Overview of Dredged Material Testing and Evaluation

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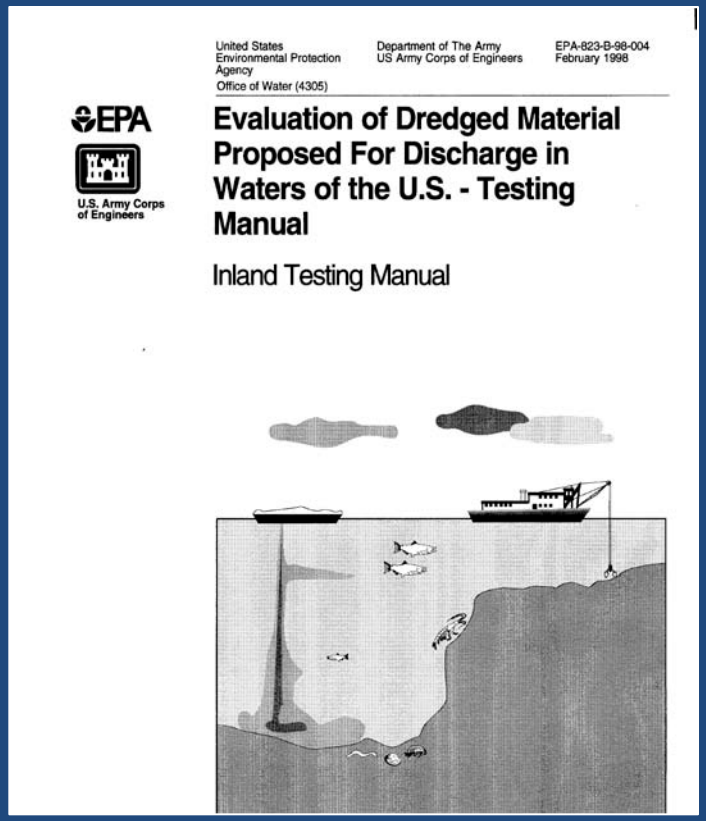
Guidance Documents for Management of Dredged Material

National Technical Guidance

- Technical Framework
- Inland Testing Manual
- Ocean Testing Manual
- Upland Testing Manual
- Ocean Site Designation Manual
- Site Management & Monitoring

Found at:
el.erdc.usace.army.mil/dots/guidance.html

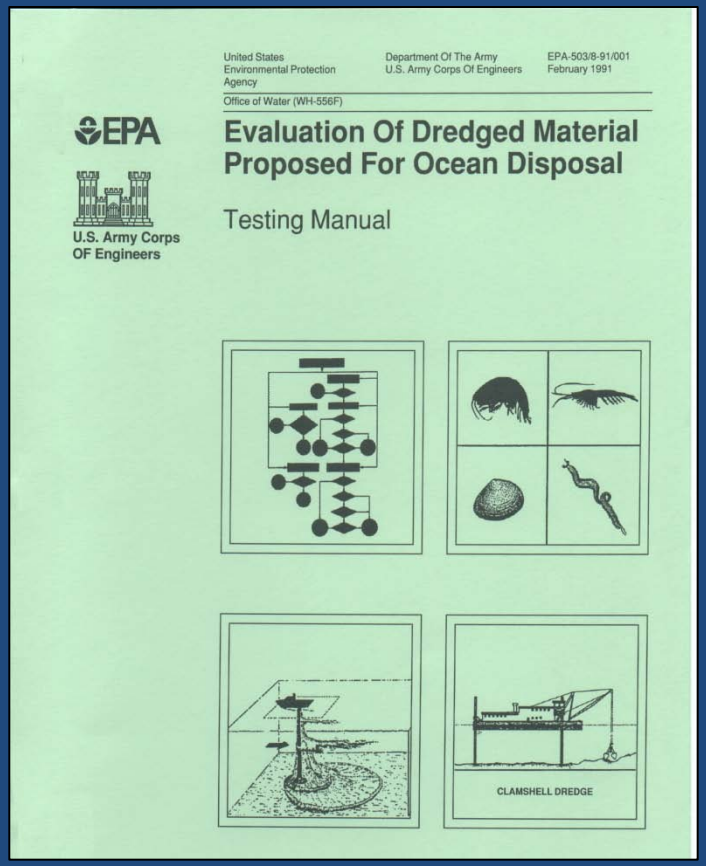
Inland Testing Manual



- Addresses CWA
- Interim guidance in 1976, updated in 1998
- Included:
  - Effects-based testing
  - Sequenced > Tiered

DM placement *"will not cause "an unacceptable adverse impact"*

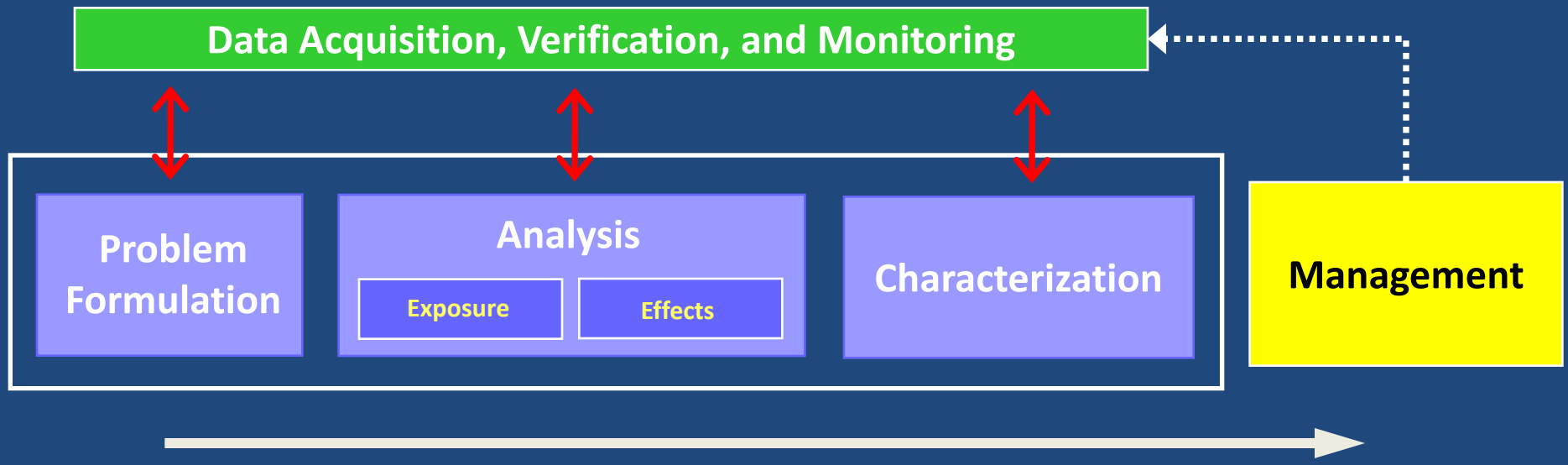
Ocean Testing Manual



- Addresses MPRSA
- Originally developed in 1977, updated in 1991
- Included:
  - Effects-based testing
  - Bioaccumulation
  - Sequenced >Tiered

