Managing Risks in a Changing Climate:

Perspectives from the Built Infrastructure Codes and Standards Community

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Overview

1) It's about increasing uncertainty, not ideology or 'sound' science!
2) Climate change risk management (CCRM): 'state of the art' vs. needs
3) Summary of available CCRM tools
4) What Standards developers are doing

The problem with ideological or 'science-based' arguments

- Debating the ideology or root cause of climate change is not helpful for building business case or economic argument for action. No matter how 'sound' the science, it is not persuasive to many decision-makers. Risk, liability and cost/benefit analysis is more persuasive. Therefore:

- Planners must consider added risks of increasing climatic uncertainty in business case development

- This can only happen when consideration of increasingly uncertain future climate states becomes a routine part of a wide array of planning decision-making processes

It's about an increasingly uncertain climate

" In this report the term 'climate change' refers to any change in climate over time, whether it is a product of natural factors, human activity or both. The usage is the same as that of the <IPCC>, but differs from the usage in the United Nations Framework Convention on Climate Change….The term 'changing climate' is used sometimes in this report to highlight that these changes are ongoing…" *

* Lemmen, DS et al, From Impacts to Adaptation: Canada in a Changing Climate 2007 – Synthesis Report; Gov't of Canada, Page 2.

CC impacts are not homogeneous. They must always be considered in combination with other 'routine' decision-making factors

"…Adaptation will usually not take place in response to climate change alone, but in consideration of a range of factors… Successful adaptation does not mean that negative impacts will not occur, only that they will be less severe had no adaptation occurred. In deciding what adaptation option is most appropriate…attention must be paid to feasibility, likelihood and the mechanisms for uptake…" *

* Lemmen, DS et al, From Impacts to Adaptation: Canada in a Changing Climate 2007 – Synthesis Report; Gov't of Canada, Pg 3.

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Responses CC for adaptation are often cross-cutting

Title	Product Type	Area of Interest					
		Climate Change Adaptation	Stormwater	Multidiscipline	Buried Liner Infrastructure	Potable Water and Wastewater	Small/Medium Utility Metrics
Development, Interpretation and Use of Rainfall Intensity-Duration-Frequency Information: Guideline for Canadian Water Resources Practioners – CSA PLUS 4013	Guideline	√	√				
Performance Improvement Tools for Small and Medium-Sized Water and Wastewater Utilities – CSA PLUS 4010	Guideline					√	√
Infrastructure in Permafrost: A Guideline for Climate Change Adaptation – CSA PLUS 4011	Guideline	√					
Visual Inspection of Sewer Pipe – CSA PLUS 4012 (Adapted from NASSCO PACP)	Guideline & In-class Training				√	√	
Climate Change Adaptation and Municipal Infrastructure: Tools and Techniques for Impact Assessment, Risk Evaluation and Response	e-Learning	√	√	√		√	
Protecting Critical Infrastructure: Risk Management and Emergency Response Training	In-class Training	√	√	√		√	

Excerpt from CSA Municipal Infrastructure/Public works product selection chart

Climate Change Risk Management Tools: The current 'state of the art' and the needs of professionals

CSA Studies

2006- Role of standards in adapting to the impacts of climate change

2007- CSA National Survey of engineers' knowledge and needs *

2007 - Climate Change and Infrastructure Engineering: Moving towards a new curriculum

2009 – CSA Assessment of existing CCRM guidance *

2010 – CSA Assessment of climatic information requirements in CSA codes and standards *

* Key studies

Approx. $235K invested over 4 years (excludes in-kind contributions from volunteer experts)

Addressing increasingly uncertain climate via updated codes, standards and risk tools –
A Pro-forma business case

	Estimated property, injuries and casualty costs ($ billions)*:
1991 – Calgary Hailstorm:	$ .9
1996 – Saguenay Flood:	$1.7
1996 - Calgary Hailstorm:	$ .3
1997 - Red River Flood:	$ .82
1998 - ICE storm Ontario, Quebec, Maritimes:	$ 5.4
2003 – BC/Alberta wildfires:	$ .7
2003 – Hurricane Juan	$ .2
2005 – Southern Alberta Floods	$ .4
2005 – Toronto extreme rain	$ .5 +
Total:	$ 10.9 +

* Public Safety Canada, 2005; Environment Canada, 2005; BC Gov't 2003

(Simplified) Pro-forma codes & standards update business case:

$10M investment over 5 yrs nets an ROI of $100 M over 14 years in avoided property & casualty losses @ 1% efficacy. Approximates a compound annual return of 18%

