



# **ENGINEERING ASSESSMENT OF THE VULNERABILITY OF INFRASTRUCTURE TO CLIMATE CHANGE: *IMPLEMENTING ACTION AT THE LOCAL LEVEL***

***Brent Burton, M.A.Sc., P.Eng.***

*Member, PIEVC Water Resources Expert Working Group*

*Member, PIEVC Stormwater and Wastewater Expert Working Group*

*Member, PIEVC National Engineering Assessment Task Group*

***Leaders' Roundtable on Climate Change Adaptation  
Conference Board of Canada***

*Pacific Palisades Hotel: May 5-6, 2009*



# INFRASTRUCTURE AND CLIMATE CHANGE

- **Because of changing climates, past climate may no longer be a good indicator of future climate**
- **Existing infrastructure normally designed based on historical design values, typically with conservative safety factors**
- **Climatic design values based solely on historical data will be less and less valid over time**
- **However, knowledge of the past is essential to understand risks of future climate changes**
- **Shifts in extremes will increase damage and destruction of infrastructure**



# **NEED FOR A STUDY OF THE VULNERABILITY OF INFRASTRUCTURE TO CLIMATE CHANGE**

- **Infrastructure needs to be designed, operated and maintained in a way that minimizes the risk of destruction, disruption or deterioration due to changing climatic conditions**
- **The engineering profession needs to understand climate change and account for it in design and retrofitting of Canadian public infrastructure**
- **Need to develop or revise policies, standards and tools to guide Professional Engineers in their day-to-day practice**



# **PUBLIC INFRASTRUCTURE ENGINEERING**

## **VULNERABILITY COMMITTEE (PIEVC)**

- **Partnership between Engineers Canada and Natural Resources Canada**
- **Oversee a national engineering assessment of the vulnerability of public infrastructure to climate change**
- **Facilitate the development of best engineering practices that adapt to climate change impacts**
- **Utilize results to facilitate reviews of infrastructure codes and standards**



# MEMBERSHIP

- **NRCan**
- **Transport Canada**
- **Environment Canada**
- **Infrastructure Canada**
- **Public Works and Government Services Canada**
- **National Research Council**
- **Alberta Infrastructure and Transportation**
- **NWT Asset Management Division**
- **Government of Newfoundland and Labrador**
- **Institute of Catastrophic Loss Reduction**
- **CSA**
- **Federation of Canadian Municipalities**
- **Municipality of Portage la Prairie**
- **City of Montreal**
- **Corporation of Delta, BC**
- **City of Calgary**
- **Ontario Public Infrastructure Renewal**
- **Ouranos**



# WHAT IS PUBLIC INFRASTRUCTURE?

**“Those facilities, networks and assets operated for the collective public benefit including the health, safety, cultural or economic well-being of Canadians, whether operated by government and/or non-government agencies”**



# ENGINEERING VULNERABILITY

**“The shortfall in the ability of public infrastructure to absorb the negative effects, and benefit from the positive effects, of changes in the climate conditions used to design and operate infrastructure.”**

***Vulnerability is a function of:***

- **Character, magnitude and rate of change in the climatic conditions to which infrastructure is predicted to be exposed;**
- **Sensitivities of infrastructure to the changes, in terms of positive or negative consequences of changes in applicable climatic conditions; and**
- **Built-in capacity of infrastructure to absorb any net negative consequences from the predicted changes in climatic conditions**