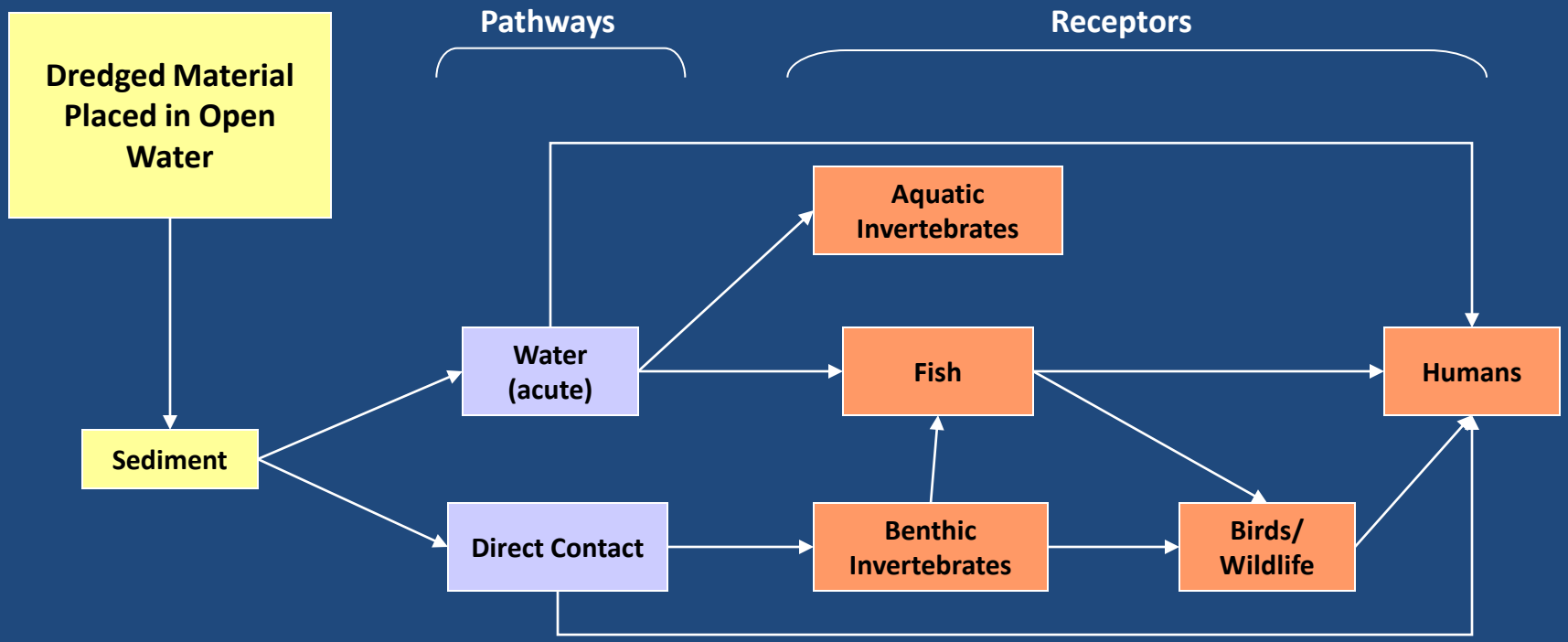
DM placement in ocean will not *"unreasonably degrade or endanger: human health, welfare, or amenities, marine environment, ecological systems, or economic potentialities"*

Risk Assessment and Management



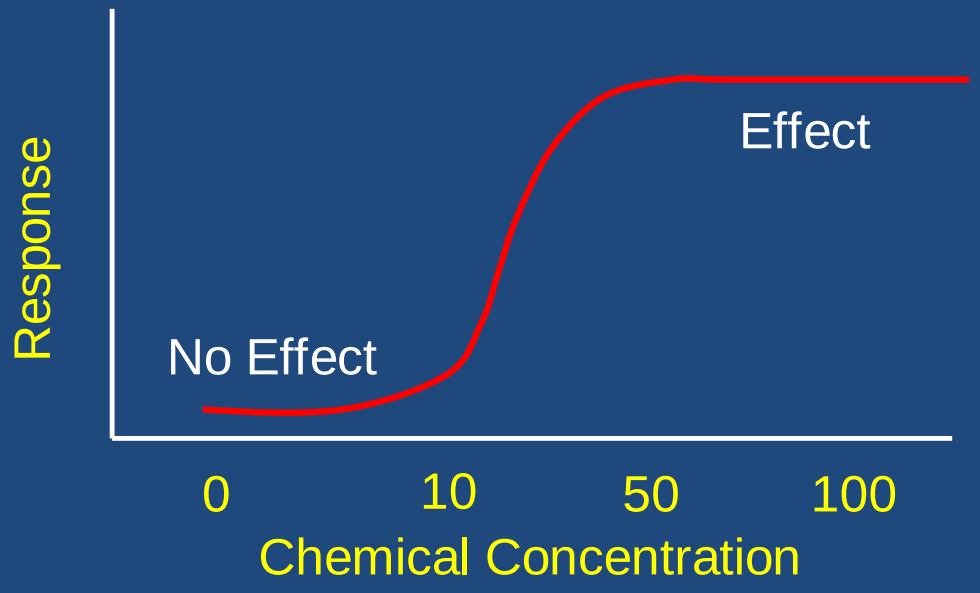
- Process that evaluates the likelihood that adverse effects may occur or are occurring as a result of exposure to one or more stressors (USEPA 1997).
- Risk management is an approach to consider the outcome and uncertainty of an assessment and mitigate risk through a range of alternatives.

