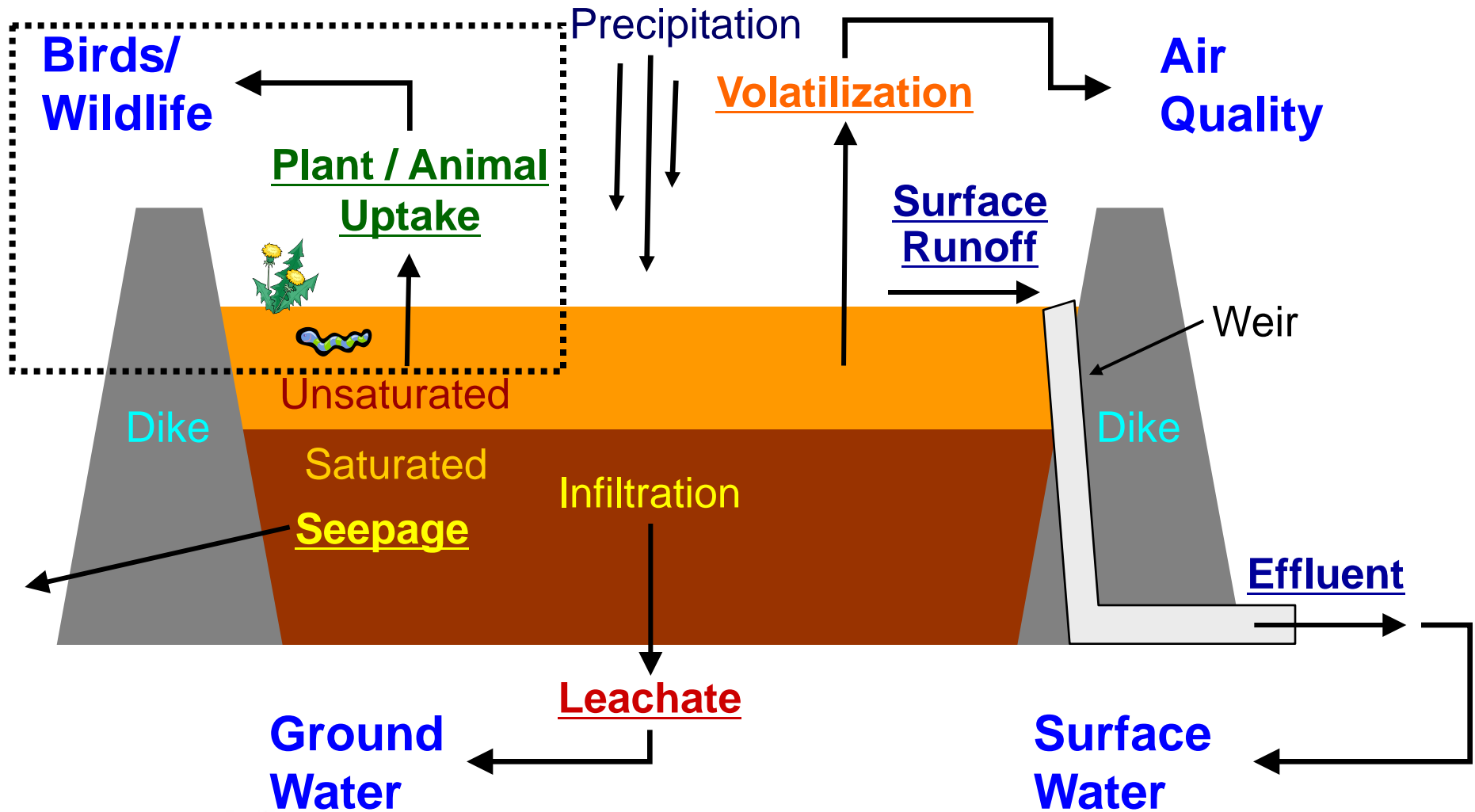

Biological Pathway Evaluations

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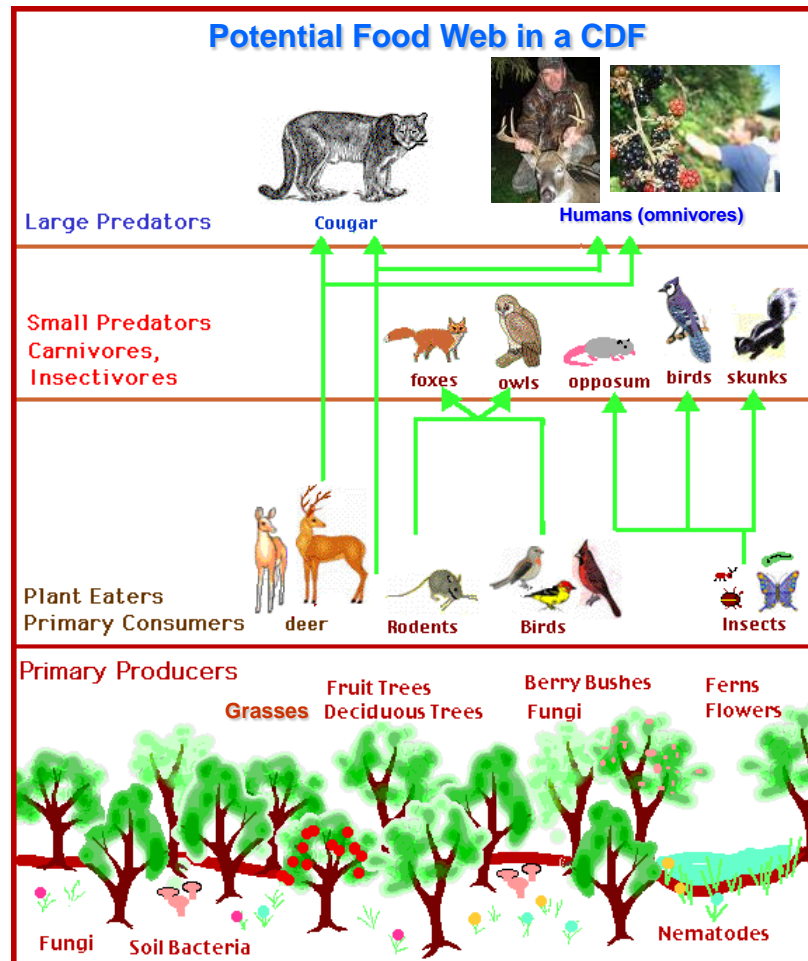


Conceptual Model-Upland CDF Contaminant Migration Pathways



CDF: Dredging Disposal Site to Ecologically Productive Site?

- End uses of CDFs: contaminant storage (closed to public), nature preserves, etc.
- Potential for Contaminants of Concern (COCs) from dredging material to bioaccumulation in tissues of plants & animals
- COCs can be passed up the food chain within and outside CDFs
- No regulatory standards for COC uptake by plants & animals in CDFs
- Compliance with CWA & other Federal laws



Potential Issues of Contaminants of Concern (COC) Exposure in CDFs

- End uses of CDFs:
 - Closed to public (contaminant storage)
 - Open to public (nature preserves, recreation)
- Wildlife potential exposure in soil, wetlands, & ponds
- Wildlife migrate in and out of CDF, eating vegetation & other wildlife
- COCs can be passed up the food chain within and outside CDFs
- Humans can eat vegetation in CDFs and hunt wildlife that has eaten in CDFs
- Concern of threatened and endangered species in CDFs



How to Evaluate CDF COCs on Terrestrial Fauna?

