SUSTAINABLE SEDIMENT MANAGEMENT AND DREDGING SEMINAR
28-30 NOVEMBER 2018
GALVESTON, TX

Water Column Evaluation:

Improving and Streamlining Dredged Material Testing and Evaluation

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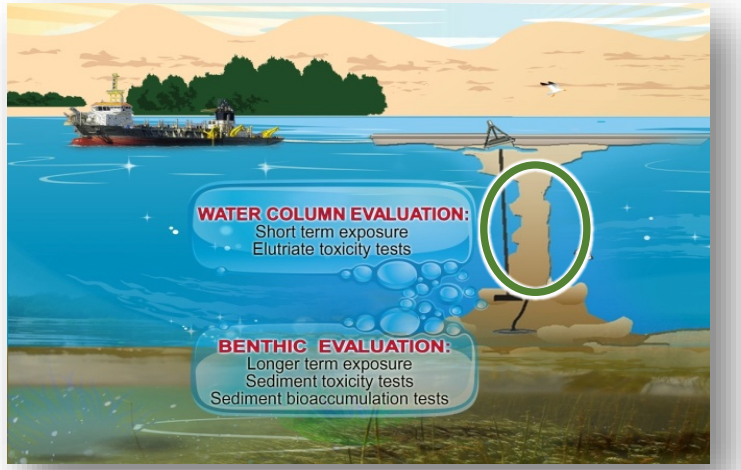
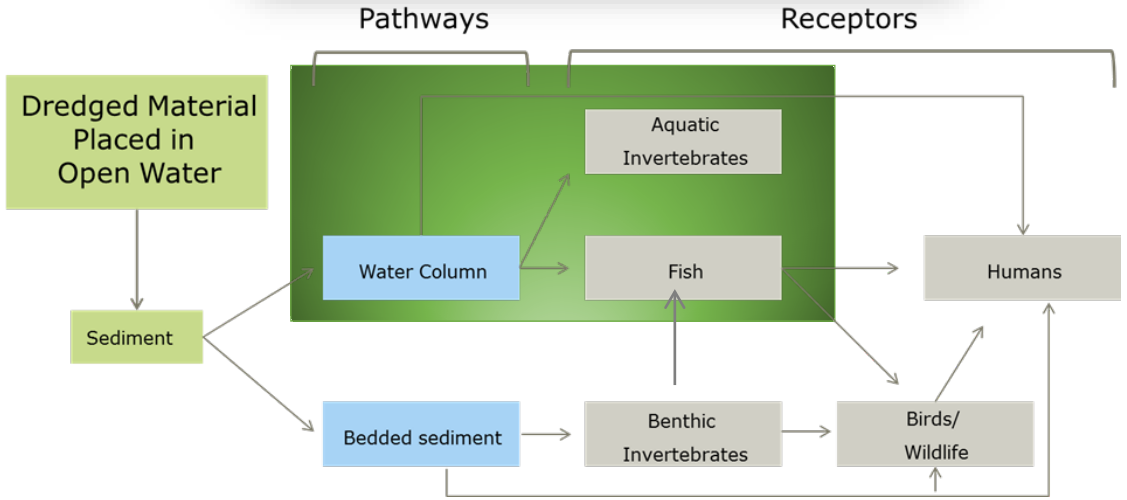
Conceptual Model

Water Quality Evaluation

- One of the pathways considered in open water placement
  - ➢Still consider sediment toxicity
  - ➢Still consider bioaccumulation
- Implications
  - ➢Does not "fail" the material
  - ➢Impacts management options
- Historic info / exclusions (Tier I)
- Analytical chemistry (Tier II)
- Toxicological data (Tier III)





Why Dredging Evaluations Are Done

Water Quality Evaluation Requirements

***Problem**: Manage contaminated sediment*

- 300-400 mcy dredged annually
- 12-20 mcy special management

Requirements: regulations on sediments

- **Ocean Disposal: MPRSA (40 CFR 227)**
  - ➢ Limiting Permissible Concentration (LPC)

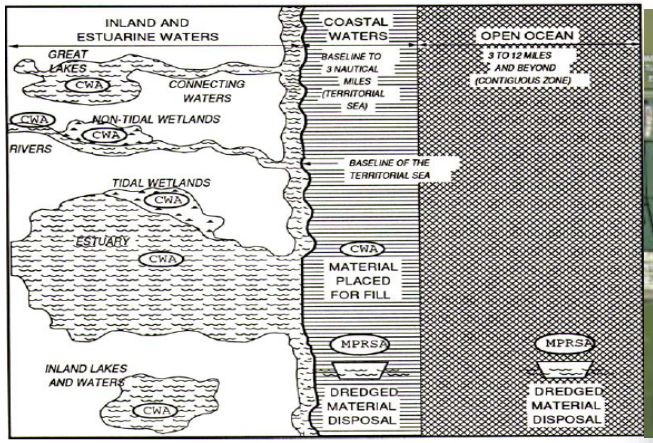
    DM cannot exceed after mixing based on:

