Dredging Operations Environmental Research (DOER)

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The Goal of DOER

Support sound environmental management and engineering practice by advancing the science and technology applied to navigation dredging operations

DOER Programmatics

- Continuing program in O&M
  - Operating for 13 years
- Organized around Focus Area themes
  - Sediment and Dredging Processes
  - Environmental Resource Management
  - Dredged Material Management
  - Risk Management
- Finite-term research projects, e.g. 1-3 years in length
  - 30-40 projects active in a given year
- Proactive R&D that shapes the debate

DOER Management

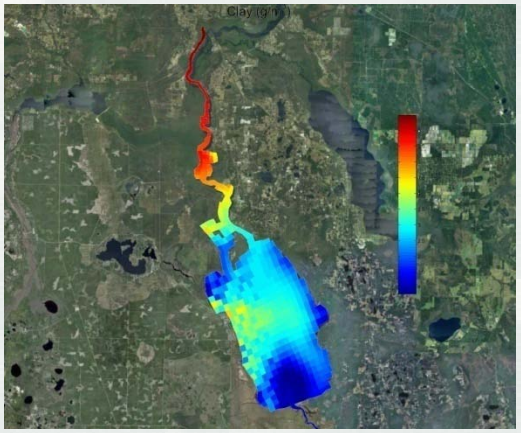
- Program Manager, Todd Bridges
- HQ Oversight
  - Jim Walker, Navigation Business Area Lead
  - Joe Wilson, Technical Monitor
- Focus Area Leaders
  - Joe Gailani, SDP
  - Doug Clarke/Todd Swannack, ERM
  - Tim Welp, DMM
  - Todd Bridges, RM

Risk Management Focus Area

- **Situation**: USACE Districts are increasingly challenged to define the environmental risks and uncertainties posed by dredging, as well as the risks to the navigation program that are posed by environmental issues and constraints
- **Barriers**: Lack of fundamental descriptors for key processes and limitations on the ability to integrate this information in a timely fashion to make credible, risk-informed decisions that will withstand regulatory scrutiny
- **Solution**: Improve the scientific understanding of the processes contributing to the risks relevant to the navigation dredging program
  - Develop a suite of peer-reviewed process models, risk models and decision analysis tools to support decisions based on a more comprehensive understanding of risk, uncertainties, and benefits

High-Fidelity Contaminant Fate and Transport Model

- **Problem**
  - Issues involving contaminated sediments occur across a range of spatial and temporal scales
    - Dredge Plumes
    - In-Place Contaminated Sediments
    - Total Maximum Daily Loads
  - A consistent, interacting set of predictive models is required that can act over spatial scales ranging from the immediate environment of a dredge to the extent of the system and over temporal scales ranging from the period of dredge operation to decades.



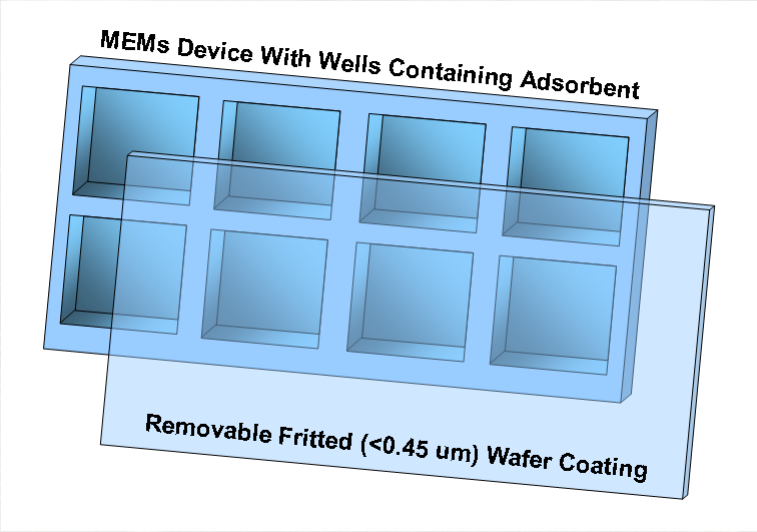
Combined ICM/SEDZLJ application to Lake George FL

- **Objective**
  - Develop a contaminant fate and transport model that will operate on spatial scales ranging from kilometers to system-wide and on temporal scales ranging from minutes to years.
  - The improved model will interface with the PTM particle tracking model, and with the Surface Modeling System (SMS).
  - Provide unique capability to simulate the generation and fate of organic matter, which influence contaminant mobility and exposure.

