WELCOME TO THE FLOOD CONSTRUCTION LEVEL WORKSHOP

JUNE 7TH 2016

north saanich

District of North Saanich

Flood Construction Level Study

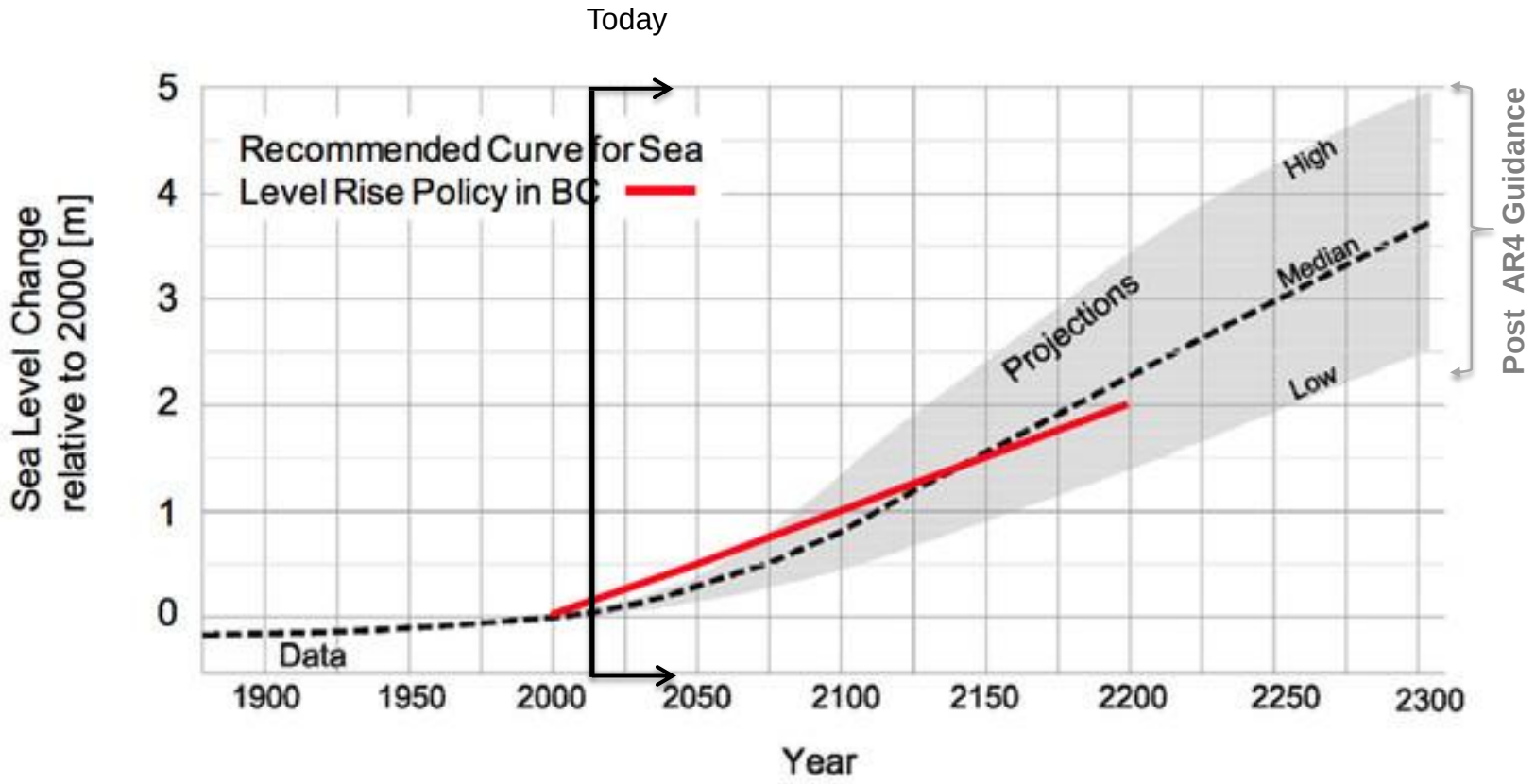
Workshop 2016-06-07

Agenda

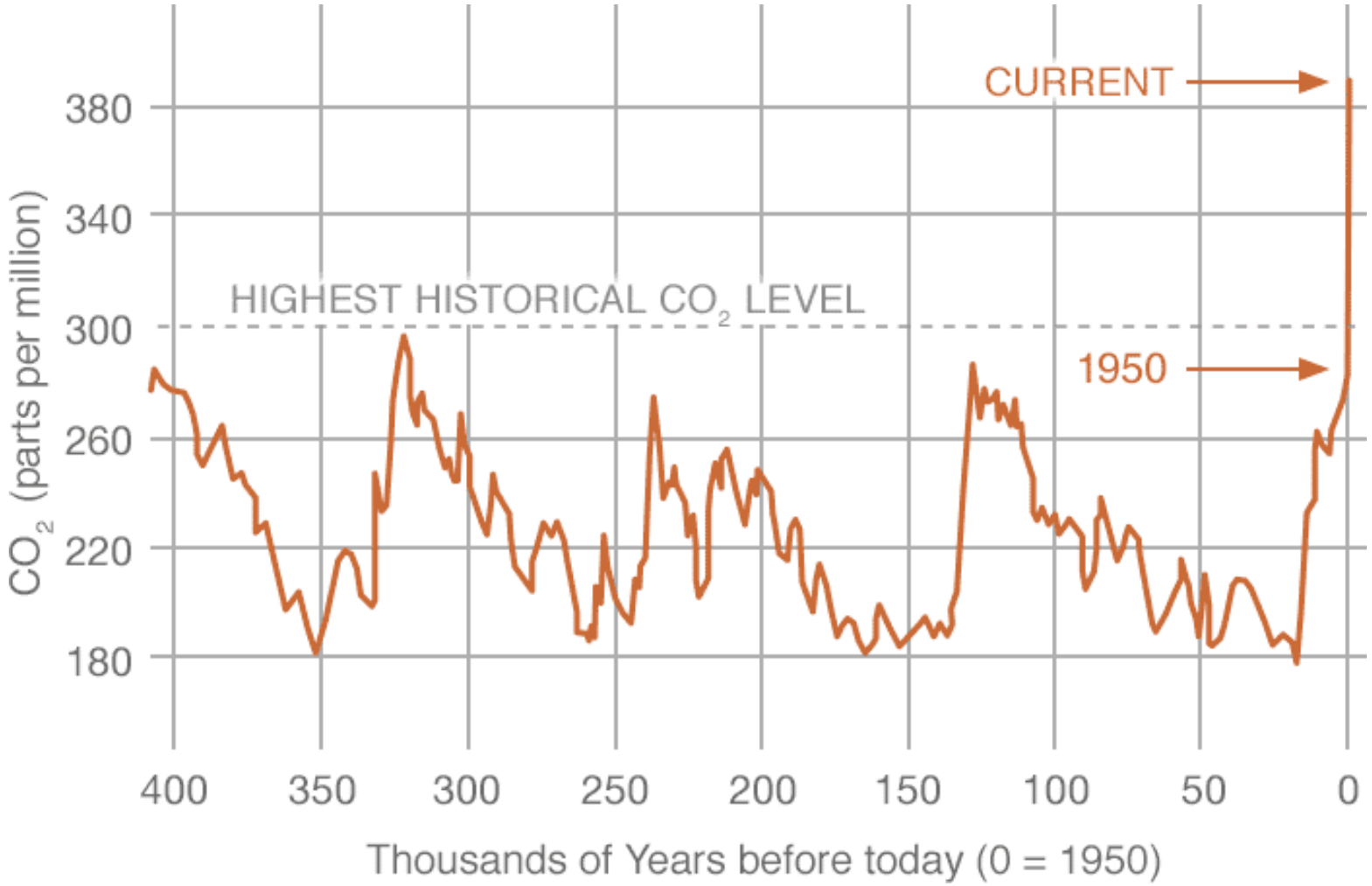
09:10	Update on Expected Sea Level Rise
09:30	Questions
09:40	Results of the Wave Effect Study and the FCL Report
10:10	Questions and Discussion
10:30	Coffee (15 min)
10:45	Implications to DoNS Marine Policy and Shoreline Development Review
11:15	Questions
11:25	Implications and Application of FCLs to DoNS Shoreline
12:10	Breakout Session
12:30	Discussion of Overall Implications
13:00	Adjourn

