ClimateWest, a central hub for climate services in Manitoba, Saskatchewan, and Alberta, is proud to host Alberta's Adaptation Resilience Training module recordings and resources.

Check out climatewest.ca for all training material available through ART and other initiatives.

ClimateWest
Building Prairie Resilience

The aim of the Adaptation Resilience Program (ART) is to build the capacity of professionals in Alberta to adapt to climate change. This module was recorded in September, 2021.

Professionals across the Prairie region may find this training useful.

Supported by the Natural Resources Canada's Building Regional Adaptation Capacity and Expertise (BRACE) Program and the Government of Alberta

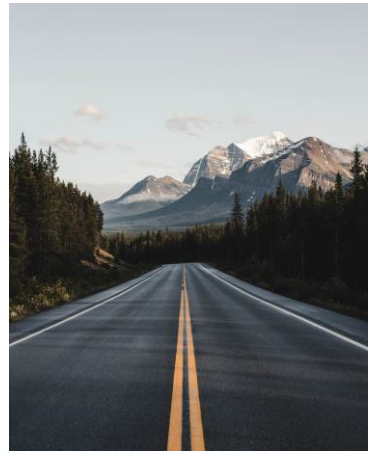
Natural Resources Canada | Ressources naturelles Canada

Canada

Alberta

Associated Engineering

CANADA'S BEST MANAGED COMPANIES Platinum member



Adaptation Resilience Training

Knowing your Infrastructure for Building Resilient Communities

Jeff O'Driscoll, P.Eng. IRP, Division Manager, Infrastructure

September 2021

Module Overview

- Demonstrate how climate data is used in assessing and managing risk, defining design parameters/criteria and communicating climate impacts.

- The ART Infrastructure Stream focuses on buildings, roads and bridges intended to have a minimum 50 year life cycle. Some parts of the Stream's content may be applicable to other Infrastructure assets such as electricity grid infrastructure, water treatment facilities, and dams.

Module Overview

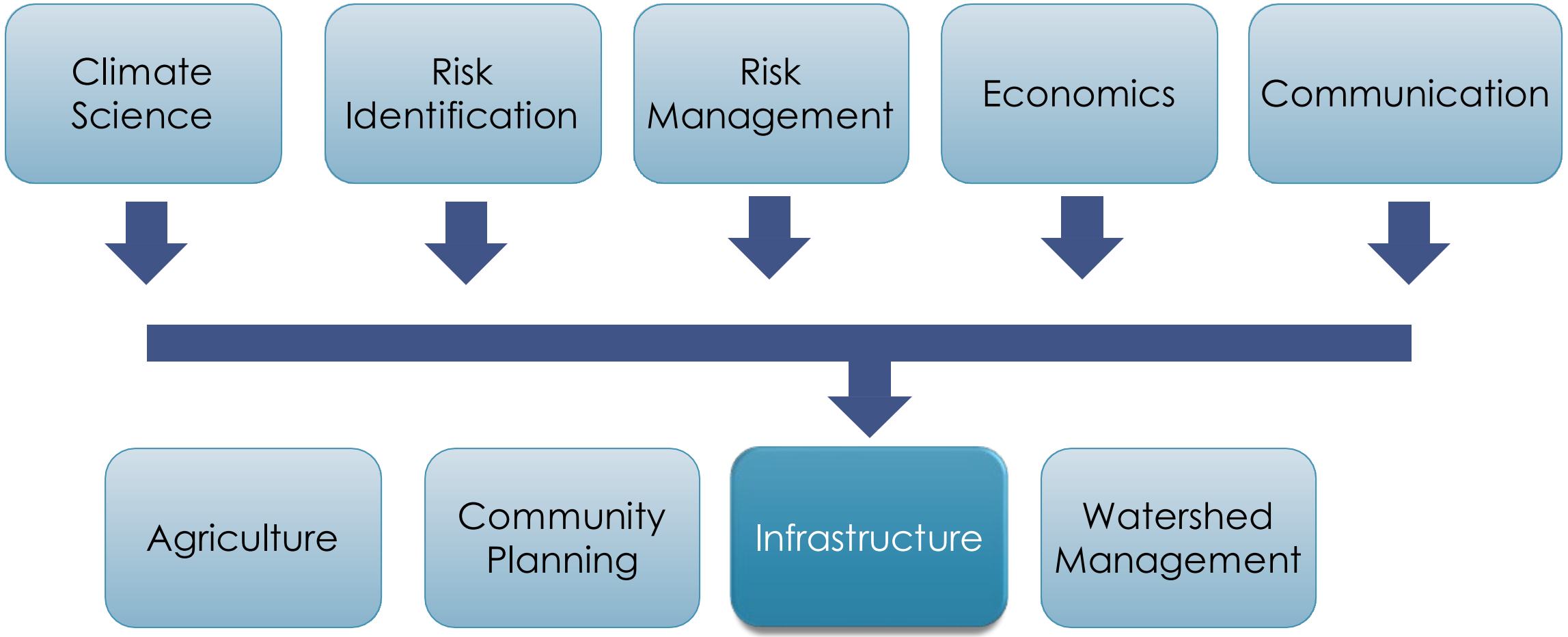
- Introduction and Links to Previous Modules
- Climate Change Resilience Assessment
- Example Project
- Defining the Scope of an Assessment
- Defining Climate Data
- Break

Module Overview

- Assessing Risk
- Group Exercise 1
- Break
- Risk Evaluation and Treatment
- Group Exercise 2
- Question and Answer Session

Links to Previous Modules

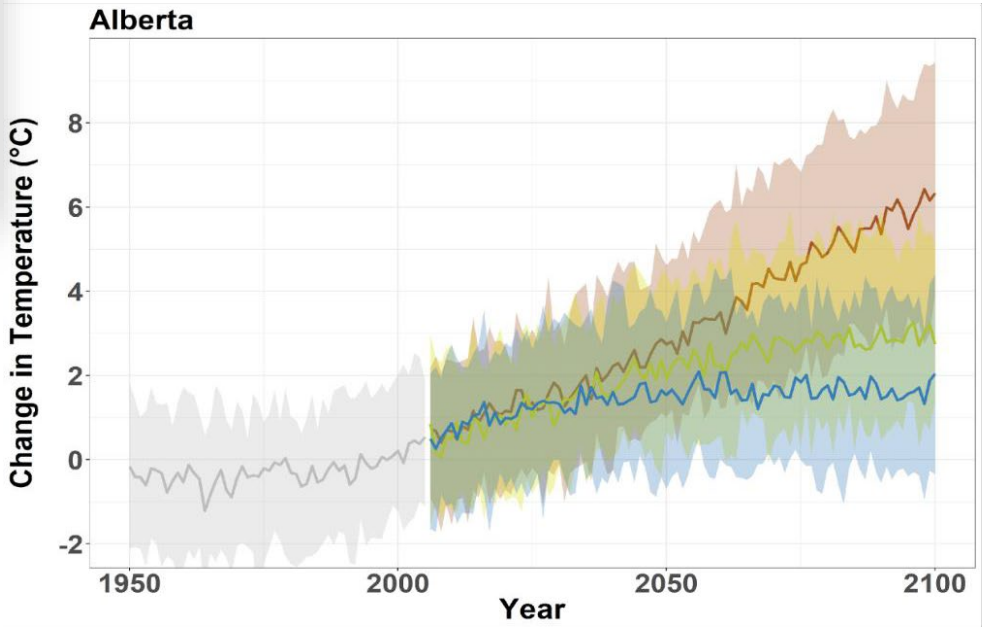
Context and relationships with other modules



