

DELTA OVERVIEW

The suburban municipality of Delta, located in the southwest portion of Metro Vancouver, is made up of three urban communities: Ladner, located in the lowlands, and Tsawwassen and North Delta, located on higher ground. The suburban residential neighbourhoods of Boundary Bay Village and Beach Grove can be found in the lowlands along Boundary Bay. The Tsawwassen First Nation has treated lands in Delta. Almost half of Delta is farmland, while one-fifth is Burns Bog.

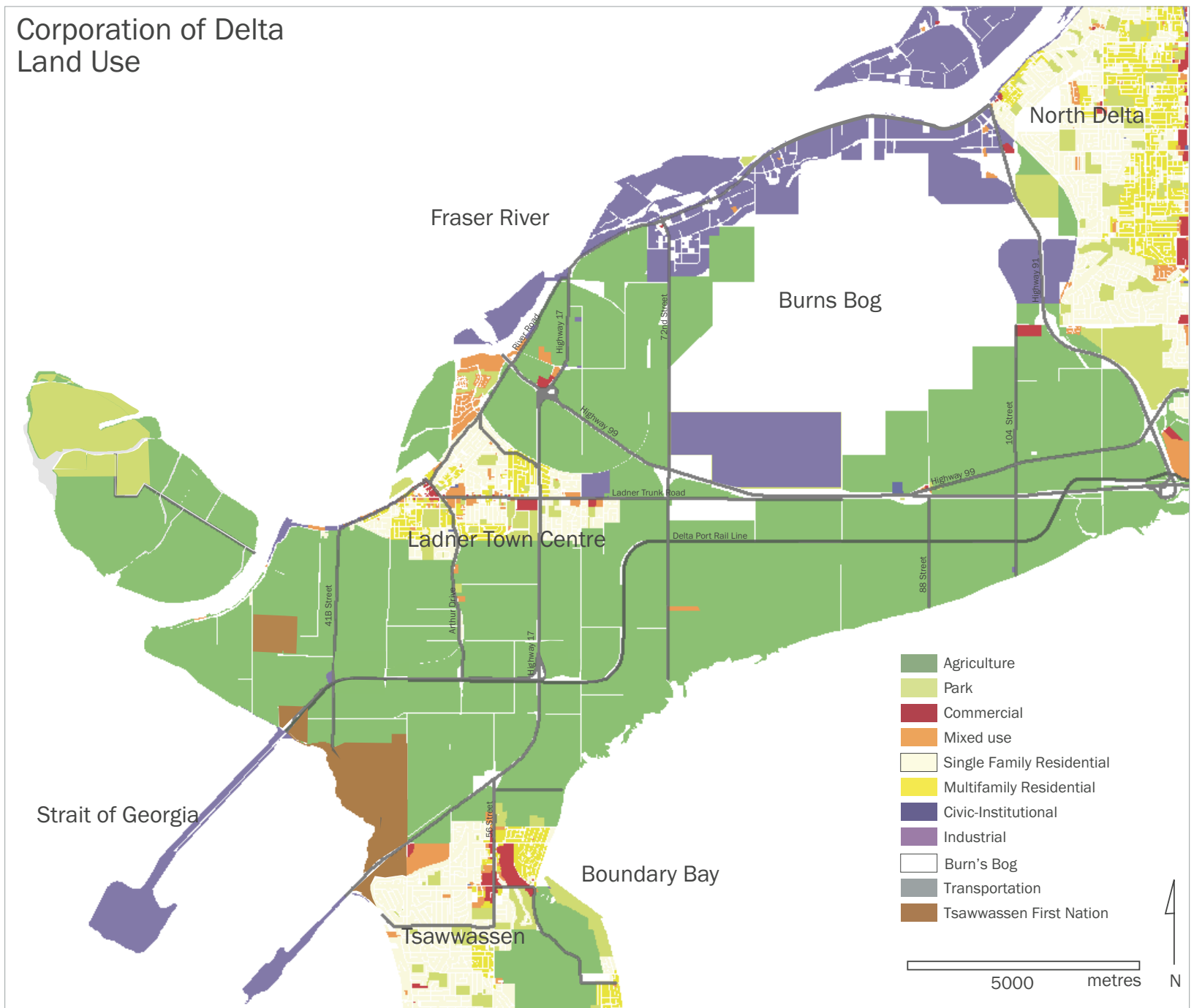
Delta's population of just over 97,000 is projected to reach approximately 112,000 residents by 2021, with most of the increase in North Delta. Over 20,000 people live in Ladner, which has over 6000 residential lots.

Delta has important transportation links for people and goods movement: Highways 99, 91, 17, and 10 cross Delta, connecting Canada to the United States, and the Lower Mainland to Vancouver Island and the Gulf Islands via the BC Ferries Terminal. Deltaport is the largest shipping terminal in the Lower Mainland.

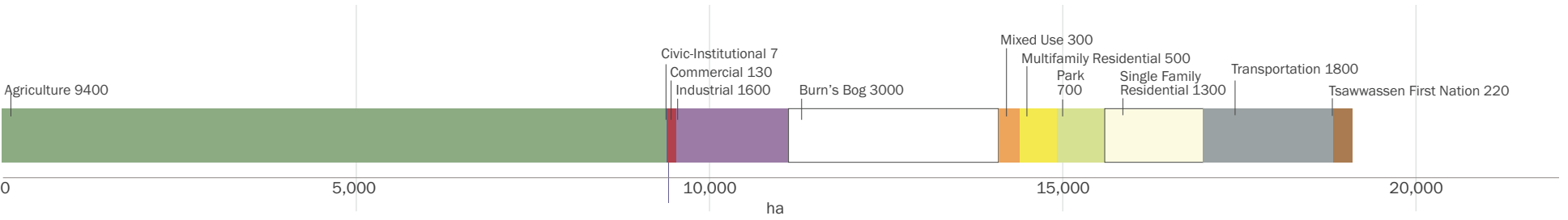
Agriculture is an important industry, with approximately 200 farms generating about \$161,000,000 of gross revenue. Soil-based agriculture - dairy, vegetables, and fruits - continue to play a significant economic role, while greenhouses are a growing sector.

