

DREDGING RESEARCH AND TECHNOLOGY TRANSFER AS A STRATEGIC ENABLER TO THE UNITED STATES NAVIGATION MISSION

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ABSTRACT

The Dredging Operations and Environmental Research (DOER) Program supports the U.S. Army Corps of Engineers' Operation and Maintenance Navigation Program. Research is designed to balance operational and environmental initiatives and to meet complex economic, engineering, and environmental challenges of dredging and materials placement in support of the navigation mission. Research results provide dredging project managers with technology and tools for cost-effective operation and evaluation of risks associated with management alternatives and environmental compliance. There are four Focus Areas in the program, which include Dredged Material Management, Environmental Resource Protection, Innovative Technologies, and Risk. High priority problems being addressed in these areas include: regional sediment and life cycle management of Confined Disposal Facilities (CDFs); dredging and materials placement activities involving threatened and endangered species conservation and protection; channel condition indices and nautical depth; and managing risk while handling and placing contaminated sediments. Research results provide innovative solutions in these areas to enable the Corps to conduct efficient, effective, productive, and environmentally sustainable channel maintenance in support of safe, reliable, efficient, waterborne commerce within the U.S. navigation system. The papers to be presented in this session will provide overviews of contemporary research and technologies evolving from the DOER Program that address the greatest technical challenges facing the navigation mission.

Keywords: Dredged materials management, environmental resource protection, innovative dredging technologies, risk assessment.

INTRODUCTION

Background

The USACE navigation dredging program faces a relatively flat Operations and Maintenance (O&M) annual budget. Planning and execution of these funds must be conducted wisely to address a combination of backlogged project maintenance requirements, as well as new needs that arise each year. Cost and time pressures on dredging operations present significant challenges for project prioritization and execution. Environmental requirements for dredging and materials placement operations pose both constraints and opportunities. With increases in efficiency, effectiveness, and productivity, more work can be accomplished with scarce resources. Within its mission, the USACE maintains and enhances its corporate expertise and know-how to address these concerns.

Risk-based assessment and management has become an accepted basis for decision-making within the navigation program. Engineering and science innovations, and their transfer for application to the field, are the keys to success in supporting and making improvements in the Corps' execution of the dredging program. Research conducted through the Dredging Operations and Environmental Research (DOER) Program is a strategic enabler in this process. The goal of the DOER program is to ensure a successful navigation program by resolving complex economic, engineering, and environmental challenges through advancing the science and engineering applied to navigation dredging operations.

Program Organization

The U.S. Army Engineer Research and Development Center (ERDC) executes the DOER Program under the proponenty and monitoring of Headquarters, USACE (HQUSACE). Program Managers and Focus Area Leaders in the DOER Program identify and examine contemporary problems, needs, and opportunities within the USACE's navigation dredging program by collaborating with field elements, which include USACE districts, dredging

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contractors, governmental agencies, Non-Governmental Organizations (NGOs), and academia. Program leaders use this information to formulate research on an annual basis in the four Focus Areas listed below:

- Innovative Technologies
- Environmental Resource Protection
- Dredged Material Management
- Risk

Within these focus areas, national priorities are addressed through finite term projects that are conducted over periods of about one to three years. Within the DOER Program, Principal Investigators (PIs) initiated research projects are vetted within the program, HQUSACE and through coordination with a Field Advisory Panel (FAP). The FAP supports the program through development of high priority questions and problems that serve as targets for research investment, as well as assisting with transfer of completed products arising from the program.

RESEARCH FOCUS AREAS

Innovative Technologies Focus Area

The purpose of this Focus Area is to develop innovative tools, databases and software; and identify, evaluate, and foster implementation of innovative technologies on a USACE-wide basis to significantly improve operation and management of dredging activities. Products being addressed in FY 07 include:

- Demonstrate/validate the USACE Campaign Plan Innovative Adoption Process (IAP)
- Silent Inspector (SI) software and documentation for cutterhead and mechanical dredges. The SI is an automated dredge contract monitoring system comprised of both hardware and software developed by the USACE. The USACE developed the SI as a low cost, repeatable, impartial system for automated dredge monitoring.
- Documentation of Fluid Mud (FM) survey systems and revision of USACE Hydrographic Surveying Engineer Manual
- Statistical analyses techniques for determining overdepth dredging of different dredge types in different geotechnical conditions in exposed and sheltered waters

These products have potential applications to a variety of field elements, which include all 30+ Corps districts that perform dredging, HQUSACE, division offices, as well as inside ERDC. Interest in these products extends outside of USACE to the U.S. Environmental Protection Agency (EPA), Minerals Management Service, National Marine Fisheries Service, and the dredging industry. The questions/answers that are used to structure the portfolio of research activities within this Focus Area are:

What are the customers' problems?