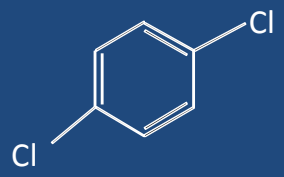
Conceptual Model: Open Water Placement of DM



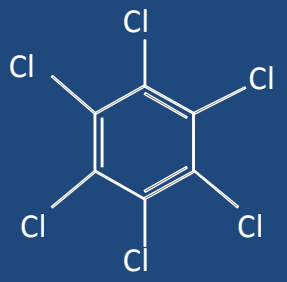
Identify Contaminants of Concern

At what concentration will an adverse effect will occur?





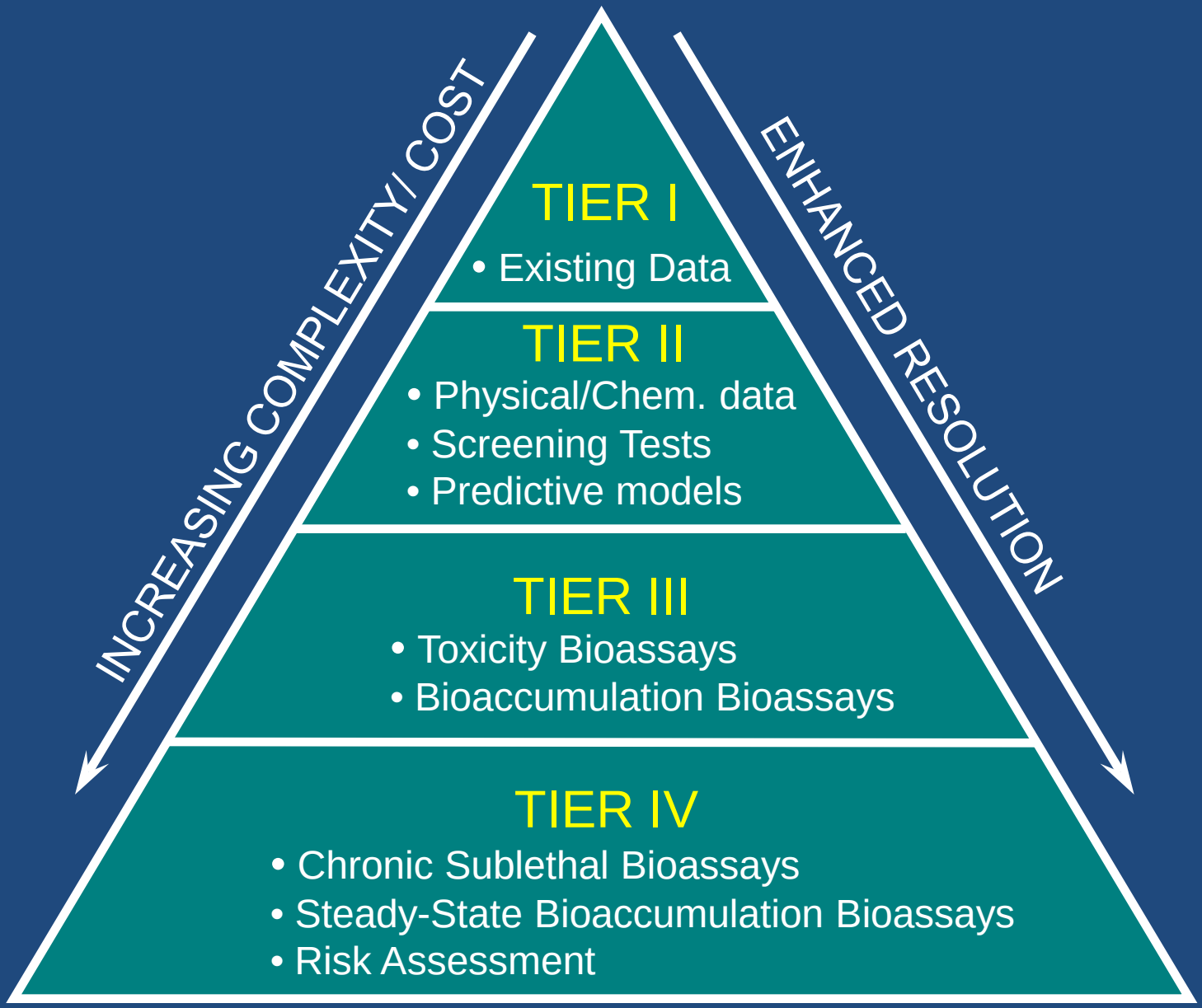
Dichlorobenzene
Half life = 10 days

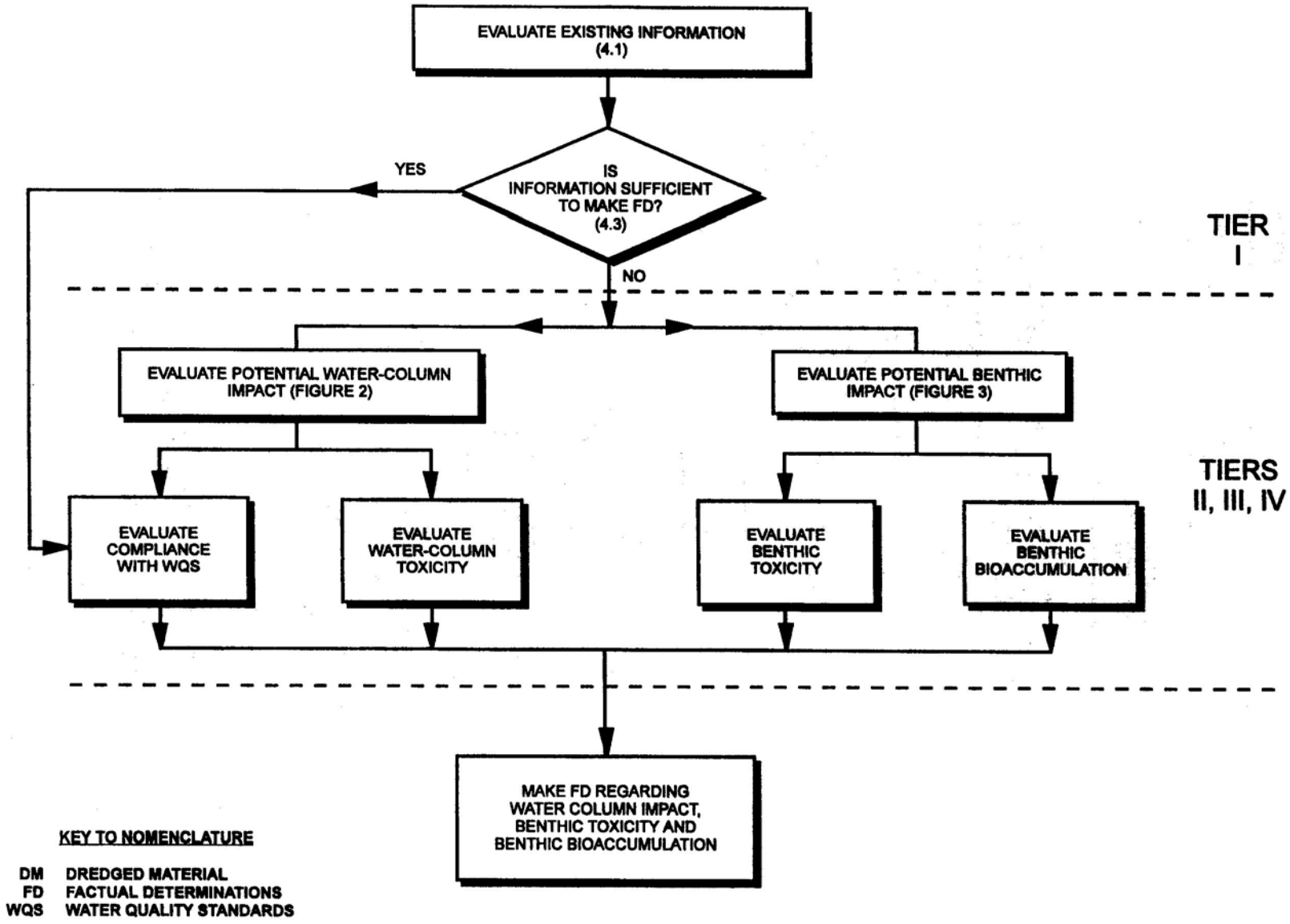


Hexachlorobenzene
Half life = 6 years

Important Factors

- Chemical properties: mobility, bioavailability, persistence
- Toxicological significance (Cr^{6+} vs Cr^{3+})
- Potential to bioaccumulate


INCREASING COMPLEXITY/ COST
ENHANCED RESOLUTION
TIER I
• Existing Data
TIER II
• Physical/Chem. data
• Screening Tests
• Predictive models
TIER III
• Toxicity Bioassays
• Bioaccumulation Bioassays
TIER IV
• Chronic Sublethal Bioassays
• Steady-State Bioaccumulation Bioassays
• Risk Assessment


EVALUATE EXISTING INFORMATION (4.1)
IS INFORMATION SUFFICIENT TO MAKE FD? (4.3)
YES
NO
TIER I
EVALUATE POTENTIAL WATER-COLUMN IMPACT (FIGURE 2)
EVALUATE POTENTIAL BENTHIC IMPACT (FIGURE 3)
TIERS II, III, IV
EVALUATE COMPLIANCE WITH WQS
EVALUATE WATER-COLUMN TOXICITY
EVALUATE BENTHIC TOXICITY
EVALUATE BENTHIC BIOACCUMULATION
MAKE FD REGARDING WATER COLUMN IMPACT, BENTHIC TOXICITY AND BENTHIC BIOACCUMULATION
KEY TO NOMENCLATURE
DM DREDGED MATERIAL
FD FACTUAL DETERMINATIONS
WQS WATER QUALITY STANDARDS

Tier I: Existing Information

- Examine existing information
  - Contaminant sources
    - Pathways of contaminant sources
    - Spill information
  - Physical characteristics of site
    - Bathymetry, currents, deposition, time since last dredging was required
  - Prior physical monitoring

Tier I: Exclusions

MPRSA, 40 CFR 227.13

- (b)(1) dredged material is composed primarily of sand, gravel, rock, AND is found in areas of high current or wave energy, OR
