

Engineering With Nature in Rivers

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US Army Corps
of Engineers.

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Creating Value through Alignment...

- What opportunities are there for achieving better alignment of natural and engineered systems?
 - ▶ Can improved alignment reduce risks to life, property and ecosystems?
 - ▶ What range of services can be produced through such alignment?
 - ▶ What are the science and engineering needs in order to achieve better alignment?



Sustainable Solutions Vision: “Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation’s water resources challenges.”

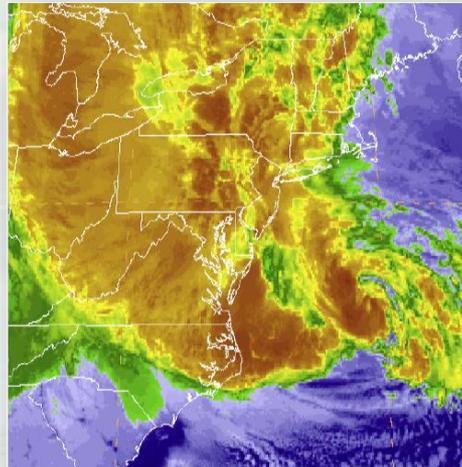


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Value and Use of Natural Systems

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%.



COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION

Using Risk Industry-based Models
to Assess Natural Defenses in the Northeastern USA

October 2016



Working with Nature: *Background*

- Developed as a position paper by PIANC's Environmental Commission in 2007-2008
 - ▶ Supported by CEDA and IADC
- Endorsed by PIANC Executive Committee
- Aims to provide a practical framework for sustainable navigation infrastructure development



PIANC Position Paper

'Working with Nature'

October 2008; revised January 2011

What do we mean by 'Working with Nature'?

Maximising opportunities; reducing frustrations. **Working with Nature** is an integrated process which involves working to identify and exploit win-win solutions which respect nature and are acceptable to both project proponents and environmental stakeholders. It is a philosophy which needs to be applied early in a project¹ when flexibility is still possible. By adopting a determined and proactive approach from conception through to project completion, opportunities can be maximised and - importantly - frustrations, delays and associated extra costs can be reduced.



Engineering With Nature™...

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

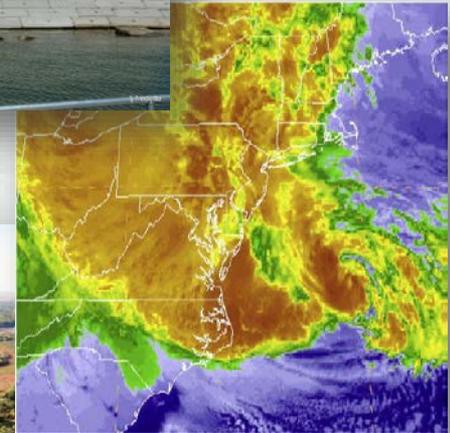
Key Elements:

- 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



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



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The North Atlantic Coast Comprehensive Study

Coastal Risk Reduction and Resilience: Using the Full Array of Measures

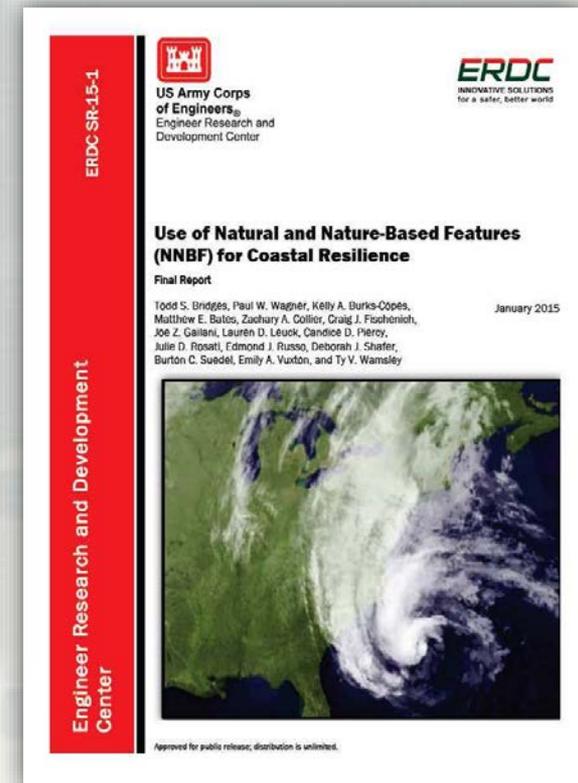
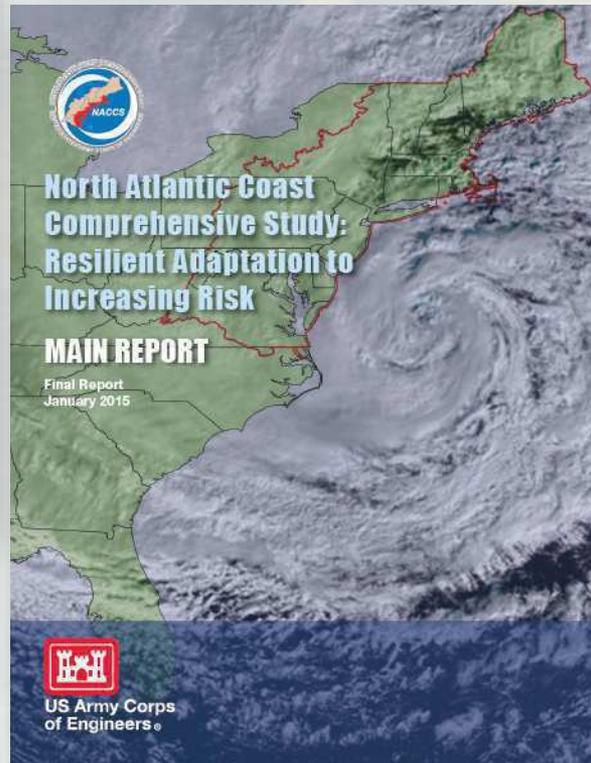


