Findings of the 2018 Science Advisory Panel on CECs in Recycled Water

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WATEREUSE
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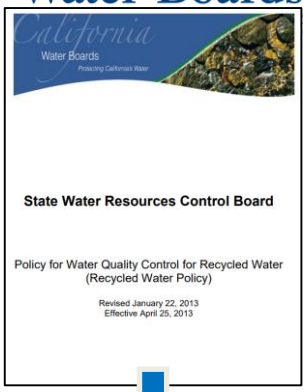
Outline

- State Water Board Recycled Water Policy & CECs
- Panel charge and approach taken by the Panel
- Outcome of applying the risk-based CEC selection framework using monitoring data from California
- Observations by the Panel
- Recommendations to adjust and improve the process

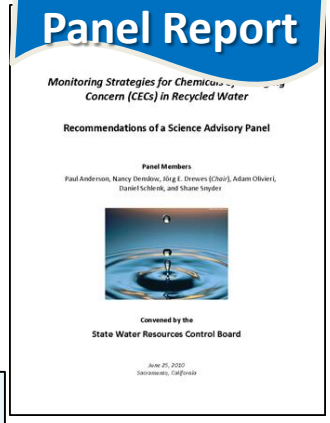
CA Recycled Water Policy and CECs

Promote the use of recycled water while protecting public health and water quality through consistent, streamlined permitting of recycled water projects

2009
Policy Adopted



2010 CEC Panel Report



2013
Policy Amended

Added CEC monitoring, Update Panel report every 5 years

2016
Resolution

Reconvene the CEC Panel

2018

Incorporate Panel's findings in the Recycled Water Policy
Public Draft Release
est. April 30, 2018

Panel Charges

- What are the appropriate constituents to be monitored in recycled water, including analytical methods and MDLs?
- What is the known toxicological information of those constituents?
- Would the list change based on level of treatment and uses as specified in Title 22 and for surface water augmentation? If so, how?
- What indicators or surrogates can be used to represent a suite of CECs?
- What CEC concentrations should trigger enhanced monitoring?

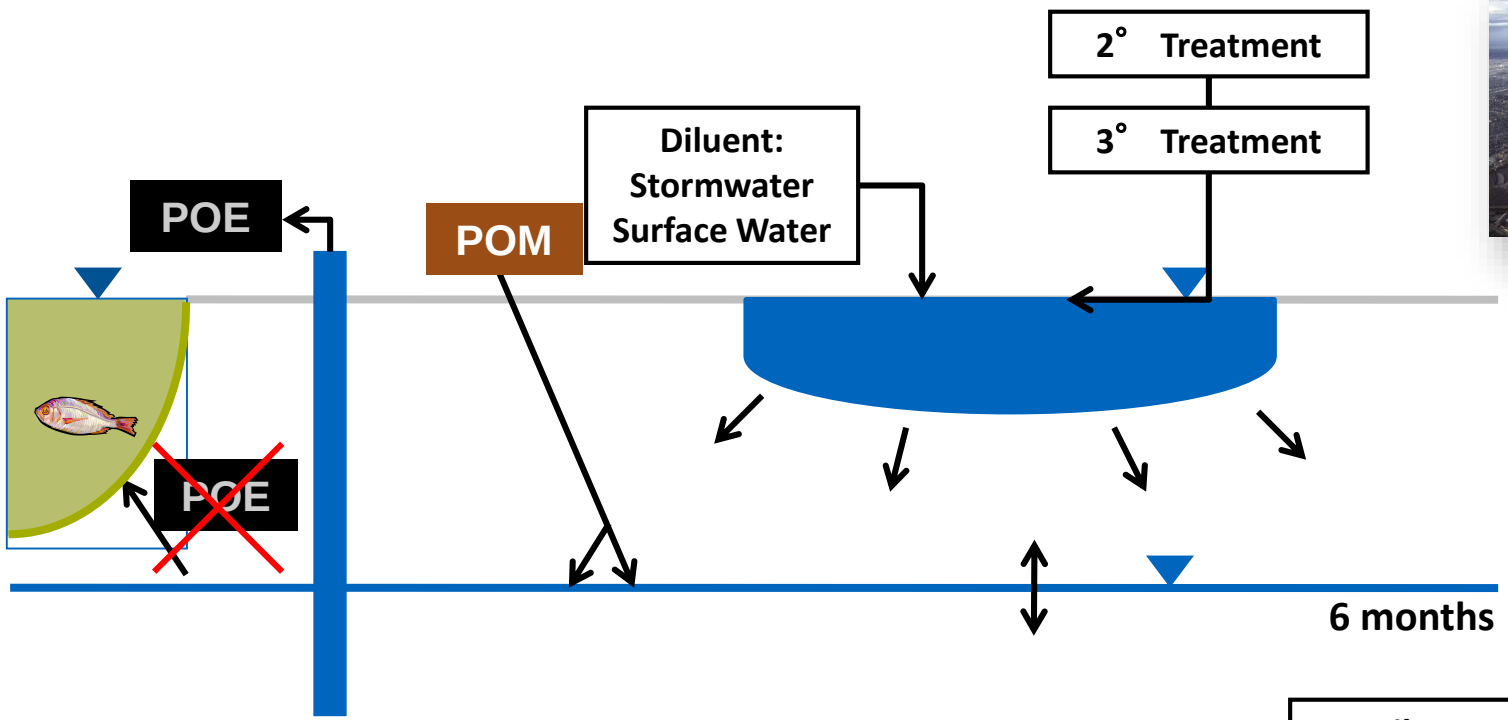
Panel Charges (cont.)

