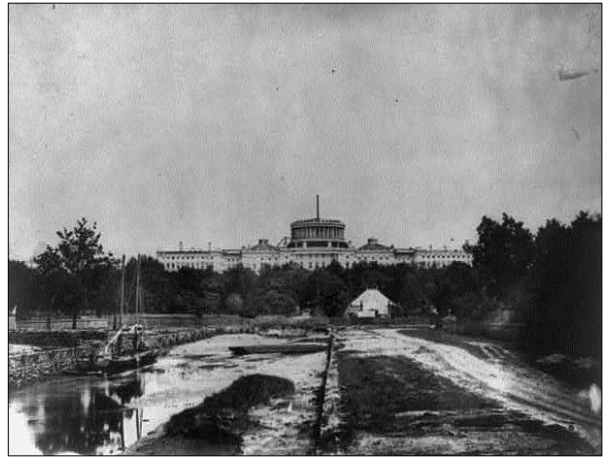


Make America's Swamps Great Again

An OpEd by Kevin G. Coulton, PE, CFM

The Trump Administration has announced an "America's Infrastructure First" policy that supports investments in pressing domestic infrastructure needs¹. While I understand and am supportive of the need to improve our nation's infrastructure, I am concerned that the new administration may end up draining more than just the "political swamp" to accomplish this goal and place new and rebuilt infrastructure at risk from natural disasters...especially flooding, the most costly natural disaster in America².

America was first made great because of our natural resources and, in part, by the draining of swamps (bogs, marshes and frequently flooded areas, collectively known as wetlands) to allow navigation, agriculture, transportation and land development to occur and our nation to prosper. In the early 1600s, the land area comprising the eventual United States had approximately 221 million acres of wetlands³; now only about half of these important resources remain⁴.



West front of Capitol, July 1860. Photo from [Library of Congress](#).

Ironically, we drained and filled swamps to build some of our first political infrastructure. In the early days of Washington, D.C. a flood-prone area below Capitol Hill was drained⁵, and the U.S. Army Corps of Engineers dredged the Potomac River in the 1870s, and used

¹ Trump Pence Make America Great Again, 2017. Infrastructure: Donald J. Trump's Vision <https://www.donaldjtrump.com/policies/an-americas-infrastructure-first-plan>

² National Flood Insurance Program, 2010. Flooding: Our Nation's Most Frequent and Costly Natural Disaster, March. <http://breathy.sd.gov/docs/Flooding.pdf>

³ Dahl, T.W., and G.J. Allord, Technical Aspects of Wetlands: History of Wetlands in the Conterminous United States, National Water Summary on Wetland Resources, United States Geological Survey Water Supply Paper 2425, <https://water.usgs.gov/nwsum/WSP2425/history.html>

⁴ Dahl, T.E., 2011. Status and Trends of Wetlands in the Conterminous United States 2004 to 2009, U.S. Department of the Interior, Fish & Wildlife Service Report to Congress, Washington, D.C. 108 pp. Page 37. <https://www.fws.gov/wetlands/Documents/Status-and-Trends-of-Wetlands-in-the-Conterminous-United-States-2004-to-2009.pdf>

⁵ Hawkins, D., 2014. "No, D.C. isn't really built on a swamp", The Washington Post, Aug. 29. https://www.washingtonpost.com/posteverything/wp/2014/08/29/no-dc-isnt-really-built-on-a-swamp/?utm_term=.c812bc038da7

dredged sediment to fill floodplain wetlands. Now portions of the National Mall⁶, including the Capitol Reflecting Pool, are located where natural swamps used to be.

