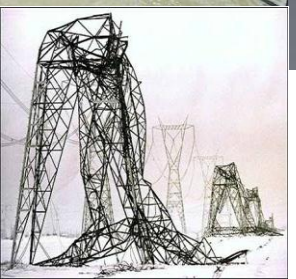






Infrastructure Climate Risk Assessment in Canada: An Engineering Strategy for Adaptation

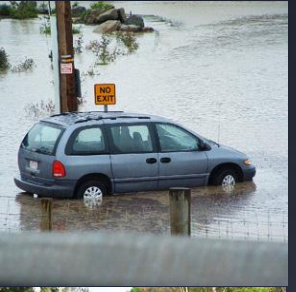
Climate Change and America's Infrastructure:
Engineering, Social and Policy Challenges
Arizona State University
Tempe, Arizona, USA
January 28, 2013

David Lapp, FEC, P. Eng.
Manager, Professional Practice, Engineers Canada
Secretary, Committee on Engineering and the Environment
World Federation of Engineering Organizations

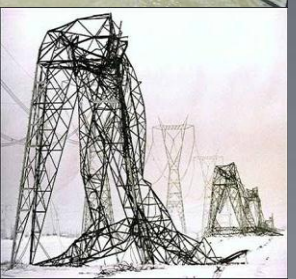
Canada

PIEVC CVIIP

engineerscanada ingénieurscanada





What is Engineers Canada?

- National body for the profession of engineering in Canada
- 12 constituent associations in Canada – matching the provinces and territories (Nunavut and NWT combined) that regulate the practice
- Over 250,000 registered professional engineers in Canada
- Promotes high standards of engineering education, professional qualifications and ethical conduct
- Accreditation of undergraduate engineering programs in Canada
- Member of the World Federation of Engineering Organizations (WFEO)
- Chair WFEO Committee on Engineering and the Environment

