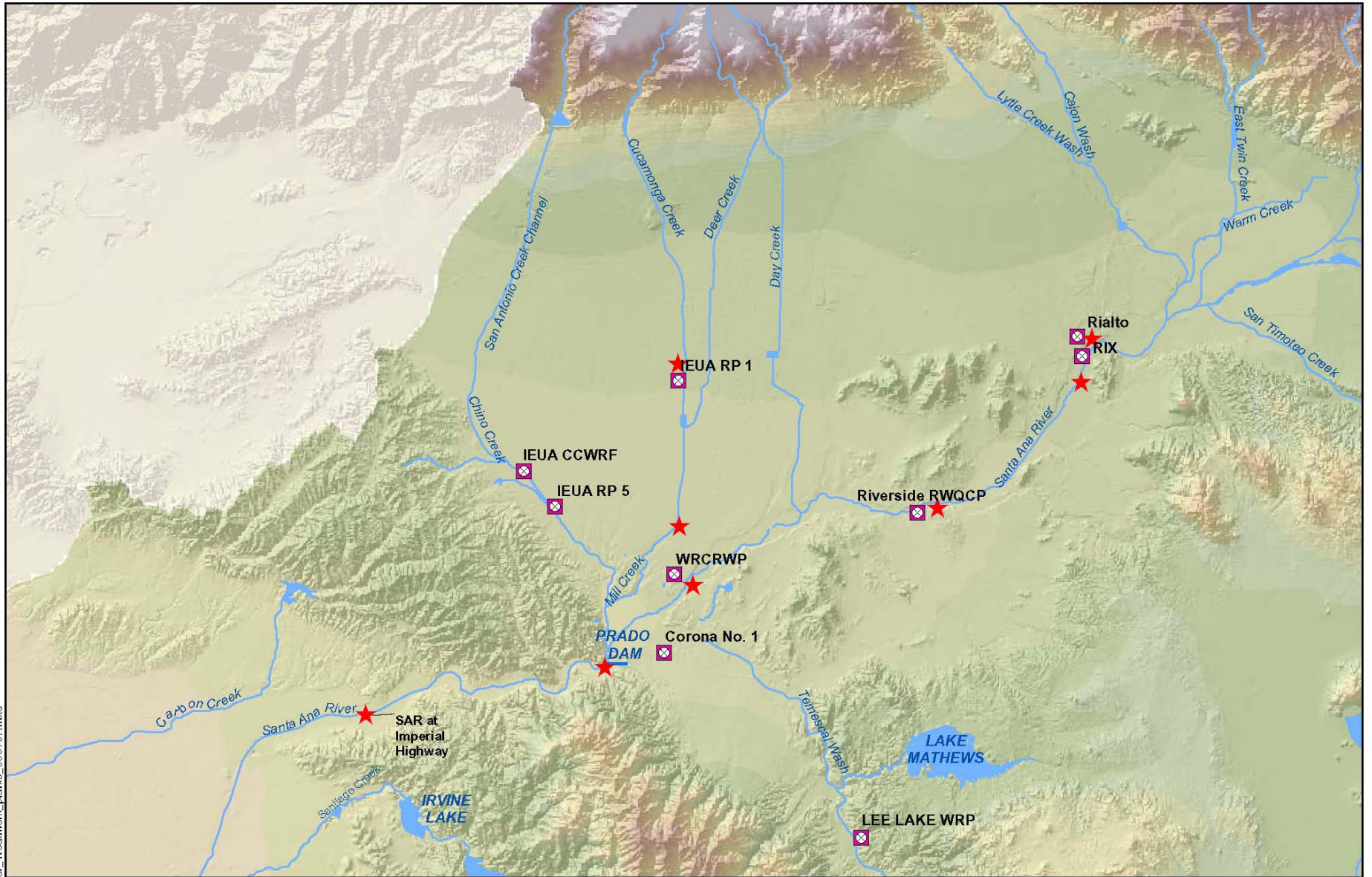
Sampling Location	Significance of the Location
Upstream of Las Vegas Wash	Upstream of WWTPs
WWTP Effluent	WWTP Effluent
Las Vegas Wash	Combined WWTP Effluents
Downstream of Lake Mead, Upstream of Davis Dam	Downstream of WWTPs
Davis Dam	---
Lake Havasu Inlet	---
Whittsett Intake	Intake for Colorado River Aqueduct
Lake Mathews Effluent	Terminal Reservoir in southern California

Colorado River Water (CRW)

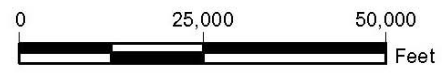
*Sampling locations



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-  Major Wastewater Treatment Plant
-  Sample Location
-  Major Rivers/Streams
-  Major Water Bodies



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Sampling Locations in the SAR System