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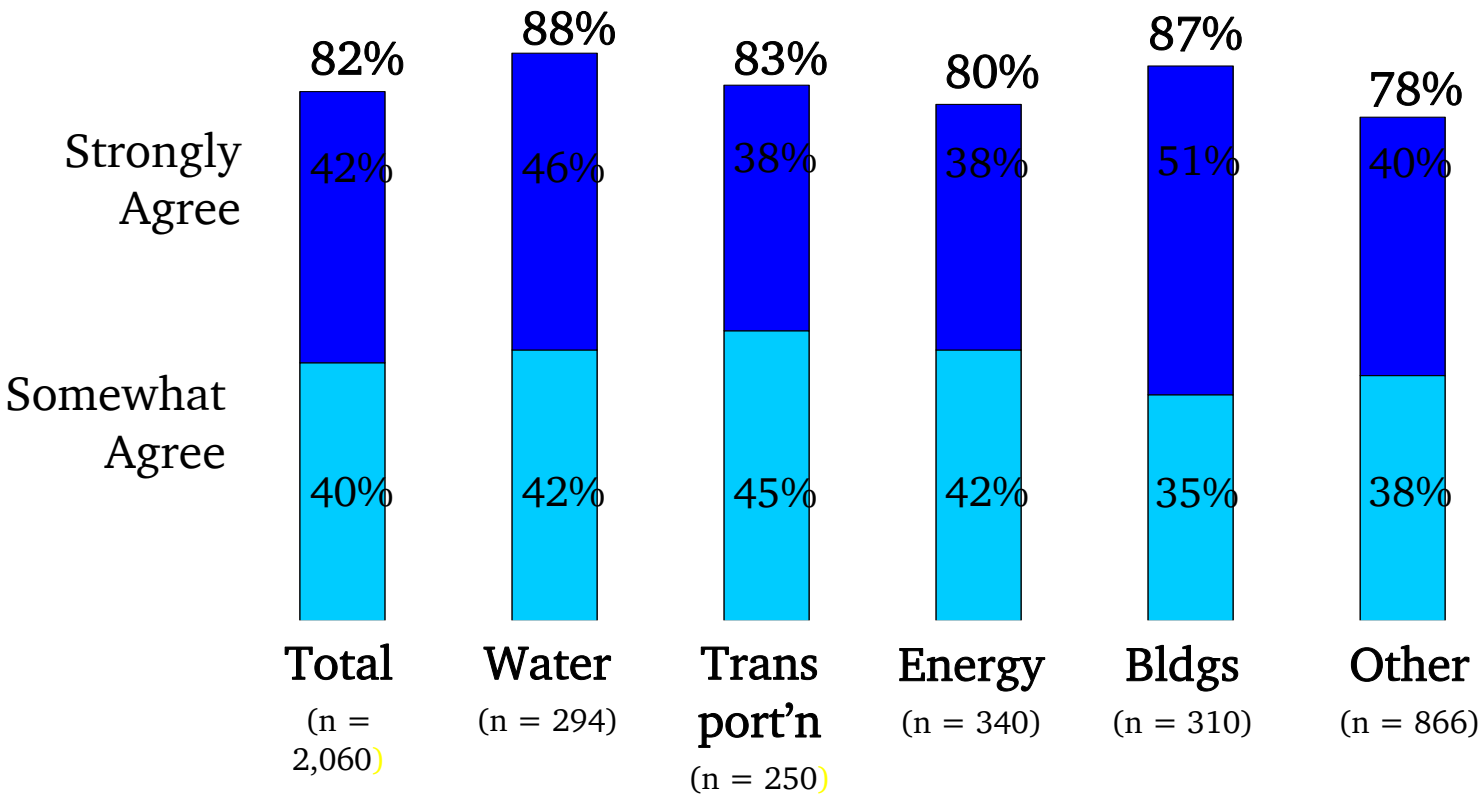
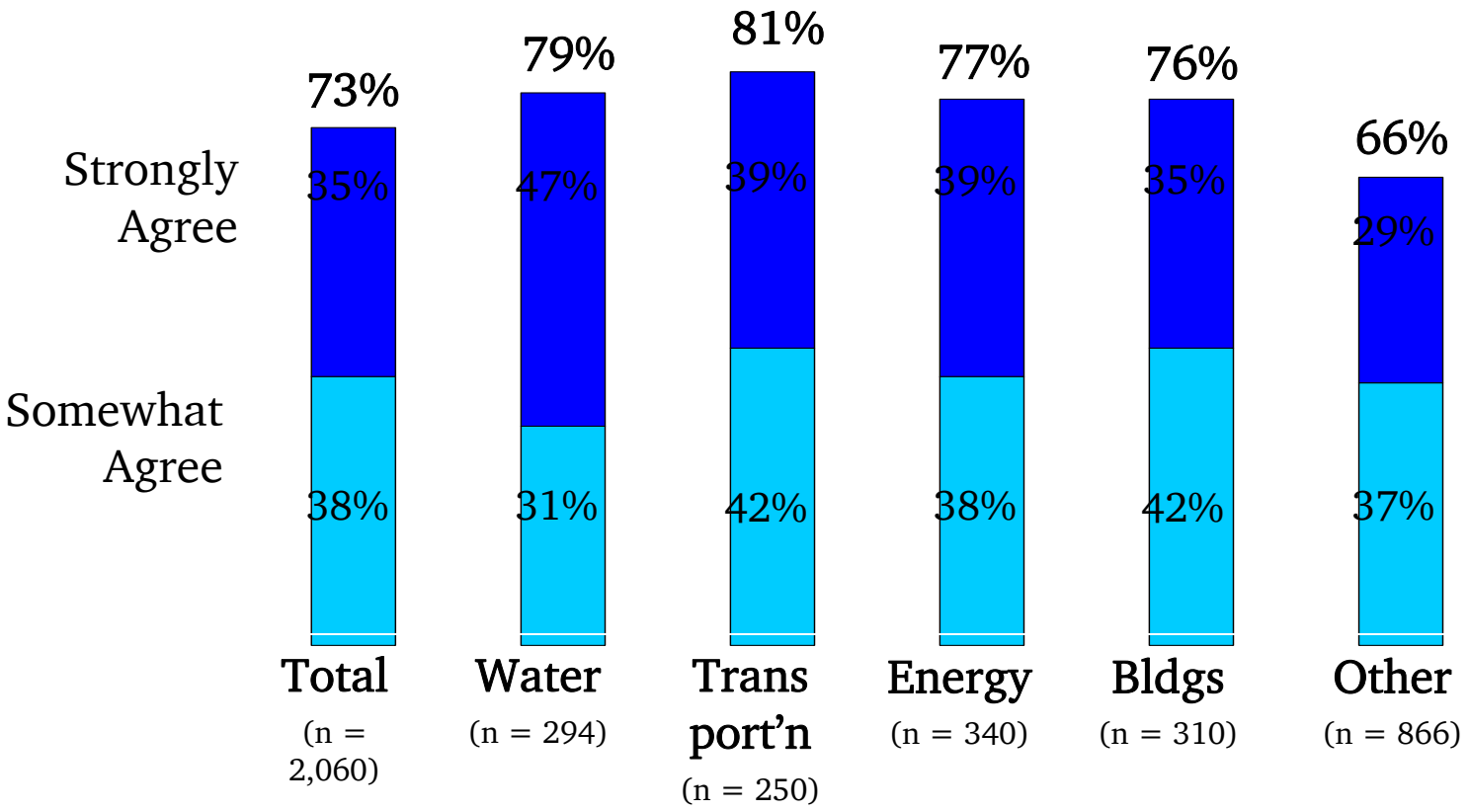
Study #1: National Survey of Engineers' Knowledge / Perceptions

INFRASTRUCTURE CATEGORY	NUMBER OF RESPONDENTS	PERCENTAGE OF TOTAL
Water infrastructure	294	14%
Transportation infrastructure	250	12%
Energy infrastructure	340	17%
Buildings infrastructure	310	15%
Other	866	42%
Total	**2060**	**100%**