SLR Update

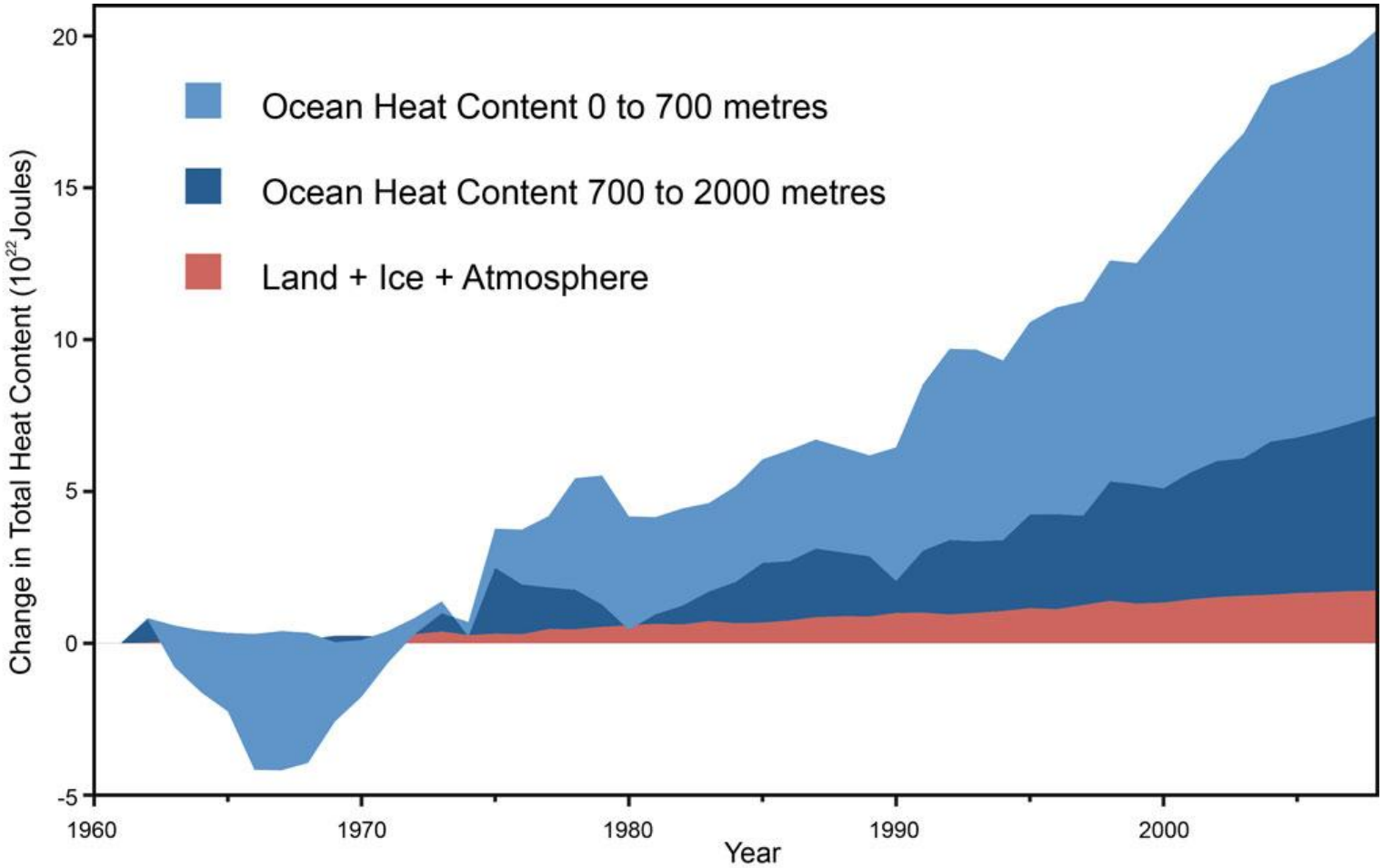
2011 BC Guidance



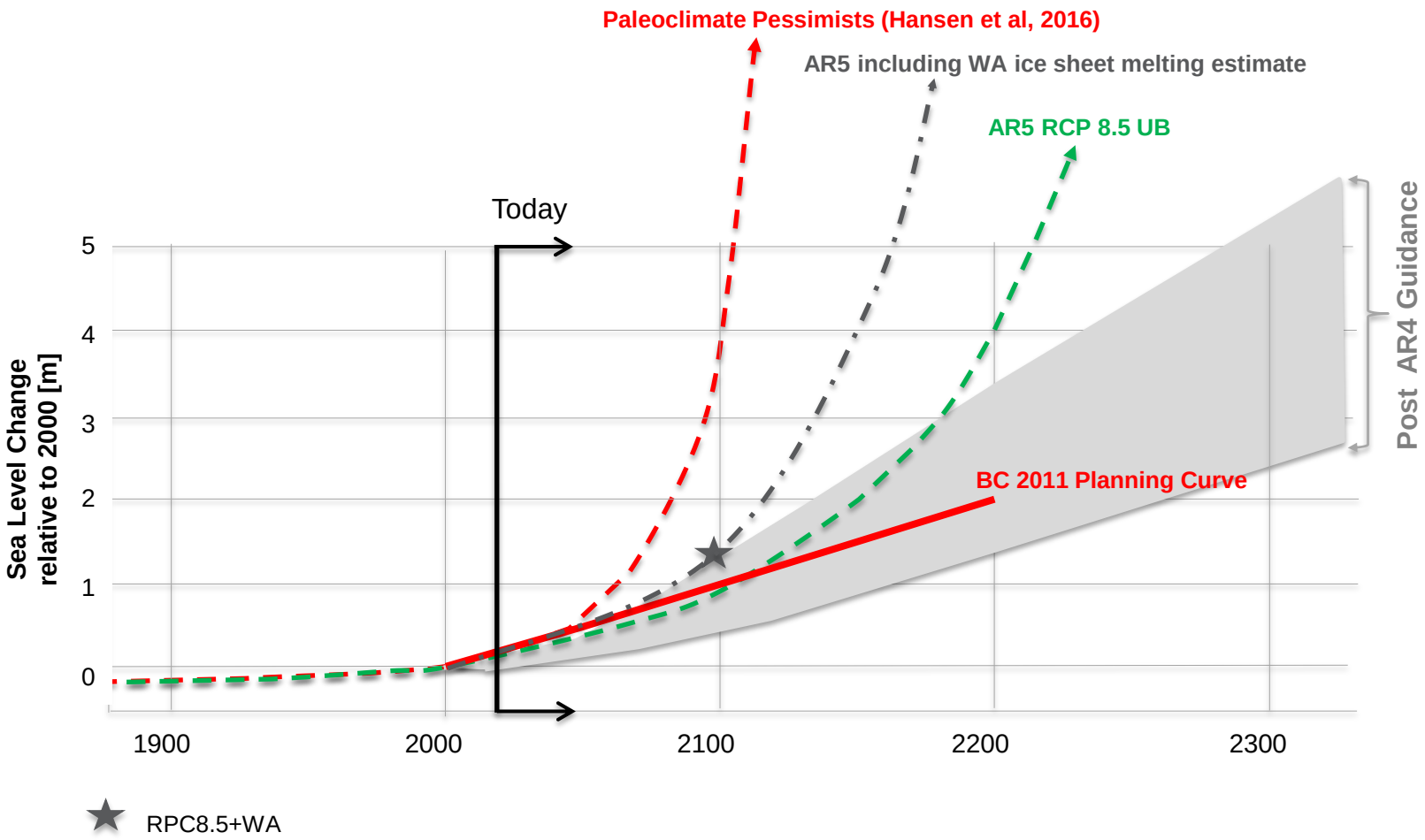
CO_2 Background



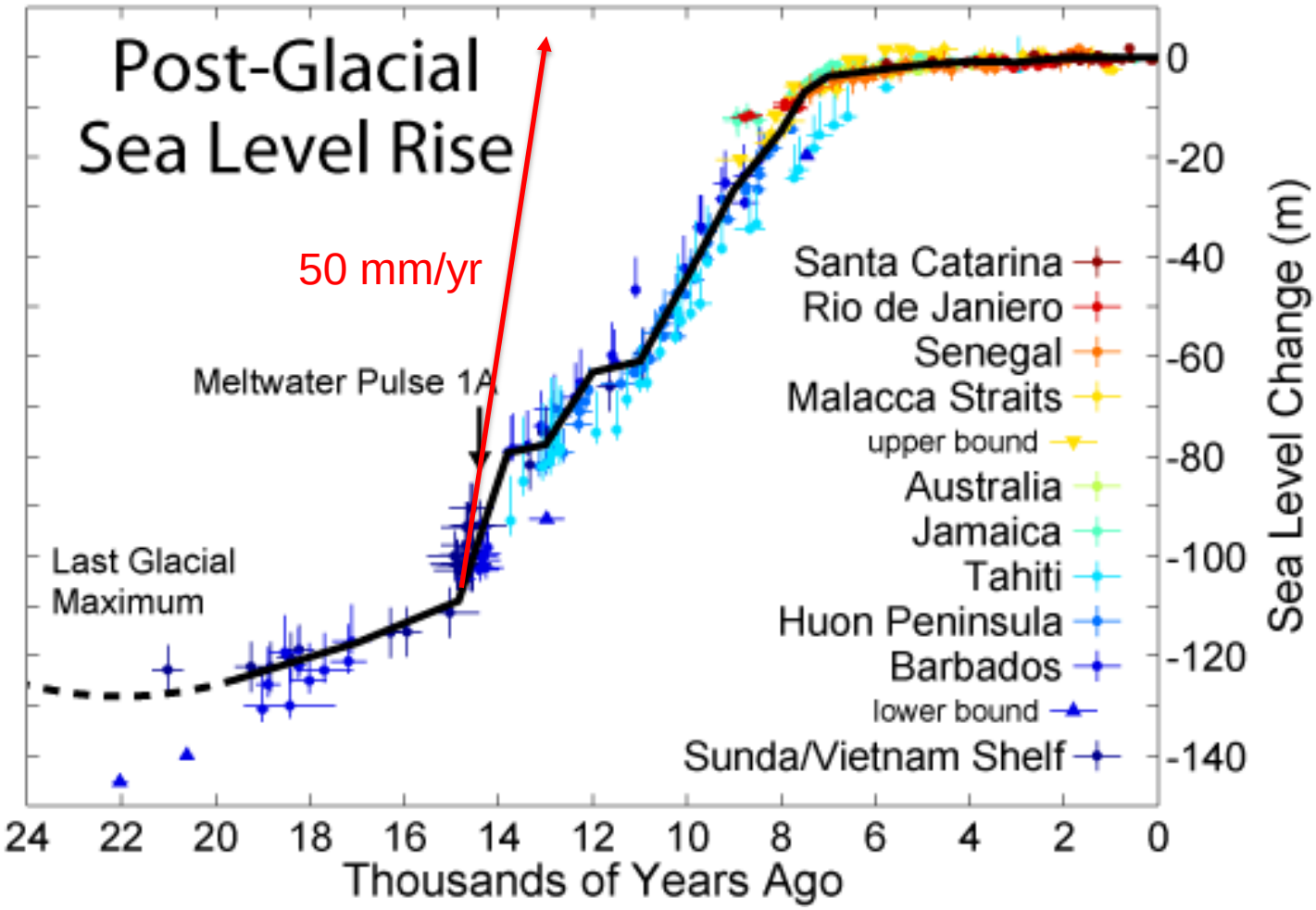
Air and Ocean Temperatures



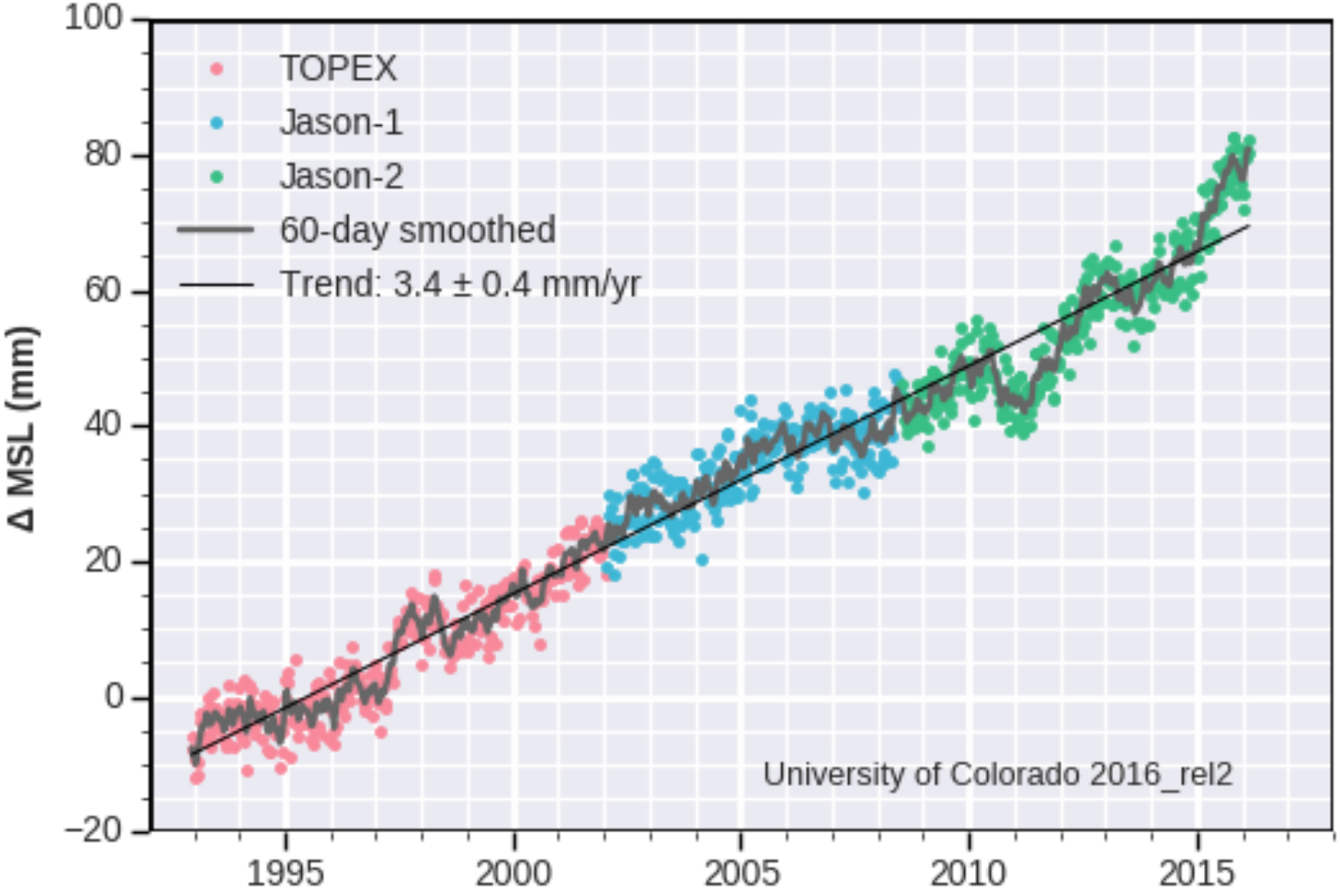
Updated Guidance



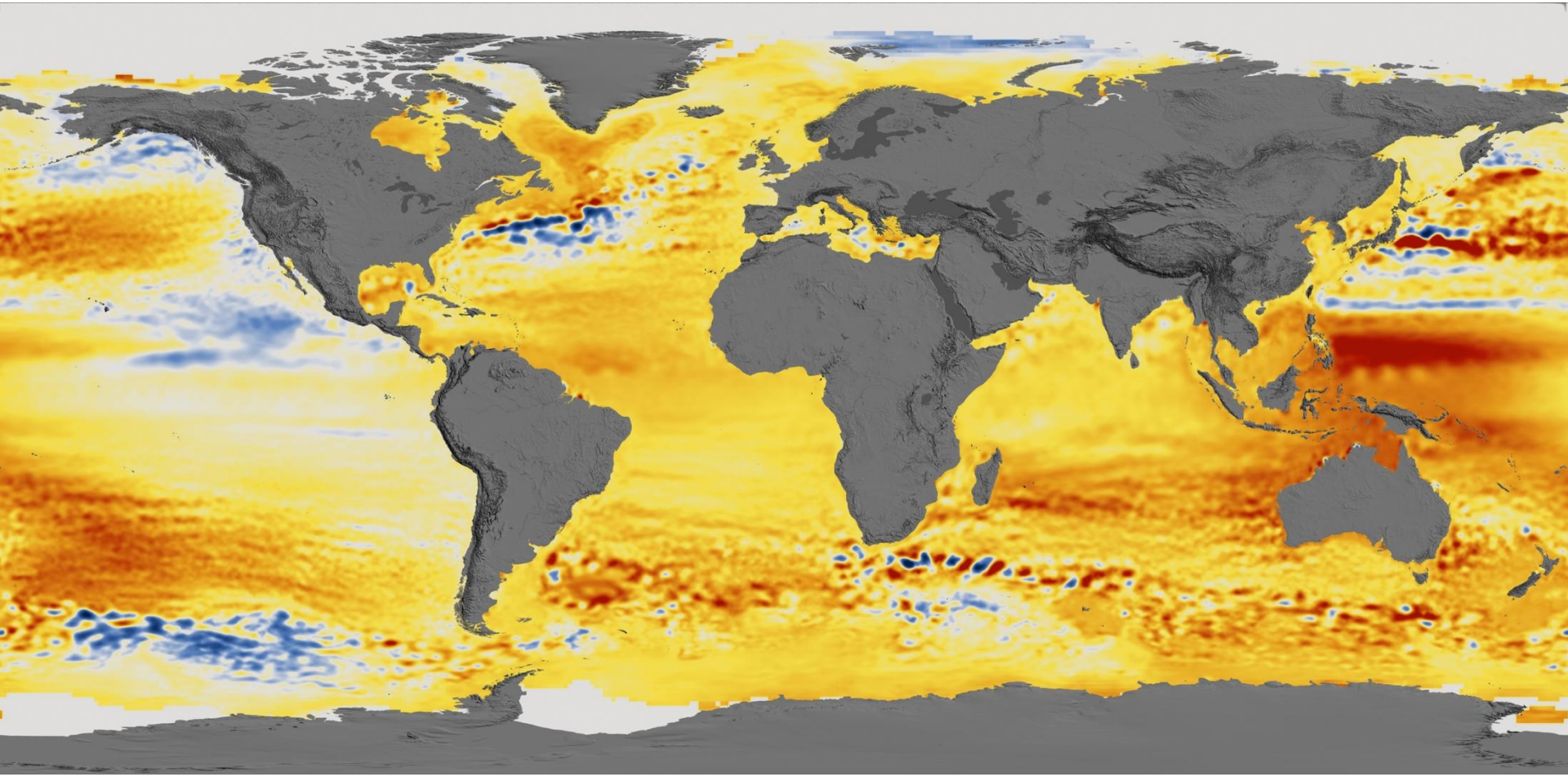
Paleoclimate Background



Recent Mean Sea Level Rise



Global SLR – 1992 -2012 - Average

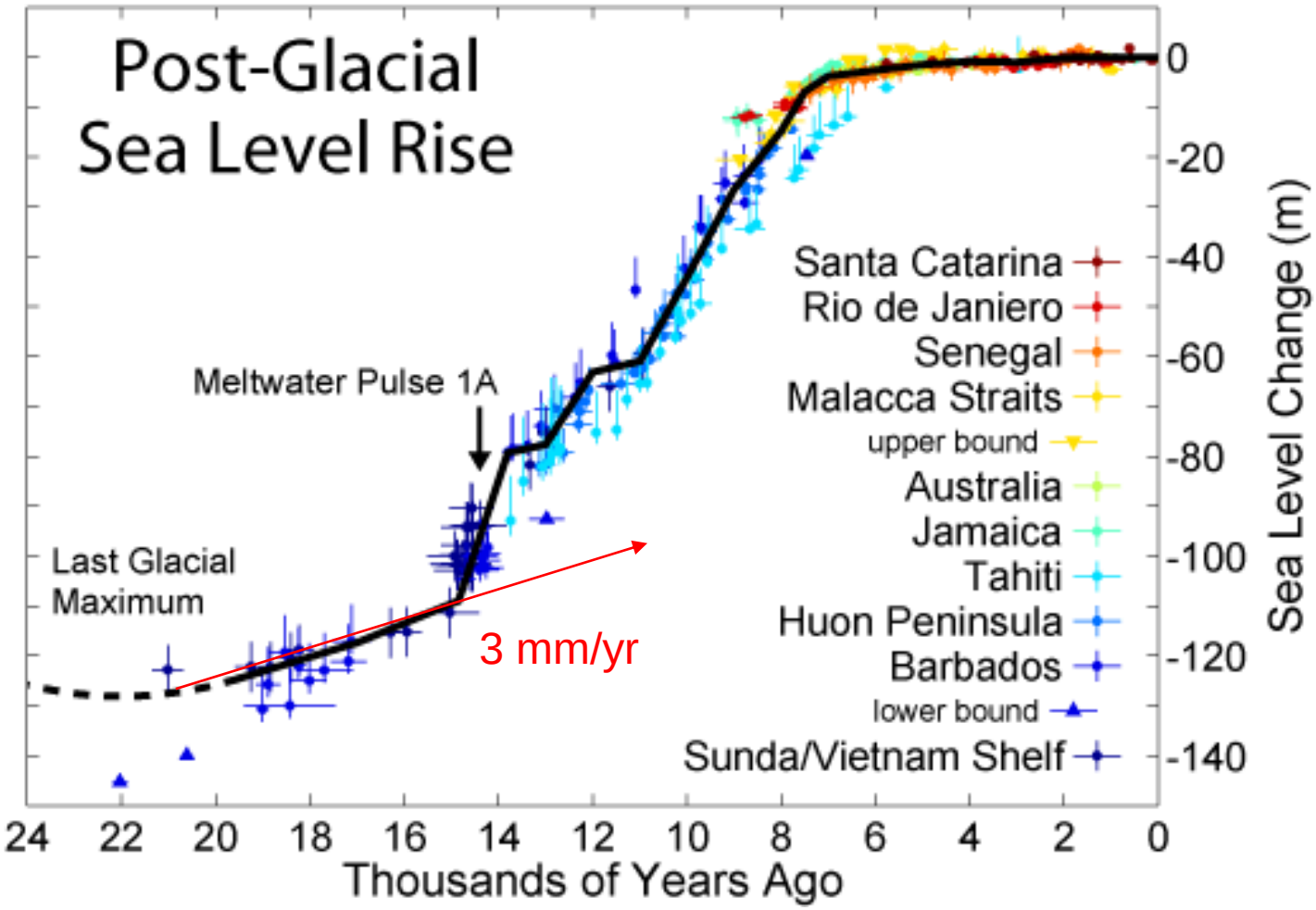


NASA and AFP August 2015

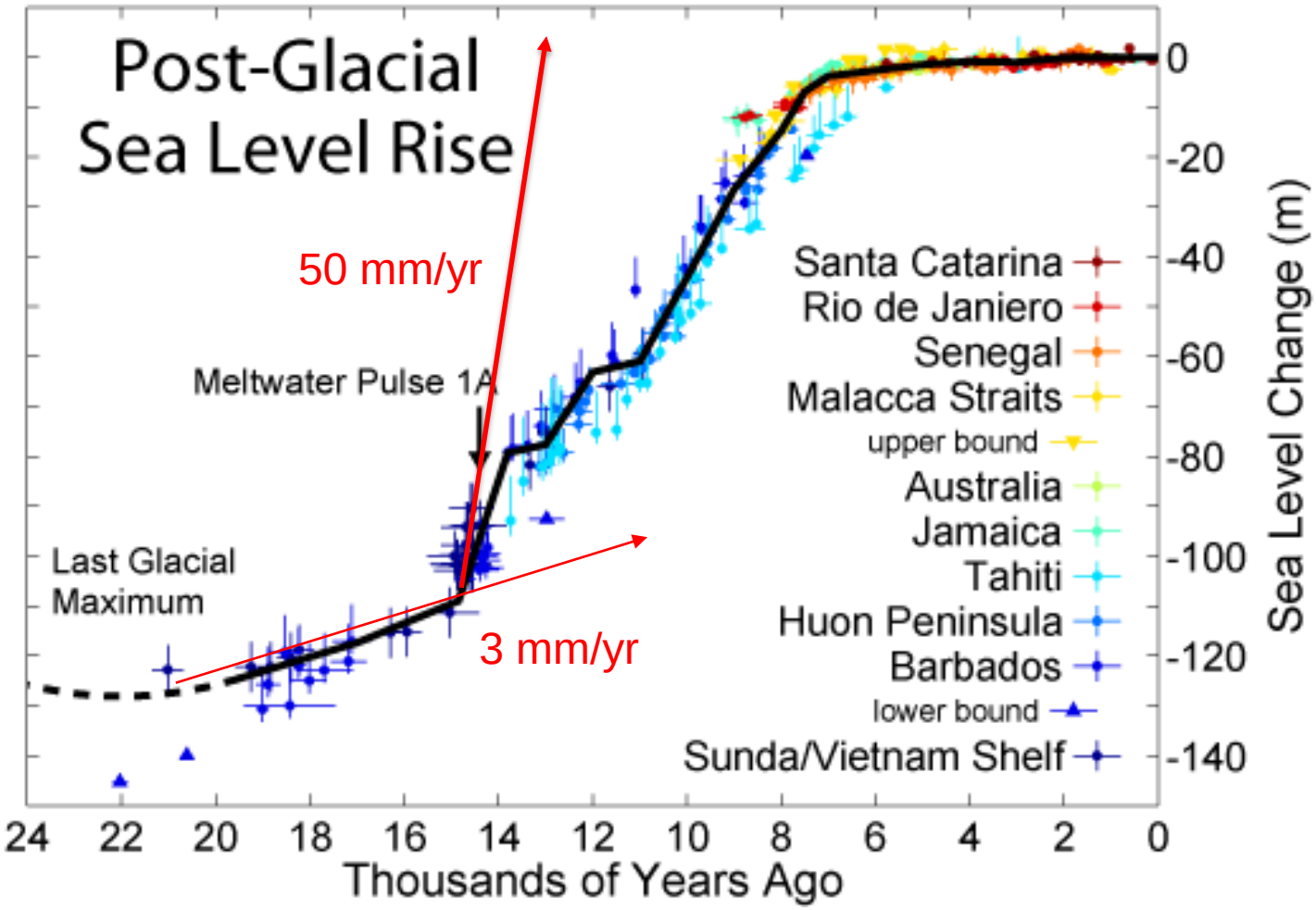
3.5
mm/yr
or
70 mm

>70 mm  <70 mm

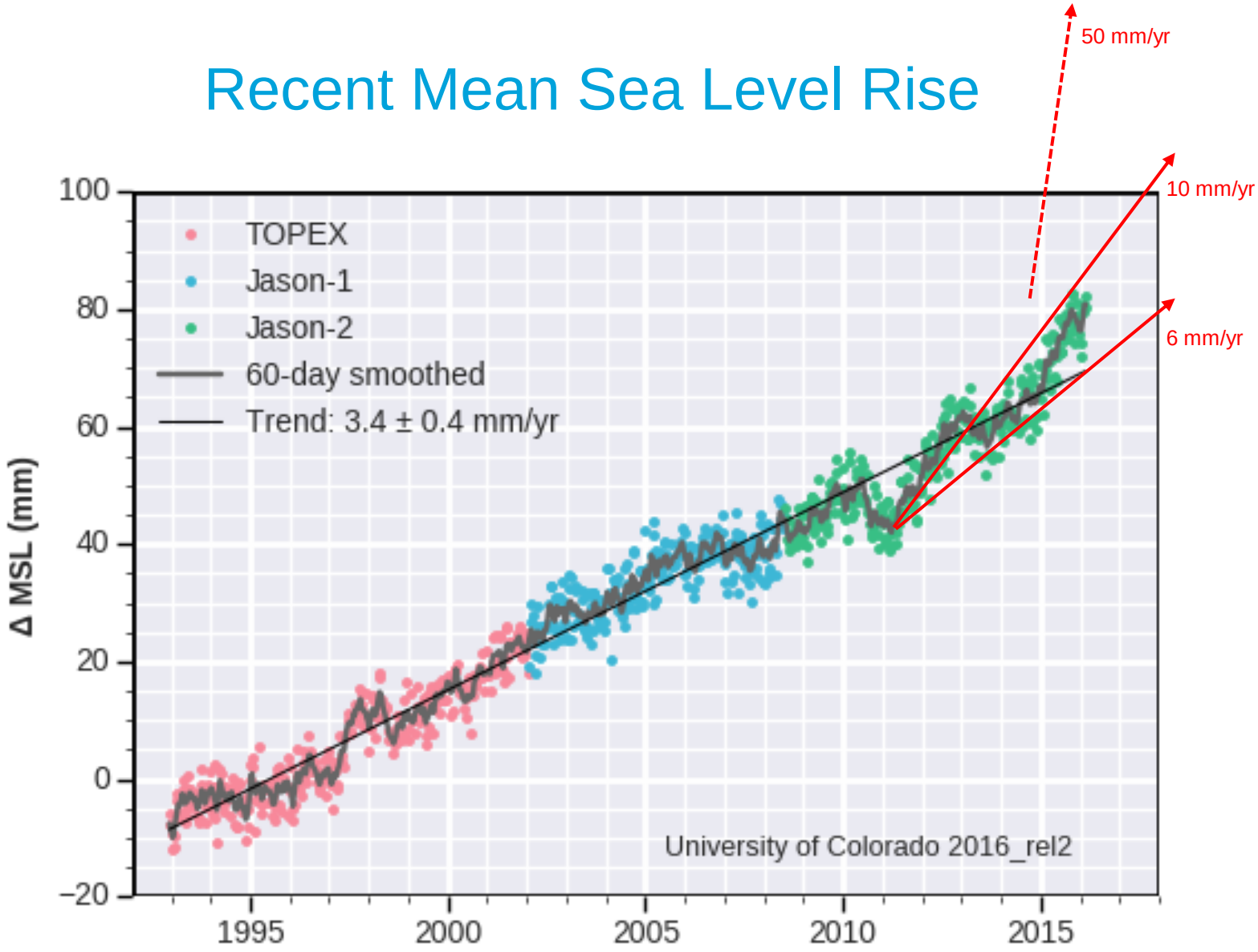
Paleoclimate Background



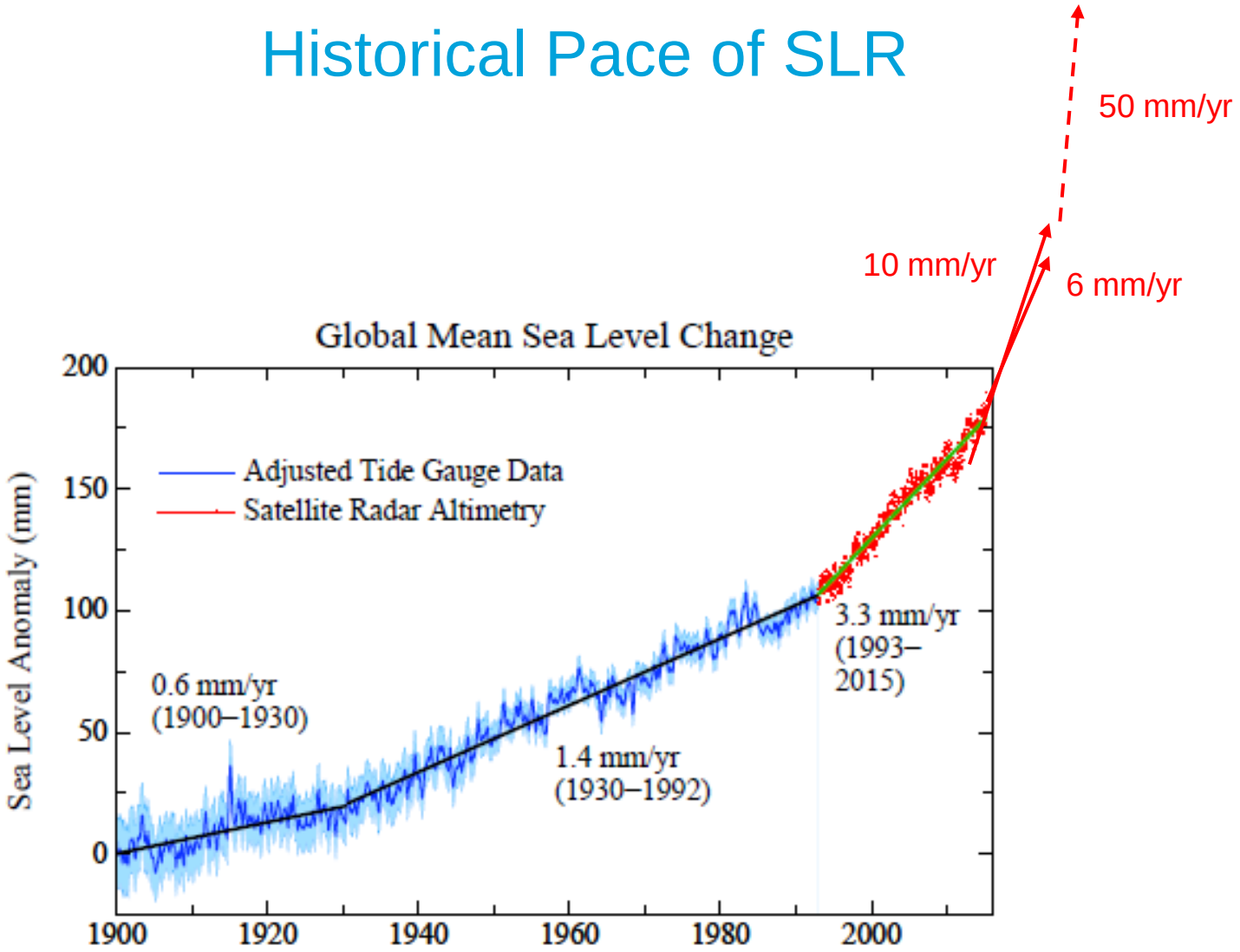
Paleoclimate Background



Recent Mean Sea Level Rise

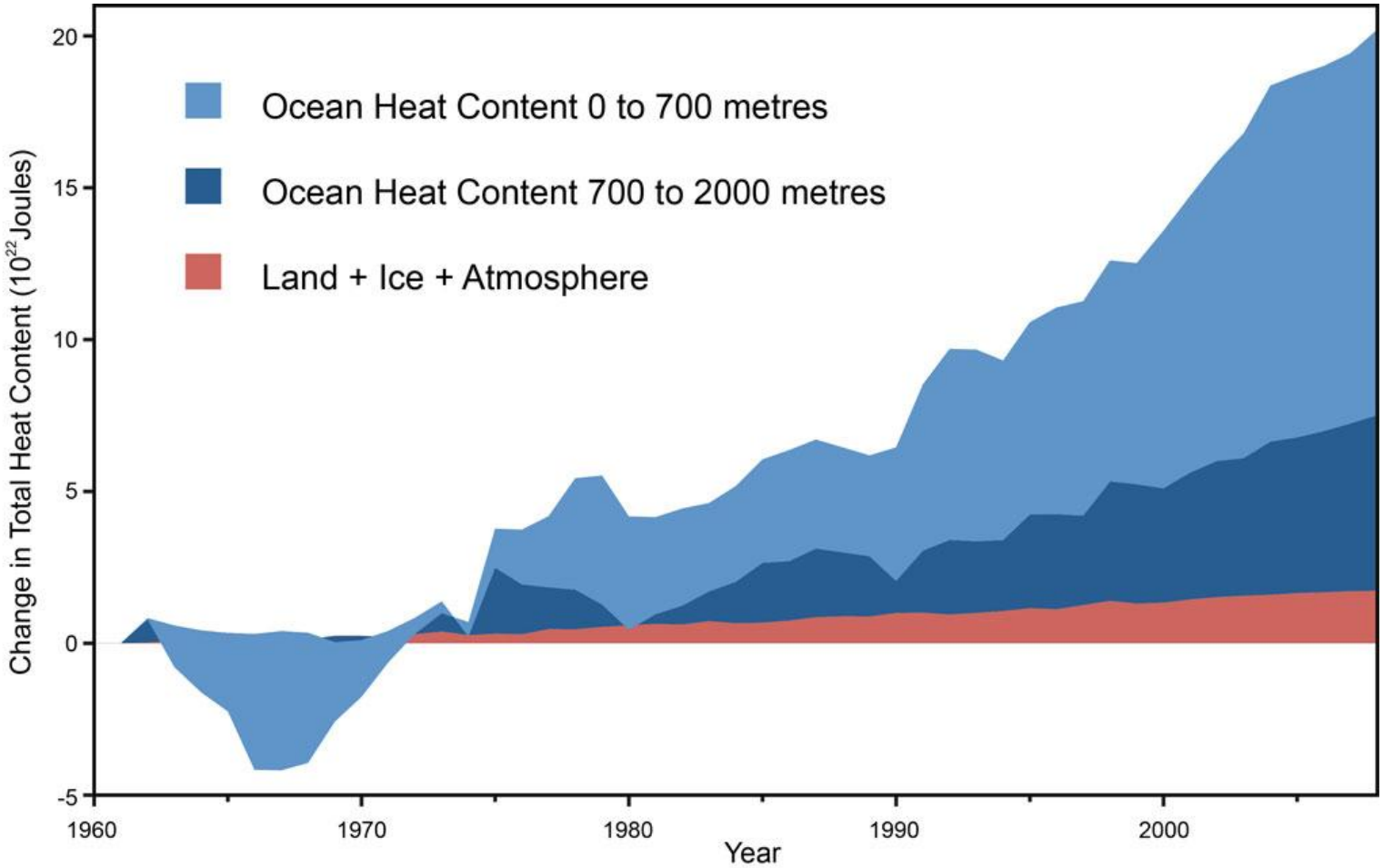


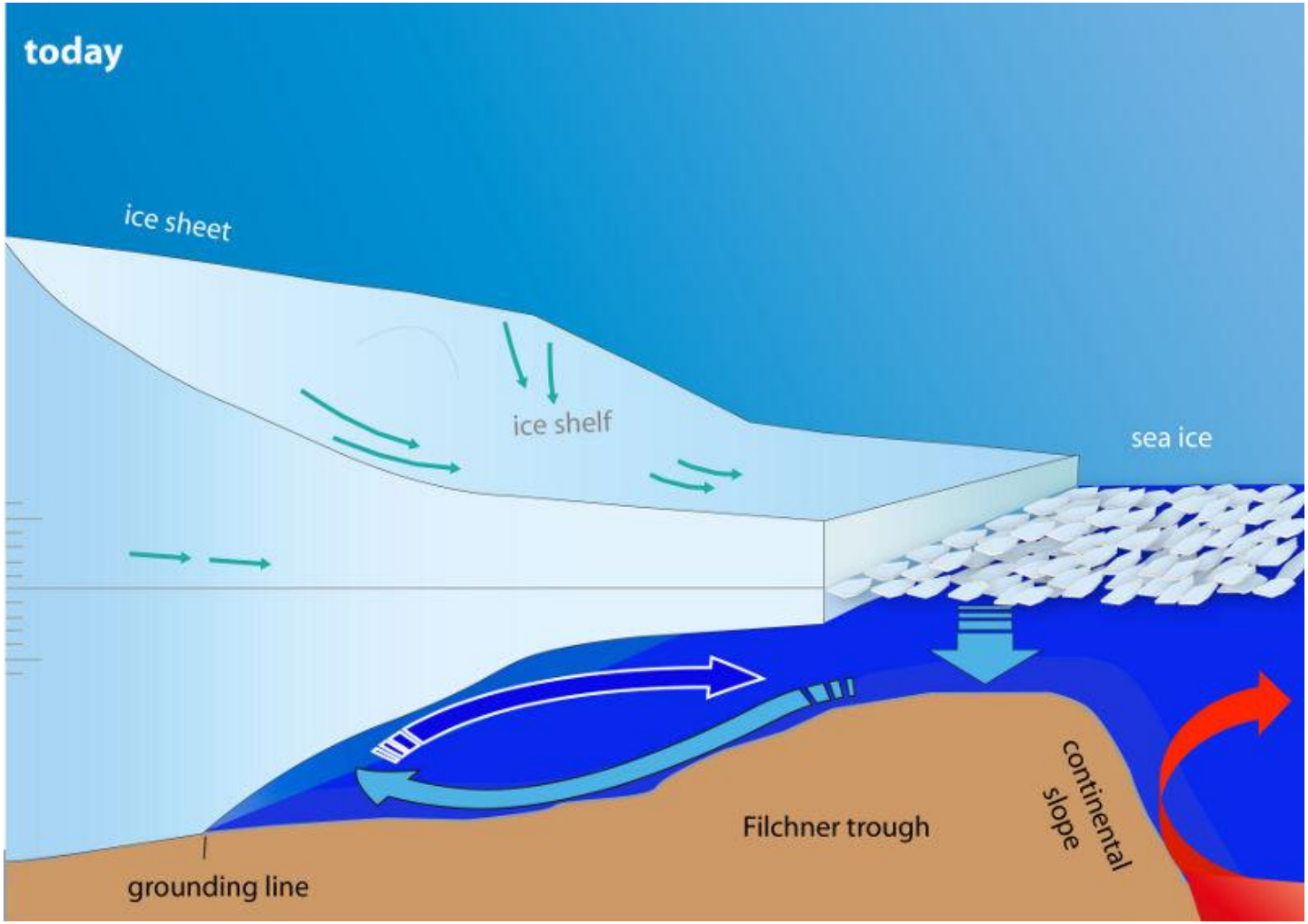
Historical Pace of SLR



From Hansen et al (2015) – reflecting work by Hay et al (2015)

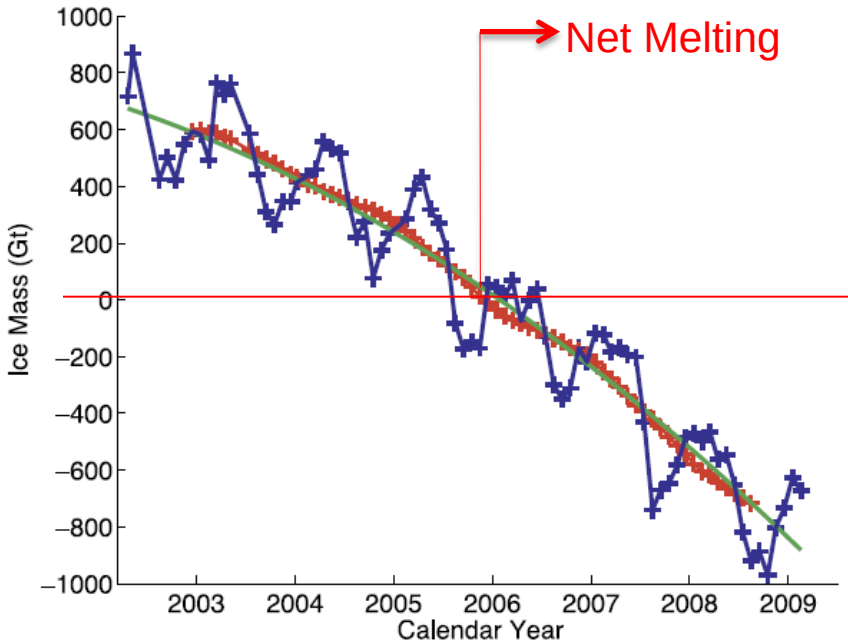
Air and Ocean Temperatures



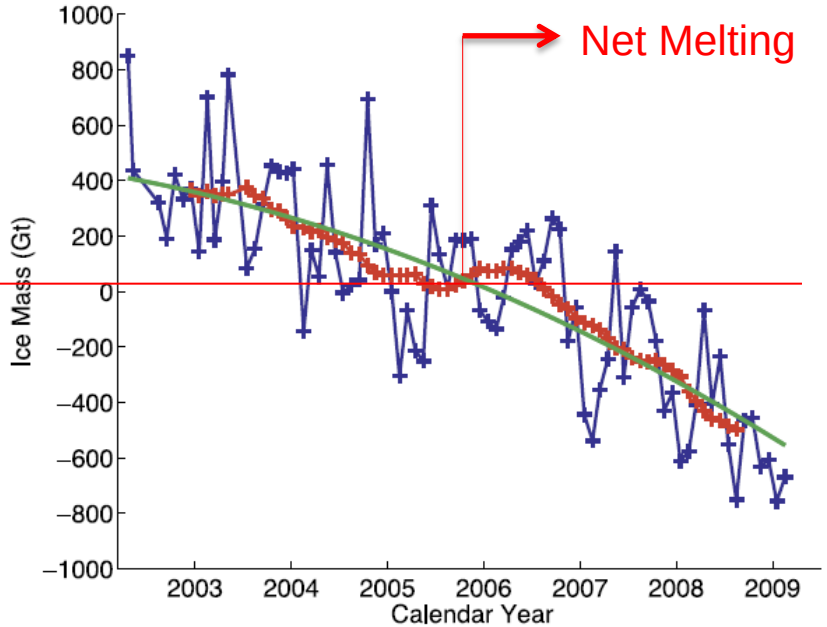

today
ice sheet
ice shelf
sea ice
continental slope
Filchner trough
grounding line

Melting of Large Ice Sheets

Greenland Ice Sheet



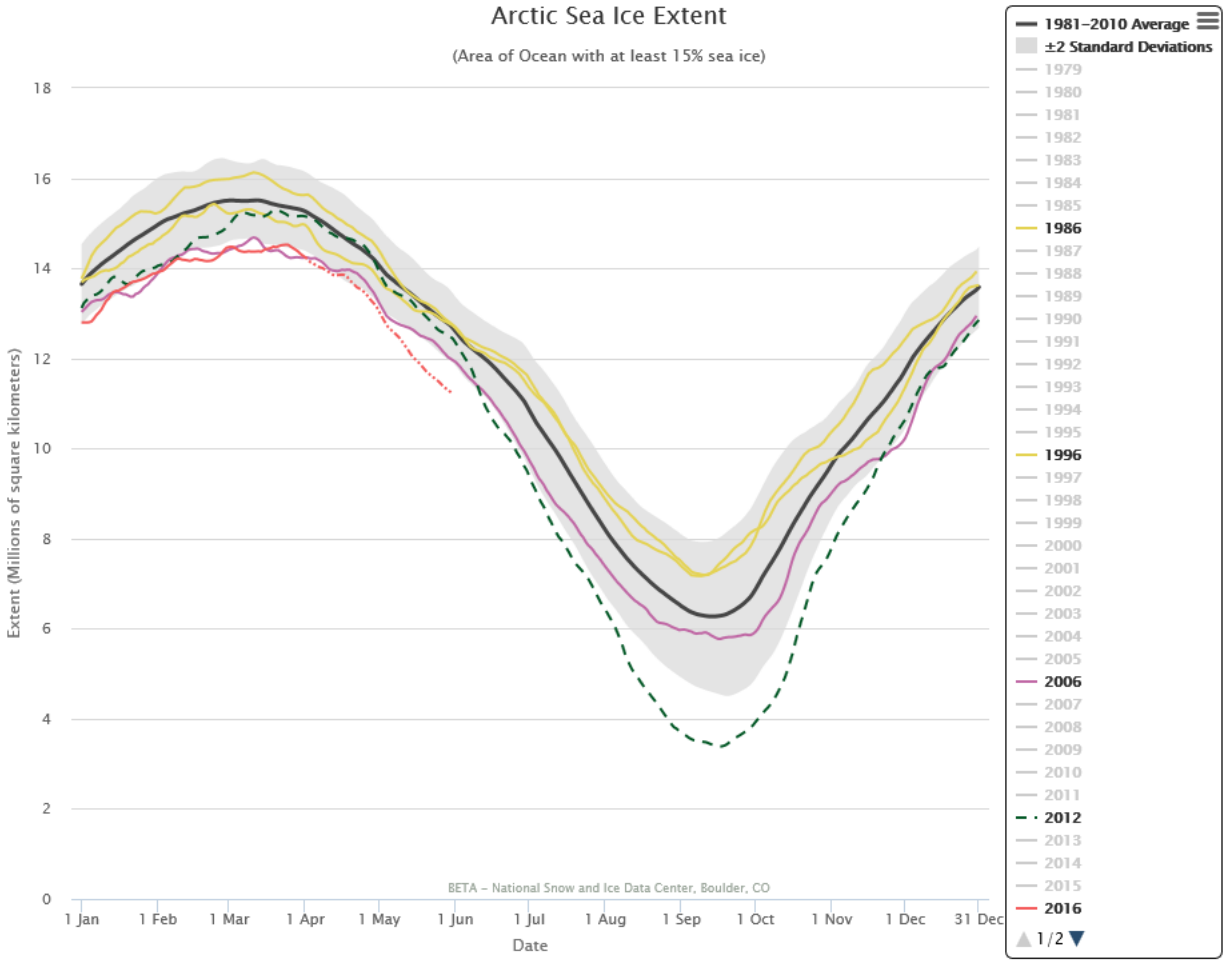
Antarctic Ice Sheet



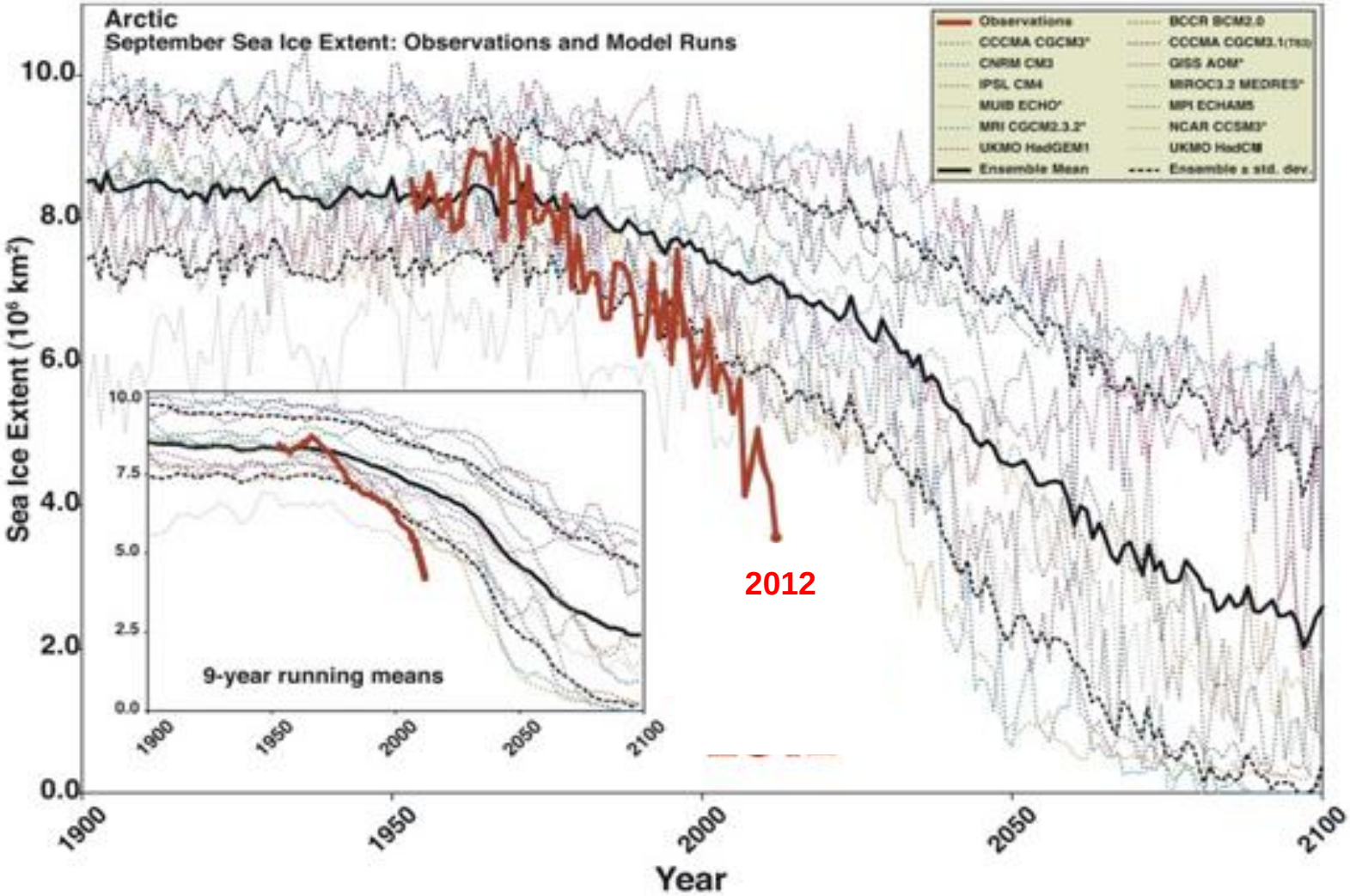
In 3 years – 10% of the way (15,000 Gt melting) to 1 m SLR

Source: Velicogna, I. *Geophys. Res. Lett.*, **36**, L19503, doi:10.1029/2009GL040222, 2009.

