CHAPTER 10 APPENDIX B
HYDRAULICS OF TIDAL BRIDGES

GUIDELINES FOR CONSIDERING THE EFFECT OF FUTURE SEA-LEVEL RISE IN MARYLAND

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WATER RESOURCE POLICIES AND AUTHORITIES INCORPORATING SEA-LEVEL CHANGE CONSIDERATIONS IN CIVIL WORKS PROGRAMS

1. Purpose. This circular provides United States Army Corps of Engineers (USACE) guidance for incorporating the direct and indirect physical effects of projected future sea-level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects. Recent climate research by the Intergovernmental Panel on Climate Change (IPCC) predicts continued or accelerated global warming for the 21st Century and possibly beyond, which will cause a continued or accelerated rise in global mean sea-level. Impacts to coastal and estuarine zones caused by sea-level change must be considered in all phases of Civil Works programs.

2. Applicability. This Circular applies to all USACE elements having Civil Works responsibilities and is applicable to all USACE Civil Works activities. This guidance is effective immediately, and supersedes all previous guidance on this subject. Districts and Divisions shall inform CECW of any problems with implementing this guidance.

3. Distribution Statement. This publication is approved for public release; distribution is unlimited.

4. References. Required and related references are at Appendix A. A glossary is included at the end of this document.

5. Geographic Extent of Applicability.

a. USACE water resources management projects are planned, designed, constructed and operated locally or regionally. For this reason, it is important to distinguish between global mean sea level (GMSL) and local (or "relative") mean sea level (MSL). At any location, changes in local MSL reflect the integrated effects of GMSL change plus changes of regional geologic, oceanographic, or atmospheric origin as described in Appendix B and the Glossary.

b. Potential relative sea-level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence. Fluvial studies (such as flood studies) that include backwater profiling should also include potential relative sea-level change in the starting water surface elevation for such profiles, where appropriate. The base level of potential relative

sea-level change is considered the historically recorded changes for the study site. Areas already experiencing relative sea-level change or where changes are predicted should analyze this as part of the study.

6. Incorporating Future Sea-Level Change Projections into Planning, Engineering Design, Construction, and Operating Projects.

a. Planning, engineering, and designing for sea level change must consider how sensitive and adaptable 1) natural and managed ecosystems and 2) human systems are to climate change and other related global changes. To this end, consider the following two documents:

(1) The Climate Change Science Program (CCSP) Synthesis and Assessment Product 4.1 (SAP 4.1) *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region* details both

how sea-level change affects coastal environments and what needs to be addressed to protect the environment and sustain economic growth. SAP 4.1 represents the most current knowledge on implications of rising sea levels and possible adaptive responses.
(2) The National Research Council's 1987 report *Responding to Changes in Sea Level: Engineering Implications* recommends a multiple scenario approach to deal with key uncertainties for which no reliable or credible probabilities can be obtained. In the context of USACE planning, multiple scenarios address uncertainty and help us develop better riskinformed alternatives.
b. Planning studies and engineering designs should consider alternatives that are developed and assessed for the entire range of possible future rates of sea-level change. These alternatives will include structural and nonstructural solutions, or a combination of both. Evaluate alternatives using "low," "intermediate," and "high" rates of future sea-level change for both "with" and "without" project conditions. Use the historic rate of sea-level change as the "low" rate. Base "intermediate" and "high" rates on the following:
(1) Estimate the "intermediate" rate of local mean sea-level change using the modified NRC Curve I and equations 2 and 3 in Appendix B (see Figures B-9 and B-11). Consider both the most recent IPCC projections and modified NRC projections and add those to the local rate of vertical land movement.
(2) Estimate the "high" rate of local sea-level change using the modified NRC Curve III and equations 2 and 3 in Appendix B (see Figures B-9 and B-11). Consider both the most recent IPCC projections and modified NRC projections and add those to the local rate of vertical land movement. This "high" rate exceeds the upper bounds of IPCC estimates from both 2001 and 2007 to accommodate for the potential rapid loss of ice from Antarctica and Greenland.
c. Determine how sensitive alternative plans and designs are to these rates of future local mean sea-level change, how this sensitivity affects calculated risk, and what design or operations and maintenance measures should be implemented to minimize adverse consequences while maximizing beneficial effects. Consider sensitivity relative to human health and safety, economic costs and benefits, environmental impacts, and other social effects. Address risks for each alternative and each potential future rate of sea-level change ("low," "intermediate," and "high"). For those alternatives sensitive to sea-level change, evaluate the potential timing and cost consequences during the plan formulation process.

FOR THE COMMANDER:

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4 Appendices:
APPENDIX A: References
APPENDIX B: Technical Supporting Material
APPENDIX C: Flowchart to Account for Changes in Mean Sea Level
Glossary