US Army Corps of Engineers
Directorate of Civil Works



US Army Corps of Engineers
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September 2013
CWTS 2013-3



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<http://www.nad.usace.army.mil/CompStudy>

Engineering Performance: Nature-Based Features Work in Different Ways

Natural and Nature-Based Infrastructure at a Glance

GENERAL COASTAL RISK REDUCTION PERFORMANCE FACTORS:
STORM INTENSITY, TRACK, AND FORWARD SPEED, AND SURROUNDING LOCAL BATHYMETRY AND TOPOGRAPHY



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
Increase infiltration

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

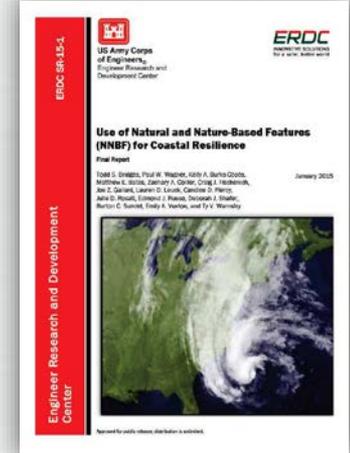
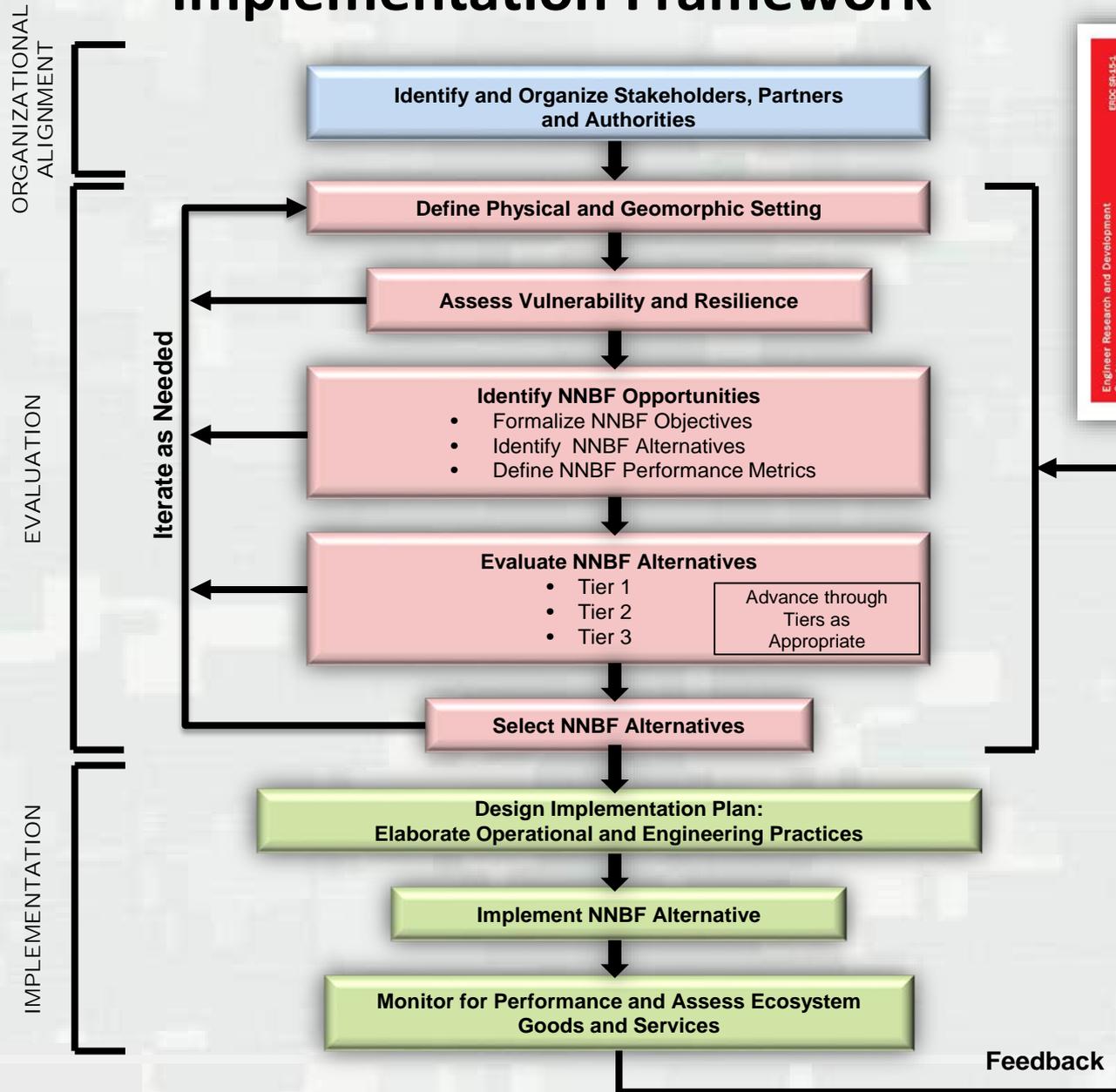


