Delaware Coastal Zone Act

Sea Level Rise and Coastal Storms Plan Development

Recommended Guidance for Development of Sea Level Rise and Coastal Storms Plans for Coastal Zone Conversion Permit Applications

DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

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Background

The 2017 Coastal Zone Conversion Permit Act requires the issuance of a Coastal Zone Act (CZA) conversion permit to facilitate the reuse of 14 grandfathered sites within Delaware's Coastal Zone. The Act also required the Delaware Department of Natural Resources and Environmental Control (DNREC) to develop regulations for issuing CZA conversion permits. Recommendations on what to include in the 2019 regulations came from a report by the Regulatory Advisory Committee, composed of various stakeholder groups. One of the DNREC requirements for each conversion permit application is to develop a Sea Level Rise and Coastal Storms Plan (SLRCSP) and for that plan to be updated every 10 years. Refer to the "Regulations Governing Delaware's Coastal Zone" (7 DE Admin. Code 101) for the minimum specific requirements of SLRCSPs.

Applicants, professional geologists (PGs) and professional engineers (PEs) are advised to engage with DNREC as early as possible to increase the efficiency of conversion permit application reviews. The SLRCSP must be complete as part of a final application submission to the CZA Program and will be reviewed for sufficiency prior to deeming an application administratively complete. The regulatory review timeline does not begin until after an application has been deemed administratively complete by the DNREC Secretary. Administratively complete applications are published online for the purpose of soliciting public comment and are incorporated into the official public record at the mandatory public hearing. Substantive changes to the SLRCSP after the application has been made publicly available may result in the need to resubmit application materials, as well as restart the public comment period and reschedule the public hearing.

Development Approach

The approach below addresses the impacts on all sites due to coastal storms and sea level rise. An additional section addresses the impacts of compound flooding due to sea level rise and coastal storms.

The sites are exposed to the threat of coastal storm impacts, including storm surge, waves, currents and wind loads on submerged and emergent structures. The impacts of storm surge and waves will be exacerbated by sea level rise.

This document details a recommended standard methodology for developing SLRCSPs to ensure all regulatory requirements are addressed to the satisfaction of the CZA Program for the 14 conversion sites located in the following areas:

1) Claymont: 4 sites
2) Wilmington: 3 sites
3) Delaware City: 6 sites
4) Kent County: 1 site

The SLRCSP should be prepared by a PG or PE and contain the following assumptions and information:

- Design life of at least 30 years from a sea level rise standpoint

- A topographic map identifying the following:

Site grounds	Areas that must be remediated
Operations facilities	Route of ingress and egress
Infrastructure (including shoreline docks, piers)	Boundary of the footprint of the heavy use industry site
Pipelines	Cut and fill areas

- Maps of the following floodplains:
  - 1% Annual Exceedance Probability (AEP) floodplain according to the Flood Insurance Rate Map (FIRM) from the Federal Emergency Management Agency (FEMA)
  - 0.2% AEP floodplain according to the FIRM from FEMA
  - Inundation area resulting from the High Sea Level Rise scenario, as described in the technical report titled, "Recommendation of Sea-Level Rise Planning Scenarios for Delaware" (November 2017)
  - Combined 1% AEP and High Sea Level Rise scenario floodplain
- Demonstration of the structural integrity of critical assets that can cause pollution
- Details on erosion control measures
- Details of designs to withstand wind, wave and current loads due to 95 MPH winds
- Downstream and upstream erosion and floodplain impacts due to the development

An applicant checklist for the development of a SLRCSP is provided in Appendix A.

Recommended Data Sources

The following data sources are typically used to achieve the objectives for the SLRCSP:

1) The latest FEMA Risk Mapping, Assessment and Planning (Risk MAP) study data, including:
   a. Digital Elevation Model (DEM)
   b. Coastal hydrodynamic and wave models
   c. Set of events used to validate the models
   d. Set of events used to develop floodplain statistics, including floodplain extents, elevations and depths.

The Risk MAP study data can be obtained by submitting a Flood Insurance Study (FIS) Data Request Form that can be found here. A copy of the form is also attached at the end of Appendix A.

2) Updated DEM data, such as 1/9th Arc Second Continuously Updated Digital Elevation Model from the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information, or from other sources. The final DEM should reflect the latest available topographic and bathymetric data, including any surveys conducted as part of this development study.

