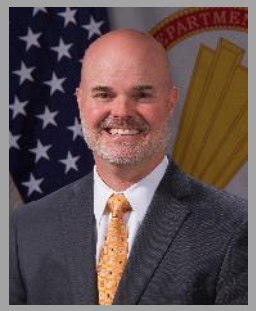
ENGINEERING WITH NATURE FOR FLOOD RISK MANAGEMENT

Todd S. Bridges, Ph.D.
Senior Research Scientist (ST), Environmental Science
National Lead, USACE EWN Initiative

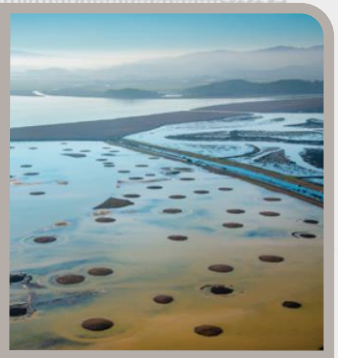
U.S. Army Corps of Engineers
U.S. Army Engineer Research and Development Center

Todd.S.Bridges@usace.army.mil



NFFA Webinar

October 15, 2019

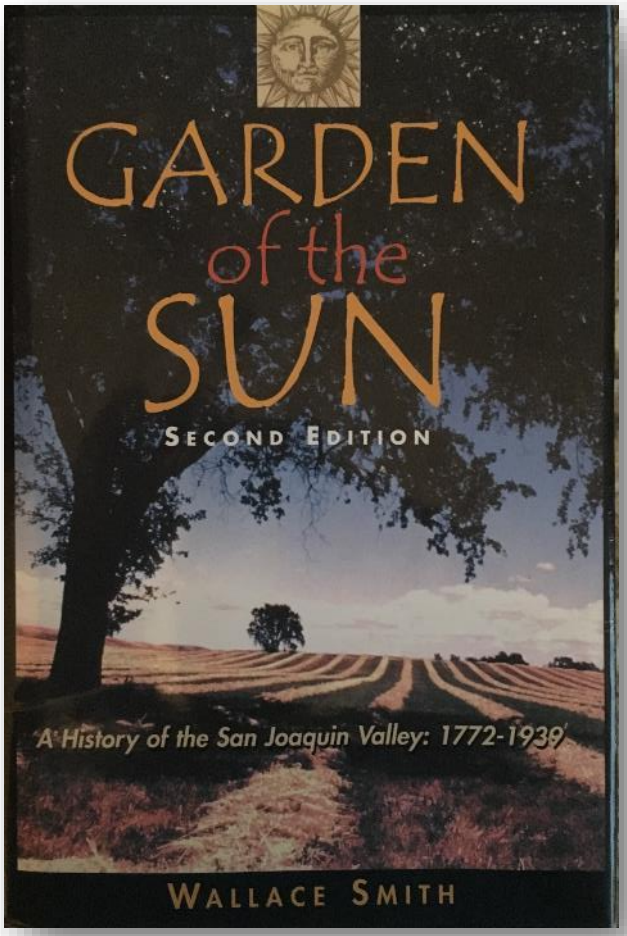


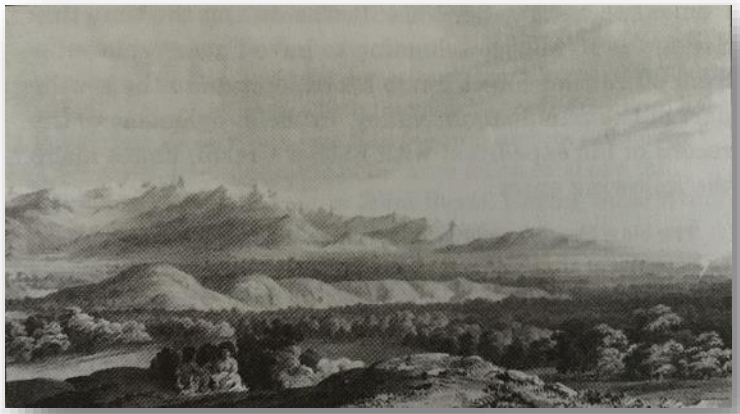
US Army Corps of Engineers

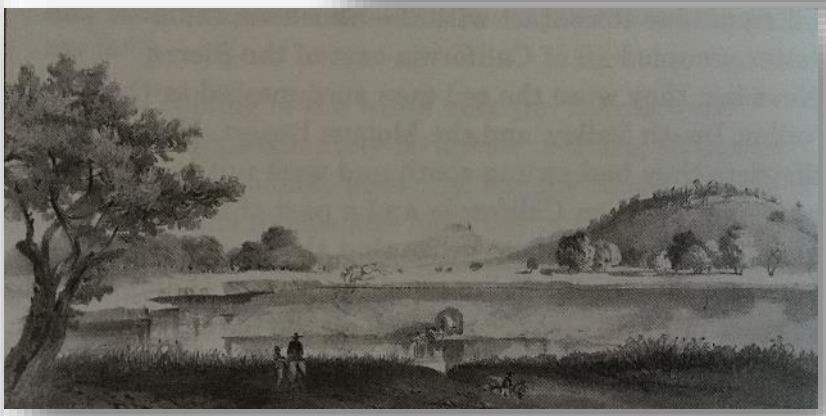
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