- For all uses of recycled water allowed under Title 22, evaluate the potential human health risks for all routes of exposure
  - **Except** potential human health risks associated with ingestion of crops irrigated with recycled water
- Provide recommendations for additional research regarding antibiotic resistant bacteria and antibiotic resistance genes related to the use of recycled water to further understand potential human exposure and potential impacts to human health
- Recommend actions that should be taken to improve the understanding of CECs and to protect public health and the environment to update 2010 monitoring recommendations

CEC Definition (2018)
'Constituents of emerging concern'

- Personal care products
- Pharmaceuticals
- Industrial
- Agricultural
- Natural hormones
- Inorganic constituents (boron, chlorate)
- Food additives and constituents (phytoestrogens, caffeine, sweeteners)
- Transformation products
- Nanomaterials
- Microplastics
- Antibiotic resistance

IPR – Ground Water Recharge Surface Spreading Application

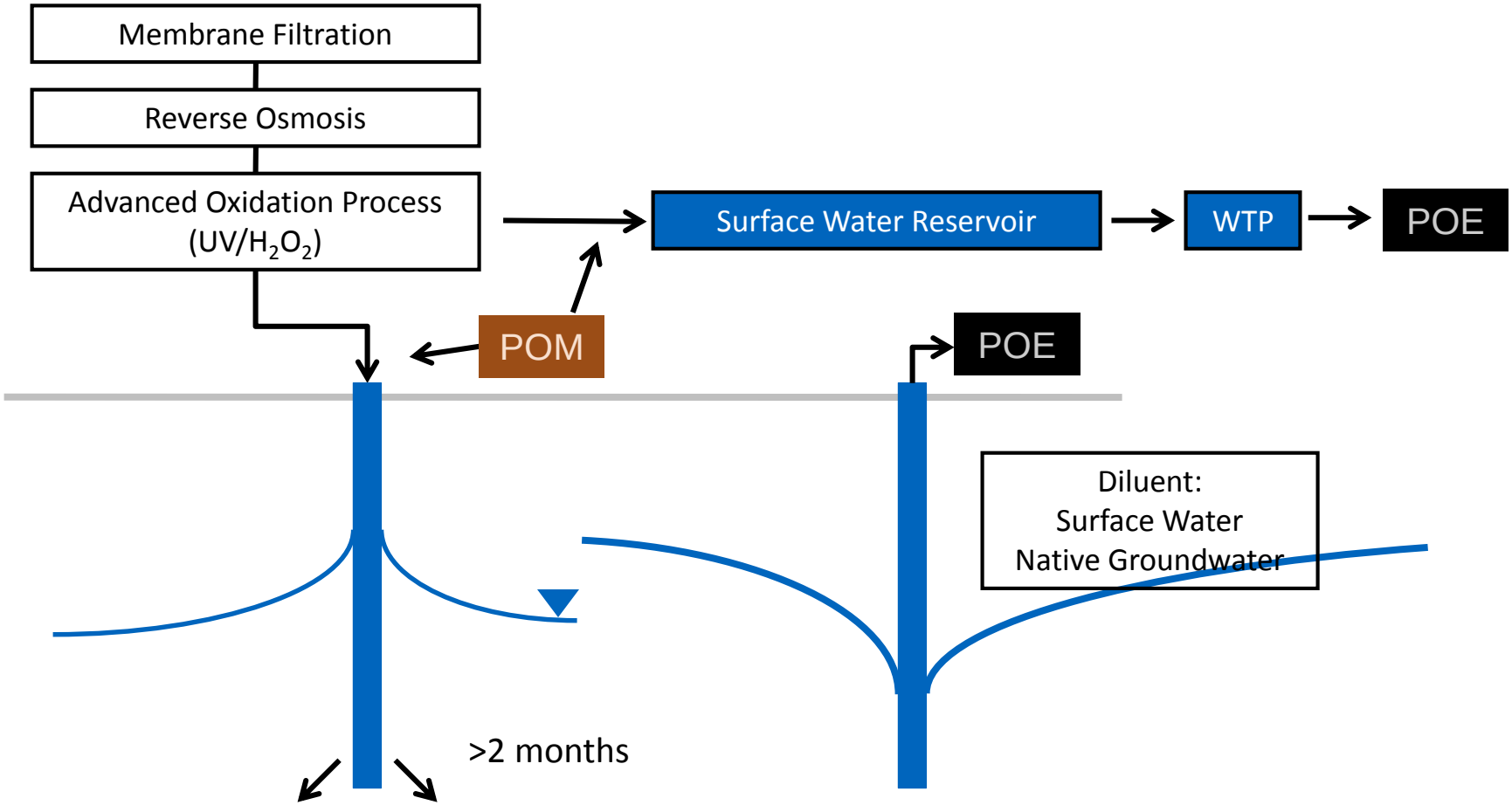


POM: point of monitoring

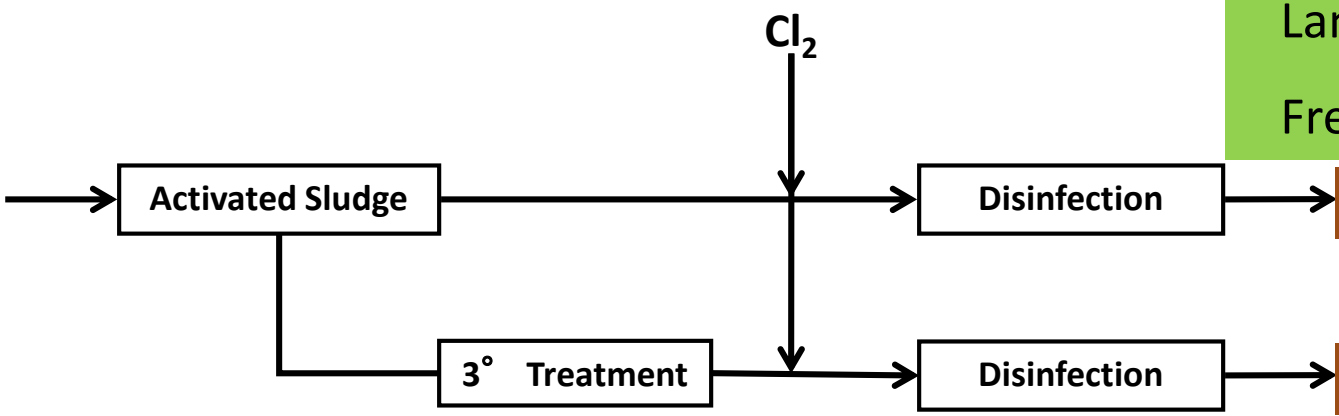
POE: point of exposure

Indirect Potable Reuse Practices

- Ground Water Recharge - Subsurface Application
- Surface Water Augmentation



Title 22 - Non-potable Reuse Practices



POE Restricted access:

- Landscape
- Freeway/golf course

POE Unrestricted access:

1. Residential
2. Golf course
3. Urban landscape
4. Impoundment

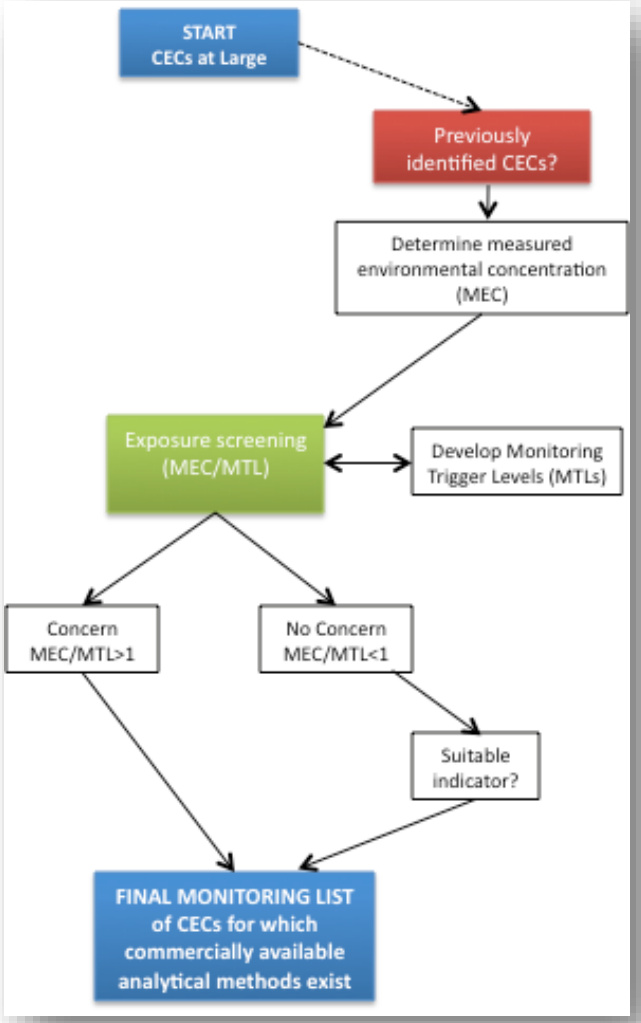
POM: point of monitoring
POE: point of exposure

