Challenge of Sea Level Rise for the City of Surrey

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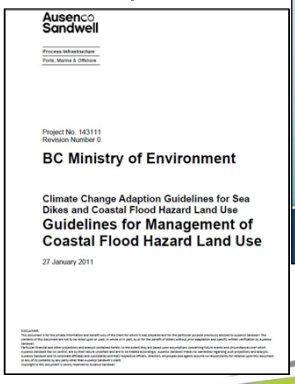
Projected Sea Level Change

Provincial Government reports predict sea level changes for BC. Key factors included in these reports are:

- Sea level rise projections
  - 2100 & 2200
- Ocean surge
- Wave run-up
- Vertical Land Movement
- Land Subsidence


Ausenco Sandwell

Process Infrastructure
Ports, Marine & Offshore

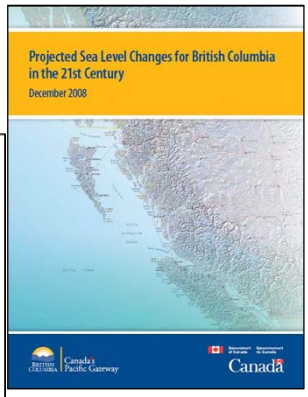
Project No. 143111
Revision Number 0

BC Ministry of Environment

Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use

Guidelines for Management of Coastal Flood Hazard Land Use

27 January 2011



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2100 Predictions

Predictions are 100 years in the future but as the community redevelops and infrastructure is renewed, these factors need to be considered in designs.

River Meets the Sea

The provincial work focused on ocean forecasts but did not address the transition of rivers meeting the sea.

In these areas, the combination of rainfall and sea level/surge level is critical.

Overall system design and hydraulics play a large role in determining floodplain area.

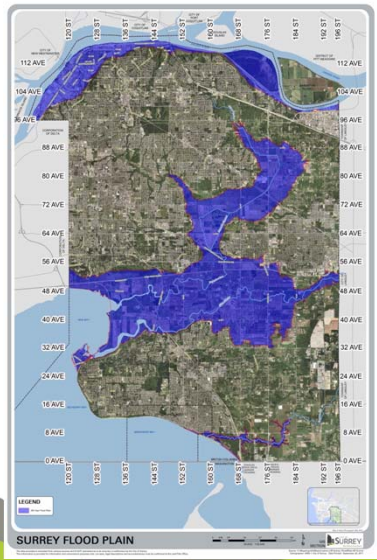
Serpentine, Nicomekl & Campbell Rivers – Climate Change Floodplain Review

Surrey is currently beginning a project that will provide the framework for future policy and design standard development within the zone of influence using the Provincial documents as a foundation.

Specific goals and objectives of this project include:

- Identification of the specific sea levels in Mud and Semiahmoo Bays consistent with the Ministry publications;
- Determination of ocean levels;
- Determination of precipitation events;
- Analysis (magnitude and timing) of combined surge, wind setup, wave setup, sea level rise, tidal pattern and precipitation;
- Identification of flood routing;
- Impact assessment of the projected sea levels on the lands upstream and downstream of the existing sea dams;
- Determination of new floodplain;
- Review of existing floodplain levels with results of the sea level impact assessment for various time horizons; and,
- Assessment of critical timing/vulnerabilities throughout the projected sea level rise to determine the order of anticipated impacts.

Existing Floodplain Areas in Surrey



- Over 8500 ha of Surrey is currently within a floodplain area.
- Surrey has 54 km of shorelines on Boundary Bay (32km) and Fraser River (22km)
- Key floodplain areas are:
  - Fraser River floodplain
  - Serpentine / Nicomekl River floodplain
  - Campbell River floodplain
  - Boundary Bay floodplain
- There are approximately 100 km of dikes, 30 drainage pump stations, 2 sea dams, over 170 flood boxes and 10 spillways

Sea Dams

Serpentine & Nicomekl Rivers both have Sea dams which prevent brackish water from travelling upriver at high tide cycles.