Maritime Forests/Shrub Communities

Benefits/Processes
Wave attenuation and/or dissipation
Shoreline erosion stabilization
Soil retention

Performance Factors
Vegetation height and density
Forest dimension
Sediment composition
Platform elevation

Natural and Nature-Based Features Evaluation and Implementation Framework



Fort Pierce City Marina, Florida



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Enhancing Ecosystem Value



Upper Mississippi River Training Structures: Chevrons



Loosahatchie Bar, Memphis

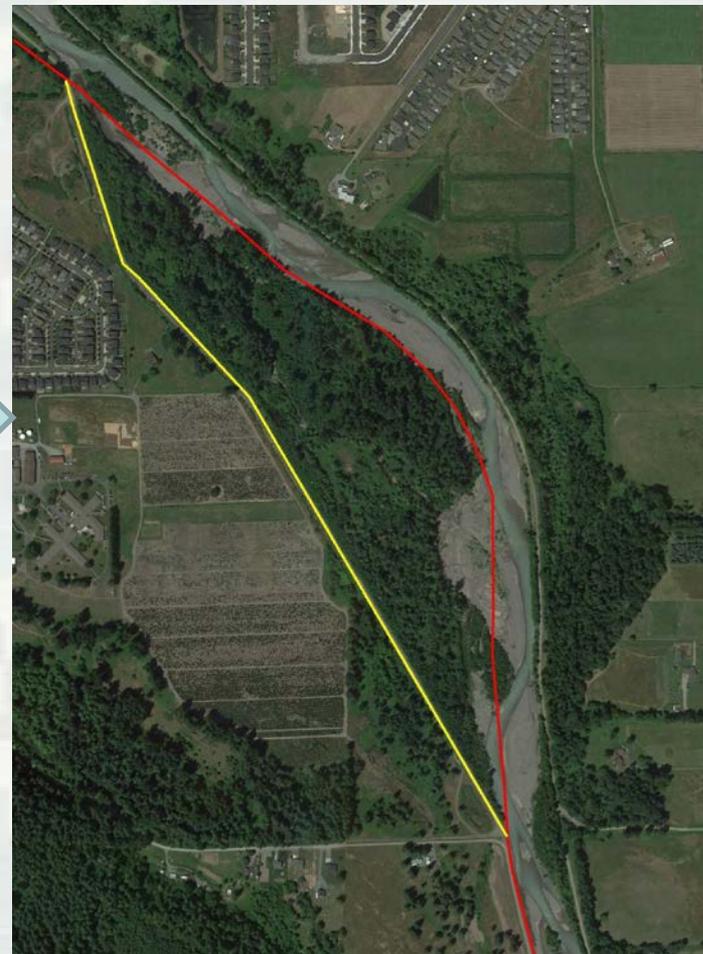
Milwaukee Harbor Breakwater



Soldier's Home Levee Setback

April 2006

June 2016



— Original Levee

== Setback Levee

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Chehalis Basin Floodplain Restoration



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Engineering with Natural Materials



National Large Wood Manual

Assessment, Planning, Design, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process, Function, and Structure