THE SAN JOAQUIN VALLEY, CALIFORNIA

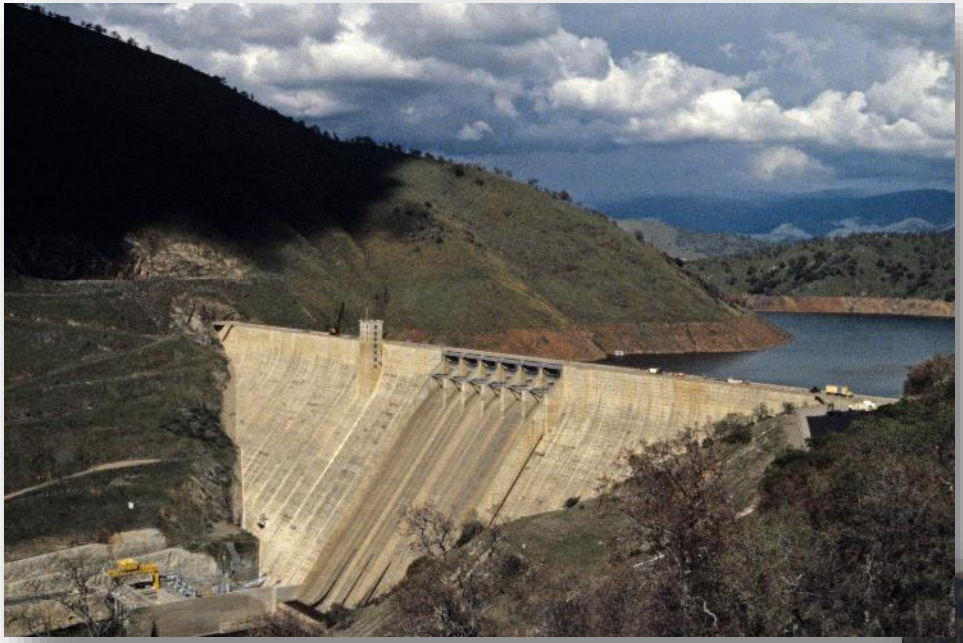
THE SAN JOAQUIN VALLEY, CALIFORNIA

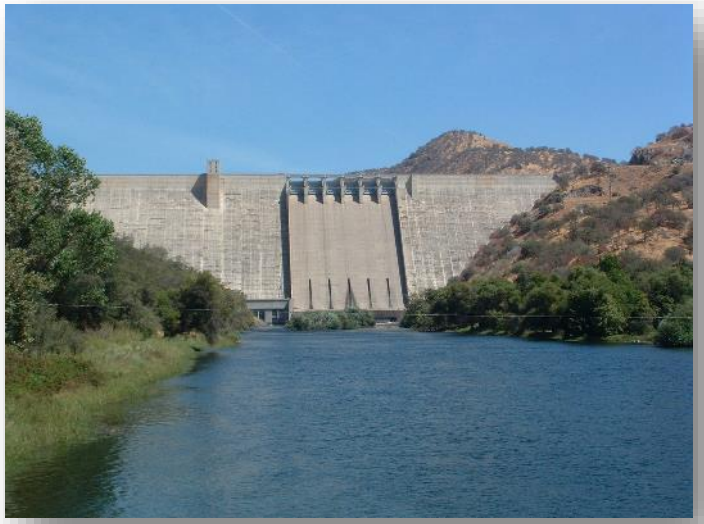






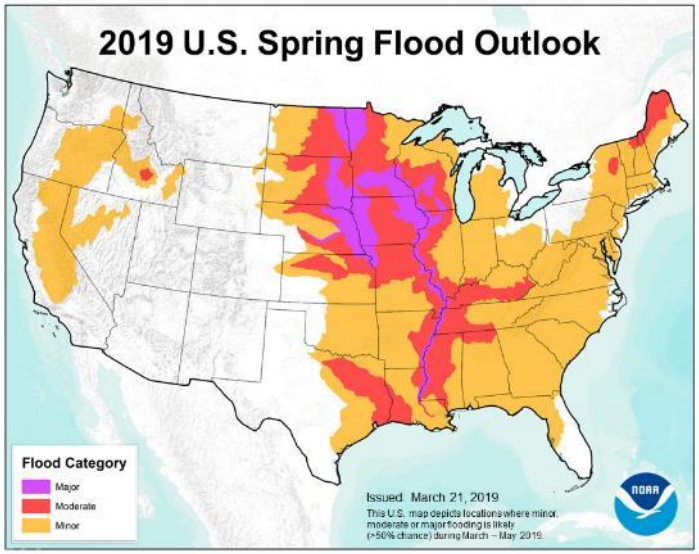
PINE FLAT DAM; KINGS RIVER, CA

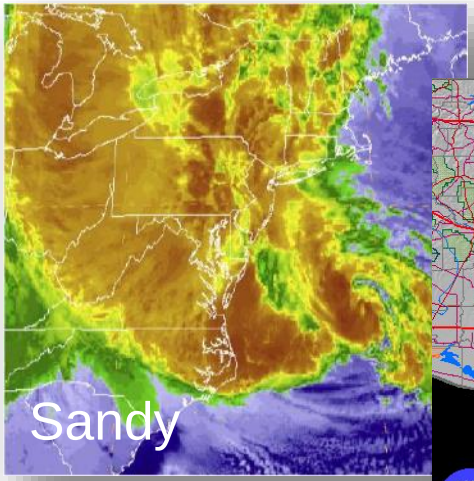




THE SAN JOAQUIN VALLEY, CALIFORNIA

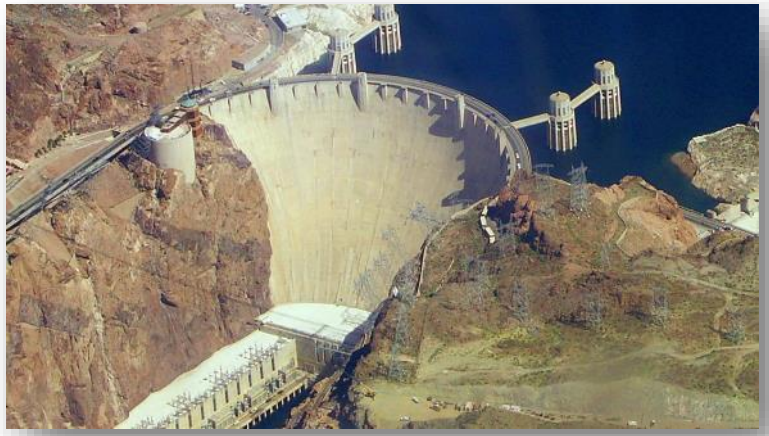
EVIDENCE SUPPORTING THE NEED FOR INNOVATION





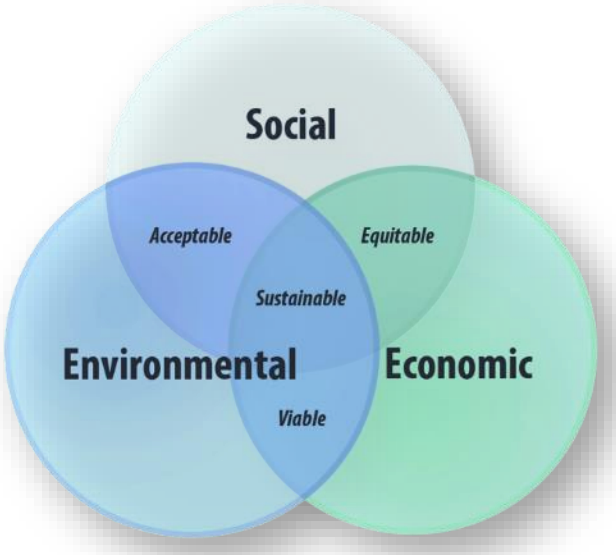
1900-2000: THE CENTURY OF INFRASTRUCTURE (US)

- 4,071,000 miles of roadway
  - 47,182 miles in the Interstate system
- 149,136 miles of mainline rail
- 640,000 miles of high-voltage transmission lines
- 614,387 bridges
- 90,580 dams
- 155,000 public drinking water systems
- 4,500 military installations
- 926 ports



SUSTAINABILITY

Sustainability is achieved by efficiently investing resources to create present and future value