A challenge in using innovative technologies is assimilating all of the information required to make management decisions. There is also a lack USACE-wide standards for monitoring critical processes. An example case is survey measurement ambiguity in channels with fluid mud. Part of problem identification in the DOER Program therefore is identifying relevant processes and frameworks to evaluate innovative technologies for application to meet USACE objectives.

What are the barriers to solving these problems?

Losing district expertise, limited time and data analyses capabilities, and limited resources and time lags, exacerbate identified problems. In addition, individual districts lack funds for evaluating innovative technologies and often lack the specific expertise necessary.

How will we overcome those barriers?

By developing and demonstrating innovative technologies, the USACE-wide navigation dredging mission can be accomplished faster, better, and cheaper. The Innovative Technologies Focus Area is designed to be a catalyst for demonstrating, evaluating, and diffusing innovative technologies to districts and other sponsors.

What are the capabilities we are developing?

The Innovative Technologies Focus Area is charged with developing and demonstrating processes to allow the USACE to more effectively identify, screen, demonstrate, evaluate, and implement innovative technologies. Standardized means to accurately monitor USACE-wide cutterhead and mechanical dredging operations, advanced

analyses methods and tools for determining the amount of overdepth dredging being conducted on navigation projects, and improved fluid mud surveying capabilities, are examples of such capabilities.

Examples of metrics being used currently to measure Focus Area success include: (1) USACE implementation rate of the SI automated dredge-monitoring system aboard hopper, cutterhead, and scows to provide dredging contract quality assurance (QA) and Threatened and Endangered (T&E) protection, (2) USACE implementation of non-nuclear fluid mud surveying equipment to reduce measurement ambiguity in determining depth, and (3) providing analysis tools to monitor and quantify overdepth dredging for dredging contract QA purposes.

There are several showcase innovations being advanced in this Focus Area. In the area of overdepth dredging, researchers are applying statistical analyses for contract QA and determination of characterization depths for environmental compliance. In the SI arena, field implementation is the first large scale (multiple project) automated dredge monitoring system in the world. While the SI system is currently mandated for use aboard all hopper dredges working on USACE and permit projects, work is being conducted in this Focus Area to expand its capabilities to include cutterhead and mechanical dredges. Data analyses tools for hopper, cutterhead, and mechanical dredges are also being developed to help address a host of crucial aspects confronting USACE dredging today, i.e., assuring environmental compliance for T&E species and providing operations personnel essential information on actual dredging processes to optimize contract management. Fluid mud measurement and analysis techniques are being developed for non-nuclear fluid mud surveying systems. An IAP is being developed as a first for specifically targeting innovative technologies on a USACE-wide (civil and military) basis.

Milestones for product infusion to the field are as follows:

- Revision of USACE Hydrographic Surveying Engineering Manual (EM) in FY 07
- Demonstrate/validate SI cutterhead and mechanical dredge software versions and implementation processes in FY 07
- Demonstrate/validate USACE Campaign Plan Innovation Adoption Process (IAP) in coordination with HQUSACE in FY 07
- Overdepth analysis tools and guidance documentation in FY 08
- Journal article – Demonstration of innovative technology in FY 08

The Innovative Technologies Focus Area conducts collaborative efforts with the Dredged Material Management and Environmental Resources Protection Focus Areas. Product advocates, proponents, and collaborators of this Focus Area include: Chiefs of Operations at districts nationwide, as well as the National Marine Fisheries Service (NMFS), Minerals Management Service (MMS), U.S. Environmental Protection Agency (EPA) Regions IV, V, and IX, National Oceanographic and Atmospheric Administration (NOAA).

