Climate Change – Combined Sewer

May 20, 2008

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.

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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.

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Engineers Canada National Assessment

Engineers Canada

- develops standards of practice
- promotes continual development of competence

engineerscanada ingénieurscanada

- 2007-2008

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

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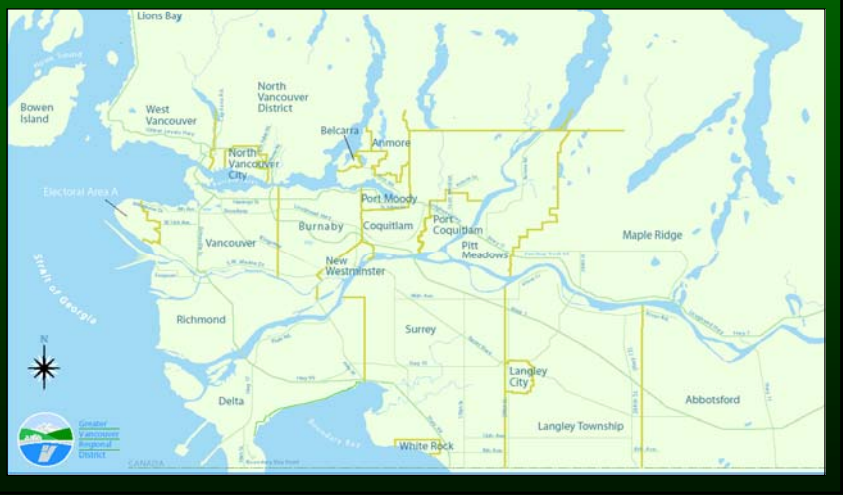
Metro Vancouver (GVRD)

- 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



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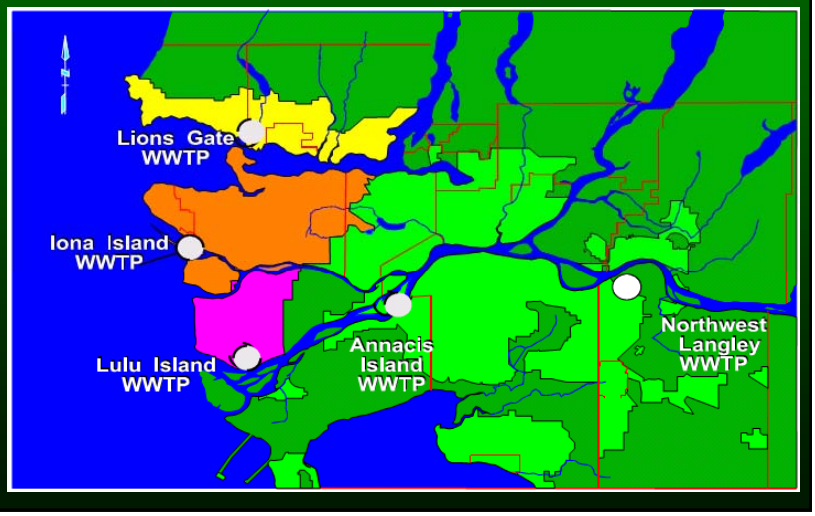
Metro Vancouver Sewerage System

- Maintains and operates major interceptor sewers and 5 treatment plants



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Local Geography

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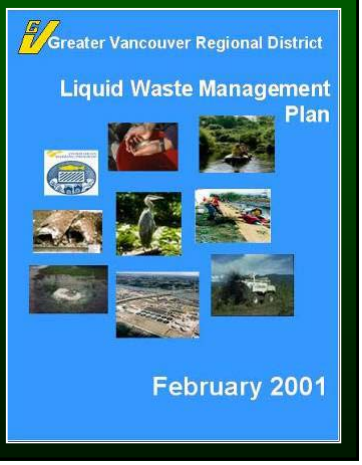
Metro Vancouver - LWMP