Assessing All Non-potable Title 22 Recycled Water Practices

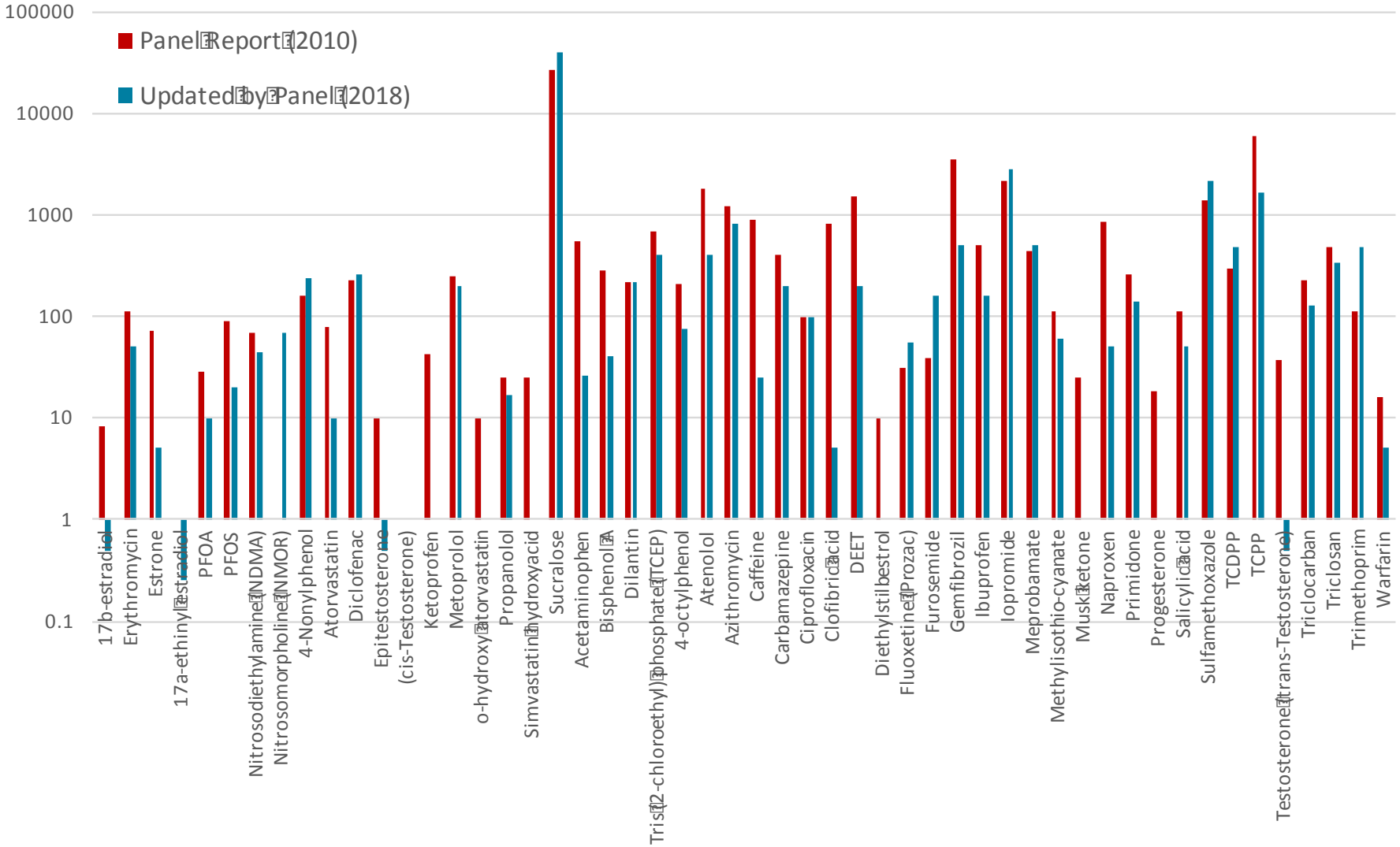
- 45 different applications
- Exposures associated with non-potable uses were estimated to be at least 10x lower than exposures associated with the potable reuse applications for all CECs, and likely to be 100x lower for most CECs
  - One exception: impoundment with fishing
- Panel recommends deriving monitoring trigger levels (MTLs) for non-potable reuse as: **(potable reuse MTLs) x 10**
- Surrogate measurements are best way to assure proper Title 22 recycled water quality

Applying the Risk-based Selection Framework

- Used utility monitoring data as measured environmental concentrations (MECs)
- 2017 data set was much more robust than 2010 data set
- Updated the toxicity/effects databases for these CECs (MTLs)
- Maintained the **conservative** screening framework to determine relevant CECs:
  - MEC/MTL < 1: no worries
  - 1<MEC/MTL<100: consider for future monitoring
  - MEC/MTL > 100: take action NOW



Changes in Occurrence Data



Applying Selection Framework – 2010

	Secondary/Tertiary Treated MEC 90th (ng/L)	Initial MTLs		MEC/MTLs	
		Potable Reuse	Irrigation	Potable Reuse	Irrigation
CCL3 CECs					
17b-estradiol	8.40	9.0E-01	9.0E+01	9.3	0.09
NDMA	68	1.0E+01	1.0E+03	6.8	0.07
Non-CCL3 CECs					
Caffeine	900	350	35,000	2.6	0.03
Triclosan	490	350	35,000	1.4	0.01

Applying Selection Framework – 2018 *Draft*

	Secondary/Tertiary Treated MEC 90th (ng/L)	Initial MTLs		MEC/MTLs	
		Potable Reuse	Title 22 Non-potable	Potable Reuse	Title 22 Non-potable
17b-estradiol	0.50	9.0E-01	9.0E+00	0.6	0.06
NDMA[a]	77	1.0E+01	1.0E+02	7.7	0.77
NMOR	107	1.2E+01	1.2E+02	8.9	0.89
1,4-Dioxane[a]	7,200	1.0E+03	1.0E+04	7.2	0.72
Caffeine	25	3.5E+02	3.5E+03	0.07	<0.01
Triclosan	340	3.5E+02	3.5E+03	0.97	0.1

Applying Selection Framework – Outcome
- There are no smoking guns!