Environmental Resource Protection Focus Area

The purpose of this Focus Area is to develop technologies that enable field offices to conduct navigation dredging with minimal conflict with T&E species, as well as to advance beneficial uses of dredged material for environmental resource applications. In FY 07, products being advanced include:

- Evaluation and standardization of sea turtle rescue trawling
- Risk factor analysis procedures for high priority species (e.g., sturgeon, Piping Plover)
- National strategy for sustainable management of Confined Disposal Facilities (CDFs), including the role of Regional Sediment Management (RSM) and beneficial uses of dredged materials
- Methods for quantifying Essential Fish Habitat benefits associated with dredged material placement and beneficial uses
- Risk assessment tools to objectively determine the need for environmental windows

Application of these products will address complex, costly concerns with T&E species encountered by districts and divisions and problems confronted by field offices as CDFs reach or approach capacity. The products are used by ERDC, as well as NOAA, EPA, USACE Regional and National Dredging Teams, State Regulatory Agencies, and NGOs. The questions/answers that are used to structure the portfolio of research activities within this Focus Area are:

What are the customers' problems?

In general, there is very little hard evidence or data pertaining to how dredging operations impact T&E species. Dredging and placement limitations, such as environmental windows, are often highly restrictive because these impacts are not understood. USACE districts are confronted by complex T&E species issues not only for specific dredging projects, but also for issues that extend across district/division boundaries. Presently, there exists no central clearinghouse for critical data and guidance.

What are the barriers to solving these problems?

Barriers include lack of data on specific species, constrained access to existing knowledge bases, highly conservative protective measures to compensate for lack of understanding, and misconceptions about the dredging process and potential threats to species of concern.

How will we overcome those barriers?

Develop and demonstrate methods for assessing the impact of dredging and placement operations on T&E species. Method development includes understanding of basic processes, a sufficient database describing species response to dredging, quantifying both positive and negative impacts of dredging, and demonstrating beneficial use of dredged or CDF material for species habitat enhancement.

What are the capabilities we are developing?

Tools and databases that increase our understanding of T&E species that permit increased flexibility in the conduct of navigation dredging projects, dredging methods that reduce conflict with T&E species, and demonstration/databases of dredged or CDF material beneficial use for habitat enhancement.

Metrics being used currently to measure Focus Area success include: (1) reduction in dredging restrictions based on sound science rather than perceptions/concern for unknowns, and (2) lowering of restrictions that have led to higher incremental dredging costs. Product objectives of this Focus Area are to: (1) adjust and add time to existing dredging windows such that significant cost savings result (e.g., revisiting environmental windows in Great Lakes waters, engagement in Long-Term Management Strategy refinements of environmental windows in San Francisco Bay), and (2) reduce delays due to protracted coordination and negotiations with regulatory agencies and NGOs.

The Environmental Resource Protection Focus Area leverages DOER Program funds with reimbursable projects of customer USACE districts, and conducts collaboration with multiple Federal and state agencies to fill knowledge gaps for critical risk factors that underlie dredging restrictions. In the process, Focus Area initiatives result in demonstration of effective approaches for beneficially using dredged materials that will restore CDF capacity.

This translates into accrual of significant cost savings at a project-specific level by avoiding initially unanticipated conflicts with regulatory agencies or internal USACE dredge scheduling. The Focus Area also improves field office access to fundamental science and solutions to meet project-specific requirements for T&E Species protection. There is emphasis on peer-reviewed science for technically rigorous protective measures employed, and innovative experimental systems are used to elucidate risk factors for T&E species.

Product infusion milestones for this Focus Area to field elements are listed below:

- Publish Standard Operating Procedures (SOP)/guidance on sea turtle relocation in FY 07
- Journal article – Operational aspects of coastal bird protection in FY 07-08
- Journal article – Dredging risk factors for sturgeon in FY 07-09
- Publish sustainable CDF strategy in FY 07
- Journal article – Risk approach for environmental windows in FY 07
- Journal article – Essential Fish Habitat (EFH) benefits of dredged material placement in FY 07-08

Product advocates or proponents of the Focus Area include Chiefs of Operations at 6 different USACE districts, as well as NOAA, USFWS, EPA, state resource agencies, and a number of ports.