- **Approach**
  - Extend the CE-QUAL-ICM finite-volume water quality model to include toxic chemical transport and fate coupled with sediment transport.
  - Employ sediment transport algorithms from the SEDZLJ sediment transport model.
  - Adapt toxics routines from the ICM-TOXI model version.
  - Provide interfaces with PTM (short-term, vicinity of dredge) and RECOVERY (extended-term, system wide) models.

Biotech Methods for Contaminant Analysis: Coupling Solid Phase Sorption to Chemical and Biological Assessment.

- Problem
  - Measuring bioavailable fraction of contaminants in sediments is critical for environmental assessment of sediments/DM
  - Current approaches can be improved by leveraging technologies in materials science



- Objective
  - Use a silicon wafer-based device designed specifically for assessing bioavailable fraction of contaminants in sediment
  - Compare silica sampler to traditional measures of bioavailability (bioaccumulation, chemistry, SPME)

- Approach
  - Construct silica-based surfaces coated with sorbant materials (PDMS and NPO)
  - Evaluate adsorption of PCB on surfaces from water (reverse SPMD)
  - Compare to bioassay and SPME using a contaminated field collected sediment

Residuals/Fluid Mud Formation Process and Effects on Contaminant Release

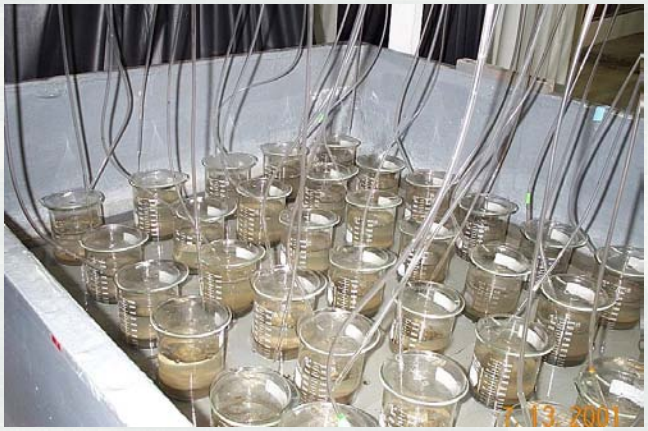
- Problem
  - Dredging does not capture all sediments disturbed, i.e., Residuals
  - Susceptible to entraining water, more likely to move
  - Potential for greater contaminant release than dredging activity

- Objective
  - Identify life cycle of residuals, sources during dredging process
  - Quantify contaminant releases with each residual source
  - Investigate potential treatment options

- Approach
  - Lab clamshell dredging to identify physical characteristics for variety of “clean” residuals
  - Use “clean” residuals info to evaluate contaminated residuals
  - Simulate treatment options with cont. sediment residuals

Linking Toxicity Identification Evaluation and Tissue-Residue Evaluation to Assess Mixture Effects

- Problem
  - Current sediment testing provides a go/no-go binary characterization for management decision with little indication of cause of toxicity
  - Need to identify contaminant causing toxicity or driving bioaccumulation so that management alternatives can be targeted
  - Bioavailability, bioaccumulation and toxicity are not adequately linked to establish cause-effect relationships



- Objective
  - Demonstrate the utility of the TIE process in assigning causality and in augmenting dredge material management decisions
  - Establish critical body residue levels for sediment contaminants using sediment dilutions or amendment gradients
  - Determine the relationship between bioavailability, bioaccumulation, and toxicity

- Approach
  - Use Phase I TIE to identify cause of toxicity within a contaminant class
  - Use combined TIE, bioaccumulation and toxicity study to determine bioavailability, toxicity and site-specific critical body residue levels
  - Use regression analysis to evaluate the relationship between bioavailability, bioaccumulation and toxicity

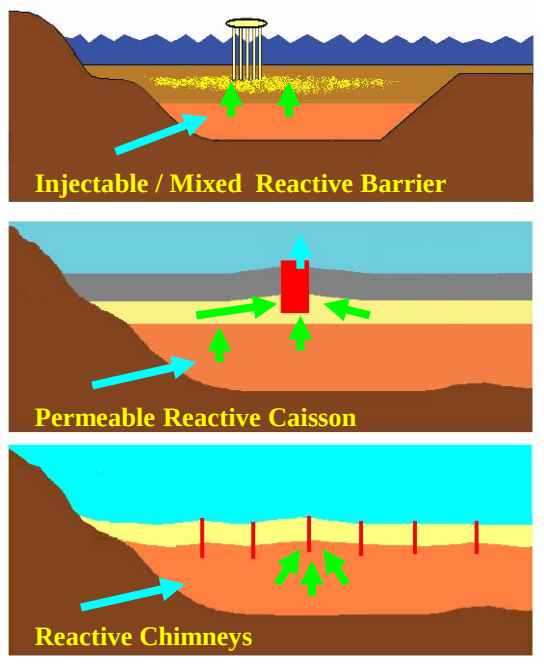
Risk-Based Guidance for CDF Reclamation

- Problem
  - Beneficial use of dredged material is hampered by a lack of consistent criteria to readily determine environmental acceptability
  - Methodology for generating criteria is needed.

