



2016 WODA Environmental Excellence Awards

Project Nomination

Prime Hook National Wildlife Refuge – Marsh Habitat Restoration
Milton, Delaware

Submission Category

Environmental Dredging

Submitting Firm

Atkins

April 15, 2016

Summary

Located 22 miles southeast of Dover, Delaware, Prime Hook National Wildlife Refuge (NWR) and its adjacent water bodies are important natural features along the western shore of Delaware Bay and throughout the region. The refuge was officially established in 1963 by the U.S. Fish & Wildlife Service (USFWS) as an inviolate sanctuary for migratory birds. Both the Refuge and its adjacent water bodies are an important natural feature along western Delaware Bay, and throughout the region. It is also home to many threatened and endangered species.

Before active management, the Refuge was a salt and brackish marsh habitat, and in the early 1980s, it was diked and managed into four freshwater impoundments that cover 10,144 acres. Over the past decade, a number of storm events, including hurricanes Irene (2011) and Sandy (2012), have caused flooding and erosion as well as the opening of several breaches between the Refuge and Delaware Bay, inundating portions with significant amounts of salt-water from tidal exchange.

The result of these events was a loss of substrate, vegetation die-off, and a transition from a freshwater vegetated habitat to a saltwater estuarine system with limited vegetative regeneration. Tidal inundation and subsequent loss of vegetation has created large swathes of open water where there used to be marsh and vegetation, reducing the available habitat for a number of migratory bird species that use the Refuge as a stopover point along the Atlantic Flyway. Additionally, higher water levels at the inland edge of the marsh have accelerated flooding and salt incursions in the active farmlands bordering the Refuge.

Due to the altered habitat and in the face of climate change and rising sea levels, USFWS decided that instead of trying to repair and maintain the artificial freshwater habitat, the best solution would be to restore and manage the system as a salt/brackish marsh, as it existed before disruption. This solution would provide effective, sustainable habitat for local aquatic species as well as local and migratory birds. The Prime Hook NWR project was implemented to restore the barrier island separating the bay from the marsh closing the breaches and circulation within the Refuge and restoring it to pre-impoundment conditions.

Ultimately, the project's goals were to:

- Limit the magnitude of saltwater flooding of the Refuge by closing the breached barrier island.
- Return internal circulation to pre-impoundment condition by restoring/creating a network of interior channels based on historical flow pathways.
- Allow saltwater exchange from Delaware Bay through inlets and channels north and south of the Refuge to encourage the growth and maintenance of a salt and brackish marsh habitat.

Project Team Members

Tidal Marsh Restoration - Conveyance Channels

U.S. Fish & Wildlife Service (USFWS)

Delaware Department of Natural Resources & Environmental Control - Division of Fish & Wildlife (DNREC)

Delaware Department of Transportation (Del-DOT)

Atkins

Stantec

AMEC-Foster Wheeler

Dredge America

EA-Engineering, Science & Technology

Tidal Marsh Restoration - Beach Restoration

U.S. Fish & Wildlife Service (USFWS)

Delaware Department of Natural Resources & Environmental Control - Division of Fish & Wildlife (DNREC)

U.S. Army Corps of Engineers (USACE)

Atkins

Gahagan & Bryant Associates

Norfolk Dredging Co.

Environmental Benefits

The overall plan for the Prime Hook NWR is to restore natural water flow and to increase resiliency of the marsh and adjacent beaches during coastal storms. Water levels within the four impoundments (units) had been artificially managed for the last 30 years to create a combination of saltwater and freshwater marshes. During the 1980s, Units II and III were converted to freshwater marshes to provide a more varied waterfowl habitat. However, saltwater from the bay overwhelmed the freshwater in Unit II and partially displaced freshwater in Unit III. To date, Unit I, (northern most impoundment) and Unit IV (southernmost impoundment) are thriving as salt marshes.

Restoring and maintaining the freshwater marshes being an unsustainable option, the breaches were filled in and 1 mile of the shoreline was restored to rebuild the marsh behind the beach reverting the open water to a viable salt marsh. After breach closure, brackish to salt conditions will persist within the Refuge via exchange through inlets to the north and south and storm surge levels will be reduced up to 1.7 feet (30 percent) when compared to existing measured data. Predicted habitat types, based on modeled water level and salinity ranges, align favorably with historical aerial vegetation mapping collected and analyzed before diking and impoundment.

