Engineering With Nature®

...the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.

Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners

www.engineeringwithnature.org
EWN® OVERVIEW

*Engineering With Nature* initiative started within USACE Civil Works program in 2010

- Engaging across USACE Districts (23), Divisions, HQ; other agencies, NGOs, academia, private sector, international collaborators
  - Workshops (>20), dialogue sessions, project development teams, etc.
- Guided by a strategic plan
- Informed by focused R&D
- Demonstrated with field projects
- Advanced through partnering
- Shared by strategic communications
- Marking progress
  - 2013 Chief of Engineers Environmental Award in Natural Resources Conservation
  - 2014 USACE National Award-Green Innovation
  - 2015, 2017 WEDA Awards; 2017 DPC Award

www.engineeringwithnature.org
EWN® ACROSS USACE MISSION SPACE

Navigation
- Strategic placement of dredged material supporting habitat development
- Habitat integrated into structures
- Enhanced Natural Recovery

Flood Risk Management
- Natural and Nature-Based Features to support coastal resilience
- Levee setbacks

Ecosystem Restoration
- Ecosystem services supporting engineering function
- “Natural” development of designed features

Water Operations
- Shoreline stabilization using native plants
- Environmental flows and connectivity
USACE GALVESTON, BUFFALO, PHILADELPHIA DISTRICTS: EWN “PROVING GROUNDS”

• EWN Proving Ground Kick-Off Workshops
  – October (SWG) and December (LRB) 2014; June 2016 (NAP)
  – District, Division, EWN Leadership Team
• Identify opportunities to implement EWN across current and future programs and projects
• Emphasis on solution co-development
Engineering With Nature®

Elements

EWN Elements

Four major elements are involved in applying EWN to develop infrastructure projects:

- Using science and engineering to produce operational efficiencies
- Using natural processes to maximize benefit
- Increasing the value provided by projects to include social, environmental, and economic benefits
- Using collaborative processes to organize, engage, and focus interests, stakeholders, and partners
ENHANCING EXISTING INFRASTRUCTURE

Ashtabula Harbor

Milwaukee Harbor
ENGINEERING WITH NATURAL MATERIALS

www.engineeringwithnature.org

US Army Corps of Engineers • Engineer Research and Development Center
USE OF NATURAL SYSTEMS TO SUPPORT FLOOD RISK MANAGEMENT

Following Hurricane Sandy:

- Risk industry-based tools used to quantify the economic benefits of coastal wetlands
  - Temperate coastal wetlands saved more than $625 million in flood damages.
  - In Ocean County, New Jersey, salt marsh conservation can significantly reduce average annual flood losses by more than 20%.
“The USACE planning approach supports an integrated strategy for reducing coastal risks and increasing human and ecosystem community resilience through a combination of the full array of measures: natural, nature-based, nonstructural, and structural. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short and long term. It also considers the full range of environmental and social benefits produced by the component features.”

NNBF ENGINEERING PERFORMANCE

**Dunes and Beaches**
- Benefits/Processes
  - Break offshore waves
  - Attenuate wave energy
  - Slow inland water transfer
- Performance Factors
  - Berm height and width
  - Beach slope
  - Sediment grain size and supply
  - Dune height, crest, width
  - Presence of vegetation

**Vegetated Features: Salt Marshes, Wetlands, Submerged Aquatic Vegetation (SAV)**
- Benefits/Processes
  - Break offshore waves
  - Attenuate wave energy
  - Slow inland water transfer
- Performance Factors
  - Marsh, wetland, or SAV elevation and continuity
  - Vegetation type and density

**Oyster and Coral Reefs**
- Benefits/Processes
  - Break offshore waves
  - Attenuate wave energy
  - Slow inland water transfer
- Performance Factors
  - Reef width, elevation and roughness

**Barrier Islands**
- Benefits/Processes
  - Wave attenuation and/or dissipation
  - Sediment stabilization
- Performance Factors
  - Island elevation, length, and width
  - Land cover
  - Breach susceptibility
  - Proximity to mainland shore

