SUSTAINABLE SEDIMENT MANAGEMENT AND DREDGING SEMINAR

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GALVESTON, TX

Decision Making

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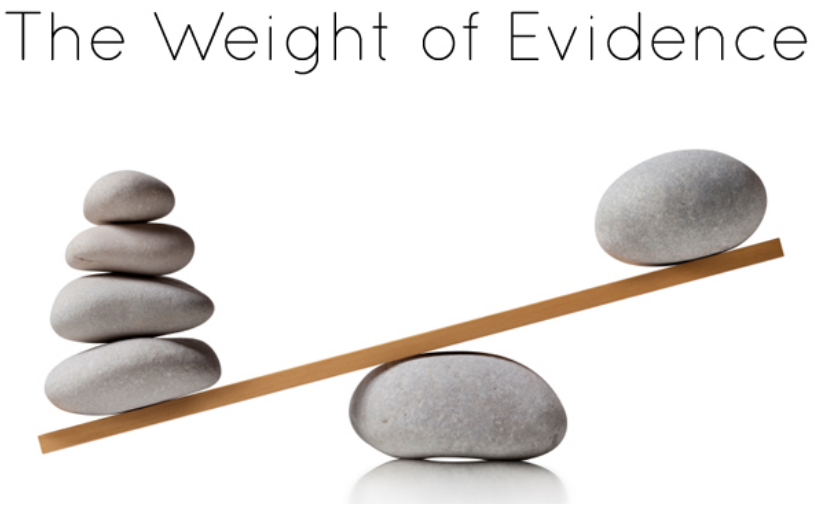
Decision Making

Utilizing Multiple Lines of Evidence (LOEs) in a Weight of Evidence (WOE) approach to make decisions re:

- **In water placement/disposal**
- **Upland Placement/management**
- **Beneficial Use options**
- **Informing engineering operational controls**
- **Monitoring requirements and adaptive management strategies**



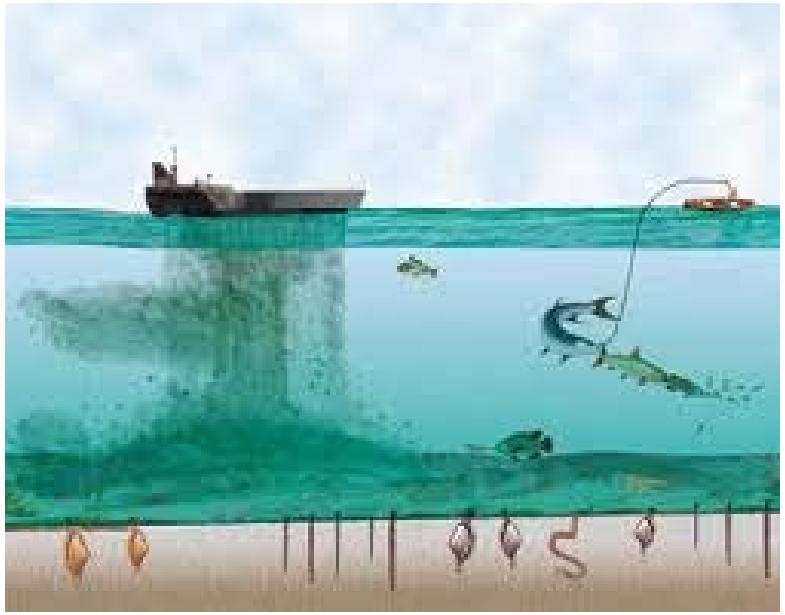
In Water Placement

Water quality – short term

- **Potential impacts to water column organisms**

Sediment quality – longer term

- **Direct toxicity to benthic organisms**
- **Indirect effects to higher trophic levels via contaminants uptake and transference through the food web.**