Looking Back

- **Climate Data**

Projected temperature change in Alberta



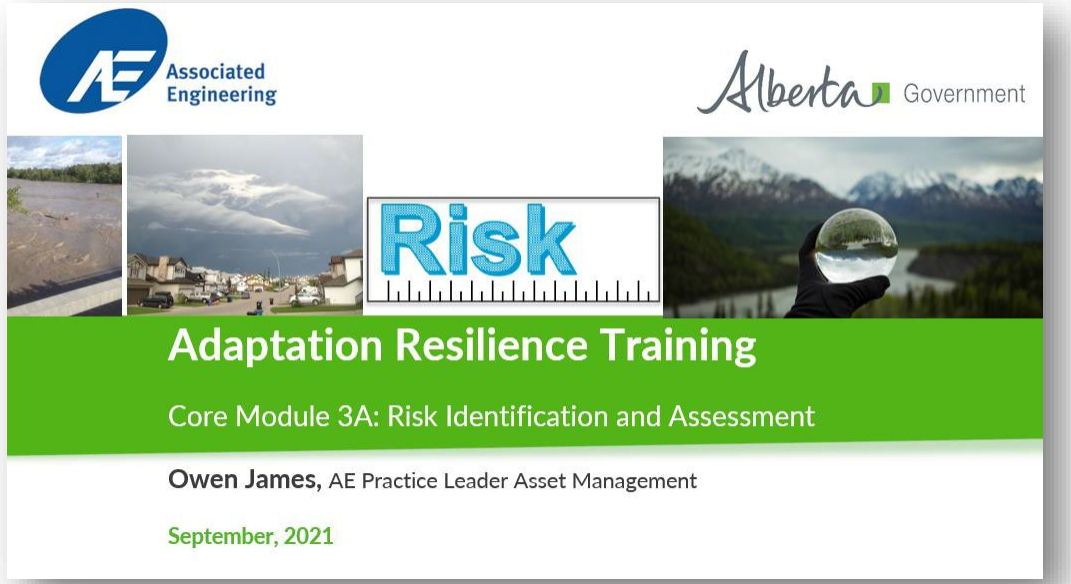
By the end of the century*:

High Emissions Scenario (RCP 8.5): +5.8°C

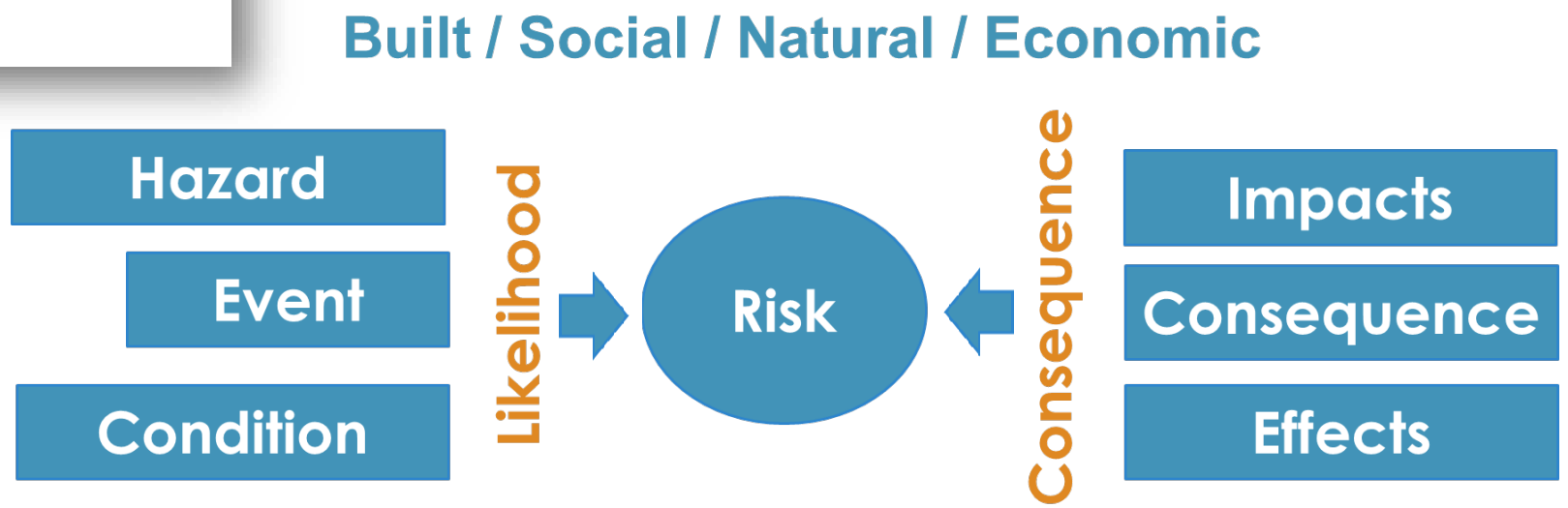
Moderate Emissions Scenario (RCP 4.5): +2.9°C