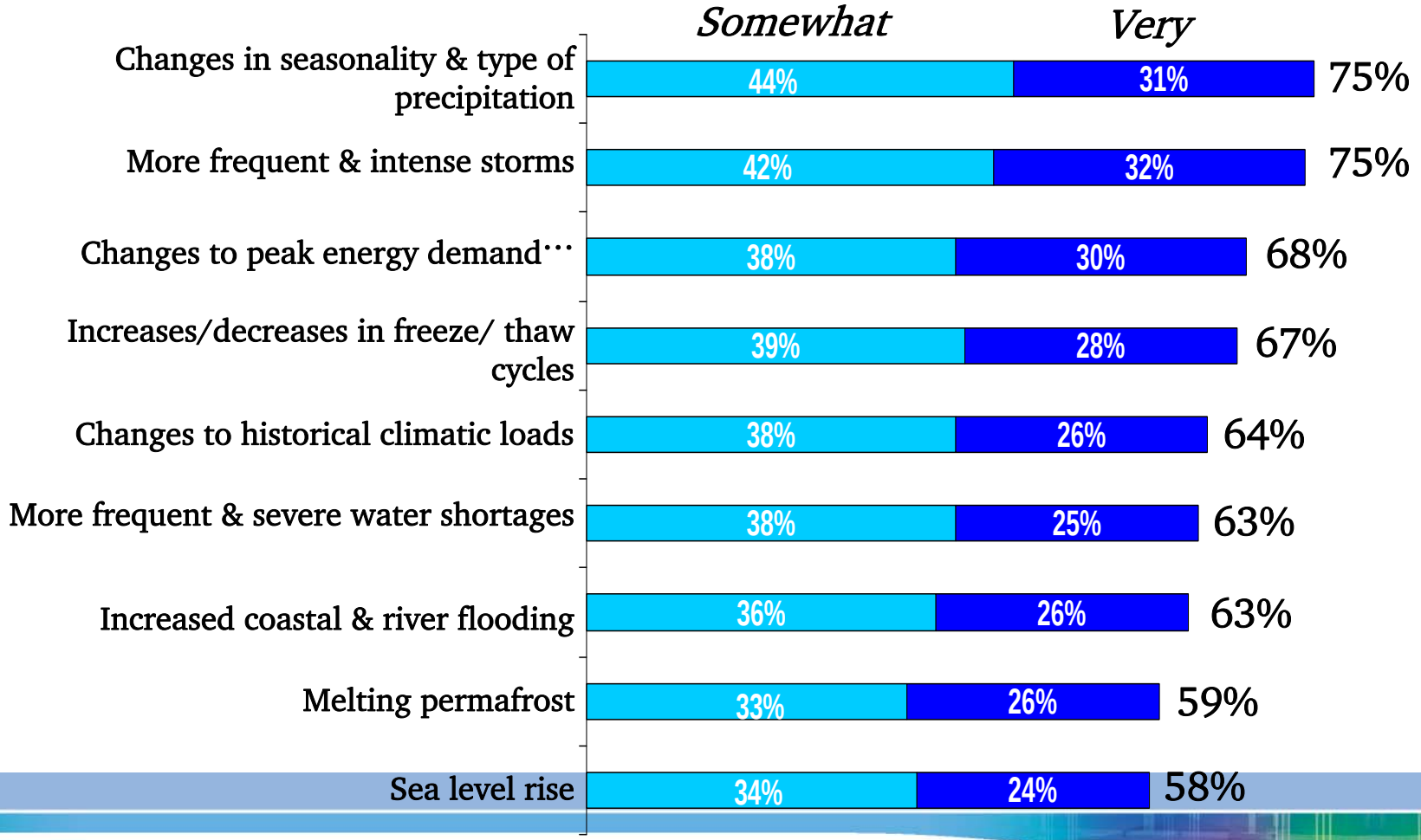
I believe that a changing climate will affect my engineering decisions in the near future.



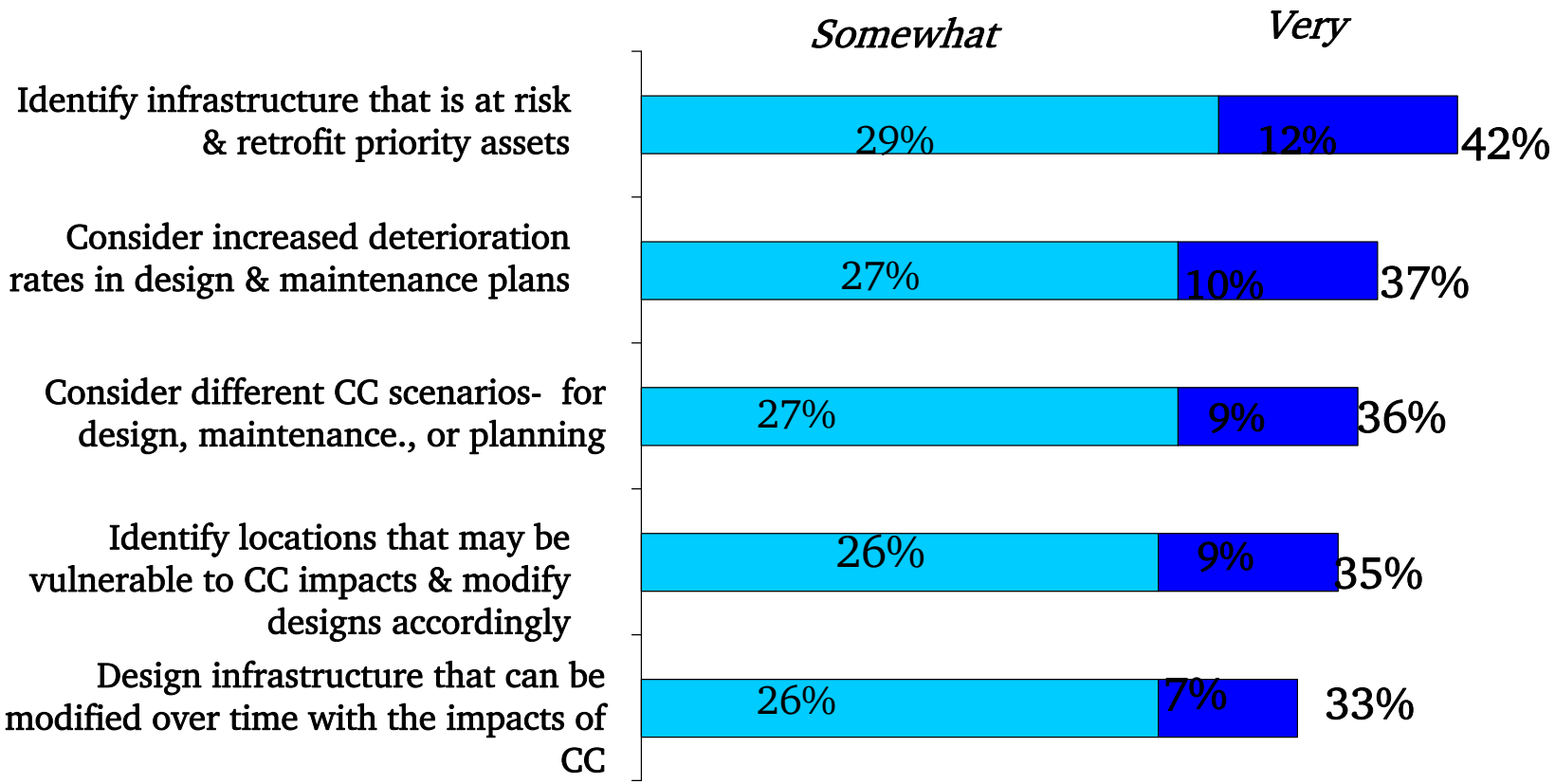
I need much more information to enable me to incorporate the impacts of a changing climate into my engineering practice.