- All 90+ CECs (re)-assessed had MEC/MTL < 10
- Three CECs coming off, two coming on, and **NDMA** remained on the list:
  - 17β-estradiol
  - Triclosan
  - Caffeine
  - **1,4-Dioxane**
  - **N-Nitrosomorpholine (NMOR)**
- The framework represents a very conservative screening tool:
  - 90th percentile MECs
  - worst case sources (e.g., non-nitrified secondary); no credit given to treatment barriers, environmental buffer, downstream DW treatment
  - ADI & PNECs have individual safety factors (e.g., 60 kg body weight)
- Collected MECs over 7 years were very useful! Only 3 out of 100 made the cut

Performance-based Indicators and Surrogates

- Are health-based indicators also good indicators of removal by different treatment processes?
  - Molecular weight cutoff (RO membranes)
  - Recalcitrant (AOP (UV/H_2O_2); SAT)
  - Ubiquitous and consistently present (very important for infrequent monitoring)
    - **Drop in occurrence:** *caffeine, gemfibrozil*
    - **More consistent occurrence:** ***iohexol***

- Are they amenable to current analytical methods?

- If yes to both above, they can serve double duty as treatment indicators

- If not, then search/retain for model indicators that meet above

- Is quarterly monitoring frequency enough? Too frequent?

- Are sampling sites (POM) still appropriate?

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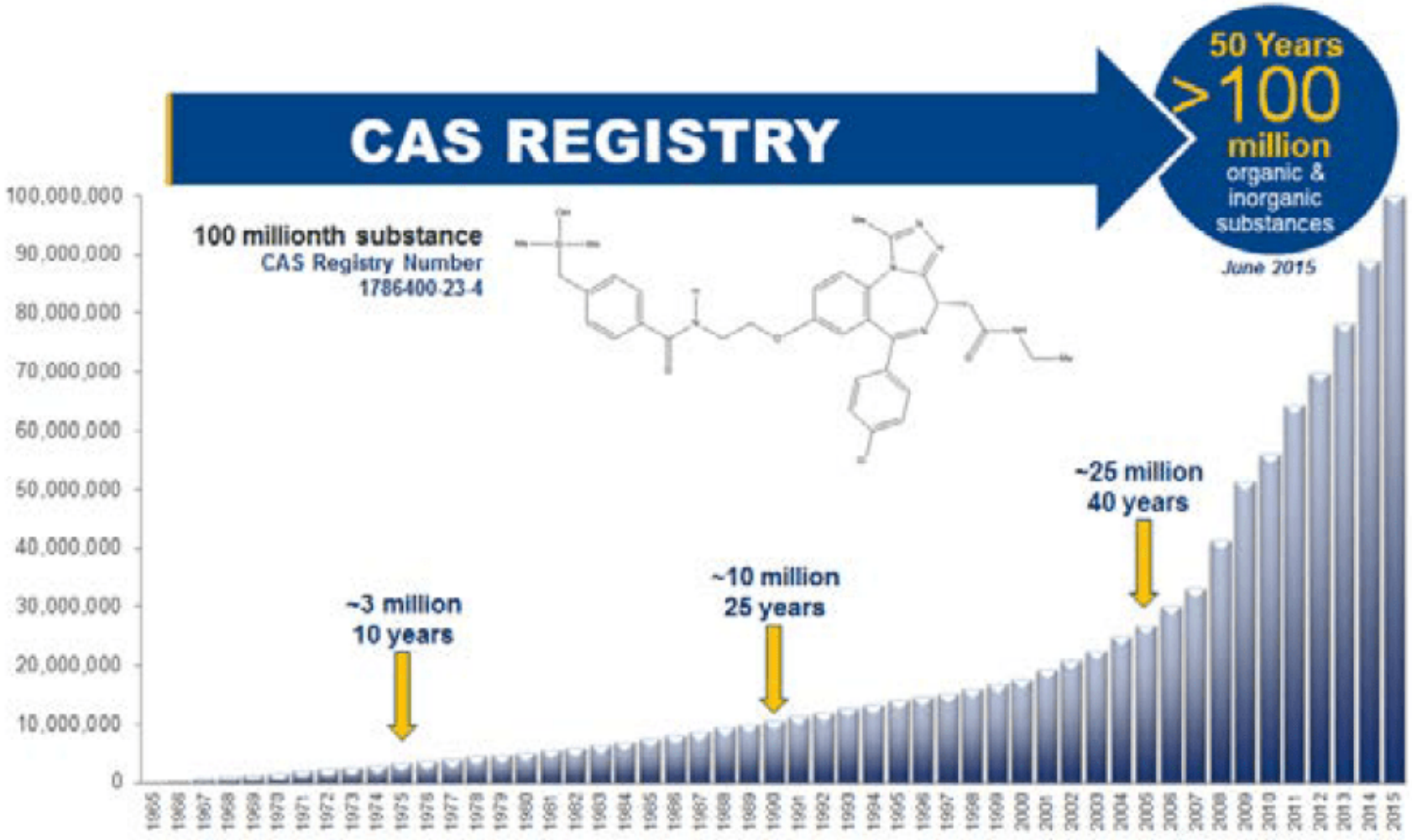
Are we done?