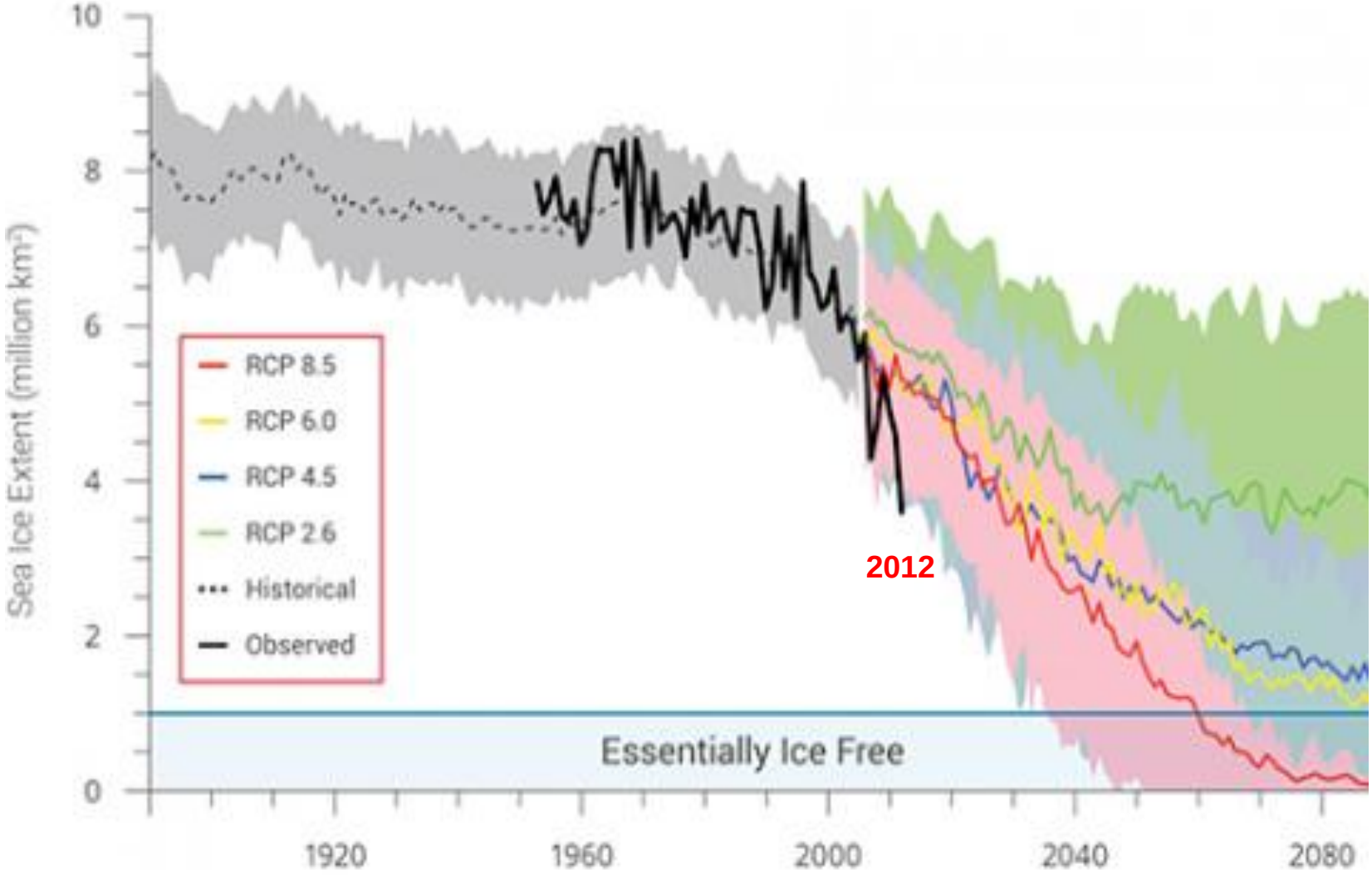
Recent Arctic Ice Cover Extent



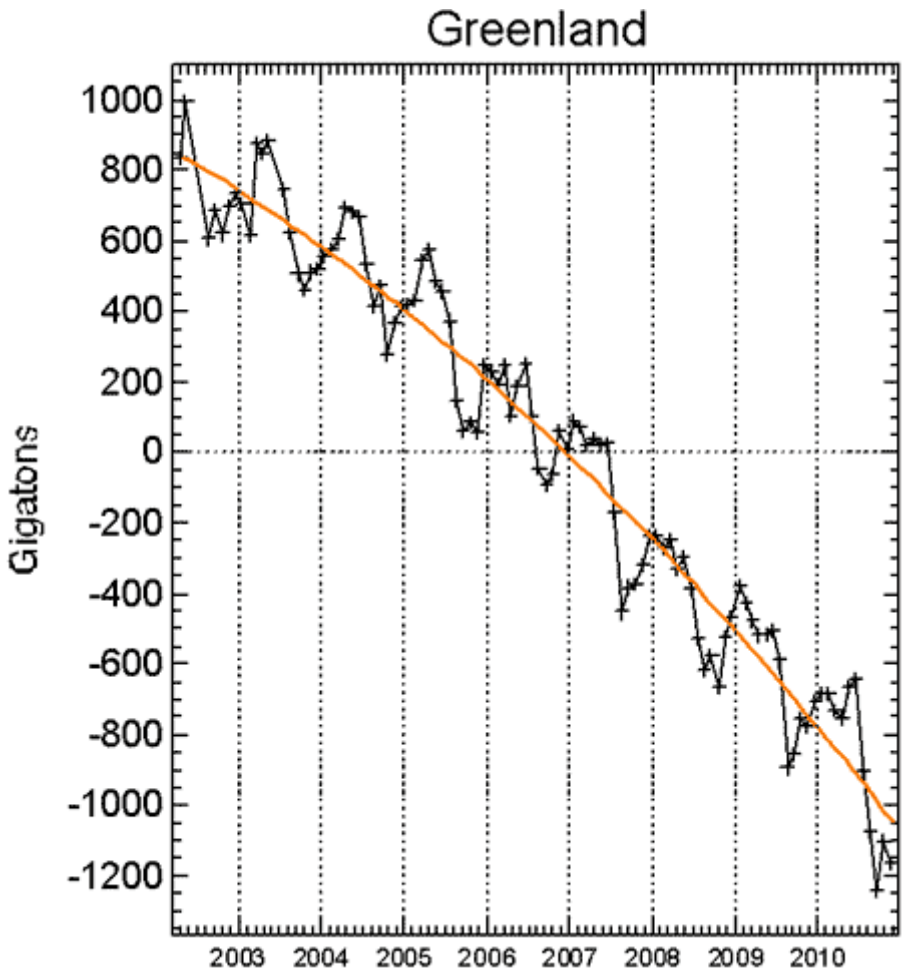
One Canary


Arctic
September Sea Ice Extent: Observations and Model Runs
Observations
CCCMA CGCM3*
CNRM CM3
IPSL CM4
MUIB ECHO*
MRI CGCM2.3.2*
UKMO HadGEM1
Ensemble Mean
BCCR BCM2.0
CCCMA CGCM3.1(T63)
GISS AOM*
MIROC3.2 MEDRES*
MPI ECHAM5
NCAR CCSM3*
UKMO HadCM
Ensemble ± std. dev.
Sea Ice Extent (10^6 km^2)
10.0
8.0
6.0
4.0
2.0
0.0
1900
1950
2000
2050
2100
Year
2012
9-year running means
10.0
7.5
5.0
2.5
0.0

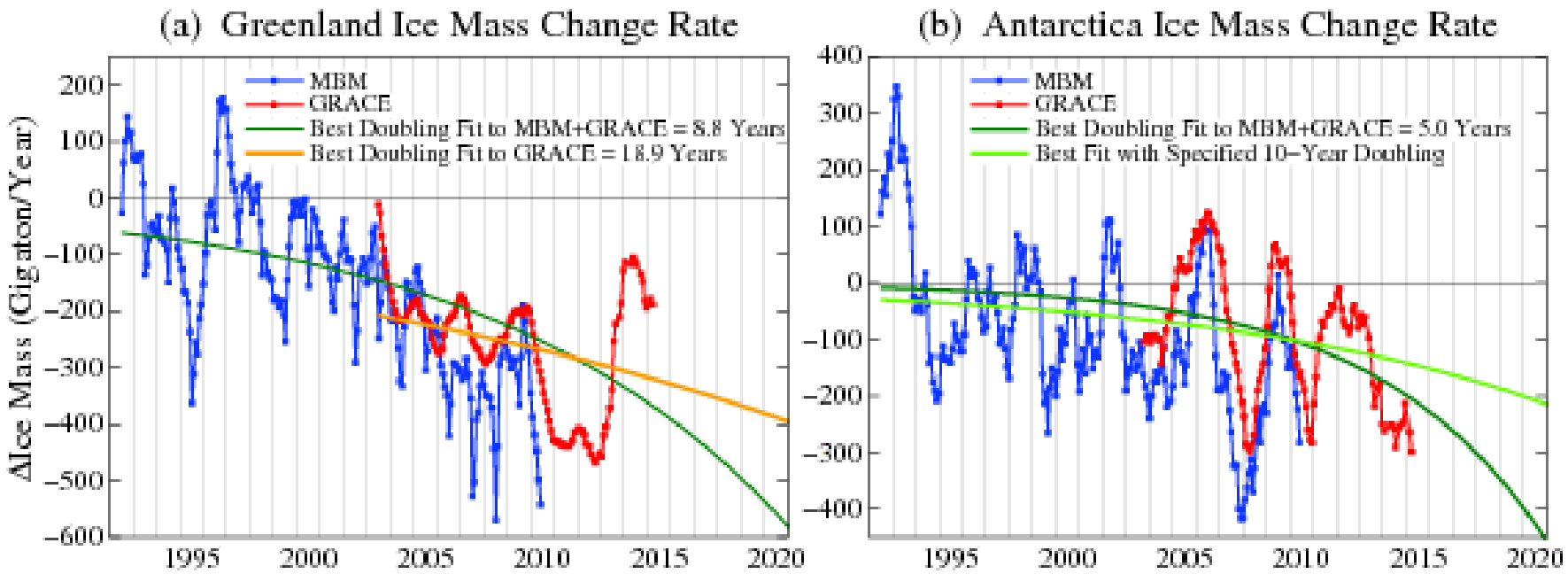
One Canary


Sea Ice Extent (million km²)
10
8
6
4
2
0
RCP 8.5
RCP 6.0
RCP 4.5
RCP 2.6
Historical
Observed
2012
Essentially Ice Free
1920
1960
2000
2040
2080

Two Canary


Greenland
Gigatons
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
2003
2004
2005
2006
2007
2008
2009
2010

Two Canary



Source: Hansen et al 2016.

What You Can Do

For latest information on the melting of snow and ice:
https://nsidc.org/
http://icebridge.gsfc.nasa.gov/
http://darksnow.org/

For latest information on measured sea level rise:
http://sealevel.colorado.edu/

For up to date information on new studies, reports, and investigations related to climate change and sea levels:
http://climatecrocks.com/

To read the paper by J. Hansen et al (2015) and monitor the online review:
http://www.atmos-chem-phys-discuss.net/15/20059/2015/acpd-15-20059-2015.pdf

Influence of SLR on FCL’s

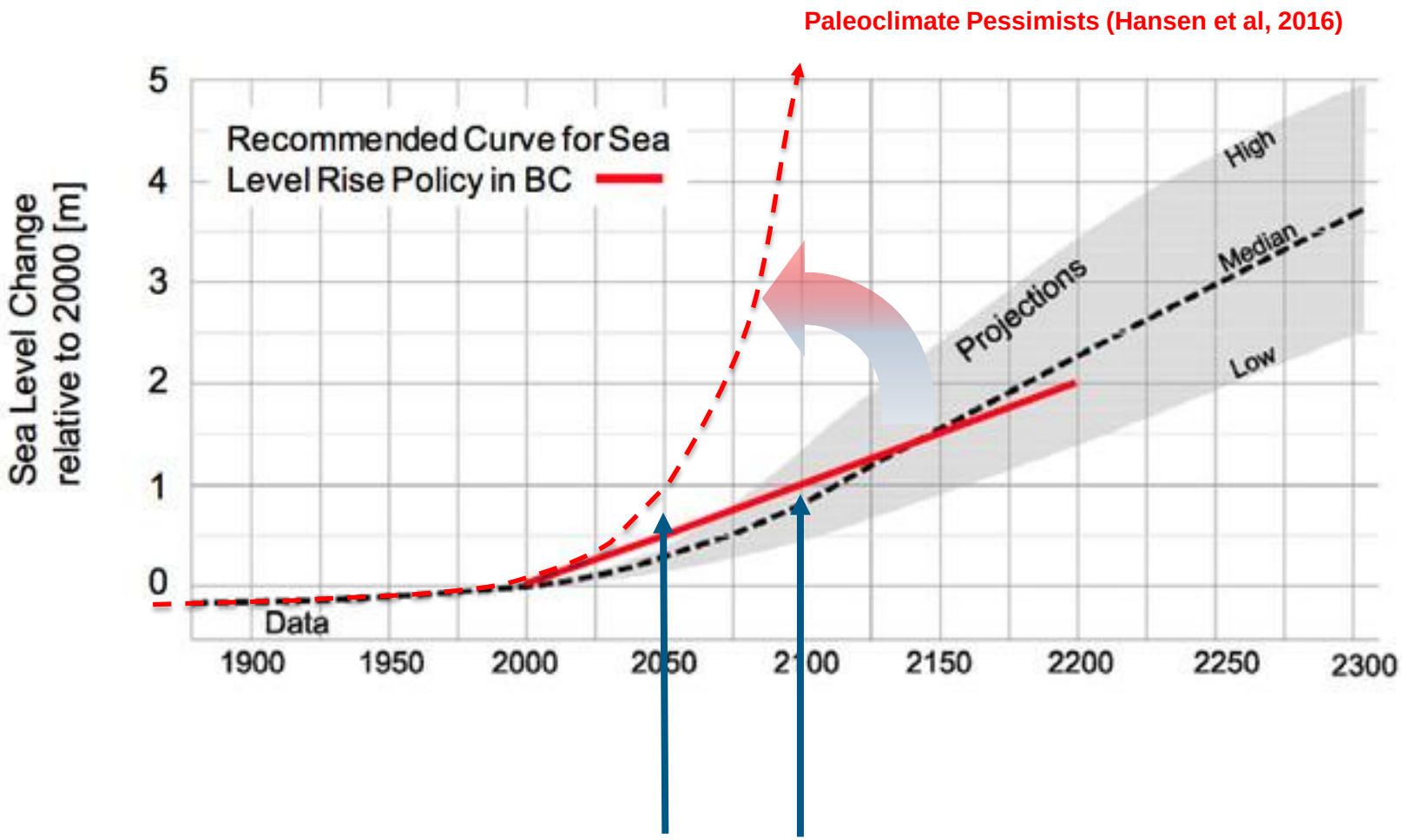
Flood Construction Level (FCL) Components

- Sea Level Rise
- Tide
- Risk
- Storm Surge
- Wave Effects
- Freeboard Allowance

Flood Construction Level (FCL) Components

- **Sea Level Rise**
- Tide
- Risk
- Storm Surge
- Wave Effects
- Freeboard Allowance

SLR Expectations 2016



1 m of SLR coming

District of North Saanich

Flood Construction Level Study

Workshop 2016-06-07

Presentation Outline

FCL Components

Designated Storm

Shorelines & Reaches

Thresholds for Wave Effects

Freeboard

Calculated FCLs

FCL Components

Flood Construction Level (FCL) Components

- **Sea Level Rise**
- Tide
- Risk
- Designated Storm
  - Surge
  - Winds and waves
- Wave Effects
- Freeboard Allowance

- 1m SLR
- Includes Land uplift rate
  - At Patricia Bay = +1.4mm/yr
- Slightly affects date of arrival

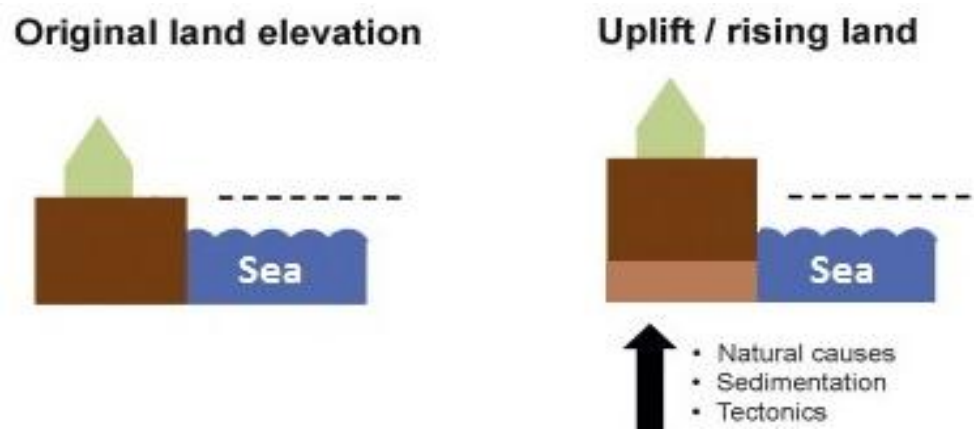


Image Source: Brown, S. & Nicholls, R.J., 2015

Flood Construction Level (FCL) Components

- Sea Level Rise
- **Tide**
- Risk
- Designated Storm
  - Surge
  - Winds and waves
- Wave Effects
  - Shoreline Composition
  - Shoreline Reach
  - Threshold
- Freeboard Allowance

- HHWLT
  - At Patricia Bay = 1.5m (CGVD28)
  - Winter storm months: tide equals or approaches HHWLT (0 to 0.1m) every 2 weeks for 2-3 days

Flood Construction Level (FCL) Components

- Sea Level Rise
- Tide
- **Risk**
- Designated Storm
  - Surge
  - Winds and waves
- Wave Effects
  - Shoreline Composition
  - Shoreline Reach
  - Threshold
- Freeboard Allowance

- Consideration of:
  - Land Use
- Leads to:
  - Selection of Designated Storm
  - Annual risk = 1/500 or 0.2%

Image Source: AIR 2015

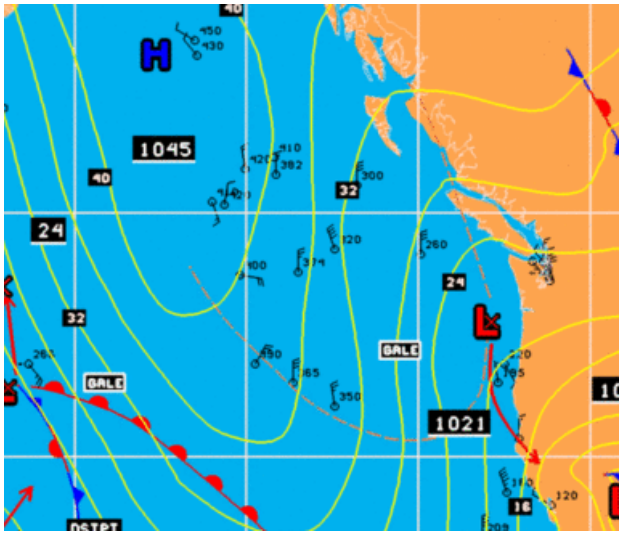
Flood Construction Level (FCL) Components

- Sea Level Rise
- Tide
- Risk
- **Designated Storm**
  - **Storm Surge**
  - **Winds and waves**
- Wave Effects
  - Shoreline Composition
  - Shoreline Reach
  - Threshold
- Freeboard Allowance

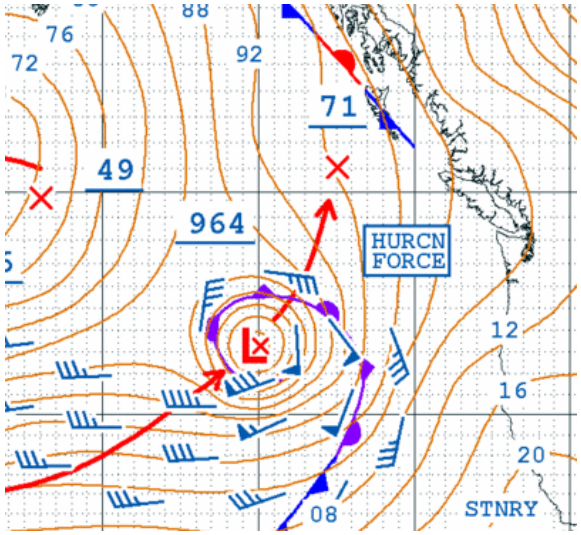
Designated Storm

1/500 AEP storm is either:

- Outflow condition
  - *Winds during outflow conditions generally consistent (NE)*
- Mid-latitude Pacific Storm or front
  - *Winds during mid-latitude storms will change directions (SE, SW, NW)*



Outflow



Mid-latitude Pacific Storm

Designated Storm

1/500 AEP storm is either:

- Outflow condition
  - *Winds during outflow conditions generally consistent (NE)*
- Mid-latitude Pacific Storm or front
  - *Winds during mid-latitude storms will change directions (SE, SW, NW)*

Storms from NE (Outflow):

- Tend to have no storm surge or a negative surge

Winter mid-latitude storms:

- Occur with storm surge, but relationship changes during storm passage

Considered several scenarios

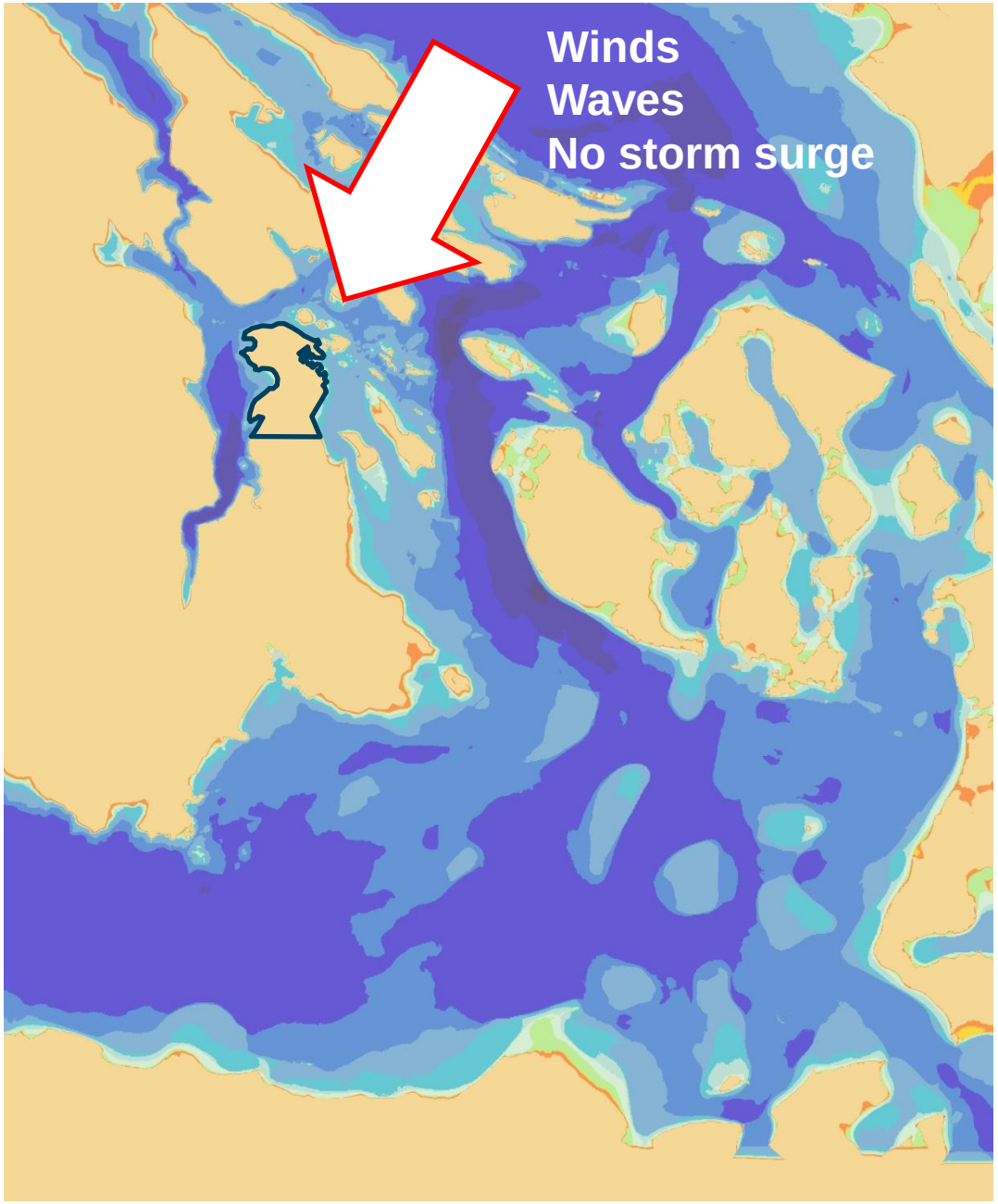
Designated Storm

North shorelines of DoNS

NE Storm

Winds = 22.4 m/s (44 kts)

Surge = -0.1 m



Designated Storm

East shorelines of DoNS

SE Storm – Peak wind speed

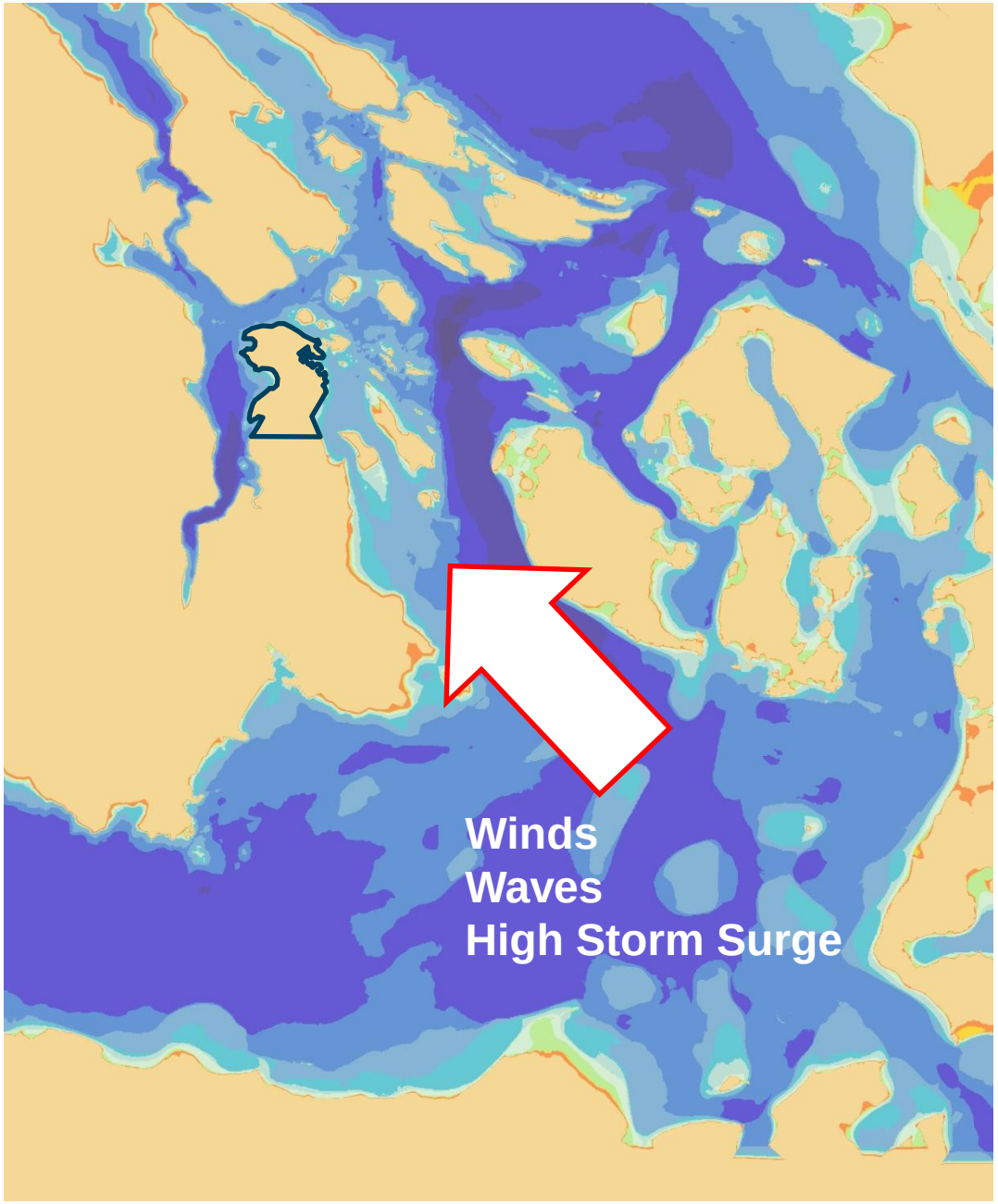
Winds = 33.4 m/s (64 kts)

Surge = 0.6 m

SE Storm – Peak storm surge

Winds = 25.2 m/s (49 kts)

Surge = 1.3 m



Designated Storm

West shorelines of DoNS

SW Storm – Peak wind speed

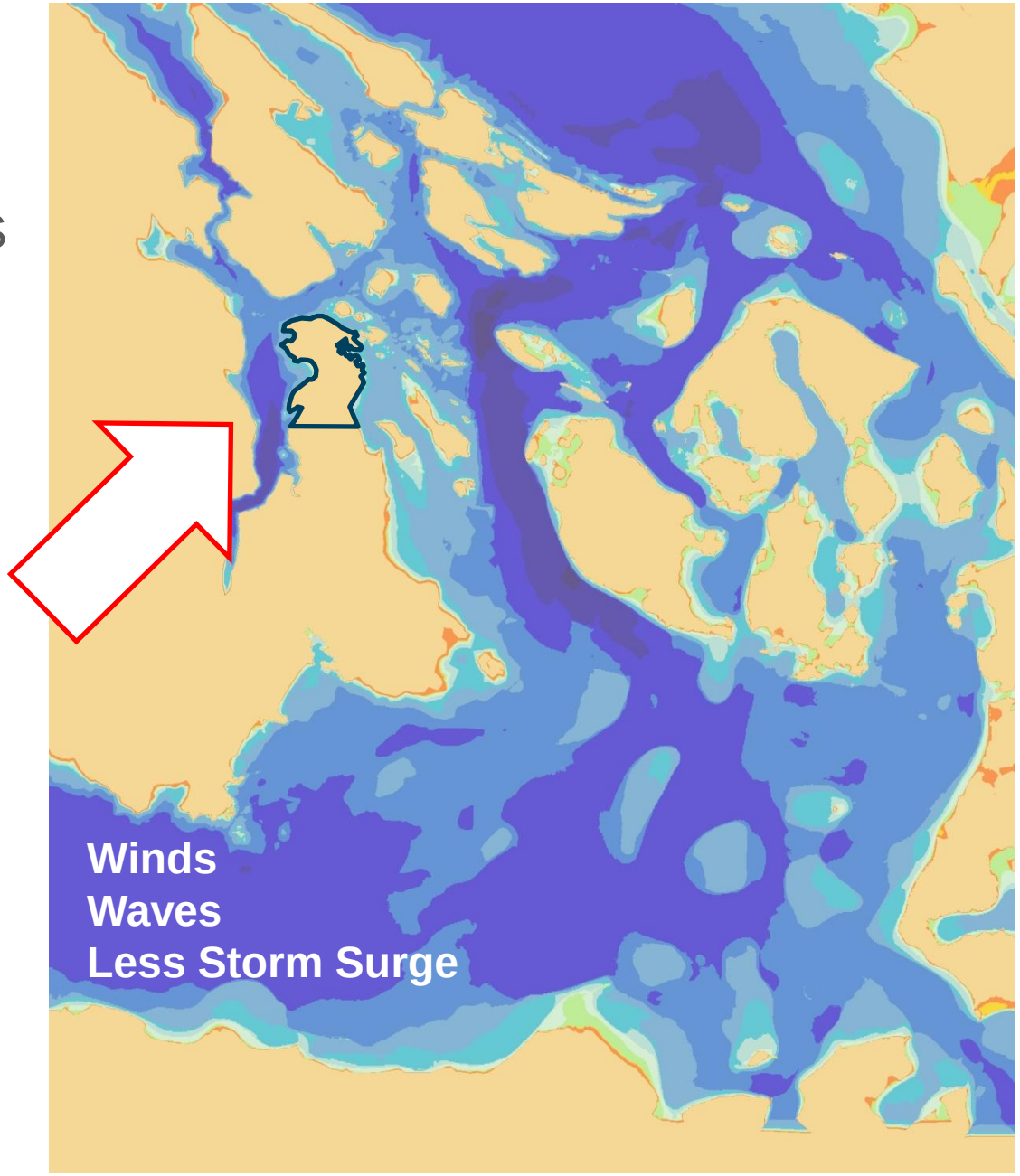
Winds = 28.6 m/s (56 kts)

Surge = 0.4 m

SW Storm – Peak storm surge

Winds = 20.8 m/s (40 kts)