***Vulnerability assessment will require assessment of all three elements above.***



# INFRASTRUCTURE CATEGORIES

- **Buildings**
- **Roads and Associated Structures**

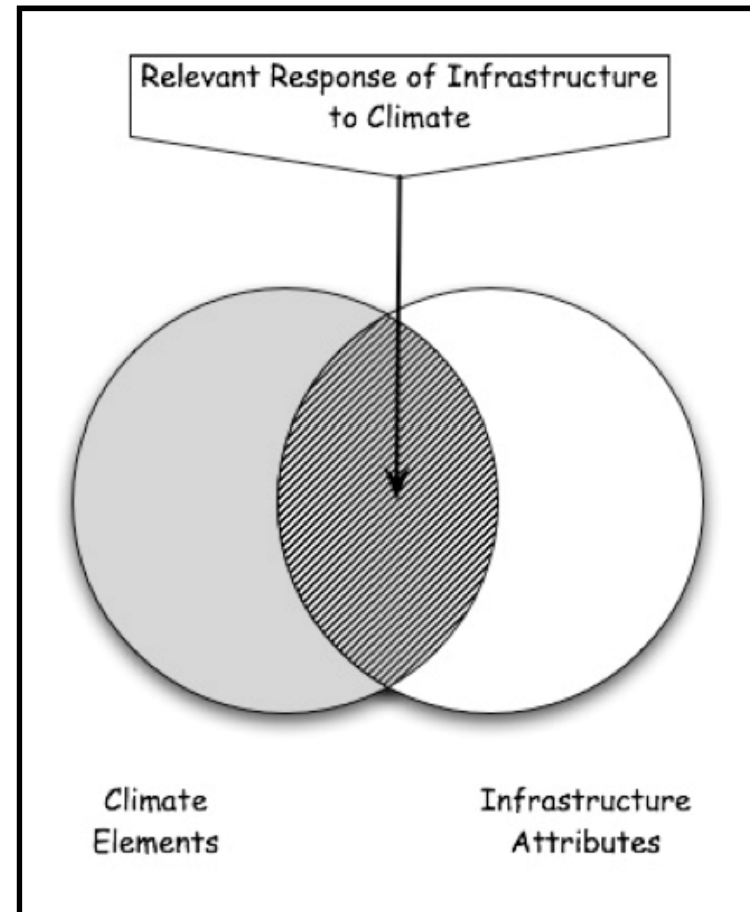


- **Water Resources**
- **Stormwater and Wastewater Systems**



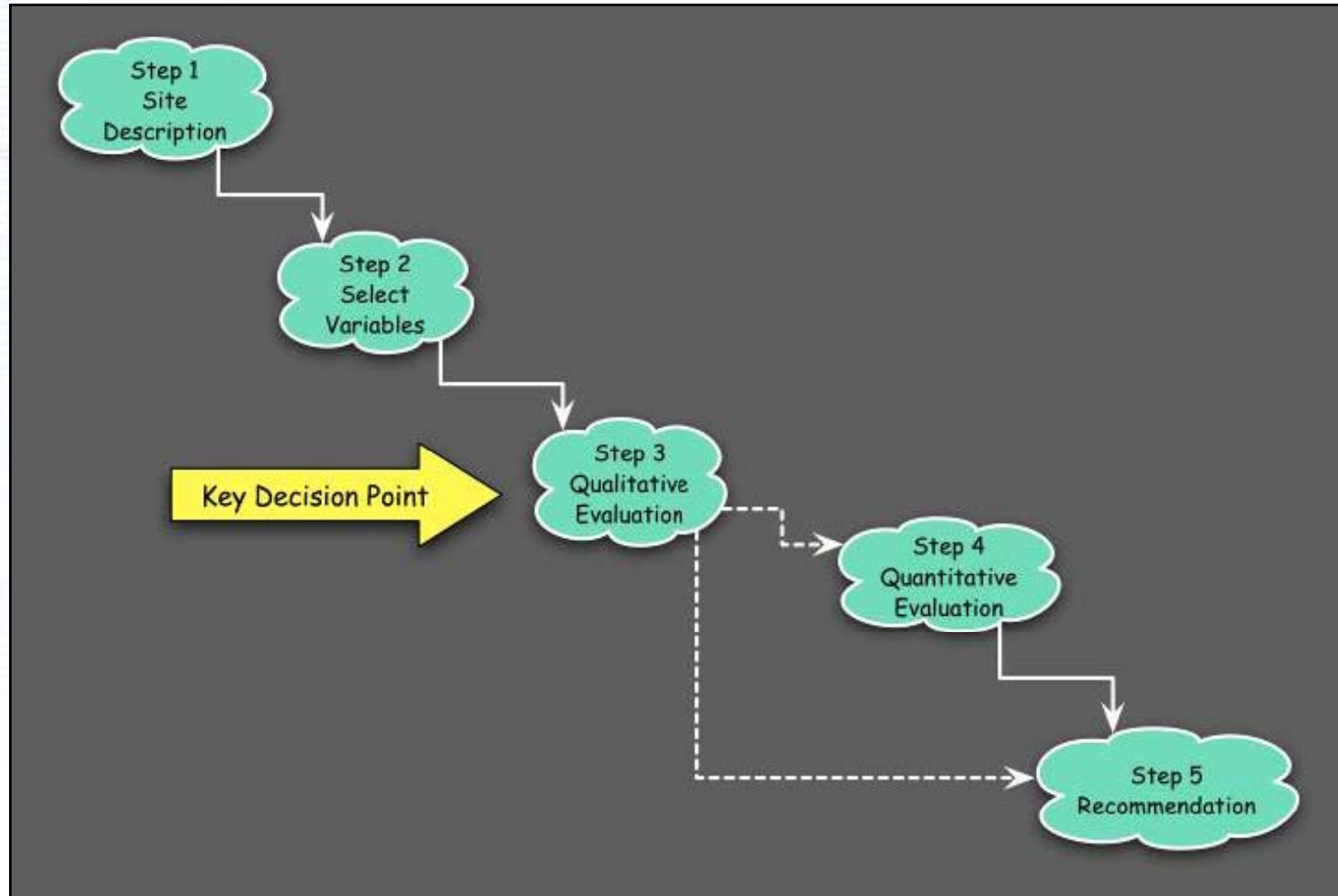
# PIEVC PROTOCOL PRINCIPLES

- The PIEVC Protocol is a step by step process, derived from standard risk