Dredged Material Management Focus Area

The purpose of the Dredged Material Management Focus Area is to develop tools to quantify dredged material processes for operation, management, and regulatory purposes, and to advance engineering practice for optimizing placement and beneficial use of dredged material.

Products under development in this Focus Area in FY 07 include:

- Particle Tracking Model (PTM) for far-field fate of material released during the dredging process – Version 2
- Equipment and methods for quantifying settling speed, resuspension, and consolidation of dredged material
- Surface Water Modeling System Dredging Toolbox
- Far-field fate water quality model for dredged material releases
- White paper on state-of-the-art CDF management

Applications for these products include: analysis of dredging turbidity, assessing impact of far-field fate of dredged material, evaluating evolution/dispersion of dredged material mounds, impact of placement operations, CDF management, and characterization of dredge-related water quality and contaminant transport. Models/tools developed in this Focus Area provide process-based capabilities to assess dredged material in open water and to evaluate CDF evolution. An integration of a suite of modeling technologies is being developed to conduct regional and sustainable dredged material management, which is anticipated to be used by districts, contractors, stakeholders, and ERDC for many dredging projects. The questions/answers that are used to structure the portfolio of research activities within this Focus Area are:

What are the customers' problems?

Improved capabilities are required to address regulatory questions regarding dredging operations. The USACE must address increasingly complex questions pertaining to dredging. USACE districts presently lack appropriately advanced dredging tools and models required to address operational, planning, management and regulatory issues.

What are the barriers to solving these problems?

Existing dredging tools lack the mechanistic and numerical components to address the increasing complexity of dredged material management issues. Increased model applicability requires, but is lacking, sufficient knowledge of dredging processes and data for model development, calibration and validation.

How will we overcome those barriers?

Advanced understanding of sediment processes during dredging is key to model improvement. Process research is specifically designed to improve accuracy and applicability of the suite of peer-reviewed dredging and sediment tools. These tools address key USACE dredged material management issues.

What are the capabilities we are developing?

The Focus Area is developing the ability to predict and analyze dredged material fate, processes, and operations over time periods ranging from a single placement to sustainable solutions, on the order of decades. The Focus Area is also assessing CDF processes relevant to management and reuse.

The first metric used to measure success in the Dredged Material Management Focus Area is the degree to which quantitative answers can be provided to address questions about dredged material processes. A second metric is the number of district applications/users of DMM tools and the benefit these tools offered in addressing specific dredged material regulatory- and management-related issues. An additional metric is monitoring the increasing accuracy, range of applicability, and increased district benefit from the improved or new DMM tools. For example, concern over dispersion during disposal operations often leads to overly conservative designs on maximum barge size or disposal rates. Research product should provide the basis for cost effective operations that meet regulatory requirements.

The Focus Area leverages/coordinates with the Coastal Inlet Research Program (CIRP), MOdeling the Relevant PHysics Of Sedimentation in 3D (MORPHOS-3D) Program, reimbursable projects, System-Wide Water Resources Program (SWWRP), USACE Plant Replacement and Improvement Program (PRIP), Strategic Environmental Research and Development Program (SERDP), EPA and other DOER Focus Areas. The Focus Area obtained PRIP funds to build advanced laboratory facilities first devised and tested under the DOER Program. Staff members have collaborated with EPA and USACE districts on using models/tools for dredging regulation and dredged material management issues, and expanded district user-base for these models/tools. Sediment processes measuring techniques are specifically tailored to dredging issues. For example, an innovative sediment erosion flume was

developed to quantify erosion in wave/current environments (leveraged with another program) to address issues related to nearshore placement for littoral nourishment as a beneficial use.

The Dredged Material Management Focus Area product infusion milestones consist of:

- Release/training: PTM Version 2 Dredged Material Fate Model in FY 07
- Release/training: Ocean Dredged Material Disposal Site (ODMDS) Optimizer Model in FY 07
- Release/training: Surface Modeling System (SMS)/Geospatial Information System (GIS) dredging model toolbox in FY 08
- Equipment for quantifying dredged material settling in FY 07
- Equipment to quantify erosion under wave/currents in FY 08
- Release/training: Dredged Material Water Quality Model in FY 08
- Demonstrations and peer-reviewed publications in FY 07-FY 08

Focus Area product advocates or proponents include: Chiefs of Operations at several districts, port authorities, dredging contractors, EPA, and other regulatory agencies.