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

And Many More!

www.engineeringwithnature.org

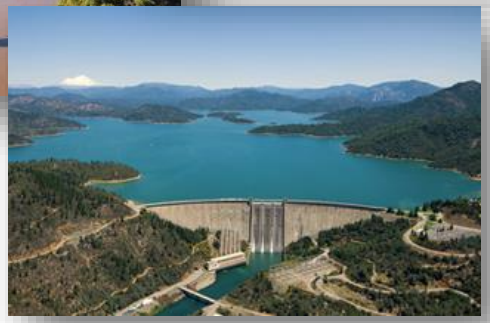
EWN® ACROSS USACE MISSION SPACE

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 FRM
- 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



EWN® OVERVIEW

Engineering With Nature® began in 2010

- Engaging across USACE, other agencies, NGOs, academia, private sector, international collaborators
- Guided by a strategic plan
- Established through Proving Grounds
  - Galveston, Buffalo, Philadelphia
- 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 PROVING GROUNDS

- Galveston District (2014)
- Buffalo District (2014)
- Philadelphia District (2016)

- Method
  - Identify opportunities to implement EWN across current and future programs and projects
  - Pursue opportunities through solution co-development

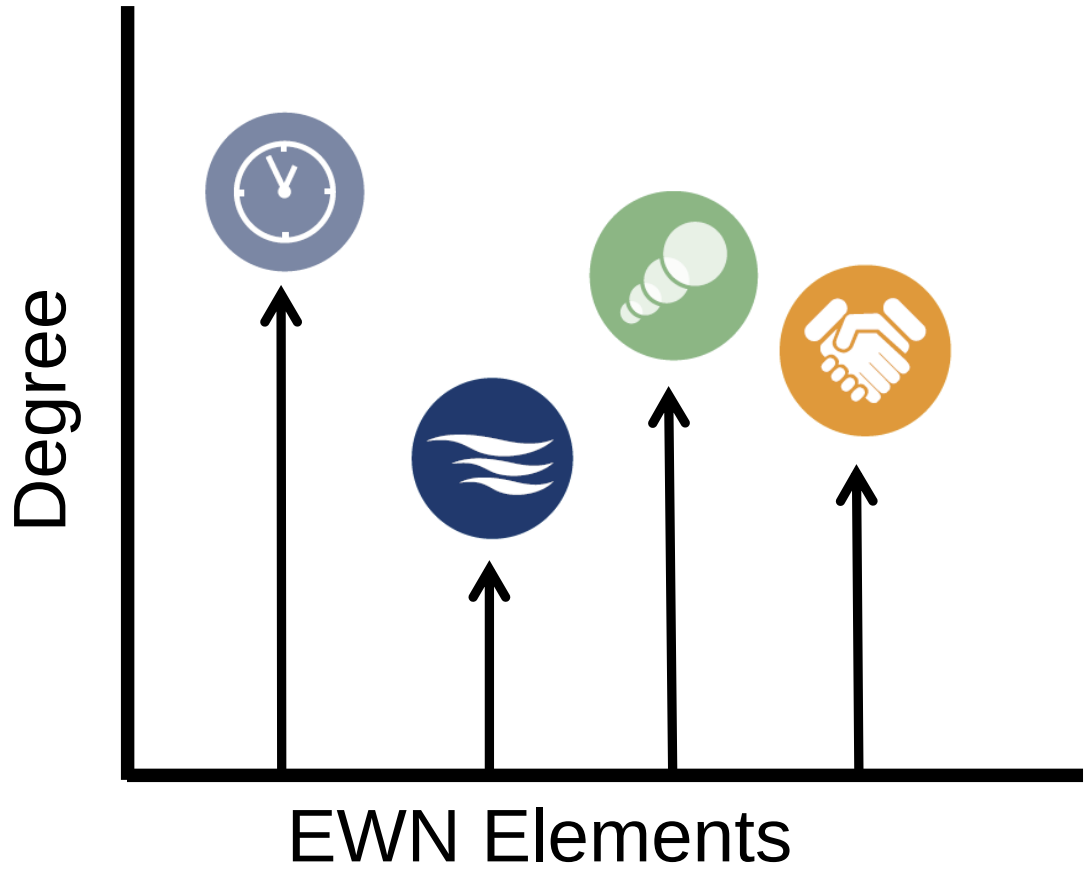
USACE ENGINEERING WITH NATURE® RECEIVES *Renewable Natural Resources Foundation* 2019 Award for Outstanding Achievement

- RNRF
  - Founded in 1972, 501(c)(3)
  - Mission: advancing science, application, and public education in managing and conserving renewable natural resources
  - Member organizations: ASCE, AGU, AMS, AWRA, ASLA, GSA, SETAC
  - BoD composed of reps of member organizations
  - 3 annual awards

www.rnrf.org

Engineering With Nature®

Elements



EWN Elements

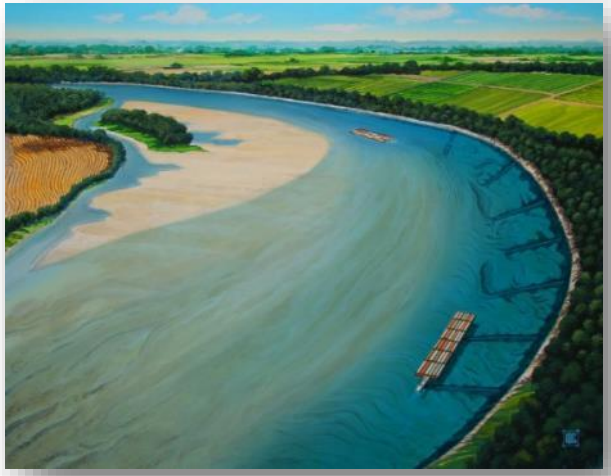
Four major elements are involved in applying EWN to develop infrastructure projects:

- 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

Combining Purposes to Create Value

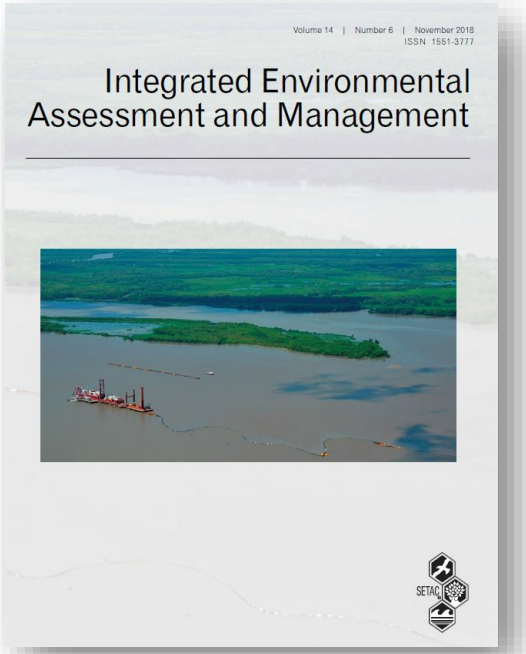
Upper Mississippi River Training Structures: Chevrons