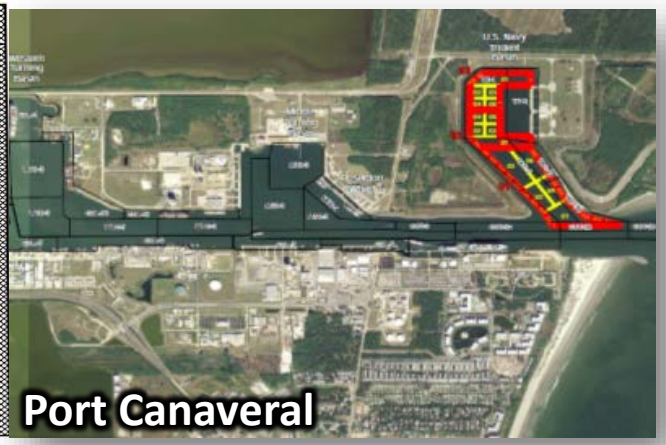
    A. WQC, or

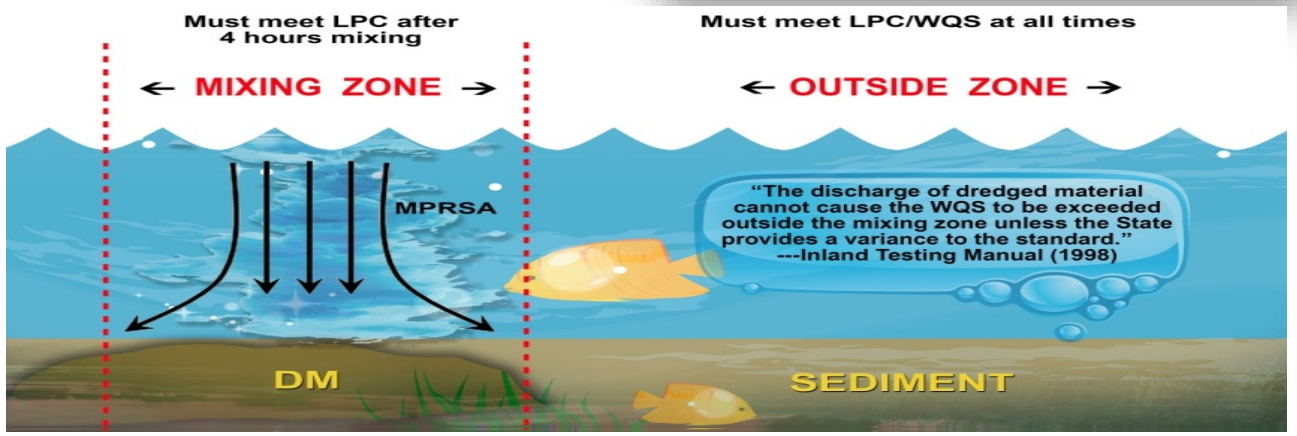
    B. Toxicity (or toxicity X safety factor)

- **Inland disposal: CWA (CFR 230, 404b1)**
  - ➢ Mixing zones determined by the state
  - ➢ Compliance with WQS, bioassay testing

"…unreasonably degrade or endanger: human health, welfare, or amenities, marine environment, ecological systems, or economic potentialities…"



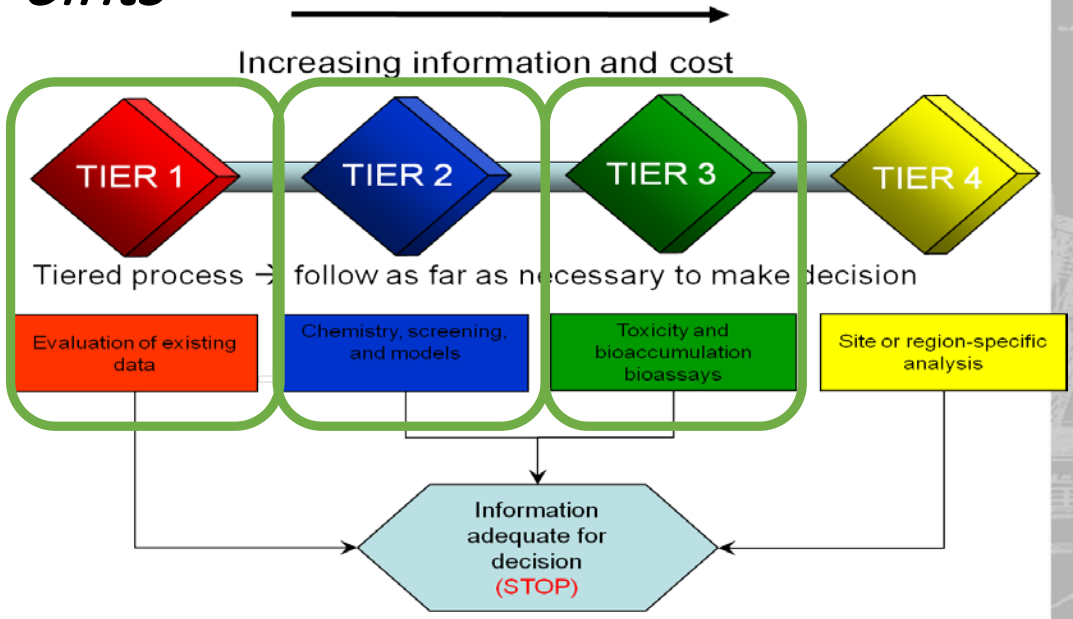




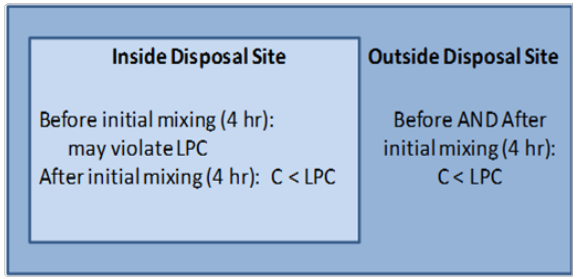
Water Column Evaluation

Main Discussion Points

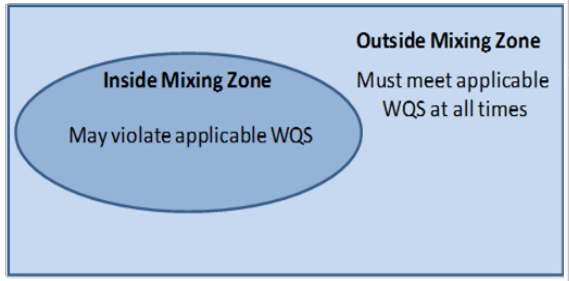
- DM suspended for a short time (short-term exposure, effects)
- Historic info: determination?
  - Exclusions, new pollution?
  - Previous toxicity, dredging method
- LPC vs. modeled concentration
  - WQC / WQS
  - Bioassays



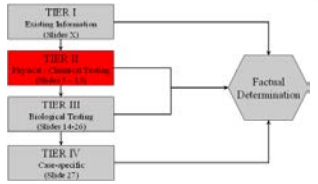
40 CFR Part 227 (MPRSA)



