



**SEA LEVEL RISE ADAPTATION GUIDELINES
FOR SEA DIKES AND COASTAL DEVELOPMENT**
Draft Overview and Summary - September 23, 2011

1. Introduction

Scientists and agencies around the world confirm that climate change is causing increased rates of sea level rise. On the BC coast, sea level rise will escalate the risks of coastal flooding, erosion and associated impacts. To prepare for the impacts of climate change, including sea level rise, British Columbia's Climate Change Adaptation Strategy directs government agencies to assess the implications of climate change for government operations and begin the process of planning for and implementing adaptation actions (to see the Strategy go to <http://www.env.gov.bc.ca/cas/adaptation/strategy.html>).

In 2010, with support from Natural Resources Canada and the Fraser Basin Council, the ministry contracted Ausenco Sandwell Ltd. to prepare "Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use". The Ausenco Sandwell (2011) report is available on the ministry web page in three volumes (http://www.env.gov.bc.ca/wsd/public_safety/flood/structural.html):

- Volume No. 1 – Draft Policy Discussion Paper
- Volume No. 2 – Sea Dike Guidelines
- Volume No. 3 – Guidelines for Management of Coastal Flood Hazard Land Use

Later in 2011, to extend and supplement the above work, the ministry contracted Kerr Wood Leidal Associates Ltd. to prepare "Coastal Floodplain Mapping Guidelines and Specifications" with consideration of sea level rise. This report (also available on the ministry web page) recommends standards for topographic mapping and engineering analyses for establishing building elevations in coastal areas.

Public and stakeholder comments are being solicited on the Ausenco Sandwell (2011) and the KWL (2011) reports through a series of presentations and workshops. This Draft Overview and Summary plus the Ausenco Sandwell and KWL reports jointly comprise the Draft Sea Level Rise Adaptation Guidelines (the "Draft SLR Guidelines"). It is expected that a formal guideline document will be developed and published in 2012.

If you would like to provide input, to comment on any of the documents, or require further information, please contact Jesal Shah, Flood Safety Engineer, at either (250) 387-9962 or Jesal.Shah@gov.bc.ca.

IMPORTANT NOTE: The Draft SLR Guidelines do not represent provincial policy at this time; they have been prepared for information and discussion purposes.

2. Purpose of the SLR Guidelines

The primary objectives of the SLR Guidelines will be to:

- a. To establish consistent requirements for the approval and construction of all new sea dikes or upgrades to existing high consequence sea dikes under the *Dike Maintenance Act* (DMA) with respect to sea level rise; and
- b. To establish a technical and policy framework to enable management of coastal flood hazard area land use to reduce the flood related impacts of sea level rise on people, property, and infrastructure.

3. Application

The SLR Guidelines are proposed to apply to the design and construction of all new sea dikes and major upgrades to existing High Consequence Sea Dikes. Dike designs must generally be consistent with the SLR Guidelines to obtain *Dike Maintenance Act* (DMA) approval and to meet current provincial standards. Lesser standards may be considered on a site specific basis for projects involving the upgrading of existing lower consequence dikes (e.g. dikes protecting agricultural areas with few residential buildings).

The SLR Guidelines are proposed to apply to the regulation of coastal development in flood hazard areas and supersede related sections of the existing “Flood Hazard Area Land Use Management Guidelines” (2004), which are published under the authority of the *Environmental Management Act*. Coastal development approving officials will need to consider the SLR Guidelines in accordance with requirements of existing land use legislation.

The scope of the SLR Guidelines is focused on flood protection and floodplain management. These aspects should be integrated with other design and planning requirements including the protection and management of natural coastal and estuarine ecosystems. While the SLR Guidelines do not explicitly address tsunami flooding hazards, coastal communities may wish to consider if they are at risk of tsunami hazards and if so, how they could address those risks in hazard and emergency response planning.

4. Definitions (also see definitions in Volume No. 1 Appendix A - Ausenco Sandwell, 2011)

High Consequence Dikes are flood protection works where the consequences of failure during a major flood are very high. These works typically protect urban or urbanizing areas, and failure of the dike could result in large economic losses and/or significant loss of life. The determination that a specific dike is classified as a High Consequence Dike is made by the Inspector or a Deputy Inspector of Dikes in consultation with the local diking authority.

Major Dike Upgrade - a project involving raising the design crest elevation of a High Consequence Dike, or where the dike is being significantly reconstructed, or widened to meet provincial dike standards. The determination that a specific dike upgrading project is classified as a Major Dike Upgrade is made by the Inspector or a Deputy Inspector of Dikes in consultation with the local diking authority.

