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*Alliance for Resilient Cities*

# **Risk Assessment of the Impacts of Climate Change on the Vancouver Sewerage Area**

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Kerr Wood Leidal  
Associates Ltd.**



# Metro Vancouver Case Study

Host: Metro Vancouver

(Legal Name: Greater Vancouver Regional District)

Partner: Engineers Canada

Consultant: Kerr Wood Leidal Assoc. Ltd.

Sub: Associated Engineering (B.C.) Ltd.

Dean Shiskowski, Ph.D., P.Eng.



# Engineers Canada National Assessment

## Engineers Canada

- develops standards of practice
- promotes continual development of competence



- 2007-2008  
national-scale assessment of Canada's public infrastructure to climate change impacts

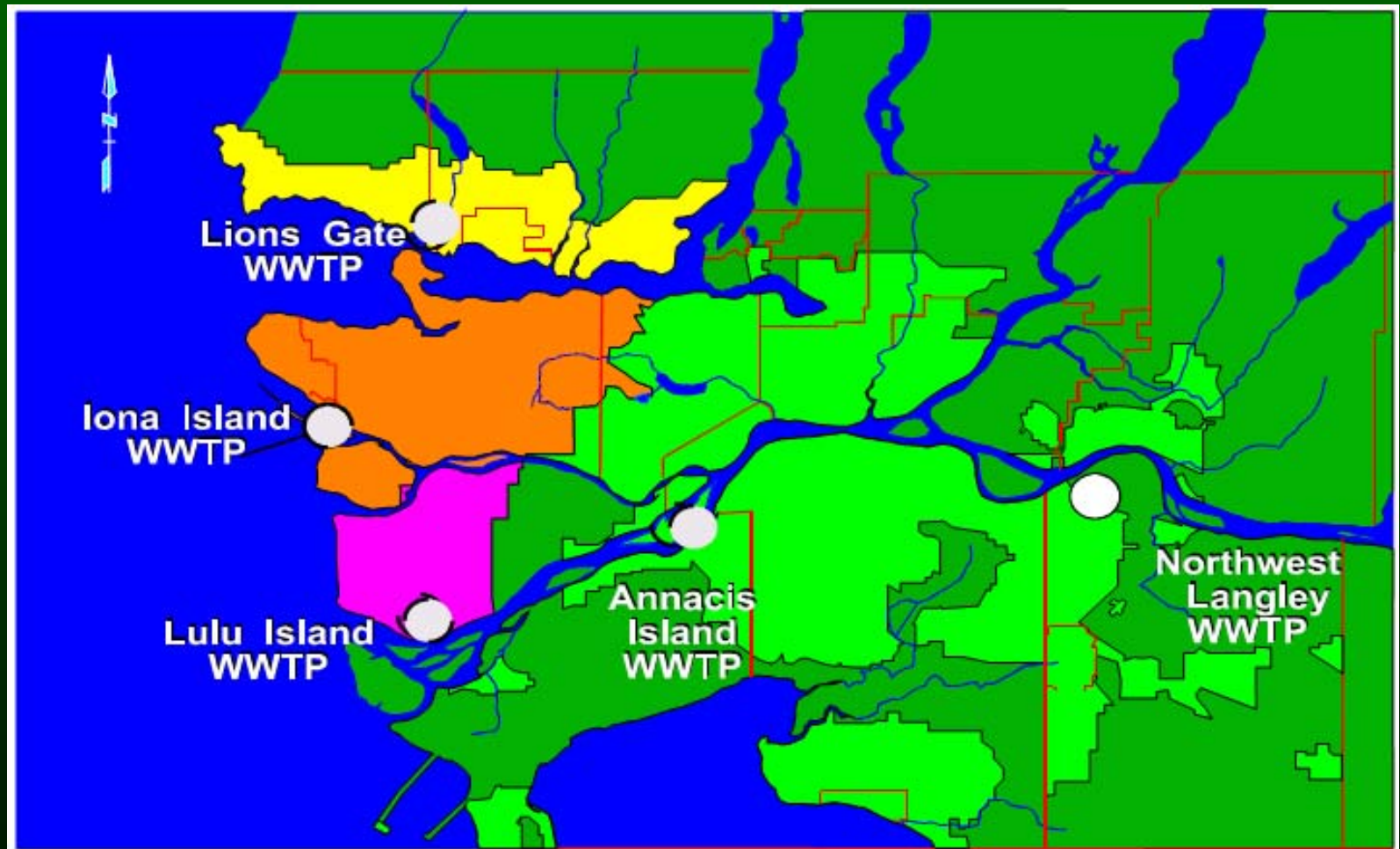
# Metro Vancouver (GVRD)

