

# **Identification of Bacterial-Related Toxicity in a POTW Effluent**

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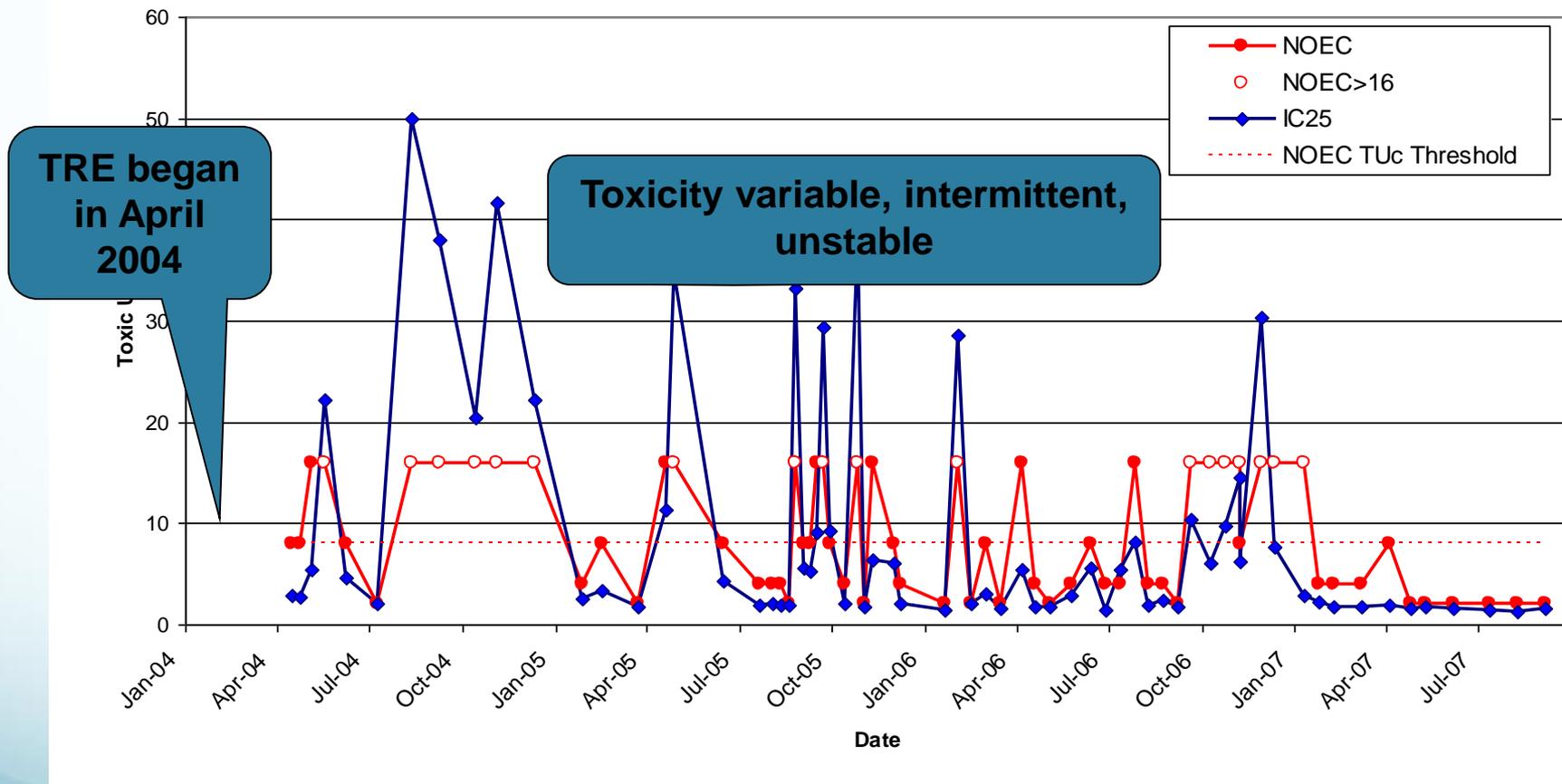
Becky Parales - UCD