Surge = 0.9 m



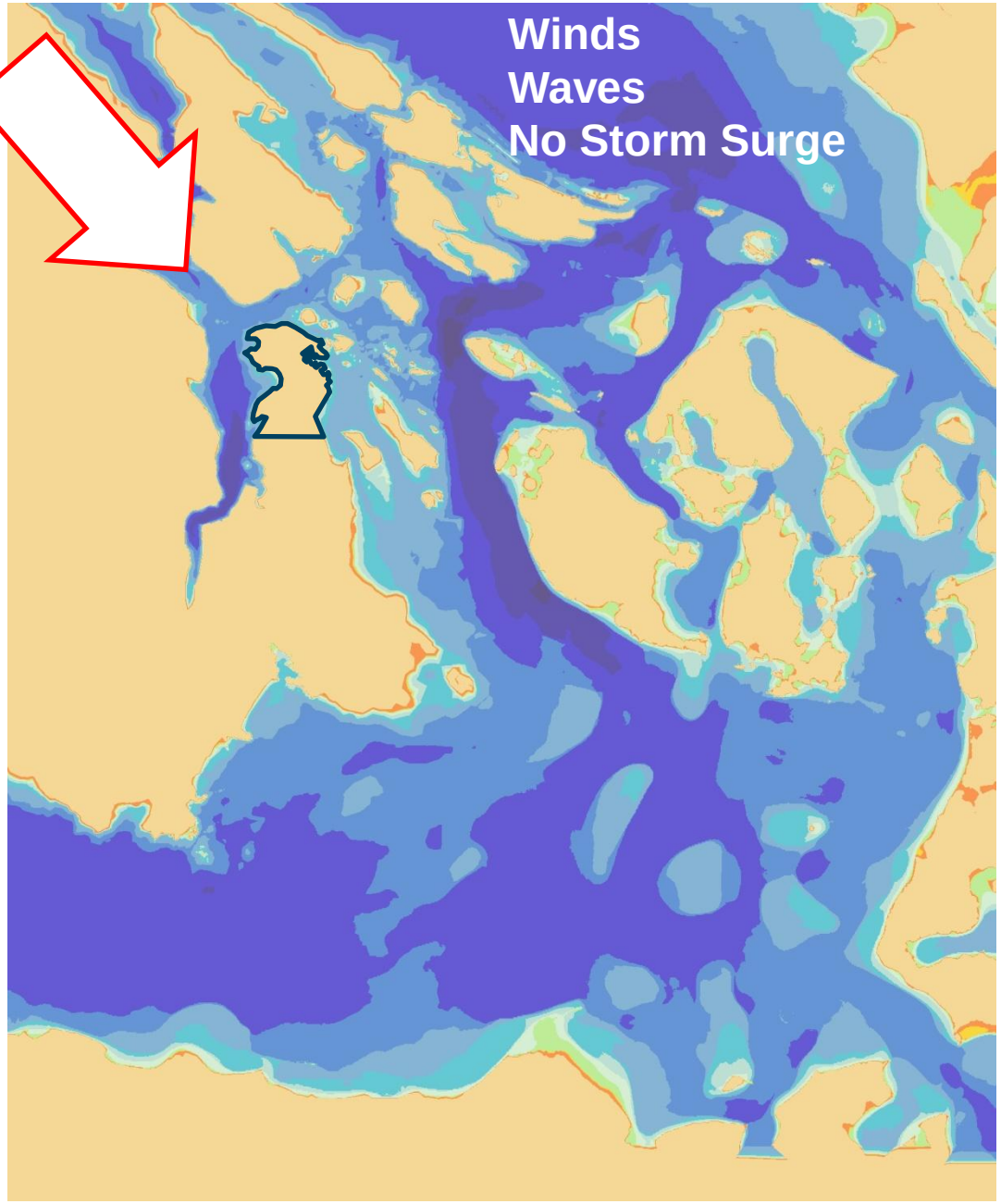
Designated Storm

West shorelines of DoNS

NW Storm

Winds = 20.9 m/s (41 kts)

Surge = -0.1 m



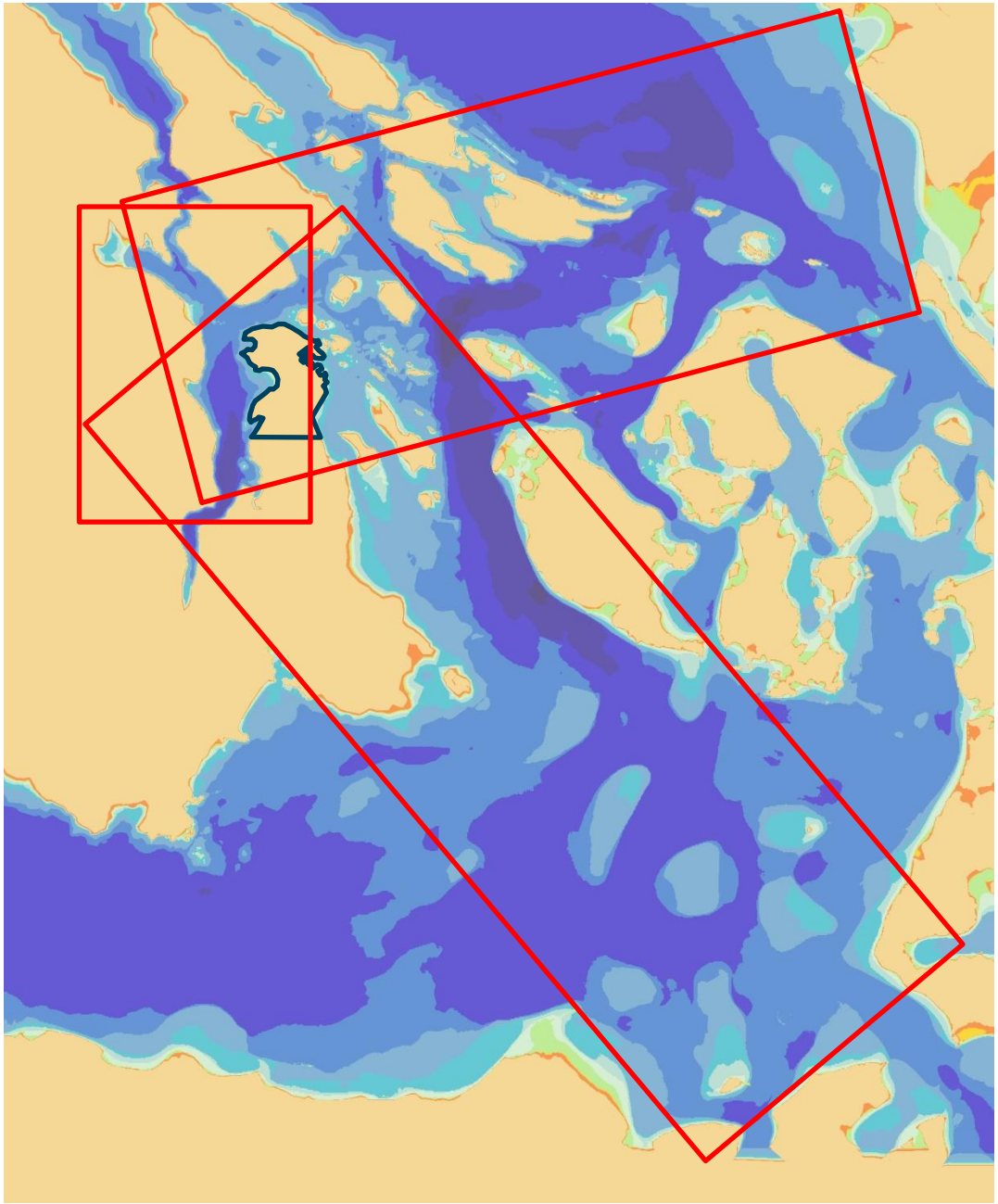
Designated Storm

Wave Generation:

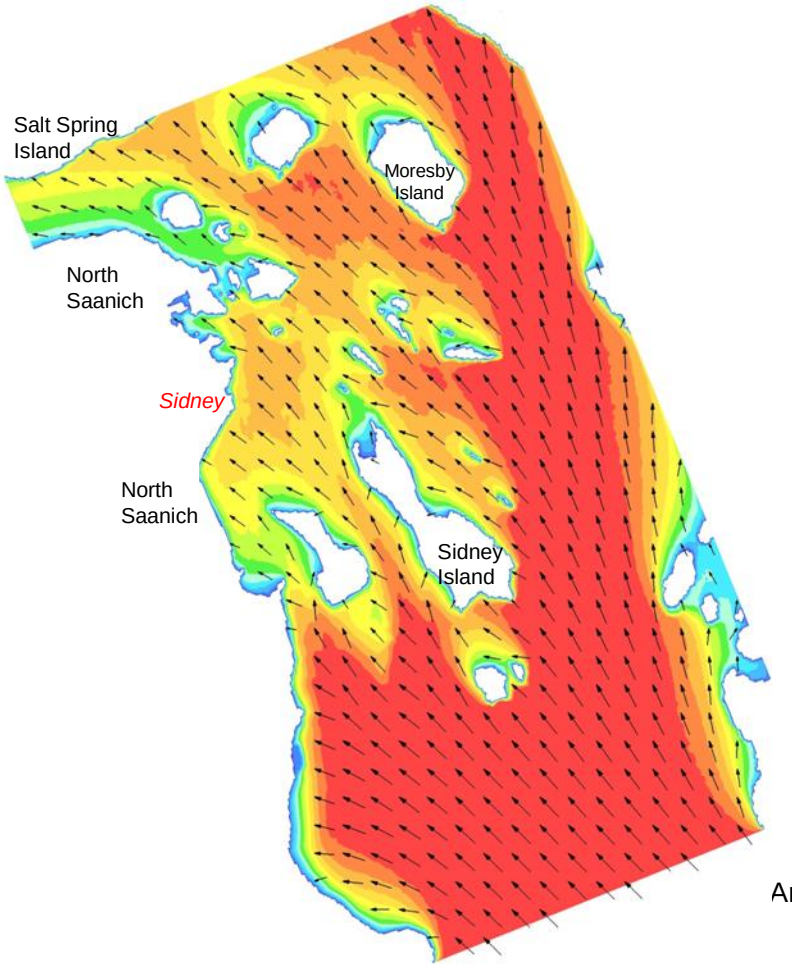
- used three SWAN model grids

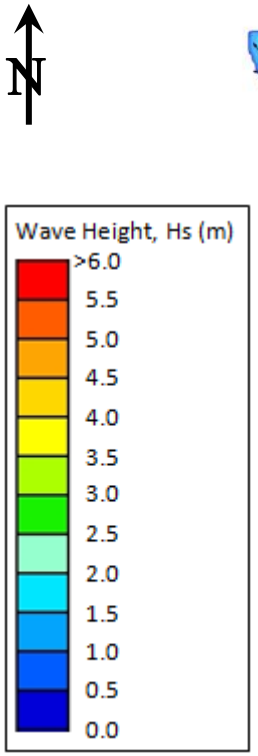
- waves dependent on wind speed and fetch

- seastate (waves) defined at mean sea level

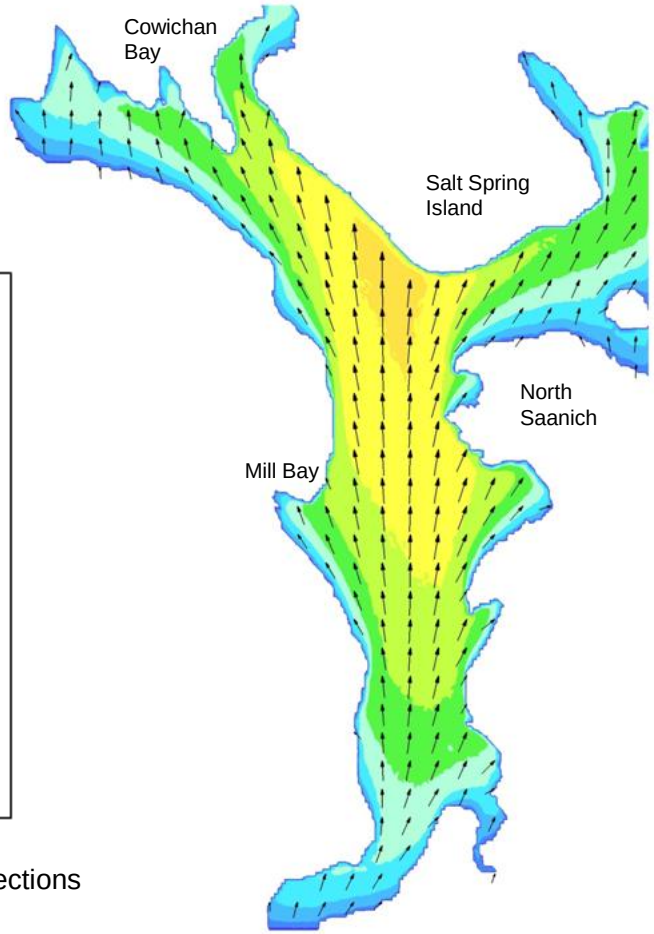


SWAN Model Result Examples





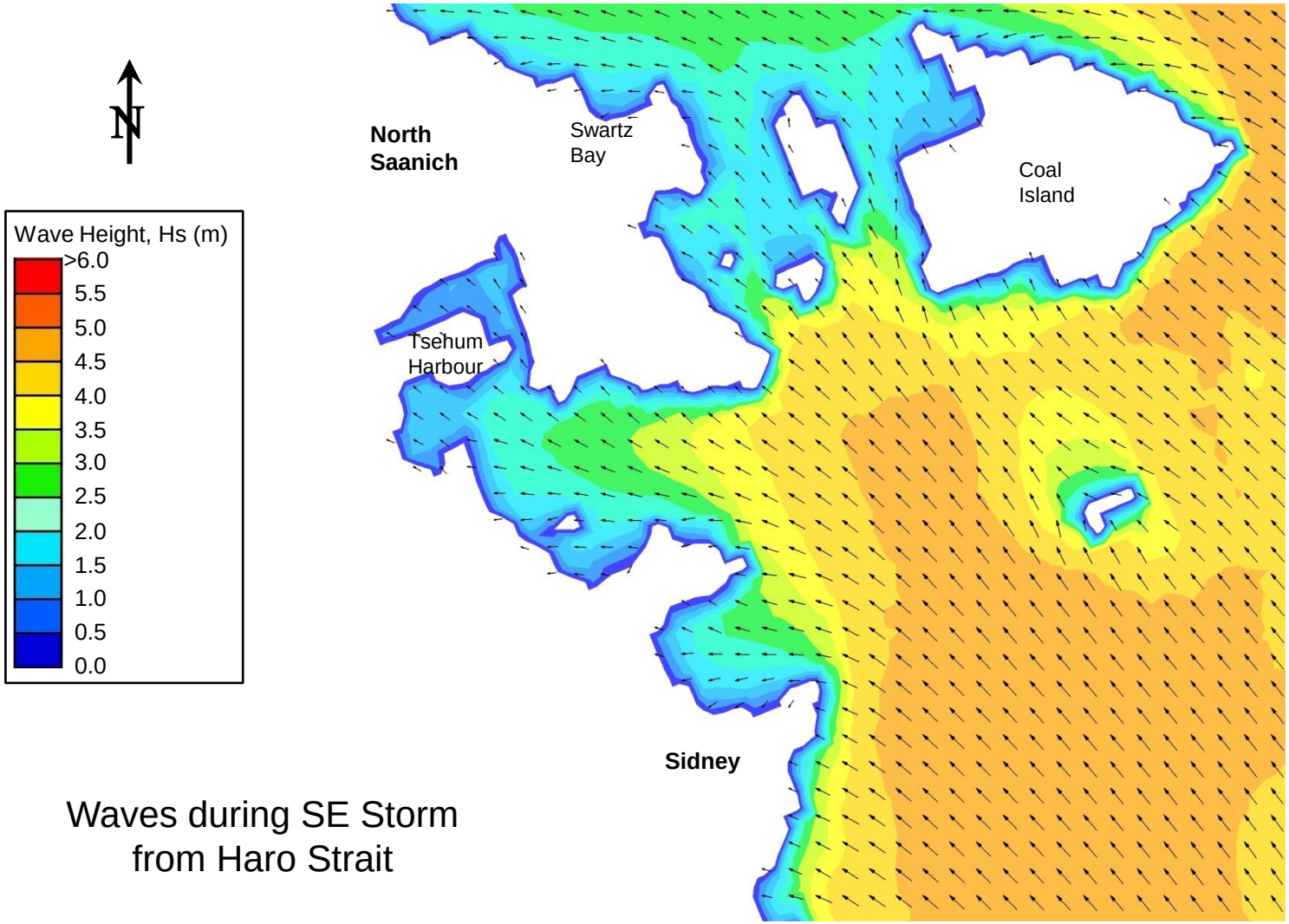
Arrows show wave directions



Waves during SE Storm in from Haro Strait

Waves during SW Storm in Saanich Inlet

Tsehum Haven Area



Waves during SE Storm from Haro Strait

Designated Storm Components

Sector	Wind		Storm Surge (m)	Storm Water Level (m, CGVD28)		
	Speed (m/s)	Dir (deg)		Tide	SLR	Design WL
NE	22.4	45	-0.1	1.5	1	2.4
SE	33.4	135	0.6	1.5	1	3.1
SE	25.2	135	1.3	1.5	1	3.8
SW	28.6	190	0.4	1.5	1	2.9
SW	20.8	190	0.9	1.5	1	3.4
NW	20.9	320	-0.1	1.5	1	2.4

Waves at Shoreline

NE Storm

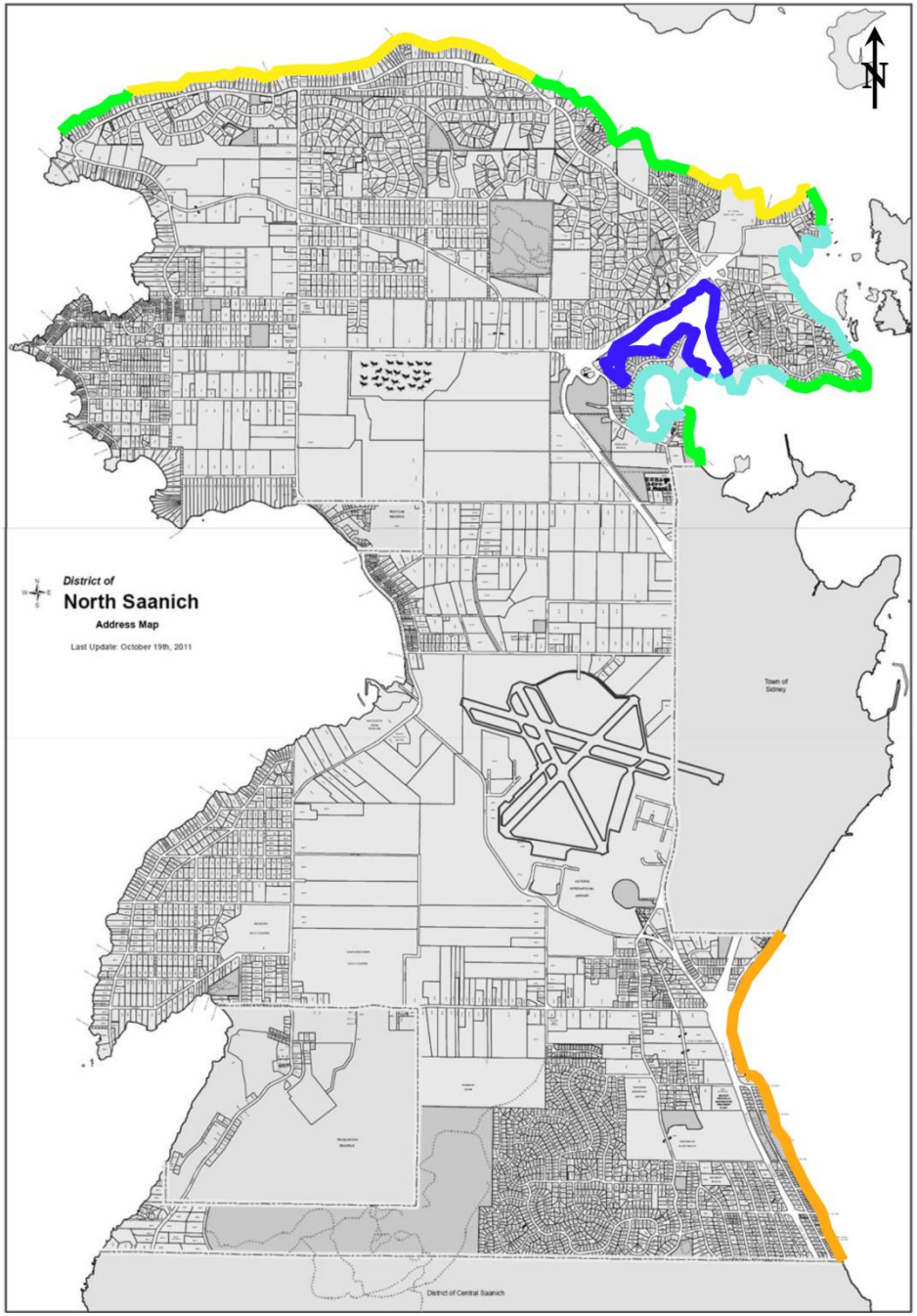
Peak Wind Speed

Winds = 22.4 m/s (44 kts)

Surge = -0.1 m

Wave height (m)

- 4.0m
- 3.5m
- 3.0m
- 2.5m
- 2.0m
- 1.5m
- 1.0m
- 0.5m
- 0.0m



Waves at Shoreline

SE Storm

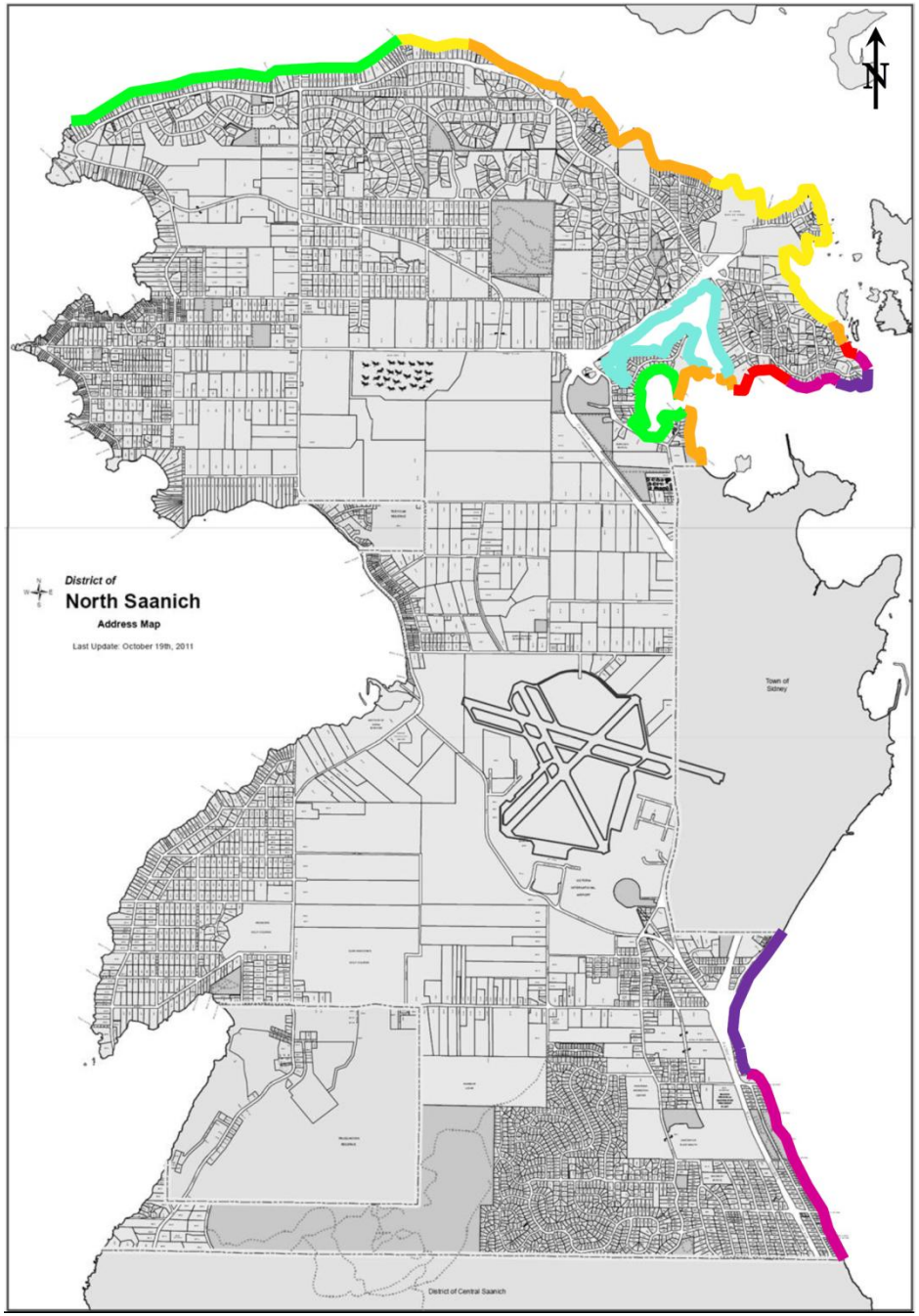
Peak Wind Speed

Winds = 33.4 m/s (64 kts)

Surge = 0.6 m

Wave height (m)

- 4.0m
- 3.5m
- 3.0m
- 2.5m
- 2.0m
- 1.5m
- 1.0m
- 0.5m
- 0.0m



Waves at Shoreline

SE Storm

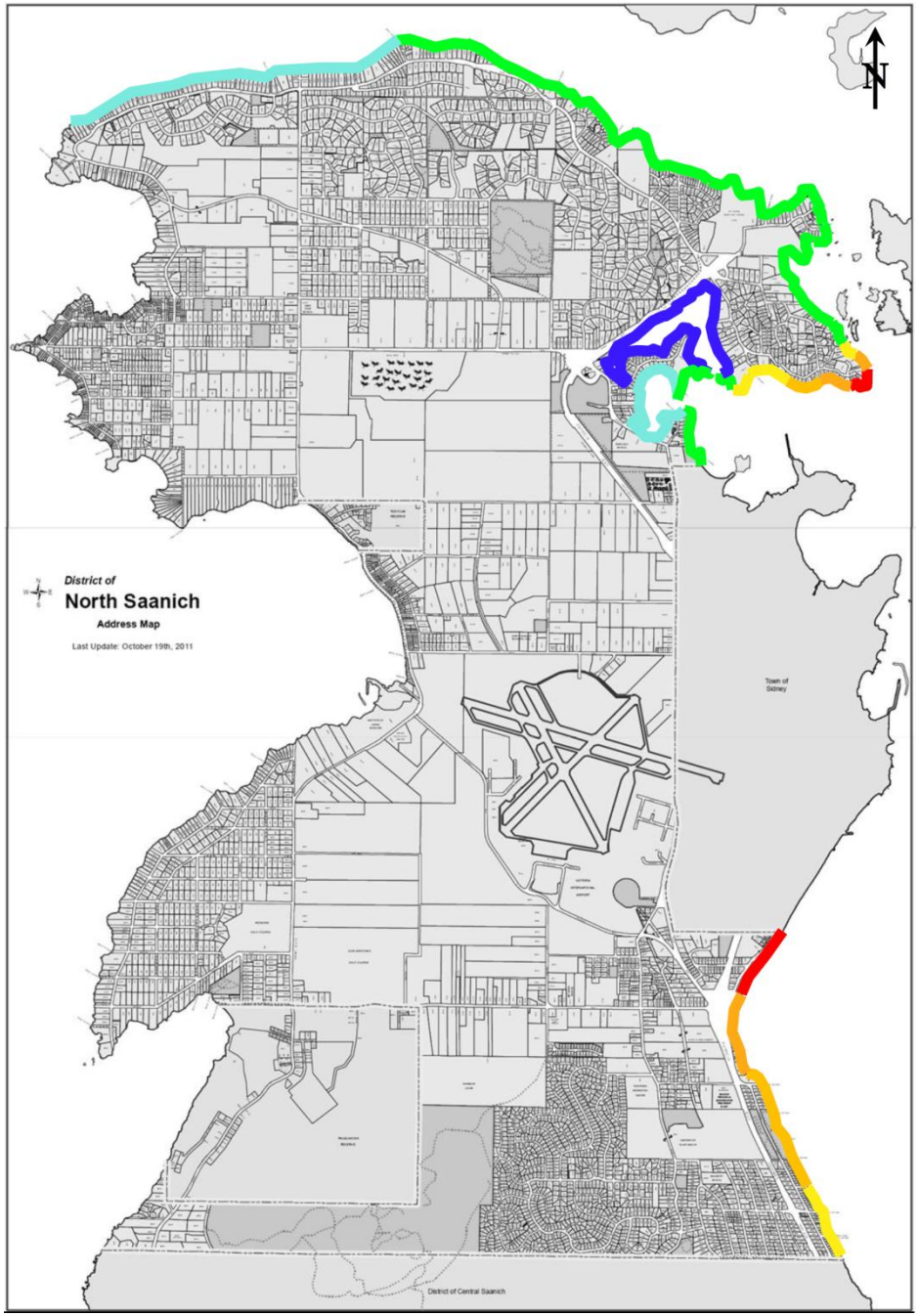
Peak Storm Surge

Winds = 25.2 m/s (49 kts)

Surge = 1.3 m

Wave height (m)

- 4.0m
- 3.5m
- 3.0m
- 2.5m
- 2.0m
- 1.5m
- 1.0m
- 0.5m
- 0.0m



Waves at Shoreline

SW Storm

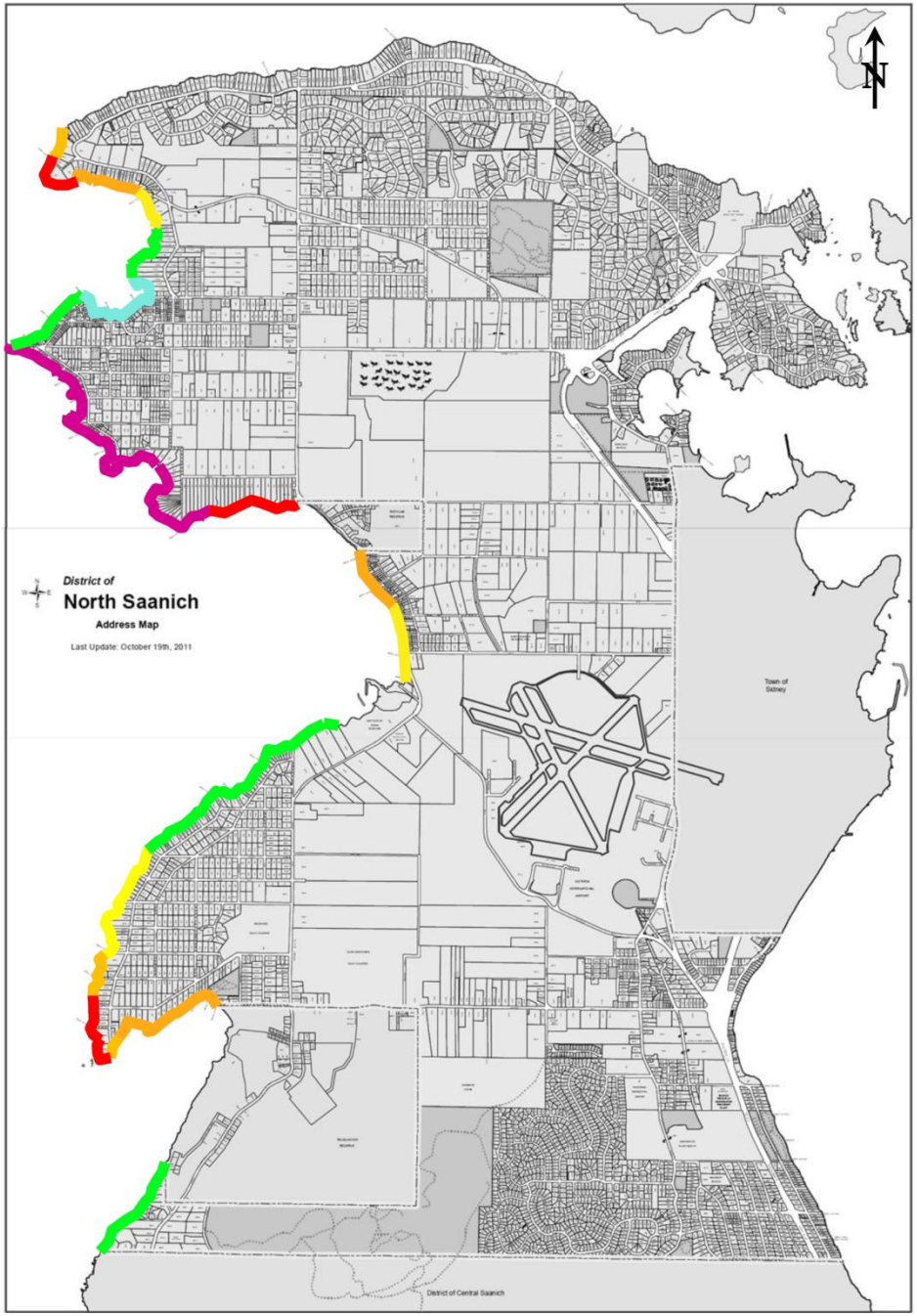
Peak Wind Speed

Winds = 28.6 m/s (56 kts)

Surge = 0.4 m

Wave height (m)