This conversion of the natural to built environment is characteristic of our perception of “infrastructure,” i.e., over the eons, human society has attempted to dominate and control nature to survive, then subsist, and now hopefully flourish. As a practicing civil engineer I was taught to design infrastructure and for much of my career I associated this with the tangible concrete and steel projects built by engineers that we see around us. This definition of infrastructure is supported by the American Society of Civil Engineers—which I am a member—that publishes a Report Card for America’s Infrastructure every four years. With respect to flood control, the recently released 2017 report card grades the 90,580 dams and the 30,000 miles of levees in the U.S. with Ds, and estimated needed investments in excess of \$64 billion and \$80 billion, respectively ⁷.

USACE manages the federal dams and levees in the U.S., part of the nation’s water resources civil works infrastructure. In addition to annual appropriations to maintain these dams and levees, in recent years USACE has frequently requested supplemental appropriations from Congress to cover unanticipated costs incurred for flood-fighting activities and repairs to flood-control infrastructure. For example, from 1987 to 2014 Congress gave USACE \$32.2 billion in supplemental funding to augment its \$61.3 billion budget for the same period⁸. In other words, natural disasters—mainly flooding from hurricanes—have caused USACE to go 53 percent over their appropriated budgets during that 27-year period.



1965 Flood on the Walla Walla River in Oregon. Photo by USACE.

⁶ Histories of the National Mall, 2017. Histories of the National Mall, “Why do people say the National Mall is built on a swamp?” The Roy Rosenzweig Center for History and New Media and George Mason University. <http://mallhistory.org/explorations/show/was-the-national-mall-built-on>

⁷ American Society of Civil Engineers, 2017. 2017 Infrastructure Report Card, March 9. <http://www.infrastructurereportcard.org>

⁸ Stern, C.V. and N.T. Carter, 2014. Army Corps of Engineers: Water Resource Authorizations, Appropriations, and Activities, Congressional Research Service Report for Congress, R41243, Feb. 9. <https://fas.org/sqp/crs/misc/R41243.pdf>

The economic value of this infrastructure is declining⁹ because the costs to fix, operate and maintain what is on the ground is increasing to make these civil works...work. A review of USACE civil works budget requests from Fiscal Years 2003 through 2017 indicates construction budgets have been steadily declining while operation and maintenance budgets are on an uptick in recent years^{10, 11}. This O&M trend may be much higher because nonfederal local sponsors own much of this infrastructure after it is constructed and they are responsible for its upkeep¹².

The Federal Emergency Management Agency is the other primary federal agency focused on national flood issues. FEMA produces maps showing flood hazards for about 1 million of the 3.2 million stream miles in the nation¹³ and nearly all coastlines¹⁴, so people can purchase flood insurance. More than 5.2 million flood insurance policies are currently in effect with over \$1.2 trillion in insurance coverage¹⁵. However, flood losses in the U.S. reached an annual average of \$10 billion in the 2000s, a nearly five-fold increase from the early 1900s¹⁶. In 2016 alone, the



Coastal flood erosion at Pacifica, California. Photo by Kevin Coulton.

⁹ Calvert, R. 2012. The Urgent Need to Transform U.S. Water Resources Infrastructure: An Interview with Steve Stockton, Director of Civil Works, U.S. Army Corps of Engineers, Livebetter Magazine, Aug. 6. <http://livebettermagazine.com/article/the-urgent-need-to-transform-u-s-water-resources-infrastructure/>

¹⁰ Civil Works budget of the U.S. Army Corps of Engineers, annual fiscal year press books. <http://cdm16021.contentdm.oclc.org/cdm/ref/collection/p16021coll6/id/42>

¹¹ e RSM means historical cost index <https://www.rsmeansonline.com/References/CCI/3-Historical%20Cost%20Indexes/1-Historical%20Cost%20Indexes.PDF>

¹² National Research Council, 2016. Corps of Engineers Water Resources Infrastructure: Deterioration, Investment, or Divestment?, Committee on U.S. Army Corps of Engineers Water Resources Science, Engineering, and Planning, The National Academies Press, Washington, D.C. <https://www.nap.edu/catalog/13508/corps-of-engineers-water-resources-infrastructure-deterioration-investment-or-divestment>