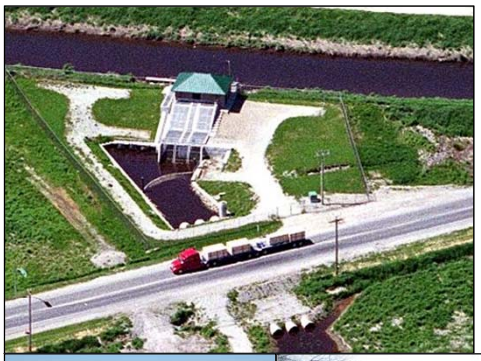
Dams were originally installed in early 1900's with upgrades in 1970's

Without these structures, brackish water would travel upstream affecting local farmers and would also change flooding patterns in the river systems

Ocean and River Dikes

Dikes are designed for the conditions present – ocean systems for wave and erosion issues while river for conveyance and fisheries.
Controlled flooding areas important in river system – want to control flood points so dikes are not lost in other places.

Drainage Pump Stations



At times of high ocean or river levels, a pump station is the only way to drain behind the dikes.

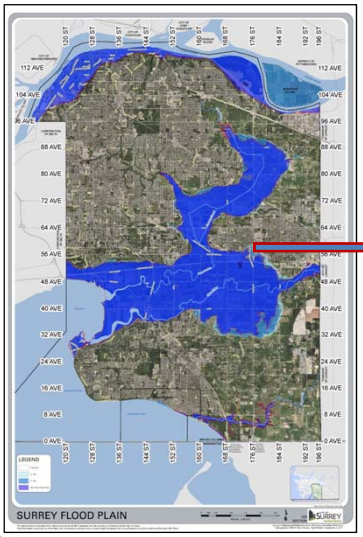
When the water is too high, we shut off the stations and allow cells to flood so dikes are not compromised. This only occurs with extreme events.

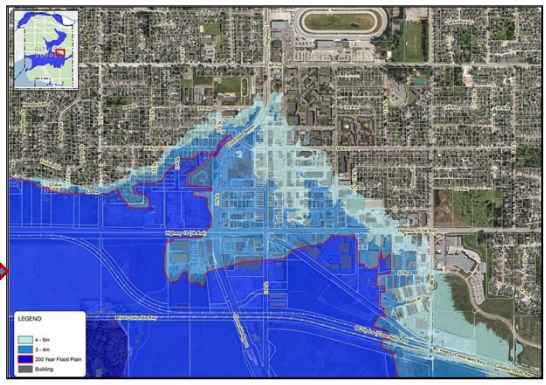
Historic Development Areas

Although most of the floodplain area within Surrey is in the Agricultural Land Reserve, there are some key historical settlement areas such as:

- Crescent Beach
- Cloverdale
- South Westminster

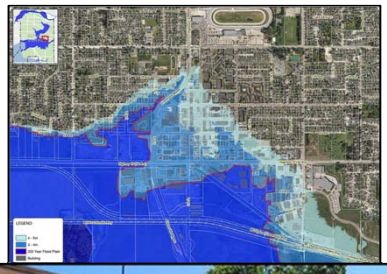
Home, businesses and industries were built on very low lying lands with only some filling occurring with redevelopment. It is difficult to meet current Provincial Building Flood Elevations.





- A 1 to 2 meter sea level rise in Boundary Bay may be felt throughout the Serpentine, Nicomekl & Little Campbell River floodplains and into historic urban development areas.

Cloverdale



If the projected sea level rise is transmitted upstream lineally, a large area of Cloverdale could be impacted not only by surface water elevations but by pipe hydraulics.

Areas outside the “flood zone” may have basements or are now connected to pipes which can’t freely drain thus potentially impacting a larger area.

Redevelopment of this area also means the City needs to know potential flood elevations in order to have buildings constructed and serviced properly.

Infrastructure Considerations

Placement of infrastructure in the floodplain area is critical. Some key items include:

- Sanitary lift stations (and treatment plants)
- Electrical control boxes for traffic signals and street lights
- Key potable water infrastructure (prevention of backflow)
- Access roads to pump stations and other critical infrastructure
- Emergency access

Crescent Beach Example

The Crescent Beach Community lies adjacent to Mud Bay within Boundary Bay. It is a fully diked community meeting current Provincial dike standards.