- Objective
  - To develop specific risk-based methodology for developing screening criteria for beneficial use of dredged material
- Approach
  - Evaluate existing methods
  - Develop methodology based on risk principles
  - Apply methodology to a given contaminant as example
  - Collaborate with States and EPA to gain acceptance

Design of Reactive Barriers & Caps for Dredged Material Management

- Problem
  - Cost-effective methods for passive in-situ management of contaminated sediment are lacking
  - Traditional sandy caps may not be effective for high porewater flux
  - Reactive cap methods are immature
- Objective
  - Develop and test “reactive chimney” concept
  - Compare alternative distributions of reactive amendments
- Approach
  - Column experiments comparing alternative amendments and distributions
  - Amendment include GAC, apatite, organoclay



Cap Design for Gas and NAPL Control

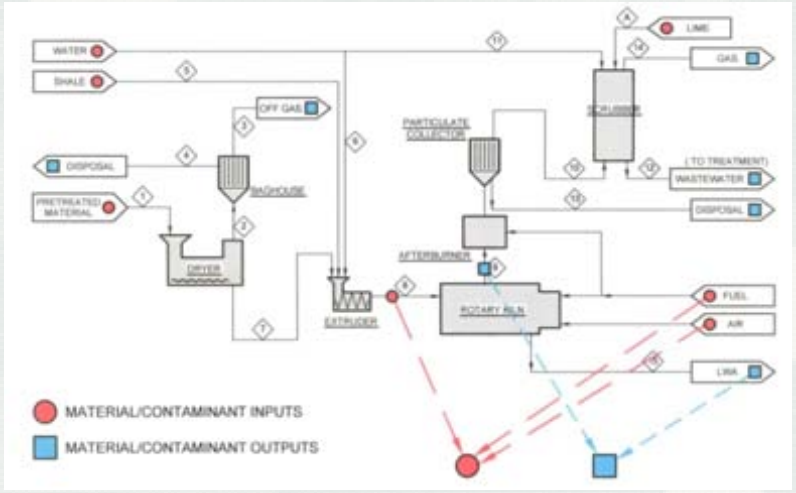
- Problem
  - Gas generation is common at many urban harbors where historical labile organic contamination exists
  - Gas will facilitate the transport of NAPL, if present, through the cap
  - Cap design guidance does not account for gas and NAPL impacts

- Objective
  - Develop design guidance on gas and NAPL controls for caps
  - Develop gas and NAPL transport process descriptions
  - Incorporate gas and NAPL process descriptors in our models for evaluating cap performance

- Approach
- Examine gas and NAPL transport processes through saturated fine-grained sediments and through collection media/systems
- Examine control measures to retard contaminants and NAPL
- Incorporate process into CAP

Sediment Treatment Technologies

- Problem/Purpose
  - Contaminant impediments to DM as “resource”
  - Slow commercialization of effective and economic sediment treatments
  - Evaluate state of the art treatments, effectiveness, cost & obstacles to use



- Objective
  - Technical verification of “near-commercial” technologies
  - Uniform technology and cost evaluation template for RPMs
- Approach
  - Review technology development literature & documentation
  - Mass balance verification
  - Vendor coordination & review

Innovative Treatment Technologies for Dredged Material Management

- Problem
  - Aqueous phase
    - metals associated with colloids/DOC
    - Ammonia
  - Impediments to beneficial use
    - Invasive species
    - Hydrogen sulfide
  - Emerging contaminants
    - Pharmaceuticals, pathogens, oil

- Objective
  - Treatment or management strategies for contaminants problematic to DM management & BU
  - Significance of emerging contaminants to DM disposal and BU
- Approach
  - Literature review
  - Laboratory testing of various detection methods and treatment technologies

Decision Modeling for Dredging Operations Using Bayesian Networks and Influence Diagrams