(Sources: Corporation of Delta Official Community Plan 2011; Delcan 2010)

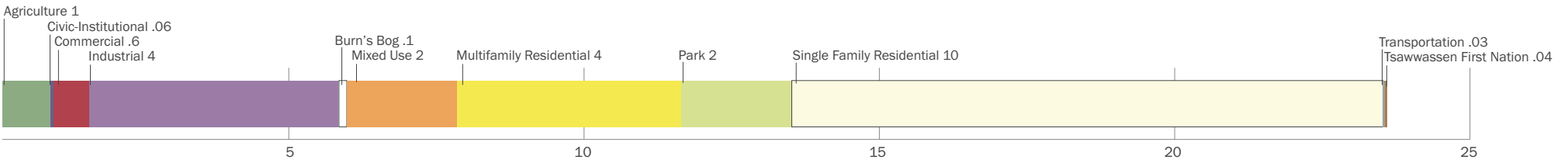
Corporation of Delta Land Use



Land Use by Area (ha)



Land and Building Value (\$ billion) by Land Use



Land value was calculated by multiplying the area for each land use by the improved and unimproved value of the land (BC Land Assessment 2008 land use value data).

Habitat and Farming

Delta's wetland, estuarine, and upland habitats support the largest wintering populations of waterfowl, shorebirds and birds of prey in Canada. Up to 5 million migratory birds use the Fraser River estuary and delta as a vital stopover on the Pacific Flyway. Boundary Bay and its adjacent uplands represent the most significant migratory waterfowl and shorebird habitat on the Pacific Coast of Canada. Boundary Bay and the Ladner Marsh are provincial Wildlife Management Areas, and the Alaksen National Wildlife Area is located on Delta's Westham Island (adapted from Corporation of Delta, 2007 Revised OCP, Schedule A: 2-16).

"Farming... contributed to the early settlement of the municipality, and today, adds to the economy and to residents' quality of life. Farming also contributes to municipal and regional food sufficiency. Today, there are 10,085 hectares (24,929 acres) in the Agricultural Land Reserve (ALR)" (Corporation of Delta, 2007 Revised OCP, Schedule A: 2-24).



Data source: Fraser River Estuary Management Program (FREMP)

COMMUNITY VULNERABILITY TO INUNDATION

Delta's Sea Level Rise Planning Area

Possible Inundation Extent

The following set of images begins with a composite map of areas vulnerable to inundation in Delta, followed by more detailed maps showing the extent of inundation based on specific dike breach simulations for seven "dike reaches" (sections of dike) across Delta.

The modeling assumed peak water heights of 3.5 meters above sea level (GSC), which accounts for a winter storm surge event (with an unspecified return period), as well as wind and waves, and only 10cm of sea level rise (KWL 2007).

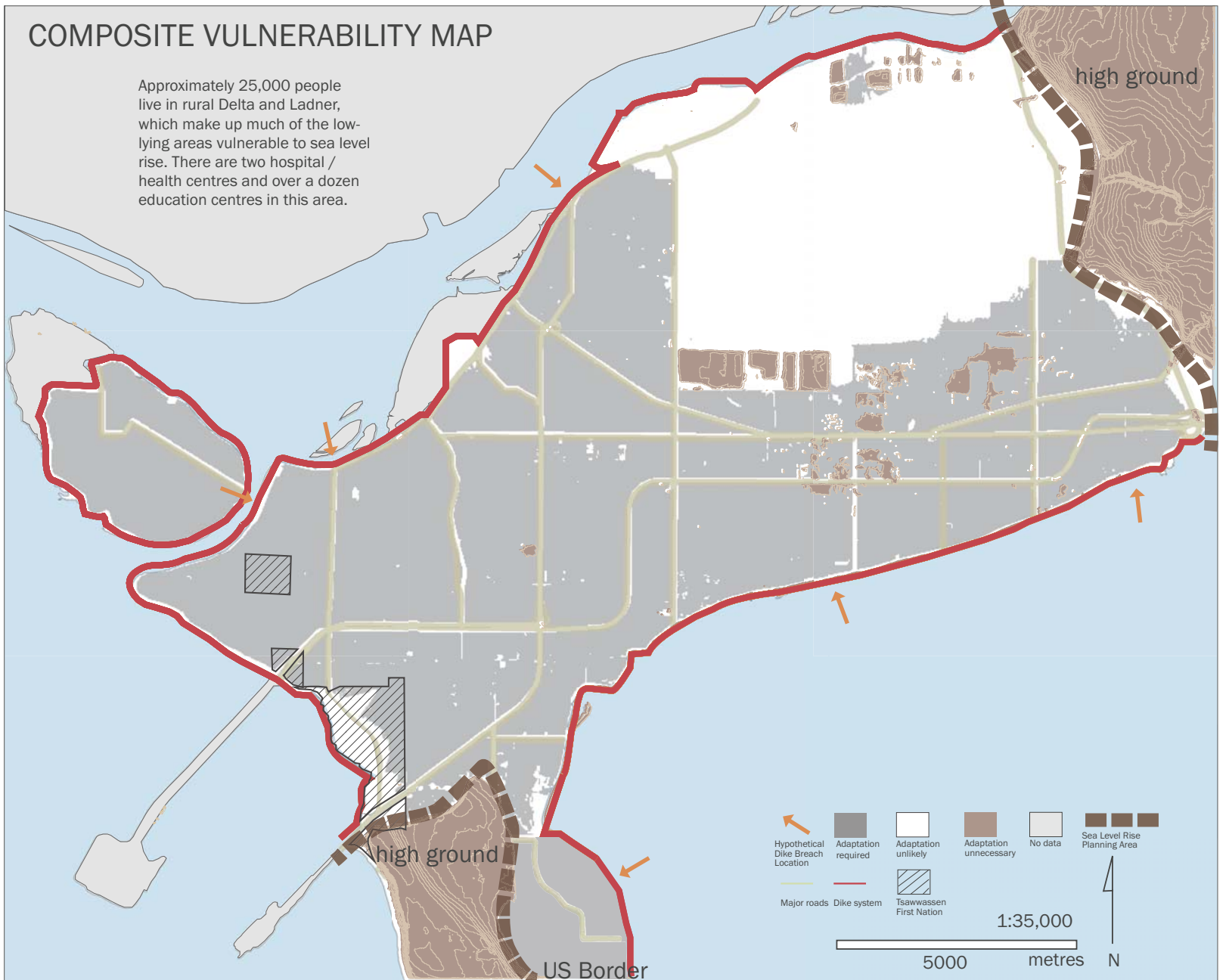
Dike overtopping could occur in some areas already, as shown by the final map in the series. It is assumed that considerable dike overtopping would lead to a breach (Delcan 2011). Inundation risk will increase with on-going sea level rise.