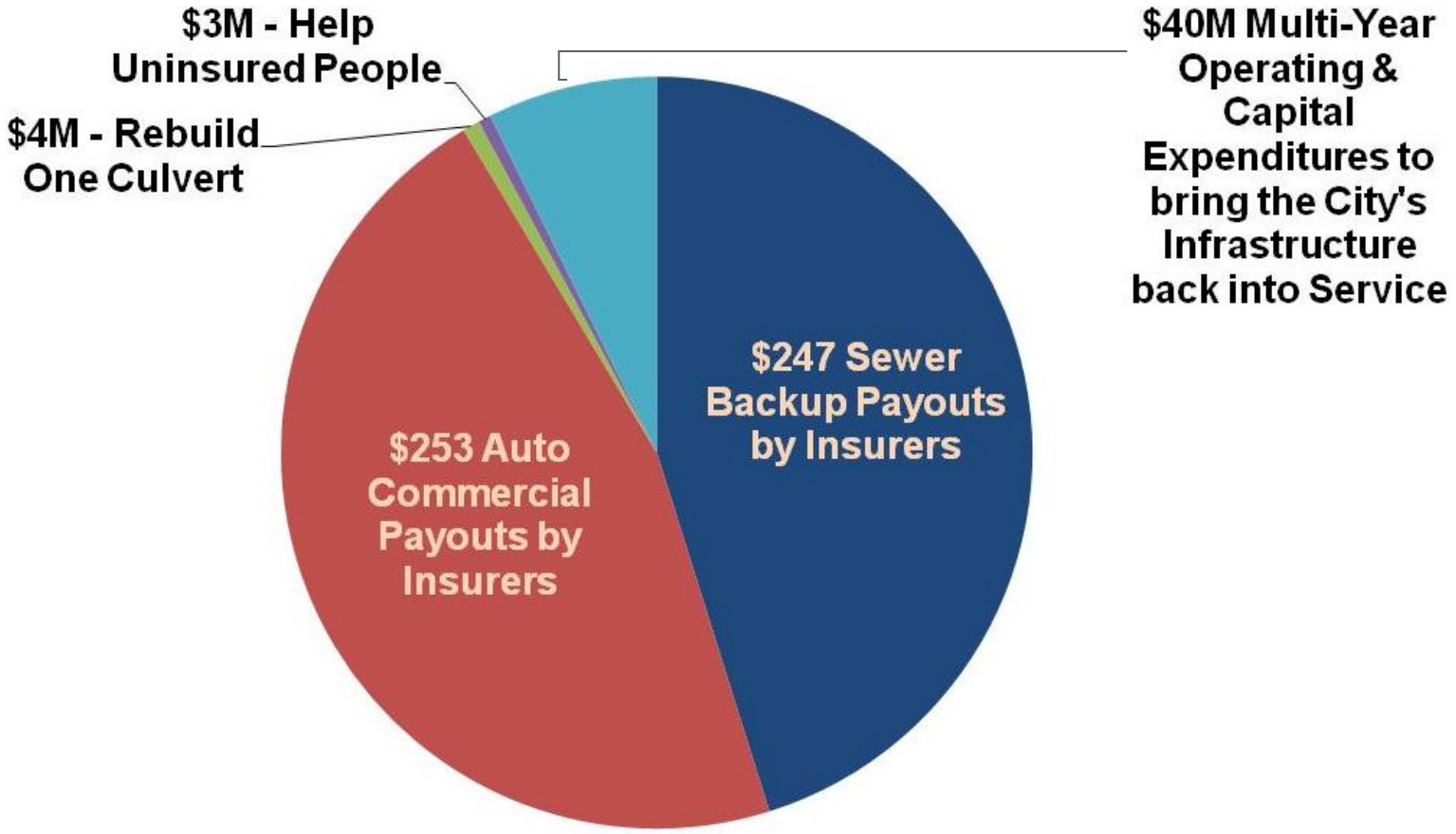

August 2005 Storm - Toronto
Photos courtesy
Jane-Finch.com


Interdependency of infrastructure
Exposed utilities at Finch Ave Wash Out


New stream crossing at
Finch Ave
2006 7 27

Toronto: August 2005 Storm

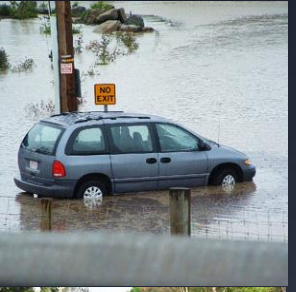
Toronto has 154 large culverts



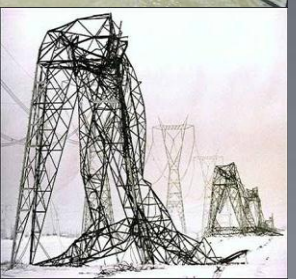
TOTAL
$547 Million

Need to Address Rising Disaster Claims

Sources: IBC, Aon Benfield; Hamilton Image: http://rhvna.com/flooding_red_hill_valley.html; Calgary Sun; City of Peterborough







Infrastructure and Climate Change

- ***"The world is entering a future in which risks are more concentrated and more complex. That is why we are pressing for policies that reduce those risks through preparation, adaptation, and mitigation. That will be cheaper than covering tomorrow's losses after disaster strikes.***

- Bruno Porro, Chief Risk Officer, Swiss Re

Civil Infrastructure




Services

Shelter

Safety and security

Aesthetics

Heat, Light and Power

Mobility for people, goods and services

Health and recreation

Wealth creation

Categories

Homes & Buildings

Transportation networks

Energy networks

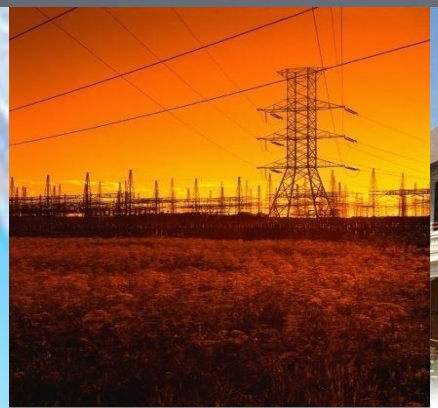
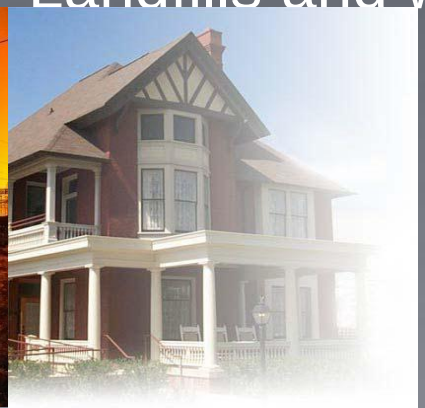
Water, Waste, & Storm water networks

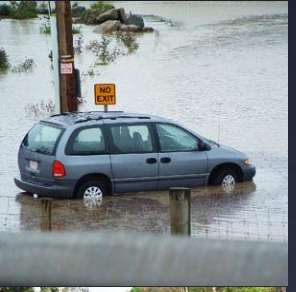
Industrial structures

Communications networks

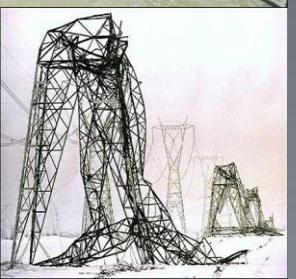
Landfills and waste depots





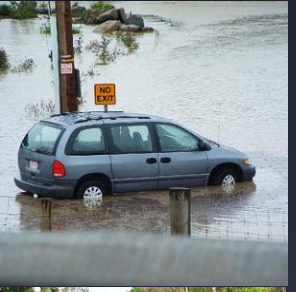




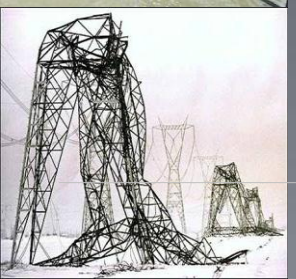
Why Address Infrastructure Climate Risks?