5. High Consequence Sea Dikes in BC

Sea dikes were first constructed in the 1800's in the Fraser River delta. The Fraser River Flood Control Program (FRFCP) reconstructed approximately 93 km of sea dikes between 1968 and 1994 in the communities of Richmond, Delta, New Westminster and Surrey. These include Fraser River dikes where the design crest elevation is governed by sea level criteria rather than river design flood levels. At the present time there are very few existing high consequence sea dikes outside of the Fraser River delta.

Today, most of the FRFCP dikes are considered to be High Consequence Dikes. The 40 year old FRFCP design criteria did not anticipate or address sea level rise and the FRFCP criteria are not consistent with current coastal engineering practice, particularly with respect to consideration of high tide, storm surge and wave effects as generally outlined in the ministry's 2003 "Dike Design and Construction Guide".

With emerging knowledge about climate change impacts and SLR, it is anticipated that most High Consequence Sea Dikes will need to be upgraded to adapt to SLR over the next several decades. While dike upgrading may be completed in phases, conceptual designs and implementation plans that are consistent with SLR Planning Area land use strategies will need to be developed. One of the planning objectives would be to ensure that adequate flood protection is constructed and maintained in advance of projected SLR.

6. Some Diking and SLR Planning Considerations

Legal Access for Dike Construction and Maintenance

There are a number of design, technical and legal problems in constructing, raising and widening dikes. For example, in order to raise a dike by one metre, it may be necessary to widen the base by more than 6 metres. Expanding the base will require additional legal access to adjacent lands for upgrading purposes. There is often extensive existing development (i.e. industrial, commercial, and residential) as well as utilities, roads and other infrastructure located either immediately adjacent to existing sea dikes, or that has encroached onto the dikes. A key planning task will be to identify the land required for dike upgrading and to implement a process to acquire the land, or the necessary right of way agreements.

For some low lying coastal areas, the value of existing and potential coastal development may justify the construction of new sea dikes to protect from SLR. These new dikes would be regulated under the DMA and would need to meet provincial dike standards, including the SLR Guidelines. Given existing foreshore development and the significant extent of private land ownership, successful strategies for new sea dikes will also be dependent on acquisition of land and legal access for construction, maintenance and future upgrading.

Habitat and Ecosystem Protection

Coastal and estuarine ecosystems will be impacted by SLR. Protection and management of these areas is an important consideration and should be integrated into SLR adaptation planning.

Site Specific Planning

The flood risk implications of SLR vary widely depending on site conditions and the pattern of development. Therefore, it is proposed that SLR Planning Areas be defined and land use strategies be developed on a community specific basis. Various planning and legislative tools can be used to ensure that future land use and buildings would be developed in a safe and sustainable manner. Completion of coastal floodplain mapping as described in KWL (2011) would be the first step in defining SLR Planning Areas.

Flood Proofing Behind Dikes

Even well designed and maintained dikes can fail. In recognition of the limitations of structural flood protection, and to avoid ever increasing flood risks, a long standing provincial policy (as included in the May 2004 “Flood Hazard Area Land Use Management Guidelines”) is to flood-proof new development behind dikes (i.e. elevating the habitable areas of buildings to the Flood Construction Level - FCL). While this policy is effective in many areas at reducing potential flood damage, flood proofing by “elevation” is particularly difficult to implement where the FCL exceed about 2.5 metres above grade, or where new development is proposed in close proximity to existing development at lower elevations.

In situations where the sea dike system has been upgraded for SLR and meets all provincial standards for High Consequence Dikes, it may be appropriate to consider relaxation of FCLs for new development in areas protected by the dikes. However, it is suggested that such relaxation should only be considered if a risk analysis concludes that the additional exposure of development to flood damage can be balanced by a corresponding increase in the standard of dike protection. Relaxed flood-proofing levels must also be compatible with the design of the sea dikes (for overtopping) and the internal drainage system.

7. Summary of Key Guidelines

a) Design and Planning Time Frame

- Requirements for sea dikes, buildings, subdivision, and zoning should allow for **sea level rise to the year 2100**. Sea dike construction may be phased where appropriate and cost-effective provided that the level of protection achieved is ahead of the sea level rise curve.
- Land use adaptation strategies should allow for **sea level rise to the year 2200**.

b) Recommended Sea Level Rise Scenario for BC

- Allow for 0.5 m by 2050, 1.0 m by 2100 and 2.0 m Global Sea Level Rise by 2200 as per Figure 1 below (Ausenco Sandwell 2011).
- Adjust for regional uplift and subsidence using the most recent and best information available. Where no information is available, assume neutral conditions (i.e. no uplift or subsidence).
- The Global Sea Level Rise Scenario should be reviewed in 2015, or sooner if there is significant new scientific information.