40 CFR Part 230 (404(b)(1) Guidelines) (CWA)

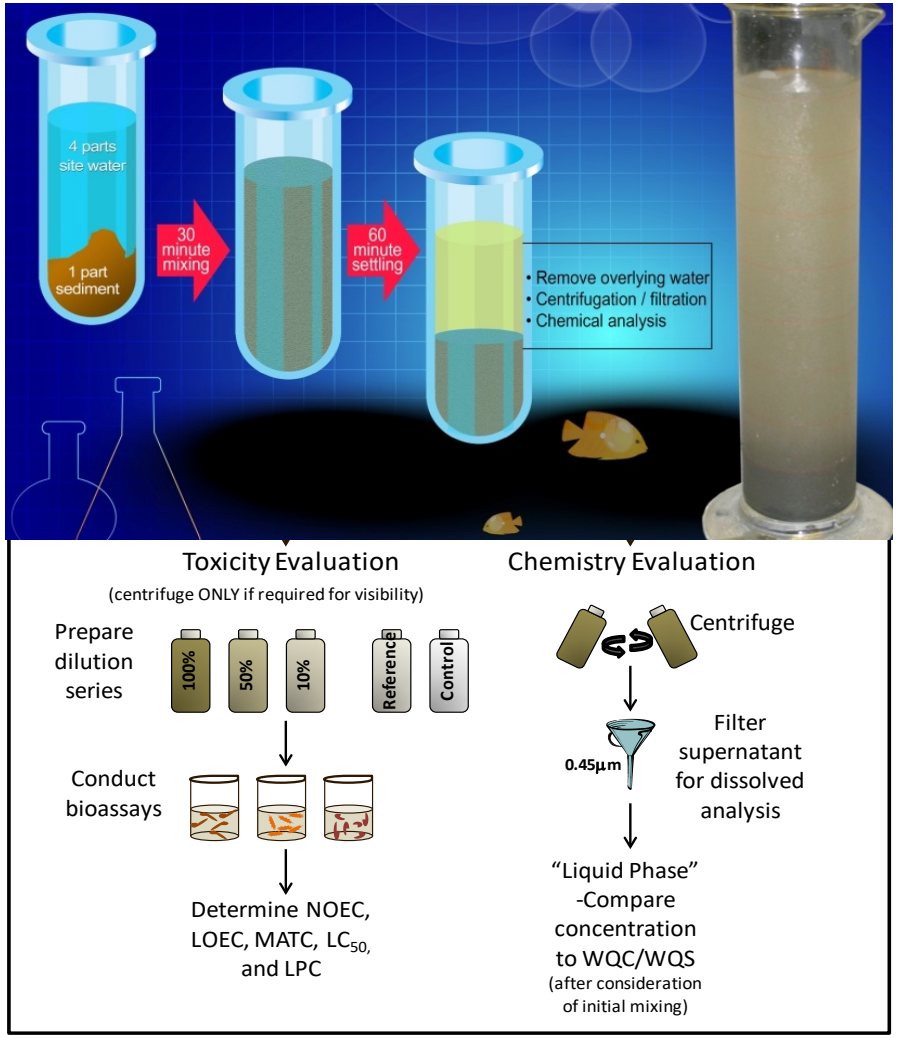


Elutriate Preparation

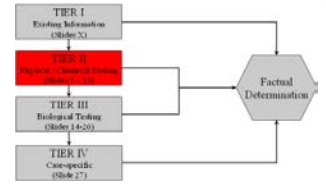


- Types of elutriates
  - **Standard Elutriate Test (SET)**
  - Effluent (Modified) Elutriate Test (EET, MET)
  - Dredging Elutriate Test (DRET)

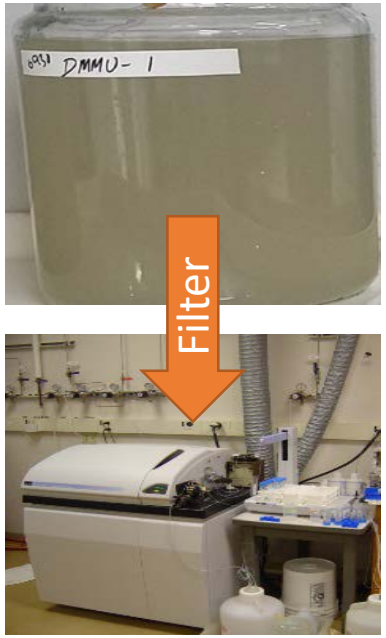
Application	Test Material	Hold Time
Elutriate preparation	4 parts site water	2 weeks+
	1 part sediment	8 weeks
Elutriate dilution	Disposal site water, lab water, other approved water	Not applicable
Statistical comparisons (0% treatment)	Same as above	
Organism Health	Negative Control (lab reconstituted, natural)	
	Reference toxicant test	