- Minimize service disruptions
- Protect people, property and the environment
- Optimize service
  - Manage lifecycle
  - Manage operations
  - Avoid surprises
  - Reduce costs
- First step in planning adaptation







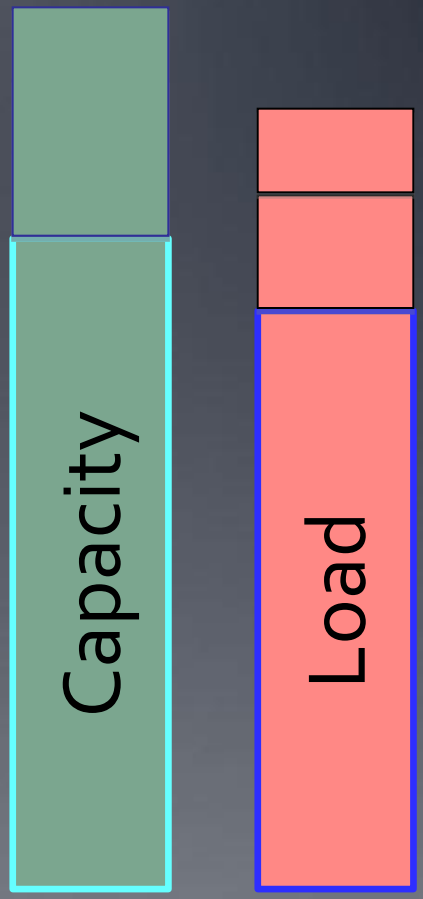


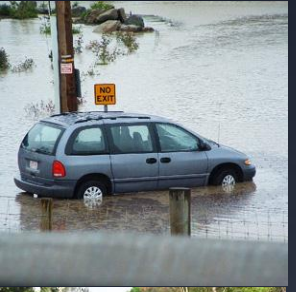
How do Small Changes Lead to Catastrophic Failure?????

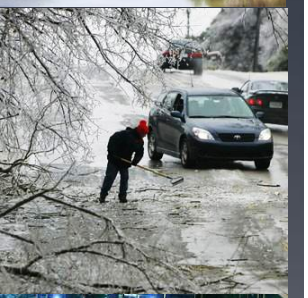
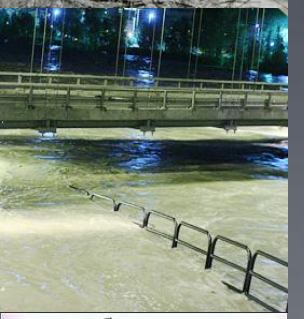
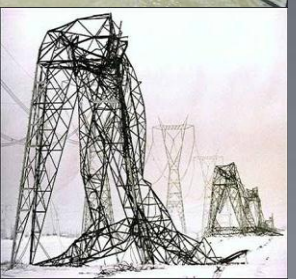
Failure

- Design Capacity
- Safety Factor
- Impact of age on structure
- Impact of unforeseen weathering

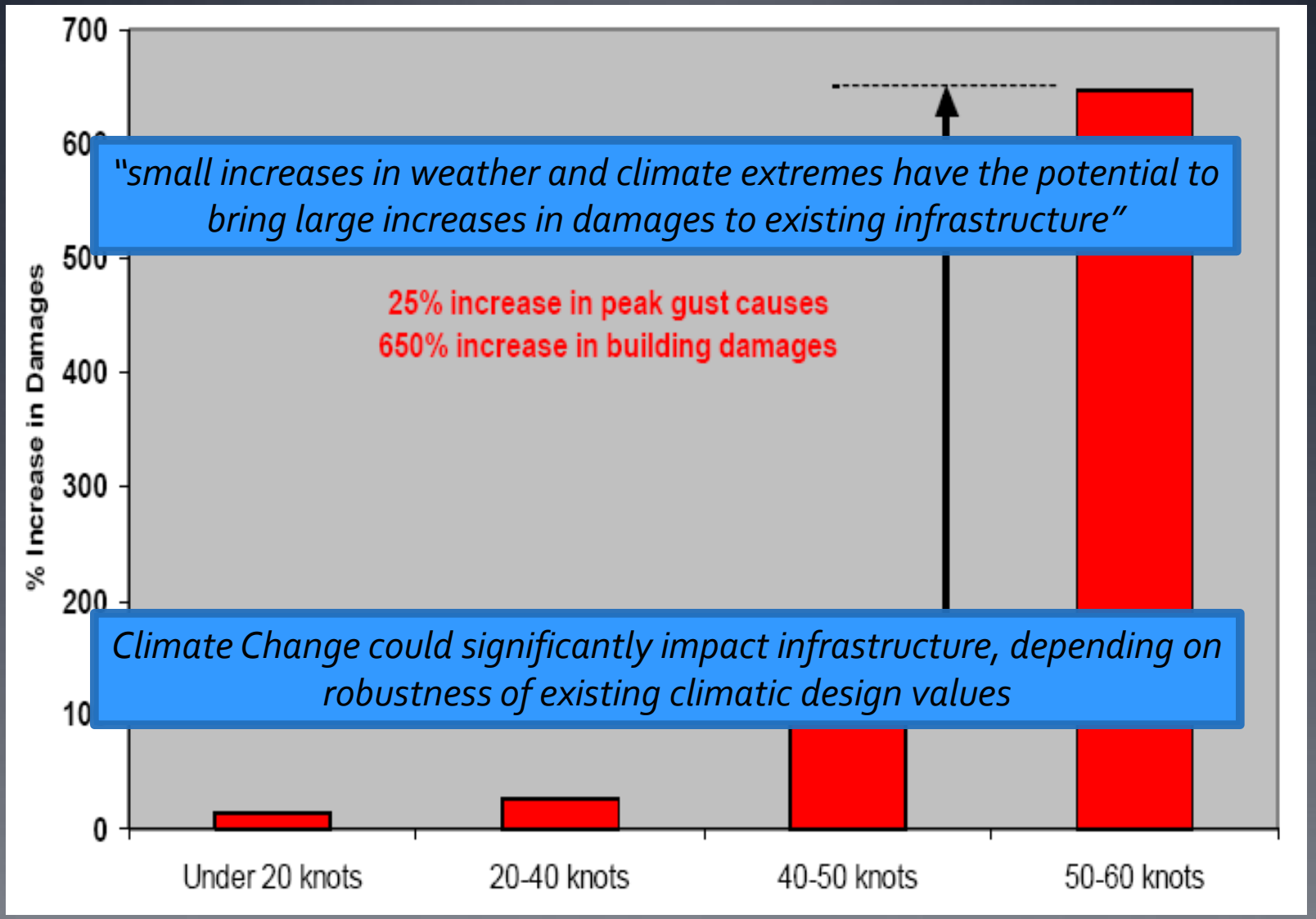
- Design Load
- Change of use over time
  - For example – population growth
- Severe climate event