**Maritime Forests/Shrub Communities**
- Benefits/Processes
  - Wave attenuation and/or dissipation
  - Shoreline erosion stabilization
  - Soil retention
- Performance Factors
  - Vegetation height and density
  - Forest dimension
  - Sediment composition
  - Platform elevation

US Army Corps of Engineers • Engineer Research and Development Center
COLLABORATION WITH FEDERAL AGENCIES


USACE/NOAA-NMFS Collaboration Workshop
Engineering With Nature, Gloucester, MA; October 5-6, 2016

www.engineeringwithnature.org

US Army Corps of Engineers ● Engineer Research and Development Center
COASTAL SCIENCE AND ENGINEERING COLLABORATIVE: TEXAS A&M ENGINEERING WITH NATURE CURRICULUM

• Working with Texas A&M Department of Ocean Engineering to develop graduate curriculum in Engineering With Nature

• Spring 2018 Engineering With Nature Seminar
  – OCEN 485/685 Engineering With Nature
  – The course is scheduled for Mondays, 12:40 to 13:30. Jan 22 -- May 7.
COLLABORATION WITH THE PRIVATE SECTOR: CATERPILLAR INC.

- Restoring Natural Infrastructure Summit; November 4th, 2015; New York City
- Natural Infrastructure Initiative – USACE Collaboration Work Streams
  1. NI Opportunity Evaluation Tool. Capitalizing on enterprise-level capability: CE Dredge DST
  2. Evaluation and Decision Making
  3. Field Application and Demonstration

INTERNATIONAL COLLABORATION: WORLD BANK GUIDANCE FOR NATURE-BASED FLOOD PROTECTION

NBFP Workshop, 11-13 April 2017

INTERNATIONAL GUIDELINES ON THE USE OF NATURAL AND NATURE-BASED FEATURES FOR SUSTAINABLE COASTAL AND FLUVIAL SYSTEMS

Purpose: Develop guidelines for using NNBF to provide engineering functions relevant to flood risk management while producing additional economic, environmental and social benefits.

- Publish NNBF technical guidelines by 2020:
  - Multi-author: government, academia, NGOs, engineering firms, construction companies, etc.
  - Addressing the full project life cycle
  - Guidelines in 4 Parts
    - Overarching
    - Coastal Applications
    - Fluvial Applications
    - Conclusions

US Army Corps of Engineers • Engineer Research and Development Center
EWN ELEMENTS

Four major elements are key to applying EWN to develop infrastructure projects:

**Producing Efficiencies**
- Using science and engineering to produce operational efficiencies

**Using Natural Processes**
- Using natural processes to maximize benefit

**Broadening Benefits**
- Increasing the value provided by projects to include social, environmental, and economic benefits

**Promoting Collaboration**
- Using collaborative processes to organize, engage, and focus interests, stakeholders, and partners
USACE PHILADELPHIA DISTRICT: BACK BAY EWN

Producing Efficiencies
This material placement option retains CDF capacity; placement site in close proximity to dredging project area - reduced transit/pump time.

Using Natural Processes
Keeps material in system vs. removal into CDF; placement in existing pools/pannes increased elevation and leverages adjacent vegetation to re-establish void area(s).

Broadening Benefits
New placement option for material; diverse habitat created; restored wetlands/islands; additional wave attenuation and flood risk reduction.

Promoting Collaboration
Partnered with USFWS, NJDEP, TNC, Green Alliance, Mordecai Land Trust, and Stone Harbor Wetlands Institute

R&D: Study TLP and long-term performance of placement sites; Offers opportunities to determine appropriate performance metrics aligned with ecosystem and engineering services.

Funded by DOER, RSM, EMRRP

US Army Corps of Engineers • Engineer Research and Development Center
HORSESHOE BEND ISLAND EWN PROJECT
ATCHAFALAYA RIVER, LA

Producing Efficiencies
Material placement created new channel, reduced frequency of maintenance dredging; shortened transit distance for ships.

Using Natural Processes
Used rivers natural flow and conveyance to engineer/construct island.

Broadening Benefits
New placement option for material; economic benefits for navigation; diverse habitat created; site used for recreational purposes.