Description	Sampling Locations
WWTPs	RIX Effluent
	Riverside RWQCP Effluent
	IEUA RP1 Effluent
SAR & Tributary Sites	SAR-1 (100 feet upstream of RIX; consists of Rialto WWTP effluent)
	SAR-2 (1 mile downstream of RIX)
	SAR-3 (7 miles downstream of SAR-2; approx. ½ mile upstream of Riverside RWQCP)
	SAR at River Road (approx. 10 miles downstream of Riverside RWQCP discharge point)
	Upstream of IEUA RP1 (urban runoff during non-stormflow)
	Mill/Cucamonga Creek at Chino Corona Road (approx. 5 miles downstream of IEUA RP1 discharge point)
	SAR Below Prado Dam
	SAR at Imperial Highway

Analytical Challenges

- **What do you look for?**
 - **Universe of chemicals of potential health concern numbers in the tens of thousands**
- **Standard analytical procedures not currently available**
 - **Sophisticated sample preparation and instrumental procedures are required**
- **Extremely low detection levels are needed**
 - **Nanogram per liter levels (ng/L)**
 - **To detect EDCs and PPCPs in surface waters**
 - **To follow fate and transport of EDCs and PPCPs**

Analytical Methods: Selection of Chemicals to be Analyzed

- **Chemicals that have been detected in other watersheds**
- **Chemicals from different categories**
- **Suggested monitoring list by California Groundwater Recharge Reuse Regulations Draft (CDHS, CDPH)**
- **Will be reviewed by Dr. Shane Snyder of SNWA**
- **May be changed as analytical methods are being refined**

Analytical Methods (cont'd)

- **Solid phase extraction of 500-mL sample**
- **Analysis of volatile and semi-volatile compounds by gas chromatography/mass spectrometry (GC/MS)**
- **Analysis of polar and non-volatile compounds by liquid chromatography/mass spectrometry (LC/MS)**
- **Expected reporting limits in the low ng/L range**
- **Both MWD and OCWD will analyze all samples from the three watersheds**

Tentative List of Compounds: GC/MS (MWD)

Class	Compound	Use
Industrial By-Product	Anthracene	PAH
	Benzo[a]pyrene*	PAH
Pesticide	Benzene Hexachloride Isomers (including Lindane*)	Pesticide
	2,2-bis(4-Chlorophenyl)-1,1-dichloroethane (DDD)	”
	Methoxychlor	”
Personal Care Product	Bisphenol A*	Plasticizer
	Nonylphenol*	Surfactant
	Octylphenol*	”

*Suspected EDCs

Tentative List of Compounds: LC/MS (MWD)

Class	Compound	Use
Pharmaceutical	Carbamazepine	Anti-seizure
	Primidone	”
	Gemfibrozil	Anti-cholesterol
	Ibuprofen	Pain killer
	Erythromycin	Antibiotic
	Sulfamethoxazole	”
Personal Care Product	Triclosan*	”
	Caffeine	Stimulant
	DEET	Insect repellent
	TCEP	Flame retardant
Hormone	Ethinylestradiol*	Birth control
Pesticide	Atrazine	Herbicide

List of Compounds: LC/MS (OCWD)

Class	Compound	Use	Class	Compound	Use	
Pharmaceutical	Acetaminophen	Analgesic	Personal Care Product	Tetrabromobisphenol A	Flame Retardant	
	Amoxicillin	Antibiotic		Triclosan*	Antibiotic	
	Azithromycin	"	Hormone	Diethylstilbestrol*	Synthetic Estrogen	
	Carbamazepine	Anti-convulsant		Epitestosterone*	Hormone	
	Ciprofloxacin	Antibiotic		Estradiol (17-a)*	"	
	Gemfibrozil	Anti-cholesterol		Estradiol (17-b)*	"	
	Ibuprofen	Pain Reliever		Estriol*	"	
	Personal Care Product	Bisphenol A*		Plasticizer	Estrone*	"
		Caffeine		Stimulant	Ethynylestradiol*	Birth Control
		4-Nonylphenol*		Surfactant	Progesterone*	Hormone
Nonylphenol Ethoxylates*		"	Testosterone*	"		
Octylphenol*		"	Pesticide	Pentachlorophenol	Fungicide	
Salicylic Acid		Skin Treatment		4-Phenylphenol	"	
				Trichlorophenol	"	

Fate and Transport

- Some EDCs and PPCPs are persistent in the environment
 - Carbamazepine
 - Primidone
- Some are biodegradable
 - Caffeine
- Some can undergo sunlight photolysis
 - Gemfibrozil
 - Ibuprofen
 - Ethynylestradiol
- Additional information on attenuation in the three watersheds will be collected during this study

Quality Assurance/Quality Control

➤ Will include

- **duplicates and matrix spikes to assess precision and accuracy, respectively**
- **isotopically labeled standards, where available, to correct for matrix effects and instrumentation variations**
- **selected samples will be analyzed for certain analytes by MWD, OCWD, and SNWA in parallel for method validation**

Budget

- **\$300,000 total**
 - **\$150,000 from NWRI**
 - **\$150,000 matching in-kind contribution from MWD and OCWD**

Anticipated Results

- **Provide the first systematic assessment of occurrence of EDCs and PPCPs in these three major drinking water sources**
- **Evaluate wastewater impact on a seasonal basis, i.e., low river flow vs. high flow time periods**
- **Evaluate fate and transport data to determine which chemicals are persistent in the aquatic environment**

Questions?