Loosahatchie Bar, Memphis



River Bendway Weirs

HORSESHOE BEND ISLAND, ATCHAFALAYA RIVER



Quantifying Wildlife and Navigation Benefits of a Dredging Beneficial-Use Project in the Lower Atchafalaya River: A Demonstration of Engineering with Nature®

Christy M Foran,† Kelly A Burks-Copes,‡ Jacob Berkowitz,‡ Jeffrey Corbino,§ and Burton C Suedel‡*

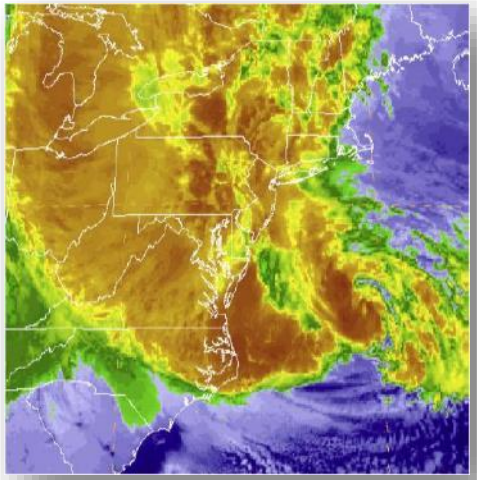
Project Awards:

- 2015 WEDA Award for Environmental Excellence
- 2017 WEDA Award for CC Adaption
- 2017 DPC Award for Working, Building, and Engineering with Nature

LEVERAGING NATURE FOR ENGINEERING VALUE

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

UNIVERSITY OF CALIFORNIA SANTA CRUZ · The Nature Conservancy · Wildlife Conservation Society

LLOYD'S TERCENTENARY RESEARCH FOUNDATION

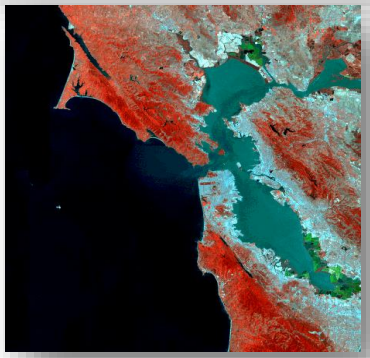
USACE PHILADELPHIA DISTRICT: EWN IN BACK BAY NEW JERSEY

Mordecai Island

Stone Harbor

Avalon

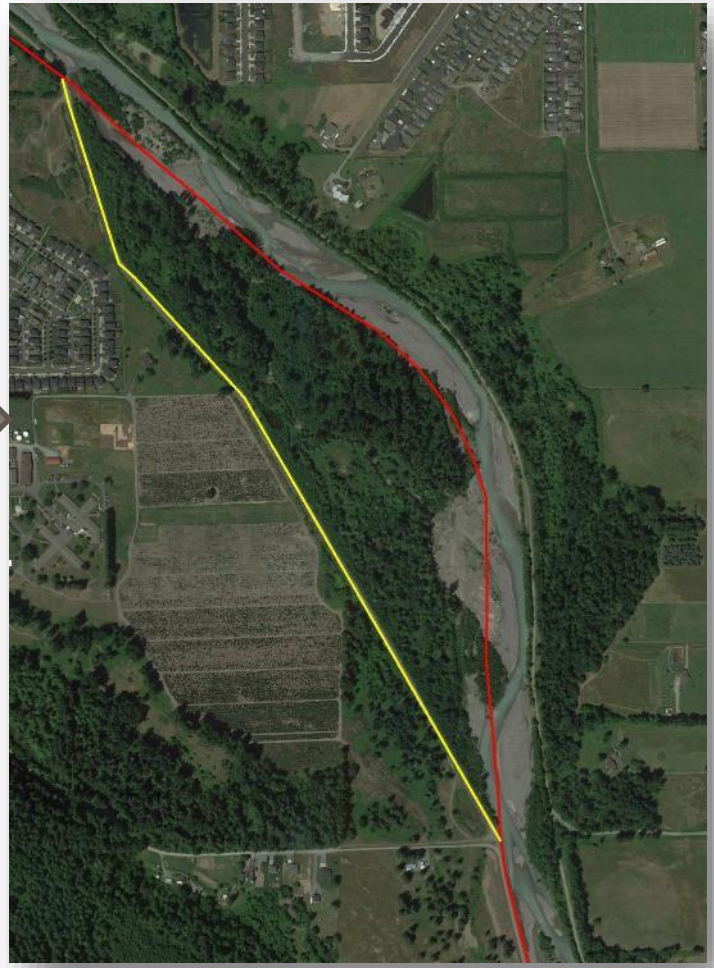
HAMILTON AND SEARS POINT WETLANDS SAN PABLO BAY, CA



SOLDIER'S HOME LEVEE SETBACK

April 2006

June 2016



HUMBER ESTUARY; ALKBOROUGH, UK (INCREASED FLOOD STORAGE CAPACITY)