- (b)(2) material is for beach nourishment and composed predominantly of sand, gravel, or shell, with particle sizes compatible with the receiving beach, OR
- (b)(3)(i) material is substantially the same as disposal substrate, AND (ii) sediments are far removed from known historical sources of pollution

Tier I: Exclusions

CWA, 40 CFR 230.60

- 230.60 (a) "material not a carrier of contaminants" Composed primarily of sand, gravel or other naturally occurring inert materials, Generally found in areas of high current or wave energy
- 230.60 (b) "sufficiently far removed ... " If sediments are from depths deposited in preindustrial times and not exposed to modern sources of pollution, mineral deposits are considered contaminant sources
- 230.60 (c) "adjacent to ... " the discharge and excavation sites are adjacent, concentrations of contaminants are not substantially different, the geochemical environments are similar, then, the bioavailability of contaminants at the two sites are likely to be similar. Technologies such as capping or underwater containment are potentially applicable.
- 230.60 (d) "if constraints are available…" "if constraints are available to reduce contamination to acceptable levels within the disposal site and to prevent contaminants from being transported beyond the boundaries of the disposal site…"

Tier II: Overview

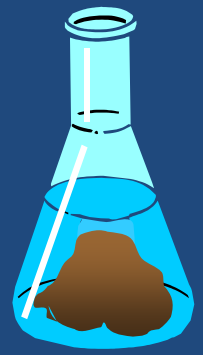
- Predictive models using physical and chemical data (e.g., chemical analysis of sediments)
- Approaches
  - Water column effects?
    - Use sediment and elutriate chemistry to determine compliance with relevant water quality criteria/standards
  - Benthic effects?
    - Use sediment chemistry to determine potential for accumulation of contaminants in biota