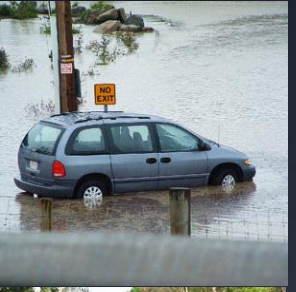


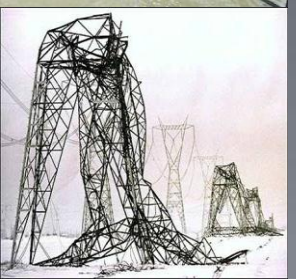




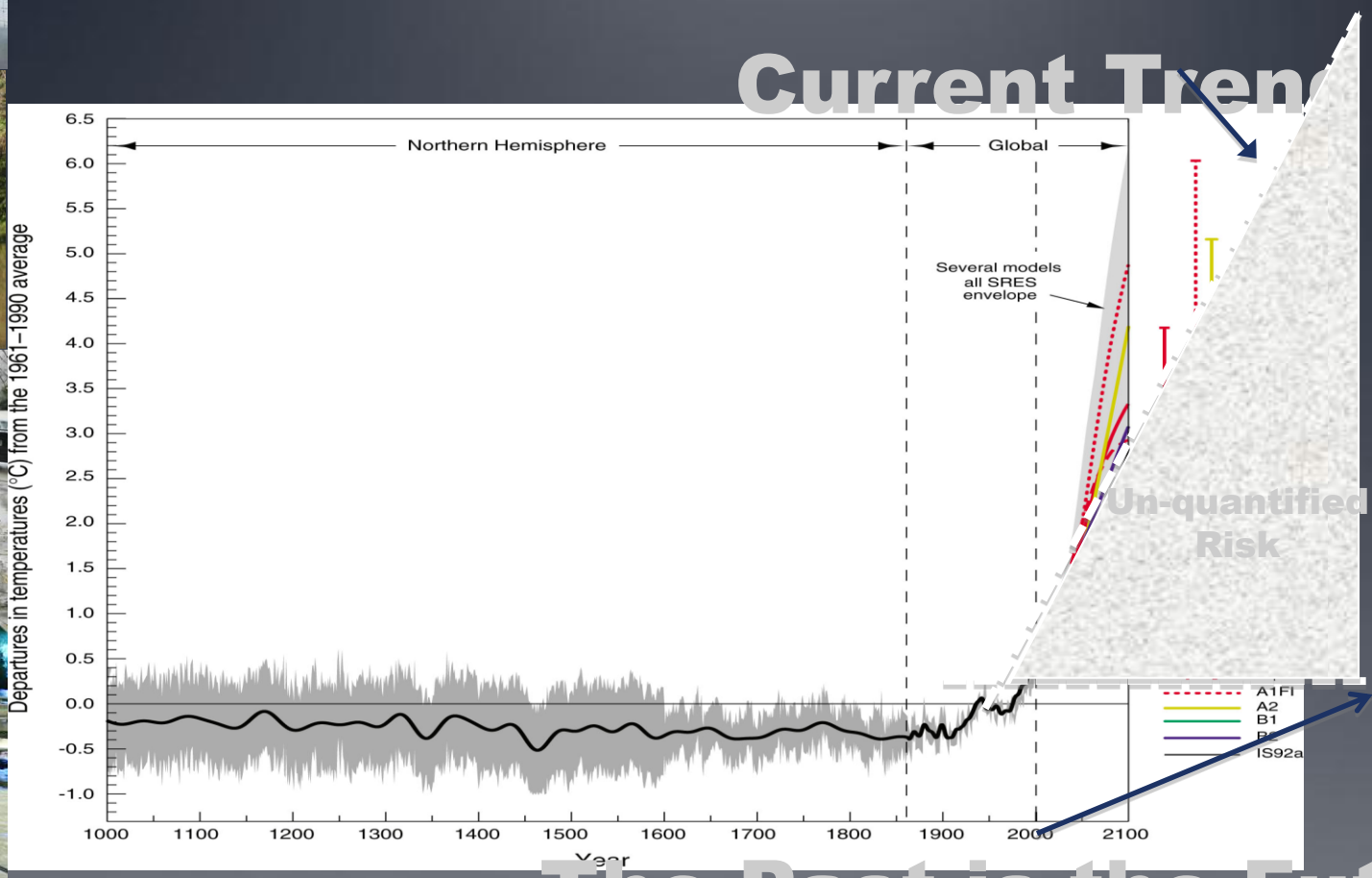
Small Increases = Escalating Infrastructure Damage