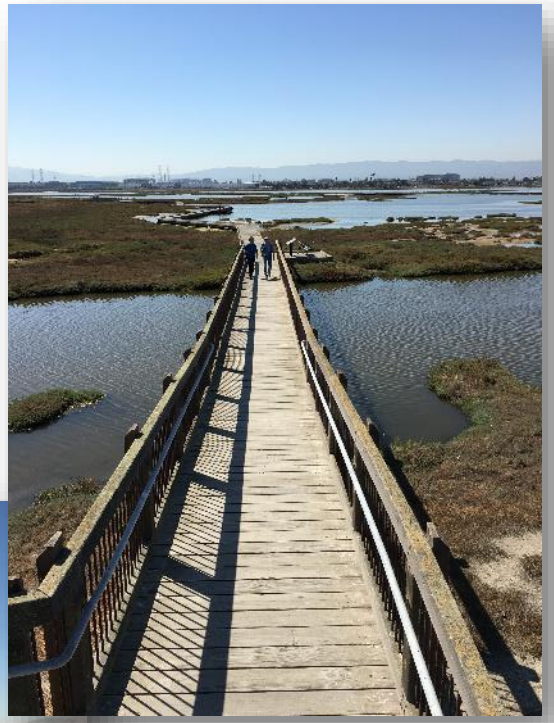
NOORDWAARD, THE NETHERLANDS

KRUIBEKE, SCHELDT RIVER BELGIUM

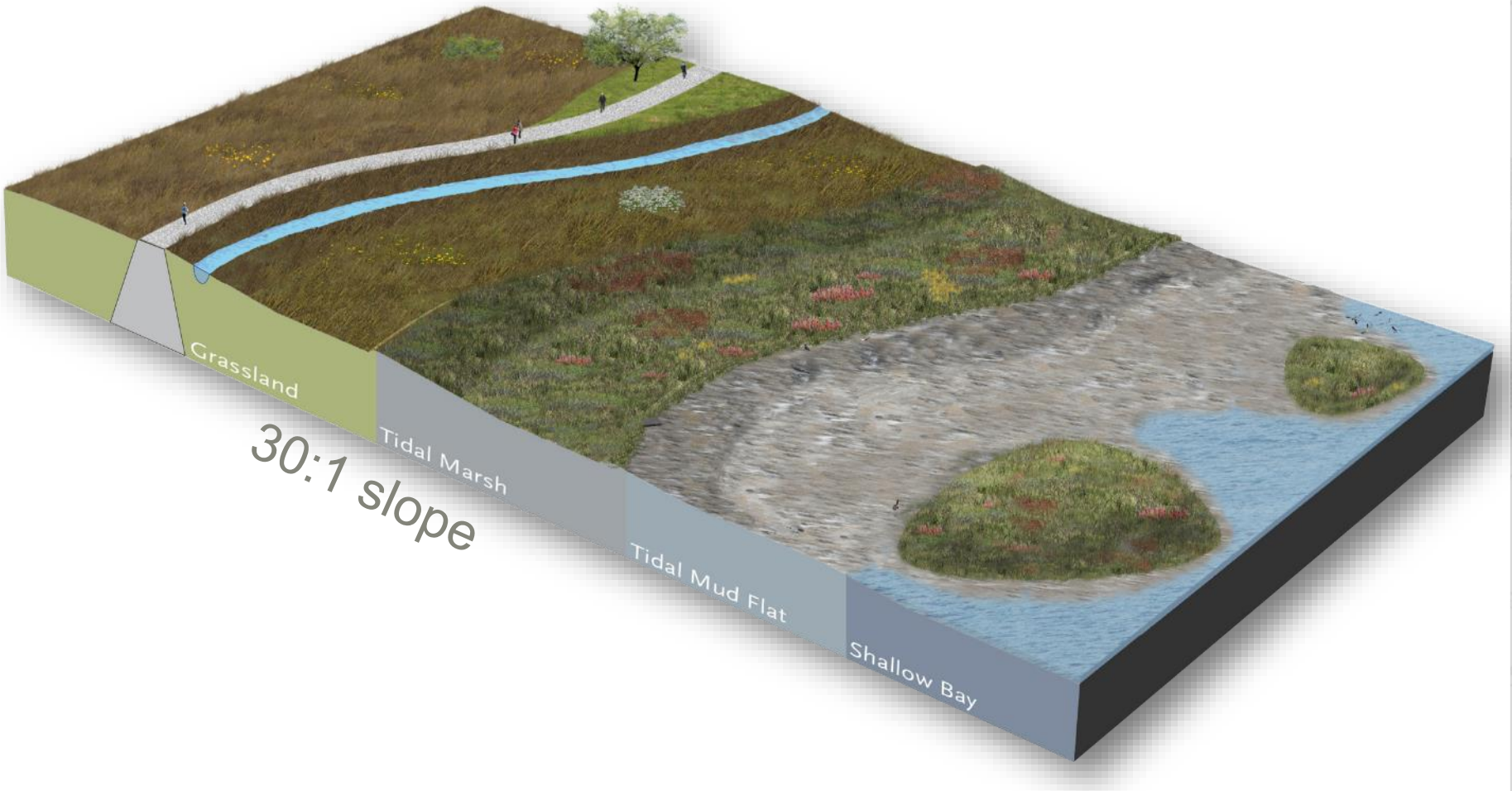
Dominiek Decleyre

US FISH AND WILDLIFE SERVICE: DON EDWARDS SAN FRANCISCO BAY NATIONAL WILDLIFE REFUGE

- Innovative 30:1 “horizontal levee” design to provide SLR adaptation
- Thin-layer Placement of sediment
- Strategic Placement of sediment
- Other opportunities

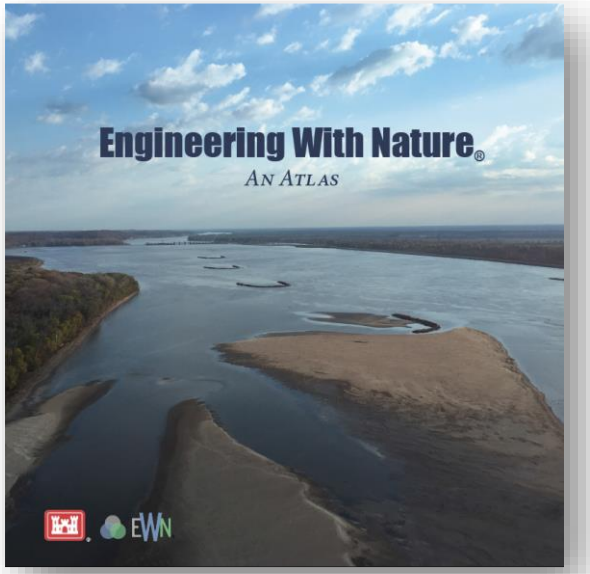


“HORIZONTAL LEVEE” CONCEPT



SYSTEMS: SABINE TO GALVESTON

EWN ATLAS LAUNCH EVENT



10:30-12:00
January 16, 2019
National Building Museum
Washington, D.C.