management techniques, to assess impacts of climate change on infrastructure
- The goal is to assist infrastructure owners and operators in effectively incorporating climate change adaptation into design, development and decision-making





# A FIVE STEP PROCESS





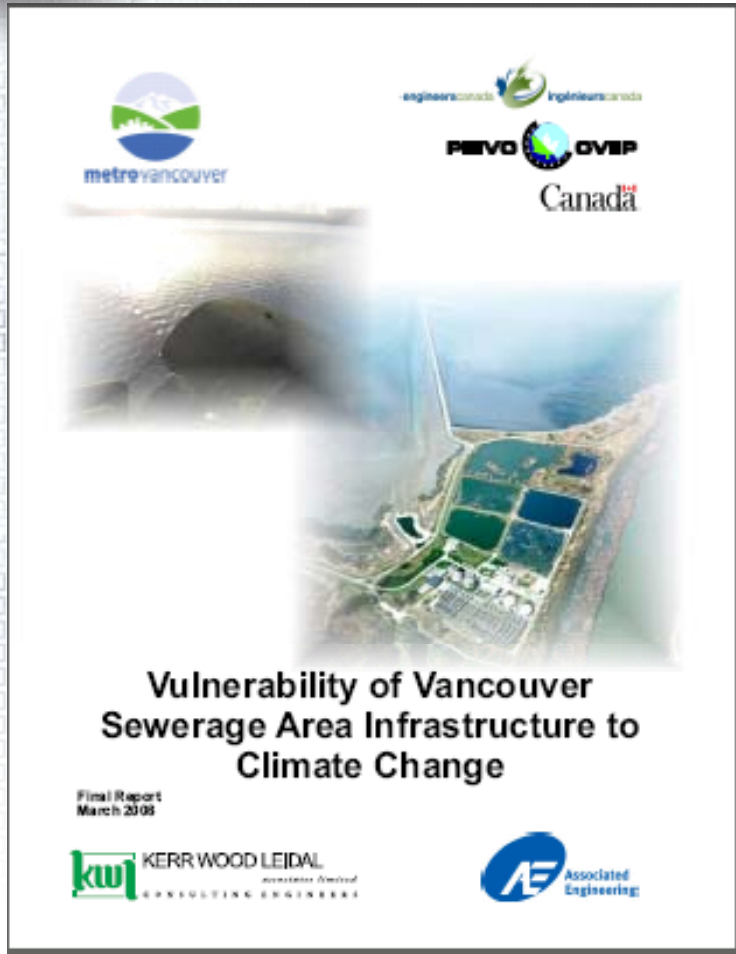
# SEVEN NATIONAL CASE STUDIES

- Water resources systems
- Storm & wastewater systems
- Roads & bridges
- Buildings