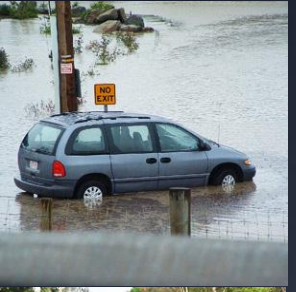


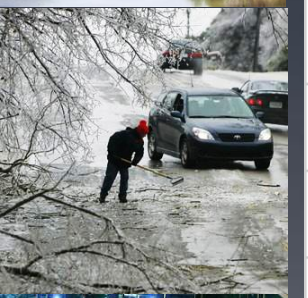
The Past IS NOT the Future

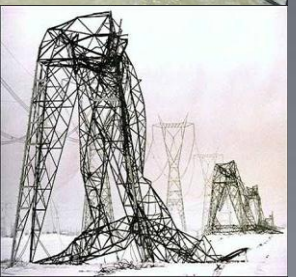












Climate Change Risk Mitigation through Adaptation

7	SEVERITY	Catastrophic 0.800		7	14	21	28		49
6		Hazardous 0.400		6					42
5		Serious 0.200	0	5	10	15	20	25	30	35
4		Major 0.100	0	4	8	12	16	20	24	28
3		Moderate 0.050	0	3	6	9	12	15	18	21
2		Minor 0.025	0	2	4	6	8	10	12	14
1		Measurable 0.0125	0	1	2	3	4	5	6	7
0		No Effect	0	0	0	0	0	0	0	0
			negligible or not applicable	improbable 1:1 000 000	remote 1:100 000	occasional 1:10 000	moderate 1:1 000	probable 1:100	frequent 1:10	continuous 1:1
			PROBABILITY							
			0	1	2	3	4	5	6	7

Flood

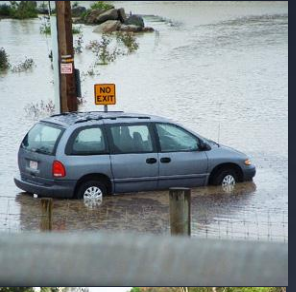
Climate Change

Flood

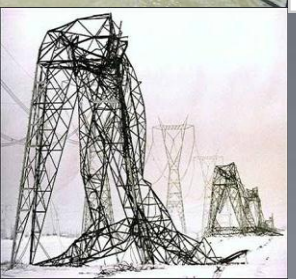
Adaptation

Flood

Vulnerability Assessment and Risk Mitigation







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0		No Effect	0	0	0	0	0	0	0
			negligible or not applicable	improbable 1:1 000 000	1:100 000	1:10 000	1:1 000	probable 1:100	frequent 1:10	continuous 1:1
			PROBABILITY							
			0	1	2	3	4	5	6	7

Flood

Climate Change

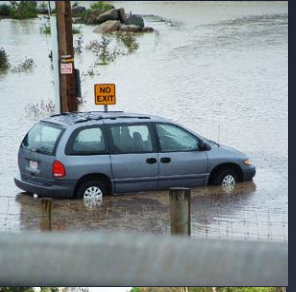
Flood

Adaptation

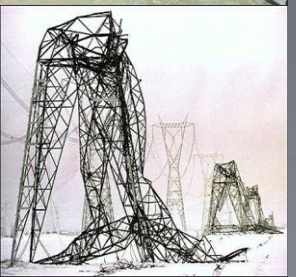
Engineering Vulnerability Assessment

Risk Mitigation

Flood



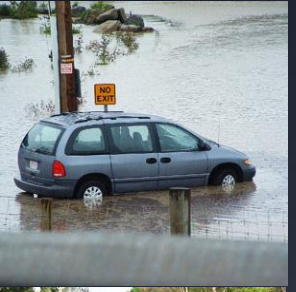




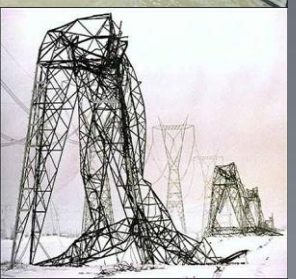
Design life-appropriate assessment

Structures	Expected Lifecycle
Houses/ Buildings	Retrofit/alterations 15-20 yrs Demolition 50-100 yrs
Storm/Sanitary Sewer	Base system 100 yrs Major upgrade 50 yrs Components 25 – 50 yrs
Dams/ Water Supply	Base system 50-100 yrs Refurbishment 20-30 yrs Reconstruction 50 yrs
Roads & Bridges	Road surface 10 - 20 yrs Bridges 50 - 100 yrs Maintenance annually Resurface concrete 20-25 yrs Reconstruction 50-100 yrs

- Design life varies
- Component-based vulnerability assessment
- Safety / economics / technical
- There is adaptive capacity because of maintenance & rehabilitation
- Conversely, poor maintenance and lack of rehabilitation contributes to vulnerability