TIER II: Water Column Effects

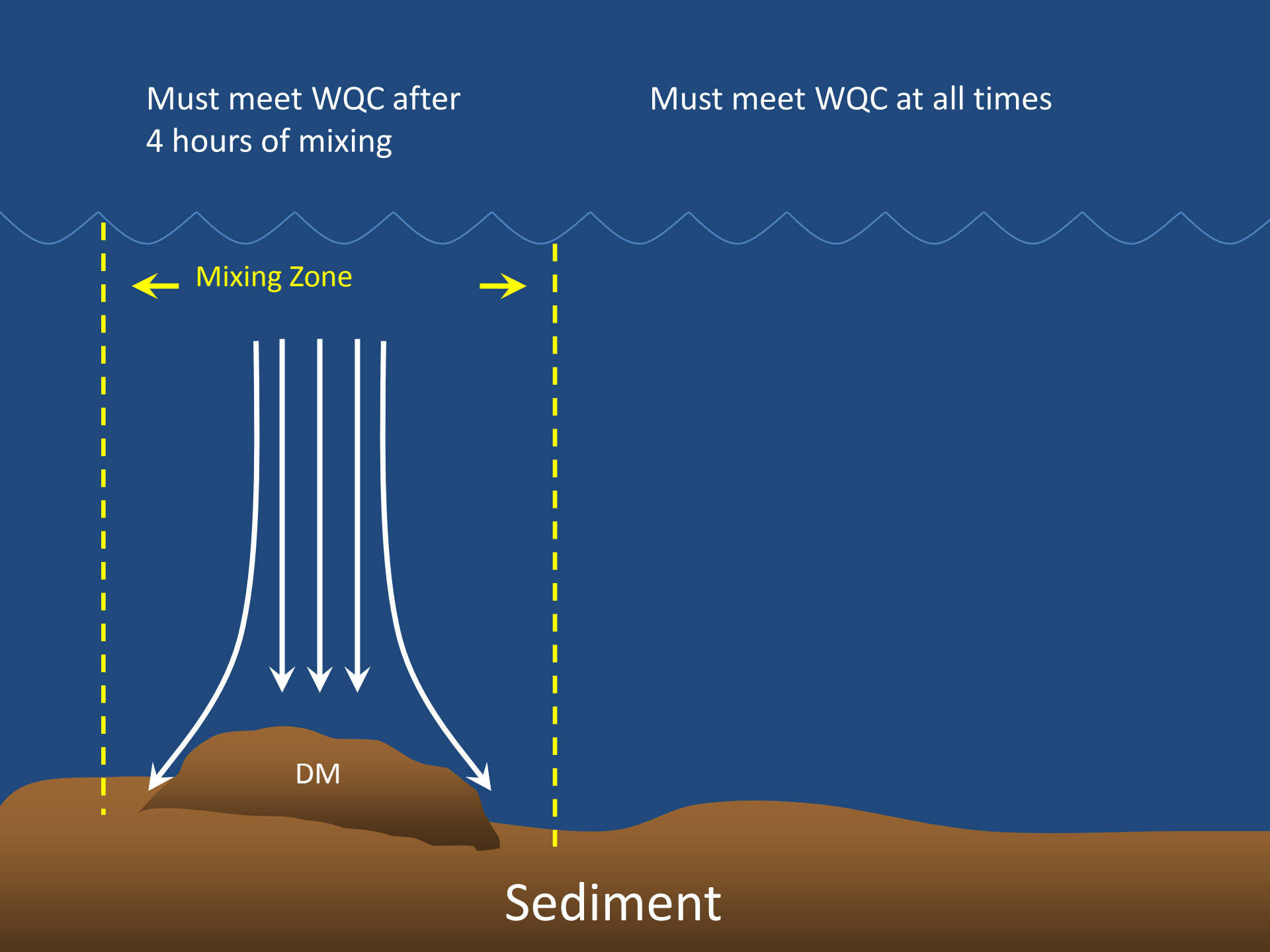
Two-Step Process

- Screening step: chemical analysis data used for conservative estimate of release to water (assumes 100 % of all contaminants measured in sediment are released to water column)
- Chemical analysis step: Use chemical analysis of elutriate to estimate releases to water column
- Both steps utilize a predictive mixing model (STFATE)

4 parts water *
1 part DM
(volume)



http://el.erdc.usace.army.mil/elmodels/addainfo.html


Must meet WQC after
4 hours of mixing
Must meet WQC at all times
Mixing Zone
DM
Sediment

Tier II: Benthic Effects

Thermodynamically Based Bioaccumulation Potential

- A model-derived estimate of steady-state concentration of chemicals in an organism
- Good only for non-polar (hydrophobic) organics
  - PAHs, PCBs, Dioxins, Chlorinated pesticides
- Used as a screening tool to determine if bioaccumulation testing is warranted

Tier II: Calculation of TBP

$$C_t = BSAF \times \frac{C_s}{\%TOC} \times \%L$$

C_t = Whole-organism concentration; C_s = conc. in sediment; %L = lipid content of organism; %TOC = total organic carbon content of sediment; BSAF = biota sediment accumulation factor

BSAF Database

http://el.erdc.usace.army.mil/dots/database.html

Tier III: Overview

- Bioassays
  - Elutriate toxicity bioassay
  - Sediment toxicity bioassay
  - Sediment bioaccumulation bioassay
- Conduct bioassays if:
  - Tier I and II evaluation suggests the DM may contain contaminants that might result in adverse effects
  - No WQS for contaminants of concern
  - Potential for synergistic interactions between chemicals