Low Emissions Scenario (RCP 2.6): +1.7°C

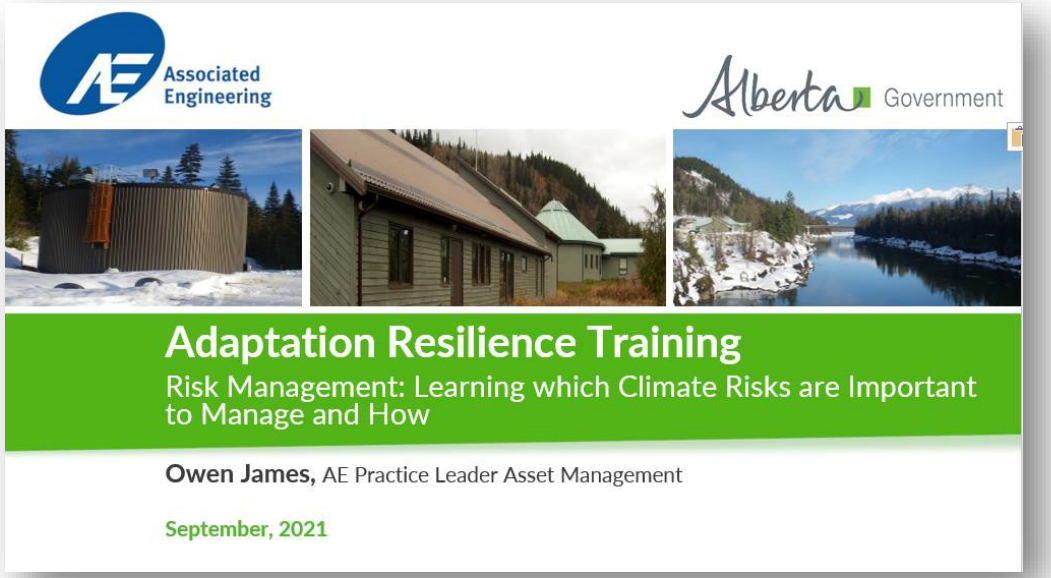
Looking Back



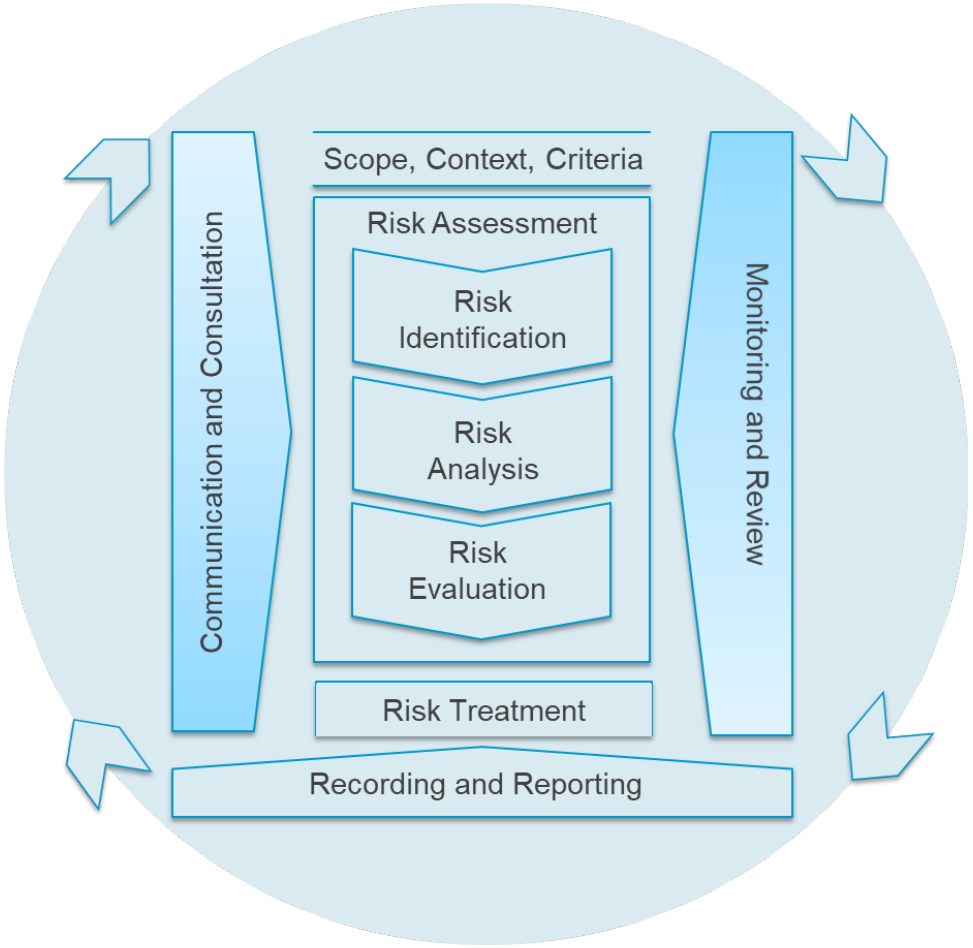
- Risk Identification and Assessment



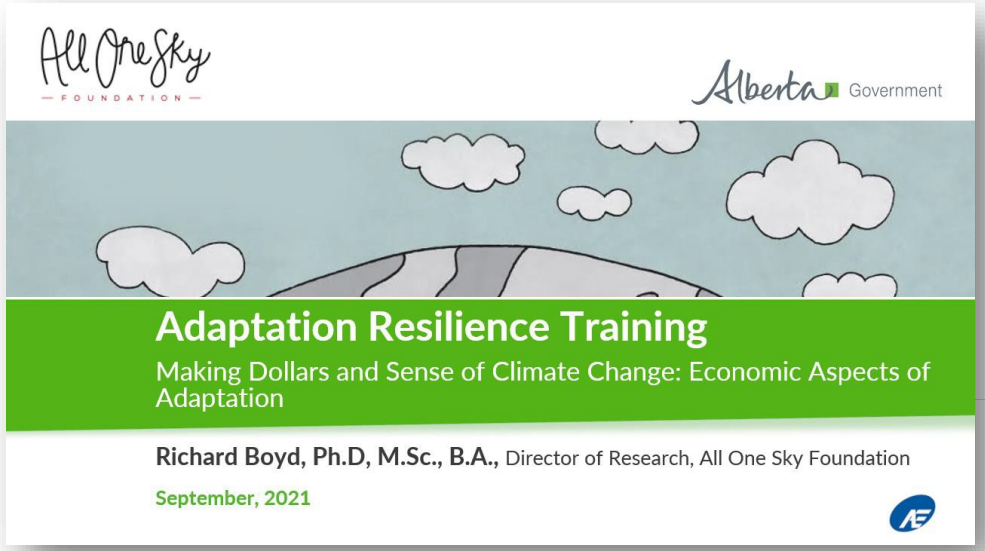
Looking Back



- **Risk Management**

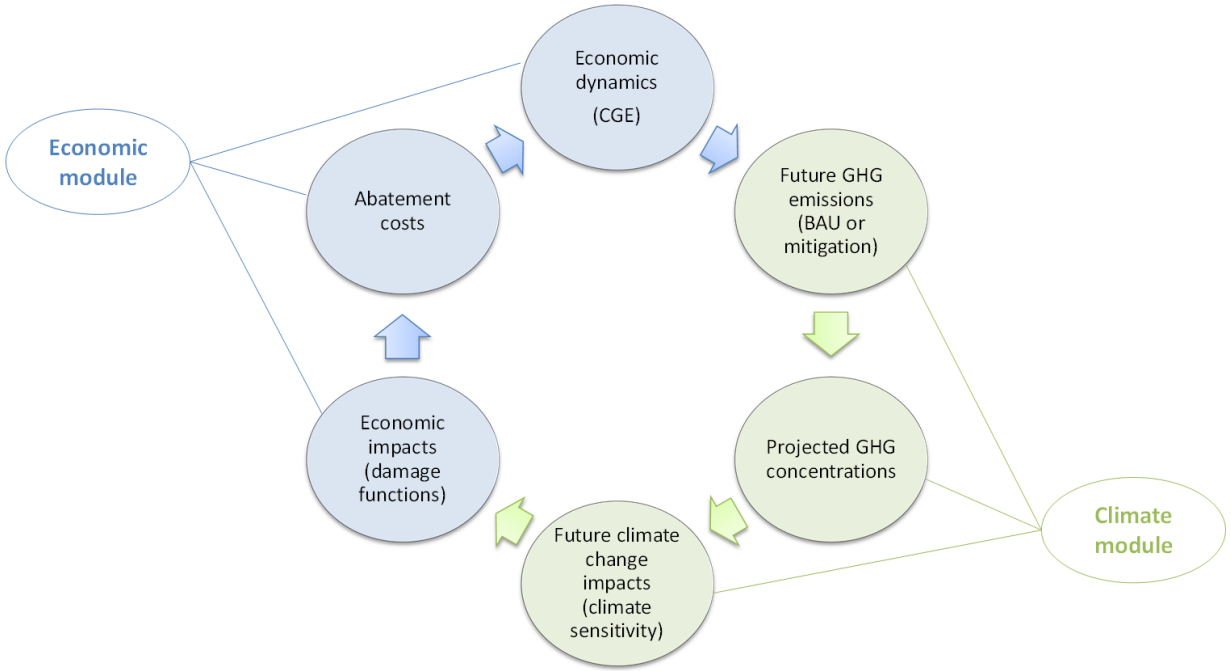


Looking Back



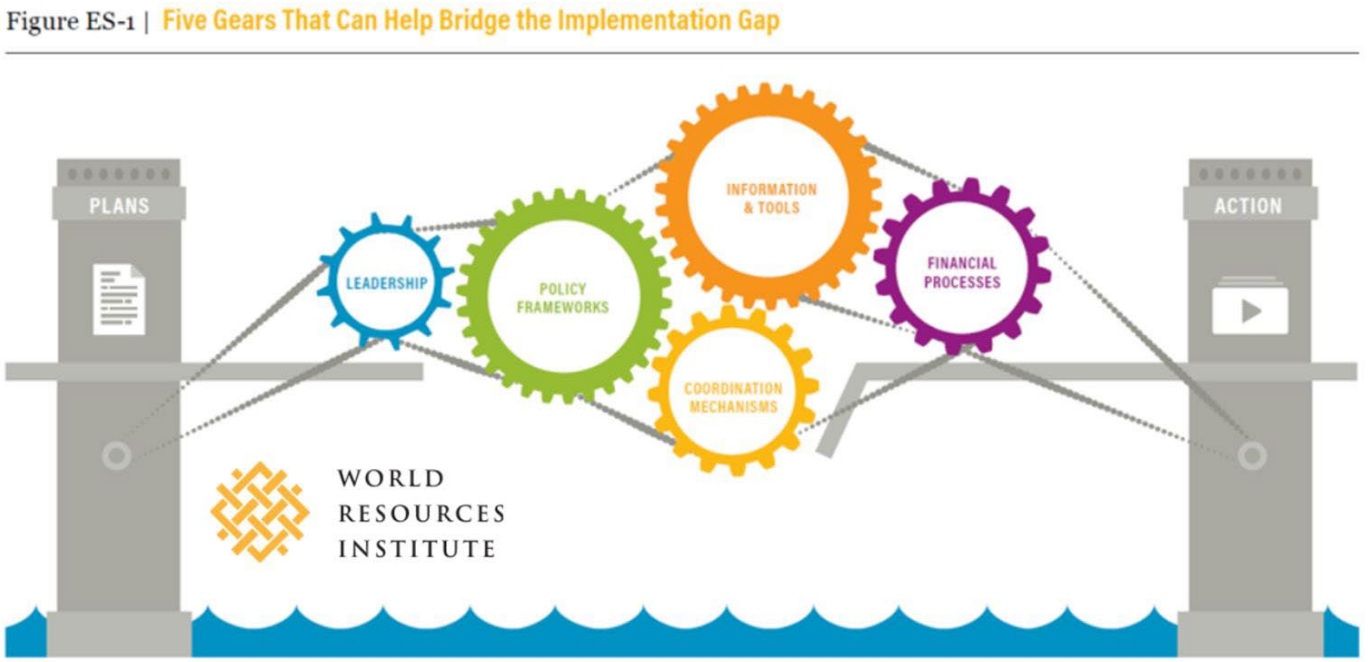
- **Economics**

Integrated Assessment Models (IAMs) of climate change costs



Looking Back

- Communication



https://www.wri.org/publication/climate-planning-to-action

Climate Change Resilience Assessment

Infrastructure and Climate

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

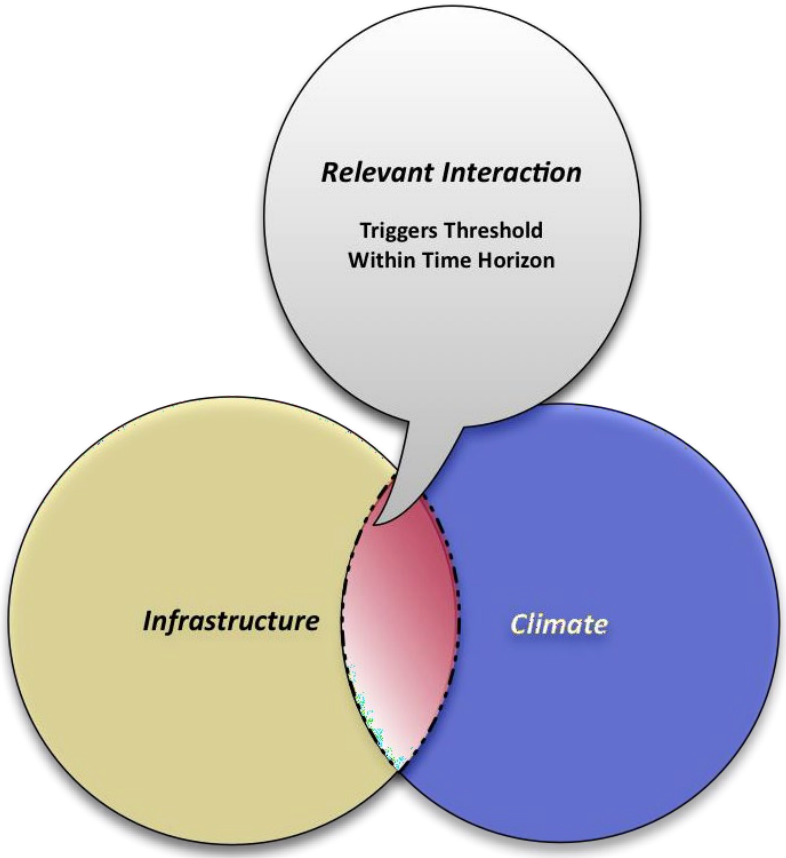
Climate Change Resilience Assessment

- Why?
  - To deal with:
    - Uncertainties of future climate
    - Risks to physical infrastructure and infrastructure service
    - Service disruptions