- 4.0m
- 3.5m
- 3.0m
- 2.5m
- 2.0m
- 1.5m
- 1.0m
- 0.5m
- 0.0m



Waves at Shoreline

SW Storm

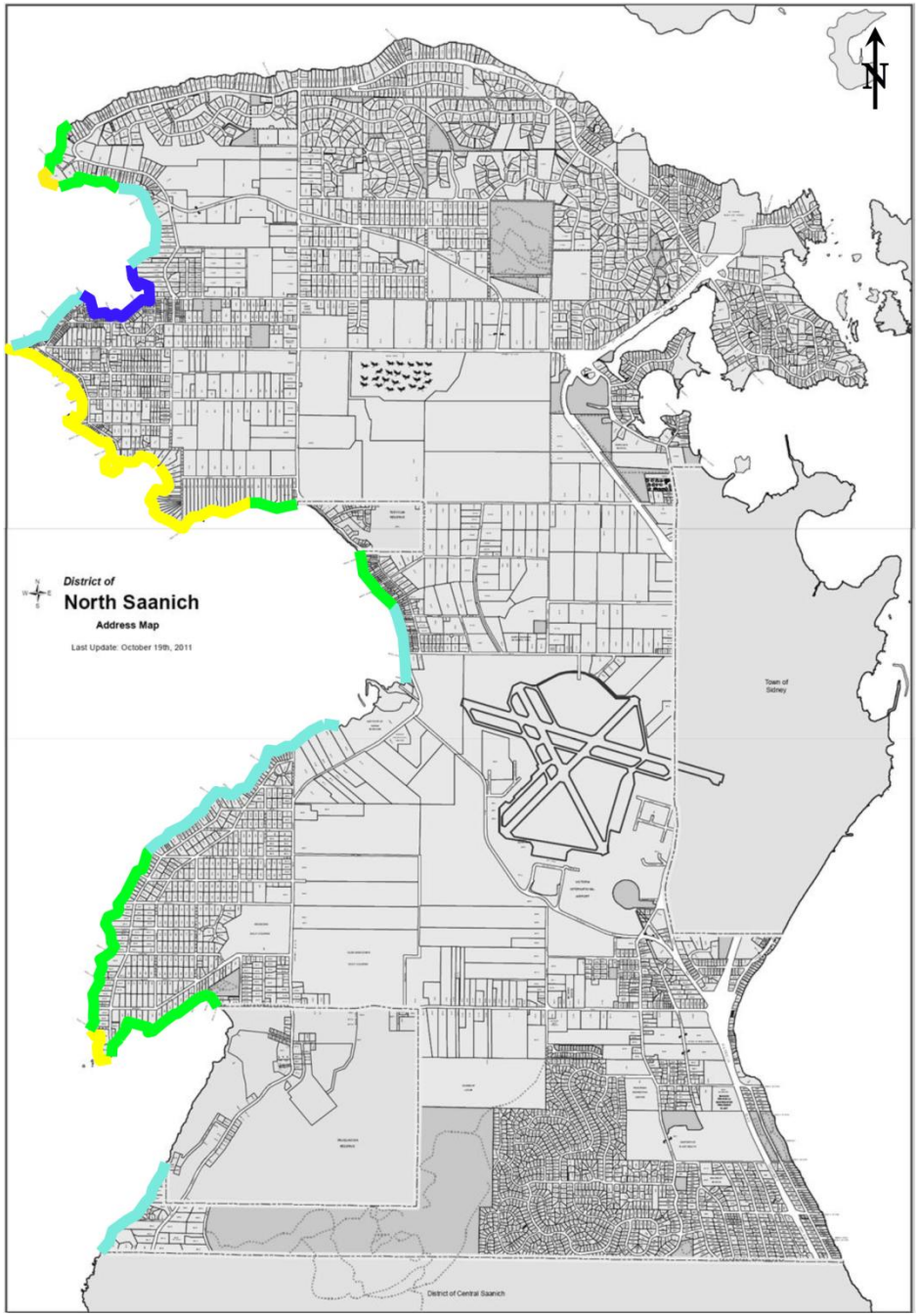
Peak Storm Surge

Winds = 20.8 m/s (40 kts)

Surge = 0.9 m

Wave height (m)

- 4.0m
- 3.5m
- 3.0m
- 2.5m
- 2.0m
- 1.5m
- 1.0m
- 0.5m
- 0.0m



Waves at Shoreline

NW Storm

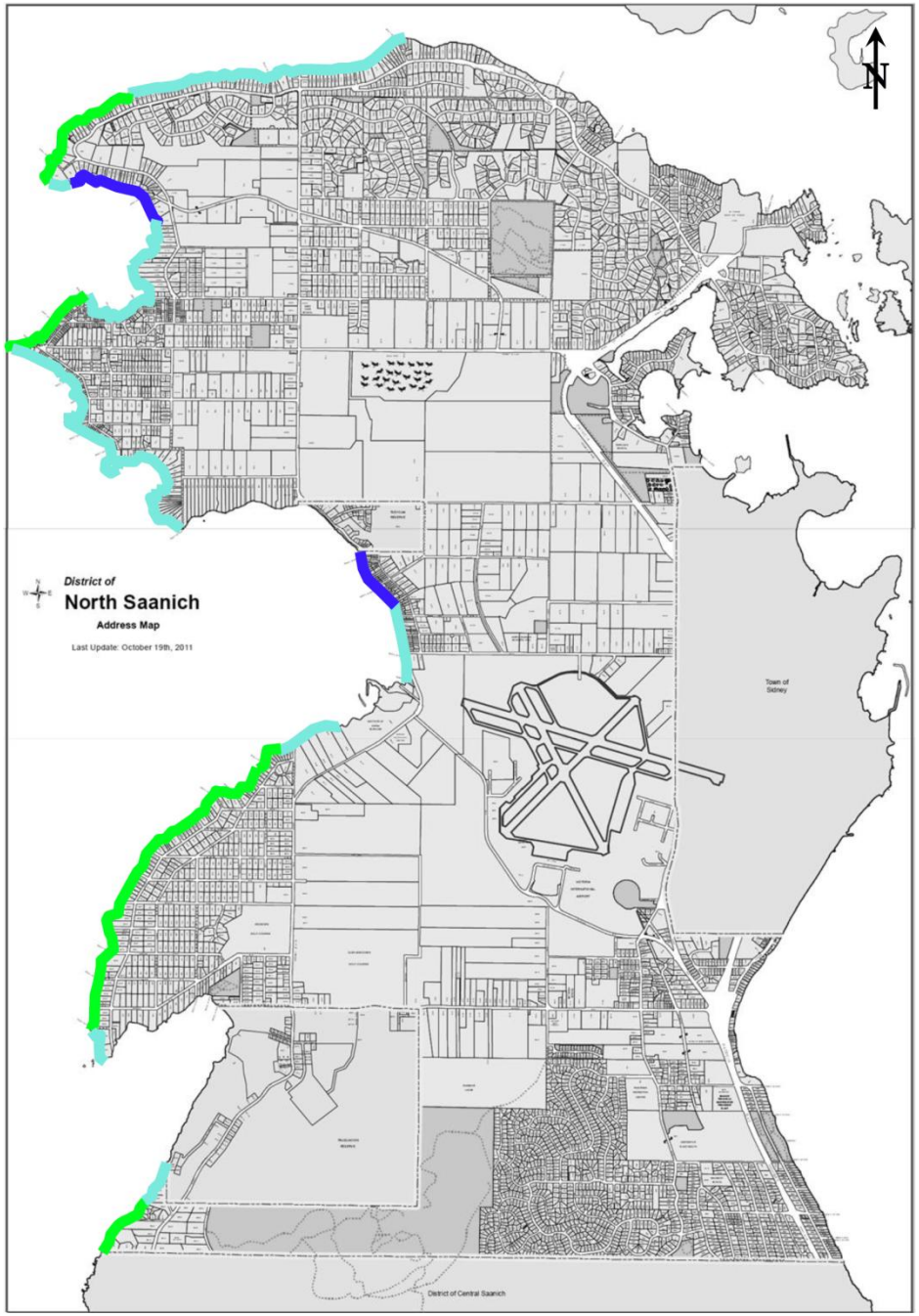
Peak Wind Speed

Winds = 22.4 m/s (41 kts)

Surge = -0.1 m

Wave height (m)

- 4.0m
- 3.5m
- 3.0m
- 2.5m
- 2.0m
- 1.5m
- 1.0m
- 0.5m
- 0.0m



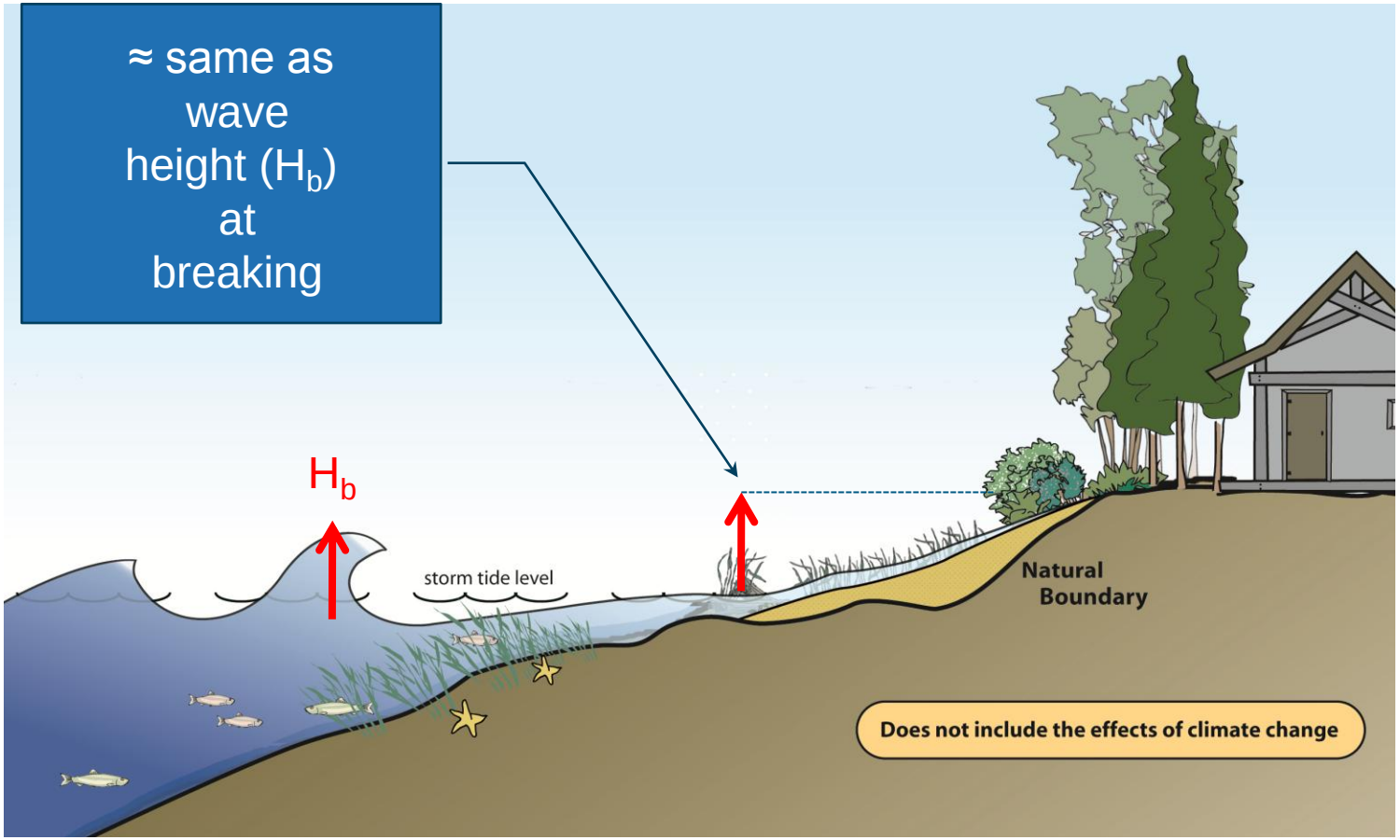
Flood Construction Level (FCL) Components

- Sea Level Rise
- Tide
- Risk
- Designated Storm
  - Storm Surge
  - Winds and waves
- **Wave Effects**
  - Shoreline Composition
  - Shoreline Reach
  - Threshold
- Freeboard Allowance

Shoreline Composition & Shoreline Reaches

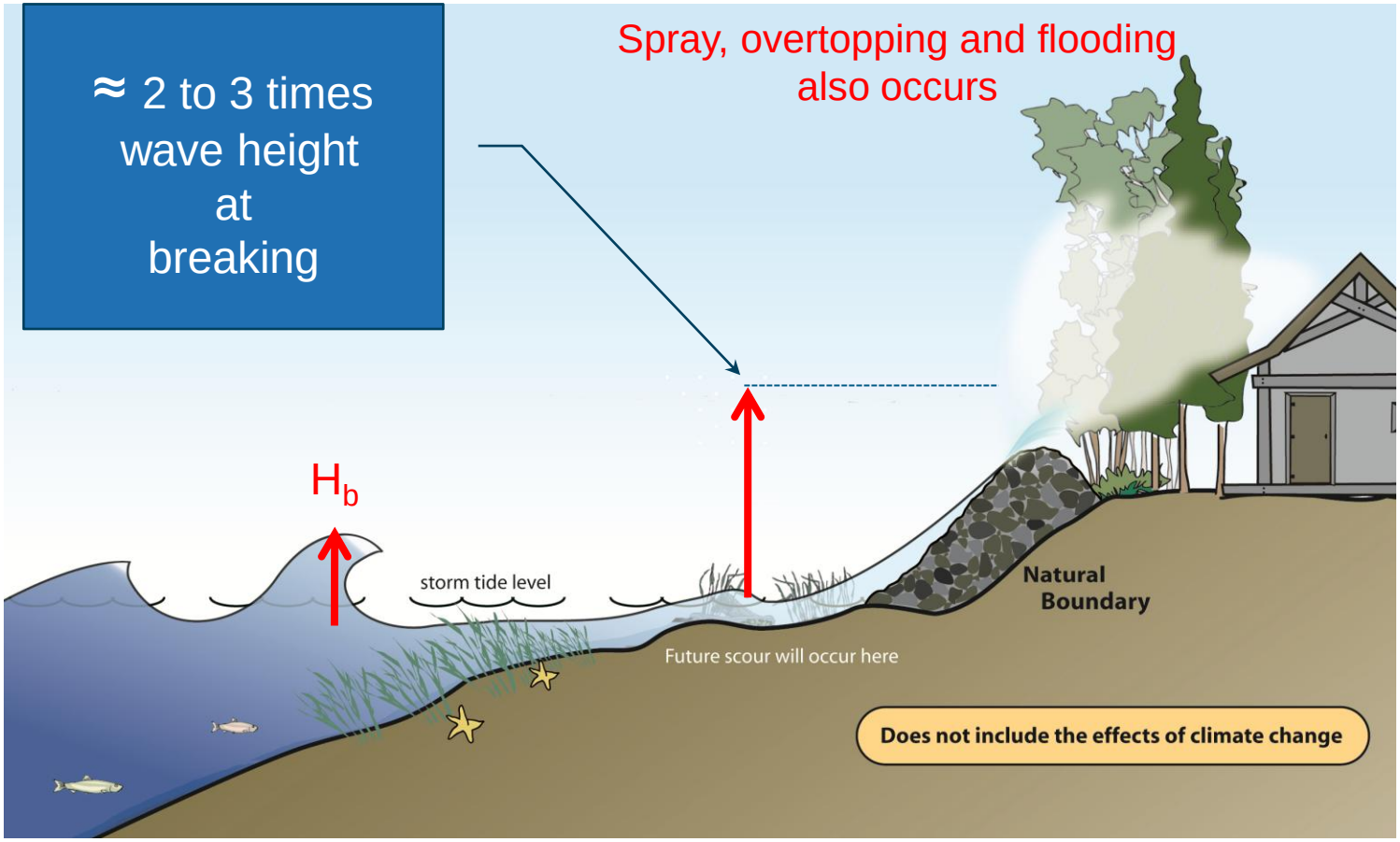
Shoreline Composition

Gentle Slopes - Beaches



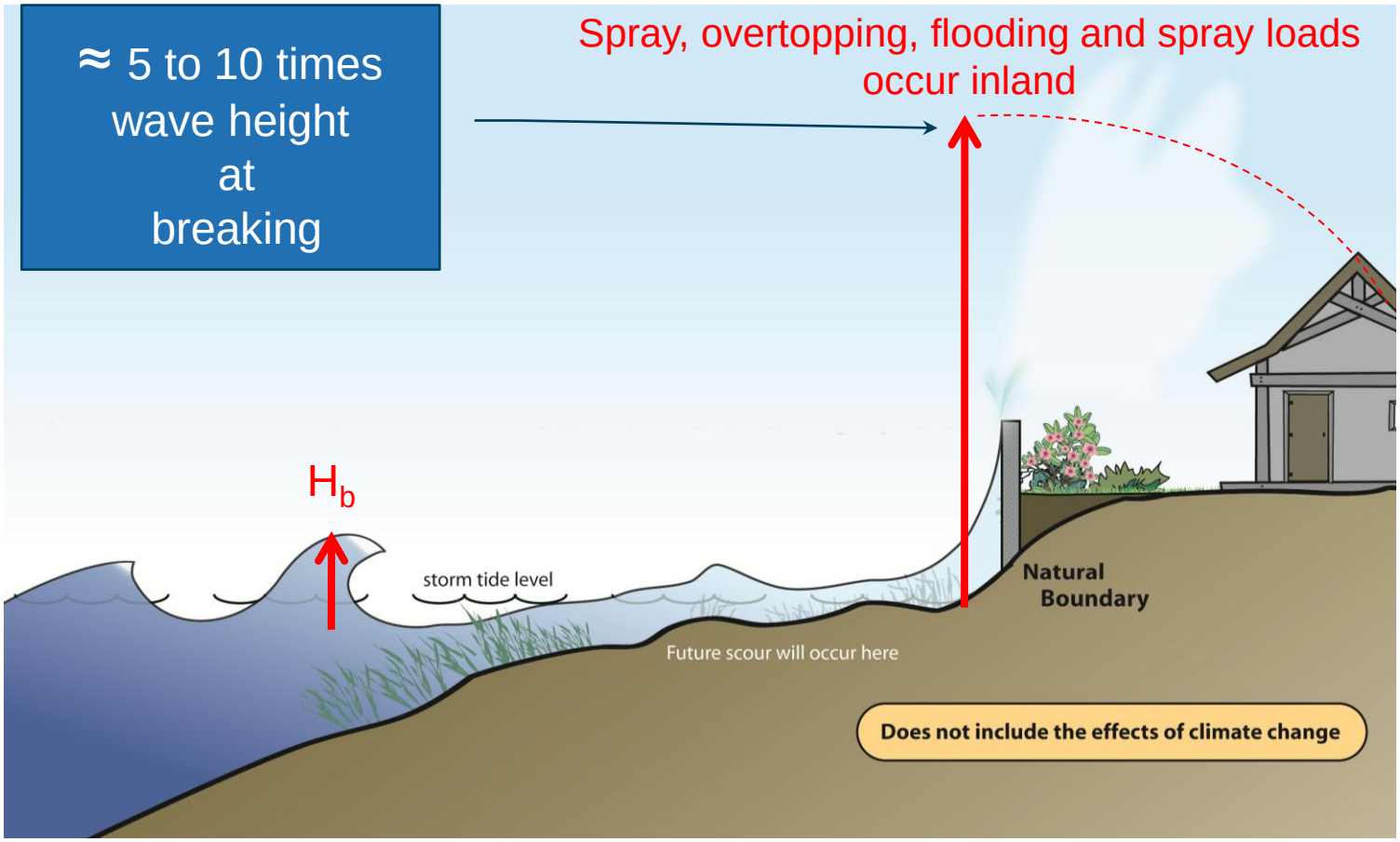
Shoreline Composition

Steep Slopes - Revetments



Shoreline Composition

Vertical Walls



Shoreline Composition

Non-Erodible Steep Shoreline

Shoreline Composition

Erodible Steep Shoreline

Shoreline Composition

Seawalls or Steep Revetments

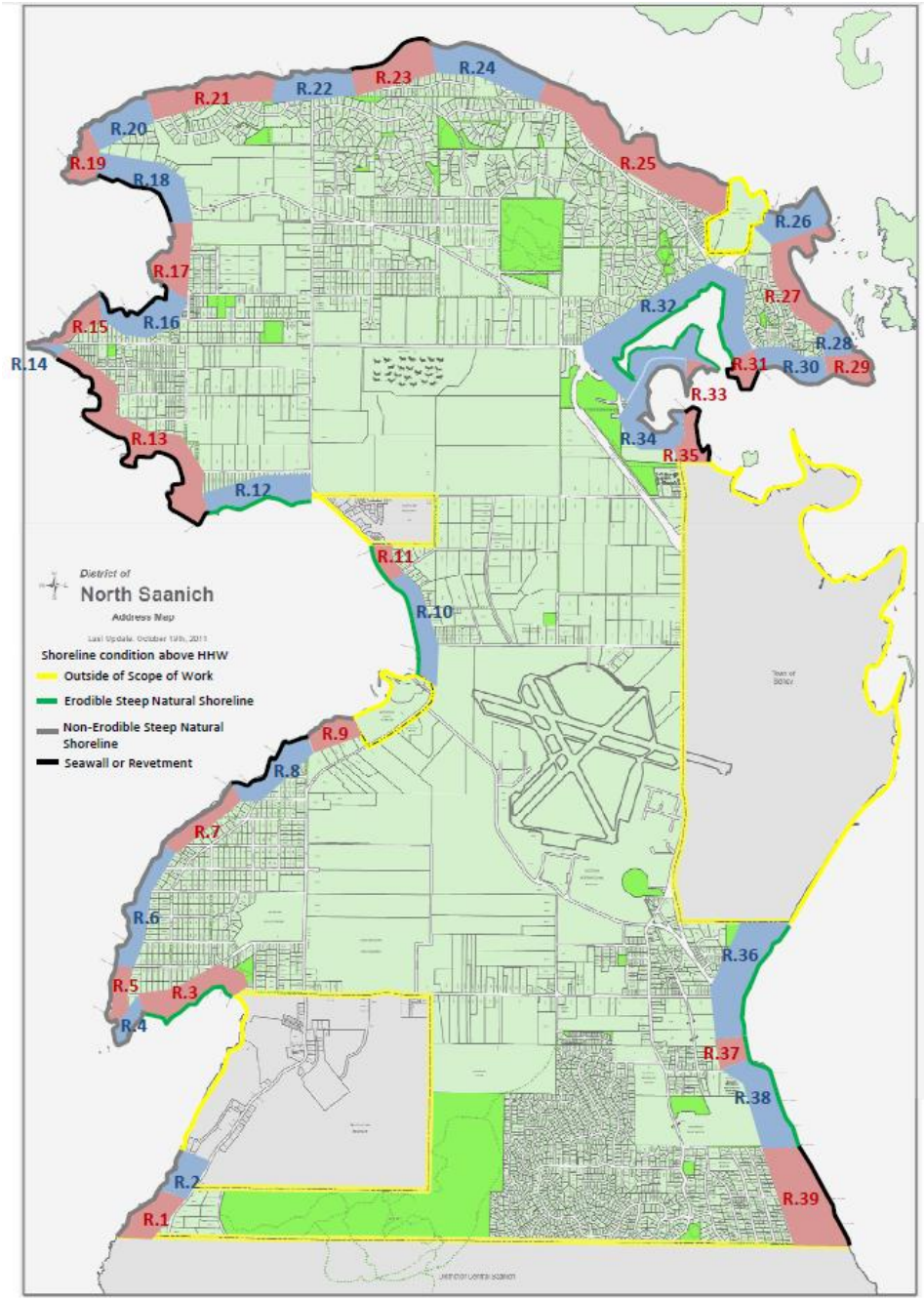
Shoreline Reaches

Shoreline type

- Non-Erodible Steep Natural Shoreline
- Erodible Steep Natural Shoreline
- Seawall or Revetment

Governing Wave Condition in Area

- Using results from SWAN model and wave transformation analysis of 1/500 AEP Designated Storms



Threshold for Wave Effects

Wave Run-up and Overtopping

Thresholds for Wave Effects

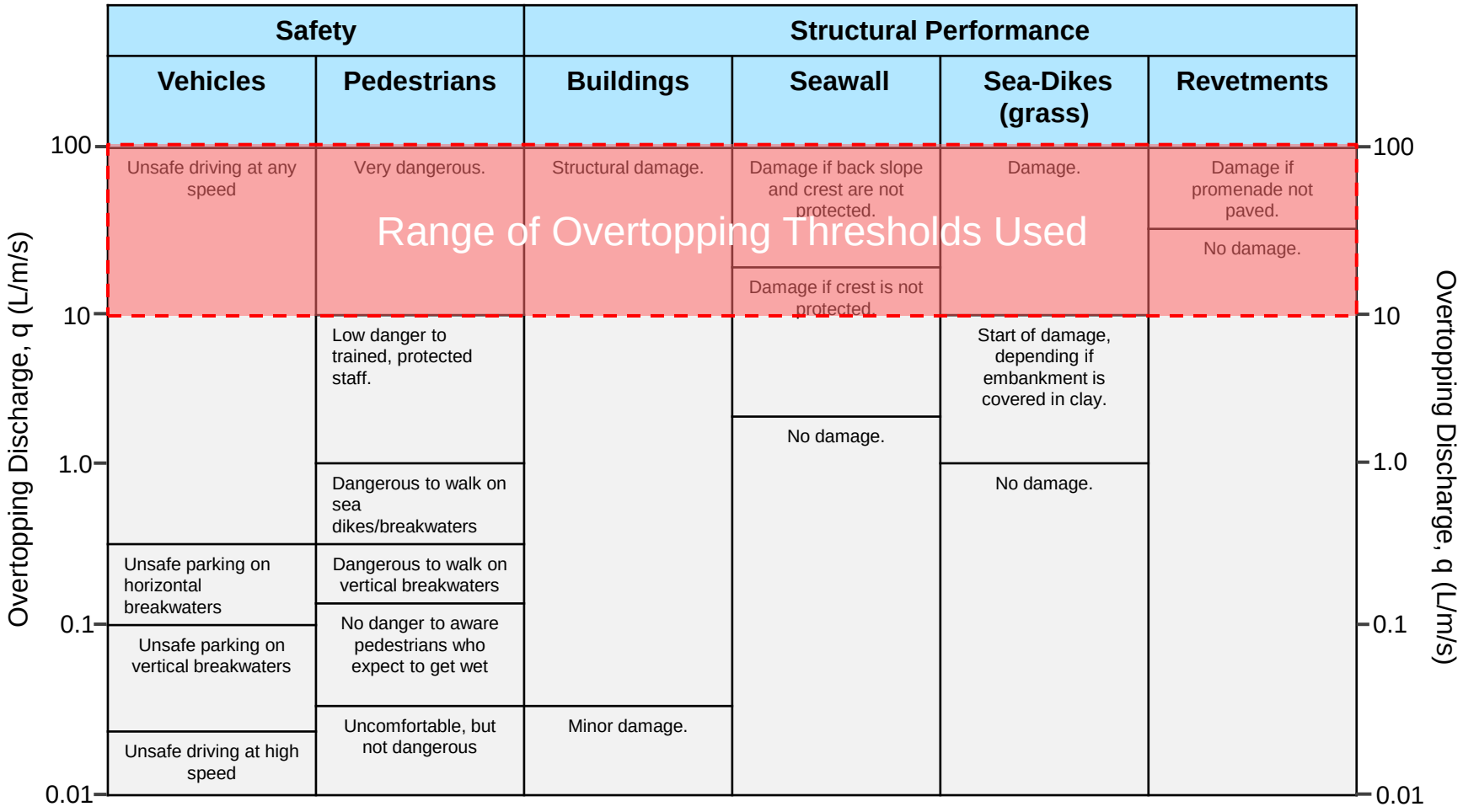
Wave Effects:

- Effects of wave-structure interaction
- Measured in terms of:
  - Run-up
  - Overtopping

Wave Effects Threshold:

- Defined by the level of performance required at the shoreline edge during a storm
- Standards exist in coastal engineering literature
- Appropriate thresholds are related to specifics of the shoreline use

Thresholds for Wave Effects



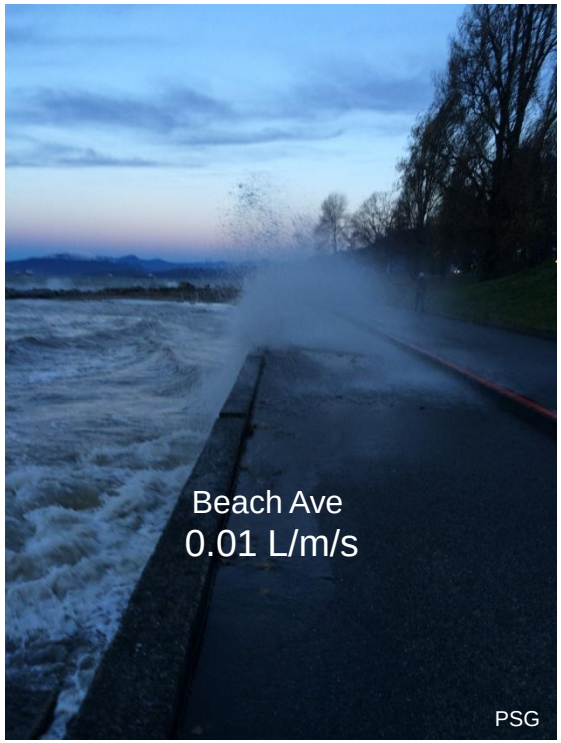
References:
Coastal Engineering Manual (CEM) Table VI-5-6
EurOtop Manual Tables 3.2-3.5

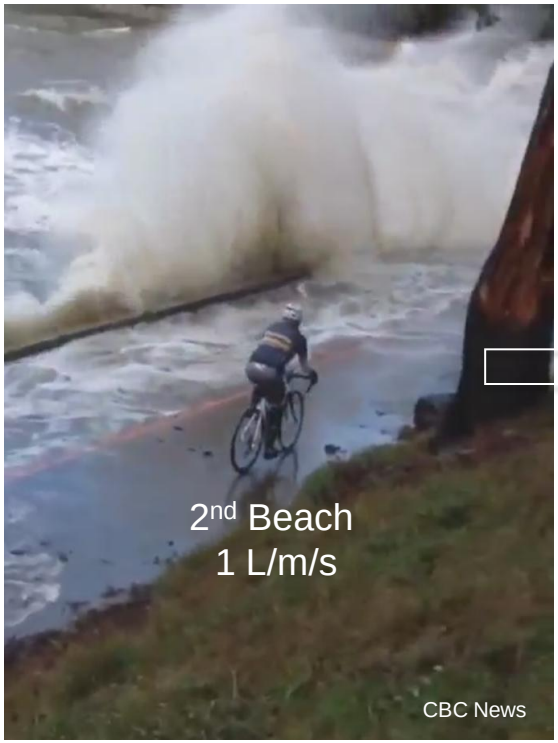
Threshold for Wave Effects

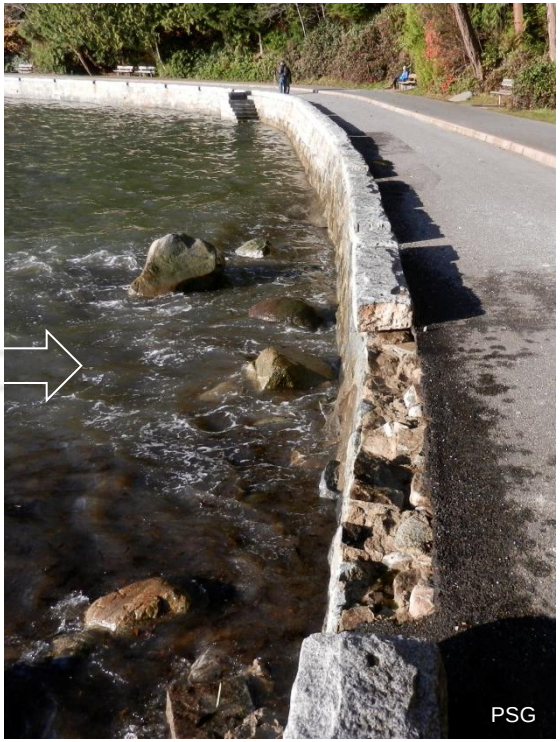
Overtopping at 0.001 – 0.04 L/m/s

Threshold for Wave Effects

Low Thresholds – Inconvenient, minor damage







November - 2014

Minor Damage

Threshold for Wave Effects

Overtopping at ~10 L/m/s – Dangerous to Public and start of damage to buildings

Threshold for Wave Effects

Overtopping at ~10 L/m/s – can result in flooding


Qualicum Beach, 2006


Qualicum Beach, 2016


Qualicum Beach, 2006

Threshold for Wave Effects

Overtopping at ~100 L/m/s – Dangerous to Drive – Flooding

Thresholds for Wave Effects

Wave Effects:

- effects of wave-structure interaction
- measured in terms of:
  - Run-up
  - Overtopping

Wave Effects Threshold:

- Defined by the level of performance required at the shoreline edge during a storm
- Standards exist in the coastal engineering literature
- Appropriate thresholds are related to specifics of the shoreline use:

Study recommends 10 L/m/s as the Threshold

Flood Construction Level (FCL) Components

- Sea Level Rise
- Tide
- Risk
- Designated Storm
  - Storm Surge
  - Winds and waves
- Wave Effects
  - Shoreline Composition
  - Shoreline Reach
  - Threshold
- **Freeboard Allowance**
  - Allowance 0.6m
  - Uncertainties and limitations:
    - Wave theories
    - Estimates of rate of SLR
    - Time frame in which decisions, or actions are made
    - Lot by lot variation

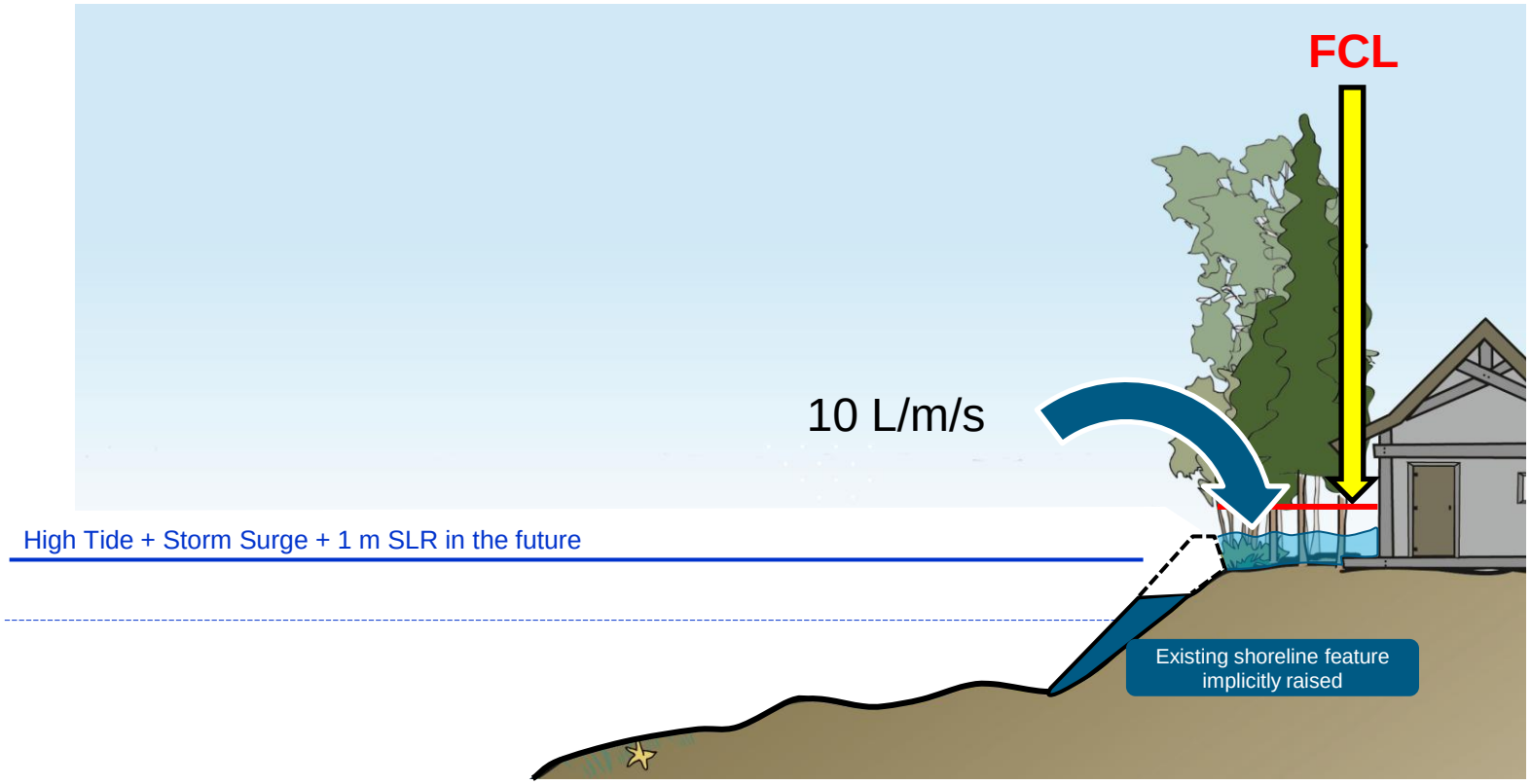
Flood Construction Levels

What exactly is the FCL

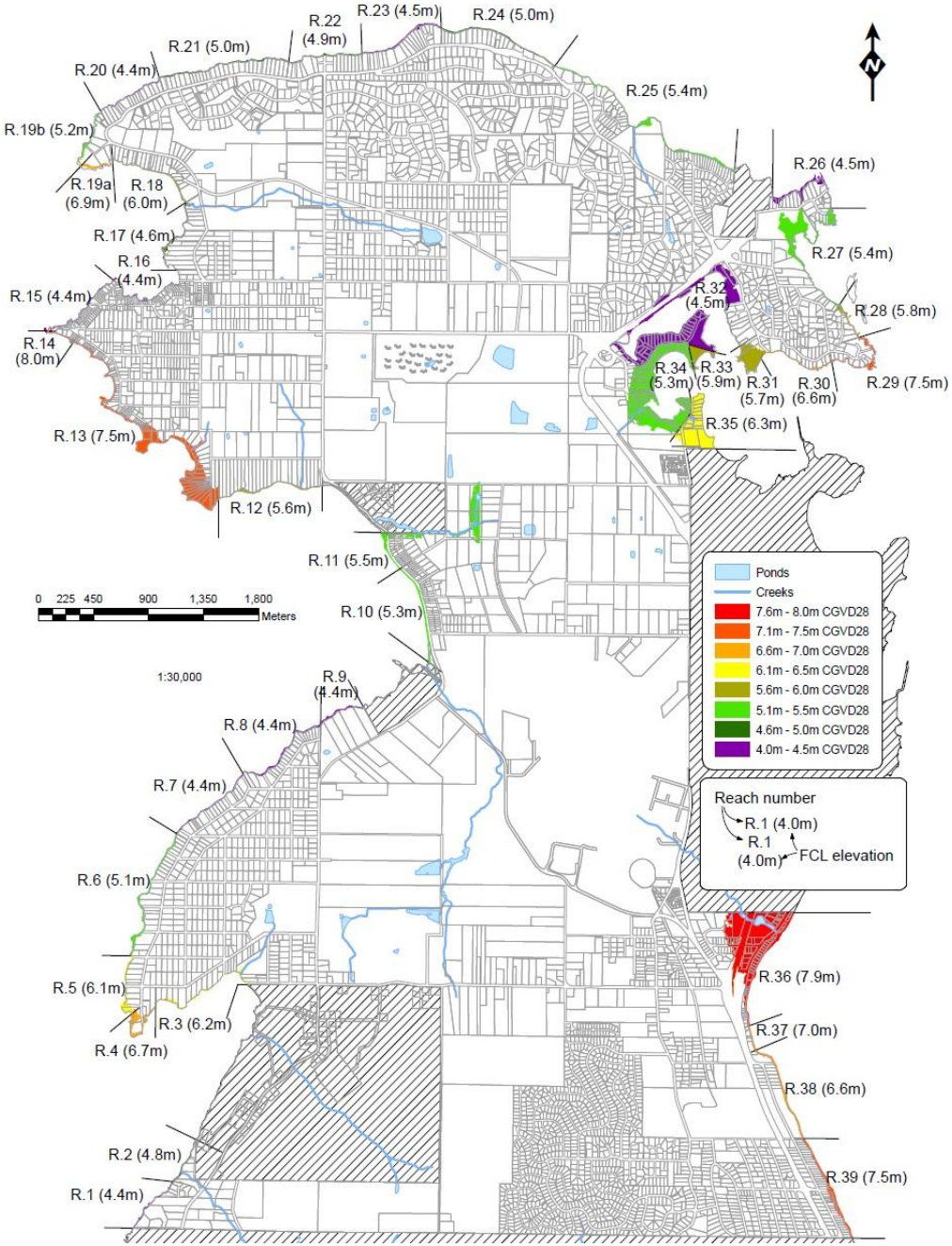
As defined by the BC Ministry of Environment (2011)

- Minimum underside elevation of a wooden floor system, or
- Minimum top elevation of concrete slab of habitable building

Implications to Shorelines: Components



FCLs


R.22 (4.9m)
R.23 (4.5m)
R.24 (5.0m)
R.21 (5.0m)
R.20 (4.4m)
R.25 (5.4m)
R.19b (5.2m)
R.26 (4.5m)
R.19a (6.9m)
R.18 (6.0m)
R.17 (4.6m)
R.27 (5.4m)
R.16 (4.4m)
R.15 (4.4m)
R.32 (4.5m)
R.28 (5.8m)
R.14 (8.0m)
R.34 (5.3m)
R.33 (5.9m)
R.31 (5.7m)
R.30 (6.6m)
R.29 (7.5m)
R.35 (6.3m)
R.13 (7.5m)
R.12 (5.6m)
R.11 (5.5m)
0 225 450 900 1,350 1,800
Meters
R.10 (5.3m)
1:30,000
R.9 (4.4m)
R.8 (4.4m)
R.7 (4.4m)
R.6 (5.1m)
R.5 (6.1m)
R.3 (6.2m)
R.4 (6.7m)
R.36 (7.9m)
R.37 (7.0m)
R.38 (6.6m)
R.2 (4.8m)
R.1 (4.4m)
R.39 (7.5m)
Ponds
Creeks
7.6m - 8.0m CGVD28
7.1m - 7.5m CGVD28
6.6m - 7.0m CGVD28
6.1m - 6.5m CGVD28
5.6m - 6.0m CGVD28
5.1m - 5.5m CGVD28
4.6m - 5.0m CGVD28
4.0m - 4.5m CGVD28
Reach number
R.1 (4.0m)
R.1 (4.0m)
FCL elevation

District of North Saanich

DoNS Marine Policy and Shoreline Development Review

Workshop 2016-06-07

Presentation Outline

- Overview of Marine Policies
- Implications of Refined FCL's to Marine Policies
- Take Aways and Next Steps

Overview of Marine Policies

Overview of Marine Policies

- Reference Documents
- Objectives
- Current Situation
- Policies and Zoning
- Findings and Recommendations

Overview of Marine Policies

Marine Task Force - Final Report, 2007

Official Community Plan (OCP), 2007

Overview of Marine Policies

- Reference Documents
- Objectives
- Current Situation
- Policies and Zoning
- Findings Recommendations

Overview of Marine Policies

1) Review and recommend changes to the current seven marine zones
2) Inventory and characterize sensitive shoreline areas
3) Assess effectiveness of existing bylaws, policies, and procedures
4) Recommend new policies to protect the marine environment and marine development

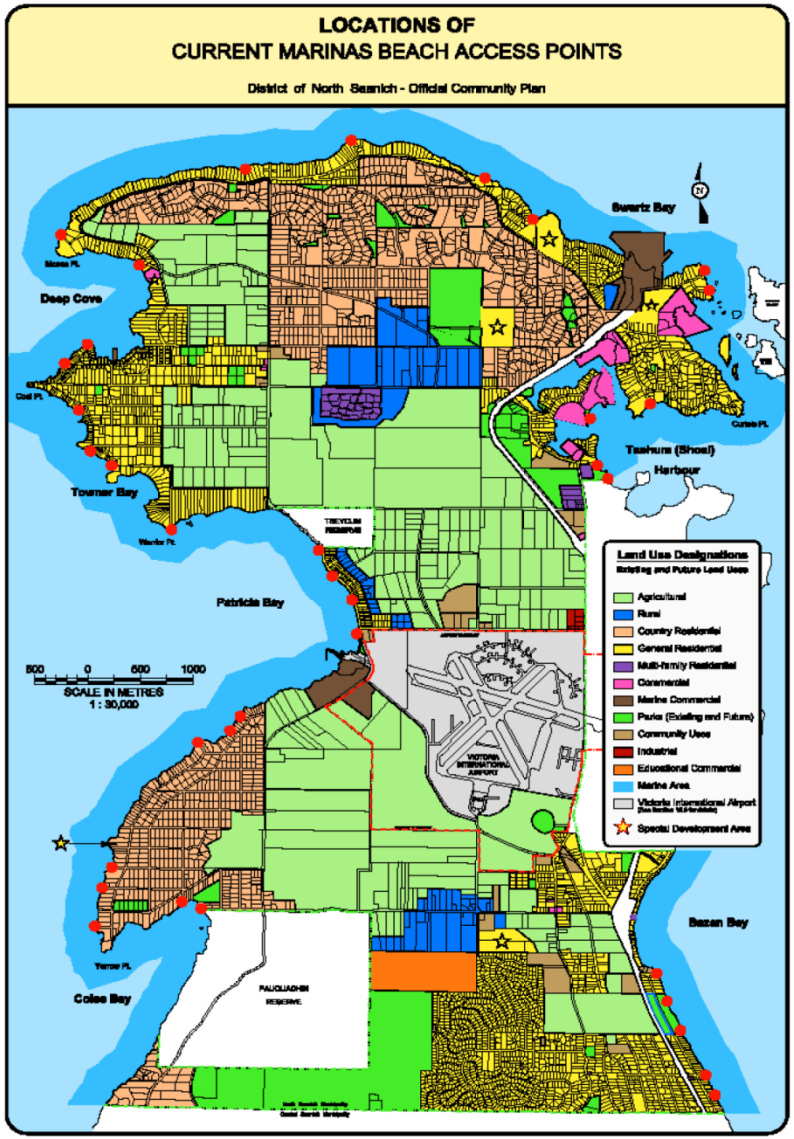
Overview of Marine Policies

- Reference Documents
- Objectives
- Current Situation
- Policies and Zoning
- Findings and Recommendations

Overview of Marine Policies

- Swartz Bay ferry terminal and Institute of Ocean Sciences (IOS) are major tax bases
  - Swartz Bay ferry terminal contributes 6.2% of tax base
  - Marinas contribute 4.5% of tax base (~$600,000)
- Increasing demand for mooring facilities
- Public access to the water/foreshore is important to community
  - Only one waterfront trail

Overview of Marine Policies



Beach Access Points
Source: Marine Task Force, Final Report, 2008

Overview of Marine Policies

- Reference Documents
- Objectives
- Current Situation
- Policies and Zoning
- Findings and Recommendations

Overview of Marine Policies

Marine Zones:

Zone 1 – Commercial Wharf
i.e. Swartz Bay ferry terminal

Zone 2 – Class A marinas and restaurants
i.e. Capital City Yacht Club (only)

Zone 3 – Class B marinas, stores, restaurants, etc.
i.e. Canoe Cove Marina

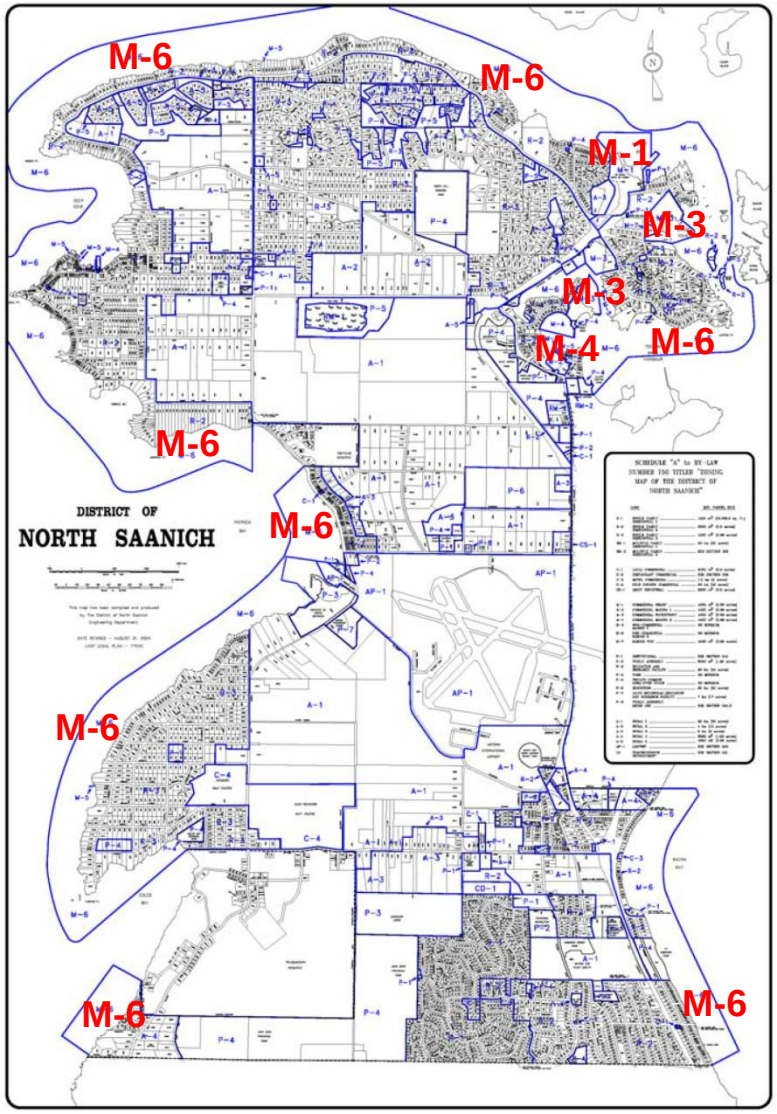
Zone 4 – Class C marinas, stores, restaurants, etc.
i.e. Deep Cove Marina

Zone 5 – Non-Commercial Type 1 (private docks allowed)

Zone 6 – Non-Commercial Type 2 (no private docks allowed)

Zone 7 – Marine Pubs
i.e. Stonehouse Pub in Canoe Cove (only)

Overview of Marine Policies



Marine Zoning
Source: Marine Task Force, Final Report, 2008

Overview of Marine Policies

Other zoning:

- Saanich Inlet is a Marine Conservation Zone
- Mudflats and marshes in Tsehum Harbour are protected areas
- Navigable Waters Act regulates mooring, and safe harbours applies to Tsehum Harbour
- Development Permit Area No. 1:
  - Marine Uplands and Foreshore
  - Extends 15m back from high water mark
- Seawalls are regulated by council
  - Discourages reflective seawalls

Overview of Marine Policies

- Reference Documents
- Objectives
- Current Situation
- Usage and Zoning
- Bylaws, Policies, and Procedures
- Findings and Recommendations

Overview of Marine Policies

- High resident demand for recreational use of the coastlines, beaches, and waters. Improved access could include:
  - Another waterfront trail, increased parking facilities, and improved kayak access and launches
- There is a severe shortage of moorage, and limited areas for expansion. Potential areas for expansion include:
  - Yacht Club Bay in Tsehum Harbour, Canoe Passage, and Deep Cove

Overview of Marine Policies

- High resident demand for recreational use of the coastlines, beaches, and waters. Improved access could include:
  - Another waterfront trail, increased parking facilities, and improved kayak access and launches
- There is a severe shortage of moorage, and limited areas for expansion. Potential areas for expansion include:
  - Yacht Club Bay in Tsehum Harbour, Canoe Passage, and Deep Cove
- Buoyed moorage is largely unregulated and could become a problem without further permanent moorage
- A small boat launching ramp is needed, preferably on the West side of the peninsula
- Identifies need for upland development related to the marine services business sector (i.e. dry-stacking)

Implications of Refined FCL's to Marine Policies

Implications of Refined FCL's

- General
  - Recreational and Commercial Uses
  - Major Infrastructure
  - Policies

Implications of Refined FCL's

- Sea Level Rise will increase exposure to flooding over time, particularly in low lying areas, i.e. Tsehum Harbour
  - Implications to values and safety
  - Exposed land is still usable
  - May require rezoning or repurposing in some locations

"Work with Sea Level Rise to Achieve Community Goals"


District of North Saanich
Source: Google Earth 2016

Implications of Refined FCL's

- General
- Commercial and Recreational Uses
- Major Infrastructure
- Policies

Implications of Refined FCL's

- Swartz Bay ferry terminal and Institute of Ocean Sciences (IOS)
  - Both marine related activities that will likely adapt and develop own plans to meet with SLR
- FCL study provides further data on wave exposure, which could identify sites for:
  - Permanent mooring and marinas locations
  - Small boat launching ramp
  - Recreational beach access (including kayak landings)
  - Beach nourishment options and bay exposure, etc.
- Exposed residential areas could evolve towards commercial or park (ecological reserve) areas.

Implications of Refined FCL's

Implications of Refined FCL's

- General
- Recreational and Commercial Uses
- Major Infrastructure
- Policies

Implications of Refined FCL's

- Increased exposure for critical regional infrastructure:
  - Highway 17 (Tsehum Harbour)
  - Highway 17 and Lochside Drive (Bazan Bay)
  - West Saanich Rd. (Patricia Bay)

Implications of Refined FCL's

Implications of Refined FCL's

Highway 17 (Tsehum Harbour)
Source: John Readshaw

Implications of Refined FCL's

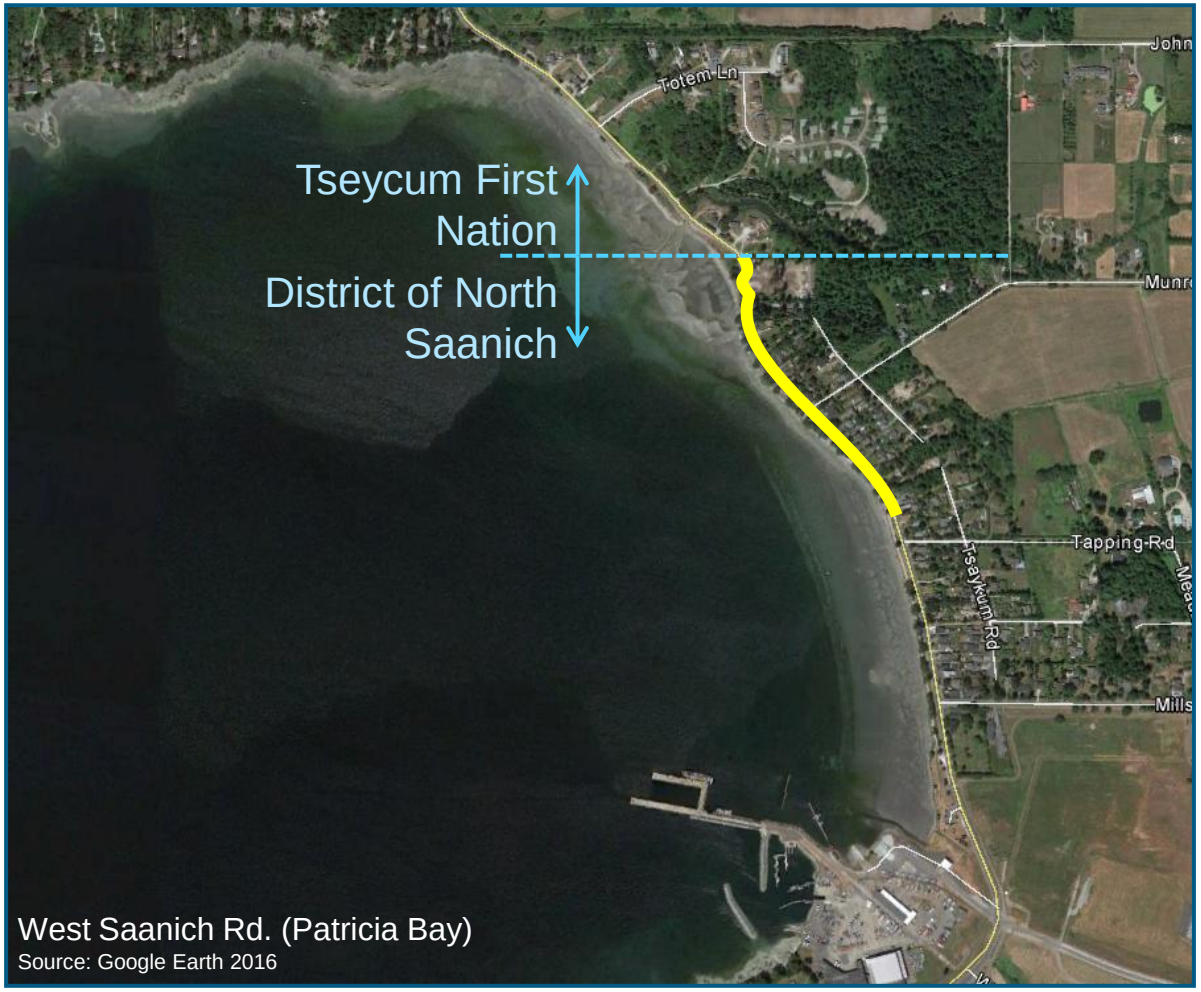
Highway 17 and Lochside Drive (Bazan Bay)
Source: Google Earth 2016

Implications of Refined FCL's

Implications of Refined FCL's

Highway 17 and Lochside Drive (Bazan Bay)
Source: John Readshaw

Implications of Refined FCL's



West Saanich Rd. (Patricia Bay)
Source: Google Earth 2016

Implications of Refined FCL's

- Increase exposure to critical infrastructure:
  - Highway 17 (Tsehum Harbour)
  - Highway 17 and Lochside Drive (Bazan Bay)
  - West Saanich Rd. (Patricia Bay)
- Some infrastructure has jurisdictional overlaps

Implications of Refined FCL's

- General
- Recreational and Commercial Uses
- Major Infrastructure
- Policies

Implications of Refined FCL's

- Will likely require update of Permit Area No. 1 (Marine Uplands and Foreshore)
  - Expanded to match refined FCL's
- Residents/Construction within new setback may require:
  - Permits for construction within setback
  - Wet or dry flood-proofing
  - Drainage control

Take Aways and Next Steps

Take Aways and Next Steps

- Sea Level Rise will increase exposure to flooding over time.
- Flooding events will start occurring on some properties before arrival of 1 m of SLR.
- Possible to work with sea level rise to rezone land and achieve community goals
  - Improve the safety of residents
  - Provide more permanent mooring facilities
  - Maintain and Improve public waterfront access
- Exposed residential areas could evolve towards productive commercial or park areas
    - *Park land: i.e. waterfront trails, beaches, kayak landings, conservation areas, etc.*
    - *Mixed Use: mooring buoy areas, small boat launches, parking lots, etc.*
    - *Commercial development: yacht clubs, marinas, dry-stacking, restaurants, etc.*

- What areas should remain as is?
- What zone changes could be made?
  - In which areas?
- What land uses should be prioritized?
- What marine uses should be prioritized?
- What infrastructure changes should be made?
- Should changes be made individually or regionally?

