



SITE-SPECIFIC WATER QUALITY OBJECTIVES: APPLICATIONS OF WATER-EFFECT RATIOS

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FROM NATIONAL CRITERIA TO SITE-SPECIFIC OBJECTIVES

- National Water Quality Criteria
- Translating national criteria for local use
- Previous water effect ratio studies in CA
- Challenges and concerns with WERs
- MdRH SSO: A case study

CALIFORNIA TOXICS RULE (CTR): NUMERIC WATER QUALITY CRITERIA

- CTR is based on US EPA's National Water Quality Criteria
 - Numeric targets for priority toxics to protect environmental and human health
 - Freshwater and marine
- Criteria designed to protect aquatic life are based on laboratory toxicity test data
 - Use standard test conditions, filtered seawater, and are tightly controlled
- Environmental conditions can impact contaminant bioavailability
 - Criteria may now be under- or overprotective

SITE-SPECIFIC OBJECTIVES ALLOW FOR LOCAL RELEVANCE

- EPA established guidelines for SSO development
- SSOs “calibrate” a water quality criteria to a local water body
 - Maintain protection of aquatic life
- SSOs are frequently derived using the Water-Effect Ratio Procedure
 - Accounts for differences in metals toxicity between site water and reference water

$$\text{WER} = \frac{\text{Site Water EC50}}{\text{Lab Water EC50}}$$

EPA WER STUDY GUIDANCE

- 1994 Interim Guidance is primary reference for WER study design and interpretation
 - General design principles for large sites with diffuse or multiple sources, like MdRH
 - *“Each design has to be formulated individually to fit the specific site. The design should try to take into account the times, locations, and depths at which the extremes of the physical, chemical, and biological conditions occur within the site, which will require detailed information concerning the site.”*

WER STUDIES IN CALIFORNIA: TWO SSO STUDIES ADOPTED

Location	# Stations	# Events	WER	Adopted SSO
San Francisco Bay (South of Dumbarton Bridge)	2	3	2.77	Yes
San Francisco Bay (North of Dumbarton Bridge)	13	4	2.4-2.77	Yes
San Diego Bay (Rosen et al., 2005)	5-16	4	1.54	N/A
North San Diego Bay (Shelter Island Yacht Basin, Bosse et al., 2014)	15-16	2	1.33	N/A
Mugu Lagoon (Ventura County)	4	3	1.51	Under review

- All WERs > 1, suggesting CTR criterion for copper may be overprotective for many marine systems in CA

MAJOR CHALLENGES AND CONCERNS WITH WERS

- Developing WERs for bays and harbors requires more site characterization
 - Contaminant sources are more diffuse and less predictable
- Few recommendations and guidance for marine systems which results in unclear study design requirements
- Ensure sufficient data that represents the site conditions
- Data uncertainty for calculation of final WER

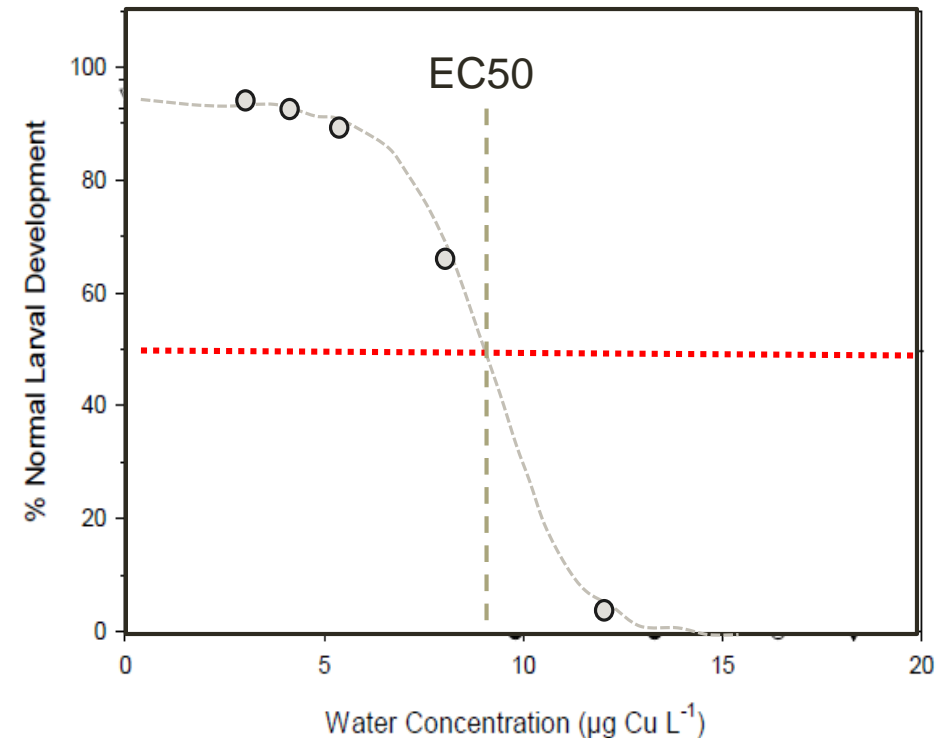
MARINA DEL REY HARBOR: TOXICS/COPPER TMDL