Tier III: Elutriate Bioassay

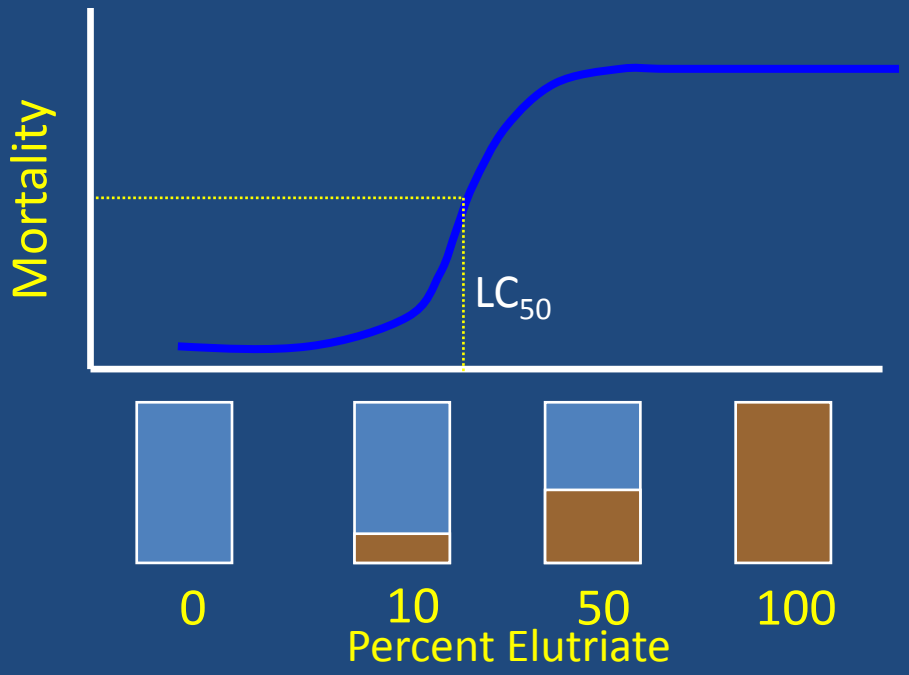
Design

- At least 3 concentrations
- control survival > 90%
- 5 replicates/10 organisms
- 48- to 96-hour duration

4 parts water
1 part DM
(volume)

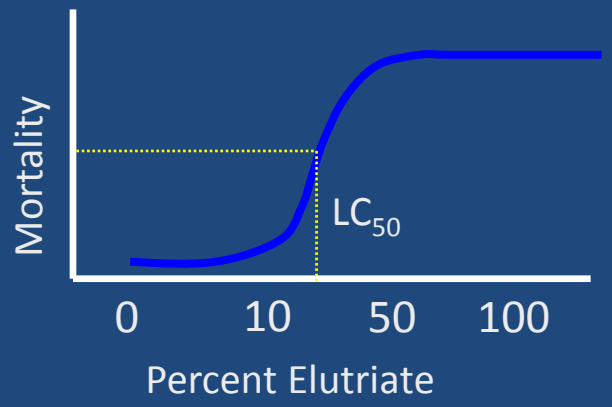
Americamysis bahia

Menidia beryllina



Tier III: Elutriate Bioassay Results

1. Determine LC_{50}

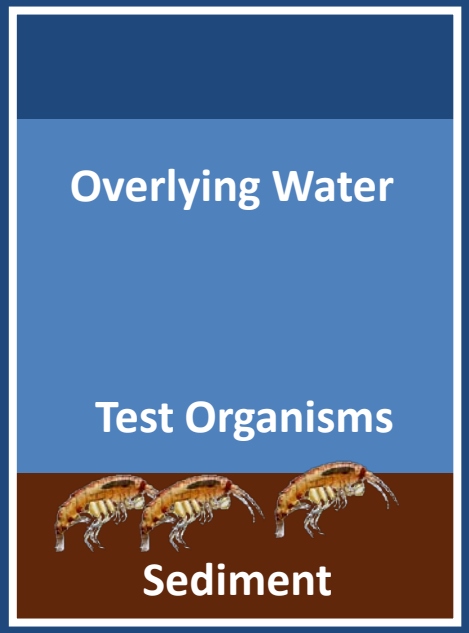


LC50 is 40%

Limiting permissible concentration (LPC) is the effect value (or 100% concentration) multiplied by an application factor (0.01)
For example, LPC = 40% x 0.01 = 0.4%

2. Model dilution of effluent from CDF or suspended DM in mixing zone; Compare the modeled concentration to the LPC

Tier III: Benthic Toxicity Bioassay



- Standardized EPA/ASTM protocols
  - Generally 10 day; 28 day chronic test
  - Minimum of 5 replicates
  - Test validity based on survival in control (> 90% or 80% for amphipods)
- Compare DM to reference and control sediments
- Use two sensitive species representing different life strategies
- Survival of organisms as toxicological endpoint

Tier III: Benthic Toxicity Bioassay

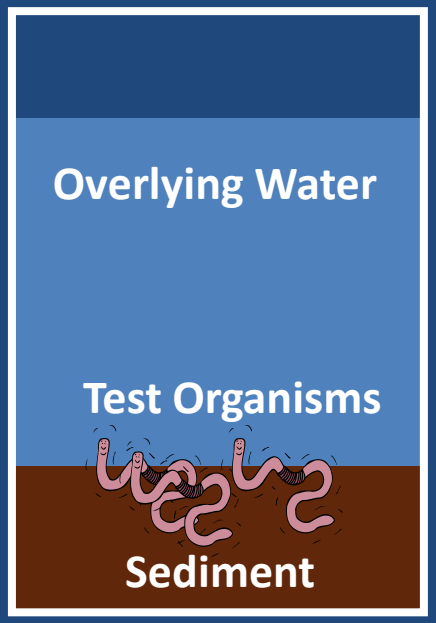
Toxicity Test Evaluation

- Mortality in dredged material is 10% greater than reference (20% for amphipods), and
- Statistically different from reference?

If No, material is not predicted to be toxic

If Yes, material is predicted to be toxic

Tier III: Benthic Bioaccumulation Bioassay



- Standardized EPA/ASTM protocol
  - 28-day exposure
  - No feeding
  - Minimum 3 replicates per treatment
  - Collect and purge organisms at conclusion of exposure
- Use 2 different organisms
  - Sediment ingester, tolerant of contaminants, adequate mass, poor metabolizer of chemicals
- Accumulation of chemicals of interest in organisms as endpoint
- Compare DM to reference sediment

Tier III: Benthic Bioaccumulation Interpretation

Concentration of contaminant in organism exposed to dredged material greater than reference?