    - Protection of people, property, environment
    - Legal and financial implications
    - Lifecycle and management of operations
    - Planning to improve resilience
- When?
  - Full lifecycle
    - Planning,
    - Design and
    - Operation
    - Upgrade

Framework (clause 5)

Climate Change Resilience Assessment

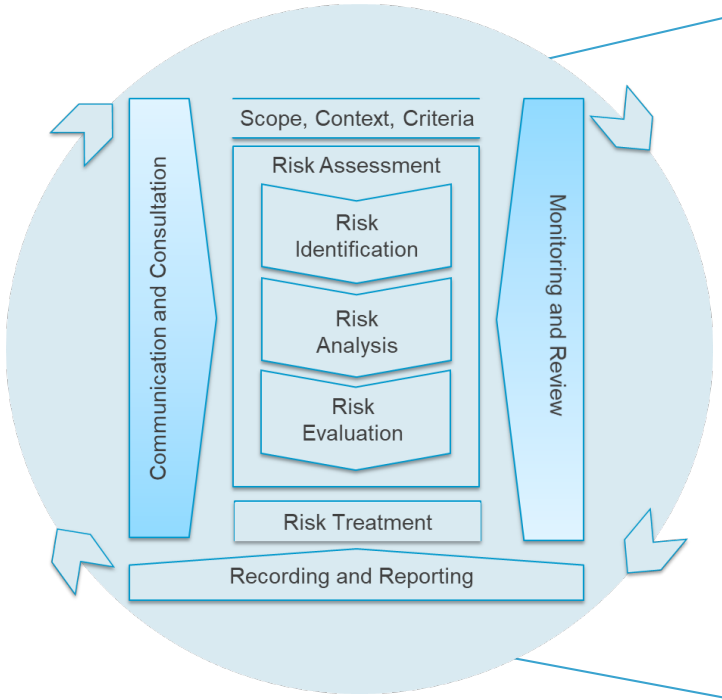
- PIEVC Protocol
  - Systematic process to assess historic climate and project the nature, consequence and likelihood of future climate changes and events on infrastructure to inform on infrastructure planning, design, operation and management. (pievc.ca)

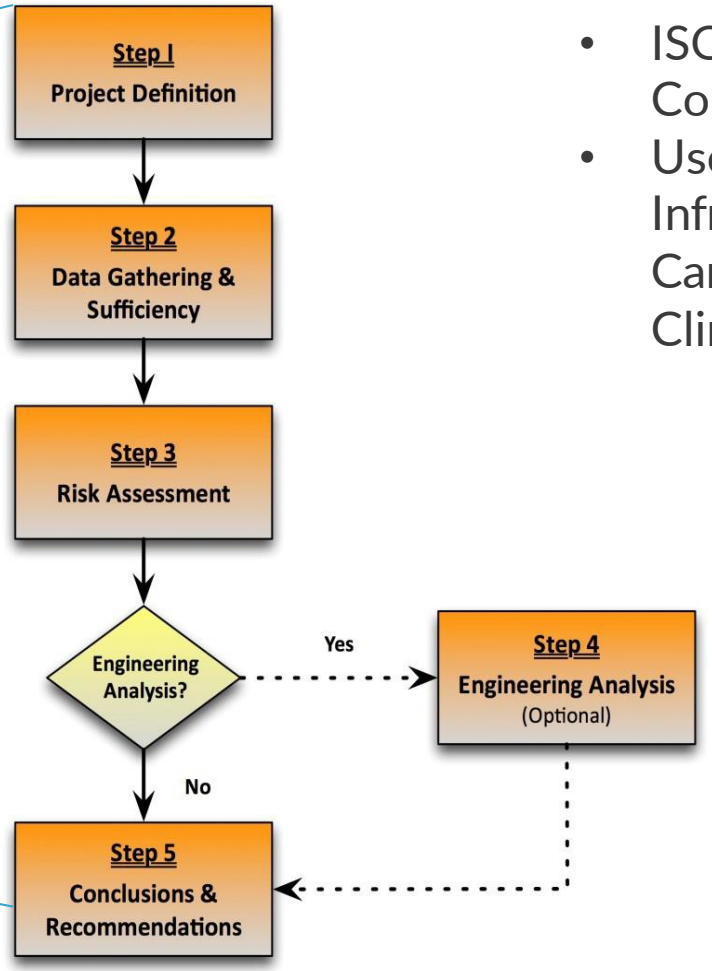


Note: Ow nership and control of the PIEVC Program by partnership consisting of the Institute for Catastrophic Loss Reduction (ICLR), the Climate Risk Institute (CRI) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Climate Change Resilience Assessment