- 2014 Revisions included a finding of copper impairment in the water column
 - Established load allocation for copper in the water column
 - Compliance target of 3.1 $\mu\text{g}/\text{L}$ dissolved copper
 - Typical dissolved copper concentrations in MdRH: 1-10 $\mu\text{g}/\text{L}$
- To meet the TMDL target, there must be an 85% reduction of copper leaching from boat hull paints by 2024
 - Minor inputs of Cu from other sources

MARINA DEL REY HARBOR: WER STUDY

- 2017 LA Regional Board approved conducting SSO study for MdRH
- WER is most applicable SSO study method for MdRH
 - Compares toxicity of contaminant in site water to lab control water

$$\text{WER} = \frac{\text{Site Water EC50}}{\text{Lab Water EC50}}$$



EC50 = Toxicant concentration causing 50% effect

NEED FOR SITE CHARACTERIZATION

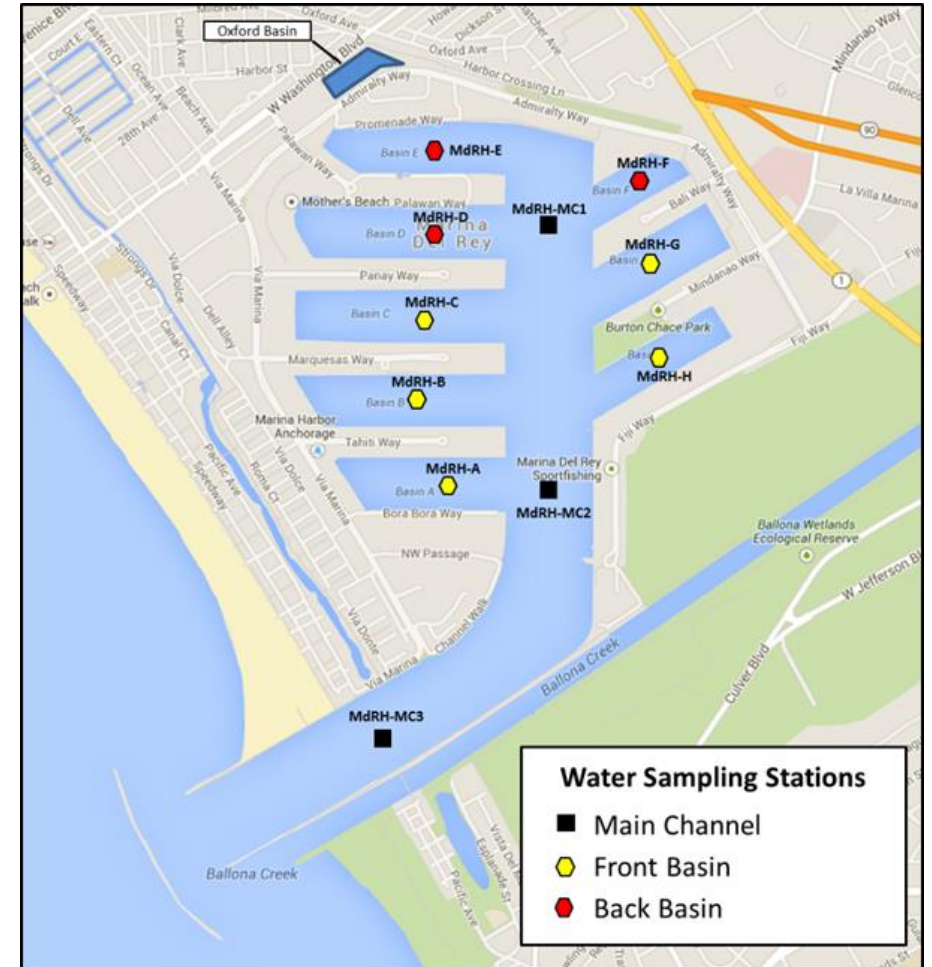
- What are the conditions in Marina del Rey Harbor (MdRH)?
 - Spatial differences
 - Temporal differences
- Characteristics that may impact copper bioavailability
 - Water quality: pH, salinity, temperature, dissolved organic carbon (DOC), plankton blooms
 - Weather patterns and stormwater discharge
 - Hydrology: tidal cycles, depth, water circulation
- Determine the critical condition