- ❑ Services a population exceeding two million (projected 2.7 million by 2027) and a land area of approx 280,000 ha
- ❑ Partnership of 21 municipalities and one electoral area



# Metro Vancouver Sewerage System

- Maintains and operates major interceptor sewers and 5 treatment plants



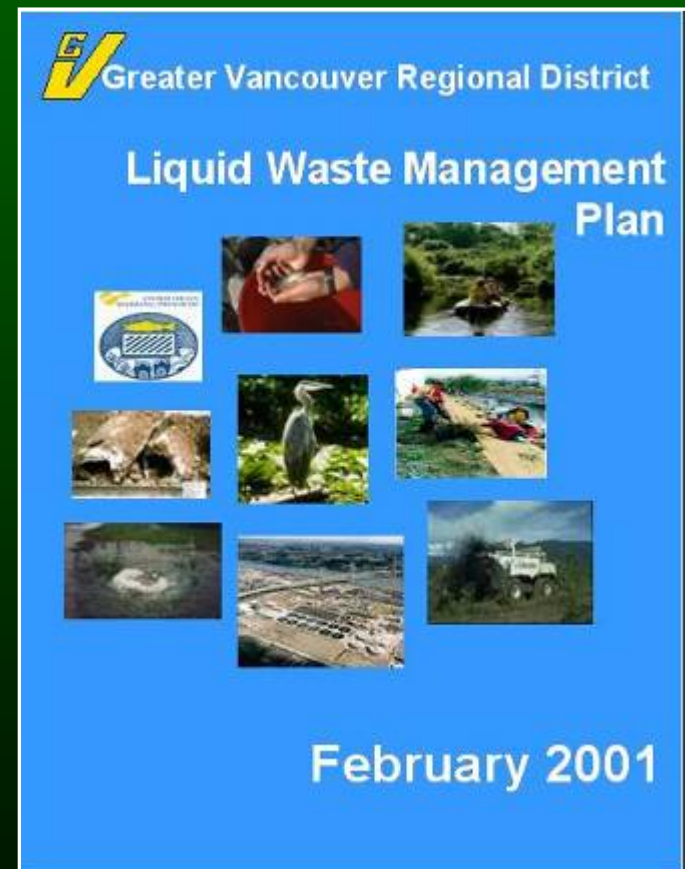
# Local Geography

Climate Change – Combined Sewer