- PIEVC Protocol



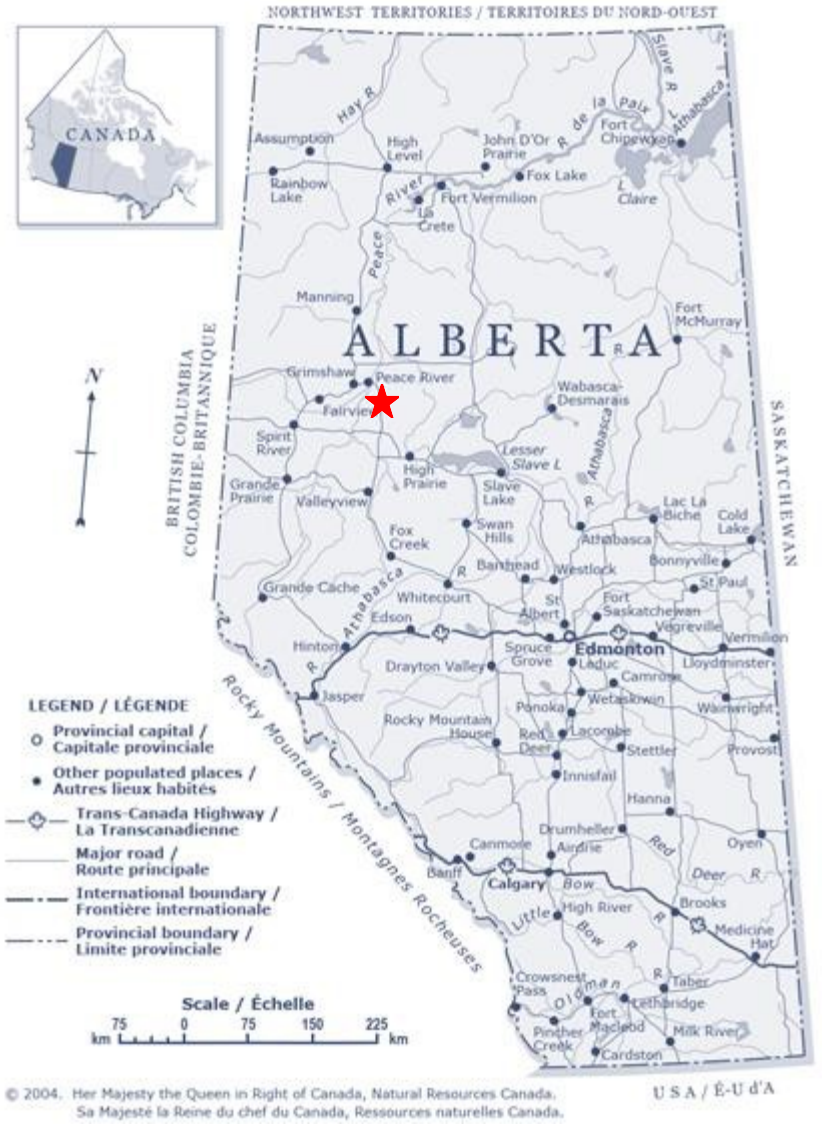


- ISO 31000 Compliant
- Used in Infrastructure Canada Climate Lens

Note: Ow nership and control of the PIEVC Program by partnership consisting of the Institute for Catastrophic Loss Reduction (ICLR), the Climate Risk Institute (CRI) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Climate Change Resilience Assessment

- For this Modules
  - Demonstrate how climate data is used in an example project
  - Highway 2 between Rycroft and Fairview including Dunvegan Provincial Park

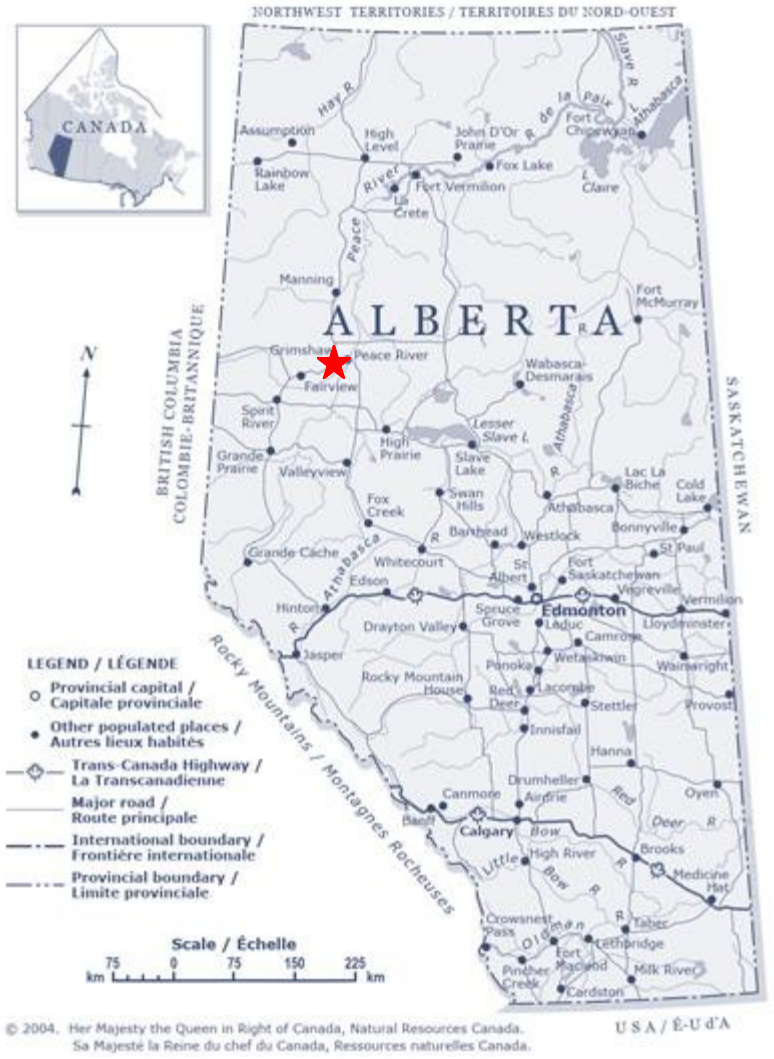


Polling Question

Example Project Description

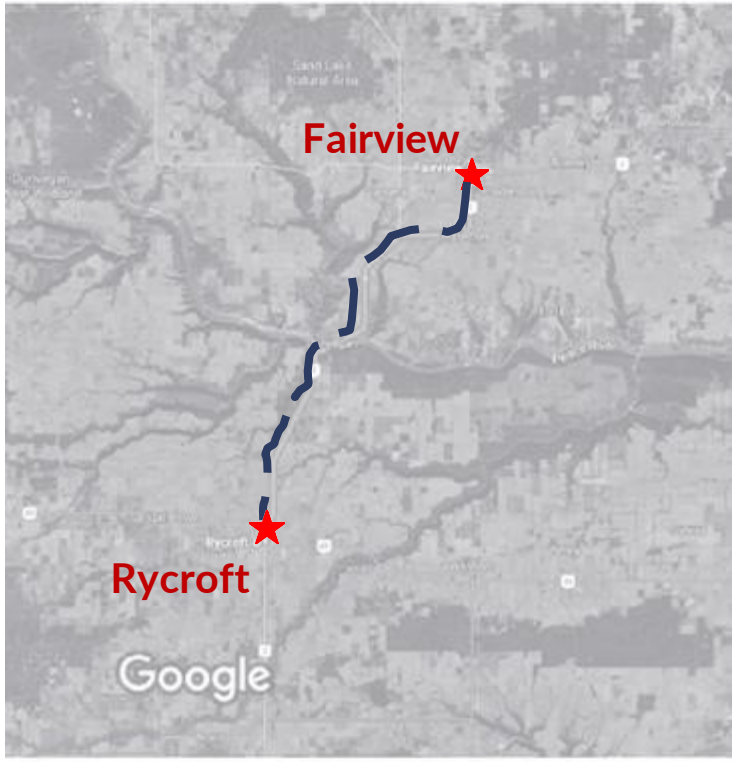
Climate Change Resilience Assessment

- Highway 2 between Rycroft and Fairview
  - Highway Roadway (~47.5 km)
  - Dunvegan Bridge
  - Dunvegan Provincial Park