Sea Level Rise Planning Area

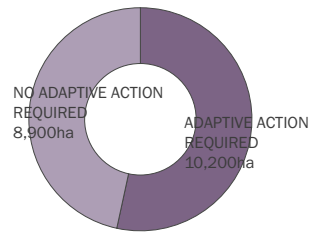
The mapped Adaptation Required areas (grey) correspond reasonably well to the new Ministry of Environment proposed Sea Level Rise Planning Areas, which for Delta is delineated as all lands below 5.6m, as shown.

If there were to be a dike breach, these areas could be inundated, although it is extremely unlikely the entire area would flood at the same time (see smaller maps below). As well, actual inundation damages will depend on the extent and depth of individual flood events, and how well prepared the community is (adequate Flood Construction Levels, emergency preparedness, etc).

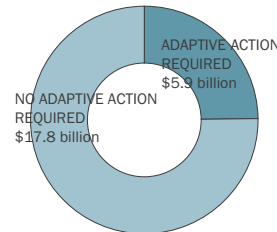
With sea level rise, and without adaptive action, there could be cumulative inundation events: over time, by 2100, parts of this area could flood multiple times.



53% of Delta's total land area could be vulnerable to inundation



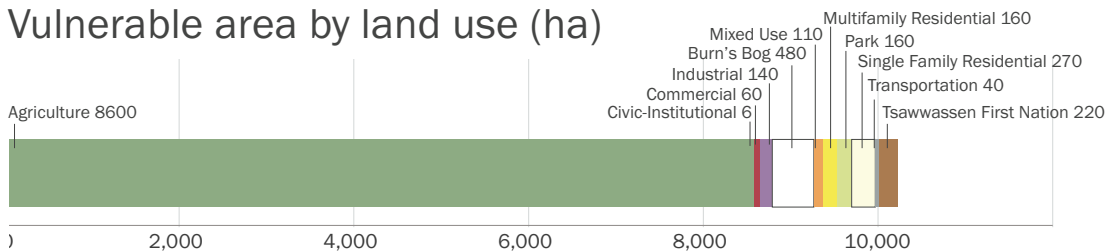
25% of Delta's total land value is within the Sea Level Rise Planning Area



XX% of the regional food supply is from Delta



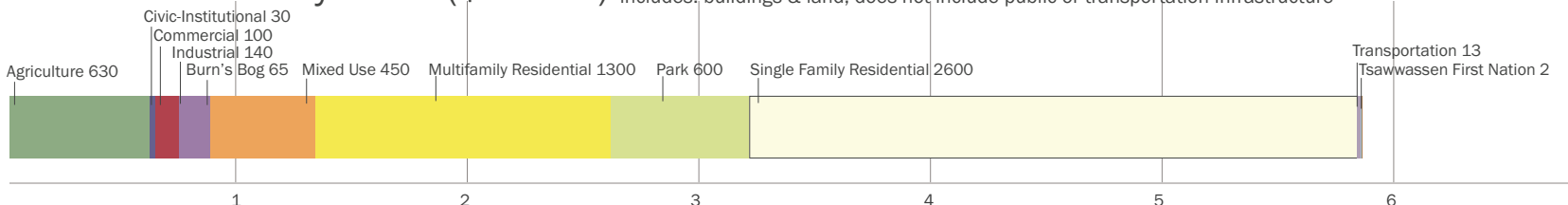
Vulnerable area by land use (ha)



The low dollar valuation of agricultural land, compared to other uses such as single-family residential, accounts for the difference between the percentage of Delta's land area that is vulnerable, and the percentage of Delta's land and buildings value that is vulnerable.