Initial Assessment

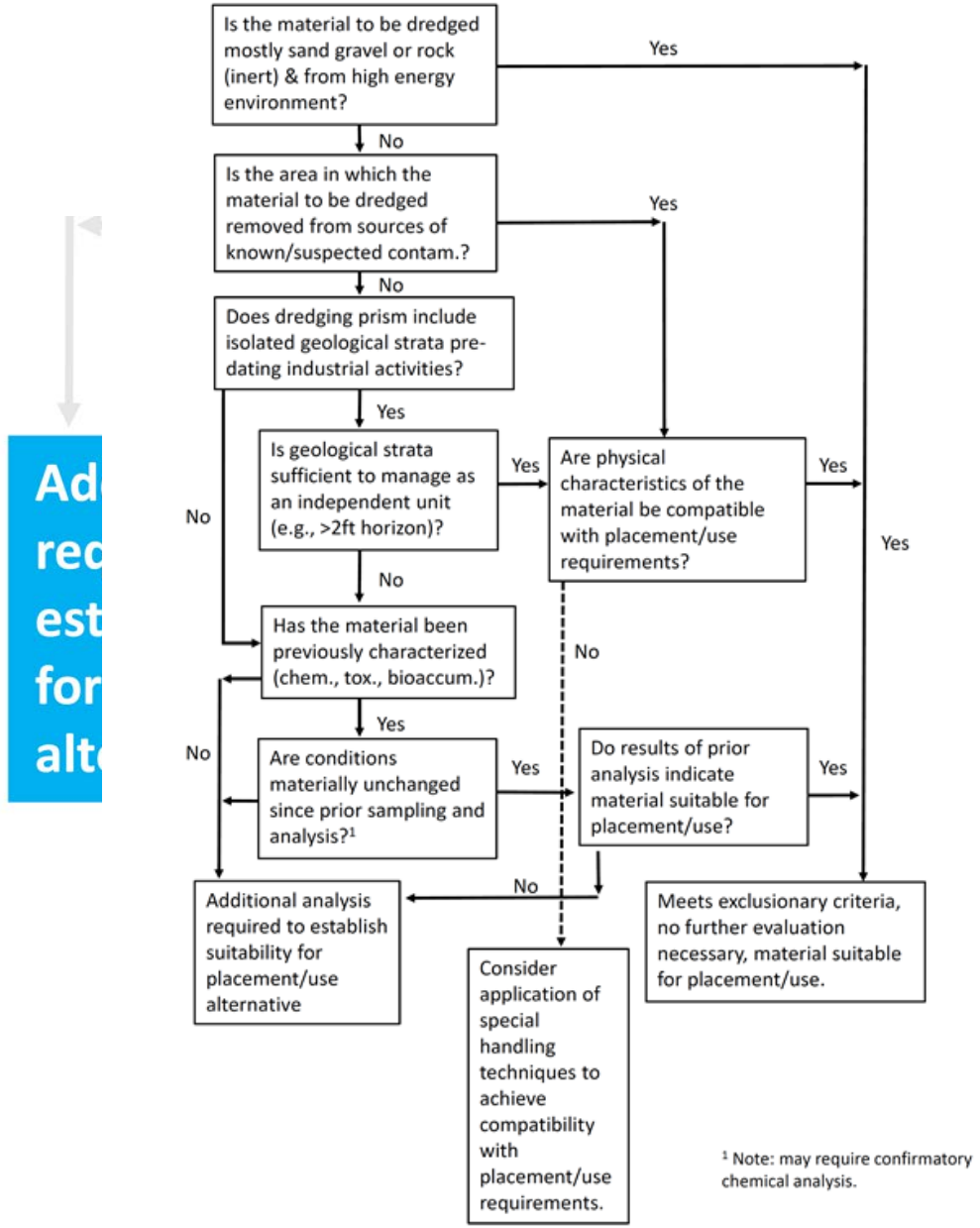
Following an initial assessment of:

- **Site/Material characteristics**
- **Other relevant existing data**

If unable reach a determination re:

- **Exclusion from testing and/or**
- **Suitability for management option(s)**

Then additional testing and analysis required

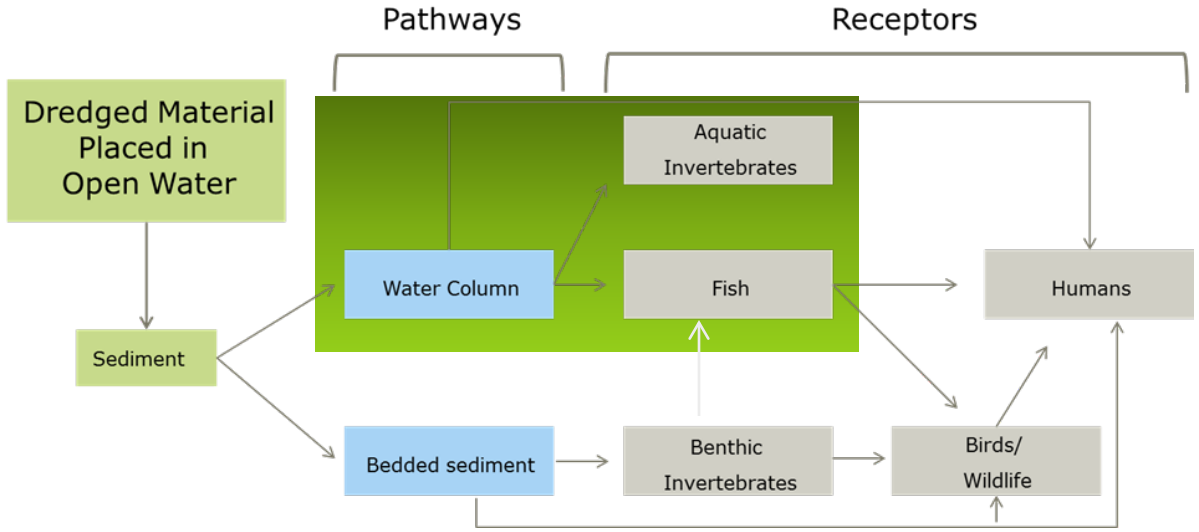


In Water Placement

LOEs for Short Term Water Column Impacts associated with dredging and placement/disposal:

- Chemical analysis of sediment elutriates - application of a mixing zone model (STFATE) followed by comparison to WQC.
- Elutriate Toxicity tests with selected water column organisms (2-3 species) - evaluate results after allowance for mixing (e.g., STFATE model); if modelled elutriate concentration < 0.01 of the calculated LC50/EC50 value material meets the LPC.

Note: exceedances of WQC or Toxicity rarely preclude in water placement but generally indicate additional engineering controls are required



SPP Analysis Example

Based on results of the three species SPP tests the lowest LC50/EC50 value obtained was for the bivalve development tests with *M. galloprovenciallis* in the DMMU-1 Composite sample:

Sample	Elutriate Conc.	% Survival	% Normality	LC50	EC50
DMMU-1	Control	99.7	95.5	70.2	54.2
	1	99.5	96.2		
	10	94.9	95.0		
	50	79.6	52.5		
	100	2.6	0.0		

- Applying a safety factor of 0.01 to the EC50 value of 54.2 we obtain a value of 0.542%.
- Inputting the sediment grain size data for the DMMU-1 composite and other requisite parameters for the STFATE model (i.e., scow size, disposal site water depth, current velocity, etc.) we calculate a release of 0.0012% - well below the lowest corrected LC50/EC50 value.
- Since 0.0012 << 0.542- material meets the LPC for potential water column effects.

In Water Placement/Disposal

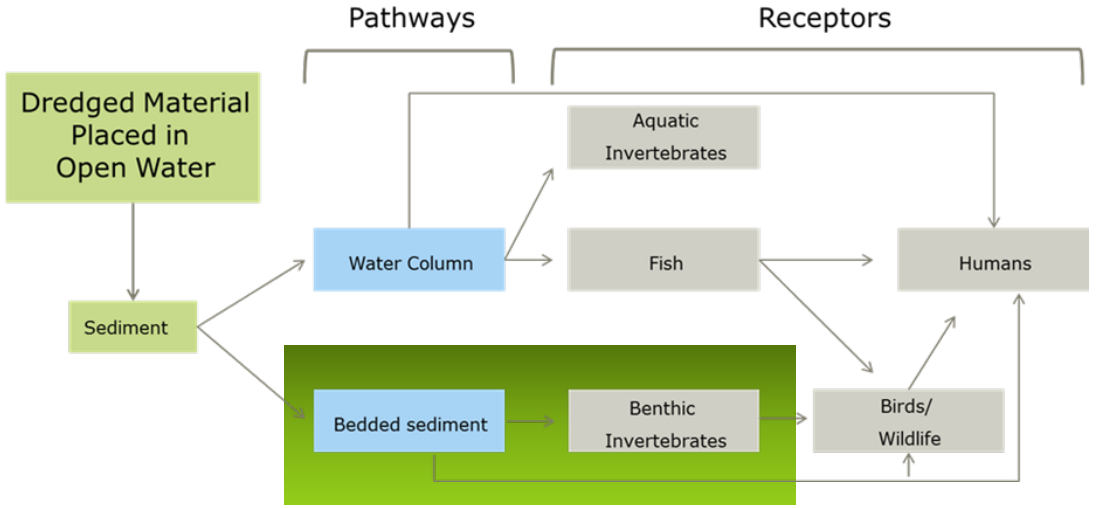
LOEs for Longer-term direct effects on benthic biota:

Results of Toxicity Tests

Toxicity Tests

Physical/chemical analysis:

- toxicity to benthic organisms exposed to the material relative to a reference (2 species).
- Grain size distribution – test organism compatibility, contaminant potential…
- TOC – high TOC reduced bioavailability, low TOC low food source…
- Porewater chemistry (salinity, ammonia [& possibly metals])- test organism compatibility, ammonia toxicity, metal availability…
- Bulk chemistry - comparison to reference and relevant sediment quality values (ER-L, ER-M, TE-L, PE-L, etc.)