Example Project

- Highway 2 between Rycroft and Fairview

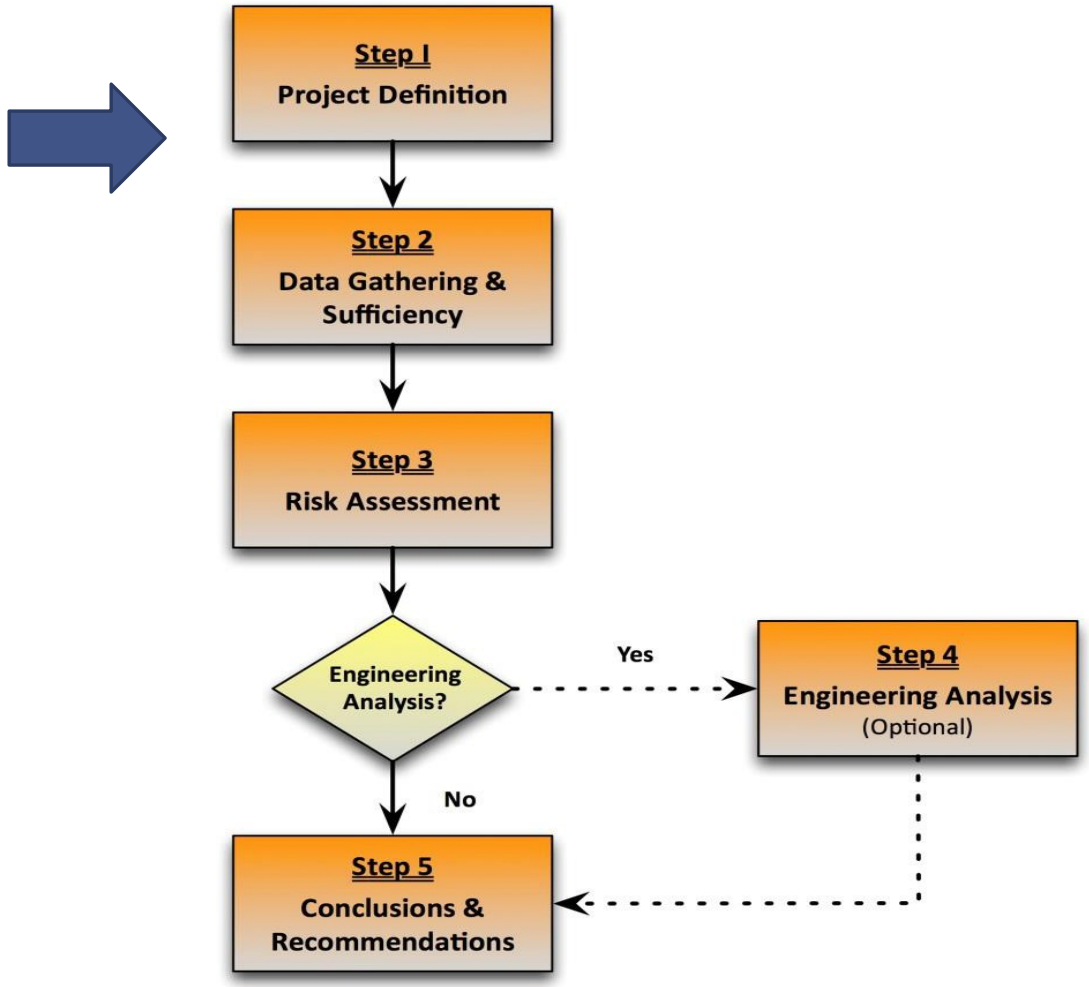


Source: Government of Alberta, https://www.albertaparks.ca/parks/northwest/dunvegan-pp/information-facilities/camping/dunvegan/

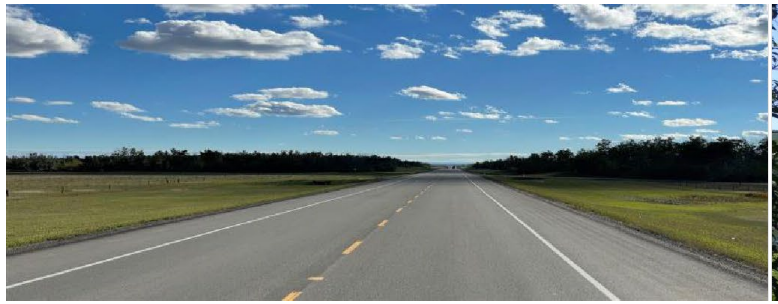
Defining the Scope of an Assessment

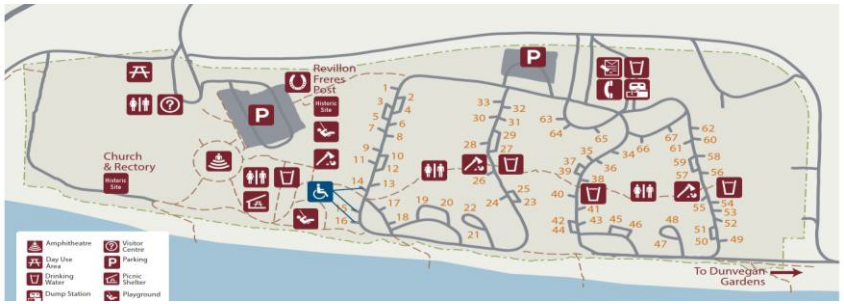
Defining the Scope of an Assessment

- Establish
  - Infrastructure
  - Climate
  - Time Horizon
  - Geographical Setting
  - Applicable Jurisdictions



Infrastructure





Highway	Bridge	Provincial Park
Road	**Bridge**	**Facilities**
• Pavement Structure	• Bridge Substructure / Foundation	• Park Buildings
• Embankments	• Bridge Superstructure	• Historic Buildings
Drainage	• Bridge Deck	• Roads and Paths
• Culverts	• Joints and Bearings	• Drainage
• Ditches	• Drainage	• Power and Communication
Highway Safety	**Bridge Safety**	• Maintenance
• Maintenance	• Lighting	• River Shoreline
• Guardrails	• Railings	• Public Use and Safety
• Signage	• Maintenance	
	Peace River	
	• River (elevation)	
	• Shoreline	

Climate

Risk identification

- Very much a brain-storming process
- Get relevant stakeholders involved – scientists, engineers, asset owners
- Use tools/matrices as prompts to help you e.g. PIEVC

	Fire	Drought	Wind	Flood	Tornado
Bridges & culverts				✓	
Buildings & structures	✓		✓	✓	✓
Rural communities	✓	✓		✓	
Roads				✓	
Buried utilities				✓	
Natural environments	✓	✓		✓	

- Begin to build information – where / when / who / extent / why / existing controls

Temperature	Mean values Extremes
Precipitation as Rain	Frequency and Intensity Annual/seasonal precipitation and rain Drought conditions
Precipitation as Snow	Annual/seasonal precipitation and snow Magnitude of snow events Rain on snow events
Hail	Frequency of events Magnitude of events
Ice Accretion	Ice storm events Ice buildup on infrastructure
Flooding	River / Lake Flooding Flooding (precipitation)
Fog	Frequency Visibility
Ice	River or lake ice
Frost	Freeze thaw cycles Change in frost season
Wind Speed	Extremes gusts / Thunderstorm winds Tornado event frequency/intensity
Fire	Wildfire / Smoke
Lightning	Lightning

Climate

Temperature	**Mean values** **Extremes**
Precipitation as Rain	**Frequency and Intensity** **Annual/seasonal precipitation and rain** **Drought conditions**
Precipitation as Snow	Annual/seasonal precipitation and snow **Magnitude of snow events** **Rain on snow events**
Hail	Frequency of events Magnitude of events
Ice Accretion	**Ice storm events** **Ice buildup on infrastructure**
Flooding	**River** / Lake Flooding **Flooding (precipitation)**
Fog	Frequency **Visibility**
Ice	**River** or lake ice
Frost	**Freeze thaw cycles** Change in frost season
Wind Speed	**Extremes gusts / Thunderstorm winds** **Tornado event frequency/intensity**
Fire	**Wildfire / Smoke**
Lightning	**Lightning**