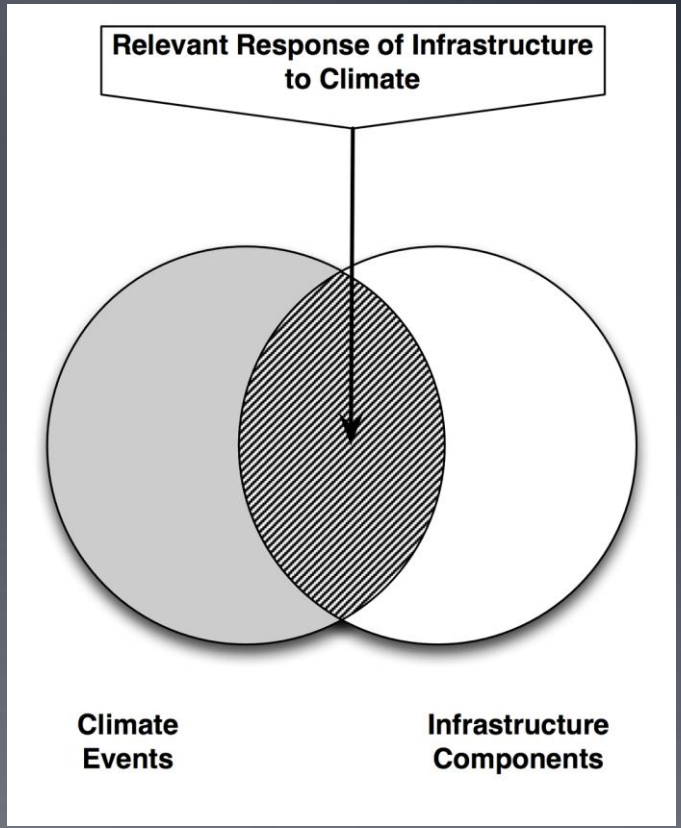


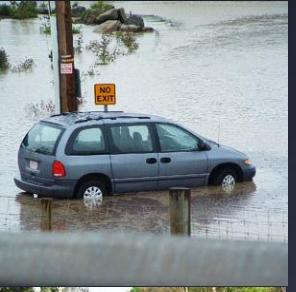




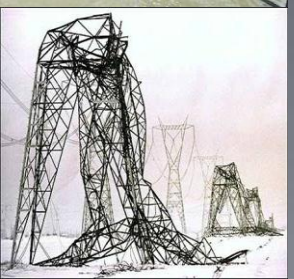
PIEVC Engineering Protocol

- Five step evaluation process
- A tool derived from standard risk management methodologies
- Intended for use by qualified engineering professionals
- Requires contributions from those with pertinent local knowledge and experience
- Focused on the principles of vulnerability and resiliency