# METRO VANCOUVER: VANCOUVER SEWERAGE AREA CASE STUDY





# VANCOUVER SEWERAGE AREA CASE STUDY

## Primary Vulnerabilities

<i>Climate Effect</i>	<i>Infrastructure Component</i>
Intense rain	Combined sewer overflows
Seasonal rain volume	Combined sewer overflows
Storm surge + sea level change [+ subsidence]	Flooding of treatment plant
Storm surge + wind/wave action	Effluent discharge; jetty structure



# **VANCOUVER SEWERAGE AREA CASE STUDY: RECOMMENDATIONS / OUTCOMES**

- **Stand-by power requirements**
- **Revisions to emergency response plan**
- **Considerations for treatment plant upgrading**
- **System operation and data management, sewer separation, green infrastructure**
- **Updates to Liquid Waste Management Plan**
- **Updated climate-adjusted Intensity-Duration Frequency (IDF) curves**
- **Currently completing a case study for an adjacent sewerage area (predominantly separated sewerage)**



# CROSS-CUTTING FINDINGS FROM CASE STUDIES

- The PIEVC Protocol is a useful tool in the hands of an experienced professional team
- Engineering Vulnerability Assessment is a useful adjunct to engineering design
- Climate change is only one of many factors that may diminish infrastructure resiliency
- *Much infrastructure is vulnerable to interruption of electricity supply*



# SUMMARY OF VULNERABILITY

<i>Infrastructure Category</i>	<i>Sensitivity to Climate Change</i>
Water Treatment Facilities	• Sensitive - water supply issues; operations
Wastewater Treatment Facilities	• Sensitive - changes in influent; operations
Roads & Bridges	• Generally robust • Site specific: slope stability, foundation weakness
Buildings	• Generally adaptive • Site specific: foundation weakness
Coastal Areas	• Sensitive to sea level rise
Permafrost Regions	• Very sensitive to temp change



# ADAPTIVE CAPACITY

- **Most infrastructure is generally robust & resilient, but issues are site-specific and infrastructure-specific**
- **Many vulnerabilities can be managed through maintenance, rehabilitation, upgrading activities**
- **Prioritize by design life**
- **Climate loads are one of several factors (such as infrastructure deficit)**
- **Planning should become longer term**



# AN ADAPTATION FRAMEWORK

- **People**
  - Engineers, planners and other professionals, policy-makers, politicians and the public
- **Tools**
  - Vulnerability assessments
  - Local/provincial codes, standards and practices
  - Climate change models and projections
  - Land use planning and zoning
  - Economic and social impact analysis
  - Risk management
- **Processes**
  - Regulatory, political, social, outreach, education



# PIEVC UPDATE

- **Progress report on National Engineering Assessment issued in June, 2008 ([www.pievc.ca](http://www.pievc.ca))**
- **A funding arrangement has been made with Natural Resources Canada for the next phase of PIEVC work (to end of March 2011)**
- **Any interested parties may use the Protocol at no charge through a license agreement with Engineers Canada**
  - **Provide results for inclusion in the national knowledge base**



# PIEVC: KEY DIRECTIONS FOR THE FUTURE

- Increase number of case studies (regionally and functionally)
- Continue to update and refine protocol
  - Financial module to assist in evaluating cost of adaptation alternatives, refine terminology, etc.
- Focused information dissemination
  - practitioners, students, educators
- Development and delivery of training workshops



# QUESTIONS



For more information on Engineers Canada and PIEVC please contact:

David Lapp, P.Eng.  
Manager, Professional Practice  
Engineers Canada  
180 Elgin Street, Suite 1100  
Ottawa, Ontario  
K2P 2K3  
Tel: 1-613-232-2474 ext 240  
Email: [david.lapp@engineerscanada.ca](mailto:david.lapp@engineerscanada.ca)

***Presenter Contact Information:***

***Brent Burton, M.A.Sc., P.Eng.***

***Metro Vancouver***

***Senior Engineer***

***Phone: 604-451-6572***

***Email: [brent.burton@metrovancover.org](mailto:brent.burton@metrovancover.org)***