¹³ National Academies of Sciences, Engineering, and Medicine. 2016. *Affordability of National Flood Insurance Program Premiums—Report 2*, Washington, DC: The National Academies Press. https://www.nap.edu/login.php?record_id=21848

¹⁴ Mark Crowell, Kevin Coulton, Cheryl Johnson, Jonathan Westcott, Doug Bellomo, Scott Edelman, and Emily Hirsch (2010) An Estimate of the U.S. Population Living in 100-Year Coastal Flood Hazard Areas. *Journal of Coastal Research*: Volume 26, Issue 2: pp. 201 – 211. <http://www.jcronline.org/doi/abs/10.2112/JCOASTRES-D-09-00076.1>

¹⁵ FEMA, 2016. National Flood Insurance Program, Policy & Claim Statistics for Flood Insurance: Statistics by Calendar Year, May 11. <https://www.fema.gov/statistics-calendar-year>

¹⁶ National Research Council. 2012. *Dam and Levee Safety and Community Resilience: A Vision for Future Practice*. Washington, DC: National Academies Press.

U.S. had more floods than any year on recent record¹⁷ and the resulting flood losses were approximately \$17 billion¹⁸. These loss trends will likely increase because America was first made great by building infrastructure on vulnerable coastlines and river floodplains¹⁹.



FEMA flood hazard mapping has significant limitations because it is based on existing conditions to establish actuarial rates for flood insurance and it does not include projected future conditions, and many maps are outdated. For example, the president himself owns a significant amount of coastal infrastructure and his Mar-a-Lago estate in Florida (seen at left) is located in a FEMA flood hazard zone that was established back in 1982²⁰. The National Oceanic and Atmospheric Administration has documented a rise in mean sea level of nearly a half foot in this area since the FEMA map was published 35 years ago²¹ and an accelerating rise in local sea levels, combined with

more frequent rain, high tide and storm surge events²², may lead to an increasing frequency of flooding for this region in the years to come.

¹⁷ Rice, D., 2017. U.S. had more floods in 2016 than any year on record, USA Today, Jan. 4.

<http://www.usatoday.com/story/weather/2017/01/04/floods-natural-disasters-2016/96120150/>

¹⁸ Corelogic, 2017. 2016 Natural Hazard Risk Summary & Analysis, January.

<http://corelogic.maps.arcgis.com/apps/MapSeries/index.html?appid=820b887bd1b245c59c0a49e8613219a1>

¹⁹Smith, A.B., 2017. 2016: A historic year for billion-dollar weather and climate disasters in U.S., Jan. 9.

<https://www.climate.gov/news-features/blogs/beyond-data/2016-historic-year-billion-dollar-weather-and-climate-disasters-us>

²⁰ FEMA, 1982, Flood Insurance Rate Map, Town of Palm Beach, Florida, Palm Beach County, Panel 3 of 5, Community Panel Number 120220 0003 C, Map Revised September 30. [The Mar-a-Lago estate is located in a FEMA Zone C (an area of minimal flood hazard, with ponding and local drainage problems)].

²¹ NOAA, 2013. Tides & Currents, Mean Sea Level Trend 8722670 Lake Worth Pier, Revised: Oct. 15.

https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8722670 [The mean sea level trend at a tide gage on the Lake Worth Pier, located about 4 miles due south of the estate].

²² Shimon Wdowinski, Ronald Bray, Ben P. Kirtman, Zhaohua Wu. 2016. Increasing flooding hazard in coastal communities due to rising sea level: Case study of Miami Beach, Florida. Ocean and Coastal Management. Volume 126, June 2016, Pages 1-8.

<http://www.sciencedirect.com/science/article/pii/S0964569116300278> [A 2016 study indicates the average regional rate of sea level rise in southeast Florida has increased to about 9 millimeters per year after 2006 based on data from a gage about 70 miles south of the estate].