District of North Saanich

Implication and Application of FCL Study to DoNS Shoreline

Workshop 2016-06-07

Presentation Outline

Implications

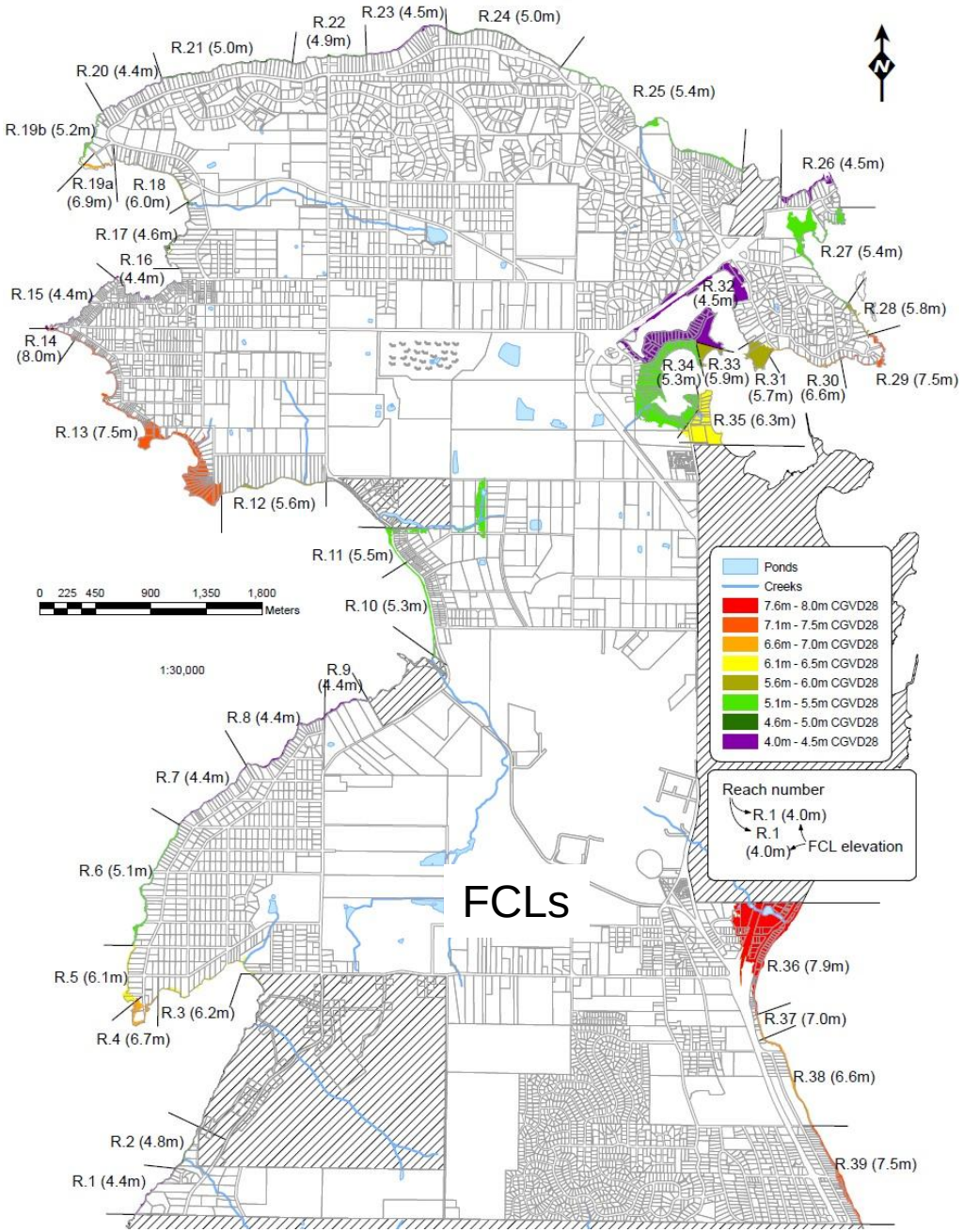
- Affected Properties
  - Direct
  - Indirect

Adaptation

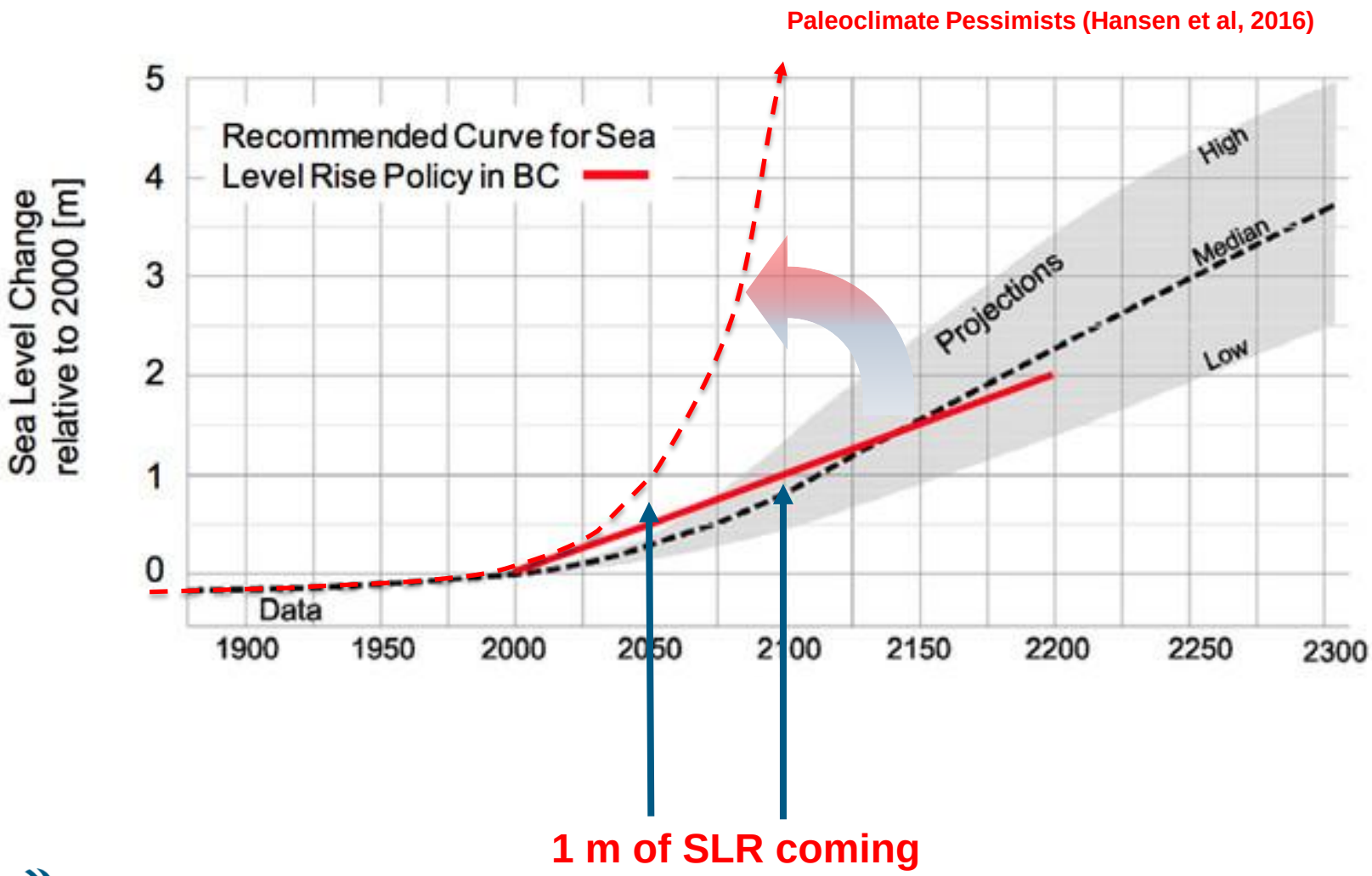
- Example options

Application

- Breakout Session
  - Issues
  - Concerns
  - Needs



SLR Expectations 2016



1 m of SLR coming

Implications to Shore Line Land Use

Eaglecrest – existing rock revetments

Hazard at Edge of Property		Existing Sea Level (2014)		1 m SLR	
Description and Threshold (L/s/meter)		#/yr	Average Occurrence		
Minor overtopping (mainly spray) No danger to public	0.001	**0-2**	Once every two years		
Substantial spray Uncomfortable to the public	0.04	**0-1**	Once every twenty years		
Danger to the public Minor damage to buildings	0.1	*	Possible		
Danger to trained personnel Light structural damage	1	*	Less likely		
Very dangerous to any observer Start of damage to coastal structures	10	*	Unlikely		
Some flooding, dangerous to drive Structural damage to buildings	50	*	Rare		
Extensive flooding Dangerous to drive at any speed Damage to most structures	100	*	Rare		
* Can occur if storm and large high tide occur simultaneously					

Implications to Shore Line Land Use

Eaglecrest – existing rock revetments

Hazard at Edge of Property		Existing Sea Level (2014)		1 m SLR	
Description and Threshold (L/s/meter)		#/yr	Average Occurrence	#/yr	Average Occurrence
Minor overtopping (mainly spray) No danger to public	0.001	0-2	Once every two years	20-38	Every week (winter)
Substantial spray Uncomfortable to the public	0.04	0-1	Once every twenty years	9-23	2 - 3 times a month (winter)
Danger to the public Minor damage to buildings	0.1	*	Possible	4-21	1 -2 times a month (winter)
Danger to trained personnel Light structural damage	1	*	Less likely	0-9	Every 1 - 2 months (winter)
Very dangerous to any observer Start of damage to coastal structures	10	*	Unlikely	0-6	Once or twice a year
Some flooding, dangerous to drive Structural damage to buildings	50	*	Rare	0-1	Once every 5 - 10 years
Extensive flooding Dangerous to drive at any speed Damage to most structures	100	*	Rare	*	Possible

* Can occur if storm and large high tide occur simultaneously

Implications

Affected Properties

Implications

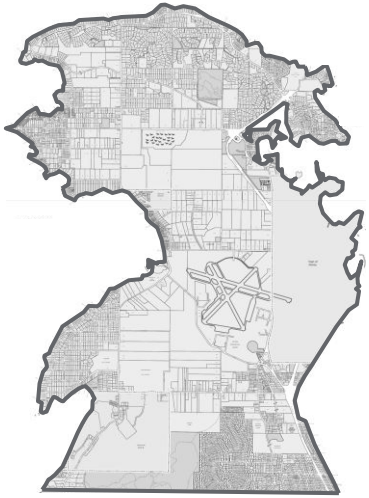
Directly Affected Properties

- Criteria 1 – Lot not affected
- Criteria 2 – Lot partially affected (< 15 m)
- Criteria 3 – Lot substantially inundated (> 15 m)
- Criteria 4 – Lot completely inundated

Indirectly Affected Properties

- Criteria 5 – Adjacent lot has flood potential
- Criteria 6 – Adjacent lot completely inundated

Affected Properties



Criteria	Number of Properties	
Directly Affected Properties		
Criteria 1	45	
Criteria 2	460	
Criteria 3	130	
Criteria 4	80	
Total	**715**	
Indirectly Affected Properties		
Criteria 5	35	
Criteria 6	39	
Total	**74**	

Directly Affected Properties

Criteria 1

(Lot not affected)

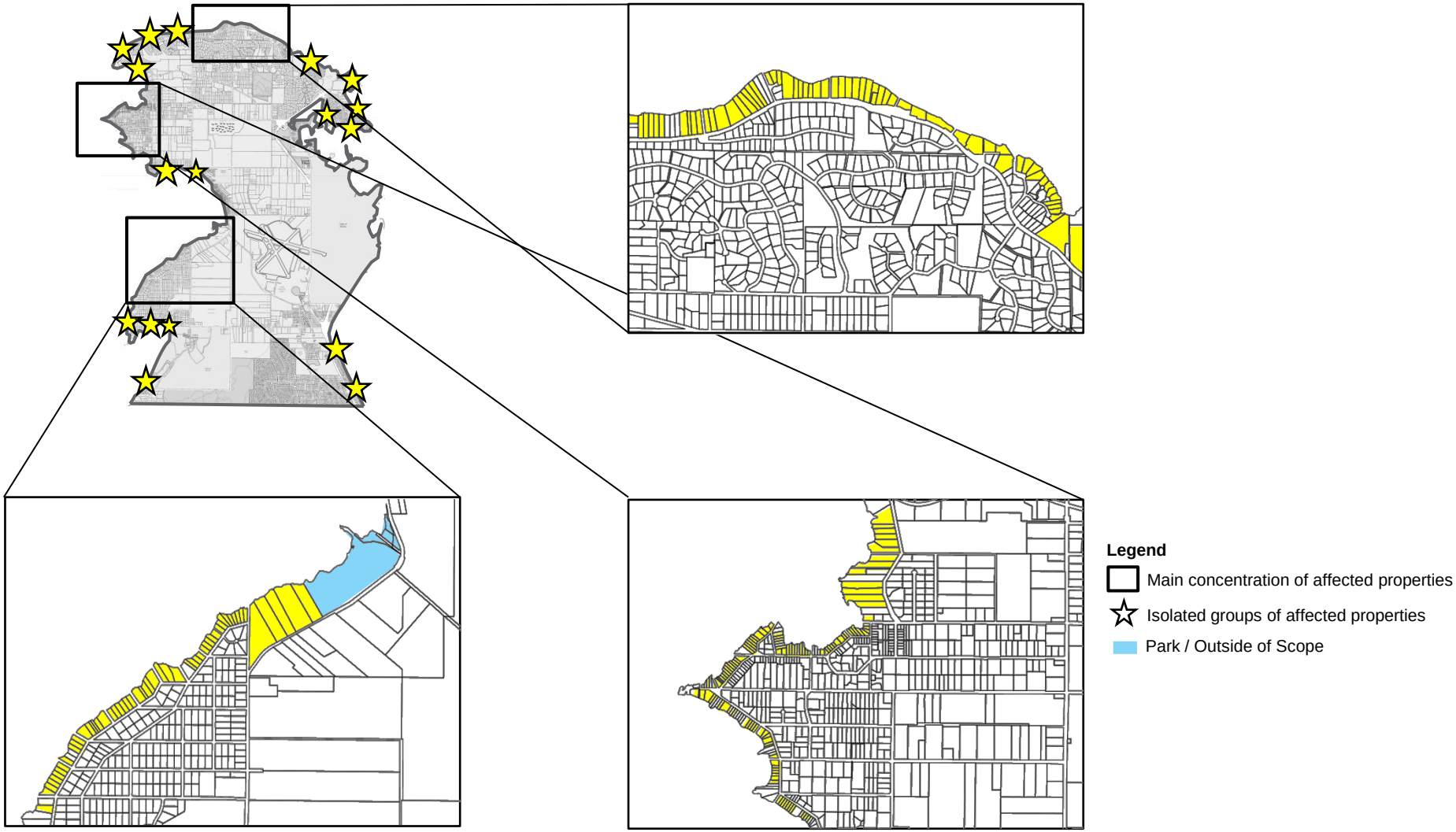
Legend

- Main concentration of affected properties
- Isolated groups of affected properties
- Park / Outside of Scope

Directly Affected Properties

Criteria 2

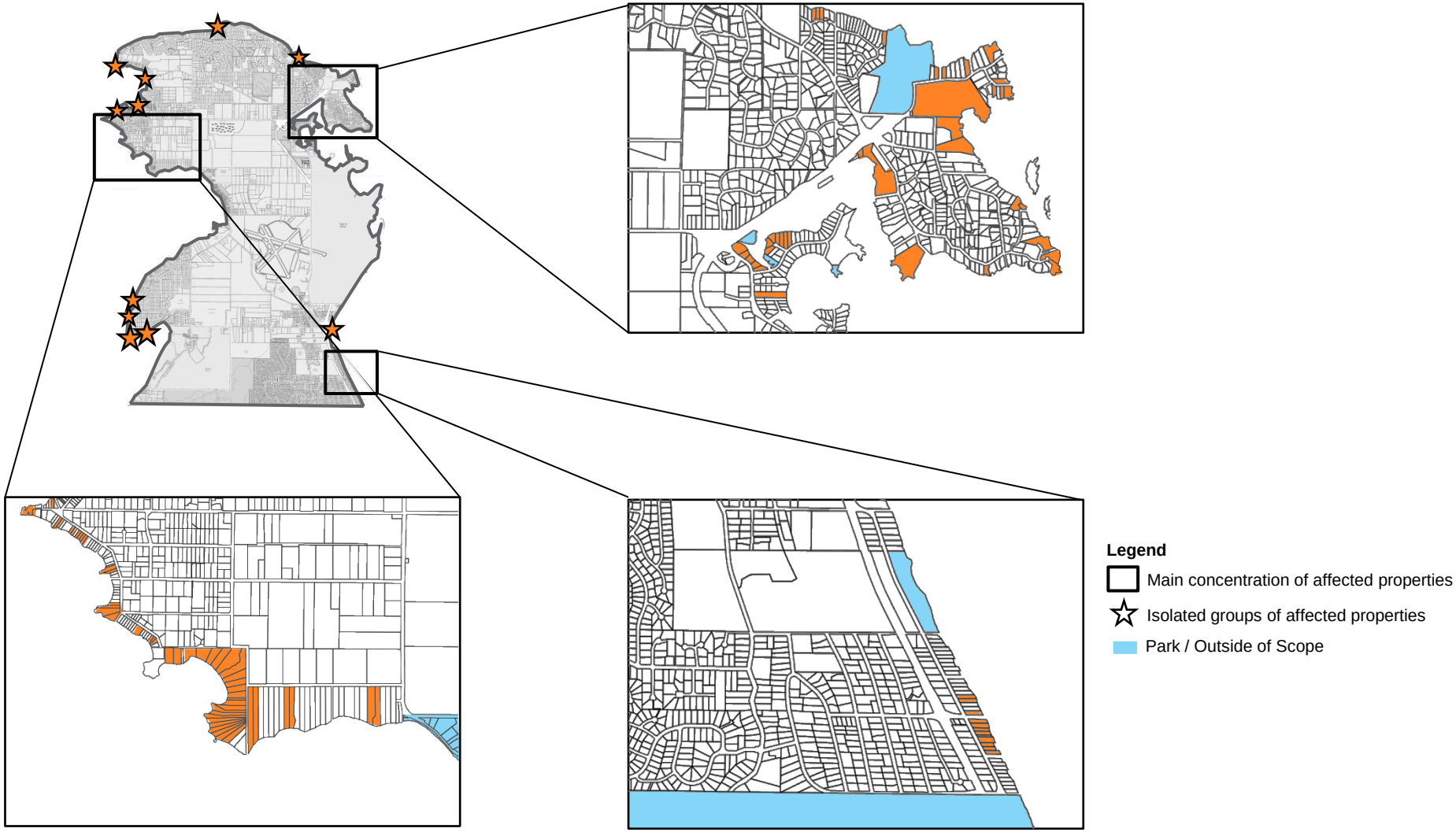
(Lot partially affected, <15m)



Directly Affected Properties

Criteria 3

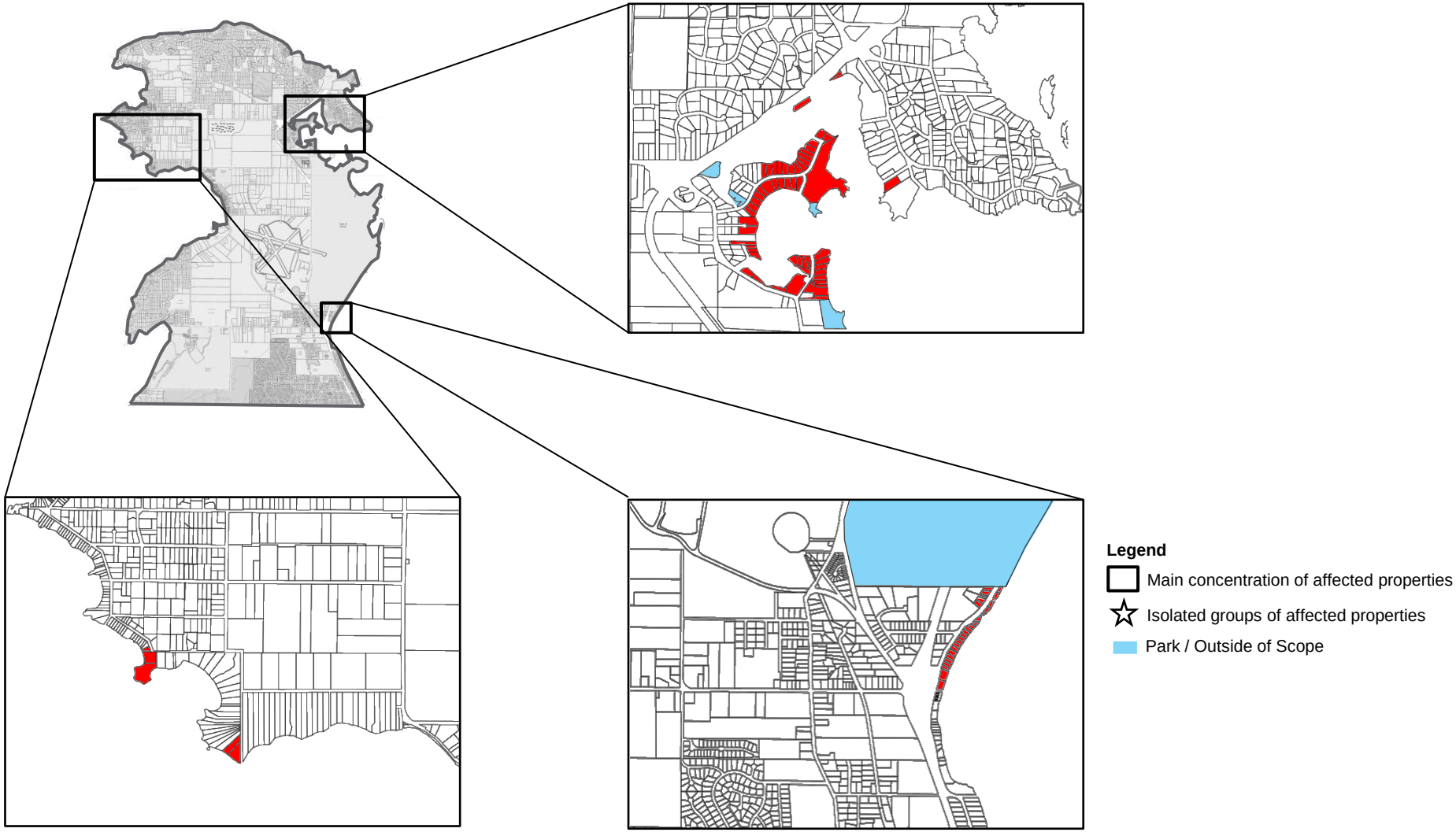
(Lot substantially inundated, >15m)



Directly Affected Properties

Criteria 4

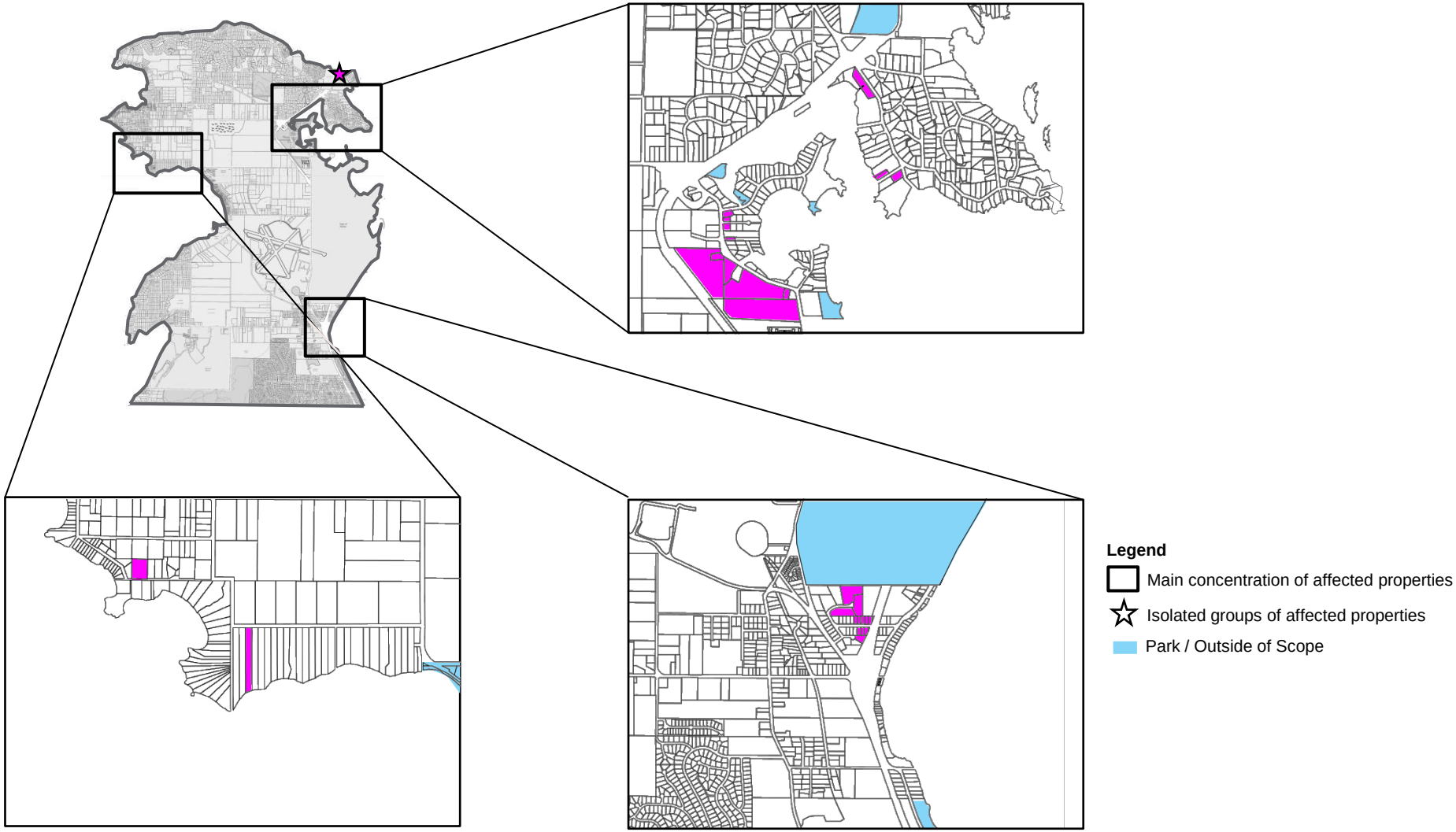
(Lot completely inundated)



Indirectly Affected Properties

Criteria 5

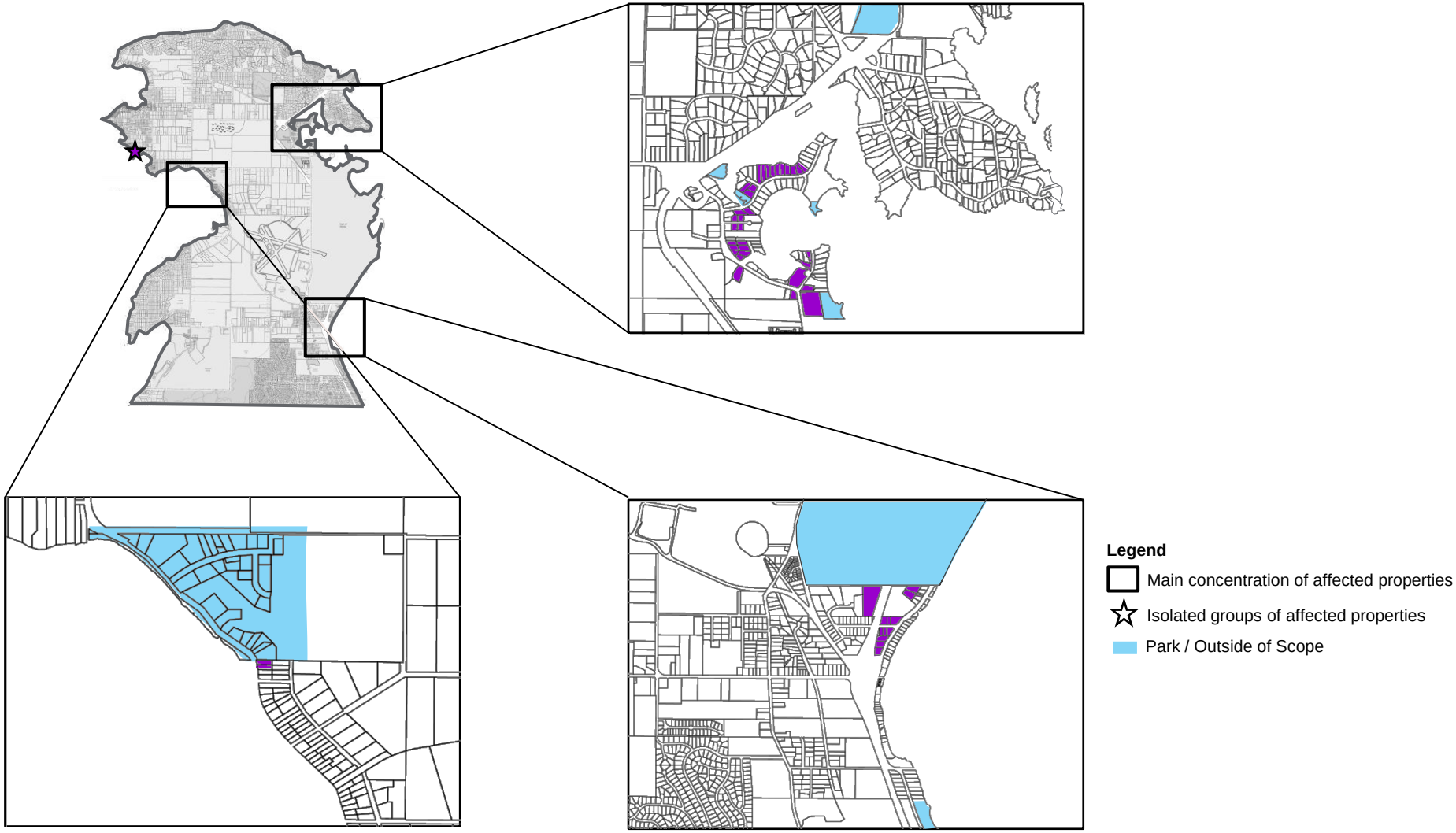
(Adjacent lot has flooding potential)



Indirectly Affected Properties

Criteria 6

(Adjacent lot completely inundated)



Adaptation

Example Options

Adaptation

Depends on:

- Location of property
- Severity of Flooding
- Density and zoning
- Location of property and surrounding features

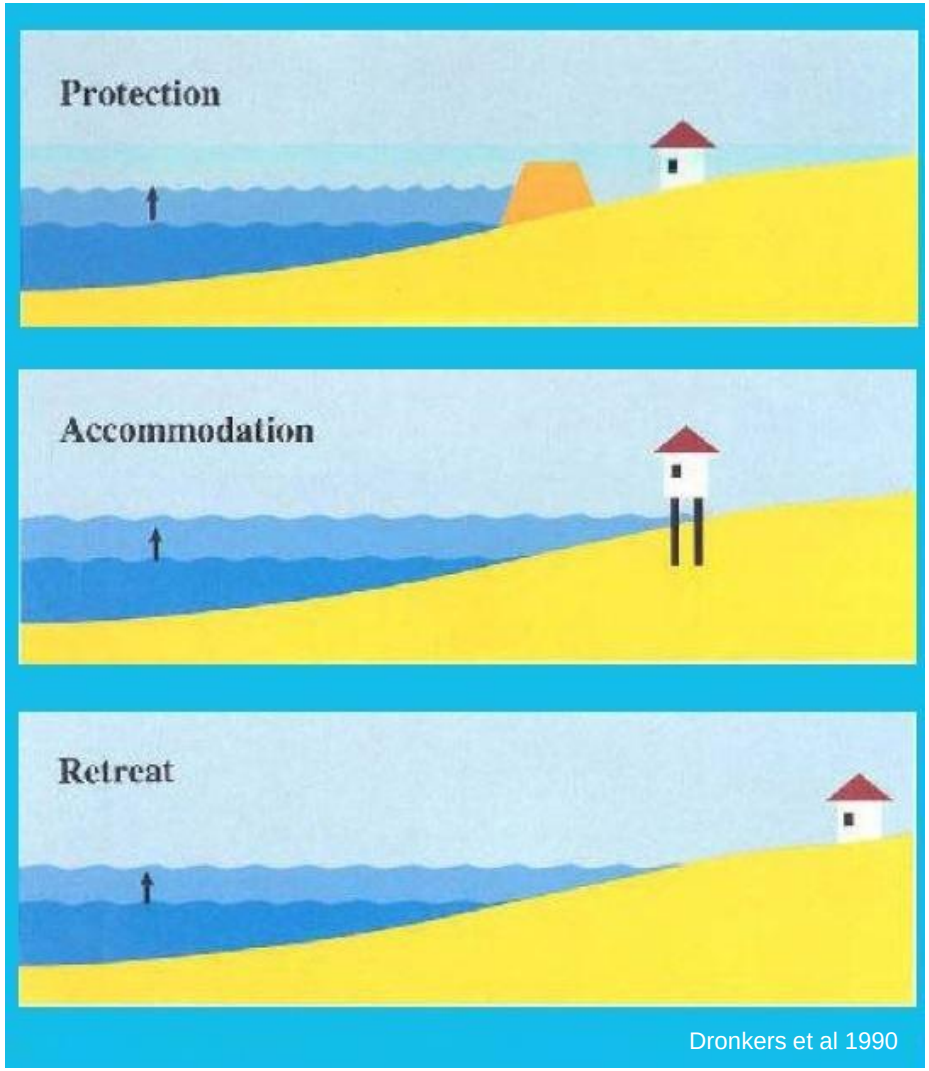
Adaptation Options

Protect

Accommodate

Retreat

Avoid



Dronkers et al 1990

Example Options

Protect

- Shoreline Composition
  - *Hard solutions*
  - *Soft solutions*

Shorefriendly.org

Example Options

Protect

- Shoreline Composition
  - *Hard solutions*
  - *Soft solutions*
- **Dikes**

Example Options

Protect

- Shoreline Composition
  - *Hard solutions*
  - *Soft solutions*
- Dikes
- **Storm/Flood Barrier**
  - *MOSE Project, Venice, Italy*
  - *Thames Barrier, London, UK*

Example Options

Protect

- Shoreline Composition
  - *Hard solutions*
  - *Soft solutions*
- Dikes
- Storm/Flood Barrier
  - *MOSE Project, Venice, Italy*
  - *Thames Barrier, London, UK*
- **Flood Wall**
  - *Passive Floodgates*