If Yes, consider

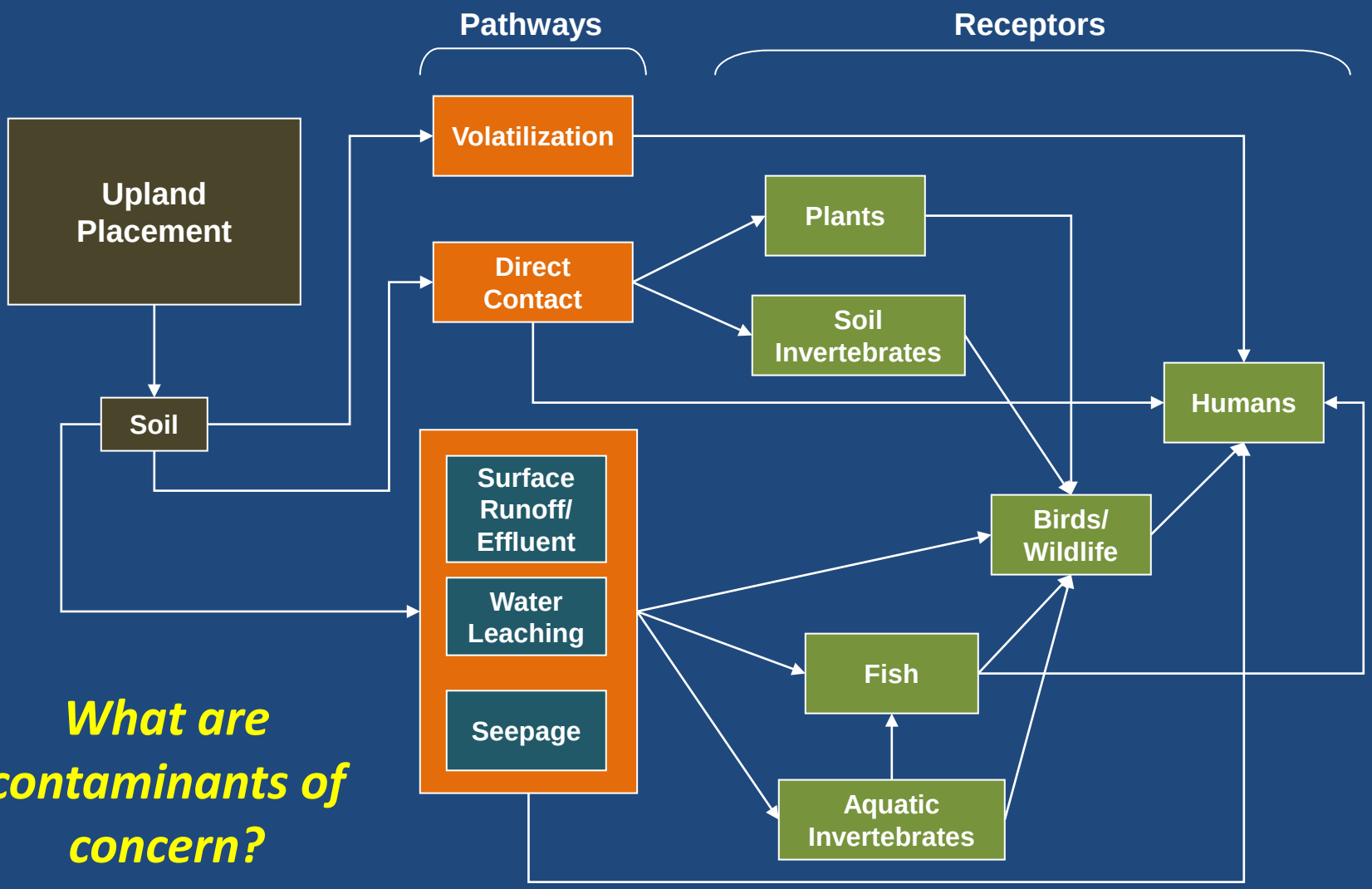
- Number of species tested
- Number of contaminants > reference
- Magnitude of bioaccumulation
- Toxicological importance
- Biomagnification potential
- Comparison to background
- Compare with critical body residues (CBRs)

Risk based interpretation using tools such as food web modeling

Upland Testing Manual

- Addresses evaluation of DM for upland placement
- Published in 2003
- Included:
  - Tiered approach to assess contaminant releases
  - Focused on contaminant pathways and use of a conceptual model
  - Goal is to determine need/extent of contaminant controls

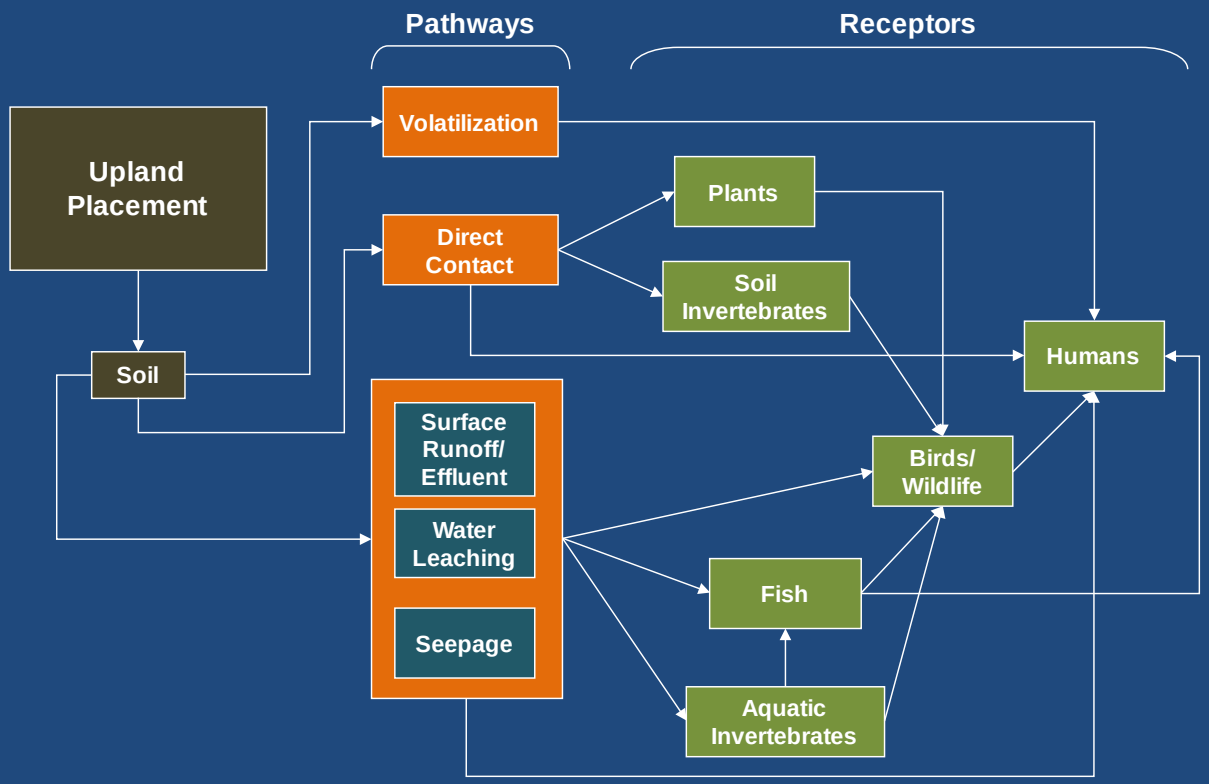
Tier I: Develop Conceptual Model for Upland Placement of Dredged Material



What are contaminants of concern?