SP Analysis Example

Results of SP tests show some reduced survival in 2 of the 3 DMMU's evaluated in tests with the amphipod A. abdita:

Sample	% Survival (S.D.)	Statistically Diff. relative to Ref. ?	More than 20% < than Ref. ?	Exceed the LPC?
Control	98 (±7.6)	NA	NA	NA
Reference	93 (±7.6)	NA	NA	NA
DMMU-1	72 (±7.6)	Yes	Yes	Yes
DMMU-2	75 (±7.6)	Yes	No	No
DMMU-3	89 (±7.6)	No	No	No

Based on these results DMMU-2 & 3 meet the LPC and are suitable for placement in the ocean.

DMMU-1 exceeds the LPC and therefore is not suitable for placement in the ocean.

In Water Placement/Disposal

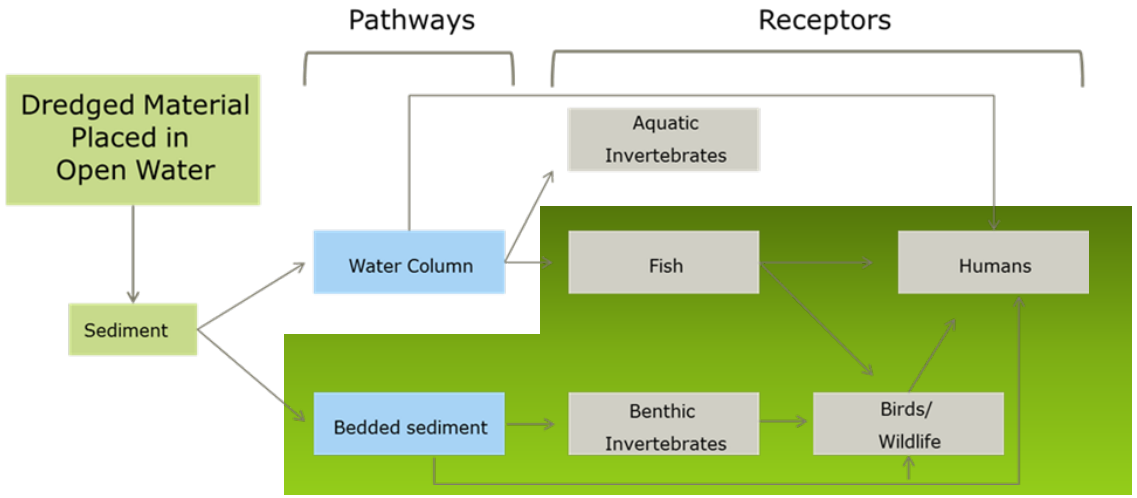
LOEs for Longer-term indirect effects in higher trophic levels:

Sediment chemistry –

- Presence of bioaccumulatives (e.g., Hg, chlorinated pesticides, PCBs, Dioxins & dibenzofurans)
- Apply model to measured sed. conc. of bioaccumulatives to estimate uptake in aquatic biota and compare estimated tissue concentrations to regulatory standards for fish tissue, regional bkg, and/or available effects data (e.g., ERED)

Bioaccumulation Potential Tests –

- Tissue Residue Concentrations in exposed test species (2 species) compared to tissue residue concentration of reference exposed organisms



Bioaccumulation Potential Analysis Example

Sample	Analyte	Time 0	Ref. 28-D Tissue Conc.	Project 28-D Tissue Conc.	Steady-State Adj. Factor	Adj. Ref. 28-D Tissue Conc.	Adj. Project 28-D Tissue Conc.	Ratio Rel. to Ref.	Lowest Relevant Effect from ERED	FDA Action Limit	Regional Bkg
DMMU-2	Ni (mg/Kg)								79 mg/kg = NOED for mortality in the Cerastoderma edule		
	Hg (mg/Kg)	0.03	0.028	0.059	1.0	0.028	0.059	2:1	Highest NOED reported for mortality in the grass shrimp *P. pugio*;no corresponding LOED reported). LD_{50} for clam *R. cuneata*= 20 mg/kg.	1.0	0.035
	Total PCBs (ug/Kg)	0.16	2.06	14.7	1.31	2.69	19.3	7:1	The lowest NOEC 1,700 µg/kg wet weight – for growth or mortality in M. nasuta.	2,000	3-347

Not a Bioaccumulative

BP Example Cont.- Screening Level Risk Assessment – Invertebrates

- Highest concentration of total PCB in tissue = 14.73 µg/kg
  - Steady-state concentration = 19.30 µg/kg
- Concentration in invertebrates are well below relevant FDA Tolerance Levels and the lowest relevant Tissue Residue Effects Levels reported in the Environmental Residue Effects Database (ERED)
  - FDA Tolerance Level for PCBs = 2,000 µg/kg
  - 1,700 µg/kg wet weight – a dose corresponding to a no effects concentration for burrowing, weight or mortality in *M. nasuta*
  - 10,000 µg/kg wet weight - a dose corresponding to a no effects concentration for survival in *Lumbriculus variegatus*