# SRWTP

- 181/392 MGD secondary treatment plant (pure oxygen-activated sludge).
- Wastewater from most of Sacramento County is received (>1 million residents)
- Disinfection by chlorine gas / SO<sub>2</sub> dechlorination
- Treated effluent is discharged to the Sacramento River



# *C. dubia* Reproduction Toxicity at SRWTP



**25 Percent Inhibition Concentration (IC<sub>25</sub>)** - Concentration causing a 25% reduction in the effect (i.e., reproduction)

# TRE Phases (Tiers)

- **Information and Data Collection**
  - Compile data on plant operation and performance & collection system
- **Facility Performance Evaluation**
  - Determine if toxicity is from in-plant sources or treatment deficiencies
- **Toxicity Identification Evaluation (TIE)**
  - Identify the toxicant
- **Toxicity Source Evaluation**
  - Determine collection system sources
- **Toxicity Control Evaluation**
  - Determine options to reduce toxicity
- **Toxicity Control Implementation**
  - Implement control and monitor effectiveness

# Collective TIE Results (1)

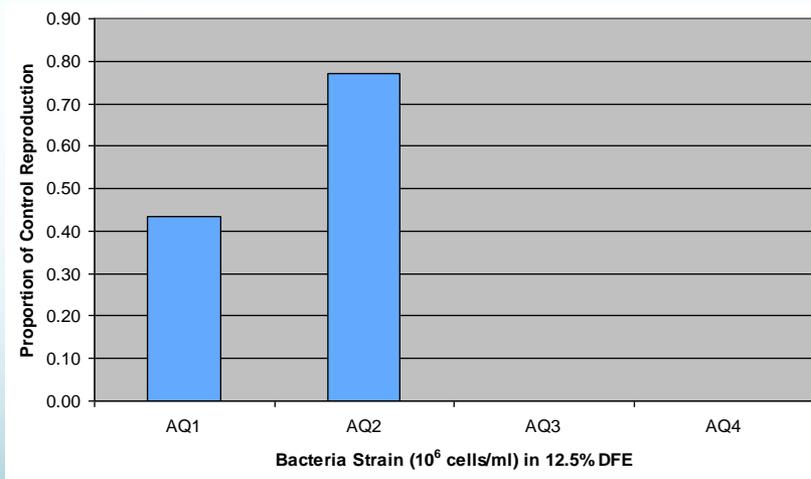
Toxicant	TIE Treatment	Toxicity Reduced/Eliminated?
Ammonia	Zeolite	No
Metals	EDTA	No
	$\text{Na}_2\text{S}_2\text{O}_3$	Variable
Non-Polar Organics (NPOs)	SPE at pH i, 3, 9	No
Volatile NPOs	Aeration	No
Polymer	Toxicity test	No
Insecticides (OP or pyrethroid)	PBO	No
Particulate	Centrifugation	
	- Supernatant	Yes
	- Particulate add-back	No

## Collective TIE Results (2)

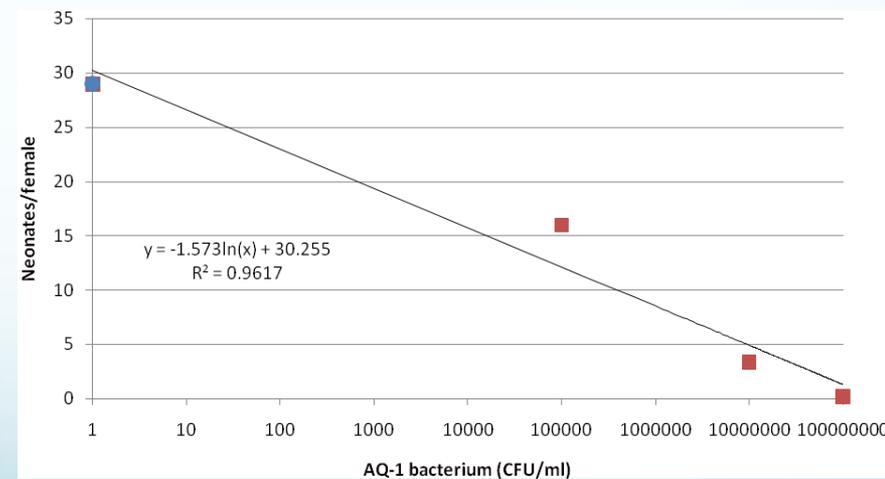
Toxicant	TIE Treatment	Toxicity Reduced/Eliminated?
Biological	Filtration (0.22 um)	Yes
	UV treatment	Yes
	Chlorination/dechlorination	Yes
	Microwave treating	Yes
	Freezing/thawing cycle	Yes
	Antibiotic addition	Yes