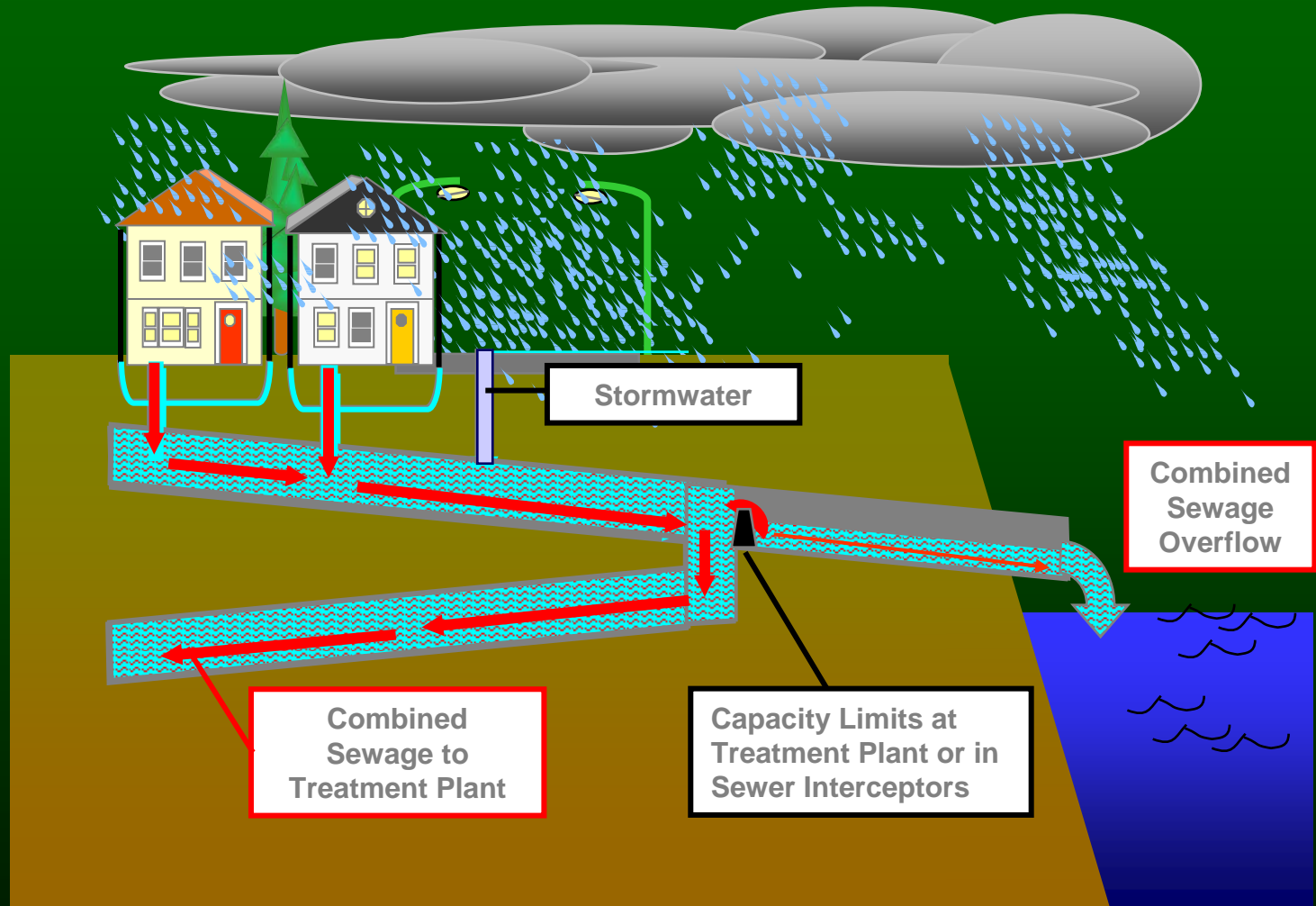


## Metro Vancouver - LWMP

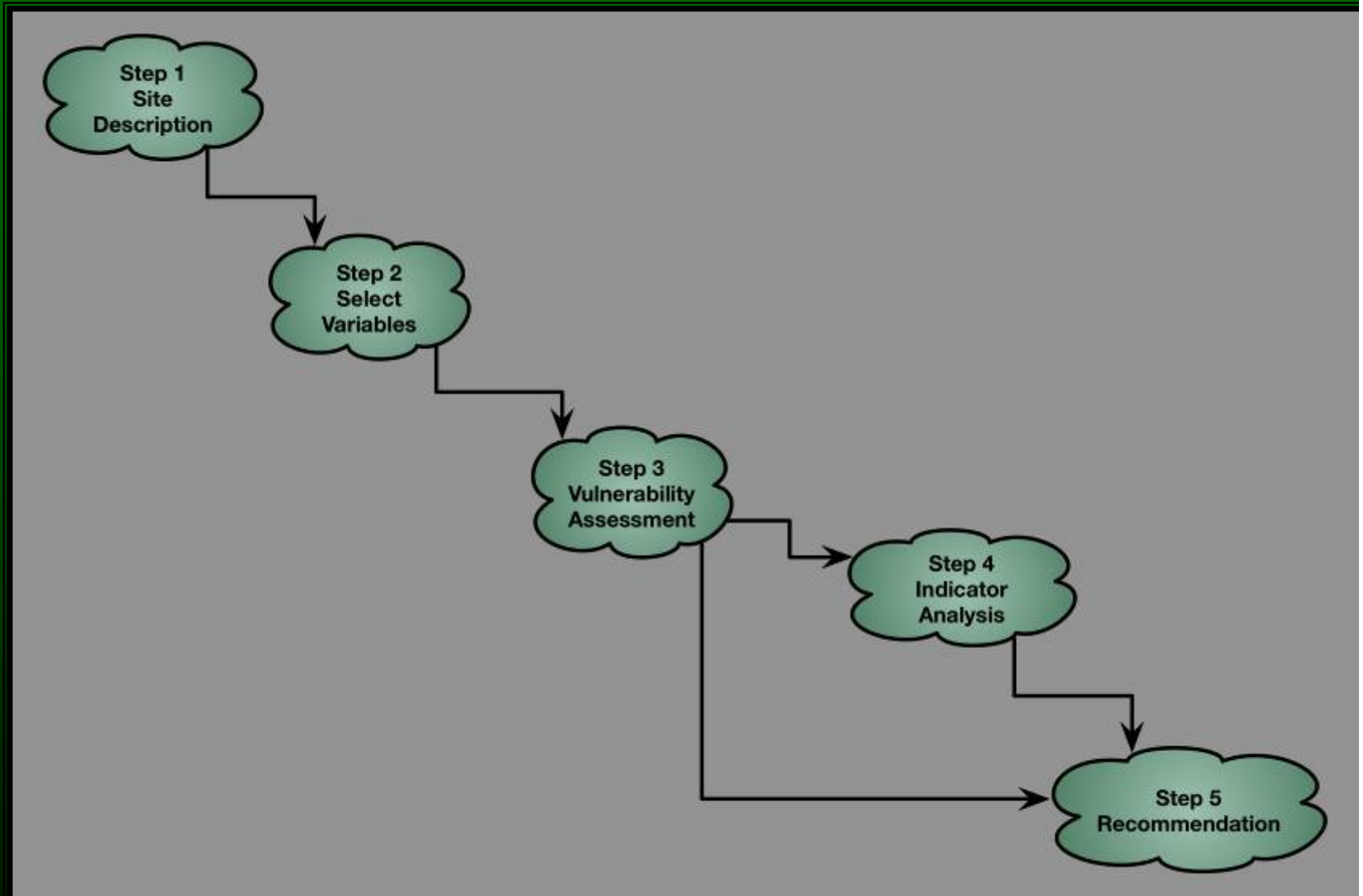
- ❑ Policies and commitments identified in a Liquid Waste Management Plan (approved by Province in 2002)
- ❑ Sewer separation is major long-term strategy outlined to address CSOs
- ❑ Commitment to eliminate CSOs by 2050
- ❑ Iona upgrade to secondary by 2020