Panel's observations regarding the process

- Applying the risk-based framework recommended by the 2010 Panel requires structure and consistent protocols yet no formal update of the selected CECs occurred until 2017
- Data format not easy to process and archive
- Reliance on health- and performance-based indicators provides assurance of proper operation, but is not suitable to account for new CECs. However, it is still the only source of information…
- Workflow and procedures in data handling not clearly defined

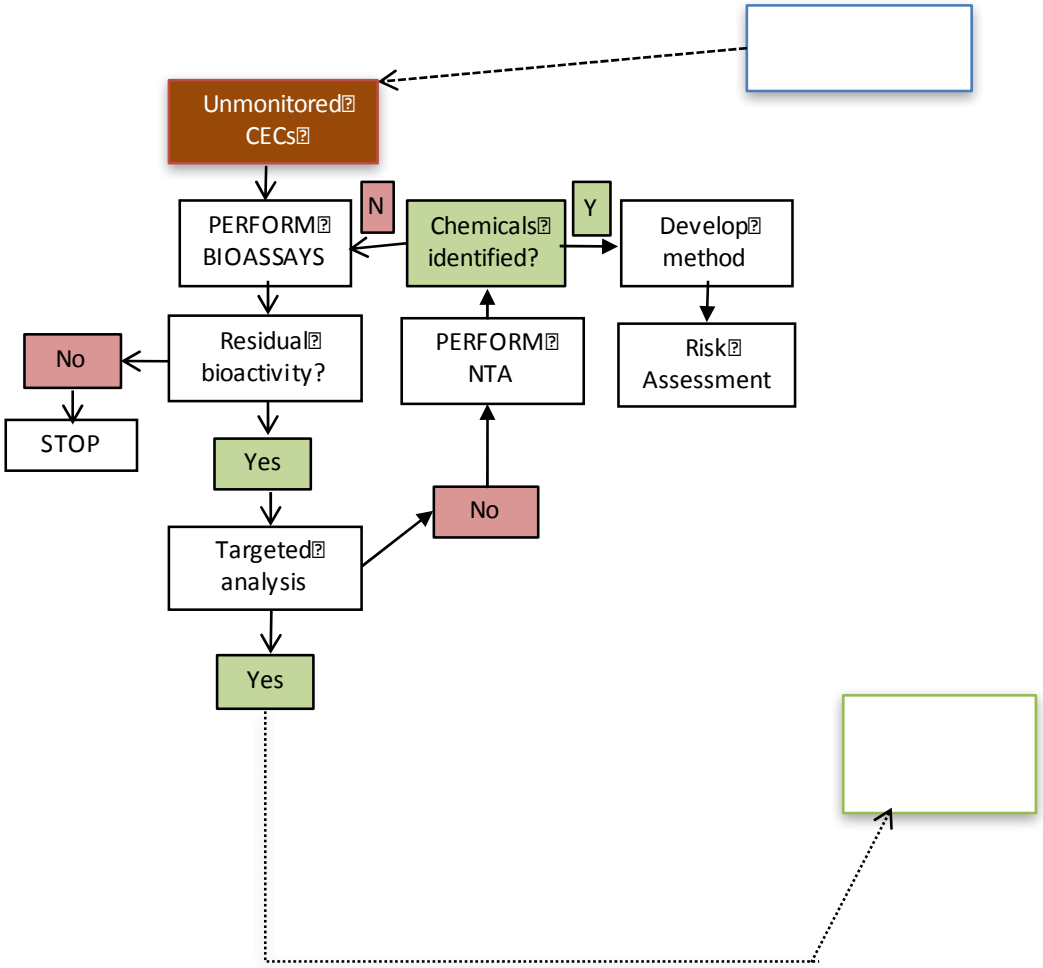
Can we do better moving forward?

- New tools to enhance information obtained by monitoring:
  - Bioanalytical and NTA to address unknowns, changing chemical use
  - Take advantage of online SCADA data of surrogates and operational information
  - Sound interpretive framework for new information that gives managers more (not less) confidence

- Fine-tune the Panel's assessment framework:
  - Incorporate broader filters for on-ramps and maintain data-driven off-ramps

- More responsive program to adjust to new information:
  - Streamline implementation of Panel recommendations
  - Enhance communication among experts, policy makers and permit writers
  - Make data widely available in easy to use format