BP Example Cont. -Screening Level Risk Assessment – Fish and Marine Mammals

- FCM applied for TL 3 (FCM = 13.3) and TL 4 (FCM = 24.7)
  - TL 3 represented by Slender sole & Pacific sanddab
  - TL 4 represented by California Sea Lion
- Predicted concentration in fish below relevant ecological effect levels and within background range for Southern California
- Concentrations in marine mammals below relevant literature based TRVs

Predicted Concentration in Pacific Sanddab and Slender sole (µg/kg)	Predicted Concentration in California Sea Lion (µg/kg)	FDA Action Level for PCBs in Fish (µg/kg)	ERED Effect Value - P. americanus (µg/kg)	Range of PCB Concentration in Southern California Coastal Fish (µg/kg)	Range of TRVs for PCBs in Marine Mammals (µg/kg, lipid)
256.6	476.6	2,000	7,100	3 - 347	1,300 - 17,000

BP Example Cont.- Screening Level Risk Assessment – Human Health

Predicted concentrations in Pacific sanddab and Slender sole (257 µg/kg):

- **Between US EPA consumption limits range for unrestricted consumption (5.9 µg total PCBs/kg) and consumption of half a meal of fish (4 ounces) per month (380 µg total PCBs/kg) for 1:100,000 cancer risk endpoint**
- **Exceeds US EPA consumption limits for non-cancer (range from less than 5.9 µg total PCBs/kg for unrestricted consumption to 380 µg total PCBs/kg for consumption of half a meal of fish [4 ounces] per month)**

Assumes 100% foraging of invertebrates with total PCB concentrations equal to highest steady-state tissue corrected result from bioaccumulation testing:

- **Overestimation of fish concentration and risk to human health**
- **Conservative predicted fish concentrations within the range of background values reported for the Region (3 – 347 µg/kg)**

Weight of Evidence Evaluation – In Water Placement/Disposal

LOEs

Chemistry

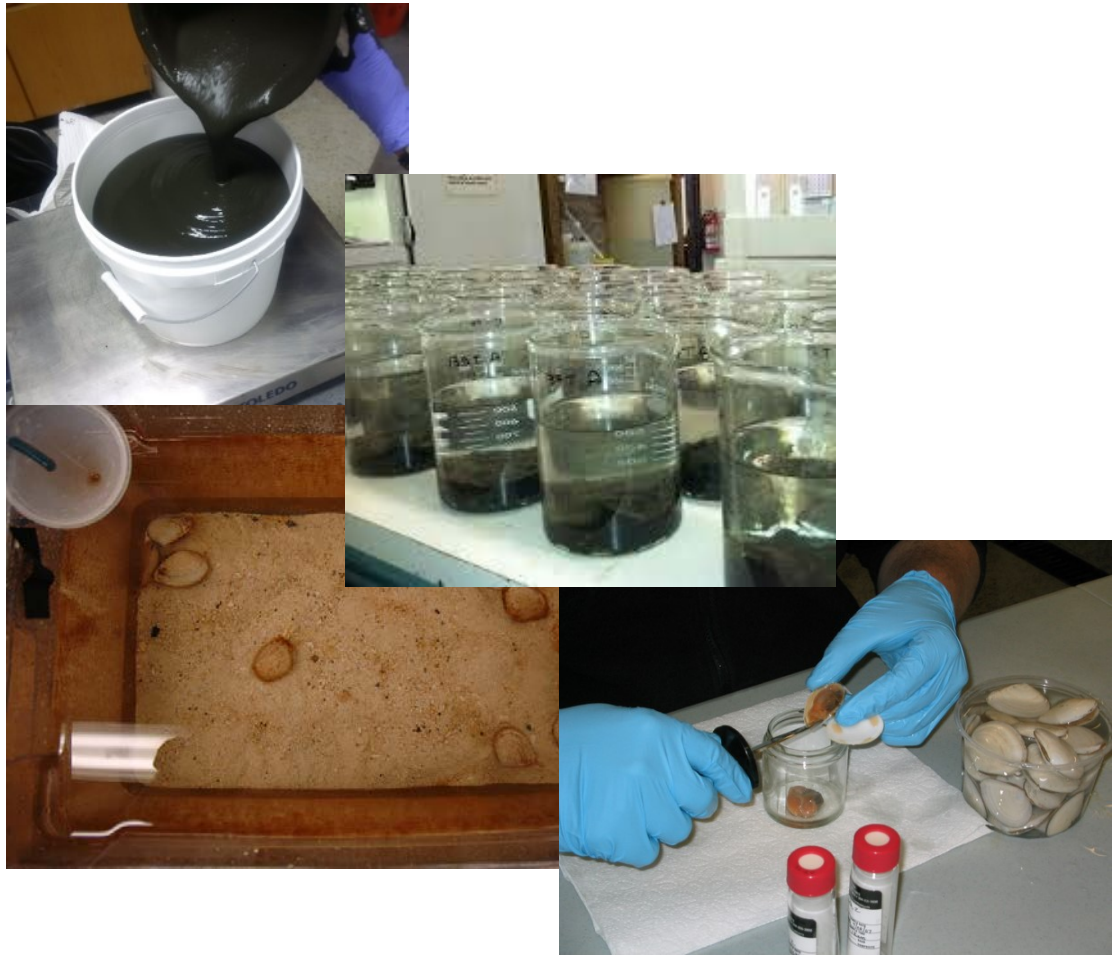
- Presence of one more contaminants at levels of concern (e.g., >ERM concentrations, AVS/SEM, etc.) for toxicity.
- Presence of one or more bioaccumulative contaminants at levels of concern (based on TBP modeling).
- Presence of contaminants at levels exceeding WQ criteria in elutriates.