- Agricultural land values not measured by dollars include:
- Character and community identity based on farming
 - Regional food security **farmland**

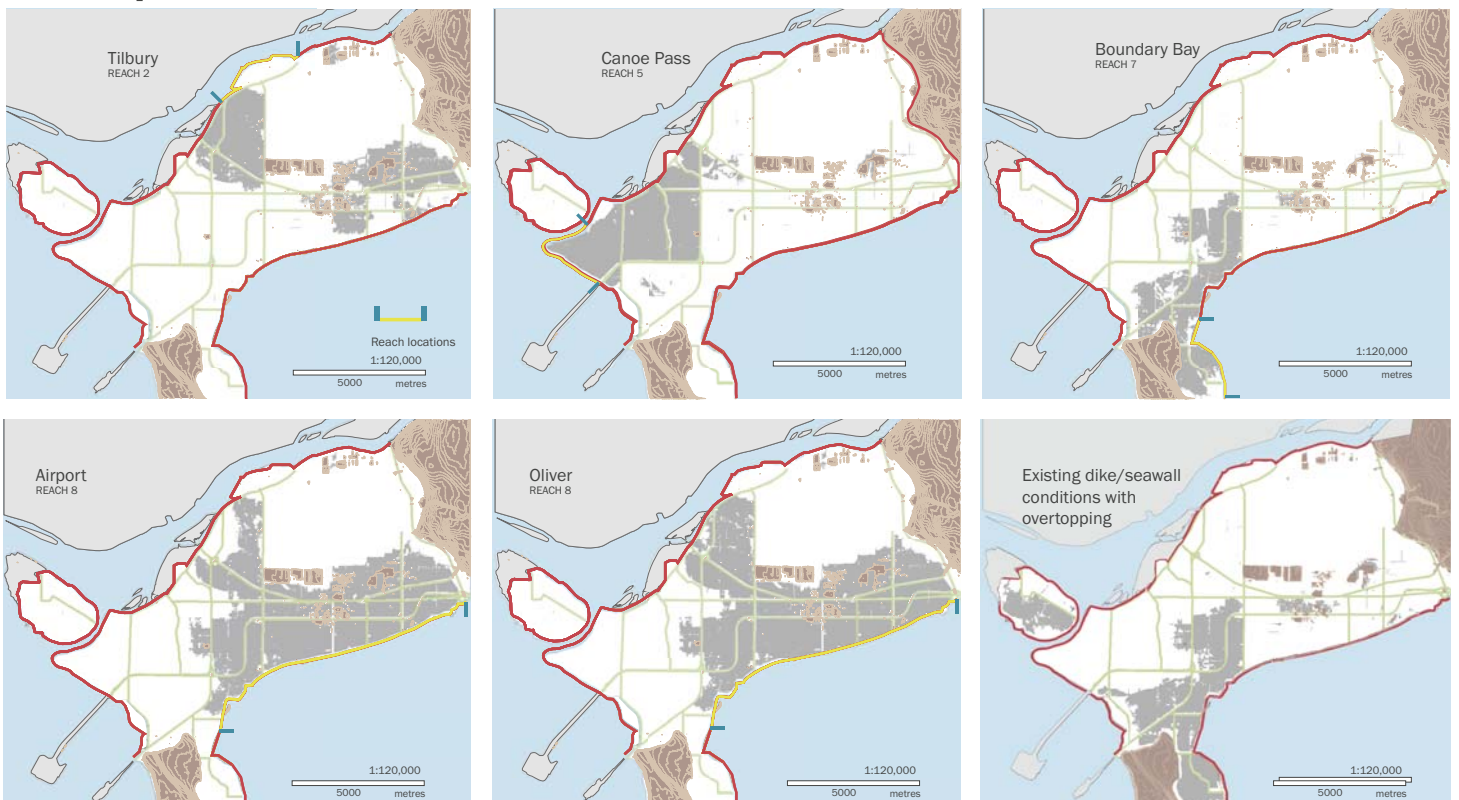
Vulnerable area by value (\$ billion)



Inundation modeling for separate dike breach events

Each map shows the results for separate, modeled dike breach events (KWL 2007). The 2007 modeling shown here has since been partially updated to include 0.3m, 0.6m, and 1.2m sea level rise (Delcan 2010, 2011). Thus, the modeling shown here is conservative.

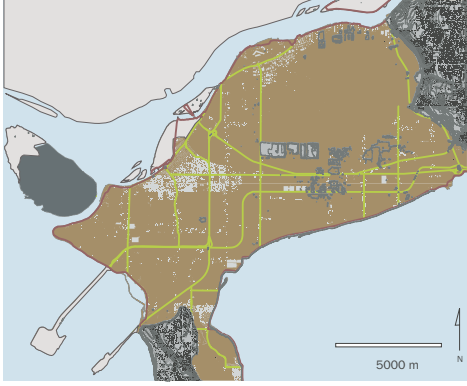
- Assumptions: (Delcan 2010: 37; KWL 2007: 4-10)
- a breach occurs about 25 hours before the peak water level is reached (high tide + storm surge)
 - over one day, a 300m breach develops
 - the inflow volume of water is applied at a constant rate over 24 hours



RESPONSE OPTIONS: 3 SCENARIOS

Who adapts or what adapts depends not only on the characteristics of the systems involved but also on the goals and values of the adaptors. The goal may simply be to manage the risk, to reduce exposure, or to address new opportunities. These different goals may lead to different strategies. (Cohen and Waddell, *Climate Change in the 21st Century*, 2009: 199)

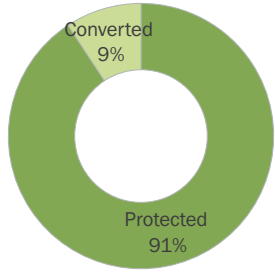
HOLD THE LINE



This ARMORING scenario maintains, strengthens, and raises the existing 60+ km of Delta's dike and seawall infrastructure, in order to protect against sea level rise. By 2100, the dike infrastructure holds the current Delta boundary and there is no net gain or loss of land, with the exception of Westham Island.