COPPER BIOAVAILABILITY IS DRIVER FOR CRITICAL CONDITION

- Copper (Cu) toxicity is driven by its bioavailability
- Critical condition is the combination of factors that result in higher bioavailability
- Site conditions that demonstrate high Cu bioavailability will result in a lower WER

MARINA DEL REY HARBOR: SITE CHARACTERIZATION STUDY DESIGN

- 11 stations
- Measurements and analyses
 - Water quality (pH, salinity, temperature, dissolved oxygen)
 - Dissolved organic carbon (DOC)
 - Dissolved and total metals
 - Chlorophyll (measurement of plankton)
 - Toxicity
 - Comparison to predicted toxicity (Biotic Ligand Model)



MARINA DEL REY HARBOR: SITE CHARACTERIZATION SAMPLING EVENTS

- 3 events
- 2 depths
 - Surface=1m below water surface
 - Bottom=1m above sediment
- Different tidal cycles
- Assess which parameters impact DOC variability
 - Lower DOC = Higher Cu Bioavailability = Lower WER

Event	Date	Weather	Precipitation (inches)	Sampling depths
1	3/23/2018	Wet	1.1	B, S
2	5/21/2018	Dry	0	B, S
3	9/10/2018	Dry	0	S

MARINA DEL REY HARBOR: SITE CHARACTERIZATION FINDINGS

Parameter	Effect on DOC?		
	Yes	No	Minor
Weather	X		
Tide height			X
Sampling depth		X	
Chlorophyll			X
Temperature		X	
Salinity*		X	
pH*		X	
Station location	X		

- Critical condition likely to be most influenced by weather and location
- Lower DOC found in dry weather
- Lowest DOC expected near marina entrance

MARINA DEL REY HARBOR: DOC IS A RELATIVE MEASURE FOR BLM-PREDICTED EC50

- Temperature, salinity, and pH had minimal impact on BLM results
- DOC most variable input parameter, resulting in largest impact on BLM results
- DOC may be a good proxy for model results