- 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



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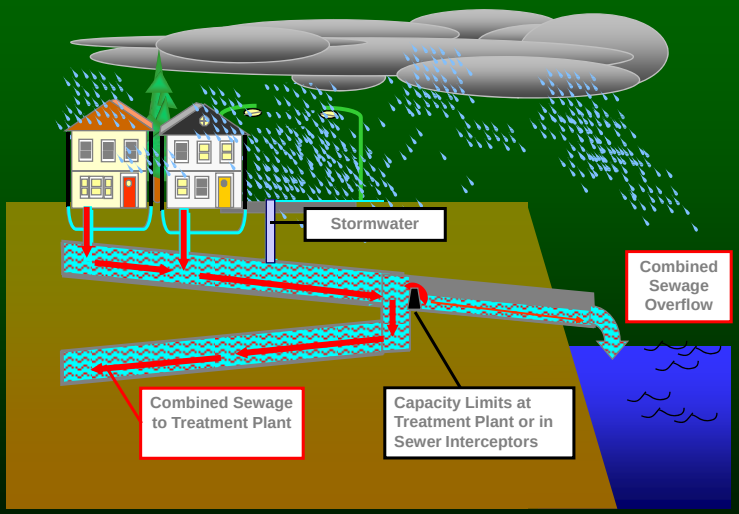
Combined Sewer Overflow (CSO)



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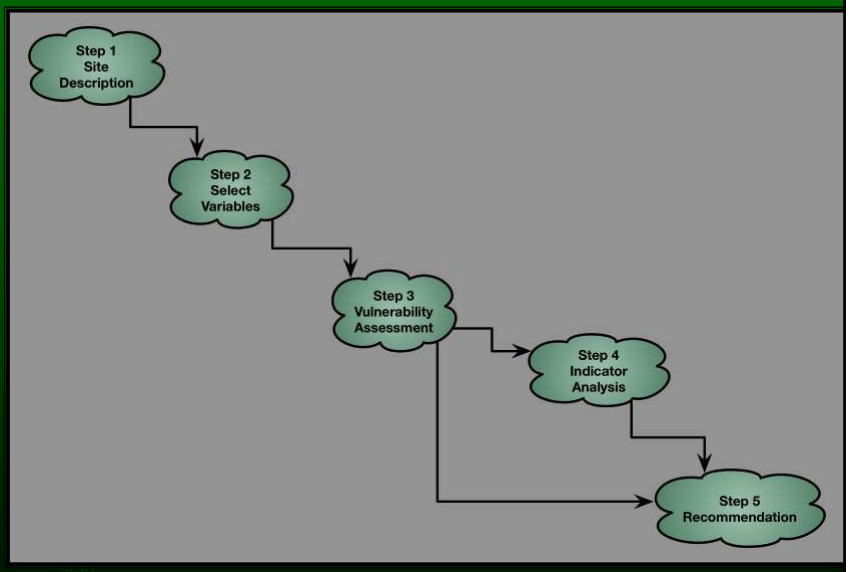
PIEVC Assessment Protocol



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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

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Step 1 - Iona Island WWTP

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Step 1 - Collection System Components

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

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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

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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)

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Step 2 – Data Gathering

Infrastructure Asset Spreadsheets
Long Range Planning Maps
Operational Plans
Sewer Model
Interviews
GIS

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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

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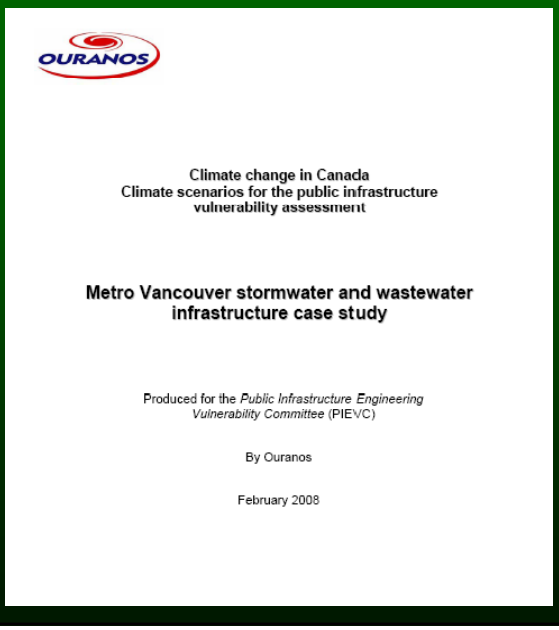
Climate Change Sources

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

Ouranos – Climate Modelling



OURANOS

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

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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 ↗

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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

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Step 3 – Vulnerability Assessment

Sc – Climate Scale Probability Factor

Scale[5]	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

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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

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Step 3 – Impact Evaluation Matrix

Table 4-2 Vulnerability Assessment Matrix

INFRSTRUCTURE COMPONENTS	CLIMATE CHANGE EFFECTS							
	Intense Rain				Total Seasonal Rain			
	Y/N	S_C	S_R	P_C	Y/N	S_C	S_R	P_C
Physical Infrastructure								
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

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Step 4 – Indicator Analysis

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

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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

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Step 5 – Recommendations

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

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Observations

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

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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

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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

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Questions

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