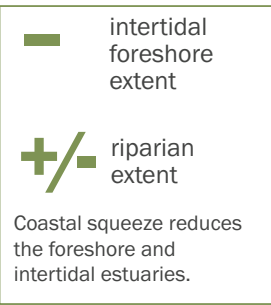


Agricultural land area

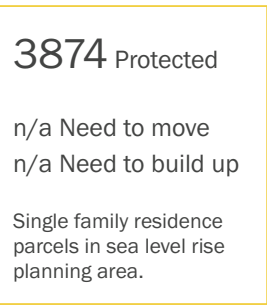


Most agricultural land is protected. Over time, a small amount converts to habitat.

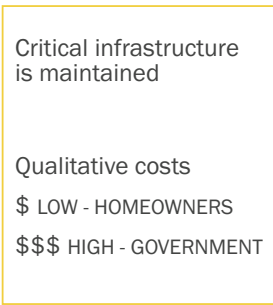
Ecology & Habitat



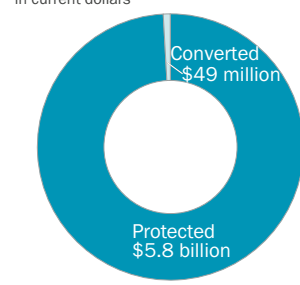
Residences



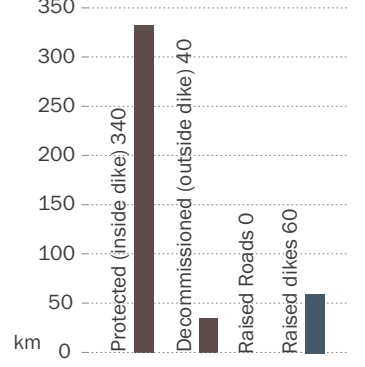
Infrastructure



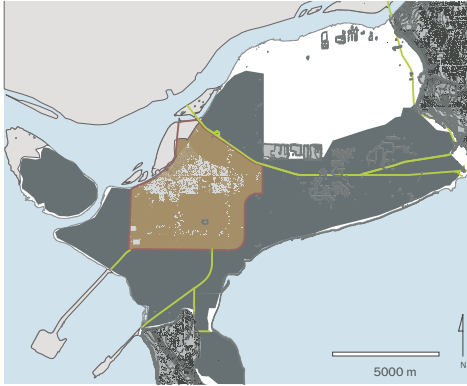
Value of land & buildings



Road / dike length



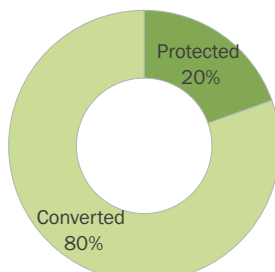
MANAGED RETREAT



This SOFT option leaves existing dike and seawall infrastructure as is for many areas, reinforcing and maintaining existing infrastructure only to protect Ladner. As a result, over time, storm surges and possibly tidal water will inundate unprotected low-lying areas. Development currently located in these unprotected areas is relocated to higher-ground or Ladner, in a phased and planned retreat.



Agricultural land area



Over time, significant agricultural land is converted to open space and habitat.

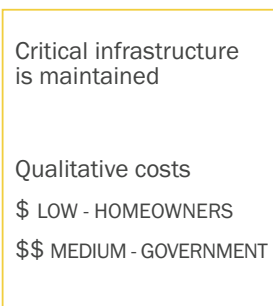
Ecology & Habitat



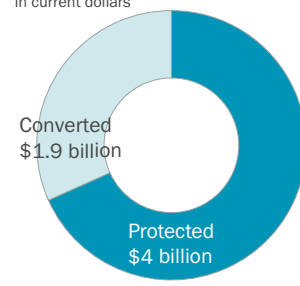
Residences



Infrastructure

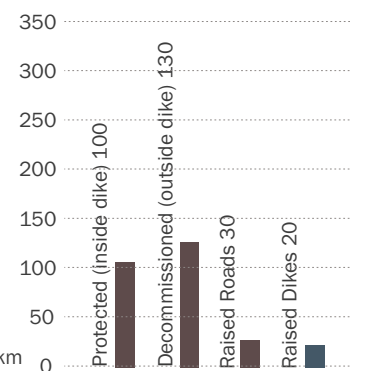


Value of land & buildings

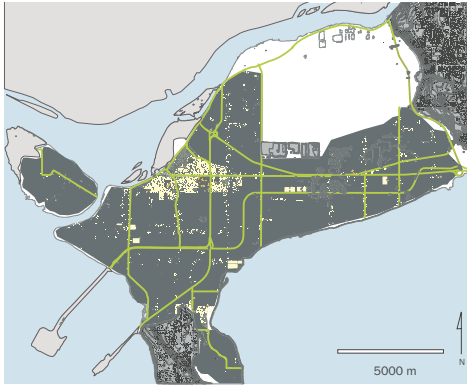


Over time, buildings are either protected or moved and land converts to habitat/open space.

Road / dike length



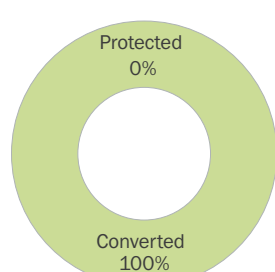
BUILD UP



This SOFT option leaves existing dike and seawall infrastructure as is across the Corporation of Delta. As a result, over time, storm surge and possibly tidal water will occasionally inundate unprotected low-lying areas. Current critical infrastructure such as hospitals, schools and fire halls are raised, new residential development is built to higher Flood Construction Levels, and older residences are gradually raised on an individual basis. Major roads are raised, while minor roads are left at current elevations. During inundation events, individuals are responsible for their own properties and access.