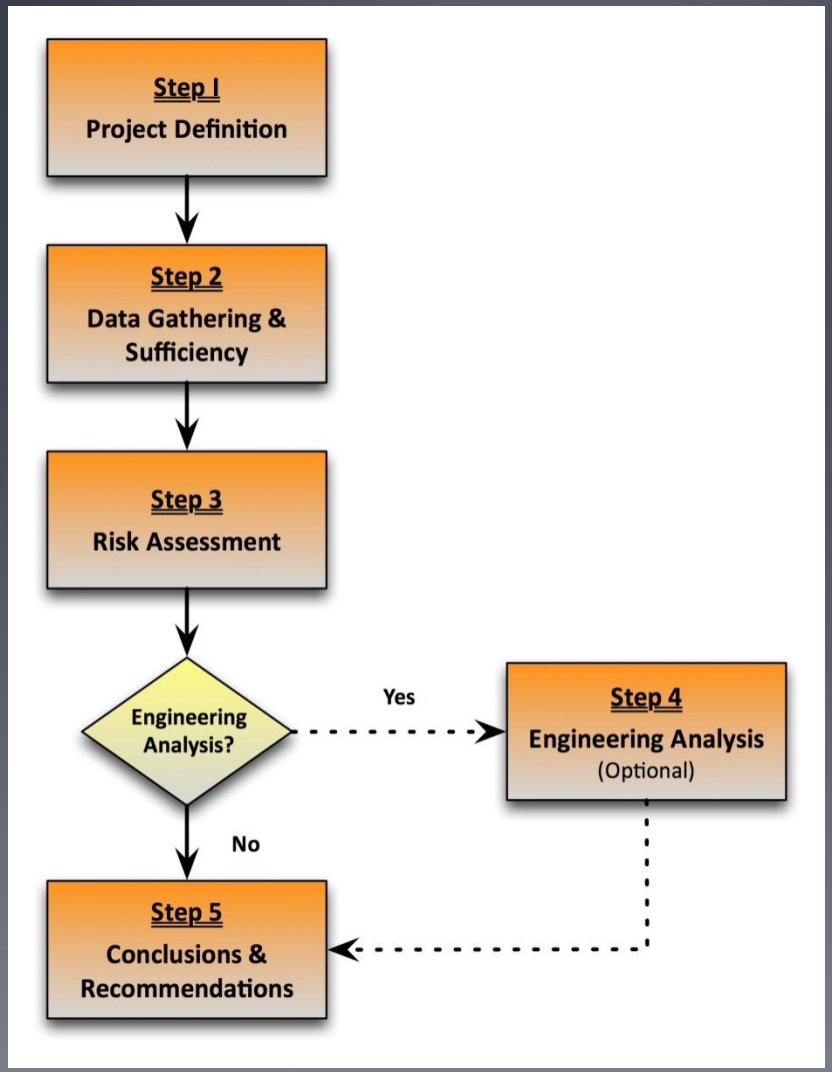


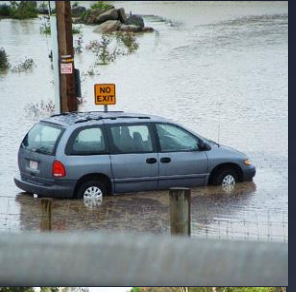




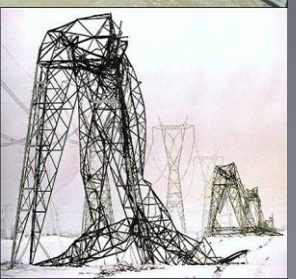


A Five Step Process





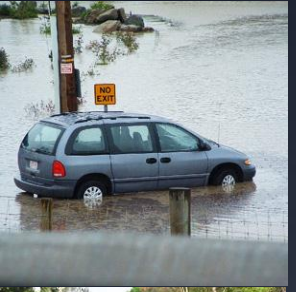




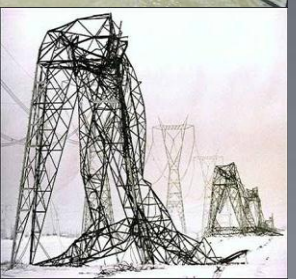
Infrastructure Categories (2005-2010)

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

- **Water Resources (water supply and water management structures)**
- **Stormwater and Wastewater Systems**
- **Now extending to other types of infrastructures -2011 onwards**



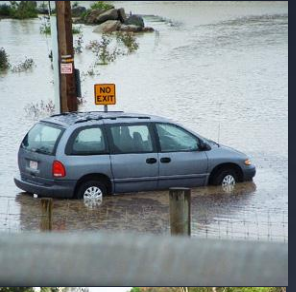


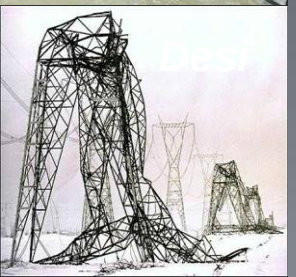



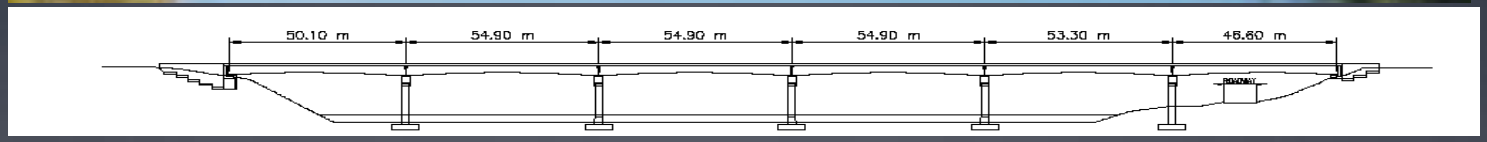
Water Infrastructure Case Studies

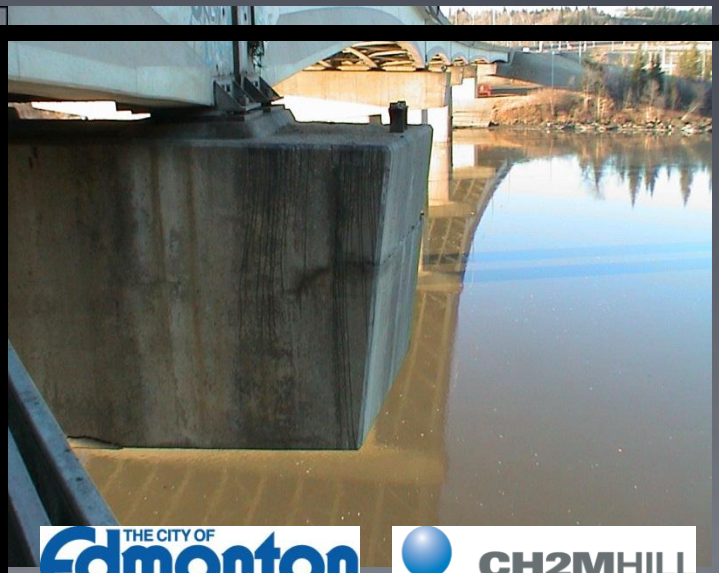
- Portage-la-Prairie MB – Potable water supply system
- Town of Shelburne NS – New sewage treatment plant
- City of Laval QC – Stormwater treatment and management system
- City of Calgary AB – Potable water supply system
- Town of Prescott ON – Stormwater management system
- City of Castlegar BC – Stormwater management system
- Town of Placentia NL – Coastal structures
- Town of Welland, ON –Stormwater/wastewater management system