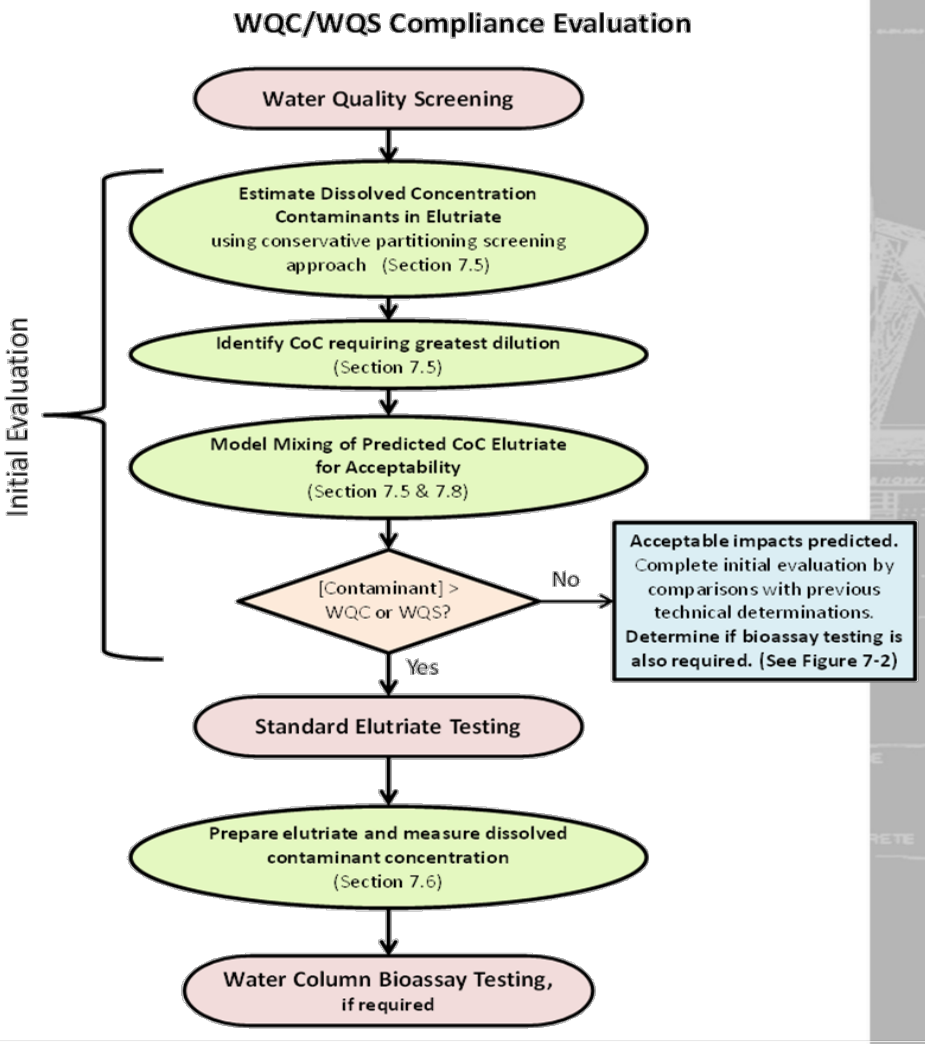


Elutriate chemistry



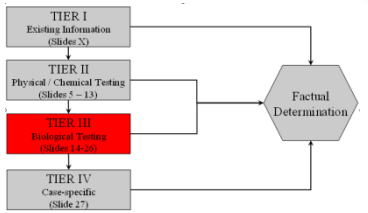
- Established CoC list
- Compare to WQC/WQS
- Determine exceedences
- Determine required dilution
- CWA: determination possible?
- MPRSA: conduct bioassays





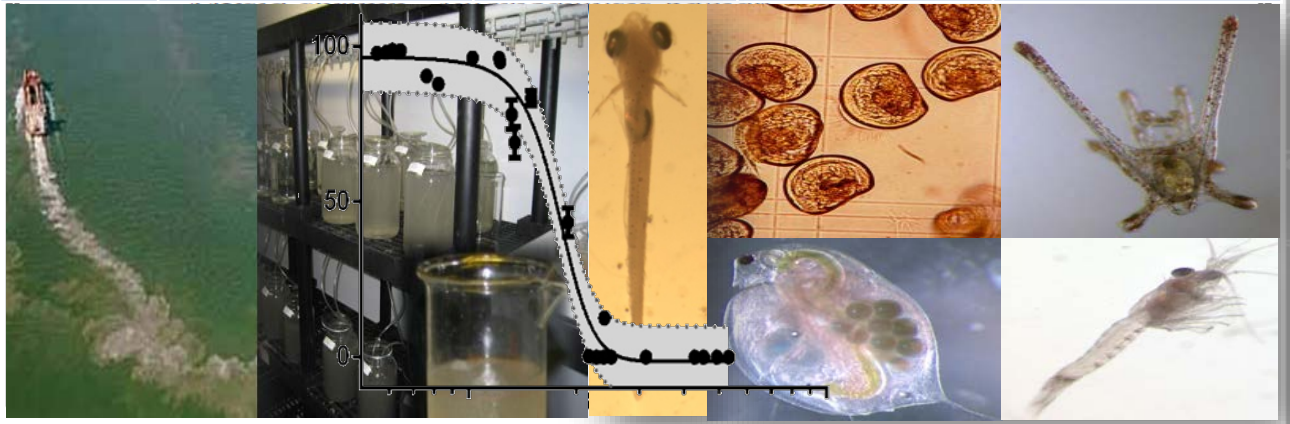
Analyte	Units	Background Concentration (from SMMP)	Acute Water Quality Criteria (from SERIM)	E-KB16-5 Elutriate	Dilution Needed for Compliance
Copper	mg/L	0.0016	0.0048	<0.0010	Below Criteria
Nickel	mg/L	0.001	0.074	0.0011	Below Criteria
Zinc	mg/L	0.0243	0.09	0.0403	Below Criteria
Ammonia	mg/L	0.109	2.41*	9.72	3.2

Elutriate Bioassay



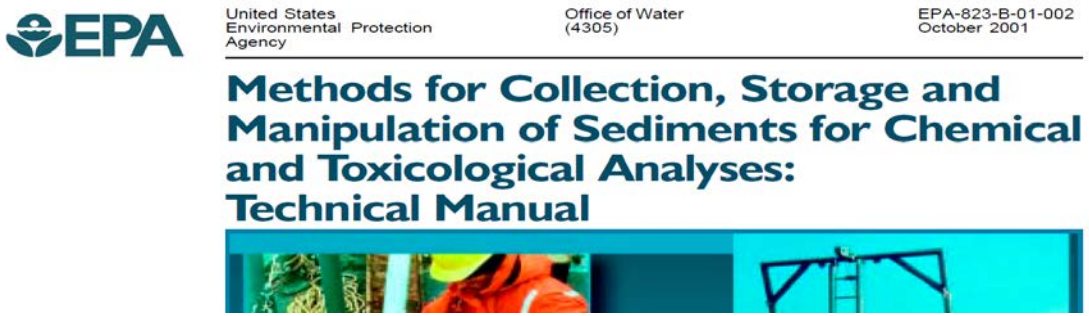
- Recommended: species representing 3 phyla
  - ➢CWA (if needed)
    - Multiple recommended
    - No WQC, unknown toxicity
  - ➢MPRSA (3 species required)
  - ➢Bioassays determine LPC
- Selection of **appropriate** test species

Reg.	Water	Fish	Crustacean	Zooplankton
CWA	Freshwater	*Pimephales* *Oncorhynchus*	*Daphnia* *Ceriodaphnia*	
CWA	Estuarine/marine	*Menidia* *Cyprinodon*	*Americamysis, Palemonetes* *Copepod*	
MPRSA	Marine	*Menidia* *Cyprinodon*	*Americamysis*	*Americamysis* *Mytilus* embryo Urchin embryo Copepod