Toxicity

- Significant toxicity in one or more sediment elutriate tests corresponding with elevated COCs in elutriate chemistry.
- Significant toxicity in one or more sediment toxicity tests corresponding with elevated COCs in sediment chemistry.

Bioaccumulation

- Bioaccumulation in or more test species of one or more COCs to levels that pose unacceptable risk.

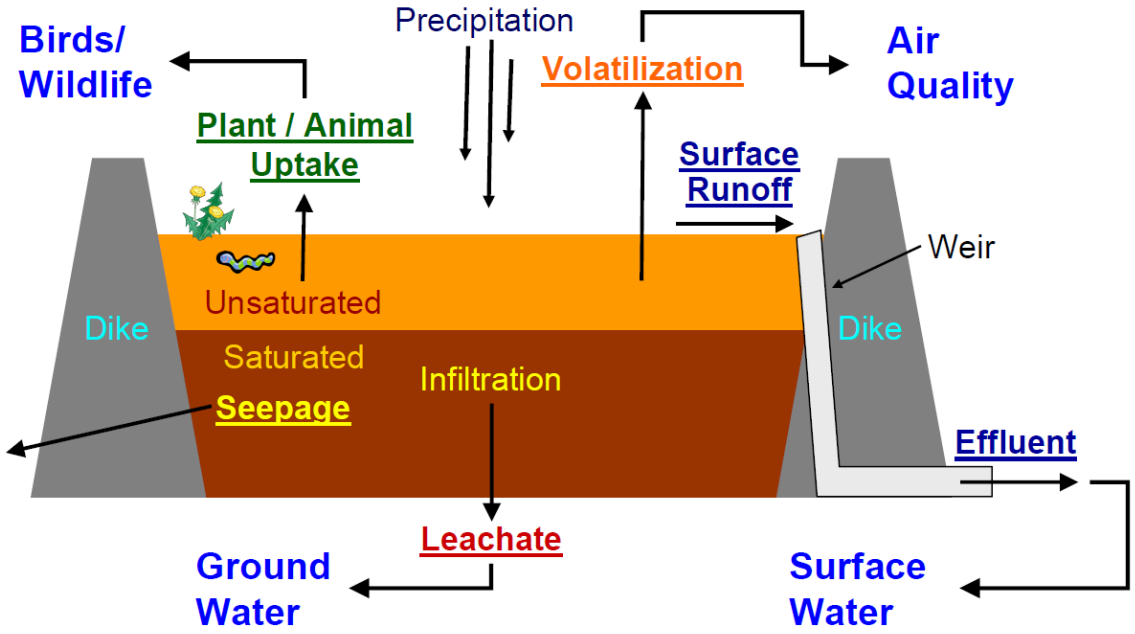


Upland Placement / Management

Water Quality
- Surface water
- Groundwater

Soil Quality
- Toxicity
- Indirect Effects (uptake and trophic transfer potential)