Risk Focus Area

The purpose of this Focus Area is to develop and apply state-of-the-art risk-based tools for the assessment and management of dredged material. It also aims to develop structured decision support tools to manage uncertainty and facilitate efficient decision-making.

Products under development during FY 07 in the Risk Focus Area include:

- Contaminant transport models to predict short/long-term and near/far-field impacts of dredging
- New technologies for measuring and predicting contaminant bioavailability
- Experimental and modeling procedures to assess effectiveness of alternative dredged materials management options
- Multi-Criteria Decision Analysis (MCDA) tools to aid complex, risk-based decision making

Many Corps projects involving contaminated sediments would benefit from the use of risk-based approaches. Research products from this Focus Area have been applied to high profile projects in New York Harbor, San Francisco District, Indiana Harbor, New Orleans, and elsewhere. The products of this Focus Area will be used by ERDC, USACE districts, regulatory agencies, contractors, and stakeholders. The questions/answers that are used to structure the portfolio of research activities within this Focus Area are:

What are the customer's problems?

USACE districts are increasingly challenged to define the environmental risks and uncertainties posed by dredging and managing contaminated sediment.

What are the barriers to solving these problems?

Lack of fundamental descriptors for key processes controlling contaminants, funding and time limitations on the ability to integrate this information in a timely fashion to make credible, risk-based decisions that will withstand regulatory scrutiny.

How will we overcome those barriers?

By improving the scientific understanding of the processes contributing to risk from contaminated sediment and developing a suite of peer-reviewed process models, risk models and decision analysis tools to support decisions based on a more comprehensive understanding of risk and uncertainties.

What are the capabilities we are developing?

A suite of advanced methods and models are being developed to accurately predict contaminant movement and adverse environmental effects from dredging and dredged material management that can be used to support risk-based decision making.

Metrics for assessing Focus Area effectiveness include easing of highly conservative regulatory criteria following adoption of a risk-based approach. An additional metric is reduced compliance costs associated with risk-based regulatory criteria.

The Risk Focus Area leverages DOER Program funds with ongoing district reimbursable projects, SWWRP, SERDP, and the Environmental Security Technology Certification Program (ESTCP). Collaborations are ongoing with EPA Regions, Office of Research and Development (ORD), and EPA Superfund, academia, and through Cooperative Research and Development Agreements (CRADA) with the private sector.

Product infusion milestones for the Risk Focus Area are as follows:

- Enhanced DREDGE excavation plume fate model released in FY 08
- Enhanced RECOVERY model for evaluation of contaminant release from bottom sediments released in FY 07
- Journal article – Bioturbation model for cap design in FY 07/08
- Release updated CAP/RECOVERY model in FY 07
- Contaminant PTM module for far-field modeling in FY 08
- Journal article – New technology for bioavailability assessment in FY 08
- Journal article – Linking modeling to decisions using MCDA in FY 08/09

Product advocates or proponents include Chiefs of Operations in several USACE districts, port authorities, dredging contractors, EPA, and other regulatory agencies.

CONCLUSION

The benefits of the DOER Program are far-reaching. The goals of the program include: (1) improving dredging operations, (2) streamlining permitting, and (3) more efficient methods to demonstrate that we meet regulatory requirements. These goals are achieved through advancing Corps capabilities to predict and assess sediment processes, dredging operations, and risks. The DOER program supports the navigation program by providing the technology needed to increase the effectiveness and efficiency of dredging operations in a manner consistent with the Corps' Environmental Operating Principles. Focus Areas within the program provide cost effective technologies for sediment management while expanding environmental benefits that can be achieved through sustainable sediment management practices. As technical improvements are incorporated into dredging projects, the USACE, its partners, and stakeholders, will enhance their ability to address their needs within the U.S. navigation program, including greater cost efficiency, reduced time requirements and adverse environmental impacts, and greater environmental benefits.

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