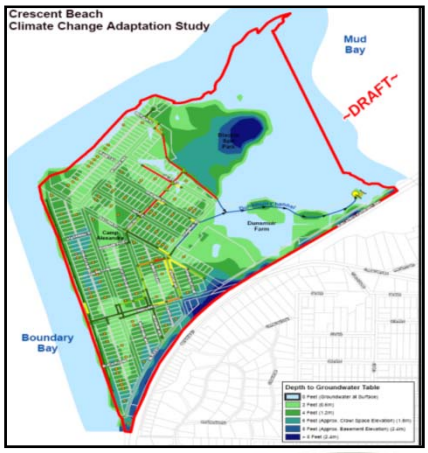
Residents began having drainage issues in the community during winter high tide events

Most of the area is serviced by rock pits, or a limited pipe system with a small pump station

Began a study in 2009 to look at flooding issues.

Influence of Climate Change

- Sea levels will rise ~0.67m over 100 years (findings prior to recent provincial document)
- Groundwater levels will also rise, potentially flooding low lying areas
- Over the long-term dikes will no longer meet Provincial dike design levels
- Insufficient pipe capacity to convey flows



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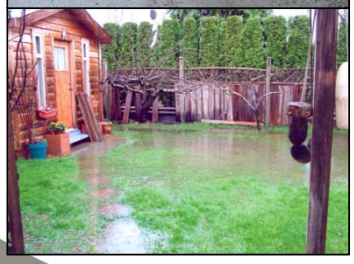
Groundwater Influence



One of the surprising findings was that groundwater is closely linked to tide levels and followed those patterns.

Time delay was not days but hours in terms of tidal influence.

In the winter during higher tide / storm events, groundwater was evident on the surface.

The influence of rising tidal levels and area submergence has slowly evolved into increased flooding in the area.

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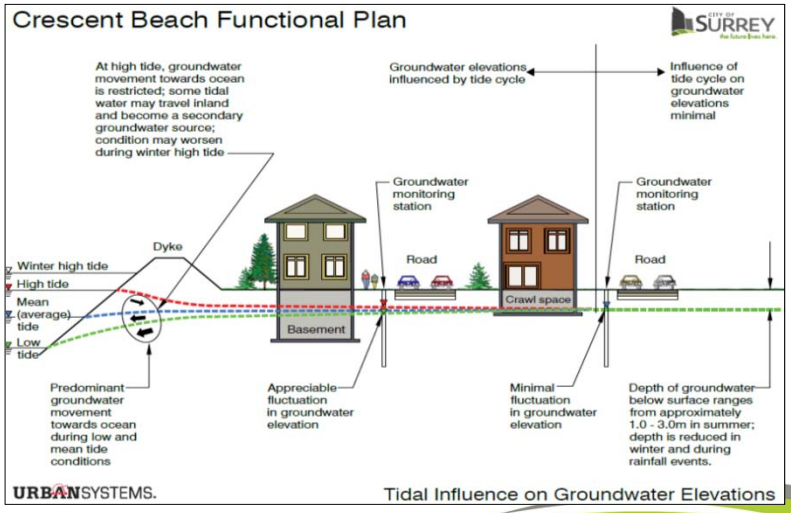
Tidal Influence on Groundwater



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Flood Construction Levels

As part of the study we also looked at flood construction levels.
The challenge will be having buildings construct to higher elevations as they redevelop.

The current existing FCL for area is 3.6m.

The potential FCL for area is approximately 5-6m.

Current lot elevations range from 0.7m to 3m with most being about 1.5m.

How do you raise a lot 3.5-4.5m?

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Proposed Servicing Strategy

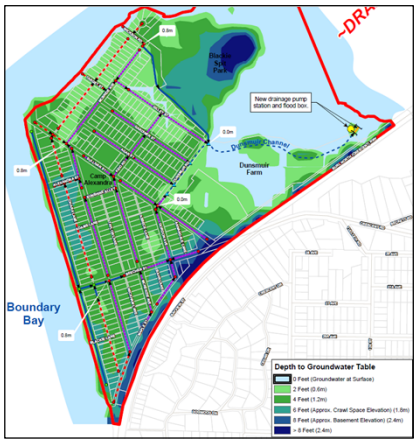
The study evolved into a proposed servicing strategy which included:

• Installing a closed sewer system along shoreline to prevent salt water intrusion and to stabilize groundwater interface issues