In the early 1900s, Allen Hazen, one of America's first flood control experts, and a vice president of ASCE, wrote in 1930, "The increase in the amount of damage from floods has been occasioned more by the increased occupation of areas that are sometimes flooded than by any increase in the volume of flood flows."²³ An immense amount of infrastructure has since been built in the U.S. to control flooding, yet flood losses are increasing and the cost to simply maintain this infrastructure is also increasing, to protect what we have built in swamps and floodplains. Furthermore, the benefits of our flood control infrastructure may be diminishing as design assumptions from decades ago become invalidated by a changing climate.

From a pure business standpoint, it seems that the economic and societal value of these investments may be declining. The new president is a businessman and, as he says in his book, *The Art of the Deal*, he takes a very conservative approach and always anticipates the worst.²⁴ As he leads the nation to rebuild our infrastructure, I would encourage him to anticipate the worst and consider an approach to reduce flood risk through infrastructure spending that costs less to maintain and is more resilient to future flooding.

But how should we do that?

Again, from the president's book, "Sometimes your best investments are the ones you don't make."²⁵ I



Wetlands on Sauvie Island, Oregon. Photo by Kevin Coulton.

agree, and some of the best flood-risk reduction infrastructure is already available to us free of charge and involves working with the natural systems of forests, floodplains—and, yes, swamps—that have inherent natural abilities to slow the movement and reduce the force of water as it moves towards the infrastructure that we have traditionally valued.

We need to view nature as our business partner. Working with nature, instead of against it, will lead to built infrastructure that is more resilient to future flooding and other catastrophes. This mindset of natural, or

²³ Hazen, A., 1930. *Flood Flows: A Study of Frequencies and Magnitudes*, John Wiley & Sons, New York NY, 199 p, page 1.

²⁴ Trump, D.J., 1987. *Art of the Deal*, Ballantine Books, New York, NY, page 48.

²⁵ Trump, D.J., 1987. *Art of the Deal*, Ballantine Books, New York, NY, page 28.

green, infrastructure²⁶ is not a new concept and has been gaining interest, in large part due to the shortcomings of built infrastructure that we have been witnessing in recent decades.

For example, USACE is now considering natural infrastructure as a standard flood-risk management measure²⁷. The U.S. Senate recently passed the Water Infrastructure Improvements for the Nation Act,²⁸ which recommends the use of such nature-based infrastructure approaches in coastal areas for federally funded infrastructure projects. Section 1184 of the act defines a nature-based feature as, “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,” and requires these features to be considered for federal projects for flood-risk management, hurricane and storm damage reduction, and ecosystem restoration.” These concepts should be more widely employed. A 2016 study funded by a foundation of Lloyd’s of London estimated natural defenses provided by coastal wetlands along the northeastern U.S. resulted in more than \$625 million in avoided flood damage from Hurricane Sandy.²⁹ Legislation in California amended the state water code last year to recognize source watersheds as integral components of California’s water infrastructure, necessary to maintain the reliability, quantity, timing and quality of the state’s environmental, drinking and agricultural water supply.³⁰

As we improve our aging infrastructure, we have an opportunity to make these pending investments more resilient to flooding and economically viable by accommodating the natural functions of floodplains (peak flow reduction, flood storage, erosion control, water quality maintenance, groundwater recharge, etc.³¹)

²⁶ Benedict, Mark A. and McMahon, Edward T., 2006. Green Infrastructure: Linking Landscapes and Communities.

Washington, D.C., Island Press.

²⁷ Wagner, P.F., 2013. North Atlantic Coast Comprehensive Study, Reducing Risk & Building Resiliency following Hurricane Sandy – Natural and Nature-based Infrastructure, U.S. Army Corps of Engineers Institute for Water Resources, July 30.

<http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/GISJ.pdf>

²⁸ Water Infrastructure Improvements for the Nation Act, 2016. Section 1183(c)(2)(D) December 10.