Tier II: Screening

- Predict volatile losses (compare to OSHA, Human Health values)
- Predict plant and animal uptake (compare to reference)
- Predict effluent, runoff, leachate concentrations (WQC/WQS)
- Refine Contaminants of Concern (COC's)

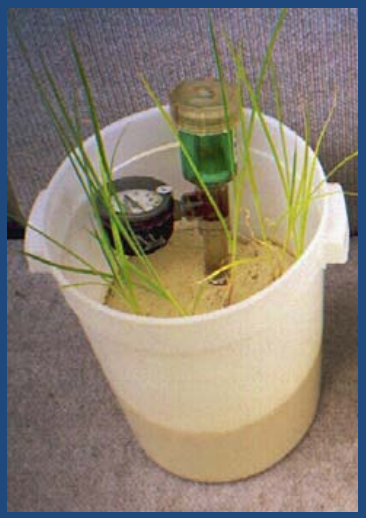


Tier III: Biological Bioassay

- Bioaccumulation
  - Terrestrial Animal Bioaccumulation Bioassay
  - Plant Bioaccumulation Bioassay
- Toxicity
  - Effluent toxicity Bioassay

Earthworm bioaccumulation bioassay
ASTM Method E-1676-04

Spartina alterniflora-
Smooth cordgrass



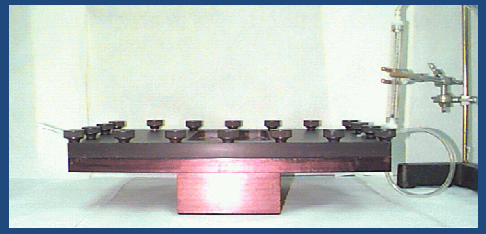
Cyperus esculentus-
Yellow Nutsedge

Tier III: Physical Testing

- Effluent and runoff
  - Column settling test
  - Effluent elutriate test
  - Simplified laboratory runoff procedure (SLRP)
  - Rainfall Simulator/Lysimeter System (RSLS)
- Leachate
  - Sequential Batch Leach Test (SBLT)
  - Pancake Column Leach Test
- Volatilization
  - Laboratory Volatile Emission Test Procedure

Column settling test

Column leach test

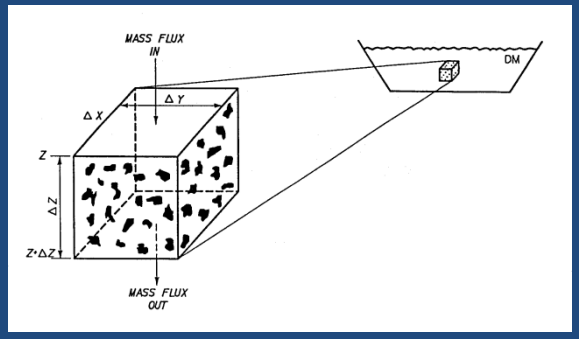


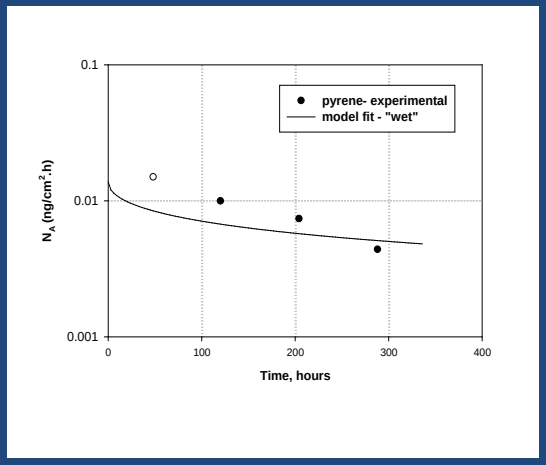
Volatile flux chamber

Field analysis of volatiles

Tier III: Physical Modeling

- Mixing (effluent/runoff discharges)
  - Dilution volume
  - Cornell Mixing Zone Expert System (CORMIX)
  - Macintyre Analytical Method for CDF Discharge in Riverine Conditions
  - Fasttabs Modeling System for Evaluation of Hydrodynamic Transport
  - Dilution Volume Method for CDF Effluent Discharges
- Volatile emissions and dispersion (on and off-site concentrations)





Regional Implementation Agreement

- Completed in 2003
- Region specific guidance
  - Process
  - Reference locations
  - Acceptable bioassays
  - Contaminants of concern
  - Target detection levels

EPA
U.S. Environmental Protection Agency
Region 6

US Army Corps of Engineers
Galveston District
New Orleans District

OCEAN DREDGED MATERIAL DISPOSAL PROGRAM

REGIONAL IMPLEMENTATION AGREEMENT

FOR
TESTING AND REPORTING REQUIREMENTS
FOR OCEAN DISPOSAL OF DREDGED MATERIAL
OFF THE LOUISIANA AND TEXAS COASTS
UNDER SECTION 103 OF
THE MARINE PROTECTION, RESEARCH AND SANCTUARIES ACT

July, 2003

http://www.epa.gov/region6/water/ecopro/em/ocean/odmd_sites.html

Terminology

Effects based approach

Use organism to indicate the bioavailability and effects of contaminants; contaminant effects are used to make a determination

Reference Sediment

A sediment which reflects disposal site conditions except previous dredged material disposal. It is the point of comparison for interpreting test/bioassay results.

Control Sediment/Water

A sediment from the area where the organisms were collected or cultured. For water-column bioassays, water in which the organisms were held or cultured is used. The control serves as a check on the health of the organism and validates the bioassay results.