Frequently Encountered Issues

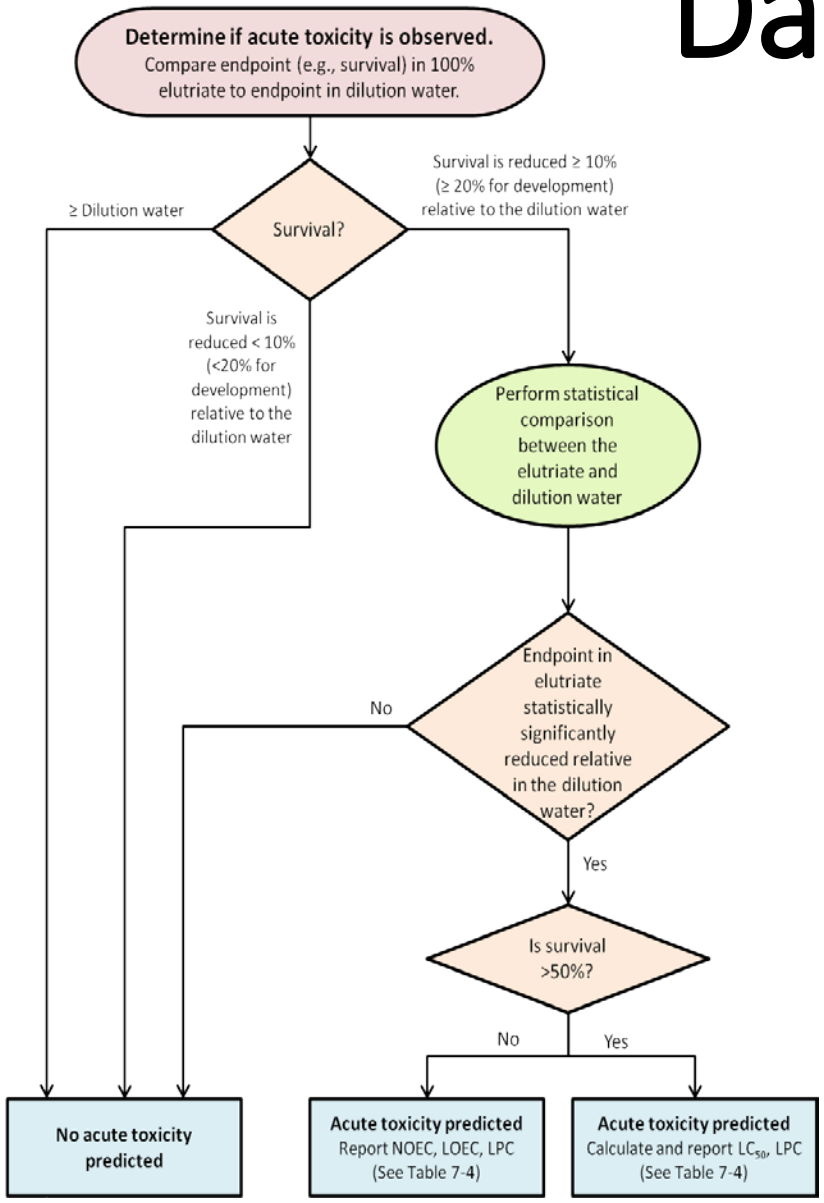
- Water hold time impact on field/lab logistics: 2 weeks
- Species selection
  - ➢Ecology, sensitivity
  - ➢Historic use / database
  - ➢Salinity adjustments (stress, control charts)
  - ➢Ammonia toxicity
- Application factor
- Bin restrictions

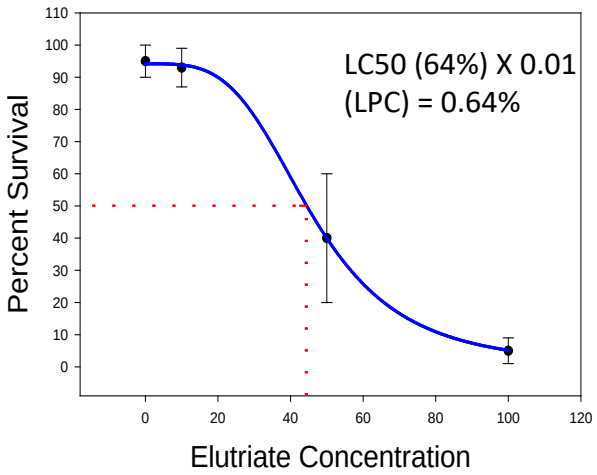


Salinity (ppt)	Fish	Invertebrate	Zooplankton
30+	Adjust down	↓Adjust down	↓Adjust down
25 - 30	***Cyprinodon Menidia***	***Americamysis***	**Copepod *Americamysis***
21 – 25	*Cyprinodon*	*Americamysis*, adjust up	↑Adjust up
11 – 20	*Cyprinodon*	↑Adjust up	↑Adjust up
1 – 15	*Cyprinodon*	↑Adjust up	↑Adjust up
0 – 1	***Pimephales***	***Daphnia, Ceriodaphnia***	

Data interpretation

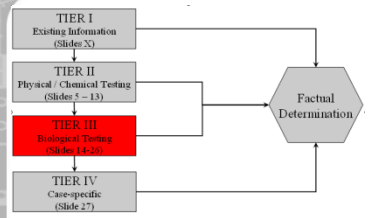
LPC





Elutriate	%	Fish	Invertebrate	Zooplankton	>10% reduced & stat. sig.?	Lowest LC/EC50	LPC (X 0.01)
DMMU 1	0%	98%	98%	96%	No	>100%	No restrictions
	10%	94%	98%	97%	No		
	50%	94%	100%	97%	No		
	100%	100%	100%	96%	No		
DMMU 2	0%	98%	98%	96%	No	64%	0.64
	10%	98%	98%	97%	No		
	50%	96%	96%	88%	No		
	100%	70%	98%	0%	Yes		

Most sensitive species



TIER III:

Toxicity Data Interpretation

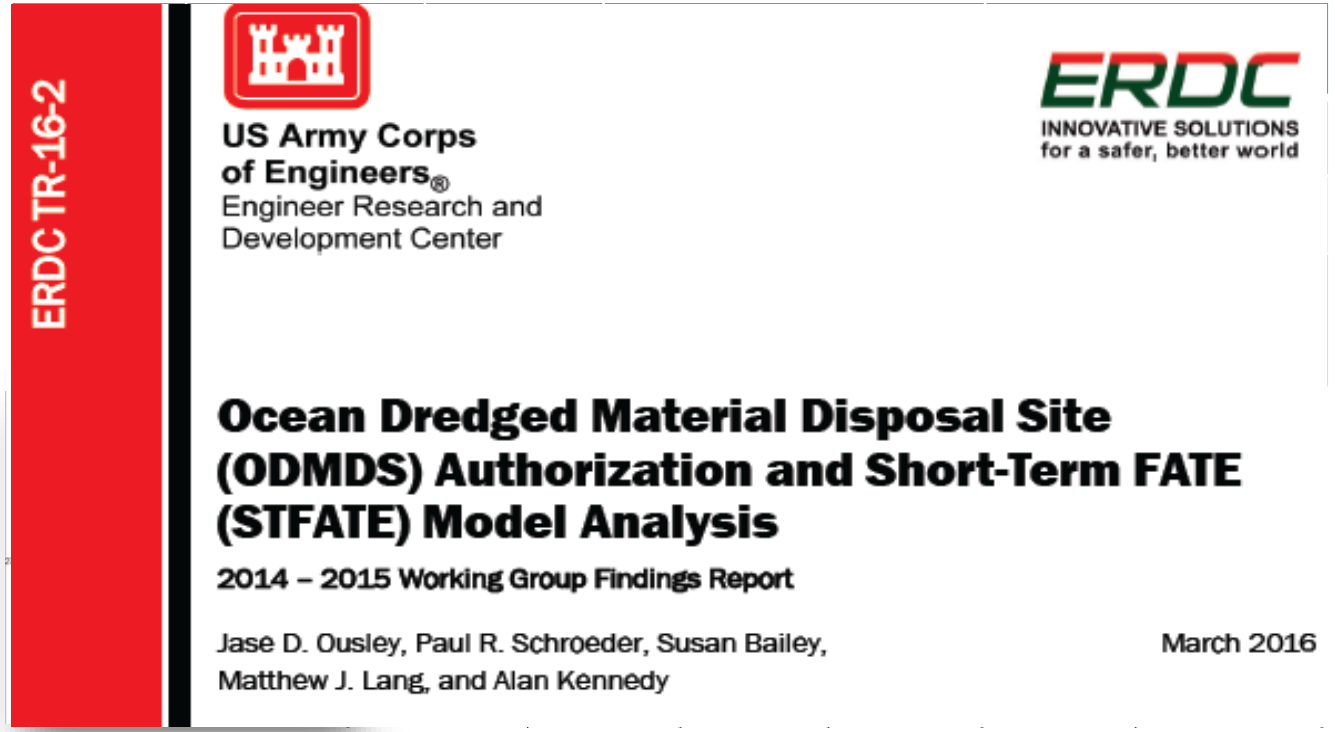
Outcome	Bioassay Interpretation	LC / EC50	Action	Value for model
Survival in undiluted elutriate **is not** reduced (<10%, statistically) relative to control	No acute toxicity predicted	Cannot be calculated (LPC>100%)	No need to run mixing model	
Survival in undiluted elutriate **is** reduced (≥10, statistically) but is > 50%	Acute toxicity predicted	Cannot calculate LC50	Run mixing model	NOEC or 100% X AF
Survival in undiluted elutriate < 50%; Survival in highest dilution ≥ 50%	Acute toxicity predicted	Compute LC50/EC50	Run mixing model	LC/EC50 X AF
Survival < 50% in all dilutions	Acute toxicity predicted	Cannot be calculated by interpolation	Repeat bioassay with greater dilutions	

e.g., LC50 = 64%
42% X 0.01 = 0.64%

Data Interpretation

Modeled Concentration

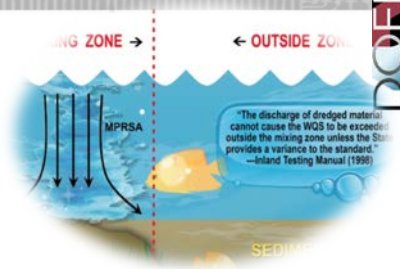
- LPC = 0.64, Requires 156X dilution
- Conclusions
  1. **DM discharge toxicity <u>not predicted</u> relative to the reference condition**
  2. DM discharge toxicity <u>is predicted</u> relative to the reference condition
  3. Further information needed for actual determinations (Tier IV)



Site	LC_{50} or EC_{50} (%Elutriate)			Application Factor	Limiting Permissible Concentration (% Elutriate)			Minimum Dilution to Achieve LPC Compliance
	Americamysis	*Menidia*	*Mytilus*		*Americamysis*	*Menidia*	*Mytilus*	
DMMU 1	NA	NA	NA	0.01	NA	NA	NA	NA
DMMU 2	NA	NA	64	0.01	NA	1	0.64	156

Modernizing Evaluations

Limiting Permissible Concentration (40 CFR 227.27)



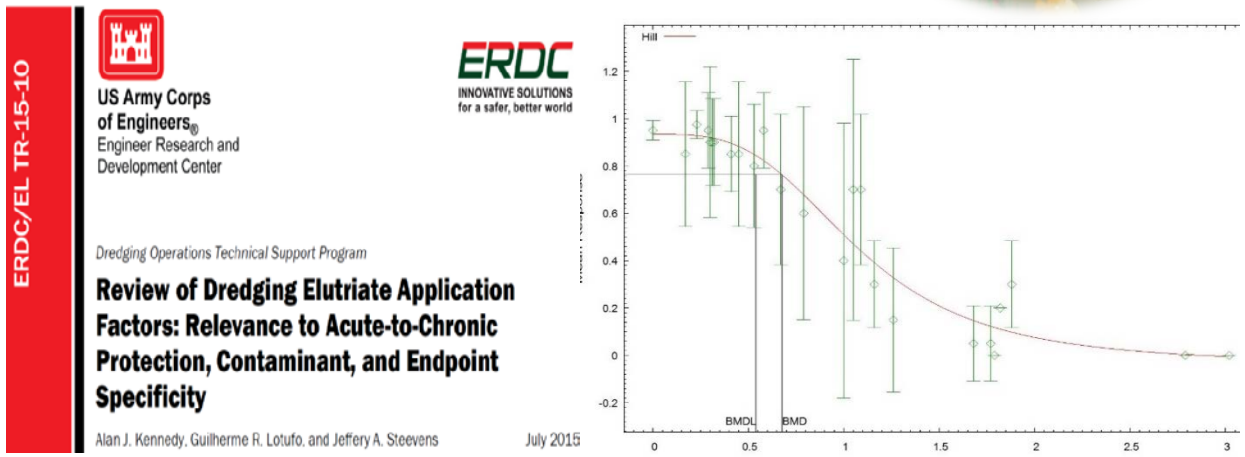
Issue: Conservative safety factor

Barge size restrictions

- LPC = acutely toxic concentration X 0.01
- Intended for survival, not development
- Other factors permissible: opportunity?
- Persistent > 8 weeks: 0.01 (NAS 1972)
- Non-persistent < 8 weeks: 0.05 (<0.1)

Solutions & Benefit:

- Consider dredging method vs. exposure duration
- Is there need for chronic protection?
- Alternative safety factors published
- Most cost effective management option



Chemical	Duration	Factor	LC50	LPC	STFATE
Default, metals, pesticides	Chronic	0.01	3%	**0.03%**	0.3%
Hydrocarbons	Chronic	0.05	3%	**0.15%**	0.3%
Ammonia/Sulfides	Chronic	0.1	3%	**0.3%**	0.3%
Other	Acute	0.2	3%	**0.6%**	0.3%
USE LOGIC!!!	Acute	EPA BMDL	--	**1.09%**	0.3%