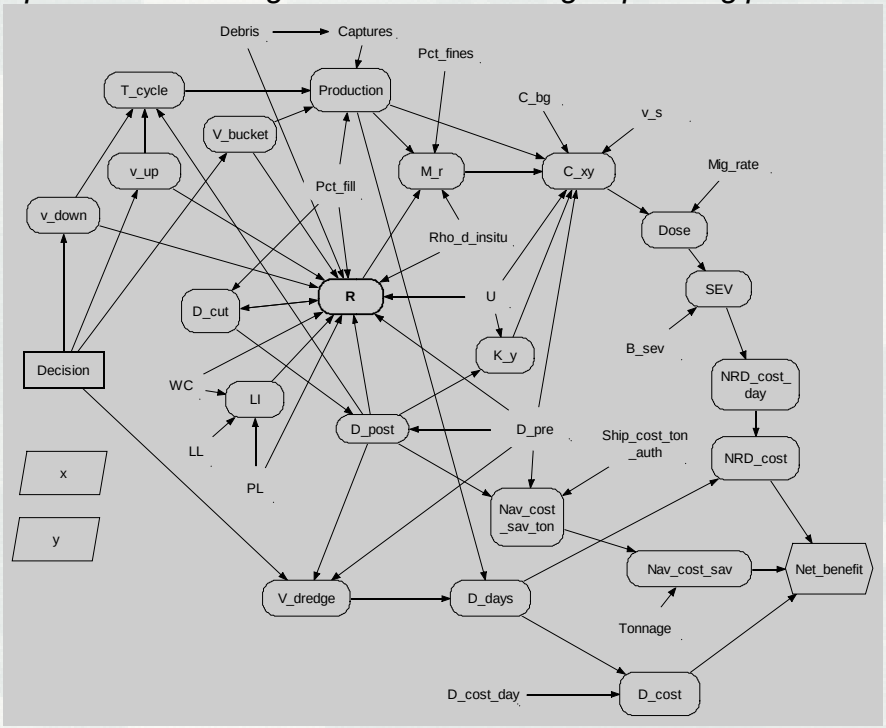
Problem

- Dredging decisions can have negative environmental impacts, but they are difficult to predict and the magnitude of effects are highly uncertain.
- Spatial and temporal scales of data and models developed for dredging decisions vary.
- Uncertainty confounds the decision making process, delaying dredging projects and raising project costs..
- Managers need integrative decision support tools that use information about uncertainty in a constructive way to help evaluate alternatives, identify and prioritize information gathering needs, and improve the quality of stakeholder interaction.

Objective

- Investigate how dredging decisions can be modeled using probabilistic networks and show how uncertainty analysis and value of information analysis can improve the quality of dredging decisions.
- Investigate how diverse USACE models and databases developed to inform dredging decisions can integrated using probabilistic networks.
- Demonstrate the application of decision modeling methods at a suitable USACE dredging site.
- Introduce dredging managers to the opportunities for and methods of dredging decision modeling.

Example: Influence diagram for bucket dredge operating parameters.



Approach

- Background study (Phase 1, FY10-FY11)
  - Identify dredging operations decision support needs.
  - Review literature on modeling ecological systems using probabilistic networks.
  - Develop examples of decision models.
  - Identify demonstration study site.
- Demonstration study (Phase II, FY11-FY12)
  - Implement demonstration study.

Working With Nature: Environmental Enhancements & Navigation Infrastructure

- Problem
  - Navigation infrastructure is infrequently designed to serve both navigation and environmental objectives. Opportunities and challenges for changing the status quo need to be identified.

- Objective
  - Identify ways in which USACE can increase the integration of environmental enhancements into navigation infrastructure projects
- Approach
  - Initial Research & Interviews
  - Outreach Presentations
  - Survey Development
  - Webinars
  - Survey

DOER Strengths

- Sediment processes and modeling related to dredging
  - ► Unique niche in Federal sector
  - ► Reimbursable work and associated leverage (many Districts, SERDP/ESTCP, EPA)
- Contaminated sediment assessment and management
  - ► Robust reimbursable program- Districts, Feds ($ 3M from EPA HQ in last 3 years), private sector
- Putting out fires: T&E species (e.g., sea turtles), Environmental Windows, overdepth dredging, etc.

Strategic Directions Identified in 2010

- Develop technical basis for sustainable dredging operations
- Align navigation dredging with PIANC concept of “Working with Nature”
- Science and engineering to promote and expand beneficial use of dredged material
- Strategy and actions to reduce the impact of T&E species and Environmental Windows on the dredging program

Your Input

- What needs do you see in these areas:
  - Exposure assessment and modeling
  - Assessing effects of exposure
  - Characterizing risks
  - Managing risks