

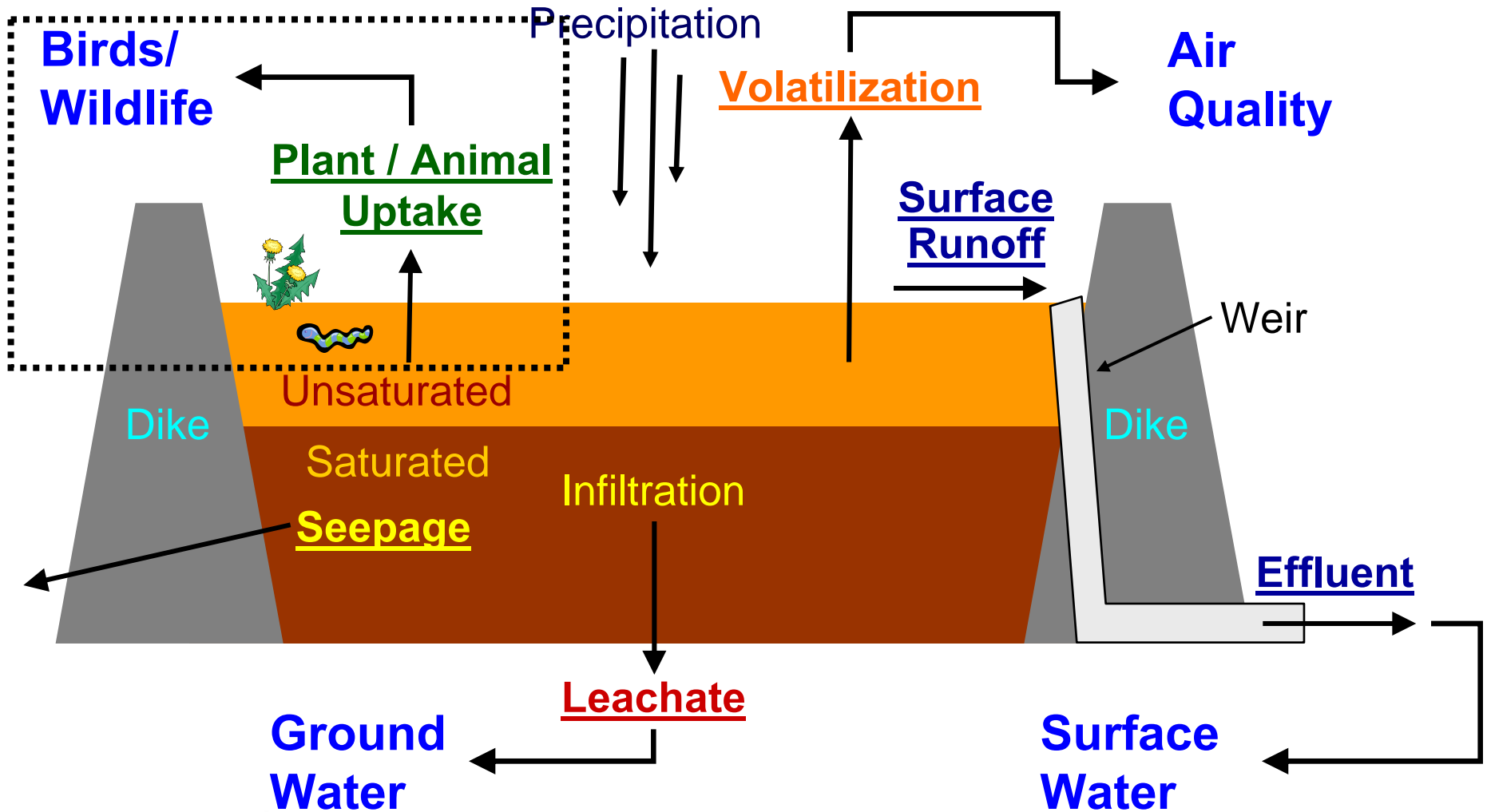
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# Biological Pathway Evaluations