3) Water level, wave and wind observations from nearby NOAA water level stations, NOAA National Data Buoy Center buoys, and local climatological data stations used to determine prevailing metocean conditions as part of the SLRCSP assessment
4) The U.S. Army Corps of Engineers (USACE) North Atlantic Coast Comprehensive Study (NACCS) contains AEP curves of water levels and waves at save points close to the 14 locations, and is a good source in addition to Risk MAP data.
5) High Sea Level Rise scenario design values from the Delaware Sea Level Rise Technical Committee's report titled, "Recommendation of Sea-Level Rise Planning Scenarios for Delaware" (November 2017)
6) United States Geological Survey flow and precipitation observation data
7) At the Wilmington sites, it would be useful to consider the impacts of pluvial and fluvial flood impacts from Christina River. There are two data sources that can be used to review the impacts of the Christina-Brandywine watershed:
    a. Delaware River Basin Flood Analysis Model by USACE-Hydrologic Engineering Center (February 2010). The report can be obtained from https://www.hec.usace.army.mil/publications/ProjectReports/PR-73.pdf.
    b. NOAA, the National Weather Service and the National Centers for Environmental Prediction completed a study on an inland-coastal compound flood prediction approach applied to the Delaware River Basin, including this watershed. The report can be obtained from https://doi.org/10.1029/2019JC015822.

Topographic Map Requirements

The topographic map showing the final facility and associated details should be consistent with the DEM used in the design. It should be demonstrated that this topographic map and DEM are reflective of current topographic and bathymetric conditions at the time of the design. It is recommended that the contour intervals be chosen at a sufficient resolution to ensure that current and projected topographic gradients and transitions are captured and presented accurately.

Floodplain Mapping Requirements

1) The 1% and 0.2% AEP floodplains can be directly obtained from the FEMA FIRM and, if necessary, Risk MAP modeling data can be used to verify the floodplain maps.
2) A bathtub modeling approach can be used to quantify and depict inundation from the High Sea Level Rise scenario.
3) The combined 1% AEP and High Sea Level Rise scenario floodplain can be estimated by adding the High Sea Level Rise value to the 1% AEP. It should be noted that this approach

assumes negligible non-linear impacts of sea level rise on storm surge. The NACCS 2015 study data provides estimates on the magnitude of these non-linear impacts and can be reviewed to assess the uncertainties associated with using a linear assumption.

To help ensure that the SLRCSP is reflective of current conditions, the following items could be of relevance:

1) The regional hydrodynamic and wave modeling effort used in developing the FEMA FIRMs for Delaware was completed in 2012. For each county, this data was then used to calculate overland wave propagation and other steps leading to development of the FIRMs and FIS reports. The timeline for the final FIRMs and FIS reports vary by count. It is likely that the input meteorological and topo-bathymetric data used in the regional and/or overland wave modeling is outdated. It would help to review the input data used in the Risk MAP study and check that the data is reflective of current conditions.

2) The Risk MAP modeling effort typically does not account for mean sea level changes since the 1983-2001 epoch that is generally used in determining tidal datums at NOAA stations. It would be helpful to estimate present day tidal datums using nearby NOAA water level stations and NOAA VDatum, and the impact on the depicted floodplains.

3) At the Wilmington locations, the Risk MAP study does not consider the interactions between pluvial/fluvial flooding from the Christina-Brandywine basin and coastal water levels from the Delaware River. A review of water level observations and recent NOAA studies can help assess the impacts of compound flooding on the depicted floodplains.

Pollution Control Through Asset Integrity

1) Identify critical assets, such as hazardous pipelines, manifolds and storage tanks.

2) Use appropriate hydrodynamic and wave design criteria, with and without sea level rise, to determine hydrodynamic horizontal and lift forces and moments on these assets. The design should demonstrate that the structures can withstand these loads for existing conditions and for the High Sea Level Rise scenario conditions. The appropriate design criteria (such as the 1% AEP) should be chosen based on design life, specifications used in the manuals identified in the approved basis of design or comparable documents.

3) Incorporate these hydrodynamic and wave loads into the design of these structures.

4) Include wind loads on these structures in the design, assuming omnidirectional wind speeds of 95 MPH at an elevation of 10 meters (33 feet).

5) Determine, as applicable, loads on mooring and berthing systems due to passing vessels during normal operations, and incorporate into design.

6) Propose operations procedures showing mitigation measures, (manual or automated shut-off of hazardous chemical transportation via pipelines for e.g.), to minimize risk of pollution incidents during a coastal storm.

7) Identify non-permanent structures that can be present in the facilities (such as barges) and potential adverse impacts due to their presence on the facility during a coastal storm. This should be accompanied by proposed mitigation measures to minimize adverse impact. For example, a barge offloading product will be moved from the path of the storm.

Erosion Control Measures

1) Identify event combinations that require design of erosion control measures. This assessment needs to be carried out for episodic and periodic erosion. For episodic erosion, events that trigger water levels, waves and currents at a specified level of risk (e.g., 1% AEP) need to be considered. An event causing 1% AEP water levels will not necessarily produce 1% waves.