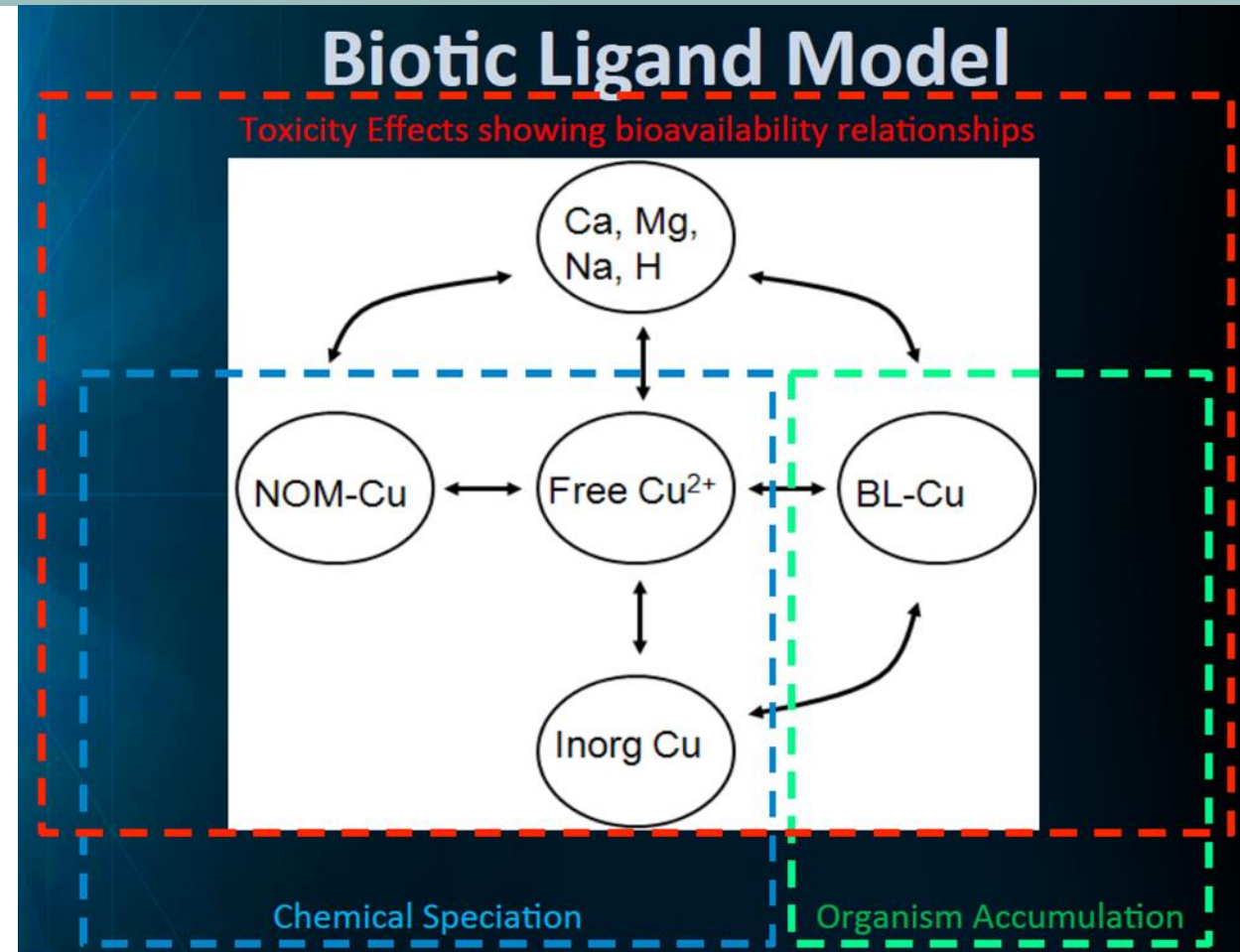
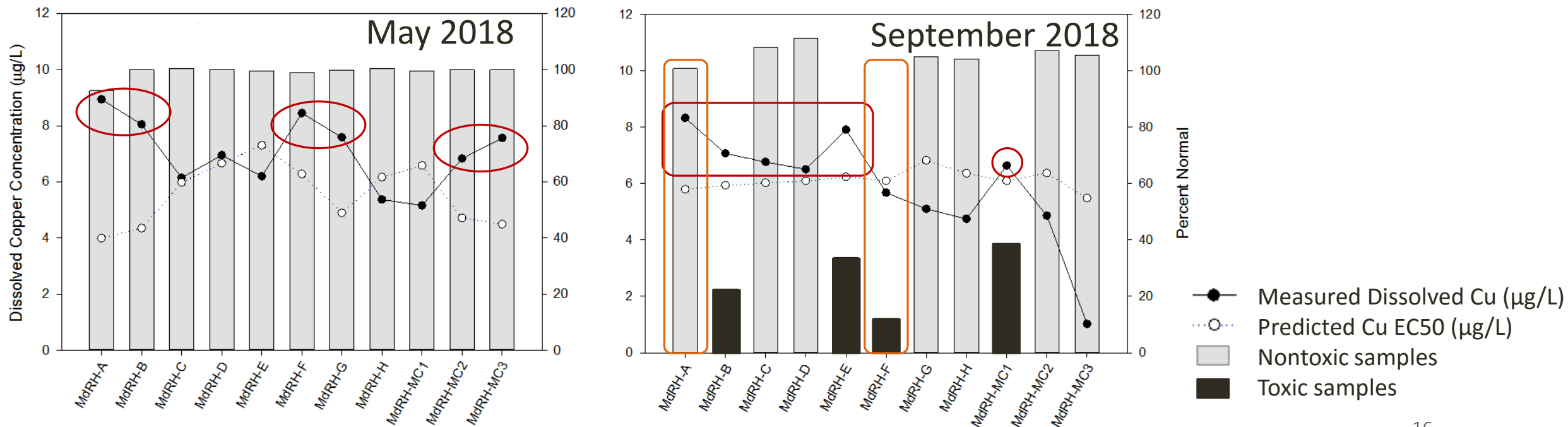