Time Horizon

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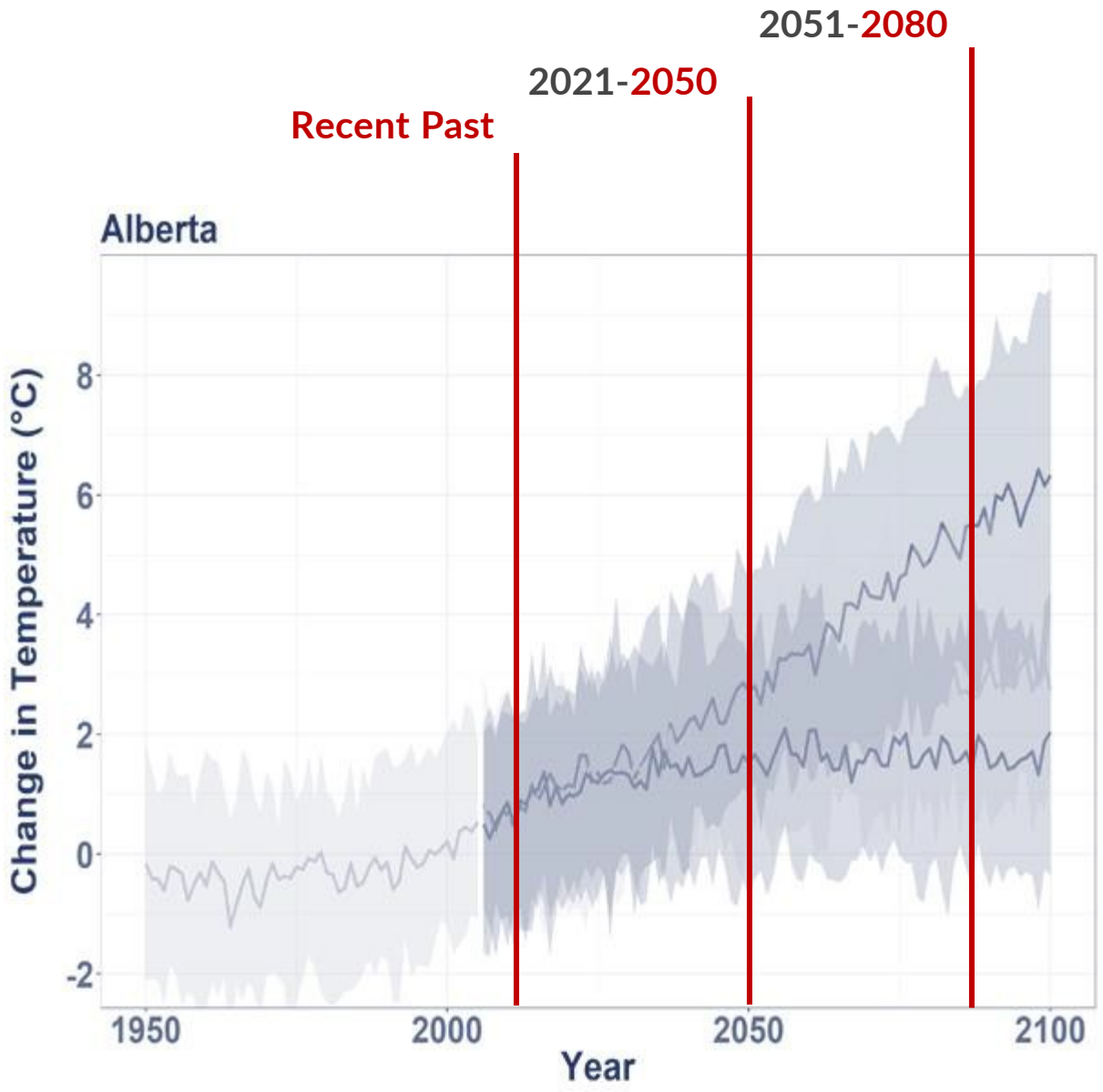
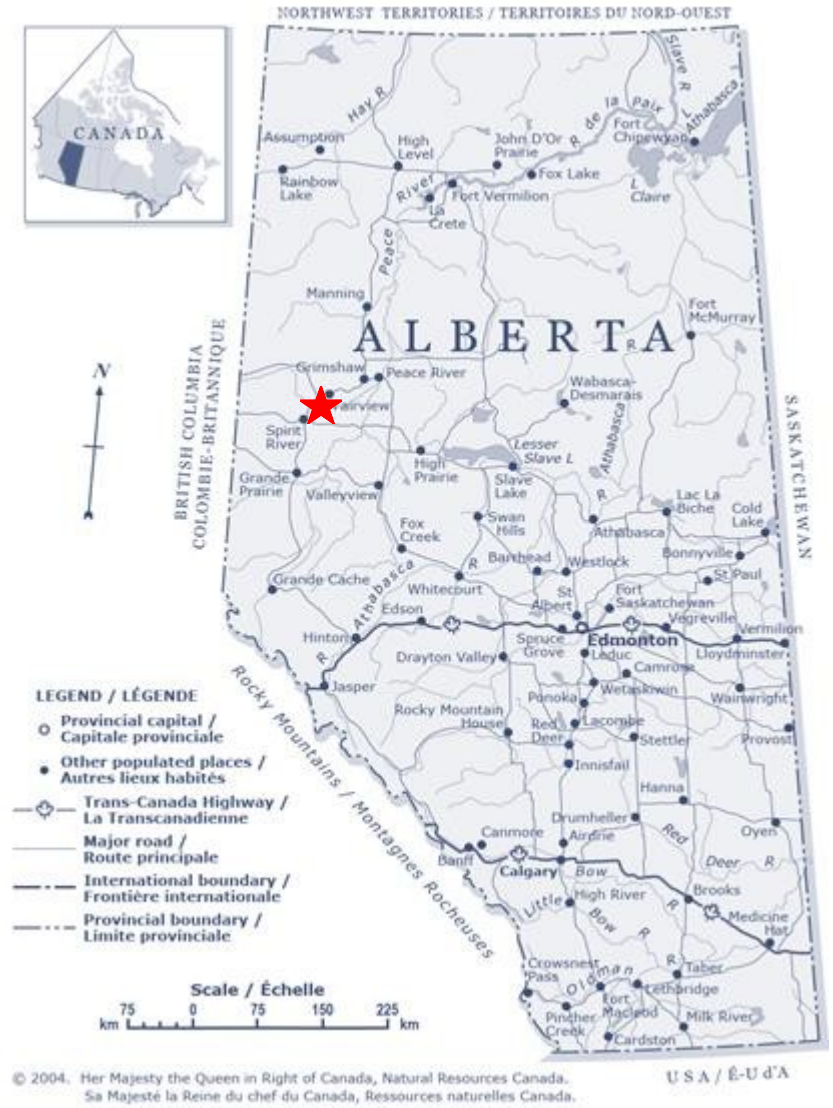