# Bacteria – Special Study

- **Bacteria Toxicant confirmed with isolates from DFE**
  - Toxicity could be introduced to non-toxic samples by adding bacteria at concentrations observed in DFE composites

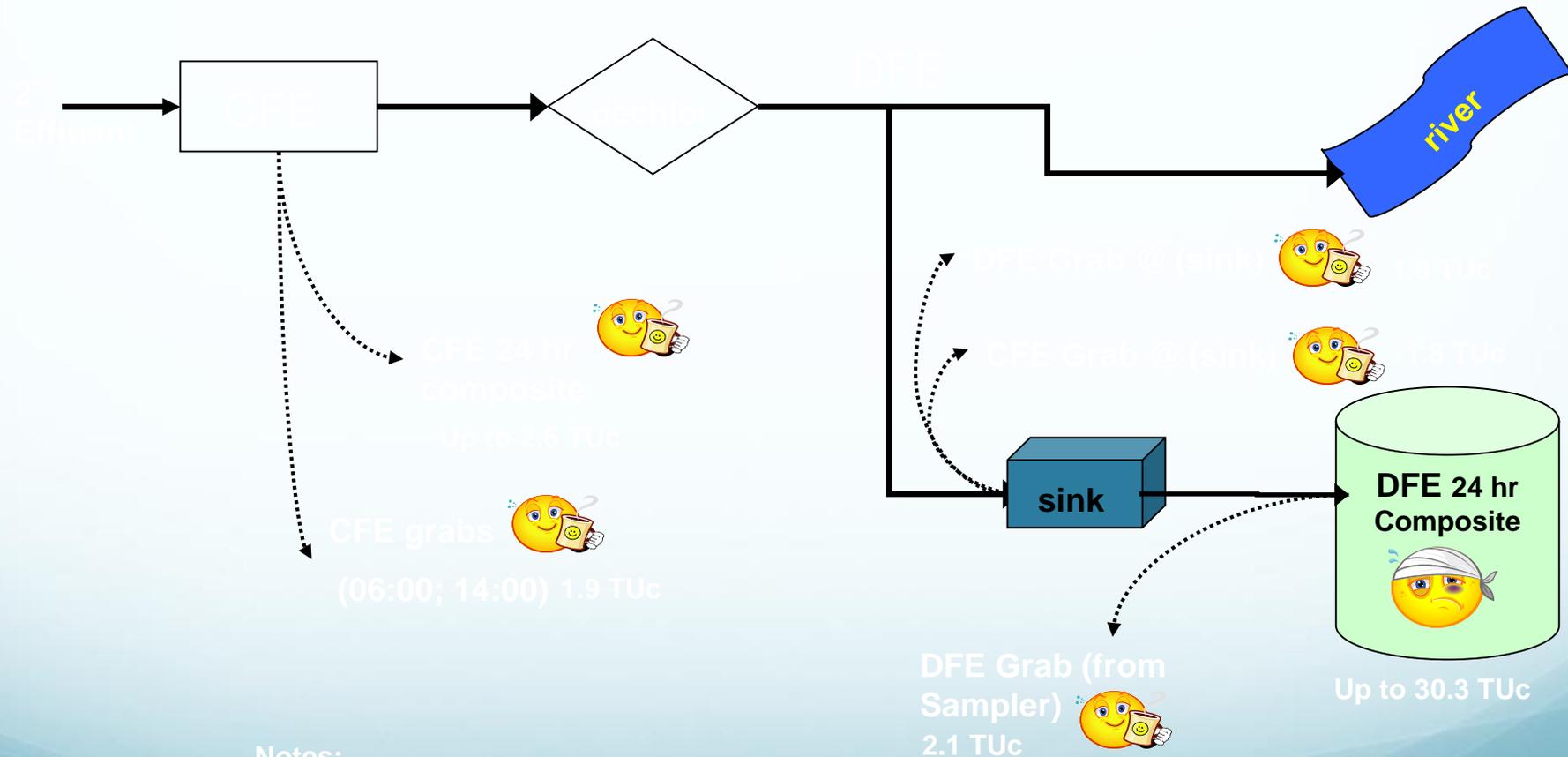


Bacteria Toxicity to *C.dubia*