<https://www.congress.gov/bill/114th-congress/senate-bill/612/text>

²⁹ Narayan, S., Beck, M.W., Wilson, P., Thomas, C., Guerrero, A., Shepard, C., Reguero, B.G., Franco, G., Ingram, C.J., Trespalacios, D. 2016. Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based Models to Assess Natural Defenses in the Northeastern USA. Lloyd’s Tercentenary Research Foundation, London, October.

https://www.lloyds.com/~media/files/lloyds/corporate%20responsibility/ltrf/coastal_wetlands_and_flood_damage_reduction.pdf

³⁰ Assembly Bill No. 2480, 2016. Chapter 695, Source watersheds, An act to add Section 108.5 to the Water Code, relating to water, Sept. 27.

http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB2480

³¹ The Task Force on the Natural and Beneficial Functions of the Floodplain, 2002. The Natural & Beneficial Functions of Floodplains: Reducing Flood Losses by Protecting and Restoring the Floodplain

instead of trying to control them. For example, where levees need to be rebuilt we should consider setting them back from the river to allow the natural functions of floodplains to work for us. The president has said, “we will protect our farmers,”³² and levee setbacks with floodplain land dedicated to farming could address this goal because much of the fertile soil in the U.S. is a result of...flooding. Farmland area in the U.S. has decreased about 21 percent from a peak in 1950³³ to 2012³⁴, while our population has essentially doubled over the same time period,^{35, 36} so accommodating this multi-purpose land use could also contribute to our national security³⁷.

Just over 20 years ago, devastating floods occurred in the Pacific Northwest where I live. I was involved in regional floodplain restoration planning efforts and had an opportunity to speak about my work to a group of retired military engineers, many of whom had spent their careers designing or operating the many dams and reservoirs in the Pacific Northwest. In my presentation I advocated for the conservation and restoration of floodplains as another way to reduce flood risk, and presented design concepts showing how the provision of floodplain storage could reduce downstream flood flows³⁸, but based on the expressions in the audience, it seemed that my words were falling on deaf ears. So I took a different tack and—catering

Environment, A report for Congress, June.

https://www.hud.gov/offices/cpd/environment/naturalfunct_flood_fema409.pdf

³² CSPAN, 2017. President Trump Remarks at Congressional Republican Retreat, Philadelphia PA, January 26. <https://www.c-span.org/video/?422829-1/president-trump-tells-congressional-republicans-now-deliver>

³³ USDA, 2007. Trends in U.S. Agriculture, Farms, Acres, and Average Size of Farm: 1900 - 1997, National Agricultural Statistics Service. https://www.nass.usda.gov/Publications/Trends_in_U.S._Agriculture/Farm_Numbers/farmnumberslandsize.csv

³⁴ USDA, 2012. 2012 Census of Agriculture - United States Data, Table 8. Land: 2012 and 2007, National Agricultural Statistics Service. https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1_Chapter_1_US/st99_1_008_008.pdf

³⁵ U.S. Census Bureau, 1950. Resident Population plus Armed Forces Overseas--Estimates by Age, Sex, and Race: July 1. (152,271,417 people in 1950). <http://www.census.gov/data/tables/time-series/demo/popest/pre-1980-national.html>

³⁶ U.S. Census Bureau, 2016. Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2015 (314,102,623 people in 2012). <http://www2.census.gov/programs-surveys/popest/tables/2010-2015/state/totals/nst-est2015-01.xlsx>

³⁷ Meyers, N. 1986. The Environmental Dimension to Security Issues. *The Environmentalist*. 6(4): 251-257; Liotta, P.H., et al. (eds.). 2007. Proceedings of the NATO Advanced Research Workshop on Environmental Change and Human Security: Recognizing and Acting on Hazard Impacts. Newport, Rhode Island, 4-7 June 2007. <http://link.springer.com/article/10.1007/BF02238056>

³⁸ Coulton, K.G., P. Goodwin, C.Perala, and M.G. Scott, 1996. An Evaluation of Flood Management Benefits through Floodplain Restoration on the Willamette River, Oregon, U.S.A., Philip Williams & Associates, Ltd., prepared for River Network, Portland, Oregon, February.

to my audience—said floodplains are simply “green” reservoirs, in that one of their primary natural functions is to store and slow the flow of floodwaters similar to the infrastructure that they designed during their careers. The audience became more receptive.