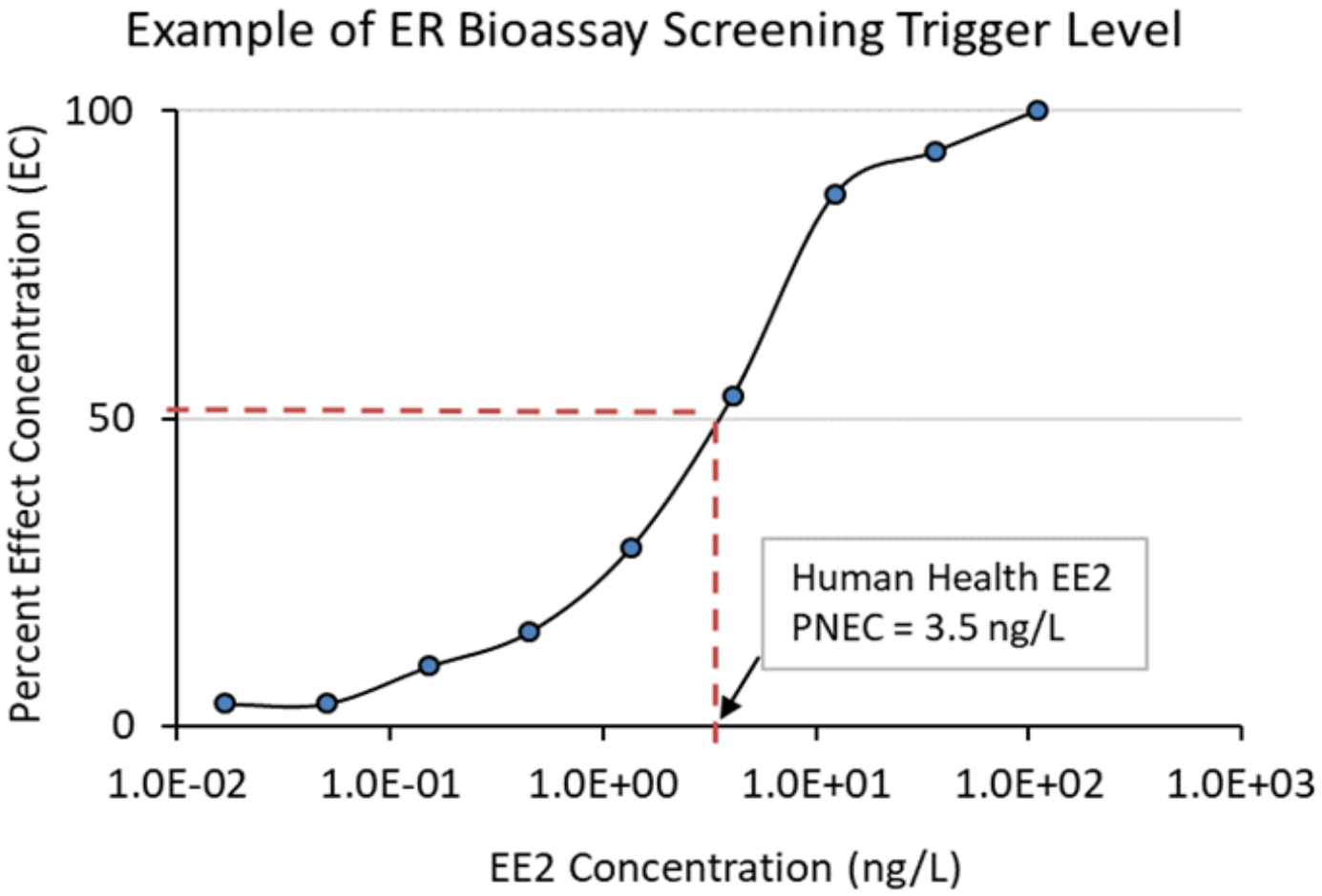
Use of Bioanalytical Methods for CEC Screening



- **Two bioassays:**
  - ERα
  - AhR
- Standardized methods available (USEPA, OECD)
- Commercial labs
- **Non-target analysis**
  - Only in support of positive bioassay results

Use of Bioanalytical Methods for CEC Screening

- Linking bioassay response to human health PNECs



Institutional controls and relationships

- **ISSUE:** Should be able to react quickly – 5-10 years is a little too slow
  - Panel review every 5 yr could result in errors/missing data
  - Quicker turn-around for on-ramps and off-ramps

  RECOMMENDATIONS:
- Foster more collaboration and communication between policy and permitting entities
  - State Water Board (DWQ, DDW)
  - State and Regional Water Boards
  - Affected utilities
  - NGOs and the public
- Keep the screening framework as simple as possible
- Engage the experts to fine-tune the framework, advise on complicated issues, case-studies

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REGIONAL WATER QUALITY CONTROL BOARDS

Application of Framework
2018 DRAFT list for CEC Monitoring

Reuse Practice	Health-based indicator	MRL (ng/L)	Bioanalytical methods	MRL (ng/L)	Performance-based Indicator	Expected Removal[6]	MRL (ng/L)	Surrogate
Surface Spreading Application (SAT)	NDMA[2]	2	ER	0.5	DGemfibrozil[3]	>90%	10	DAmmonia
	NMOR[1]	2	AhR	0.5	DSulfamethoxazole[4]	>30%	10	DNitrate
	1,4-Dioxane[1]	100			DIohexol[3]	>90%	50	DDOC
					DSucralose[5]	<25%	100	DUVA
								DTotal fluorescence
Subsurface Application (Direct Injection) and Surface Water Augmentation	NDMA[2]	2	ER	0.5	DSulfamethoxazole	>90%	10	DConductivity
	NMOR[1]	2	AhR	0.5	DSucralose	>90%	100	DDOC
	1,4-Dioxane[1]	100			DNDMA	25-50%	2	DUVA
Non-potable reuse practices					None			Turbidity Cl_2 residual or operational UV dose Total coliform