Air Quality
- Volatilization



Upland Placement / Management

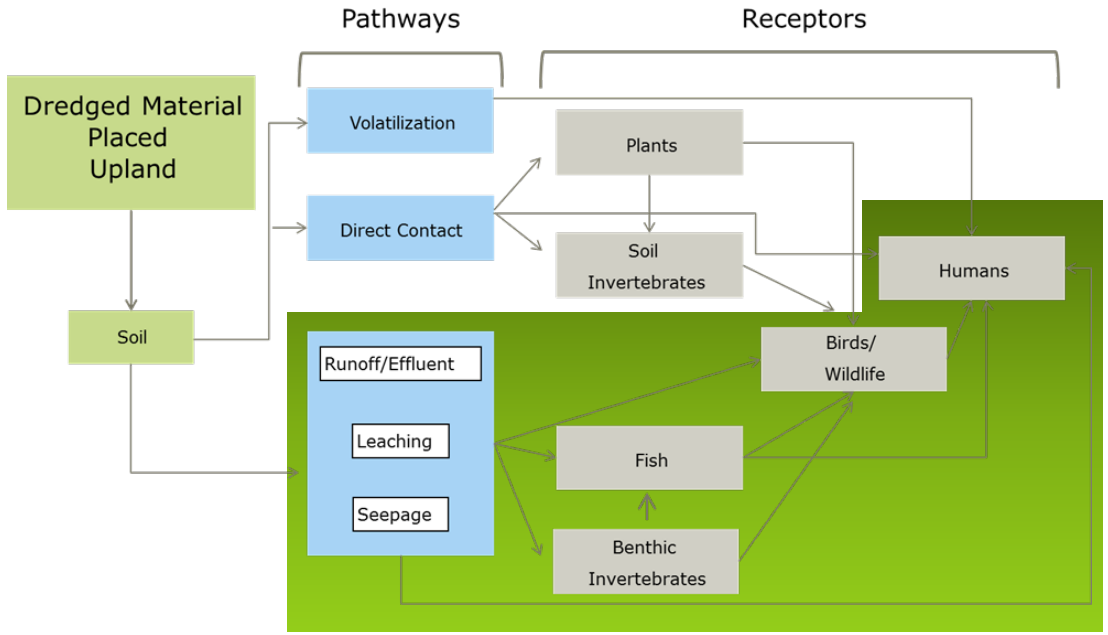
LOEs for Water Quality:

Surface Water - Effluent and Runoff

- Compare concentrations measured in simulated effluents with WQ standards (may include allowance for mixing)
- If it exceeds may require special management conditions (treatment prior to discharge)

Groundwater - Leachate

- Compare concentrations from leachate tests with applicable groundwater and surface water standards
- If it exceeds may require special management conditions (impermeable liner, collection, and treatment)

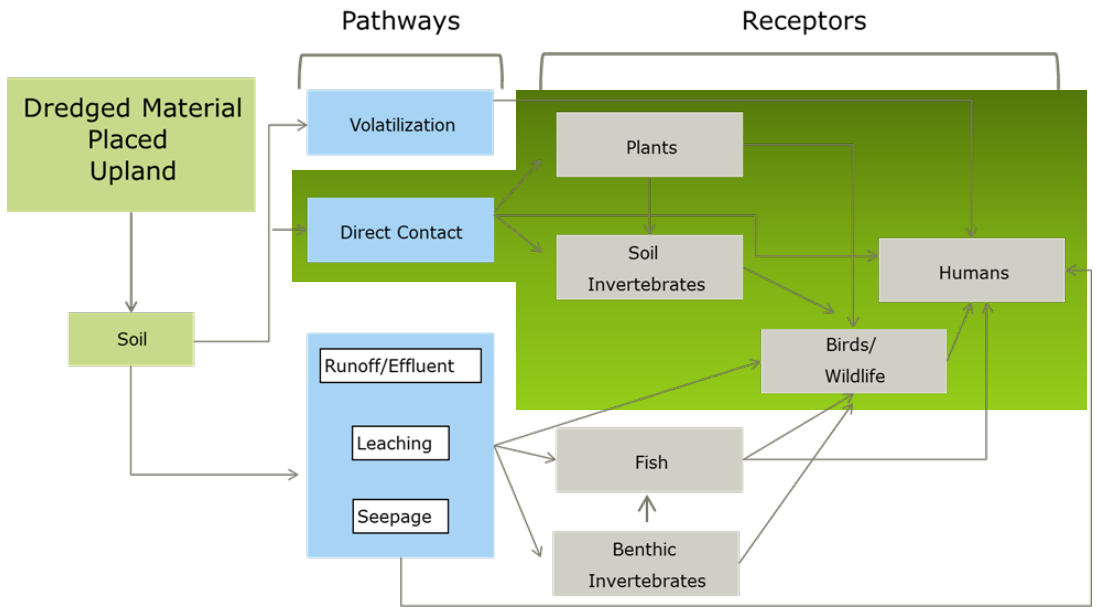


Upland Placement / Management

LOEs for Direct Contact

- Application of models to measured sediment concentrations to estimate uptake in plants and animals followed by comparison to EcoSSLs
- Bioaccumulation test to determine whether unacceptable bioaccumulation of contaminants in plants and soil invertebrates exposed to the material relative to a reference followed by comparison to EcoSSLs
  - Apply model to measured tissue residues to evaluate ecological and human health risk