# Combined Sewer Overflow (CSO)



# PIEVC Assessment Protocol



# Step 1 - Collection System Components

## Wastewater Infrastructure

Combined Sewer Trunks  
Pump Stations & Wet Wells  
Force Mains  
Siphons  
Outfalls  
Manholes

Flow & Level Monitors  
Grit Chambers  
Flow Control Structures  
Control Valves  
Air Valves



# Step 1 - Iona Island WWTP

*Climate Change - Combined Sewer*



## Step 1 - Collection System Components

- ❑ Conveyance
- ❑ Administration/Operations
- ❑ Electric Power & Communications
- ❑ Maintenance
- ❑ Transportation



## Time Frame

### 2020 – 2050 Study Horizons

- Liquid Waste Management Plan
  - Upgrade to secondary treatment by 2020
  - Eliminate combined sewer overflows by 2050
  
- Infrastructure age ~ 50 yrs+
  - Service life – 50 to 100 yrs

## Other Change Factors



- ❑ Population increase
- ❑ Increased development leading to greater impervious area (therefore greater runoff)
- ❑ Inflow and infiltration reduction
- ❑ Changes in Laws, Regulations and Standards that affect the load pattern on the infrastructure (CCME initiative)

## Step 2 – Data Gathering

Infrastructure Asset Spreadsheets

Long Range Planning Maps

Operational Plans

Sewer Model

Interviews

GIS



## Relevant Climate Change Factors

- Rainfall (annual, seasonal, 24-hour)
- Rain on Snow Events
- Frost (Freeze-Thaw cycles)
- Wind Speed (Extremes, Gusts)
- Extreme Temperatures
- Drought Conditions
- Storm Surge
- Sea Level
- Snowfall
- Ice



Photo: Corporation of Delta

## Climate Change Sources

- ❑ Ouranos
- ❑ PCIC (Pacific Climate Impacts Consortium)
- ❑ Environment Canada
- ❑ BC Ministry of Environment
- ❑ Literature Review

# Ouranos – Climate Modelling



Climate change in Canada  
Climate scenarios for the public infrastructure  
vulnerability assessment

**Metro Vancouver stormwater and wastewater  
infrastructure case study**

Produced for the *Public Infrastructure Engineering  
Vulnerability Committee (PIEVC)*

By Ouranos

February 2008

## Climate Factors

### 2050 Horizon

\*Intense Rain – (24 hr – 73mm) ↗ 17%

\*Annual Rain – (1881mm) ↗ 14%

\*Sea Level – ↗ 0.3 – 1.6m (2080 Horizon)

\*Storm Surge – N/A, expected ↗

Temperature – ↗ 1.4 – 2.8c

Drought – no change (20 days)

Wind – N/A, expected ↗

## Climate Factors

Snowfall – ↘

Frost, Ice, Freeze Thaw – ↘

Other Effects:

Flooding – Fraser River ↘

Ground Subsidence – 2mm/yr ↘

Data Gaps:

Rainfall IDF curves, shorter durations

Wind, Storm Surge

# Step 3 – Vulnerability Assessment

## Sc – Climate Scale Probability Factor

Scale <sup>5</sup>	Probability*		
	Method A	Method B	Method C
0	negligible or not applicable	<0.1 % <0.1 / 20	negligible or not applicable
1	improbable / highly unlikely	5 % 1 / 20	improbable 1:1 000 000
2	remote	20 % 4 / 20	remote 1:100 000
3	occasional	35 % 7 / 20	occasional 1:10 000
4	moderate / possible	50 % 10 / 20	moderate 1:1 000
5	often	65 % 13 / 20	probable 1:100
6	probable	80 % 16 / 20	frequent 1:10
7	certain / highly probable	>95 % >19 / 20	continuous 1:1

# Step 3 – Vulnerability Assessment

## Sr - Severity Scale Factor

Scale	Magnitude	Severity of Consequences and Effects
	Method D	Method E
0	no effect	negligible or not applicable
1	measurable 0.0125	very low / unlikely / rare / measurable change
2	minor 0.025	low / seldom / marginal / change in serviceability
3	moderate 0.050	occasional loss of some capability
4	major 0.100	moderate loss of some capacity
5	serious 0.200	likely regular / loss of capacity and loss of some function
6	hazardous 0.400	major / likely / critical / loss of function
7	catastrophic 0.800	extreme/ frequent/ continuous / loss of asset

# Step 3 – Impact Evaluation Matrix

INFRASTRUCTURE COMPONENTS	CLIMATE CHANGE EFFECTS							
	Intense Rain				Total Seasonal Rain			
	Y/N	S <sub>C</sub>	S <sub>R</sub>	P <sub>C</sub>	Y/N	S <sub>C</sub>	S <sub>R</sub>	P <sub>C</sub>
<b>Physical Infrastructure</b>								
Combined Sewer Trunks	Y	7	6	42	Y	7	3	21
Combined Sewer Interceptors	Y	7	6	42	Y	7	3	21
Sanitary Mains	Y	7	6	42	Y	7	2	14
Designated Force Mains	Y	4	1	4	Y	4	0	0
Siphons	Y	5	2	10	Y	3	2	6
Outfalls	Y	6	2	12	Y	3	2	6
Pump Stations & Wet Wells	Y	6	3	18	Y	7	1	7
Manholes	Y	4	5	20	Y	3	3	9
Flow & Level Monitors	Y	4	6	24	N			
Flow Control Structures	Y	4	4	16	Y	3	1	3
Grit Chambers	Y	6	2	12	Y	4	2	8

## Step 4 – Indicator Analysis

Infrastructure Component	Climate Variable	Priority of Relationship
<b>COLLECTION SYSTEM</b>		
Combined Sewer Trunks	Intense Rain	42
Combined Sewer Interceptors	Intense Rain	42
Sanitary Mains	Intense Rain	42
<b>TREATMENT (IIWWTP)</b>		
Effluent Disposal	Storm Surge	36
Buildings, Tankage and Housed Process Equipment	Storm Surge	36

## Step 5 – Key Vulnerabilities

- ❑ Combined Sewer Overflows (CSO)
  - ❑ Intense rain, annual rain
- ❑ WWTP Flooding
  - ❑ Combined effects of storm surge, sea level rise and subsidence
- ❑ Outfall-jetty structure
  - ❑ Storm surge, wind/wave
- ❑ Standby power
  - ❑ Wind



## Step 5 – Recommendations

- Review regional design standards
- Consider policies and commitments to set targets for climate change adaptation
- Reaffirm commitments to green infrastructure

## Observations

- ❑ Vancouver is fortunately situated - limited extreme or catastrophic climate events
  - ❑ No ice storms, drought, tornadoes
  - ❑ Lots of rain



## Observations

- Combined Sewers may have ‘built-in’ adaptive capacity
- Designed to overflow in controlled manner
- Many built when sizing was empirical. i.e. big enough for a person to walk through



## Observations

- Climate data uncertainty
  - Regional models unable to account for local effects (wind speed & direction, storm surge)
  - Expense/Practicality limited the model runs to two initial conditions (same GHG scenario)
- Infrastructure renewal cycles may address some climate change vulnerability
- Professional judgment required to bridge science and engineering worlds

# Questions

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