Figure from Bob Santore

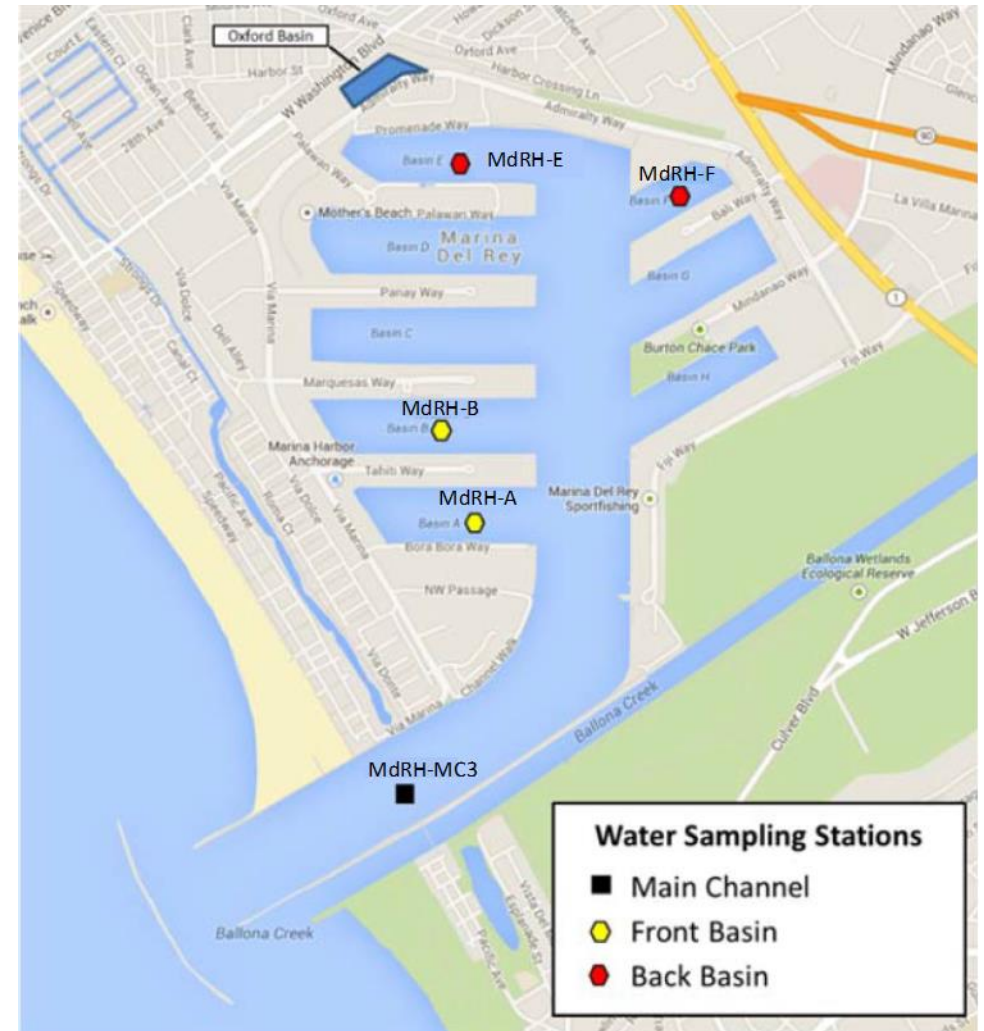
MARINA DEL REY HARBOR: DOC TYPE/QUALITY MAY BE IMPORTANT

- Toxicity only observed in September 2018
- About half of the samples had copper concentrations greater than predicted EC50; expect some toxicity (May and September 2018)