Bacterium Concentration-Response

# Source Evaluation – CFE – DFE Toxicity



## Notes:

= toxicity elevated      = toxicity not elevated

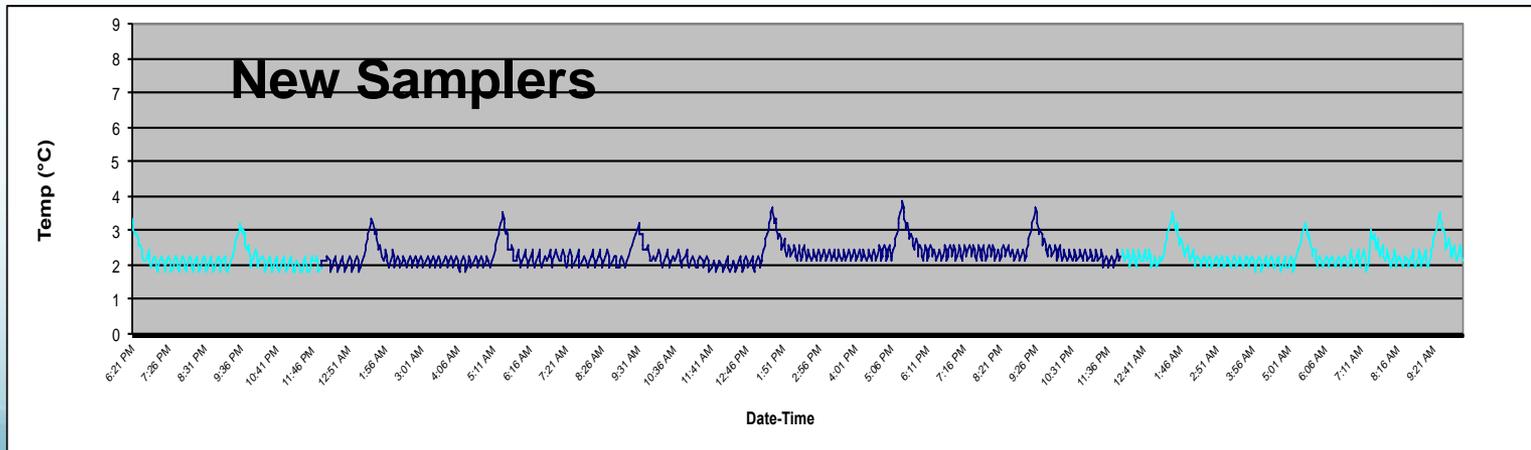
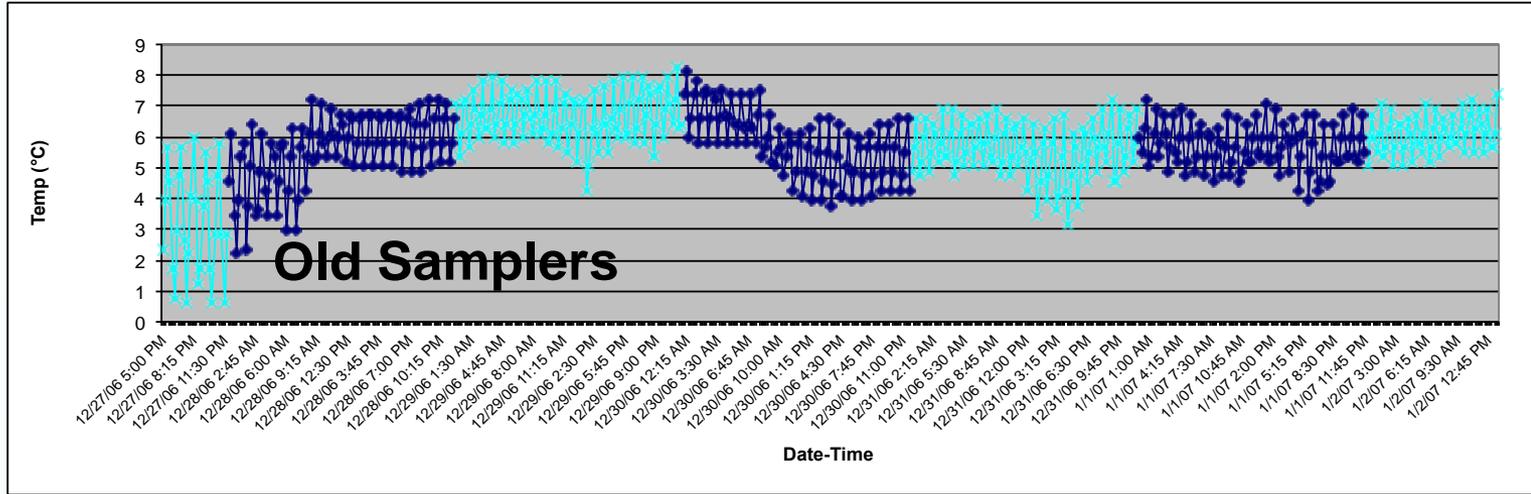
DFE = Dechlorinated Final Effluent