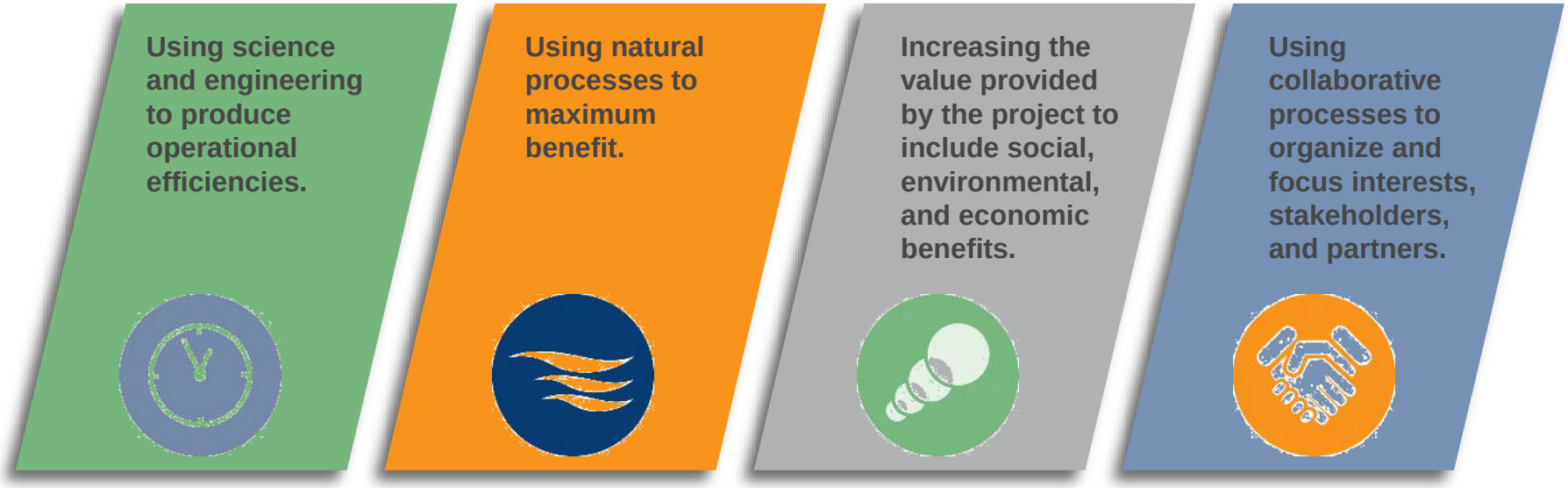
"Engineering With Nature is an important initiative for the U.S. Army Corps of Engineers." James Dalton, USACE Director Civil Works

www.engineeringwithnature.org

Call for Project Nominations
Engineering With Nature®: An Atlas – Volume 2

Publication Launch fall 2020!

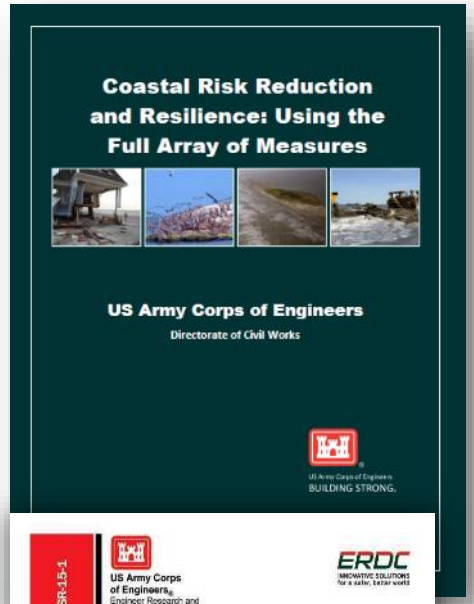
Evaluation Criteria

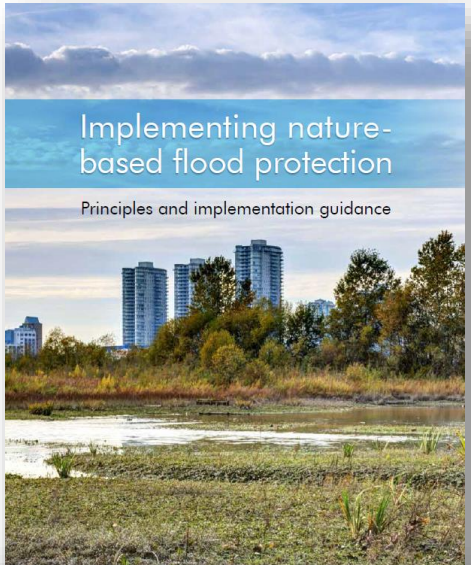


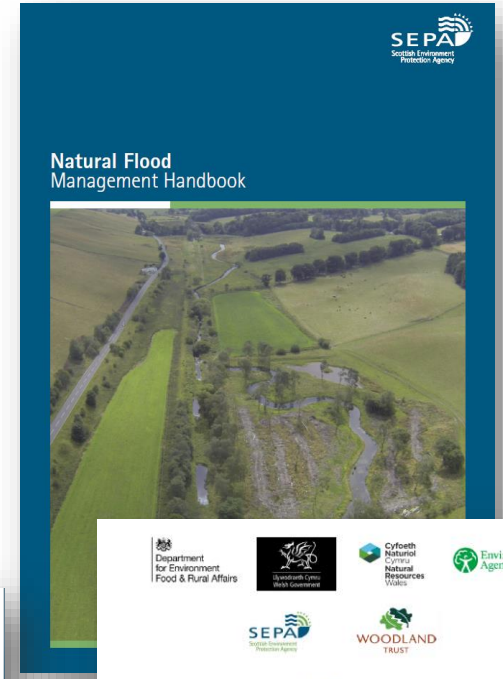
www.engineeringwithnature.org

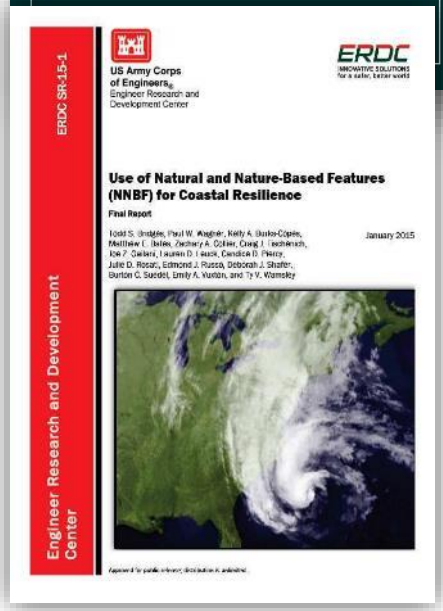
https://ewn.el.erdc.dren.mil/atlasv2.html

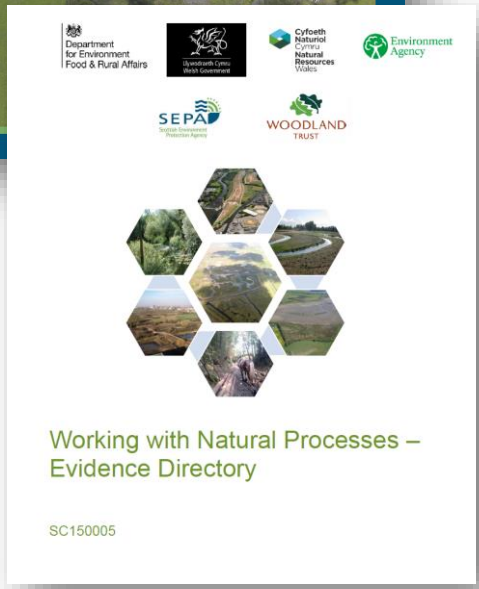
NATURE-BASED GUIDANCE, STANDARDS, EVIDENCE











www.engineeringwithnature.org

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

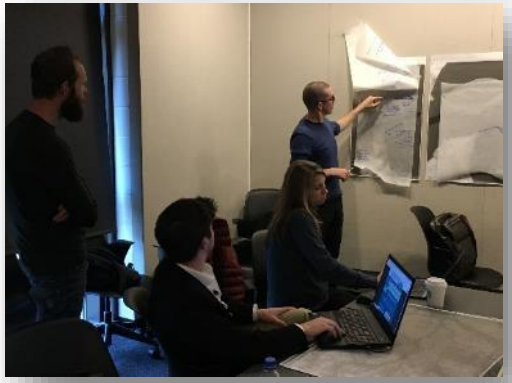
Purpose: Develop guidelines for using NNBF to provide engineering functions relevant to flood risk management while producing additional economic, environmental and social benefits.