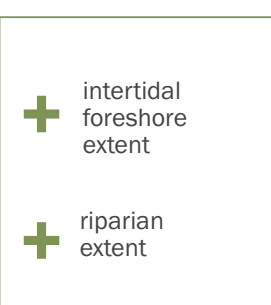


Agricultural land area

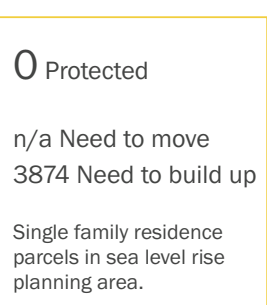


Over time, agricultural land transitions to open space and habitat.

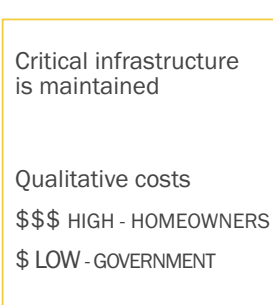
Ecology & Habitat



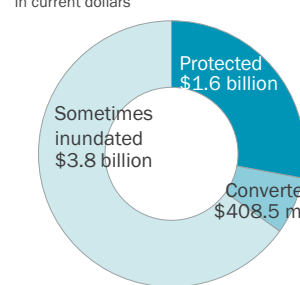
Residences



Infrastructure

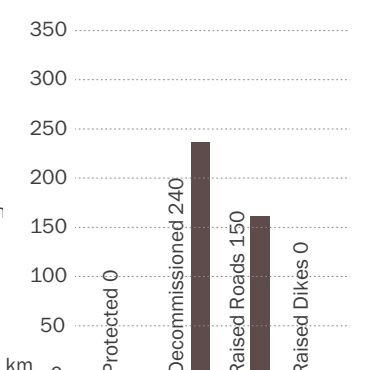


Value of land & buildings



All buildings are assumed to be protected. Agricultural land converts to habitat over time. Residential lots and other land (non-agricultural) are sometimes inundated.

Road / dike length



All indicators are measured for the Sea Level Rise Planning Area, excluding Burns Bog.

HOLD THE LINE SCENARIO

1.2m Sea Level Rise, Year~2100

Description

This ARMORING scenario maintains, strengthens, and raises the existing 60+ km of Delta's dike and seawall infrastructure, in order to protect against sea level rise. By 2100, the dike infrastructure holds the current Delta boundary and there is no net gain or loss of land with the exception of Westham Island. Westham Island infrastructure is not upgraded, and the Island eventually becomes an open space/habitat area.

Key components

dikes and seawalls

Infrastructure assumption

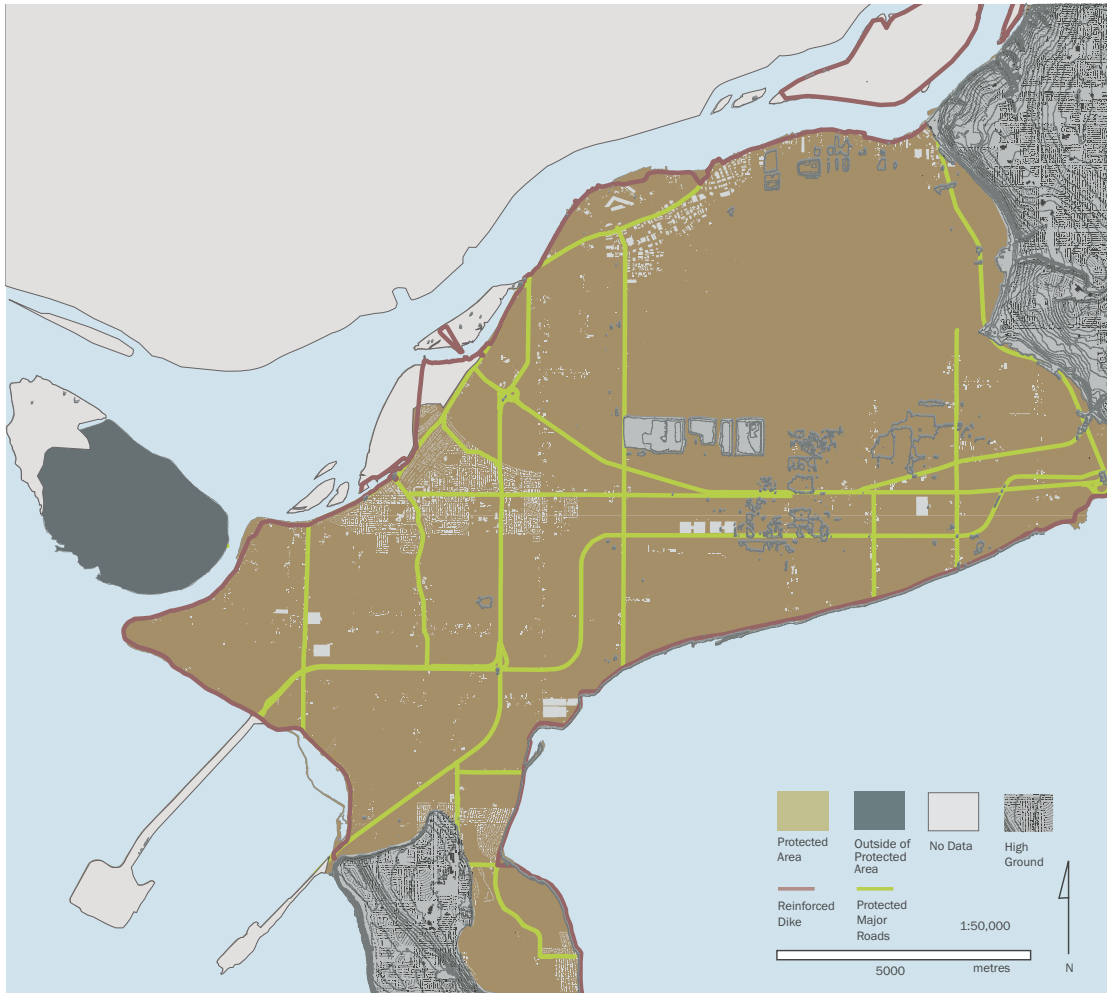
The dike system is built such that the probability of a breach or system failure is so low that in the context of planning, the dikes are "break proof".