Edmonton – Quesnell Bridge







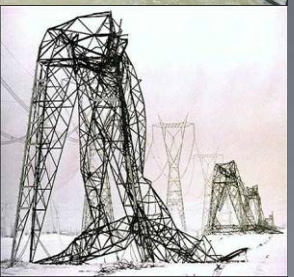


THE CITY OF Edmonton

CH2MHILL







Edmonton – Quesnell Bridge

Vulnerabilities

Climate Effect	*Infrastructure Component*
Flood + peak rain	Drainage system overload - serviceability
Freeze-thaw, ice accretion	Weather surface – increased deterioration Drainage system performance
Snow volume / pattern	Snow clearing increase/decrease

Recommendations

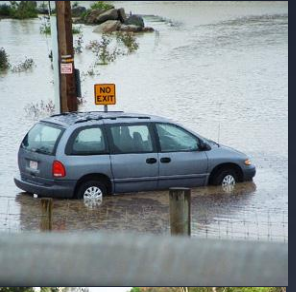
- Design drainage system for increased peak rain
- Review monitoring / maintenance / operations procedures
- Material selection/design (e.g. based on new temperatures ranges)
- Perform sensitivity analyses
- Review / update climatic data in bridge design code
- Assess other bridges that would be sensitive to scour; slope instability; wind; softening foundations / settlement

Project Lifecycle

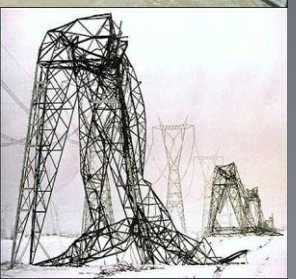
PIEVC Integration with Design Process

- Pre-Design
  - Specification
  - Site Selection
  - Technology Selection
  - **PIEVC**
- Detailed Design
- Tendering
- Construction
- Operation

- PIEVC Process
  - Project Definition
  - Data Gathering & Sufficiency
  - Risk Assessment
  - Engineering Analysis
  - Conclusions & Recommendations

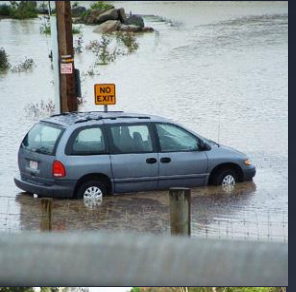




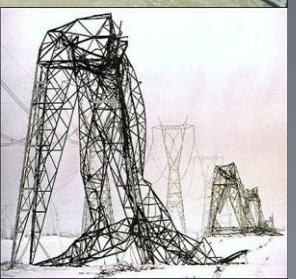


Risk Assessment
Shelburne NS
New Sewage Treatment Plant

- **The majority of high risks related to power supply, communications and access to infrastructure components during extreme climate events**
- **SCADA complete with UPS and backup power system requirements identified**
- **Shut-off for existing pumping station when seawater ingress experienced**
- **Planned increases in maintenance due to climate events**
- **Installation of weather station at the plant site**

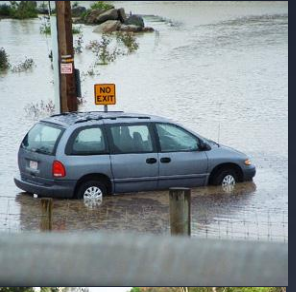






Benefits of Infrastructure Climate Risk Assessment

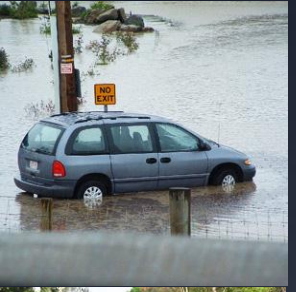
- Identify nature and severity of risks to components
- Optimize more detailed engineering analysis
- Quick identification of most obvious vulnerabilities
- Structured, documented approach ensures consistency and accountability – **due diligence**
- Adjustments to design, operations and maintenance
- Application to new designs, retrofitting, rehabilitation and operations and maintenance
- Reviews and adjustments of codes, standards and engineering practices



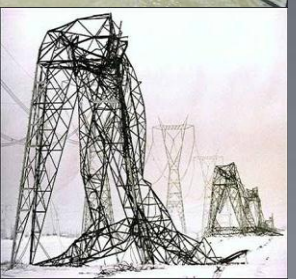



What it's about

1. Adaptation is risk management – climate is another risk
2. Professionals must translate to common lingo
3. Responses compete for resources
4. Need risks and costs (for new and existing infrastructure)
5. Long-term commitments required
6. Much can be accomplished within routine & redevelopment cycles
7. It's not always about ``building a bigger pipe``

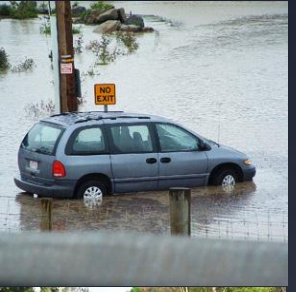




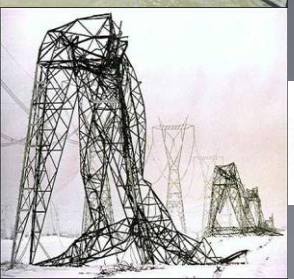


An Infrastructure Adaptation Framework

- People
  - Engineers, planners, managers, operators and other professionals, policy-makers, politicians and the public
- Tools
  - Vulnerability and risk assessment
  - Codes and standards
  - Climate change models and projections
  - Economic and social impact analysis
  - Risk and asset management
- Processes
  - Political, social, outreach, education, training multi-disciplinary teamwork







Questions?

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