- 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

INCORPORATING EWN/LA TECHNIQUES AND PRACTICES INTO USACE INFRASTRUCTURE

Work on USACE infrastructure pProjects with private/academic LAs

- Projects include:
  - Moses Lake Tide Gate Area (SWG);
  - Comite Canal Project (MVN);
  - Franklin Lock/Dam Recreation Area (SAJ);
  - Morehaven West Campground Site (SAJ);
  - Back Creek and Fishing Creek Jetties (NAB);
  - Proctor Creek (SAM); and
  - NEW: Sabine to Galveston (S2G) Project (SWG)
  - NEW: NJ Bay Bays Study (NAP)
- Team visits project sites and collects data
- EWN/LA Team met JAN 19 at Auburn to work on initial renderings
- Meetings w/ USACE Districts to discuss rendering beginning MAR 19
- Final report/renderings delivered to Districts JUL 19



Urban River Parkways

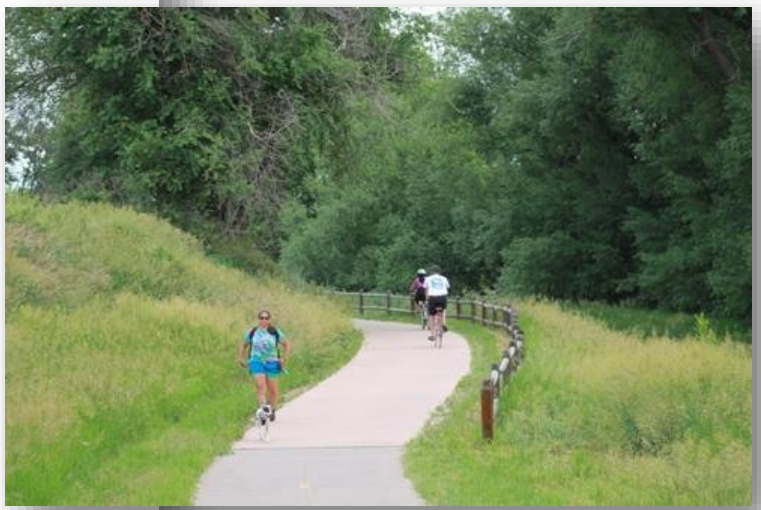
An Essential Tool for Public Health

Richard J. Jackson, MD, MPH - UCLA Fielding School of Public Health
Tyler D. Watson, MPH - UCLA Fielding School of Public Health
Andrew Tsiu, MPH - UCLA Fielding School of Public Health
Bianca Shulaker, MURP - USC Department of Urban Planning
Stephanie Hopp, MPH - Johns Hopkins School of Public Health
Mladen Popovic - UC Santa Barbara