•Installing a perforated drainage system to control groundwater levels internally in the community

•Raising low properties and roads during redevelopment & other servicing improvements

•Constructing a new pump station to handle storm and groundwater flows



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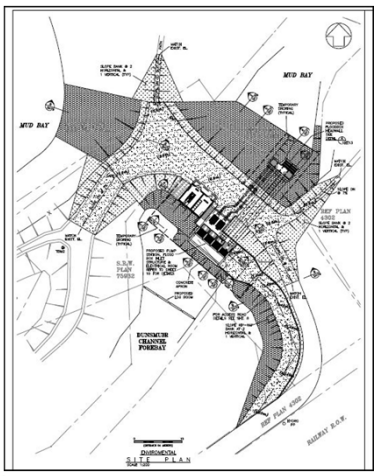
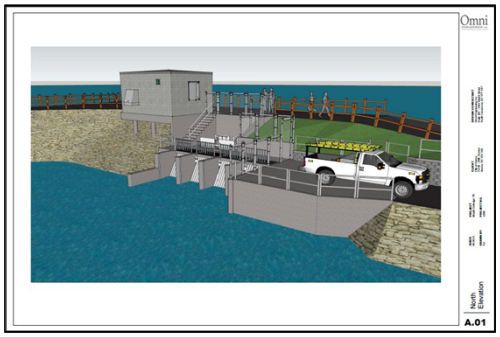
Maple Pump Station Replacement





Designed for 100 year life span with some localized dike raising to accommodate potential sea level changes. Construction to start 2012.

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Beyond a Local Government's Control

In addition to local government infrastructure within the floodplain, many private and senior government agencies own and operate infrastructure within the floodplain.

These agencies and assets include:

- Highways constructed across floodplain areas (Hwy 15, Hwy 10, Hwy 99, new SFPR)
- Agricultural Land Commission (ALR)
- Port facilities
- Railway facilities and tracks along shorelines and through floodplains (BNSF, CNR, CP, Southern Rail & BC Rail)
- BC Hydro, Fortis, Kinder Morgan, Shaw, Telus etc. who have critical infrastructure in & across floodplains
- Treatment plants, transmission lines i.e. Metro Vancouver facilities in floodplains

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Coordinated Efforts

Managing assets & infrastructure in a floodplain is a coordinated effort.

Who will determine the value of ALR lands versus dike construction in sea level rise scenarios?

Who determines critical infrastructure placement relative to flood elevations?

Current issues exist with Highway construction levels through floodplain, electrical controls, & regional infrastructure ie sanitary lift stations for example.

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Environmental Approvals

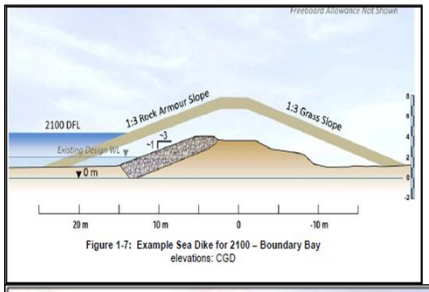

Figure 1-7: Example Sea Dike for 2100 – Boundary Bay elevations: CGD

The provincial figures look clear and easy but in reality, how will you build a dyke 10 to 20m seaward without having environmental approvals?

Is Fisheries & Oceans Canada, Environment Canada, Canadian Wildlife Services and Ministry of Environment on board with this concept?

What is the environmental strategy – provincially for the "squeeze effect" which will result in the loss of significant environmental areas?

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Assistance at all Phases

As communities begin to examine what the new provincial documents could mean to them, they will quickly find they will need expert resources, cooperation from other levels of government and financial assistance.

- The base planning studies to find out impacts could be expensive.
- Conducting designs, acquiring properties, getting approvals from fisheries and others will be complicated and expensive.
- Implementing design features which include more than just dike construction will be a challenge as existing flood funding is targeted for dykes and some pump stations typically.
- Having Fisheries and Oceans (DFO), Environment Canada and MOE waive some of the environmental requirements will be critical as shoreline squeeze will occur.
- Changing provincial policies regarding local government liability i.e. flood construction elevations or non conforming dikes are necessary.
- Provincial & Federal plan on retreat strategies, if applicable, as this is too involved and expensive to be managed at a local government level.

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Questions