For all the following impacts that have been suggested for a changing climate, please indicate your current level of familiarity



For the following tools and techniques that have been suggested for responding to the impacts of a changing climate, please indicate your current level of familiarity



Study #2: "Mainstreaming the Risk-based Management of Climate Change Impacts in Canada: Which Guidance is Needed?"

- Interview-based
- Assessed the need and most appropriate focus for accredited CCRM guidance

Abridged history of CC risk and vulnerability assessment tools

- 2000 - CIDA-funded tool for Caribbean (Bruce/Egener)
- 2001- CSA Q850 Risk Management Guide
- 2003- UK Climate Change Impacts Program Guide (UKCIP)
- 2006 – Australian Guide
- 2006 – Ontario Municipal Guide (Bruce/Egener)
- 2007 – PIEVC protocol
- 2007 – ICLEI USA Guide
- 2008 – City of Chicago Guide
- 2009– Alberta Municipal Guide (Bruce/Egener)
- 2010 – CAN/CSA-ISO 31000
- 2010 – City of Toronto Tool

Respondents

Developers of existing instruments	Users of existing instruments	Economic sector representatives	Management system experts and others
Eight (8) interviewees with respect to seven CCRM instruments	Eleven (11) interviewees with respect to seven different instruments	Eleven (11) interviewees from three sectors	Four (4) management system experts, one (1) emergency management expert, one (1) water systems expert, and one (1) hospital system administrator

What we found

1) In the Canadian context, existing guidance for CCRM is:

   a) generally good enough for screening purposes

   b) often insufficient to rationalize changes to capital investment, planning or design

What we found (cont.)

2) Further technical guidance required for risk evaluation, ranking, prioritization
   - development and use of forward-looking climatic information
   - characterization and communication of related uncertainties

3) At the same time, many municipal sector players require guidance from ground up

Conclusions

1) Tailor CCRM guidance sector by sector

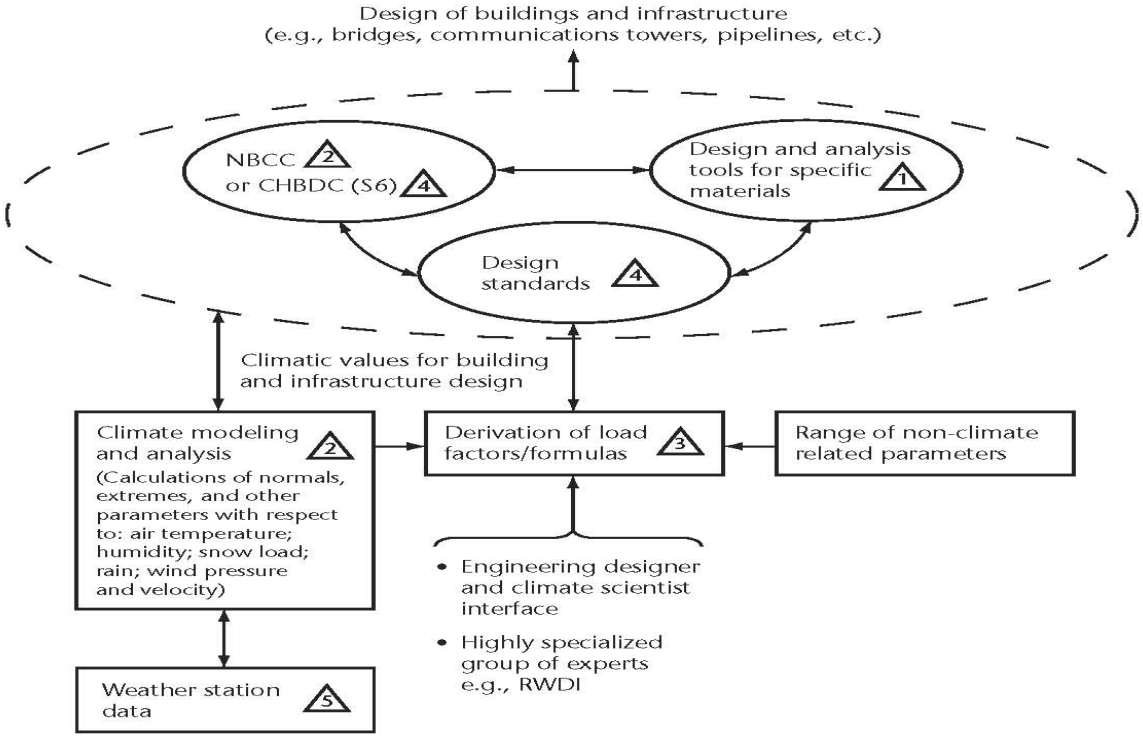
2) For industry sectors, link to existing Enterprise Risk Management standards

3) Make guidance “authoritative” and link to recognized sources of *climatic data and information*

Study #3: "…Climatic Information Requirements of Built Infrastructure Codes and Standards and their Users"

- *Identified* CSA's built infrastructure codes and standards that heavily rely on climatic data
- *Characterized* climatic information requirements
- *Interviewed* climate design experts re: further information requirements

Knowledge Chain for Climate Data in Infrastructure / Building Codes and Standards



Legend:

1 — Academia and industry groups

2 — Environment Canada (EC), Climate Modeling Groups, Canadian Codes Centre

3 — Applied R&D related to buildings and public works infrastructure

4 — CSA Standards Development Technical Committees

5 — WMO and non-WMO certified weather stations

What we found

- 29 out of 250 CSA infrastructure codes and standards are heavily reliant on climate data
- Climatic information they require is not always centrally located
- In various cases, referenced information was last calculated over two decades ago

What we found (cont.)

- *Update of climate design values is 'ad hoc'*
- *Overlap in climatic information needs (and priorities) among sectors suggests various opportunities*
- *CSA Technical Committees want more guidance on how to incorporate forward-looking climatic information into design standards*

What we've done (so far) as a result….

New Guides, Standards & Training (Multi-subject) related to CC Adaptation

Topic areas

- Storm water (training, 4 modules; 1 std)
- Potable water (various standards & guides)
- Climate science (Guide, IDF curves)
- Permafrost (Guide for planners & specifiers)
- Emergency Mgmt & Biz Continuity (for Public works)
- Operations and Energy Efficiency in Public Buildings

New CSA Guidance - Highlights

- **Guideline** (2010): Permafrost, climate change and community infrastructure
- **Guideline** (2010): Extreme rainfall and water resources (IDF) infrastructure
- **E-learning** (2010): Adapting infrastructure to climate change training module

"Infrastructure in Permafrost: A Guideline for Climate Change Adaptation"

1) General Background (Chpts 2-4)

