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Chapter 12

Coastal Flooding and Sea Level Rise for Energy and Mineral Facilities: Ripple Effects or Sea Change?

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Synopsis

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§ 12.01. The Problems and Risks of Relative Sea Level Rise (SLR) and Recurrent Flooding.

[1 — Nature and Components of Relative Sea Level Rise.

Coastal flooding is hardly a new phenomenon. Coastal shorelines have for millennia experienced periodic coastal storms and other weather that leads to flooding; inhabitants of these areas have learned over thousands of years how to anticipate, plan for and respond to such events. Interior portions of the United States have also had their share of flooding history with swollen rivers, streams and lakes overtopping their banks, leading to major flood control projects in most states. However, sea level rise (SLR), as recorded and documented to occur at varying rate for many coasts around the globe over the past 100 years, has become a growing contributor to the frequency and intensity of coastal recurrent flooding and associated impacts. Certain factors can compound SLR effects otherwise expected from more general global trends, causing such areas to experience an even greater difference between land levels and tide levels; the overall blended effect is known as "relative SLR."[2]

By example, shoreline industry owners and other stakeholders share a growing concern about continued relative SLR in the mid-Atlantic region, particularly in the southern Chesapeake Bay areas known as Hampton Roads, the Middle Peninsula and the Eastern Shore. Factors driving relative SLR in the Hampton Roads area, where it is most pronounced, appear to be three-fold: general SLR in the oceans at large, land subsidence in portions of the coastal plain of Virginia (between the geological fall line on the west and the Chesapeake Bay or Atlantic Ocean on the east), and particular ocean currents mounding water against the mid-Atlantic seaboard.[3] The historical trend of increasing relative SLR in Virginia is well documented by higher average tide levels over many decades, amounting to an average increase of about 4.6 millimeters (0.18 inches) per year over a number of decades and

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2 Relative SLR reflects local factors that may aggravate or diminish the more general SLR trends seen in the open ocean. *See* Tal Ezer and Larry P. Atkinson, "Sea Level Rise in Virginia – Causes, Effects and Response," 66 *Virginia J. of Science* 355, 355 (Fall 2015) (hereinafter, "SLR Causes, Effects and Response"); Larry P. Atkinson *et al*., "Sea Level Rise and Flooding Risk in Virginia," 5 *Sea Grant Law and Policy J.*, Winter 2013, 4-7, *available at* http://nsglc.olemiss.edu/sglpj/vol5no2/2-atkinson.pdf.

3 This land subsidence itself has two apparent causes: loss of pressure in the Coastal Plan groundwater aquifer due to groundwater withdrawals over time and larger forces associated rebalancing of the earth's crust after the last ice age. For a summary of the causes of relative SLR in Virginia, *see* "SLR Causes, Effects and Response" 360-63; Virginia Ctr. for Coastal Resources Mgmt., Virginia Inst. of Marine Science, "Recurrent Flooding Study for Tidewater Virginia" 110 (January 2013) ("VIMS Study"), *available at* http://ccrm.vims.edu/recurrent_flooding/Recurrent_Flooding_Study_web.pdf; Tal Ezer *et al*., "Gulf Stream's Induced Sea Level Rise and Variability Along the U.S. Mid-Atlantic Coa*st*," 118 *J. Geophys. Res. Oceans*, 685–697 (2013), *available at* http://onlinelibrary.wiley.com/doi/10.1002/jgrc.20091/pdf. *See also*, Hampton Roads Planning Dist. Comm'n, "Climate Change in Hampton Roads Phase III: Sea Level Rise in Hampton Roads, Virginia," 6 (July 2012) (hereinafter, "HRPDC Phase III Report"), *available at* http://www.hrpdcva.gov/uploads/docs/HRPDC_ClimateChangeReport2012_Full_Reduced.pdf.

an overall increase of 1.5 feet over 100 years at Sewell's Point in Norfolk. Virginia's Eastern Shore and Middle Peninsula have experienced similar relative SLR.[4] These localized factors result in a relative SLR for Hampton Roads and nearby areas of Virginia greater than that for most of the rest of the nation and even much of the world. According to tide gauge records, relative SLR appears to be accelerating.[5] Increasing relative SLR is in turn leading to increasing levels of recurrent flooding, in part because so many coastal areas are low-lying and very flat or have significant amounts of stormwater flowing down to the coast from interior higher uplands, compounding the effects of the small increases in relative SLR year-to-year.

[2] — Relative SLR and Recurrent Flooding Risks and Impacts.

Impacts of relative SLR and recurrent flooding in many areas the of the nation (and the world) are already being felt, but the risks vary significantly due to shorelines and coastal communities being host to a diverse and unique set of private sector and governmental land uses, facilities and public safety services. Virginia provides a classic, if not obvious, example.[6] The result is a variety of recurrent flooding scenarios. At the least, but still disruptive, end of the spectrum, stormwater backing up into streets and properties can cause periodic or frequent nuisance flooding even without a significant storm

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4 "Mean Sea Level Trend 8638610 Sewells Point, Virginia," *available at* https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8638610. Other tide gauges in Virginia's tidal waters show similar increases over time. *See* https://tidesandcurrents.noaa.gov/sltrends/sltrends_states.htm?gid=1249. *See also* "SLR Causes, Effects and Response" at 355-360.

5 *See* "Sea Level Rise and Flooding Risk in Virginia" at 6-9.

6 A hardly exhaustive roster includes economically and militarily strategic facilities, industries, and enterprises vulnerable in various ways to relative SLR and recurrent flooding, such as ports and other bulk storage, cargo and transloading terminals; Norfolk Naval Station and other Department of Defense shoreline facilities; shipyards (civilian and Navy); civilian airports and Navy and Air Force air bases; Coast Guard stations; schools, colleges and universities; transportation routes, tunnels and ferry landings; rail lines and rail yards; marinas and boat repair yards; power stations; commercial and retail establishments, single family and multifamily housing and boat access ramps.