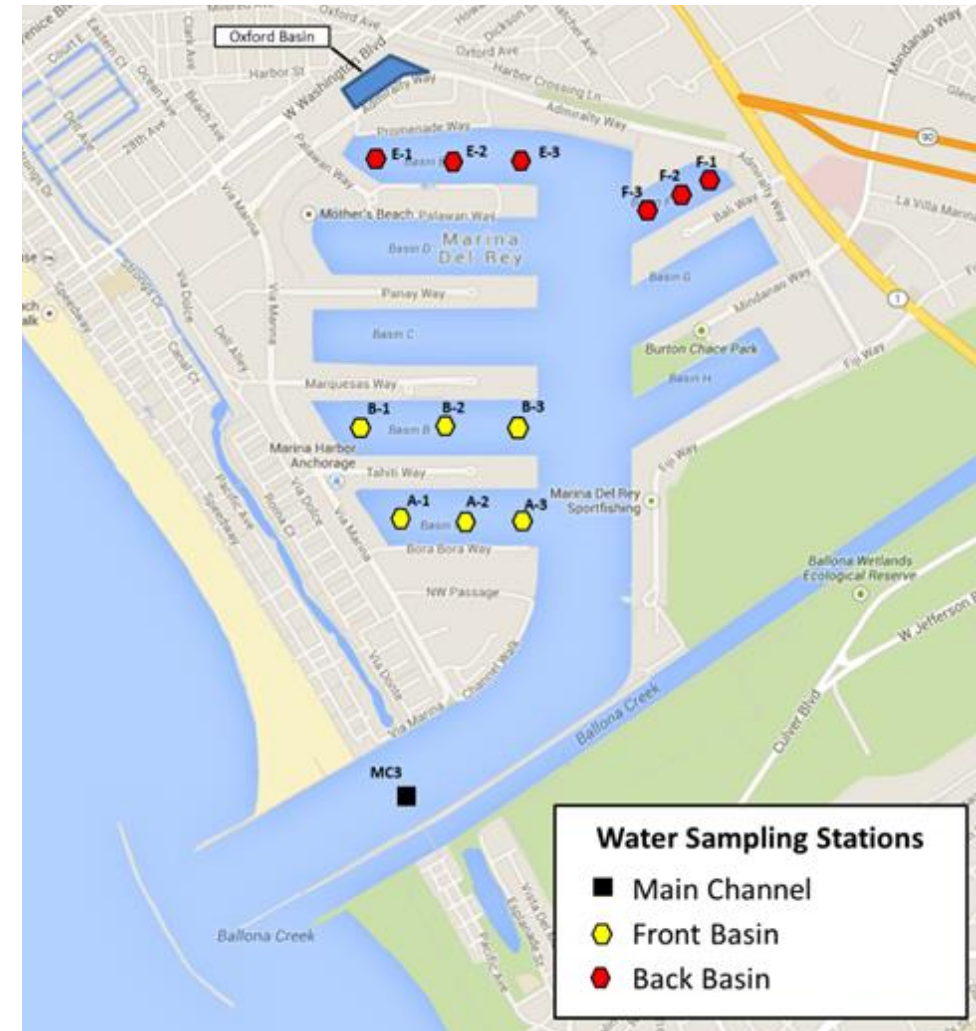
MARINA DEL REY HARBOR: PROPOSED WER STUDY DESIGN

- Stations with low DOC
 - Represent critical condition
- Stations with higher dissolved copper concentration
 - Represent risk to aquatic life
- Front and back basins, and main channel represented
- Six sampling events over time (wet and dry)



MARINA DEL REY HARBOR: STUDY DESIGN REVIEW PROCESS

- Technical Advisory Committee and Stakeholder review of draft workplan
- TAC recommendations
 - Use composites for better representation of site
 - More frequent DOC analysis
 - Spectrophotometric characterization of DOC



MARINA DEL REY HARBOR: IMPROVED WER STUDY DESIGN PROCESS?

- Developing WERs for bays and harbors requires more site characterization
 - *Site characterization study to identify key parameters in MdRH*
- Few recommendations and guidance for marine systems which results in unclear study design requirements
 - *TAC review and study design recommendations to ensure consideration of important site-specific variables*
- Ensure sufficient data that represents the site conditions
 - *Study design based on site-specific knowledge and independent TAC review*
- Data uncertainty for calculation of final WER
 - *TAC review of the study design and data analysis*
 - *Transparent process with stakeholders and planned public outreach workshops*

COMMENTS AND QUESTIONS?