Note: Exceedances indicate potential need for special management conditions to eliminate unacceptable risk (i.e., cover)



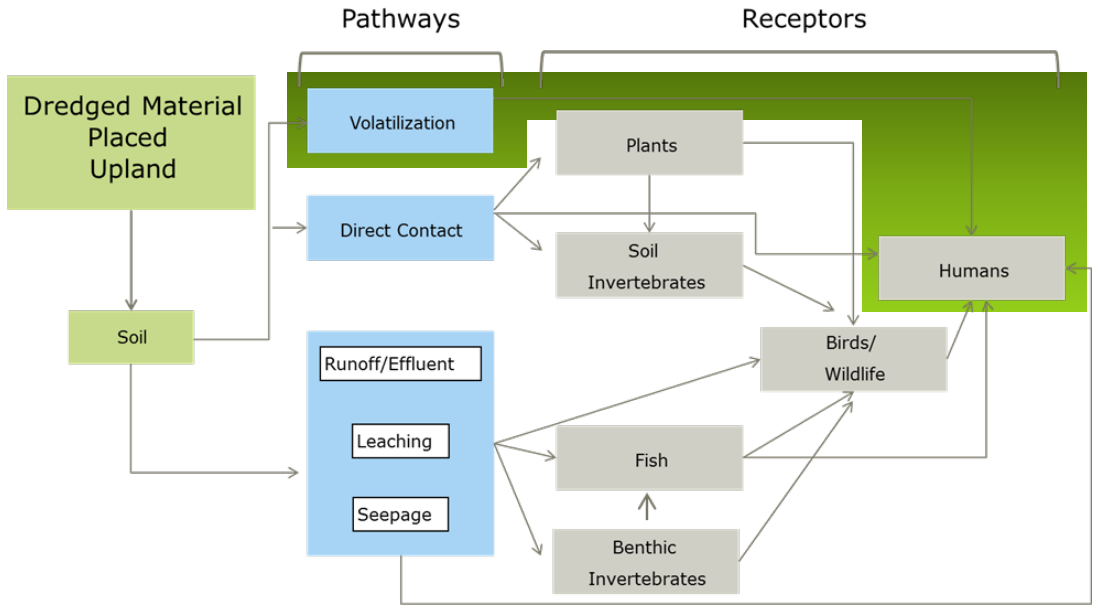
Upland Placement / Management

LOEs for Air Quality:

Volatiles

- Comparison of volatile concentrations (modelled or measured) to air quality standards after dispersion modelling

Note: Exceedances indicate potential need for special management conditions to eliminate unacceptable risk (i.e., cover)



Weight of Evidence – Upland Placement

- LOEs
  - Chemistry
    - ▸ Presence of one more contaminants at levels of concern (e.g., > SSL concentrations).
    - ▸ Presence of one or more bioaccumulative contaminants at levels of concern (based on TBP modeling).
    - ▸ Presence of contaminants at levels exceeding WQ criteria in elutriates/leachates.
    - ▸ Volatilization of contaminants (e.g., VOCs) at levels that exceed air quality standards (e.g., NAAQS)
  - Toxicity
    - ▸ Significant toxicity in one or more soil tests (earth worm, plant) corresponding with elevated COCs in sediment chemistry.
  - Bioaccumulation
    - ▸ Bioaccumulation in or more test species of one or more COCs to levels that pose unacceptable risk (e.g., >EcoSSLs).

Beneficial Use

Many of the same LOEs evaluated for beneficial use.

Analysis & evaluation may need to be tailored to better reflect likely exposure scenarios and receptors of concern.

Summary

- **Establishing suitability of dredged material for a particular management option is based on multiple lines of evidence (LOEs) evaluated in a weight of evidence approach.**
- **Assessment and interpretation is risk-based.**
- **Application of screening tools such TBP, Trophic Trace can be used to help inform decision but should not preclude “common sense”.**

References

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- USACE/USEPA 1998. Evaluation of Dredged Material Proposed for Discharge in Water of the US-Testing Manual. EPA-823-B-98-004.
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- USACE/USEPA 2003. 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 MPRSA.
- USEPA. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment – Status and Needs. EPA-823-R-00-001.
- Specific Guidelines for Assessment of Dredged Material, London Convention 1972 & 1996 Protocol, July, 2012