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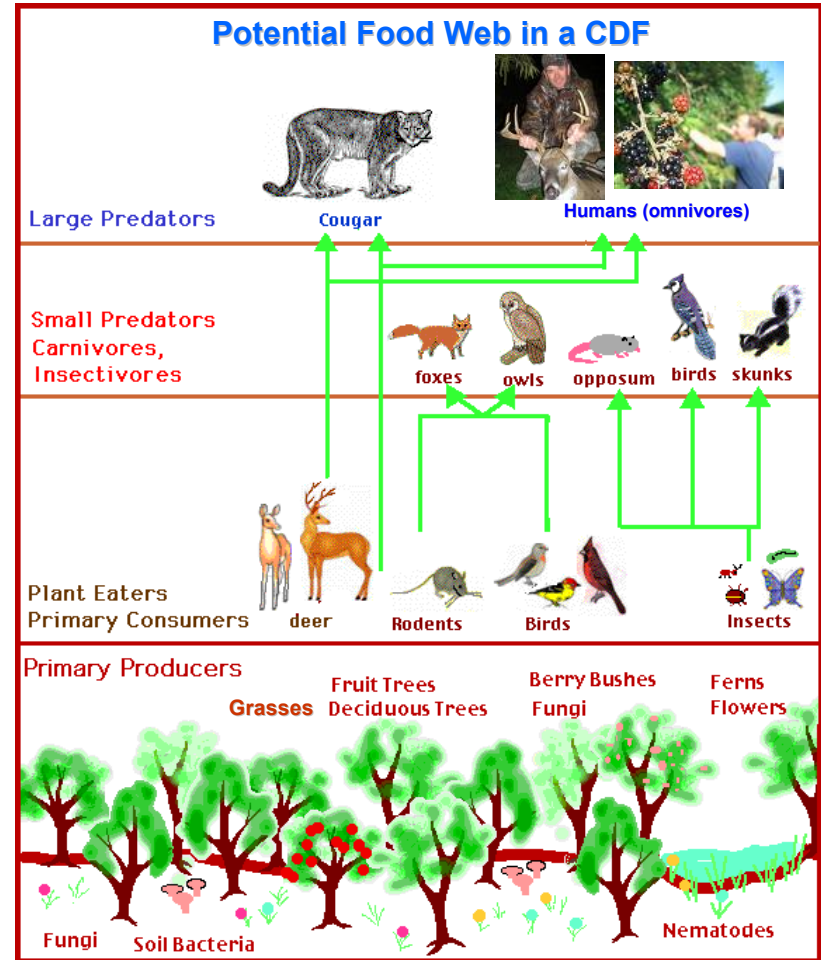


# Conceptual Model-Upland CDF Contaminant Migration Pathways



# 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

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- 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?

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- 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

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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

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- **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)

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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  $K_d$ )

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

(4)





# 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?

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- **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

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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

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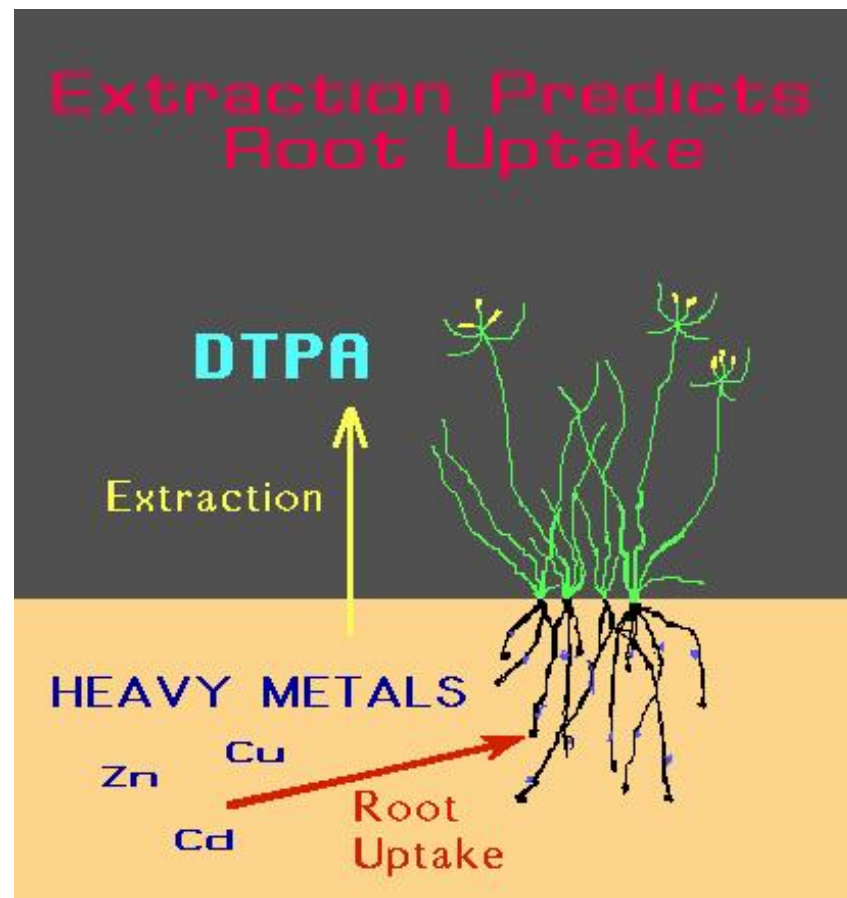
- **Demonstrates that contaminant evaluations are needed and that plant bioaccumulation is a contaminant mobility pathway of concern for the project**
- **Uses the same project-specific conceptual site model developed for animal bioaccumulation**
- **ROC populations outside the CDF for plant bioaccumulation 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



***Cyperus esculentus***-  
Yellow Nutsedge

## 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



***Spartina alterniflora***-  
Smooth cordgrass



# CDF Management & Controls

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





# Summary—Biological Pathway Evaluations

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- 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