CFE = Chlorinated Final Effluent (manually dechlorinated prior to toxicity tests)

# Sampling System Changes

- Sampling system procedures revised:
  - Increased purging/draining time in sampler lines
  - Lowered composite temperature  $\leq 4$  °C
  - Increased changing of disposable sample lines
  - Increased cleaning of fixed lines
  - Installed new sampling system equipment

# Sampler Air Temperature



# TRE Project Team

- **SRWTP**
  - **Mitch Maidrand** – Regulatory Compliance Supervisor / TRE Supervisor
  - **Aaron Bennett** – TRE Project Manager (2004-2005)
  - **Water Quality Control Lab** – Routine chemical monitoring and sampling
  - **Wastewater Source Control Section** – Source Investigations
  - **The Many Operators and Engineers at the plant**
- **AQUA-Science - Bioassay Lab/Consultants**
  - **Jeff Miller and Mike Miller** – Toxicology
- **UC Davis**
  - **Dr. Rebecca Parales** – Microbiology
- **CH2M HILL**
  - **Cameron Irvine** – Ecotoxicology / TRE Project Manager (2006-2007)
  - **Dana Rippon** – Wastewater Processes
  - **Dr. Brad Sample** – Toxicity / Statistics

# Effect of Dissolved Oxygen on *C. dubia* Chronic Toxicity (1)

- Some effluents exhibit biological oxygen demand (BOD), resulting in test DOs less than test protocol minimum (> 4.0 mg/L)
- The scientific literature on effects of DO on effluent toxicity is sparse and incomplete
- Low test DOs can be prevented by sterilization techniques (0.22 um filtration, antibody addition)
- It is difficult to characterize DO effects below saturation levels (8 mg/L @ 25 °C)
- Pure O<sub>2</sub> sparging of samples to > 8 mg/L prior to testing did not result in stable DOs (DO utilized by effluent bacteria to metabolize effluent BOD)

# Effect of Dissolved Oxygen on *C. dubia* Chronic Toxicity (2)

- Stable sub-saturation DOs can likely be obtained using O<sub>2</sub>-doped test atmospheres
- Likely will not need O<sub>2</sub> active control system (ACS) but ACS is available
- Overall prevention of low DO is a better option than dealing with effluent tests that exhibit low DO