Coulton “Floodplains are “Green” Reservoirs” slogan proposal.

Related research over the years by others has confirmed the flood reduction benefits of natural floodplain infrastructure³⁹, with a recent study demonstrating floodplain wetlands can serve as a natural solution for flood reduction under future climate change scenarios^{40, 41}. ASCE should begin to also grade the condition of our nation’s floodplains and their natural ability to store and convey floodwaters to reduce flood risk.

As a practicing civil engineer, and former city planning commissioner, I understand the human desire to build things, and flat floodplain lands have been tempting to drain and develop to increase the tax base of a community and the economic vitality of the nation. However, this economic boost is then plagued in perpetuity with the uncertainty of the timing and magnitude of the next flood event that will inevitably occur and threaten infrastructure that was built in harm’s way.

According to ASCE, the nation’s aging roadways, bridges, ports, water systems and other critical infrastructure will require \$4.6 trillion to fix by 2025⁴². While we intuitively understand the economic benefits of a road or a bridge, and that the concrete and steel for this infrastructure comes from our natural resources, what about the economic benefit of a swamp? Increasing efforts are being made to value the benefits we derive from ecosystem services (water supply, natural waste treatment, habitat, food

³⁹ U.S. EPA, 2006. Wetlands: Protecting Life and Property from Flooding, EPA843-F-06-001, Office of Water, May. <https://www.epa.gov/sites/production/files/2016-02/documents/flooding.pdf>

⁴⁰ Walters, K.M. and M. Babbar-Sebens, 2016. “Using climate change scenarios to evaluate future effectiveness of potential wetlands in mitigating high flows in a Midwestern U.S. watershed”, Ecological engineering, 89, February 7, pgs 80-102.
<http://www.sciencedirect.com/science/article/pii/S0925857416300143>

⁴¹ Civil Engineering, 2016. *Civil Engineering News: Study says Restoring Wetlands in the Midwest Could Reduce Flooding*, The Magazine of the American Society of Civil Engineering, May, page 24.

⁴² American Society of Civil Engineers, 2017. 2017 Infrastructure Report Card: Economic Impact, March 9. <http://www.infrastructurereportcard.org/the-impact/economic-impact/>

production, etc.)⁴³. With an estimated 20 million acres of floodplain area in the U.S.⁴⁴ and a potential value of \$10,000 per acre per year in ecosystem services provided by swamps and floodplains,⁴⁵ we may have \$200 billion per year in natural infrastructure available to help us reduce America's flood risk...while making America's swamps great again.

Kevin Coulton, a consulting water resources engineer and CFM with an academic background in civil engineering and landscape architecture, can be reached at kevin.coulton@gmail.com or (971) 322-8043.

*Published in the Association of State Floodplain Managers "What's New" section on January 11, 2018
<https://www.floods.org/n-news-hottopics/article.asp?id=528>*

⁴³ Earth Economics, 2016. The Ecosystem Valuation Toolkit. <http://esvaluation.org/>

⁴⁴ Tockner, K, and J.A. Stanford, 2002. Review of: Riverine flood plains: present state and future trends, Biological Sciences Faculty Publications, Paper 166, University of Montana.
http://scholarworks.umt.edu/biosci_pubs/166

⁴⁵ Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S. J. Anderson, I. Kubiszewski, S. Farber, and R. K. Turner, 2014. Changes in the global value of ecosystem services, Global Environmental Change 26, pages 152–158. <http://www.sciencedirect.com/science/article/pii/S0959378014000685>