- Examine COC bioaccumulation
- Bioaccumulation is not an indicator of effect on the on-site organisms, but...
- Bioaccumulation is considered a component of exposure for off-site organisms (receptors of concern (ROCs) (not effects)

Exception: when ROCs are humans or endangered species



Animal Uptake: Tiered Approach

Evaluated in the context of the conceptual site model:

- **Populations of ROCs outside the CDF**
- **COCs**
- **Complete exposure routes**

Tier I: Initial Evaluation of Animal Bioaccumulation

Tier II: Theoretical Bioaccumulation Potential (nonpolar organic chemicals)

Tier III: Animal Bioaccumulation Test

Tier IV: Regional/Site-Specific Investigation of Animal Uptake & Bioaccumulation



Tier I: Initial Evaluation of Animal Bioaccumulation

- **Compilation and evaluation of existing information**
- **Development of conceptual site model: site characterization and defining complete exposure routes**
 1. **Describe the dredged material management activity**
 2. **Identify the kinds and spatial extent of habitats and land uses present in and around the CDF**
 3. **Identify the off-site animal species and humans that may consume animals that have bioaccumulated COC from the dredged material**
 4. **Specify the COC for animal bioaccumulation**
 5. **Describe the mechanisms that may bring COC into contact with a human or ecological ROC**
 6. **Describe the potential processes of contact between COC and ROC**
 7. **Describe the complete exposure routes, and eliminate from further evaluation those potential routes that are not complete**



Tier II: Theoretical Bioaccumulation Potential (TBP)

Evaluates bioaccumulation potential of nonpolar organic chemicals in earthworms

Bioaccumulation estimated from

- the dredging material's organic carbon content
- the earthworm lipid content
- the relative affinities of the chemical for sediment organic carbon and animal lipid content (e.g., K_{ow} or K_d)

$$\text{TBP} = \text{BSAF}_{(4)} \times \frac{C_s}{\text{TOC (\%)}} \times \text{Organism Lipid Content (\%)}$$



Tier III-Earthworm Bioaccumulation Test

Methods

- Based on ASTM Method E-1676-04
- Approximately 30g biomass
- 28-day exposure to reference soil & dredging materials

Results & Data Interpretation

- Control survival ($\geq 90\%$ for test validity)
- Compare results between reference soil & dredging material
 - Life history effects: e.g., individual survival, growth, reproduction
 - COC bioaccumulation
- Extrapolation to conceptual site model and evaluate wildlife at risk of exposure



How to Evaluate CDF COCs on Terrestrial Flora?

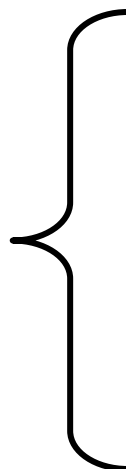
- Examine COC bioaccumulation in flora:
- Plant COCs: Metals >> organic chemicals
- Unique characteristics of dried sediment that colonizes with plants and animals
- Bioaccumulation is not an indicator of effect on the on-site plants
- Bioaccumulation is considered a component of exposure for off-site ROCs (not effects)
Exception: when ROCs are humans or endangered species



Plant Uptake: Tiered Approach

Evaluated in the context
of the conceptual site
model:

- Populations of ROCs
- COCs
- Complete exposure routes



Tier I: Initial Evaluation of Plant Bioaccumulation

Tier II: Prediction of Plant Bioaccumulation Potential

Tier III: Plant Bioaccumulation Test

Tier IV: Regional/Site-Specific Investigation of Plant Uptake & Bioaccumulation



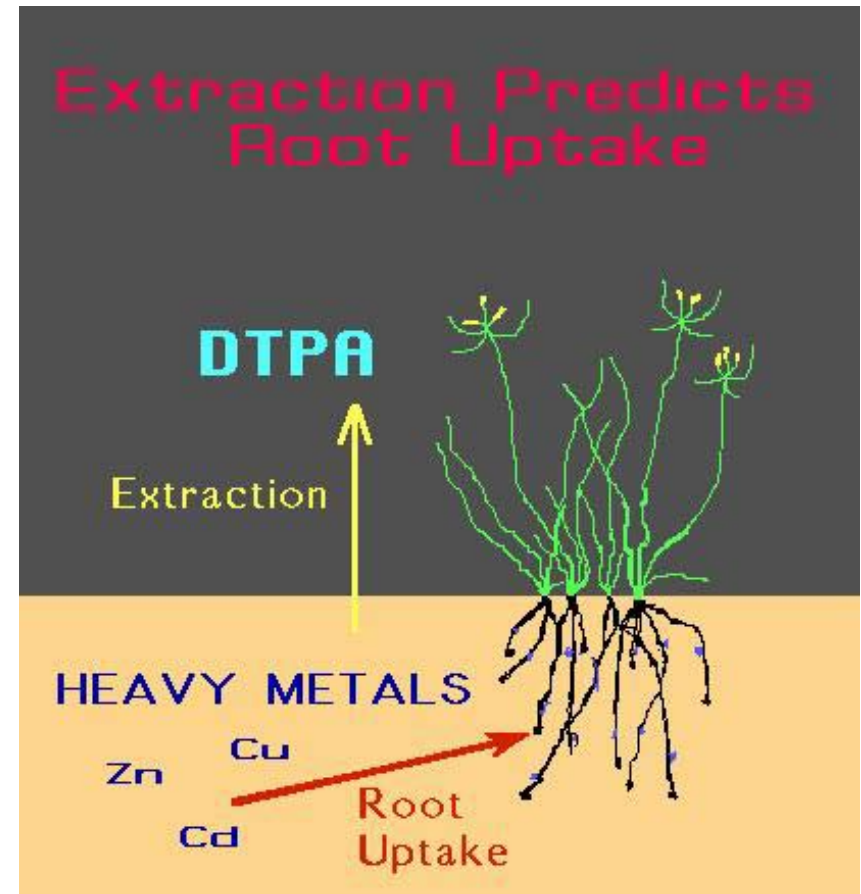
Tier I-Initial Evaluation of Plant Bioaccumulation

- Demonstrates that contaminant evaluations are needed and that plant bioaccumulation is a contaminant mobility pathway of concern for the project
- Uses the same project-specific conceptual site model developed for animal bioaccumulation
- ROC populations outside the CDF for plant bioaccumulation will be the same as animal bioaccumulation
- Emphasizes identification of complete exposure routes in the context of the conceptual site model.



Tier II-Predicting Plant Bioaccumulation Potential

- Prescreen evaluation of field plant tissue
- DTPA procedure for prediction of plant bioaccumulation potential
- Plant uptake program (PUP): prediction of heavy metals uptake by freshwater plants



Tier III-Plant Bioaccumulation Test

Methods

- ***Cyperus***: saltwater terrestrial, freshwater wetland, and freshwater terrestrial habitat; 45-day exposure to reference soil & dredged material
- ***Spartina***: saltwater wetland habitat; 90-day exposure to reference soil and dredged material

Results & Data Interpretation

- Control survival ($\geq 90\%$ for test validity)
- Compare results between reference soil & dredging material
 - Survival & growth
 - COC bioaccumulation
- Extrapolation to conceptual site model and evaluate wildlife at risk of COC exposure



***Cyperus esculentus*-
Yellow Nutsedge**



***Spartina alterniflora*-
Smooth cordgrass**



CDF Management & Controls

- **Manage vegetative cover**
- **Amendments/treatments to reduce bioavailability**
- **Cap to reduce exposure**
- **Others more site specific depending on target species**



Summary—Biological Pathway Evaluations

- No regulatory standards or criteria for COC uptake by plants & animals in CDFs
- Animal & plant bioaccumulation evaluation is based on a tiered risk-assessment approach
 - Tier I: Conceptual site model
 - Tier II: Animal and plant bioaccumulation potential
 - Tier III: Animal and plant bioaccumulation tests
 - Earthworms, upland (*Cyperus*) and wetland (*Spartina*) plants
 - Tier IV: Case-specific uptake & bioaccumulation investigations
- Data from each tier taken into account for weight-of-evidence approach to determining potential risks of COC exposure to off-site ROCs in order to make management decision