2) Quantify and design for impacts of periodic longshore and cross-shore sediment transport in addition to those from event-based erosion. This assessment should examine both current conditions and future conditions, including the impacts of the High Sea Level Rise scenario.

3) Once the episodic and periodic erosion impacts are quantified, develop coastal erosion control measures following industry standard practices, such as the USACE Coastal Engineering Manual. Assumptions used in the design of erosion control should be identified along with reasoning in the SLRCSP.

4) Demonstrate the performance of these erosion control measures for present day design conditions and for future design conditions, incorporating the High Sea Level Rise scenario.

Impacts of 95 MPH Winds

1) Assume omnidirectional hourly winds of 95 MPH at an elevation of 10 meters (33 feet). Omnidirectional winds are used to consider worst case impacts to design.

2) Develop site-specific waves from the most conservative fetch direction using a validated and calibrated wave model, or the USACE Coastal Engineering Manual, for different water level conditions, including:

    a. Current mean high water; mean low water; and 10%, 2% and 1% stormwater levels

    b. Mean high water; mean low water; and 10%, 2% and 1% stormwater levels, incorporating the High Sea Level Rise Scenario

3) Compare these wave statistics with the wave statistics developed for design, and use the more extreme wave conditions for design.

Adjacent Impacts

Evaluate and quantify adjacent impacts of the development on upstream and downstream floodplains, and shoreline accretion/recession due to long-term erosion impacts.

1) Modify the hydrodynamic, wave and sediment model to incorporate the design associated with the SLRCSP.

2) Run this model, with the proposed design, to assess long-term erosion impacts upstream and downstream of the project site.

3) Run this model, with the proposed design, to assess impact to upstream and downstream floodplain extents, elevations and depths.

4) Compare the model results of water levels, waves and currents with the existing conditions model.

5) Develop spatial maps showing impacts to the current and future floodplain due to the development.

6) Ensure that measures to mitigate adjacent impacts are designed to comply with all federal, state and local regulations.

Useful References

Guidance for Flood Risk Analysis and Mapping – Combined Coastal and Riverine Floodplain, December 2020, FEMA

Guidance for Flood Risk Analysis and Mapping – Coastal Flood Frequency and Extreme Value Analysis, November 2016, FEMA

Flood Insurance Study, FEMA, New Castle County, Delaware and Incorporated Areas, Revised, January 22, 2020

Flood Insurance Study, FEMA, Kent County, Delaware and Incorporated Areas, Revised, June 20, 2018

Nadal-Caraballo, Norberto C.; Melby, Jeffrey A.; Gonzalez, Victor M.; Cox, Andrew T.; North Atlantic Coast Comprehensive Study (NACCS), Coastal Storm Hazards from Virginia to Maine, November 2015, USACE Engineering Research Development Center

Sabine Pass to Galveston Bay Orange County, Port Arthur & Freeport Hurricane Flood Protection System Preconstruction, Engineering and Design - Using Multivariate Statistical Modeling to Assess Compound Flooding Effects in Sabine Lake, Victor Santos and Thomas Wahl, U.S. Army Corps of Engineers Galveston District and National Center for Integrated Coastal Research

Coupled Induced Riverine Flow-Storm Surge Modeling in Support of Hurricane Flood Protection System Evaluation for the Sabine to Galveston Pre-construction, Engineering and Design Project in Coastal Texas, BY18-102SP, Clint Dawson and Amin Kiaghadi, DOD HPCMP