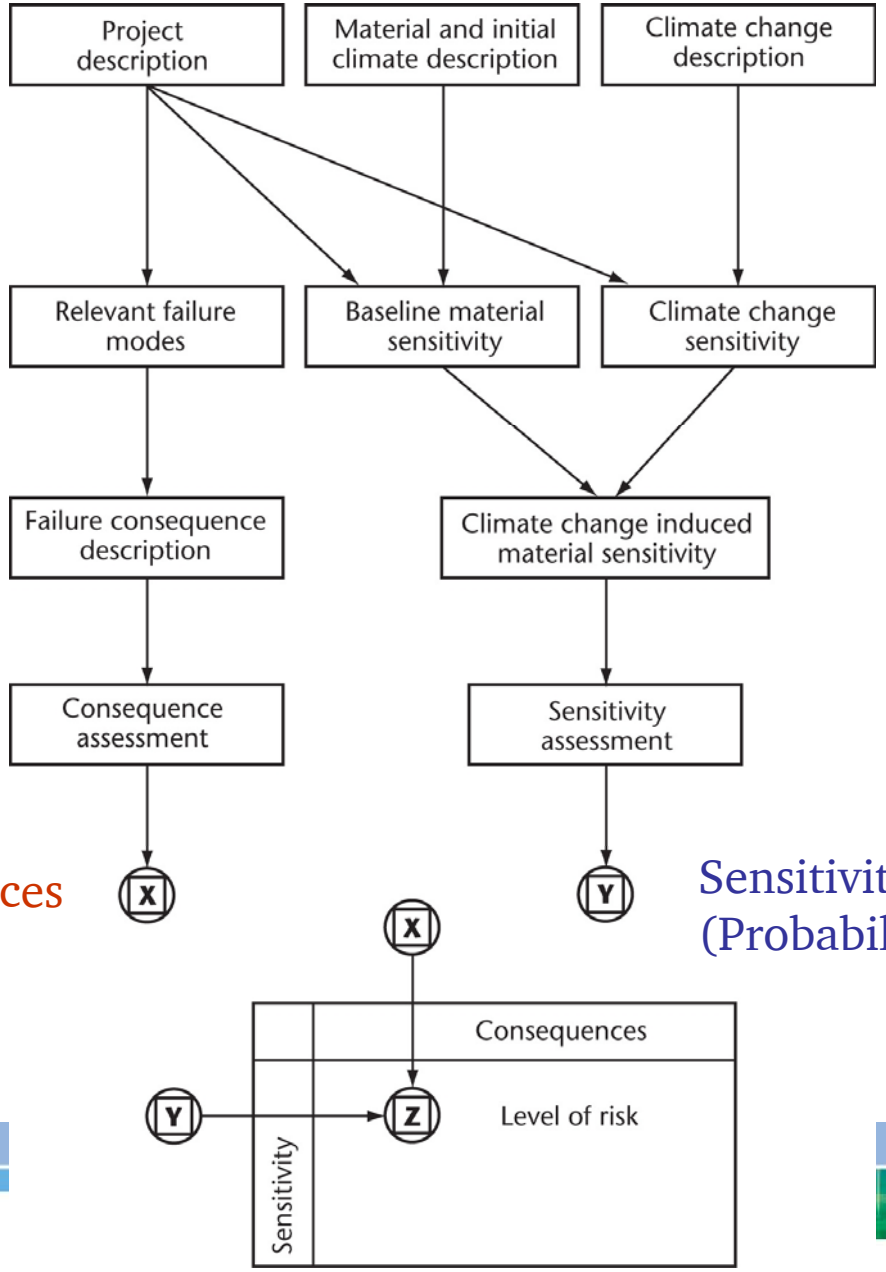
2) Changing trends (Chpts 5,6)

3) Risk-based protocol (Chapter 7)

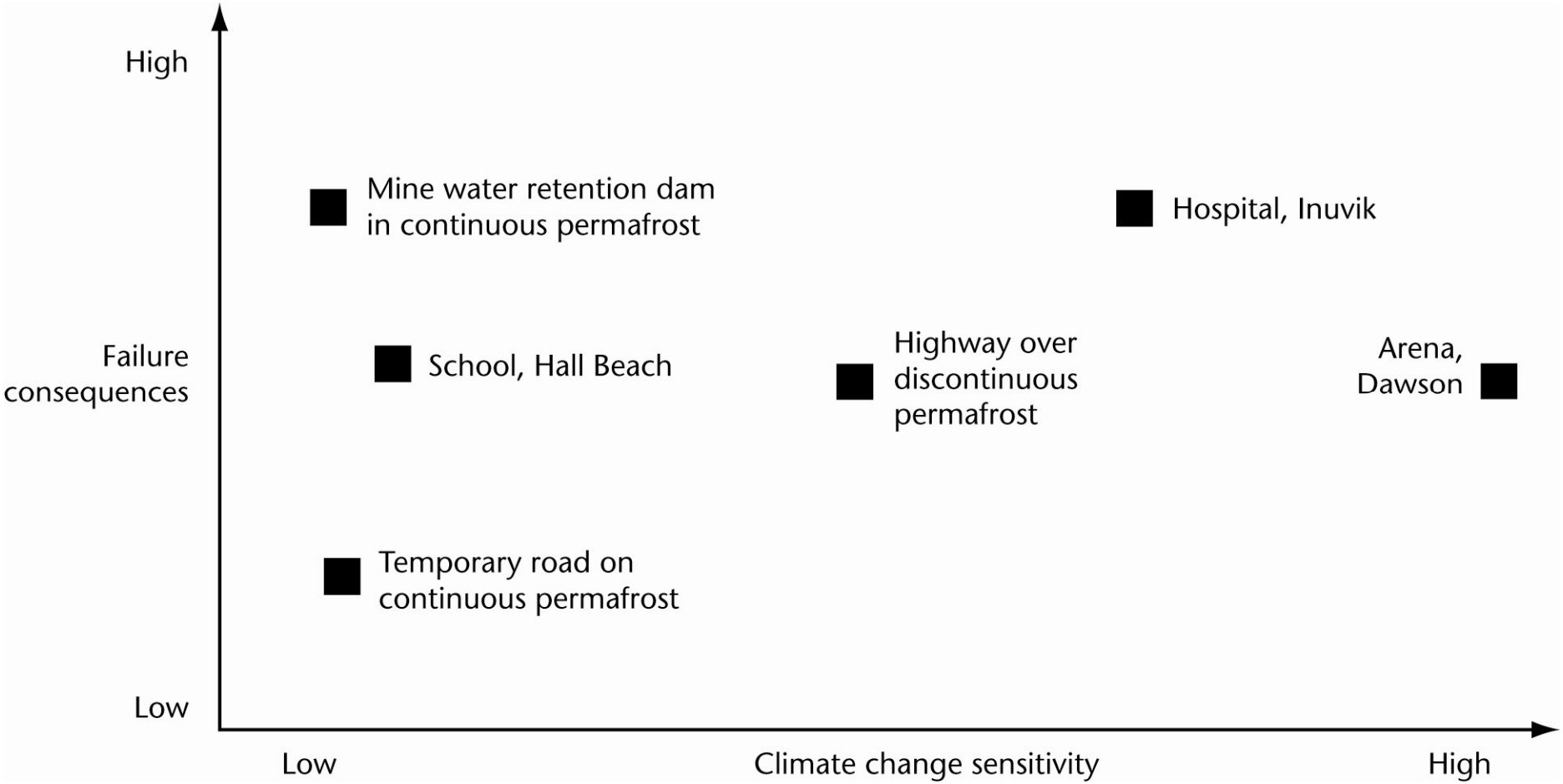
Risk-based Protocol

- **Stage 1: Screening**
  - Site Characterization
  - Functional Criteria
  - **Screening for Climate Change Sensitivity & Risk**
- **Stage 2: Advanced Design Implementation**
  - Geothermal Analyses
  - Preliminary Design
  - Limitations Assessment
  - Final Design
  - Documentation