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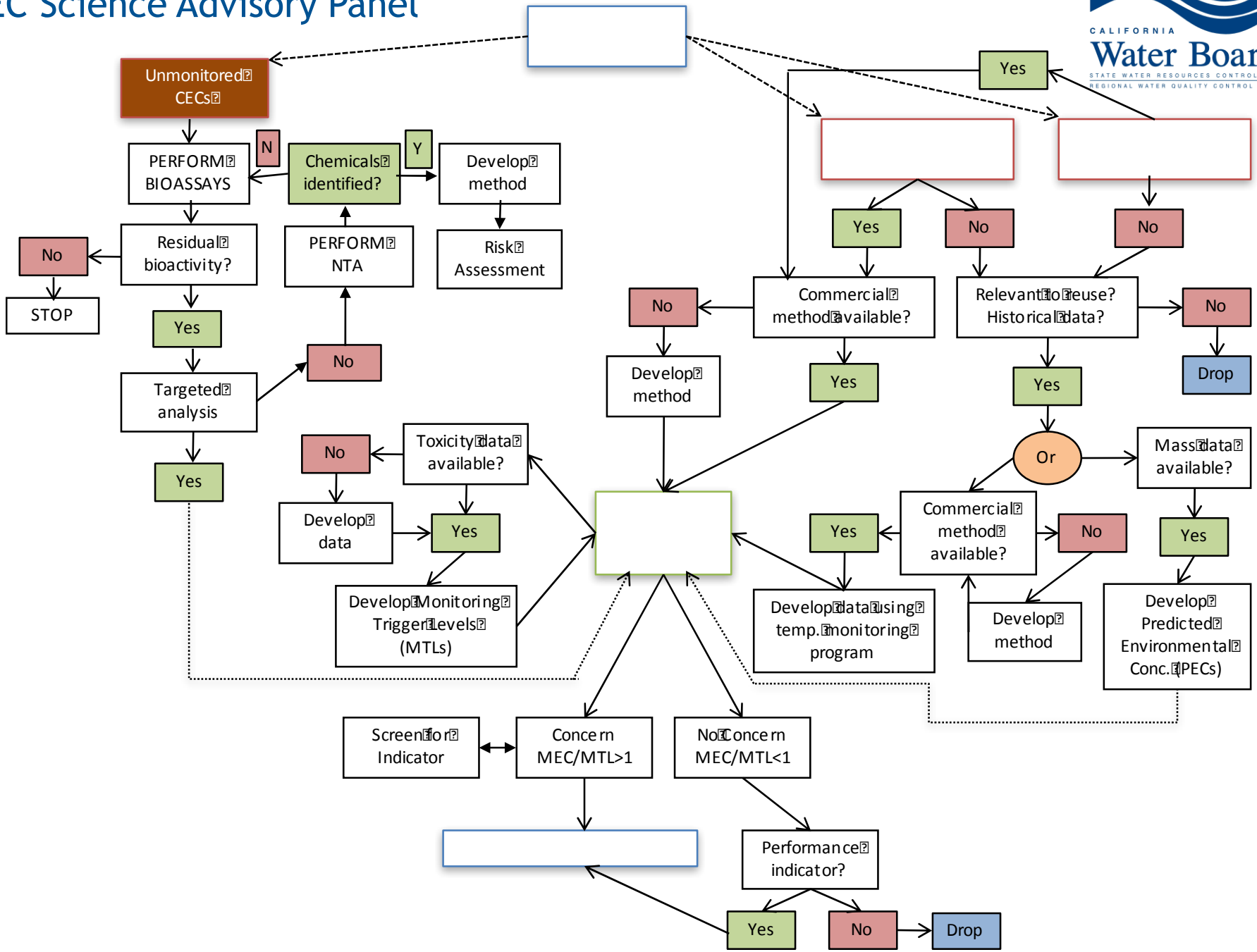

Antibiotic Resistance (2018)

- AR is a valid and serious worldwide public health concern & is found in wastewater and other environments like soils and source waters not necessarily impacted by wastewater
- **Risk levels** associated with ARB/ARG in water have **not been determined**
- Standardized methods for their quantification are still missing but necessary
- Current studies reviewed do not indicate that antibiotic resistance transmission is a consequence of water reuse practices considered in the CEC report
- Current wastewater treatment technologies (e.g., activated sludge, tertiary filtration, and chlorine disinfection) reduce ARB and ARG concentrations.
- SWB IPR/DPR Panel found that concentrations of ARB/ARG in waters subject to advanced treatment processes **would likely be lower than that from current water sources** entering DWTFs

Panel Recommendations

- Non-potable Title 22 exposures do not warrant CEC monitoring
- CEC monitoring is recommended for potable reuse
  - groundwater recharge & surface water augmentation
- Risk-based CEC selection framework provided state-of-the-art data assessment (off-ramps and on-ramps)
- State Water Board should conduct a thorough review of CECs likely to occur in recycled water using MEC and PEC data from peer-reviewed literature and occurrence studies outside CA to proactively inform framework selection
- Collect *in vitro* assay data (ER and AhR) to screen for known and unknown CECs in recycled (product) water

Panel Recommendations (cont.)

- Current state of science does not justify using non-targeted analysis (NTA) as a regular screening tool
  - NTA could be used in conjunction with bioanalytical tools to elucidate chemicals that give positive results
- Issue drinking water permits for potable reuse projects that include enhanced source control measures
- Develop a data management system for potable water facility monitoring data and consistent permittee electronic reporting requirements
- Develop internal protocols for DDW staff review and response to
  - CEC and Bioanalytical data
  - Source control data
  - High-frequency operational monitoring data

Panel Recommendations (cont.)

- Develop internal staff and external utility communication protocols
- Develop external review of reported data and recommendations for potable reuse program updates
- Provide a public annual report summarizing performance of potable reuse projects
- Reconstitute an independent advisory panel every three years to evaluate the overall CEC monitoring program for recycled water and make further recommendations for the use of the framework

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Thank you!