Promoting Collaboration
MVN and ERDC partnered with USFWS, Port of Morgan City to achieve results.

R&D: Study island integrity/performance over time and river hydrology to determine critical factors required to duplicate in other river systems.


Funded by DOER, RSM, NavSys

US Army Corps of Engineers • Engineer Research and Development Center
MISSOURI RIVER LEVEE SETBACK
OMAHA DISTRICT

**Producing Efficiencies**
Setback reduces frequency of maintenance and repair of levees; reduced navigational maintenance; reduction in associated O&M and RR&R costs.

**Using Natural Processes**
Setback leverages decreased hydrologic loading, decreased flood velocities, and reduced erosion/scour.

**Broadening Benefits**
Improved ecosystem sustainability; improved hazard mitigation; increased recreational, cultural and educational opportunities.

**Promoting Collaboration**
NWO collaboration with USGS, USFWS, Idaho Dept. of Natural Resources, NGOs, and stakeholders.

**R&D:** Opportunities to quantify ecological, engineering, and societal benefits; increase USACE's capacity to provide effective programs for NSA applications; and data/lessons learned will advance guidance and policy that supports future levee setback projects.

Recent reviews funded by DOER and F&C
RESERVOIR SEDIMENT MANAGEMENT (FLUSHING AND BYPASSING)

Producing Efficiencies

Innovative methods to bypass reservoir sediments.

Using Natural Processes

Provide means to allow sediments to follow natural transport patterns and pathways through the river system.

Broadening Benefits

Innovative methods to reduce reservoir sedimentation, increase water storage capacity, and improve sediment management; Utilize sediments to improve down river environment.

Promoting Collaboration

Industry, Government agencies, Districts, Stakeholders.

R&D NEED: Enhance numerical models and tools for predicting reservoir flushing, and impacts/benefits above and below the reservoir. Innovative technologies (Water Injection Dredging and bedload interceptor) to bypass sediments, prediction and management tools. Contributors: RSM, DOER, HEC, NWO, NWK, NWP, UBR, USGS, USDA-ARS

US Army Corps of Engineers • Engineer Research and Development Center
DESIGNING NATURALLY RESILIENT DUNE SYSTEMS

Producing Efficiencies
Utilize state-of-the-art field observations to identify characteristics of naturally resilient dunes and to develop tools to simulate dune growth & erosion to aid in dune design.

Using Natural Processes
Coastal storms can be significant contributors to dune growth if the beach is wide enough to limit inundation.

Broadening Benefits
Dunes are an essential component of the coastal sediment budget and provide ecosystem, tourism, and coastal protection services.

Promoting Collaboration
2016 Dune Management Challenges on Developed Coastlines Workshop (ERDC/USGS/ASBPA led effort; academics; coastal engineers & managers)

R&D NEED: Coupled hydrodynamic, aeolian, biological, and morphodynamic models that can simulate surf-zone, beach, and dune evolution at storm through decadal time-scales.

Funded by CODS, F&C, CIRP

US Army Corps of Engineers • Engineer Research and Development Center
SCIENCE, ENGINEERING, TECHNOLOGY RESEARCH TARGETS

1. Fundamental processes
   - Sediment transport through and around NNBF
   - Long-term engineering and environmental performance of features
   - Environmental Services provided by engineered features and structures
   - Processes contributing to system-scale resilience

2. Modeling systems that support broad-scale application
   - Planners, stakeholders and decision-makers
   - Engineering design
   - Operations and maintenance

3. Reliable, cost-efficient monitoring technologies
   - Measuring system evolution
   - Infrastructure/feature performance

4. Demonstration/pilot projects to innovate, evaluate, and learn at relevant field scales
   - Facilitate necessary collaboration
   - Evolve organizational culture and practice
   - Produce credible evidence of success
   - Fuel the “power of the story”
BUILDING ON MOMENTUM

- Opportunities to scale-up progress?
- How leverage partnerships across sectors and interests?
- How to consider the diverse benefits provided projects and systems?
- How to evaluate, design for and adaptively manage the engineering performance of projects?
- What form of guidance is needed for different functional areas?
- How to incentivize, institutionalize and codify progress?