Screening Process Schematic



Climate Change Screening Process



Screening Process Objective

- **Risk-based analyses for rational inclusion of climate change in the design process**

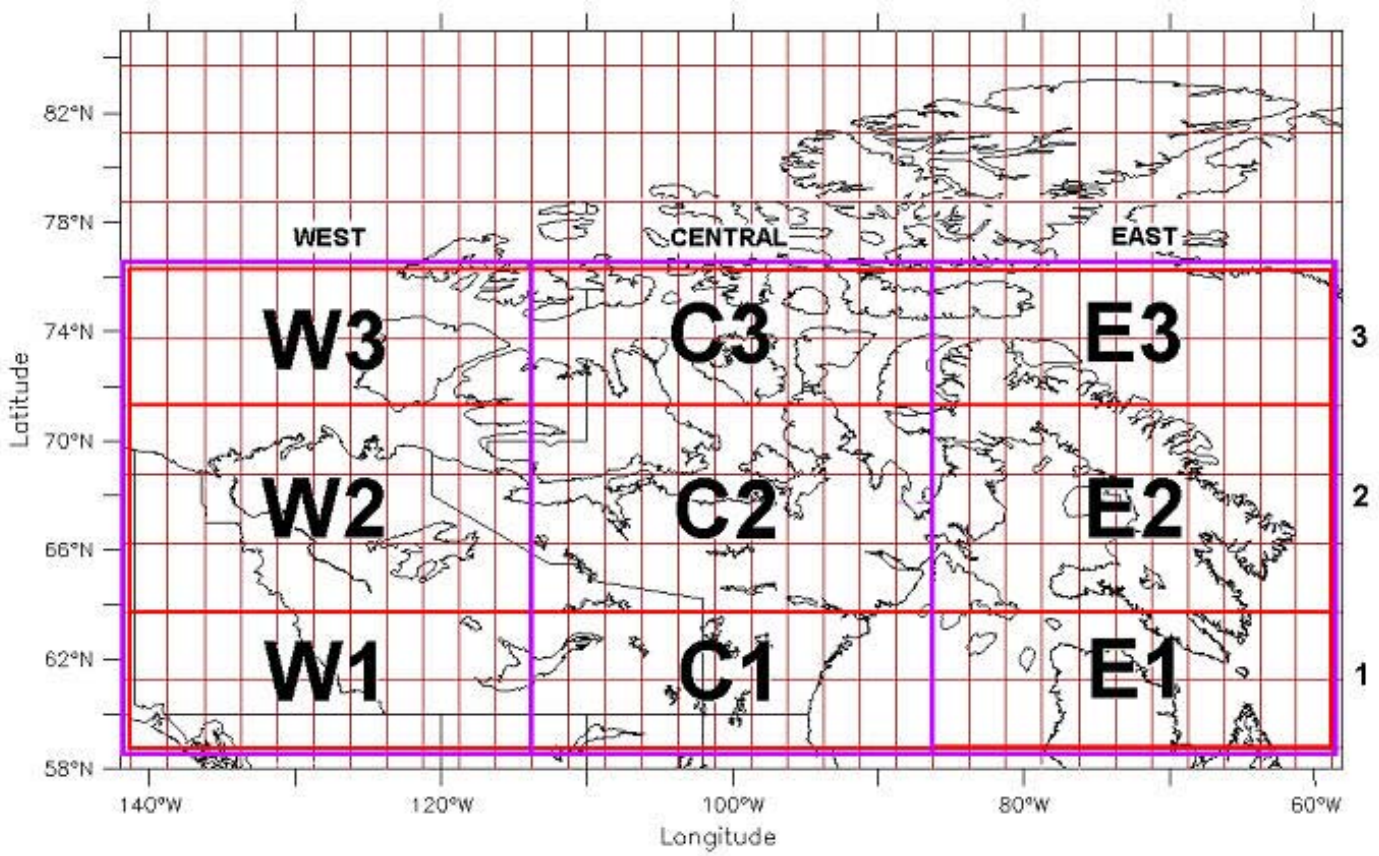
Likelihood of induced failure	Consequence			
	Negligible	Minor	Major	Catastrophic
Frequent	C	A	A	A
Probable	C	B	A	A
Occasional	D	B	B	A
Remote	D	C	B	A
Improbable	D	C	C	B

Risk Level	Analysis Prescribed
D	Not Required
C	Qualitative
B	Semi-quantitative
A	Detailed Quantitative

Site Sensitivity

Ground material	Permafrost temperature zone			
	Zone 4 ($T < -7$ °C)	Zone 3 ($-7 \leq T < -4$ °C)	Zone 2 ($-4 \leq T < -2$ °C)	Zone 1 ($-2 \leq T < 0$ °C)
Any soil containing massive ice	M	H	H	H
Peat and organic	L	M	H	H
Lacustrine (silt or clay)	M	M	M	H
Diamiction (dominantly fine grained)	M	M	M	H
Diamiction (dominantly coarse grained)	L	L	L	M
Marine soils with salinity	M	M	H	H
Alluvial and glaciofluvial (sand or gravel)	L	L	L	M
Frost-shattered rock	L	L	M	M

NEW modeling results – for each of nine Arctic Zones



Required levels of analysis

Table 7.4
Risk screening framework for permafrost-related projects

	Negligible	Minor	Major	Catastrophic
High	C	B	A	A
Medium	D	C	B	A
Low	D	C	C	B

Risk Level	Analysis Prescribed
D	No action required.
C	Perform qualitative analysis. Apply expert judgement. Document result of evaluation. Perform quantitative evaluation for projects with limited precedence in: • design, • function, or • construction method.
B	In addition to requirements for 'C': Perform limited quantitative analysis. Use engineering judgement for input parameters. Monitor permafrost performance. Perform full quantitative evaluation for projects with limited precedence.
A	Perform detailed quantitative analyses. Refine input parameters with additional investigation and testing. Perform full scale monitoring programme with periodic evaluation of performance. Independent expert review required.