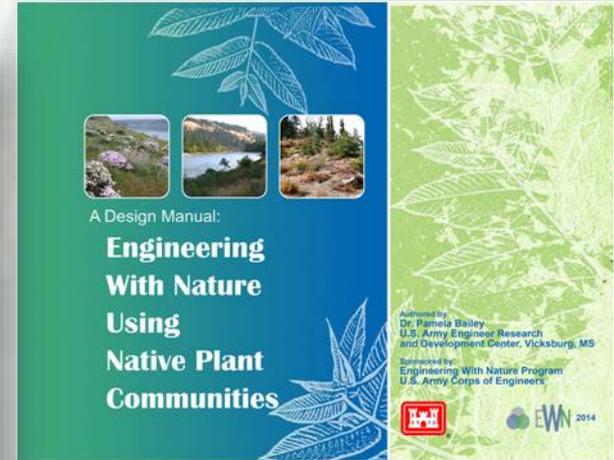
January 2016



U.S. Department of the Interior
Bureau of Reclamation



US Army Corps
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Bank Stabilization: Rootwad – LPSTP

TNC-USFWS Restoration Project, Black Walnut Creek-Trib to Rock River, Ogle County, IL



Horseshoe Bend, Atchafalaya River

- Options for managing dredged material via shore-based wetland creation were exhausted
- Strategic placement of sediment (0.5-1.8 mcy/1-3 yrs) was used to create a ~35 ha island
- Producing significant environmental and engineering benefits
- Project won WEDA's 2015 Award for Environmental Excellence



Laws and Mandates: Water Infrastructure Improvements for the Nation Act (WIIN Act) 2016

SEC. 1184. Consideration of measures.

(a) Definitions.—In this section, the following definitions apply:

(1) NATURAL FEATURE.—The term “natural feature” means a feature that is created through the action of physical, geological, biological, and chemical processes over time.

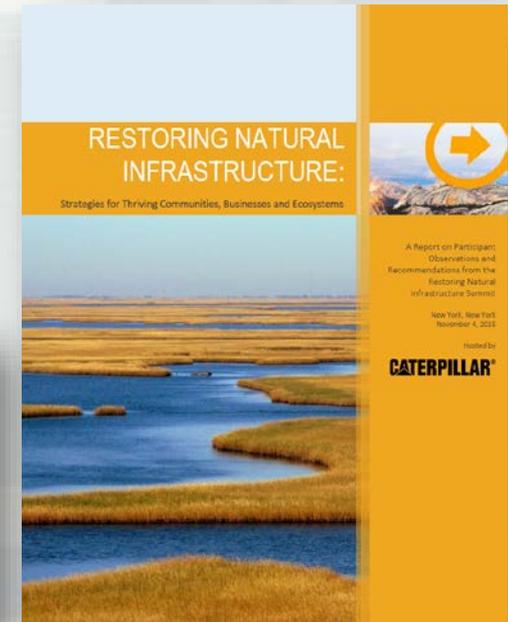
(2) NATURE-BASED FEATURE.—The term “nature-based feature” means a feature that is created by human design, engineering, and construction to provide risk reduction in coastal areas by acting in concert with natural processes.

(b) Requirement.—In studying the feasibility of projects for flood risk management, hurricane and storm damage reduction, and ecosystem restoration the Secretary shall, with the consent of the non-Federal sponsor of the feasibility study, consider, as appropriate—

- (1) natural features;
- (2) nature-based features;
- (3) nonstructural measures; and
- (4) structural measures.



The Private Sector: Caterpillar Corporation's *Restoring Natural Infrastructure Summit* 4 November 2015, New York City



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<http://www.caterpillar.com/en/company/sustainability/natural-infrastructure.html>

Collaboration: USACE Galveston, Buffalo, and Philadelphia Districts-- The 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



Collaboration: USACE – NOAA Workshop on Natural and Nature-Based Features Charleston, SC; 1-3 March 2016



National Oceanic and Atmospheric Administration (NOAA) United States Army Engineer Research and Development Center (ERDC) United States Army Corps of Engineers (USACE)

Proceedings from the U.S. Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA)
Natural and Nature-Based Features Workshop

March 1-3, 2016
Charleston, South Carolina



Approved for public release; distribution is unlimited.



www.engineeringwithnature.org (NNBF)



International Guidelines for Use of Natural and Nature-Based Features for Sustainable Systems

- Publish coastal NNBF technical guidelines by 2020:
 - ▶ Multi-author: government, academia, NGOs, engineering firms, construction companies, etc.
 - ▶ Addressing the full project life cycle: planning, design, engineering, construction, and maintenance
 - ▶ Guidelines in 3 Sections
 - Overarching topics
 - Coastal Applications
 - River/Inland Applications



1906 San Francisco Earthquake



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Agnews State Hospital, 1906



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