Responsibility

Corporation of Delta

Major costs

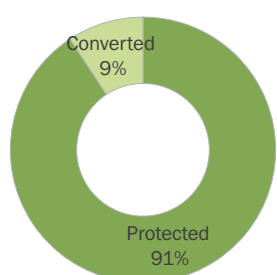
- dike and seawall infrastructure upgrades
- possible internal flood cell boundaries upgrades
- parcel buy-out where needed to accommodate larger dikes



The Hold the Line scenario proposes to upgrade Delta's dike and seawall infrastructure (red line) to protect Delta's low-lying areas from sea level rise.

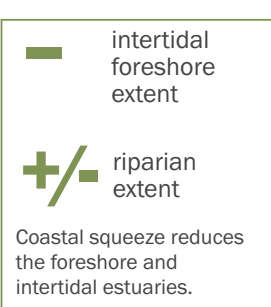


Agricultural land area



Most agricultural land is protected. Over time, a small amount converts to habitat.

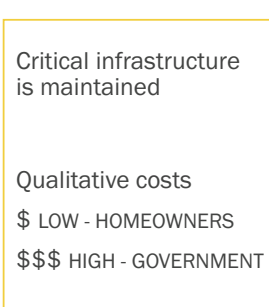
Ecology & Habitat



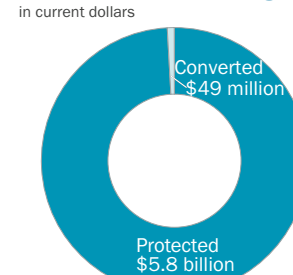
Residences



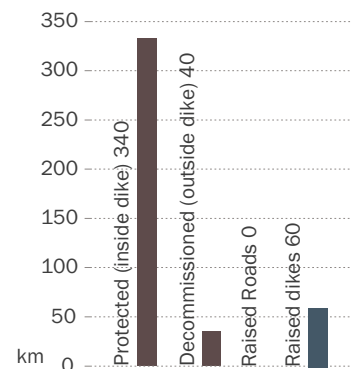
Infrastructure



Value of land & buildings



Road / dike length



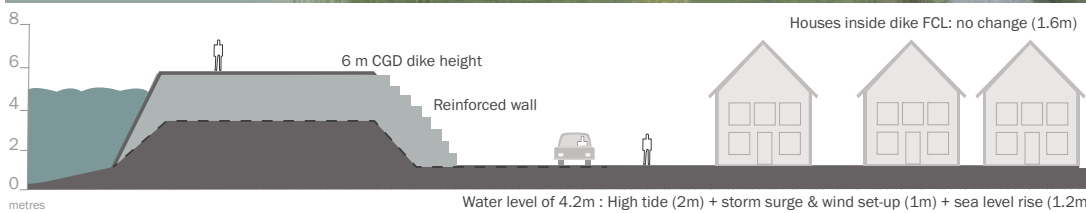
All indicators are measured for the Sea Level Rise Planning Area, excluding Burns Bog.

HOLD THE LINE SCENARIO

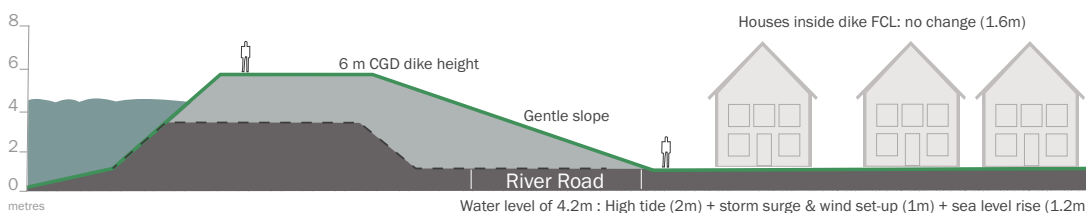
1.2m Sea Level Rise, Year~2100

LADNER

This strategy shows a steep, concrete-reinforced wall in order to maintain the current right-of-way for River Road. The dike is only raised to 5.6m because there is less storm surge and wave run-up in Ladner than in Boundary Bay. Land use on top of the dike is no longer residential, but the dike can accommodate a greenway corridor with walking and cycling paths.