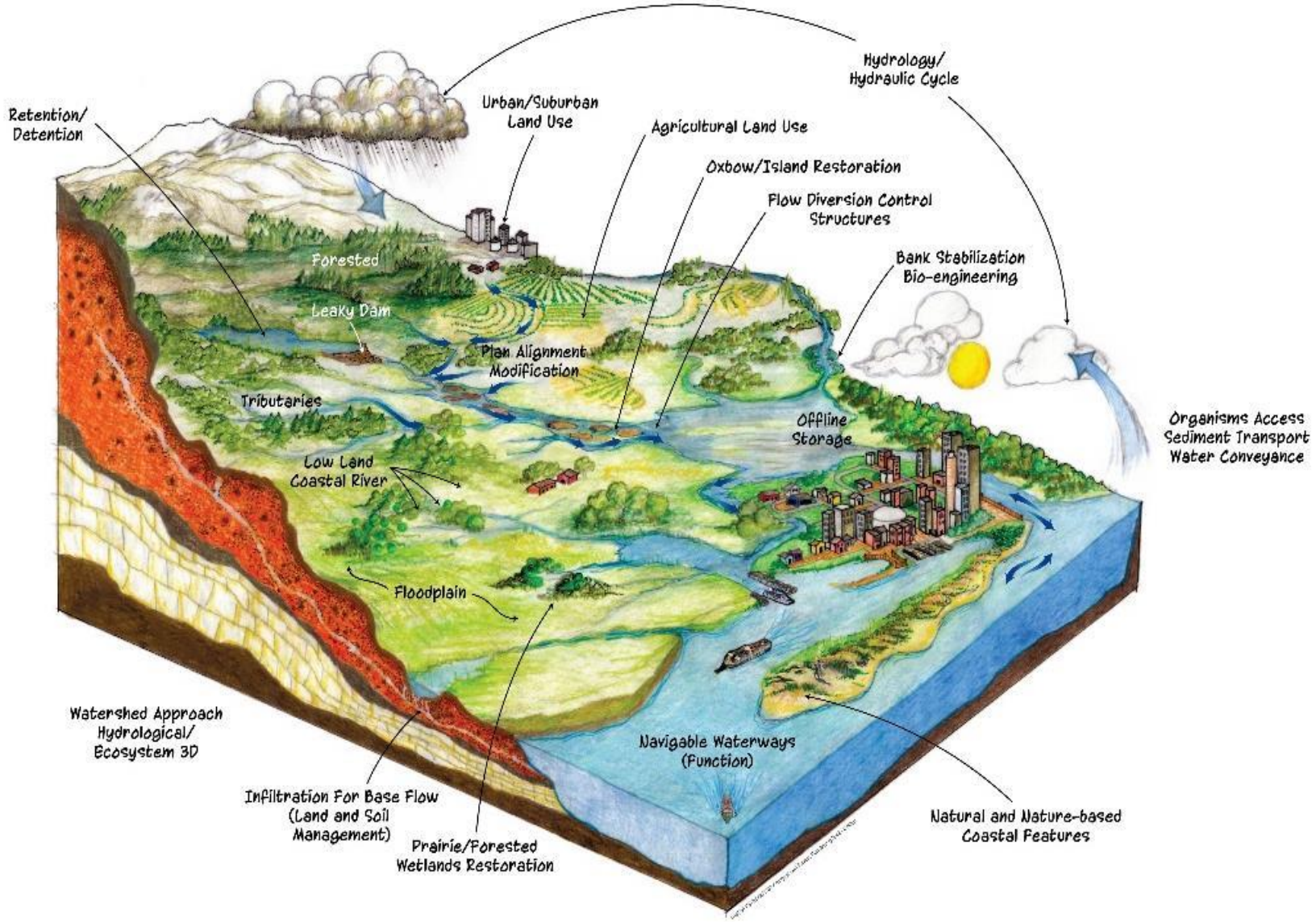
July 2014

Center for Occupational & Enviromental Health UCLA

Every $1 spent on rec trails results in $3 to >$10 of direct medical benefit

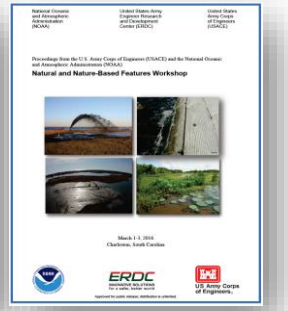


A SYSTEMS VIEW OF SOLUTIONS



COLLABORATION ACROSS GOVERNMENT

USACE/NOAA Collaboration Workshop: Natural and Nature-based Features, Charleston, SC; 1-3 March 2016



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

www.engineeringwithnature.org (NNBF)

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
- Western Dredging Association (WEDA)
  - Collaborative technical workshop on "Construction Methods Supporting Engineering With Nature"

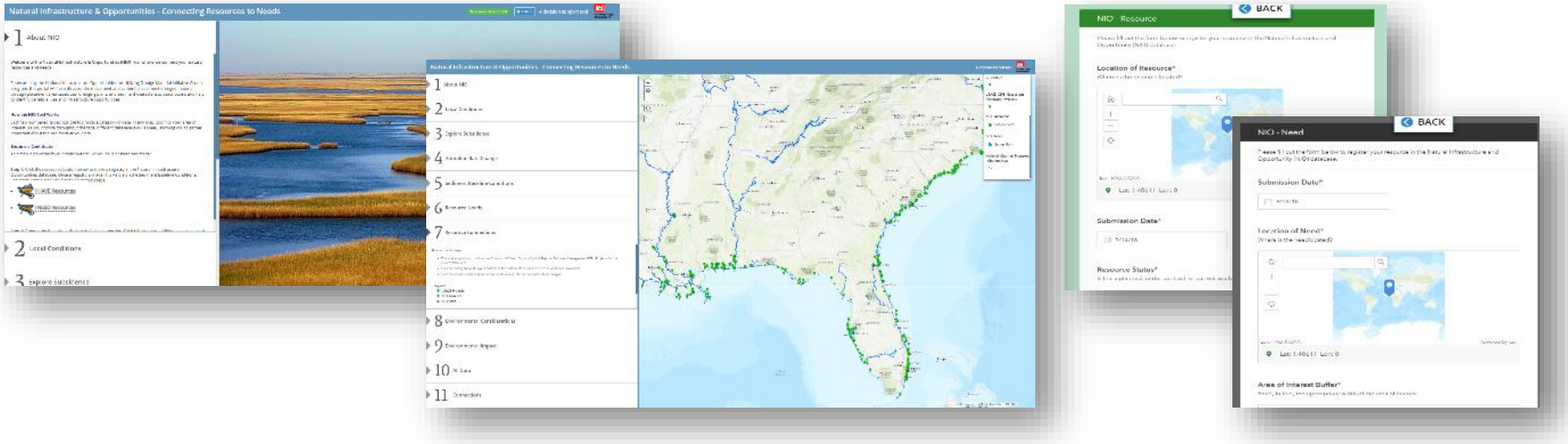
http://www.caterpillar.com/en/company/sustainability/natural-infrastructure.html

COLLABORATION WITH ACADEMIA

- Texas A&M University
  - Partnering through the Coastal Science and Engineering Collaborative (CSEC)
  - Joint research on NNBF
  - EWN Seminar spring 2018
  - Developing graduate curriculum to support EWN
- University of Georgia
  - Institute for Resilient Infrastructure Systems (IRIS
  - Multiple levels of collaboration on EWN and NNBF
  - EWN curriculum development
- University of Oklahoma
  - Water Security
  - Focus on mid-western and western landscapes and water resources
  - Streams, rivers, reservoirs and related infrastructure and purposes

NATURAL INFRASTRUCTURE OPPORTUNITIES TOOL

The public facing *Natural Infrastructure Opportunities Tool*, developed in collaboration with the Natural Infrastructure Initiative, focuses on identifying natural infrastructure and beneficial use opportunities. Through map based visualizations of environmental, geomorphic and sediment conditions, as well as upcoming USACE projects, and an interface for users to add their resource needs and resource availability, this portal will help discover natural infrastructure connections and inspire innovative opportunities.



Partners: CAT The Nature Conservancy DIG AECOM

https://ewn.el.erdc.dren.mil/tools.html

ENGINEERING WITH NATURE ON CAPITOL HILL

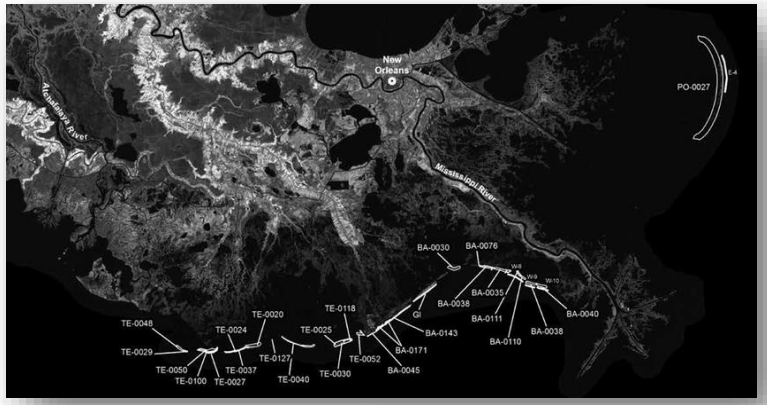
Engineering With Nature

US Army Corps of Engineers • Engineer Research and Development Center

BUILDING PROGRESS

Engineering With Nature

- There is tremendous potential to leverage natural systems and landscapes to build resilience.
- Project scale is critical and must match your goals.
  - “Go big or don’t bother.”
- Progress will be proportional to success of multi-organization collaboration and partnership.
- Field-scale piloting and demonstration are critical to progress.
- Affordability, affordability, affordability!
  - Don’t over-engineer!
- Document and communicate the value created.



STEPPING STONES

Engineering With Nature

1. Pursuing innovation while managing organizational risk.
2. Intervention based on “projection” of future need rather than “restoration” of past conditions.
3. Regulatory reform to incentivize positive action.
4. Partnering to achieve innovative financing of solutions.

“Satellite” Image of California, circa 1851
by Mark Clark

https://www.kcet.org/shows/lost-la/six-strange-maps-of-california