Coastal Engineering Manual, USACE, 2002

Mooring Equipment Guidelines (MEG4), Fourth Edition, 2018, OCIMF

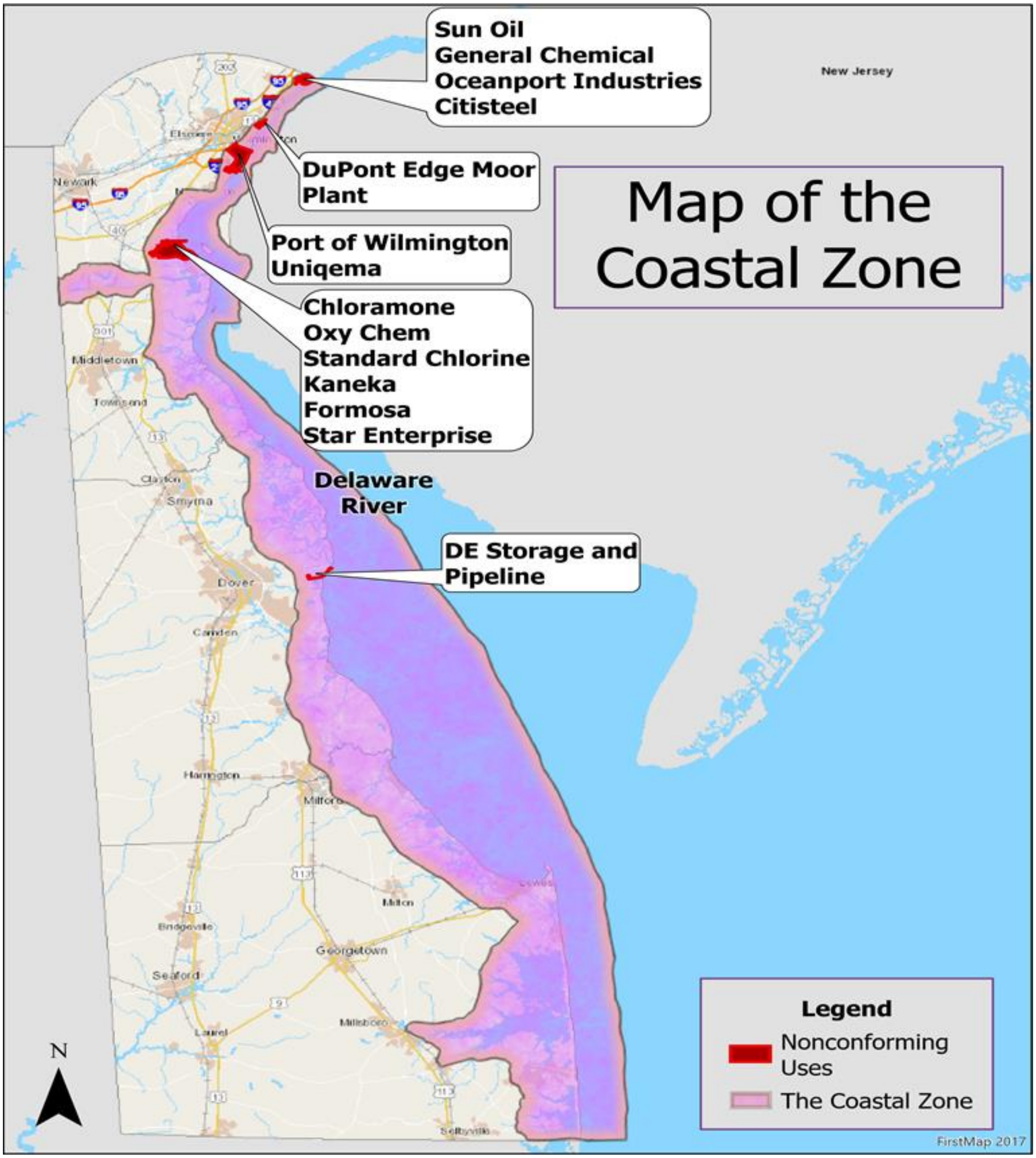
Recommendations of the Design and Assessment of Marine Oil and Petrochemical Terminals, MarCom Working Group 153, PIANC

Wind Loads: Guide to the Wind Load Provisions of ASCE 7-16

Unified Facilities Criteria – Moorings, UFC 4-159-03, March 2020

National Research Council 2007. Mitigating Shore Erosion Along Sheltered Coasts. The National Academies Press.

Appendix A: Conversion Sites



Appendix B: SLRCSP Checklist

The SLRCSP should contain the following assumptions and information:

- ☐ Design life of at least 30 years
- ☐ A topographic map identifying the following:
  - ☐ Site grounds
  - ☐ Operations facilities
  - ☐ Infrastructure (including shoreline docks, piers)
  - ☐ Pipelines
  - ☐ Areas that must be remediated
  - ☐ Route of ingress and egress
  - ☐ Boundary of the footprint of the heavy use industry site
  - ☐ Cut and fill areas
- ☐ Map of 1% AEP floodplain
- ☐ Map of 0.2% AEP floodplain
- ☐ Map of floodplain resulting from the High Sea Level Rise scenario
- ☐ Map of 1% AEP floodplain, including impacts of sea level rise 30 years from the commissioning of the designed facility
- ☐ Floodplain maps provided should be in an electronic format (GIS layers) that contains the extents of floodplain, flood elevations and flood depths around the project area
- ☐ Identification of assets that can cause pollution
- ☐ Details of designs and mitigation measures to protect assets that can cause pollution from damage
- ☐ Details of designs to withstand wind, wave and current loads due to 95 MPH winds
- ☐ Description and quantification of downstream and upstream erosion impacts due to the proposed development
- ☐ Details of designs to mitigate erosion, demonstration of projected erosion mitigation, and compliance with applicable federal and state regulations
- ☐ Description and quantification of downstream and upstream floodplain impacts due to the proposed development
- ☐ Details of designs to address floodplain impacts, demonstration of floodplain mitigation performance, and compliance with applicable federal and state regulations