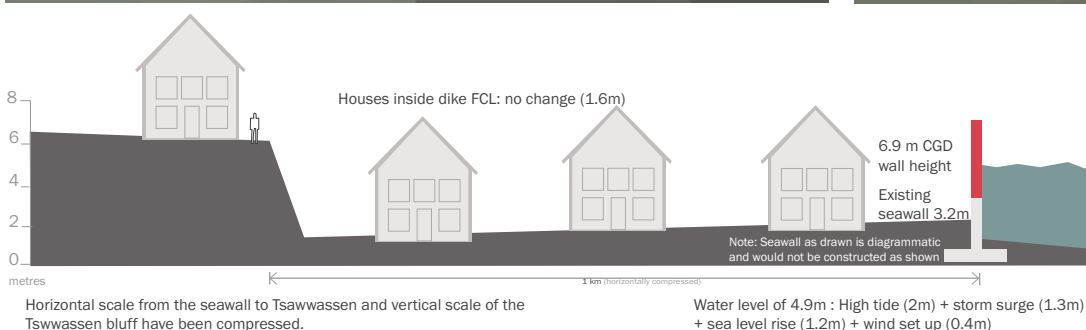
This strategy shows a landscaped berm with a more accessible 1:3 slope that avoids the need for hard reinforcement like the option above. The dike is raised on its centreline. As a result of this design, half of River Road's right-of-way is taken up by the dike, making it a one-way-only lane. Heavier vehicle circulation would be displaced to other streets.



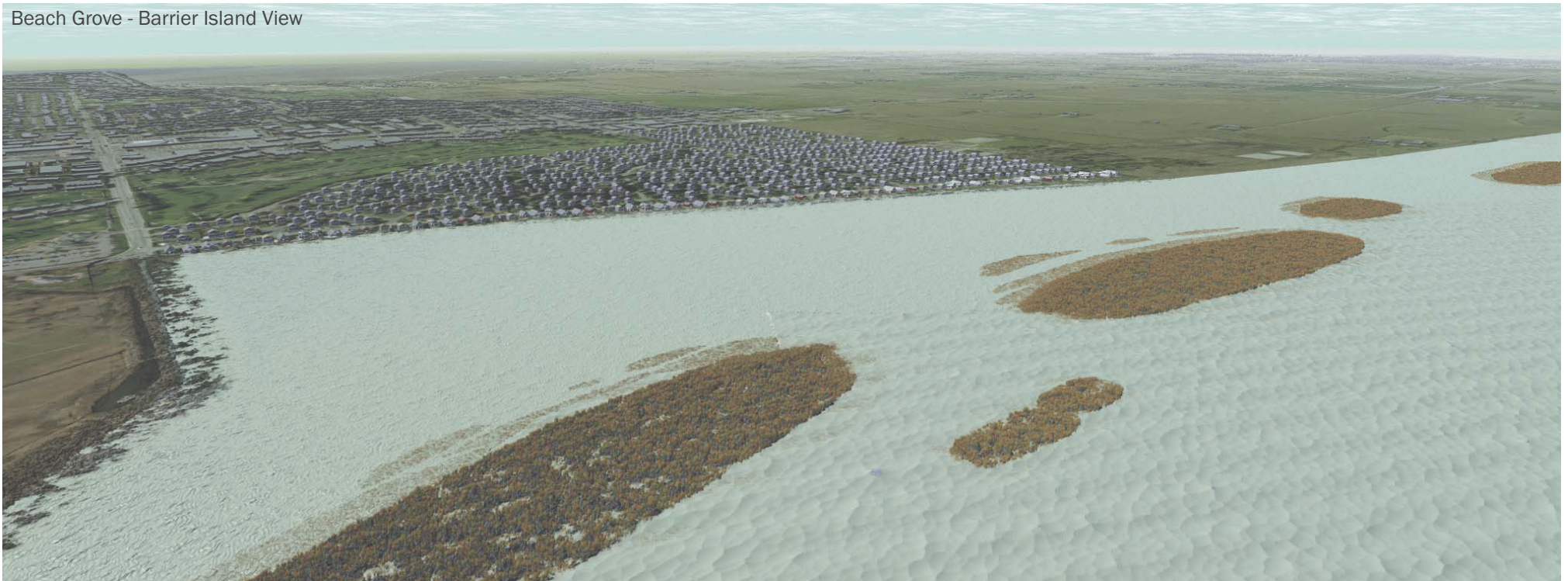
BEACH GROVE

The 2011 provincial Dike Guidelines suggest a top-of-dike height of 6.9m (CGD) for the Boundary Bay area.

Experts have suggested that with a vertical seawall, the wall would need to be higher than an earthen dike because of the increased wave action associated with a vertical barrier (wave run-up). Considerable coastal engineering measures, such as concrete "tetrapods" to reduce the impact of waves and storm surges, could also be required.



Beach Grove - Barrier Island View



DESCRIPTION

This soft ARMORING sub-scenario of Hold The Line maintains, strengthens, and raises the existing 60+ km of Delta's dike and seawall infrastructure, built to higher standards, in order to protect against sea level rise. In addition, outer dikes close off some areas from the river/sea (eg. Ladner Harbour, and Deas Island to protect the Massey Tunnel exit). Ecologically functional barrier islands could be used to reduce the probability of inundation around Boundary Bay. By reducing incoming wave energy off-shore, the barrier islands would allow for slightly lower dikes or seawalls around Boundary Bay, as compared to those in Hold the Line.

Key components

dikes and seawalls; barrier islands; beach nourishment

There are potential small gains in usable land, and in habitat areas. This scenario works to reduce coastal squeeze and to maintain and/or improve inter-tidal habitat.

Westham Island infrastructure is not upgraded, and the Island eventually becomes an open space/habitat area.

Responsibility

Corporation of Delta

Major costs

- Dike and seawall infrastructure upgrades
- Dike additions (eg. Ladner Harbour)
- Internal flood cell boundary upgrades
- Parcel buy-out where needed to accommodate larger dikes
- Barrier islands; other beach nourishment measures