"Development Interpretation and Use of Rainfall Intensity-Duration-Frequency (IDF) Information"

1) How extreme rainfall (IDF) information is developed

2) Assumptions contained within IDF information

3) How to account for climate change

On-line Training Module

CSA STANDARDS

Adapting Your Infrastructure to Climate Change

COURSE INTRODUCTION

- WELCOME
- COURSE OUTLINE
- INVOLVING ALL STAKEHOLDERS
- COURSE LEARNING OBJECTIVES
- LEARNING OUTCOMES
- A COLLABORATIVE EFFORT
- FRAMING THE ISSUES

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A collaborative effort

This course has been developed in collaboration with leading experts from stakeholders across Canada, among them individuals representing municipalities, industry and professional associations, consultants and government agencies. This course would not have been possible without their commitment to and contribution throughout the entire development process.

A Strategic Collaboration Serving Municipal Government and the Practitioner Community

FCM
Federation of Canadian Municipalities
Fédération canadienne des municipalités

The Federation of Canadian Municipalities (FCM) has shared in the significant investment required to develop this course including funding, guidance and other resources and is working in collaboration with CSA Standards to create awareness and access to this course to the practitioner community.
The Federation of Canadian Municipalities (FCM) has been the national voice of municipal government since 1901. With more than 1,900 members, FCM represents the interests of municipalities on policy and program matters that fall within federal jurisdiction. Members include Canada's largest cities, small urban and rural communities, and 18 provincial and territorial municipal associations.

Read about FCM Climate Change Adaptation Initiatives (**Feature sheet link**).

Website **http://www.fcm.ca/**

On-line Training Module

CSA STANDARDS

Adapting Your Infrastructure to Climate Change

Course Learning Objectives

This course aims to familiarize staff and decision makers in Canada's municipalities with a range of available tools and techniques to support efforts in to climate change impact assessment, climate change risk evaluation, and response planning.

This course will provide you with:

- a high level review of key concepts associated with climate change, impacts and adaptation;
- an objective, balanced commentary relating to contemporary issues associated with climate change adaptation that have practical implications with respect to the performance and resilience of municipal infrastructure;
- a "road map" of key resources available to municipal infrastructure practitioners addressing climate change adaptation challenges;
- a demonstration of the application of select resources using practical examples and case studies so that the value of their use or application can be illustrated and reinforced;
- information on the implications of climate change from a life-cycle perspective including planning, designing, building, maintenance and operations;

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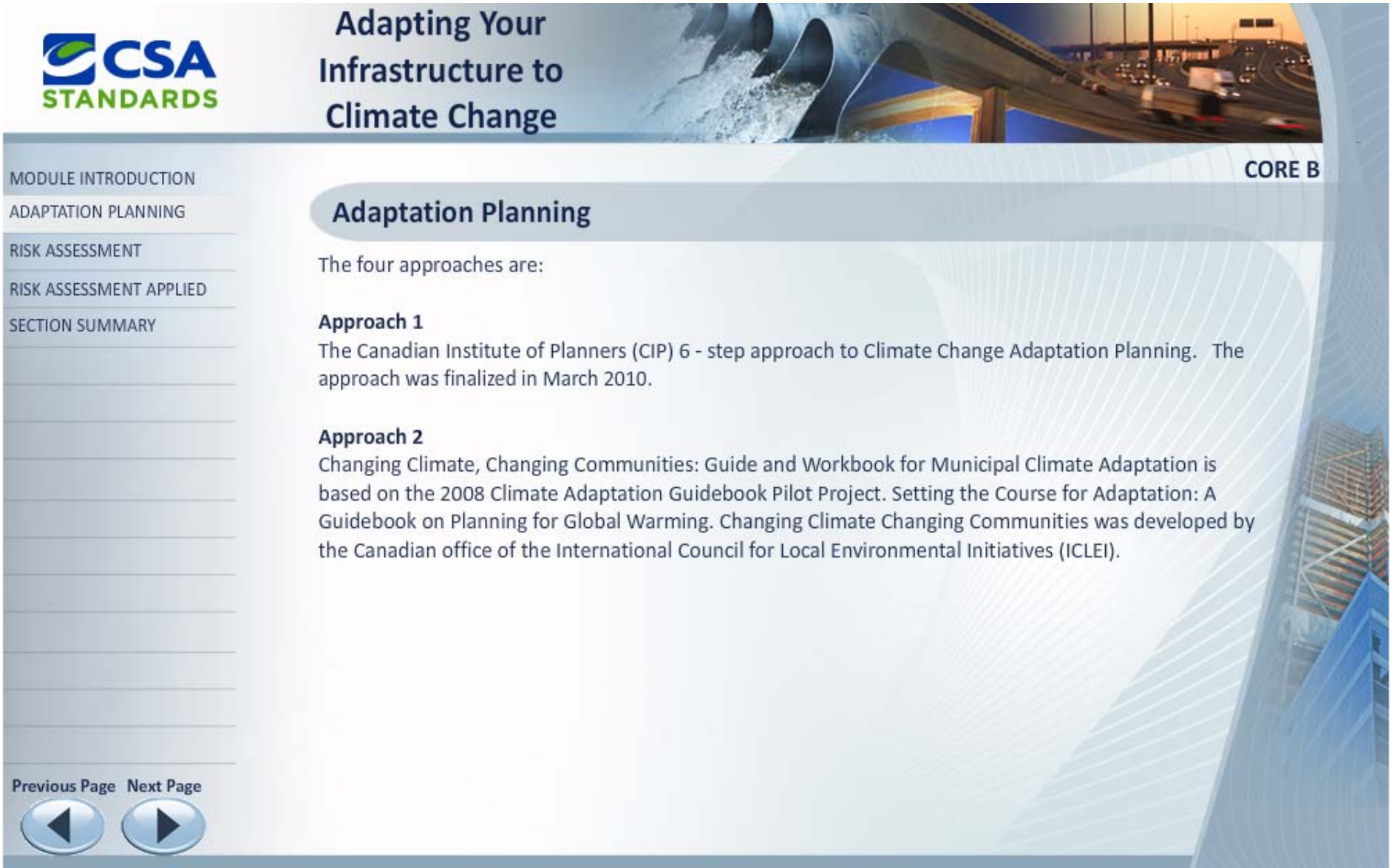
Course Outline

This course is divided into three (3) core modules: "Core A", "Core B" and "Core C". Each core module is then divided into smaller sections.

"Core A" provides an introduction to Climate Change and its impact on society.
"Core B" focuses on municipal infrastructure and the identification and assessment of risks associated with climate change. Four existing approaches developped in Canada will be highlighted.
"Core C" discusses key threats to infrastructure, and will walk you through completing a case study.

Study Guide
A study guide is provided **here** with details to help you work through the course and to track your progress and make personal notes.