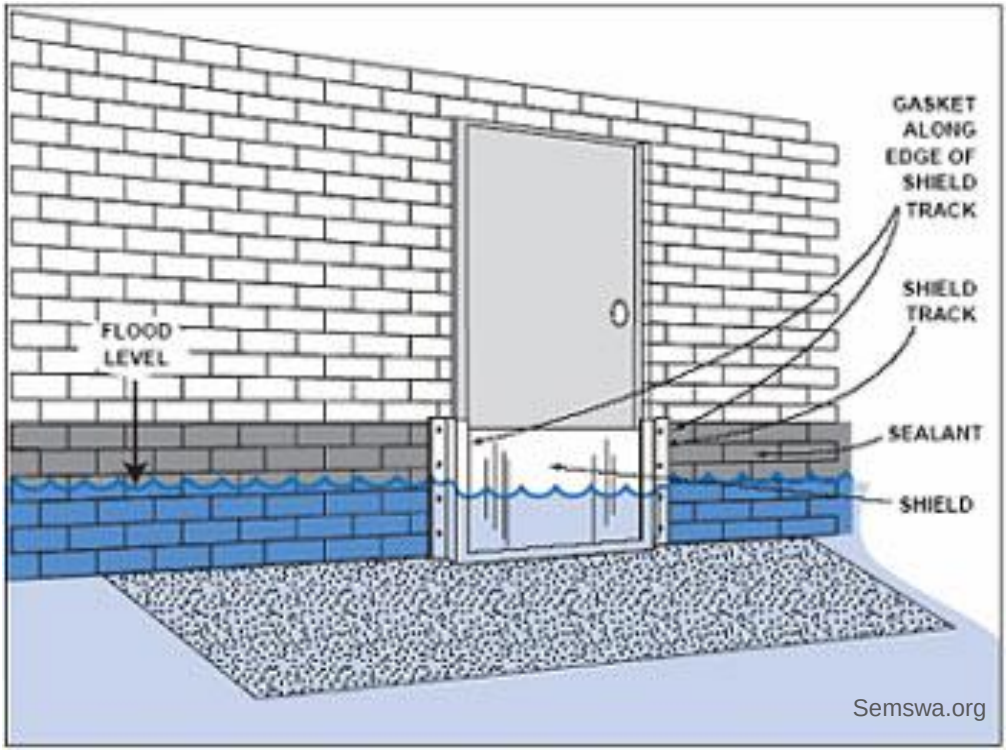
Roadway Gate

Entrance Gate

Example Options

Accommodate

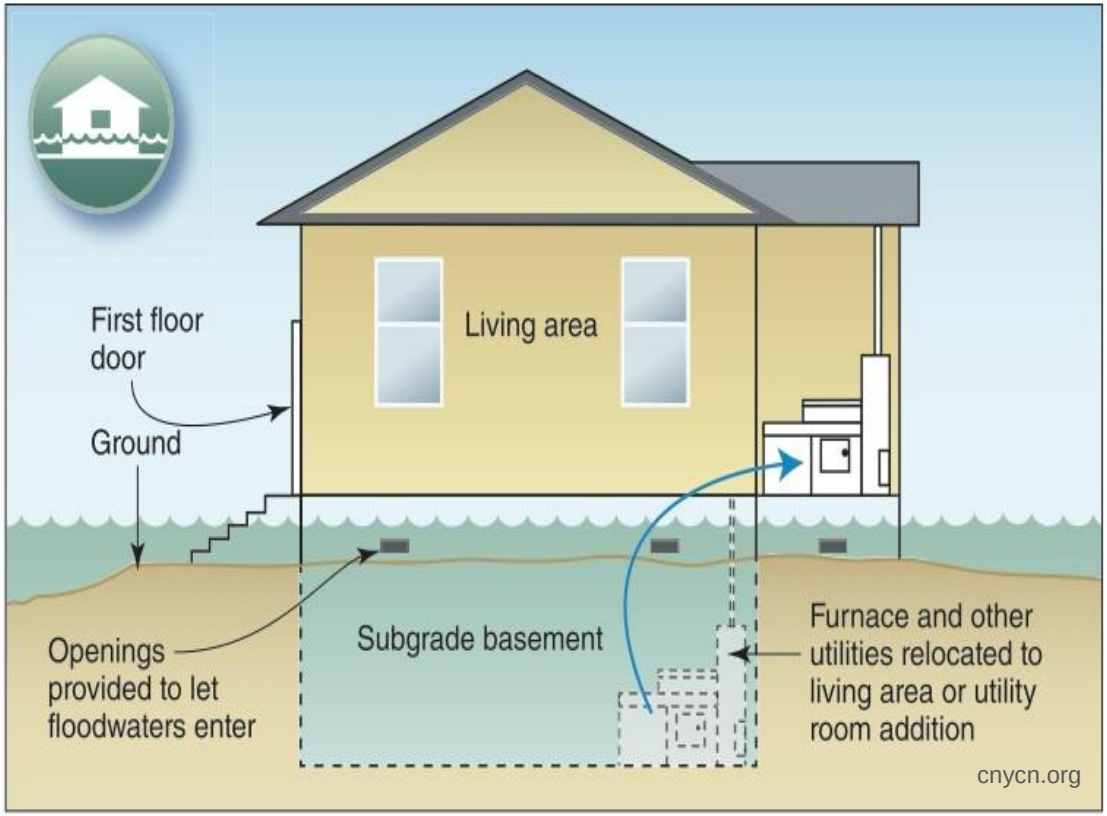
- **Dry-proof**
- Wet-proof
- Raise home



Example Options

Accommodate

- Dry-proof
- **Wet-proof**
- Raise home



Example Options

Accommodate

- Dry-proof
- Wet-proof
- **Raise home**

Example Options

Accommodate

- Dry-proof
- Wet-proof
- Raise home
- **Flood Proofing**
  - **Raise utilities (electric, heating, gas systems)**
  - Modify water valves
  - Modify external water flow

Example Options

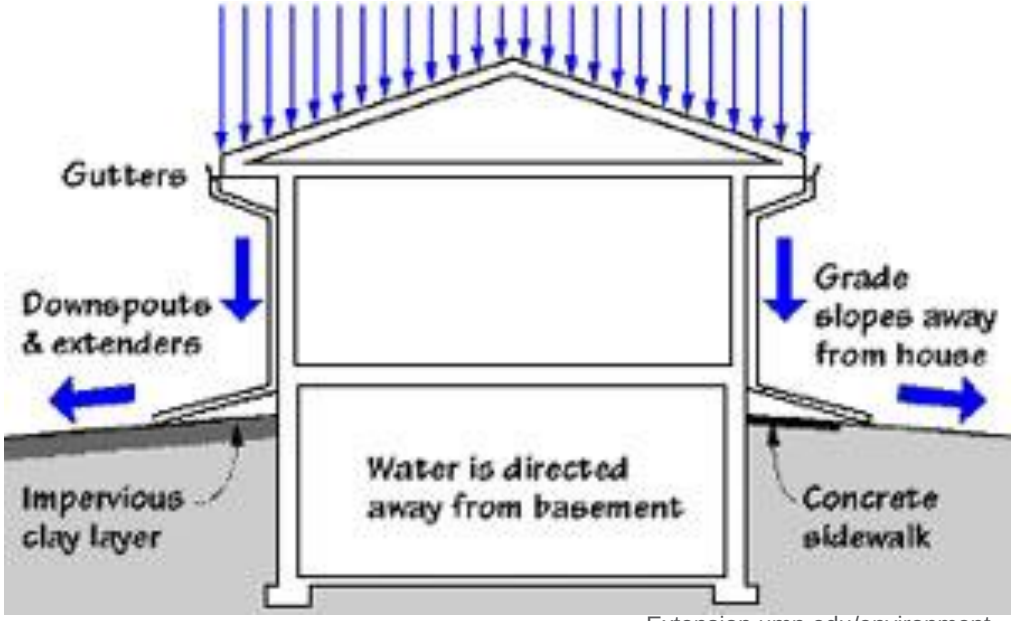
Accommodate

- Dry-proof
- Wet-proof
- Raise home
- **Flood Proofing**
  - Raise utilities (electric, heating, gas systems)
  - **Modify water valves**
  - Modify external water flow

Example Options

Accommodate

- Dry-proof
- Wet-proof
- Raise home
- **Flood Proofing**
  - Raise utilities (electric, heating, gas systems)
  - Modify water valves
  - **Modify external water flow**



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Example Options

Accommodate

- Dry-proof
- Wet-proof
- Raise home
- Flood Proofing
  - Raise electric and climate systems
  - Modify water valves
  - Modify external water flow
- **Evacuation Plan**

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Example Options

Retreat

- Limit development in areas likely to be inundated
- Rezoning

BREAKOUT SESSION

Implications

Breakout Session (10-15 minutes)

Directly Affected Properties

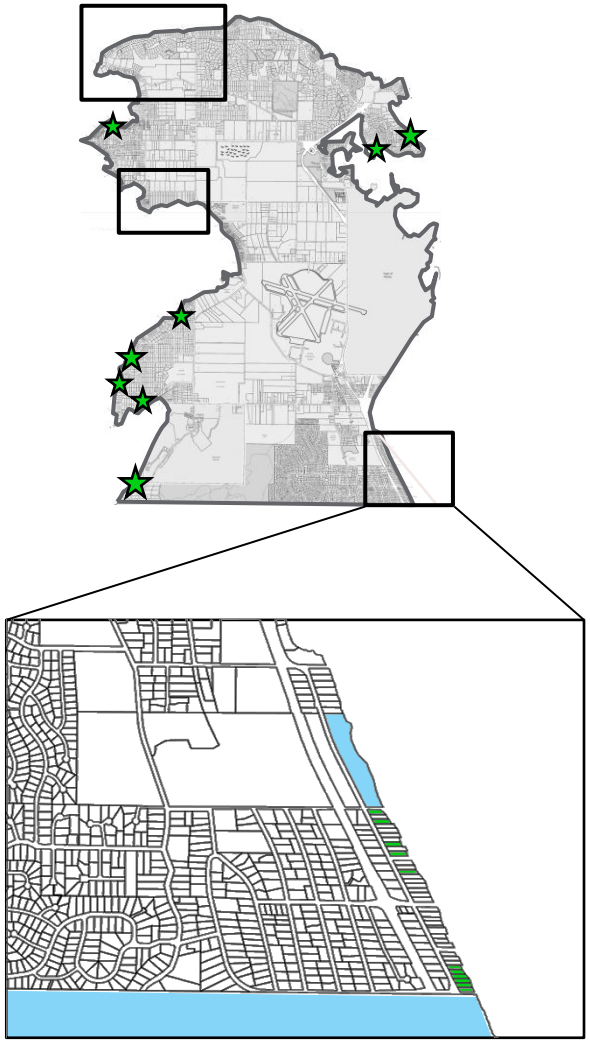
- Criteria 1 – Lot not affected
- Criteria 2 – Lot partially affected (< 15 m)
- Criteria 3 – Lot substantially inundated (> 15 m)
- Criteria 4 – Lot completely inundated

Discussion on:

- Issues for area
- Specific concerns
- Information needs

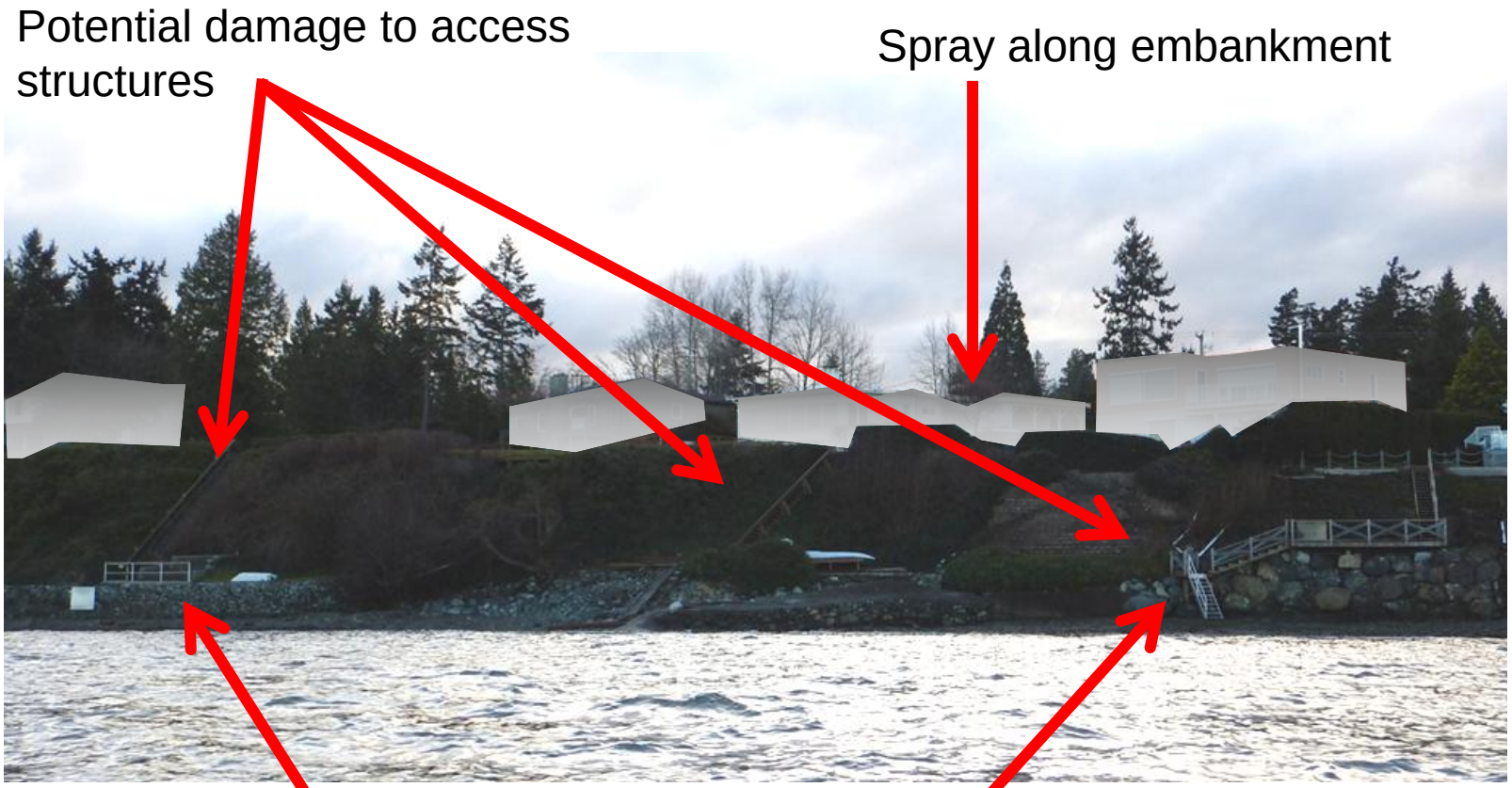
Application
R.39 (7.5m)

Criteria 1
(Lot not affected)



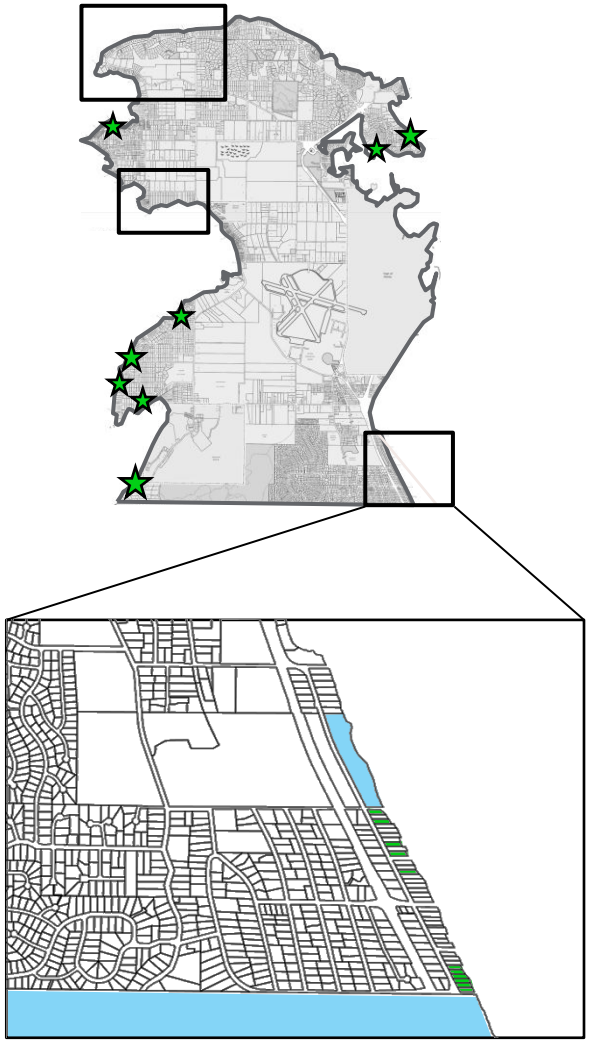
Typical Interactions (indicative only)

Criteria 1
(Lot not affected)



Application
R.39 (7.5m)

Criteria 1
(Lot not affected)



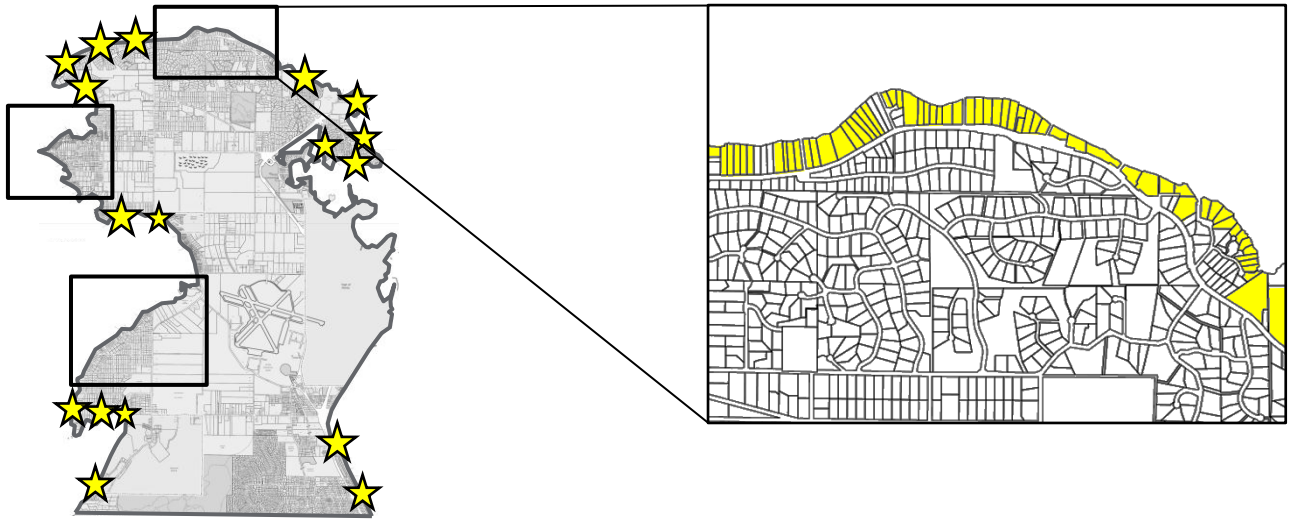
Issues for Area

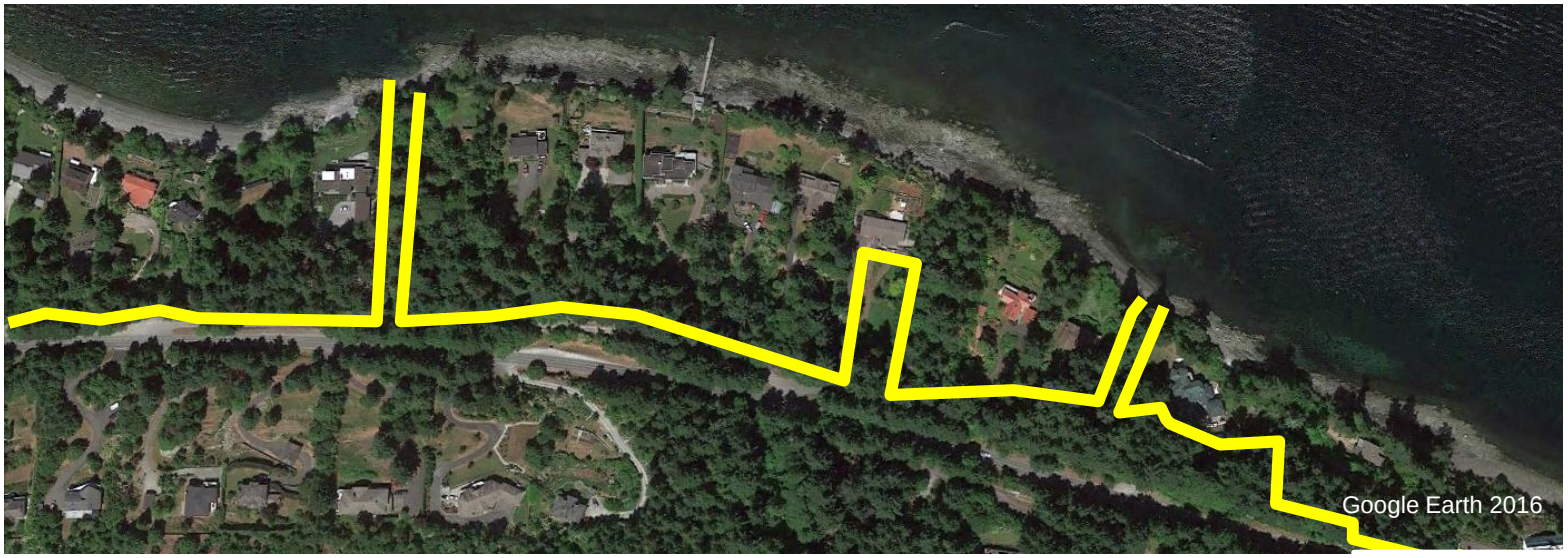
Specific Concerns

Information Needs

Application
R.24 (5.0m)

Criteria 2
(Lot partially affected, <15m)





Criteria 2

(Lot partially affected, <15m)

Typical Interactions (indicative only)

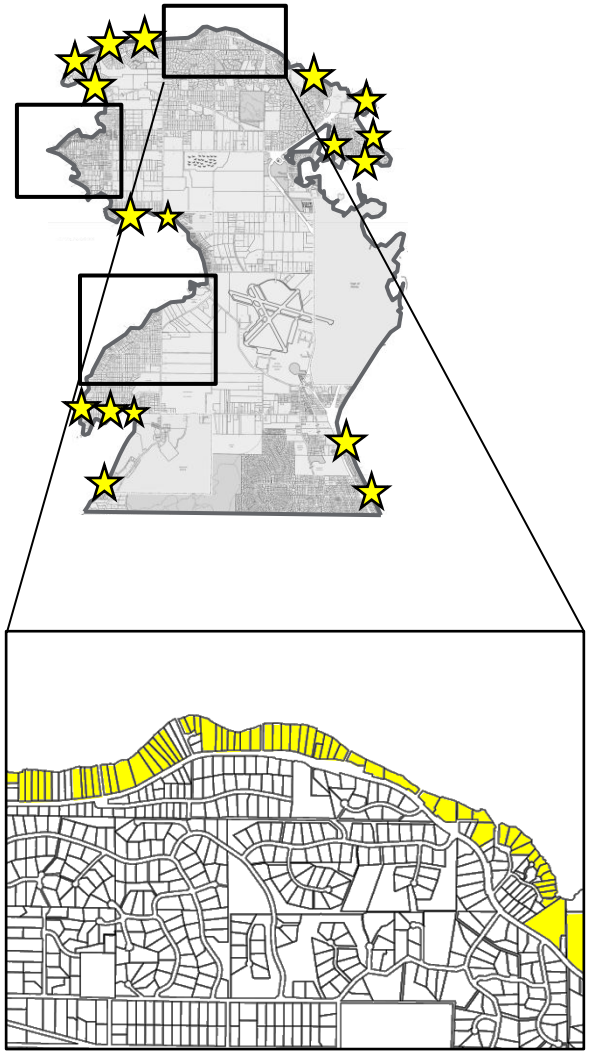
Potential erosion of shoreline

Spray and overtopping at along embankment

Potential damage to beach access structure

Application
R.24 (5.0m)

Criteria 2
(Lot partially affected, <15m)



Issues for Area

Specific Concerns

Information Needs

Application
R.13 (7.5m)

Criteria 3
(Lot substantially inundated, >15m)

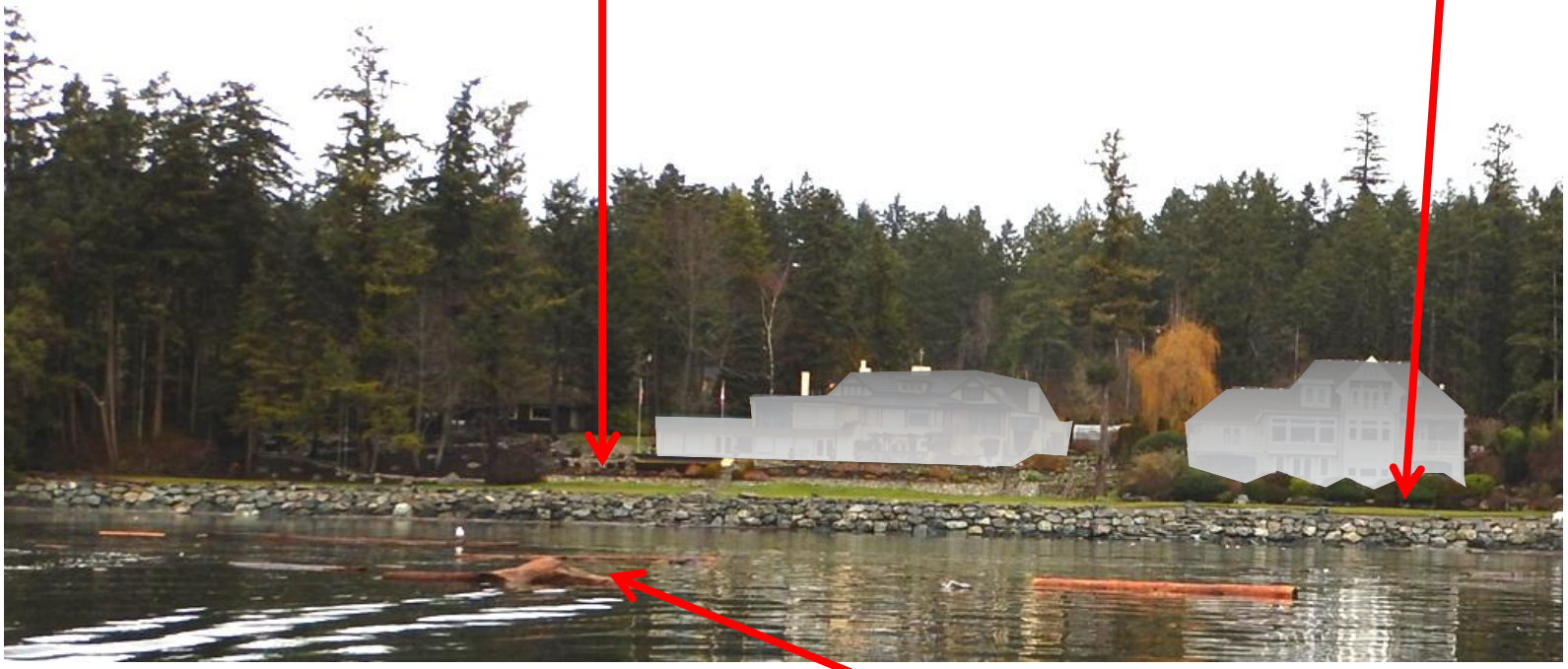
Criteria 3

Typical Interactions (indicative only)

(Lot substantially inundated, >15m)

Flooding of lawn, and potential damage to stone seawall

Spray and overtopping at stone seawall



Overtopping of debris onto lawn and potential damage to building elements

Application
R.13 (7.5m)

Criteria 3
(Lot substantially inundated, >15m)

Issues for Area

Specific Concerns

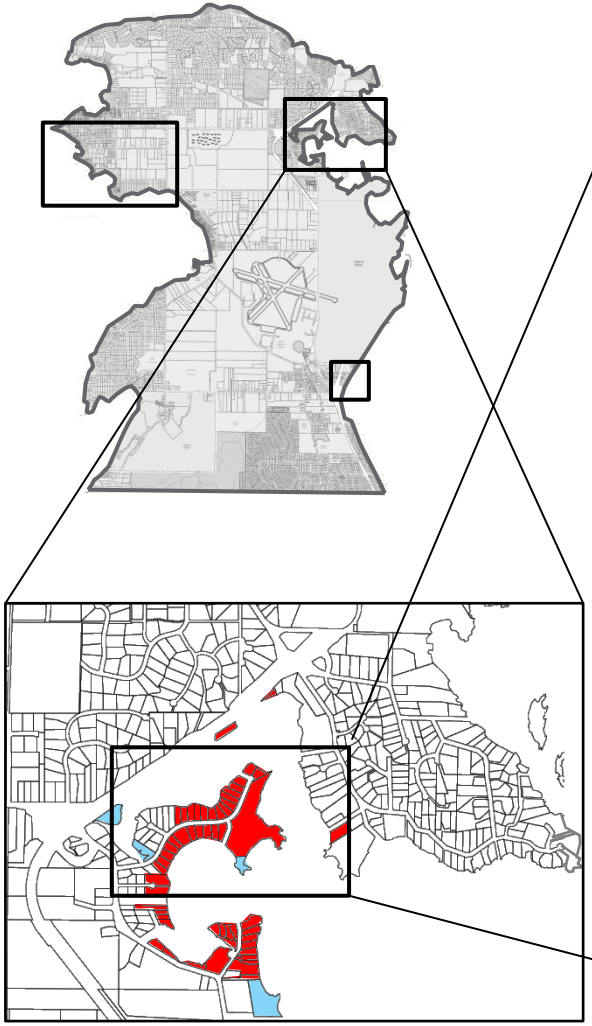
Information Needs

Application

R.32 (4.5m), R.33 (5.9m), R.34 (5.3m)

Criteria 4

(Lot completely inundated)



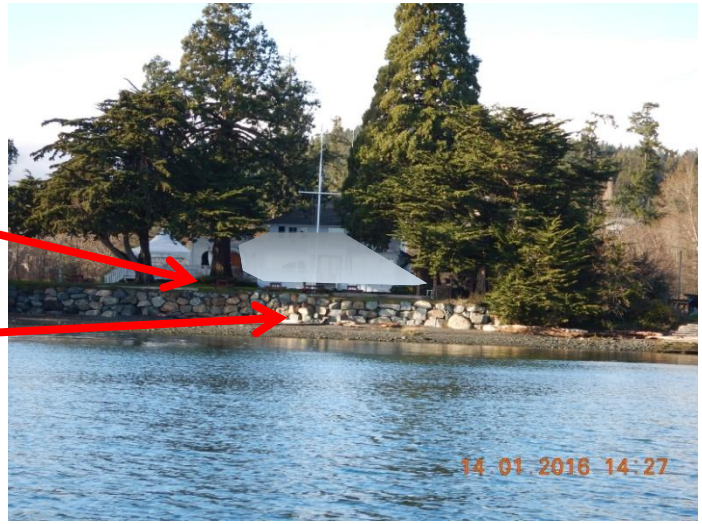
Criteria 4

(Lot completely inundated)

Typical Interactions (indicative only)

Potential erosion of lawn

Spray and overtopping at stone seawall



Flooding of lawn

Spray and overtopping at rock revetments

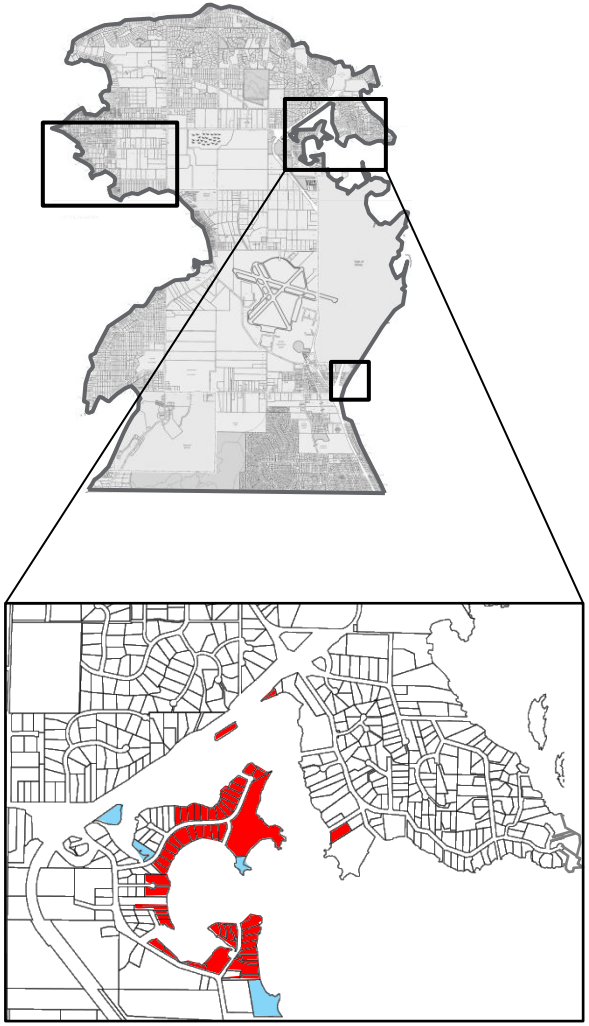
Implications to drain

Application

R.32 (4.5m), R.33 (5.9m), R.34 (5.3m)

Criteria 4

(Lot completely inundated)



Issues for Area

Specific Concerns

Information Needs

Breakout Session (10-15 minutes)

Directly Affected Properties

- Criteria 1 – Lot not affected
- Criteria 2 – Lot partially affected (< 15 m)
- Criteria 3 – Lot substantially inundated (> 15 m)
- Criteria 4 – Lot completely inundated

Discussion on:

- Issues for area
- Specific concerns
- Information needs