FAIL

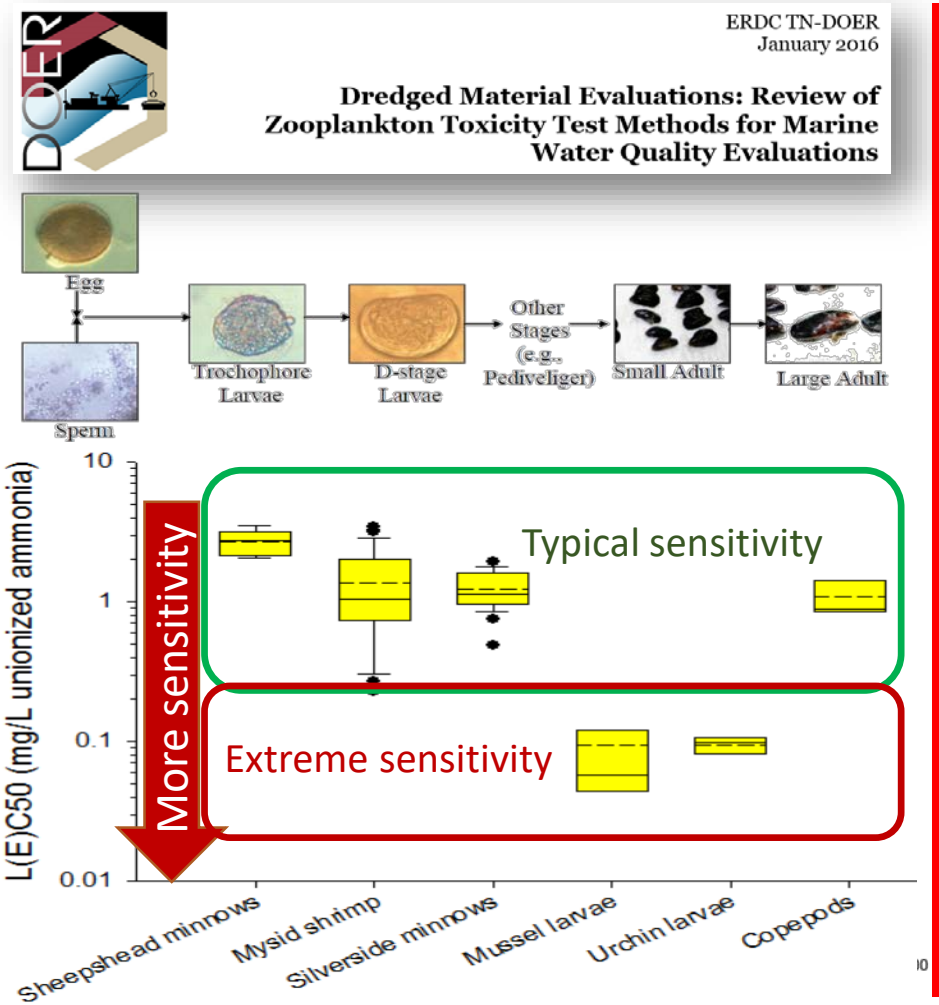
PASS

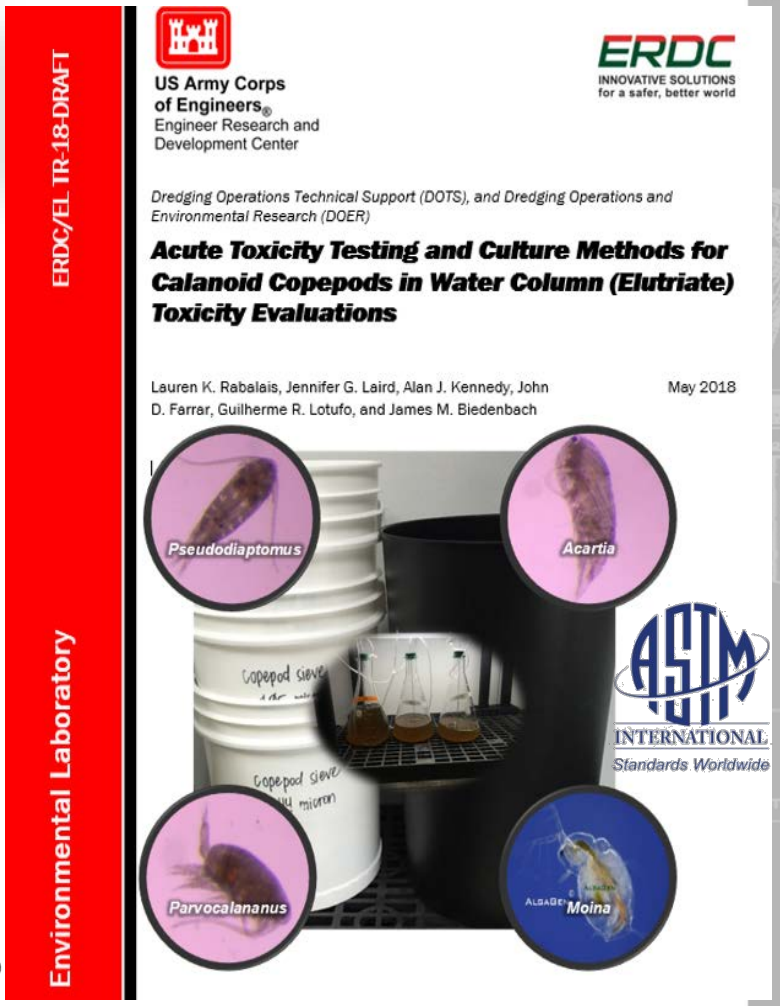
Canaveral Harbor Increase from 3600 to 8900 cy allowable placement

Modernizing Evaluations

More Appropriate Marine Zooplankton Tests

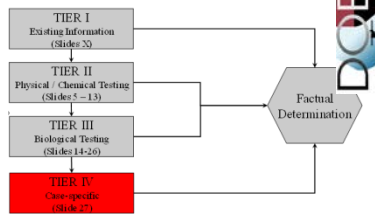
- Marine copepods
- Development tests
- Full life cycle
- Confounders:
  - Particles
  - Ammonia
- Lab culture
- In the Region 6 RIA
- Sensitive to CoCs