On-line Training Module



On-line Training Module

CSA STANDARDS

Adapting Your Infrastructure to Climate Change

MODULE INTRODUCTION
ADAPTATION PLANNING
RISK ASSESSMENT
RISK ASSESSMENT APPLIED
SECTION SUMMARY

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CORE B

Adaptation Planning

Approach 3

Robert Black, James Bruce and Mark Egener have devised a Risk-based Guide for adapting to climate change. This Guide is published in two volumes. Volume 1 contains a six step risk management process, while Volume 2 is a workbook with case studies. The Guide has been developed for several provinces / territories: Ontario, Alberta, British Columbia and the North.

Approach 4

The Canadian Council of Professional Engineers through its Public Infrastructure Engineering Vulnerability Committee (PIEVC) has developed the "PIEVC Engineering Protocol for Climate Change Infrastructure Vulnerability Assessment". This protocol provides a five phase process for planning and executing infrastructure vulnerability assessments.

Module Introduction

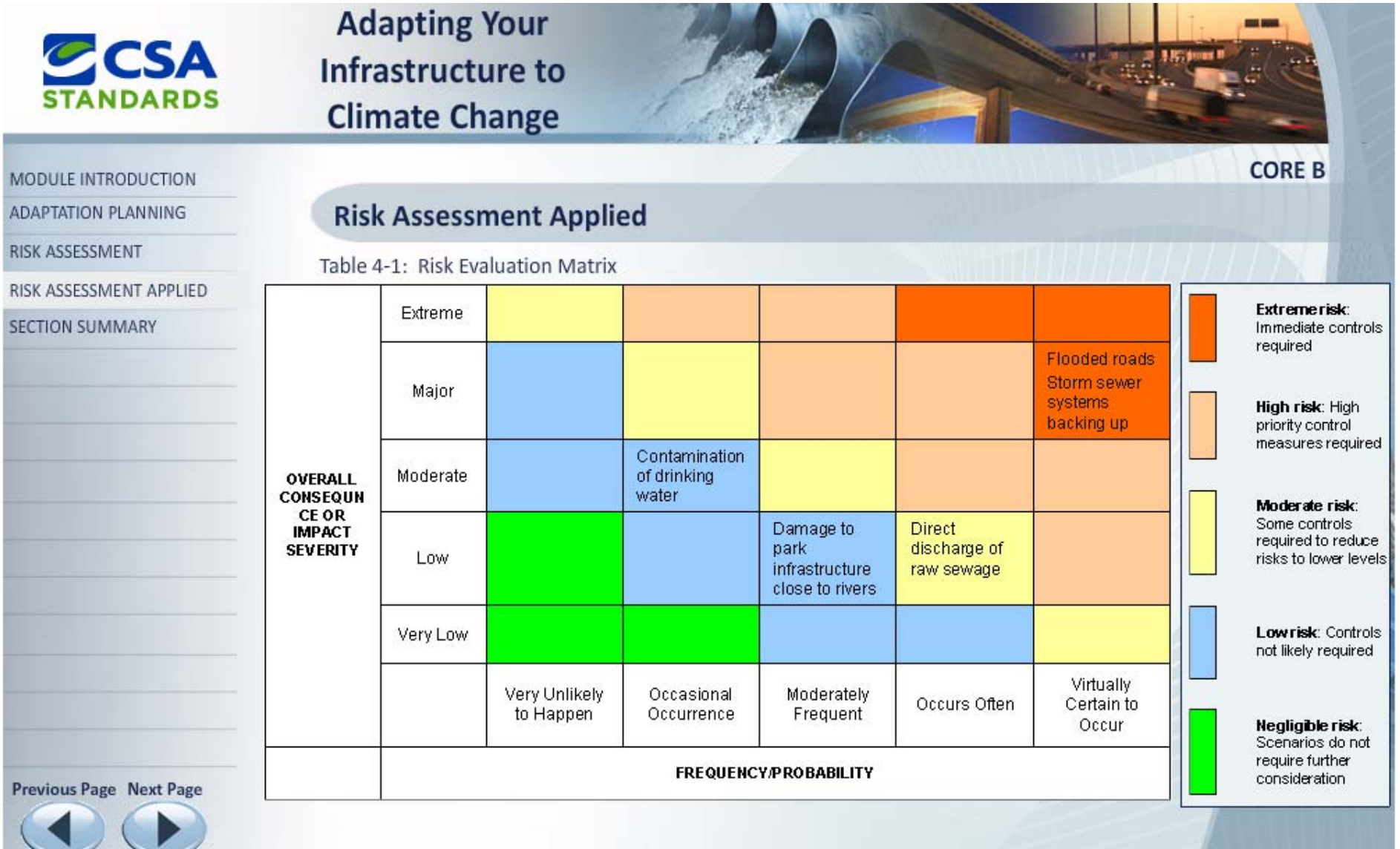
Welcome to Core C, the final part of the CSA Climate Change Training Module.

In Core C you will:

- Become familiar with some of the key climate change hazards or threats to infrastructure in Canadian communities.
- Choose one key climate change hazard likely to affect your community.
- Complete a risk management case study focusing on how that key climate change hazard puts your community's infrastructure at risk.
- Identify adaptation measures to deal with the risks from that key climate change hazard.
- Develop an implementation and monitoring plan for the adaptation measures you have identified.

Note: There may be time to repeat the risk management process for another key climate change hazard during the course of this module.

On-line Training Module



On-line Training Module

Resource Toolkit

Tables

- Table 2.1: Preliminary Risk Scenario Assessment
- Table 3-1: Frequency / Probability Rating
- Table 3-2: Impact Rating Matrix
- Table 3-3: Suggested Display for Stakeholders and Risk Perception
- Table 4-1: Risk Evaluation Matrix
- Table 5-1: Risk Controls and Adaptation Measures

Working documents

Additional Resources

- CCCSN
- UNFCCC

Links to Resources

Climate Change Hazards

Permafrost Warming/Thawing

- Case Study Workbook
- Post-Case Study Resources

Sea Level Rise

- Case Study Workbook
- Post-Case Study Resources

Drought

- Case Study Workbook
- Post-Case Study Resources

Wind Storms

- Case Study Workbook
- Post-Case Study Resources

Flooding

- Case Study Workbook
- Post-Case Study Resources

Core C
Case Study Workbooks including Pre-Reading Resources

&

Post-Case Study Resources with Assessment Examples

Click on the document titles to print or save a copy to your computer.

Next Steps for Standards Developers

- Establish a routine, properly funded process for ensuring that climatic information required for a range of critical standards is updated at appropriate intervals
- Ensure that the information is accessible for use by codes & standards community, professionals, etc.
- Expanded focus on Northern issues
- CCRM guidance aimed at critical infrastructure in specific industrial sectors (e.g., electricity transmission; telecommunications)
- Continue to develop sector-specific technical annexes or guides based on applied research

THANK YOU

More information at: www.csa.ca/infrastructure

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