Environmental Benefits (continued)

Two critical factors for the project were salinity and water flow for the revitalization of the marsh. The addition of the design conveyance channels significantly increases the volume of salt water distributed throughout the Refuge, as compared to a closed breach and no conveyance channels. These channels are largely based on existing flow pathways and historical channels that existed pre-impoundment.

Innovation

After a decade of encroachment from Delaware Bay, and the resulting environmental damage from salt intrusion into an artificial freshwater habitat, USFWS determined that the sustainable solution would be to allow the marsh to revert to a salt and brackish system, as it was before impoundment. Atkins engineers and scientists helped address the necessary repairs and identified steps necessary to make that possible. A hydrodynamic and numerical model of the Refuge and adjacent bay region was created using Delft3D, chosen for its ability to account for the effects of tides, wind, waves, and fresh and salt water mixing. The model was driven by tidal, riverine, and wind forces for both operational (“normal”) conditions and for conditions during Hurricane Sandy, for which a wealth of measured data was available within the Refuge for model verification.

In addition, the domain decomposition feature allowed the use of widely varying grid spacing with more abrupt transitions in resolution not possible with typical finite-element models. This enabled the model to have a very fine (10 meter) spatial resolution in the Refuge, but quickly transition to a much coarser grid in the bay and beyond, minimizing total computation time and output file size while maximizing detail in the Refuge, the area of interest. Domain decomposition also facilitated fitting the irregular boundaries of the domain within the geometric restrictions of a curvilinear-type mesh. The model framework was designed to test a number of potential restoration alternatives under normal and extreme conditions. With assistance from USFWS and Atkins scientists, the model results were used to identify the scenarios which maximized conditions favorable for saltmarsh habitat restoration and growth.

The results of the modeling effort were used in conjunction with the coastal engineering analysis to recommend a preferred alternative for modifying and managing the Refuge under the new environmental regime post-Sandy.

Two dredging projects are associated with the \$38 million effort to help restore Prime Hook Refuge to a functioning saltwater habitat. They were implemented concurrently with cooperation across multiple State and Federal agencies dating back to 2010. The Dune Construction Phase of the project is complete and the Conveyance Channel Creation Phase of the project is currently underway scheduled for completion July 2016.

Innovation (continued)

The Dune Construction Phase was a critical element to habitat restoration, repairing breaches cut by storm events which altered water flow and salinity levels in the Refuge. A total of 1.6 million cubic yards of sand was placed along 8,400 feet of shoreline. Under contract with the U.S. Army Corps of Engineers, Norfolk Dredging performed the \$16 million dredging event with the 24" CSD "*Charleston*". Construction of the beach restoration phase occurred from October 2015 – February 2016.

The Conveyance Channel Creation Phase of the project was implemented to facilitate the circulation of water throughout the system. Designs were created to promote healthy salinity levels and proper flushing throughout the various "zones" within the system as a whole. This phase of the project calls for the creation of 112,392 linear feet of conveyance channels throughout the Refuge. It is a project design balancing science and engineering inputs with constructability parameters to yield channel templates that could not only function properly, but also be constructed without extraordinary equipment requirements. Dredge America under subcontract to AMEC Foster-Wheeler will conduct this \$15 million conveyance event. The work is being performed with three (3) Ellicott 12" swinging ladder CSD dredges, operating in a side-cast configuration. Dredging began August 2015 and is scheduled for completion July 2016. The work will conclude with a series of modeling efforts to compare the as-built dimensions of the work to the original design so that refuge managers can plan their management strategies for the various habitat zones accordingly.

Economic Benefits

As one of the largest marsh/beach restoration projects in the eastern U.S., the restoration plan was designed to attract wildlife, encourage new marsh vegetation, and jump-start the natural process so that vegetation is re-established in areas where there previously was significant degradation. The refuge is an important stopover site for migratory birds as they travel up and down the Atlantic Flyway and provides protected breeding habitat for federally and State-listed threatened and endangered species, as well as many neo-tropical migrating bird species. The marsh's restoration will also sustain significant public activities at the Refuge, such as hunting, fishing, wildlife observation, photography, environmental education, lecture programs, and environmental interpretation.

Transferability

Prime Hook's restoration is a model solution to coastal erosion due to climate change for all areas along the United States' coastlines. It's a template for habitat restoration and flood-proofing cities of coastal developments in the face of sea-level rise, incorporating sustainable design into natural and manmade features. The implementation of conveyance channels into the design is a "next step" approach to basic marsh-fill approaches that may provide resource benefits to recent re-nourishment projects along the Gulf coast.