Modernizing Evaluations

Improved Toxicity Reduction / Identification Methods

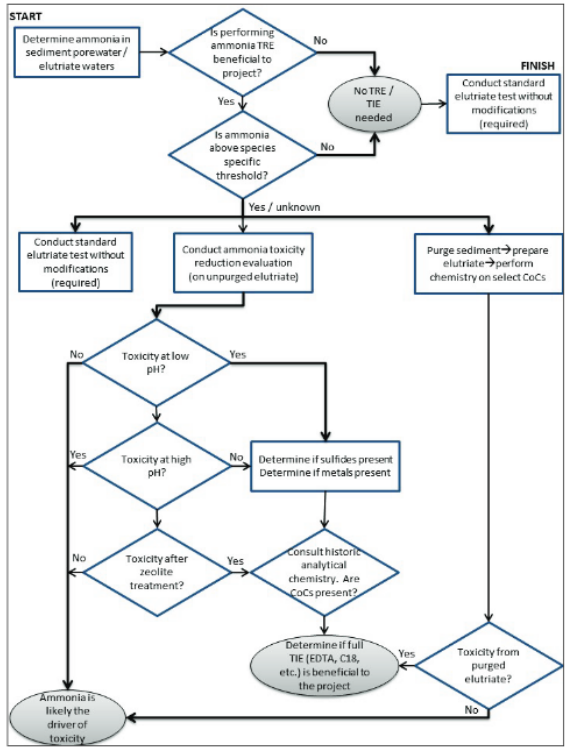


- "Toxicity" not always CoC
- Performed as Tier 3 - 4
- Improve ammonia TRE methods for SERIM
  - ➢Region 4
  - ➢Isolate toxicity cause
- Select appropriate application factor
  - ➢0.01, 0.05, 0.1, etc.

May 2018

Toxicity Reduction (and Identification) for Dredging Evaluations: Methods for Sediment Elutriate Bioassays

by Nicolas L Melby, Alan J Kennedy, J Daniel Farrar, Anthony J Bednar, David W Moore and Wade Lehmann



Questions?

Take home messages:

1.Streamline procedures:

Save Time & Cost

2.Improving testing and evaluations

3.Modernize evaluations:

Closing the gap: historical practice vs. available science

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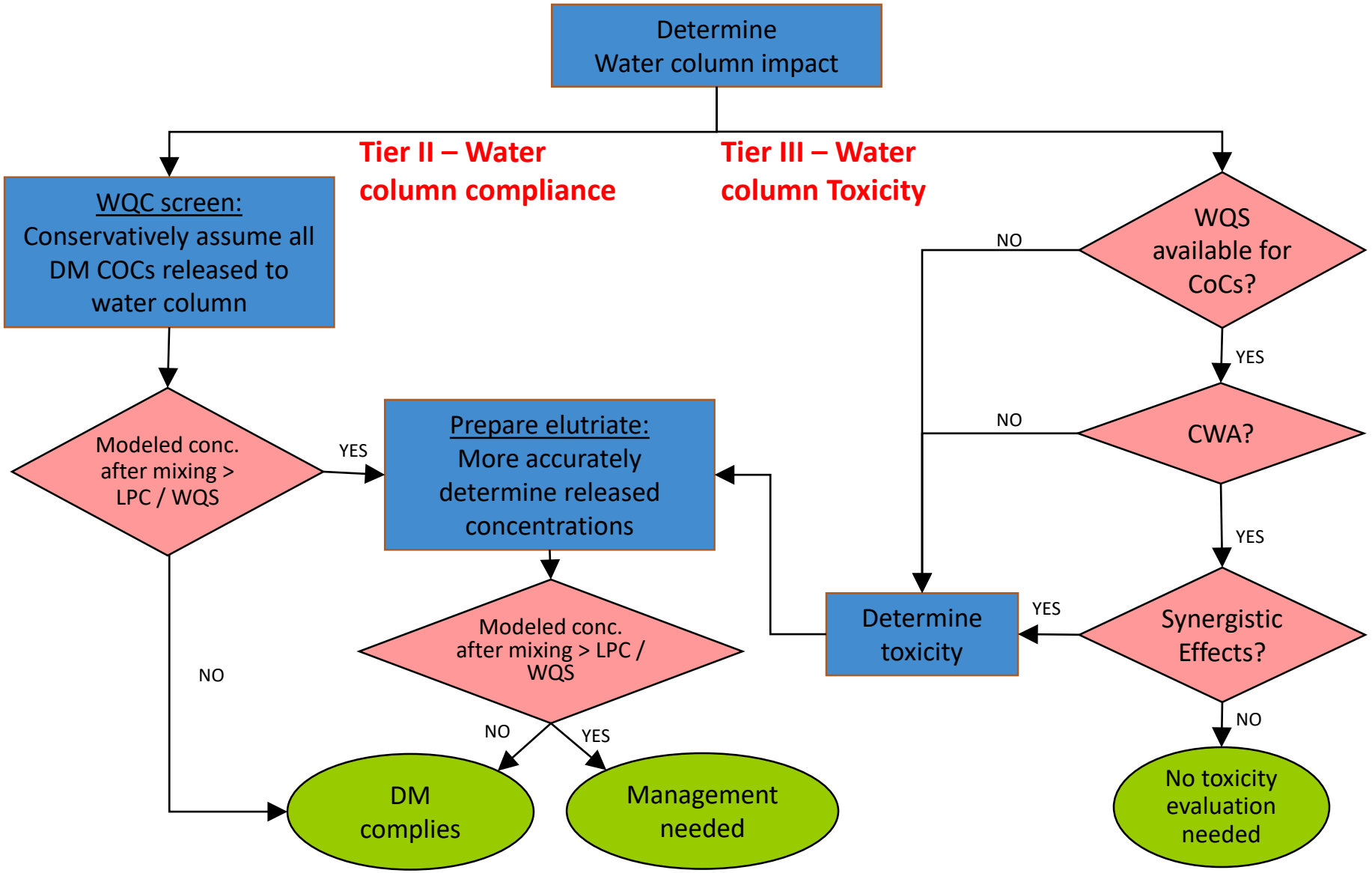
Determine
Water column impact
Tier II – Water column compliance
Tier III – Water column Toxicity
WQC screen:
Conservatively assume all DM COCs released to water column
Modeled conc. after mixing > LPC / WQS
YES
NO
Prepare elutriate:
More accurately determine released concentrations
Modeled conc. after mixing > LPC / WQS
NO
YES
DM complies
Management needed
Determine toxicity
WQS available for CoCs?
NO
YES
CWA?
NO
YES
Synergistic Effects?
YES
NO
No toxicity evaluation needed