Education & Outreach

With heavy support from state officials, the Prime Hook Marsh Habitat Restoration project was covered in local media outlets with a regular frequency. Public inquiries were directed through the public relations departments of USFWS or USACE and regular updates were posted to the USFWS website. A simple internet search on the project yield dozens of reports on the current happenings of the work during the 6-year lifecycle. Project stakeholders were engaged early in the process through the use of regularly scheduled "Town Hall" meetings that were held to inform interested parties about project updates and garner feedback and local knowledge for incorporation into the design and planning of the work. Members of the engineering and design team have submitted papers and presented on various aspects of the project at the following conferences:

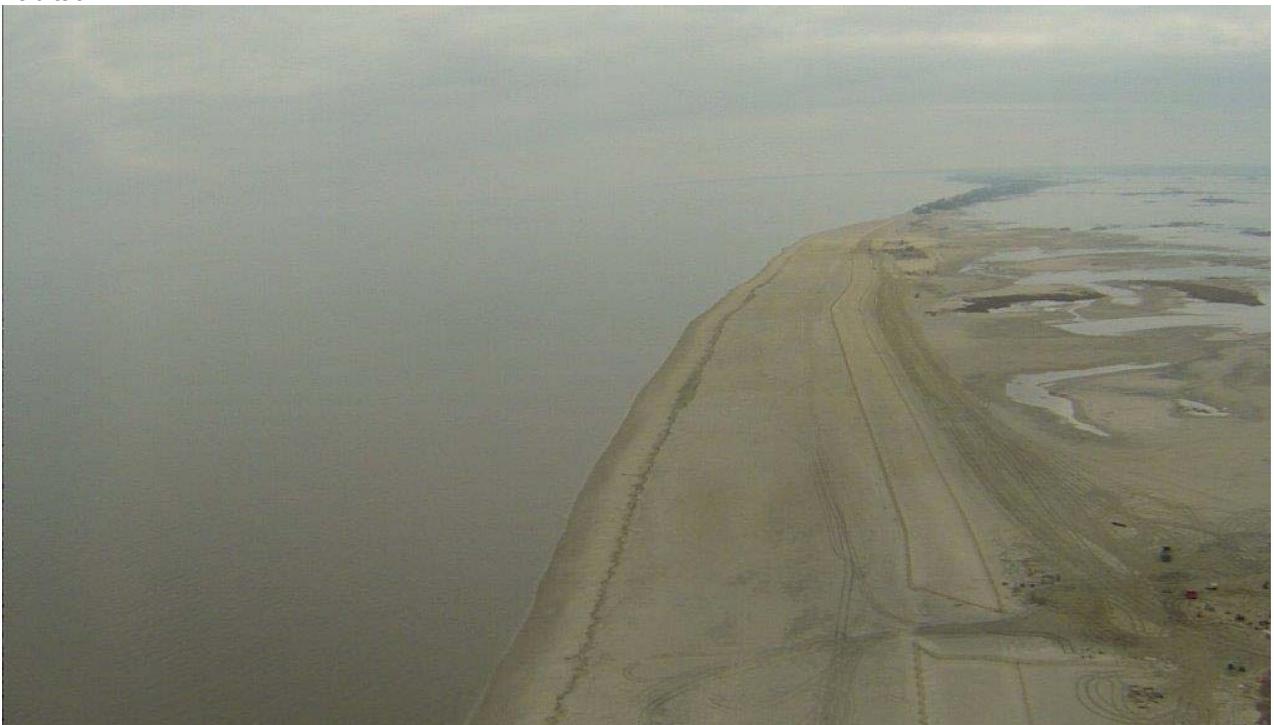
- Todd DeMunda – Northeast Shore and Beach Preservation Association, September 2013
- Susan Guiteras – Delaware Wetlands Conference 2014, January 2014
- Todd DeMunda – Delaware Wetlands Conference 2014, January 2014
- Todd DeMunda – National Summit on Coastal and Estuarine Restoration, November 2014

Project Photograph

An aerial view shows the breaches of the shoreline allowing bay water to enter the refuge



This is a post-construction view of the reconstructed shoreline which will allow for the rehabilitation of marsh habitat.



Project Photograph

The photo below shows a dredger in the Refuge excavating within one of the design channels and sidecasting dredge material to elevate areas for marshland recovery. Water elevations elevated during construction to facilitate vessel draft.



This photo is a good representation of a functioning conveyance channel at the Refuge. Higher marshland is on the sides and wooded upland can be seen in the background.



For additional questions contact

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