Geographical Setting and Jurisdictions

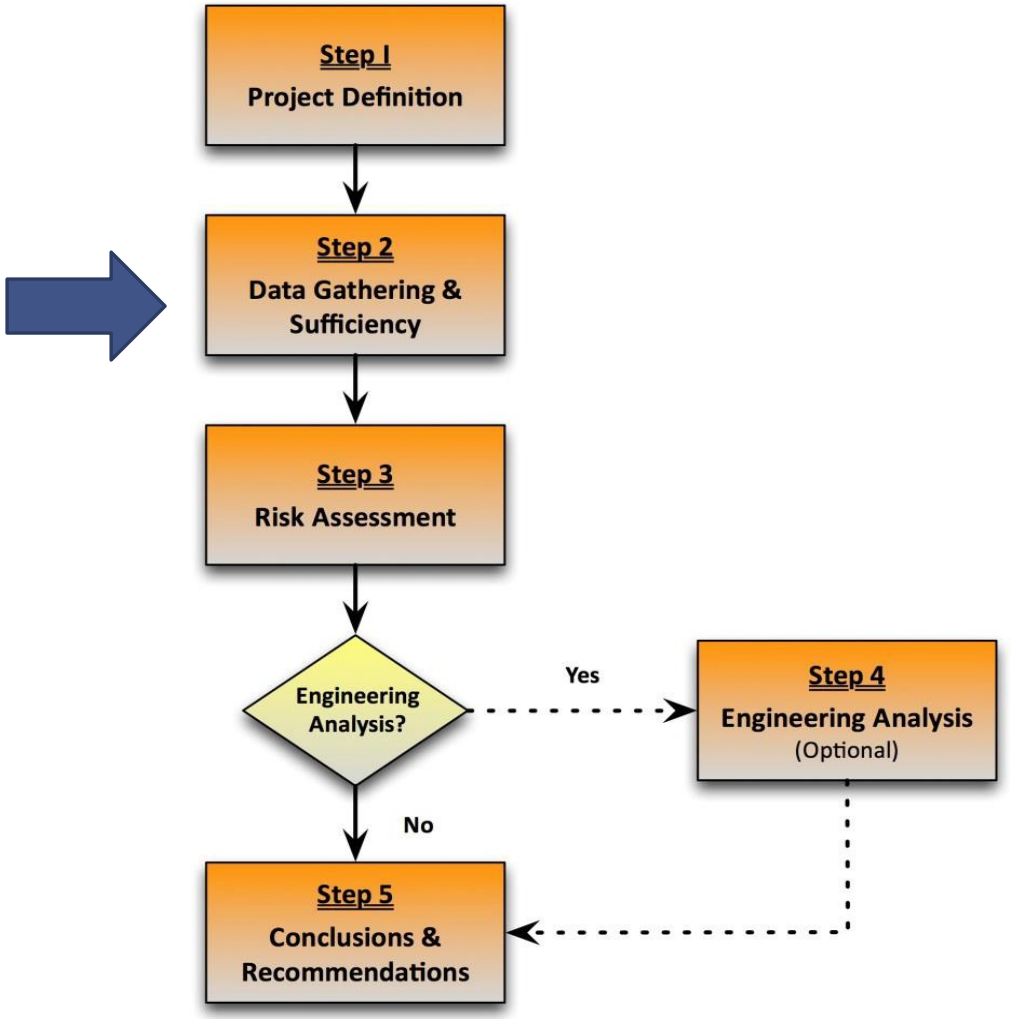


- Government of Alberta Infrastructure
  - Highway 2 Roadway
  - Dunvegan Bridge
  - Dunvegan Provincial Park

Defining Climate Data

Defining Climate Data

- Collect data on:
  - Baseline Climate (Recent Past
  - Climate Change (2050, 2080)
  - Time Horizon
- Establish level of precision
  - Level of assessment ⇒ Level of detail



Defining Climate Data

- Climate Resources
  - Climate West (climatewest.ca)
    - ClimateData.ca
    - Climate Atlas of Canada (climateatlas.ca)
    - PARC Data Applications (www.parc.ca)
  - Flood Mapping, Flood Studies, Modeling
  - Refined data sets and technical documents prepared by municipalities that can be leveraged by nearby communities.

Defining Climate Data

- Climate Atlas of Canada

Spirit River

Climate Atlas Report

Municipality: Spirit River

RCP 8.5: High Carbon climate future

GHG emissions continue to increase at current rates

Variable	Period	1976-2005 Mean	2021-2050 Low	2021-2050 Mean	2021-2050 High	2051-2080 Low	2051-2080 Mean	2051-2080 High
Precipitation (mm)	annual	444	354	470	601	363	498	638
Precipitation (mm)	spring	79	45	86	135	50	96	154
Precipitation (mm)	summer	190	105	196	299	109	201	304
Precipitation (mm)	fall	92	57	100	150	61	106	166
Precipitation (mm)	winter	83	53	90	133	59	96	140
Mean Temperature (°C)	annual	1.9	2.2	3.9	5.6	3.9	6	8.1
Mean Temperature (°C)	spring	2.5	1.6	4.6	7.7	3	6.3	9.9
Mean Temperature (°C)	summer	15	15.4	17	18.6	17	19.1	21.2
Mean Temperature (°C)	fall	2.7	1.9	4.5	6.7	4.1	6.6	9
Mean Temperature (°C)	winter	-13	-15.3	-10.6	-6.1	-12.8	-8.2	-3.8
Tropical Nights	annual	0	0	0	0	0	1	3
Very hot days (+30°C)	annual	2	0	7	17	3	18	38
Very cold days (-30°C)	annual	15	1	8	19	0	4	12
Date of Last Spring Frost	annual	May 12	April 12	May 3	May 18	March 31	April 24	May 12
Date of First Fall Frost	annual	Sep. 16	Sep. 8	Sep. 27	Oct. 16	Sep. 15	Oct. 5	Oct. 25
Frost-Free Season (days)	annual	123	119	143	171	132	161	195

RCP 4.5: Low Carbon climate future

GHG emissions much reduced

Variable	Period	1976-2005 Mean	2021-2050 Low	2021-2050 Mean	2021-2050 High	2051-2080 Low	2051-2080 Mean	2051-2080 High
Precipitation (mm)	annual	444	356	473	605	359	483	608
Precipitation (mm)	spring	79	45	87	139	50	91	141
Precipitation (mm)	summer	190	111	197	293	109	196	292
Precipitation (mm)	fall	92	56	100	153	61	104	156
Precipitation (mm)	winter	84	53	90	130	57	93	135
Mean Temperature (°C)	annual	1.9	1.9	3.7	5.5	2.9	4.8	6.6
Mean Temperature (°C)	spring	2.5	1.2	4.3	7.4	2.4	5.4	8.4
Mean Temperature (°C)	summer	15	15.1	16.7	18.3	15.8	17.6	19.5
Mean Temperature (°C)	fall	2.7	1.8	4.3	6.5	2.6	5.2	7.5
Mean Temperature (°C)	winter	-13	-15.4	-10.9	-6.6	-13.7	-9.4	-5.2
Tropical Nights	annual	0	0	0	0	0	0	1
Very hot days (+30°C)	annual	2	0	6	15	0	10	23
Very cold days (-30°C)	annual	15	1	10	21	0	6	16
Date of Last Spring Frost	annual	May 12	April 15	May 5	May 20	April 7	April 30	May 16
Date of First Fall Frost	annual	Sep. 16	Sep. 8	Sep. 26	Oct. 17	Sep. 9	Sep. 29	Oct. 18
Frost-Free Season (days)	annual	123	114	140	170	119	148	180

Establish Climate Parameters

Variable	Period	1976-2005	2021-2050			2051-2080		
		Mean	Low	Mean	High	Low	Mean	High
Precipitation (mm)	annual	444	354	470	601	363	498	638
Precipitation (mm)	spring	79	45	86	135	50	96	154
Precipitation (mm)	summer	190	105	196	299	109	201	304
Precipitation (mm)	fall	92	57	100	150	61	106	166
Precipitation (mm)	winter	83	53	90	133	59	96	140
Mean Temperature (°C)	annual	1.9	2.2	3.9	5.6	3.9	6	8.1
Mean Temperature (°C)	spring	2.5	1.6	4.6	7.7	3	6.3	9.9

RCP 8.5

Establish Climate Parameters

Variable	Period	1976-2005 Mean	2021-2050 Low	2021-2050 Mean	2021-2050 High	2051-2080 Low	2051-2080 Mean	2051-2080 High
Precipitation (mm)	annual	444	354	470	601	363	498	638
Precipitation (mm)	spring	79	45	86	135	50	96	154
Precipitation (mm)	summer	190	105	196	299	109	201	304
Precipitation (mm)	fall	92	57	100	150	61	106	166
Precipitation (mm)	winter	83	53	90	133	59	96	140
Mean Temperature (°C)	annual	1.9	2.2	3.9	5.6	3.9	6	8.1
Mean Temperature (°C)	spring	2.5	1.6	4.6	7.7	3	6.3	9.9

	Annual	Mean Temperature (deg C)
Present	1.9	3
2050	3.9	4
2080	6	5

Score	Likelihood		
	Method A	Method B	Method C
0	Negligible Not Applicable	< 1 in 1,000	
1	Highly Unlikely Improbable	1 in 100	Likely to occur less frequently than current climate
2	Remotely Possible	1 in 20	
3	Possible Occasional	1 in 10	Likely to occur as frequently as current climate
4	Somewhat Likely Normal	1 in 5	
5	Likely Frequent	> 1 in 2.5	Likely to occur more frequently than current climate

Establish Climate Parameters

	Precipitation					
	Annual	Intensity	Intensity	Drought Conditions	Winter Precipitation	Ice Storms

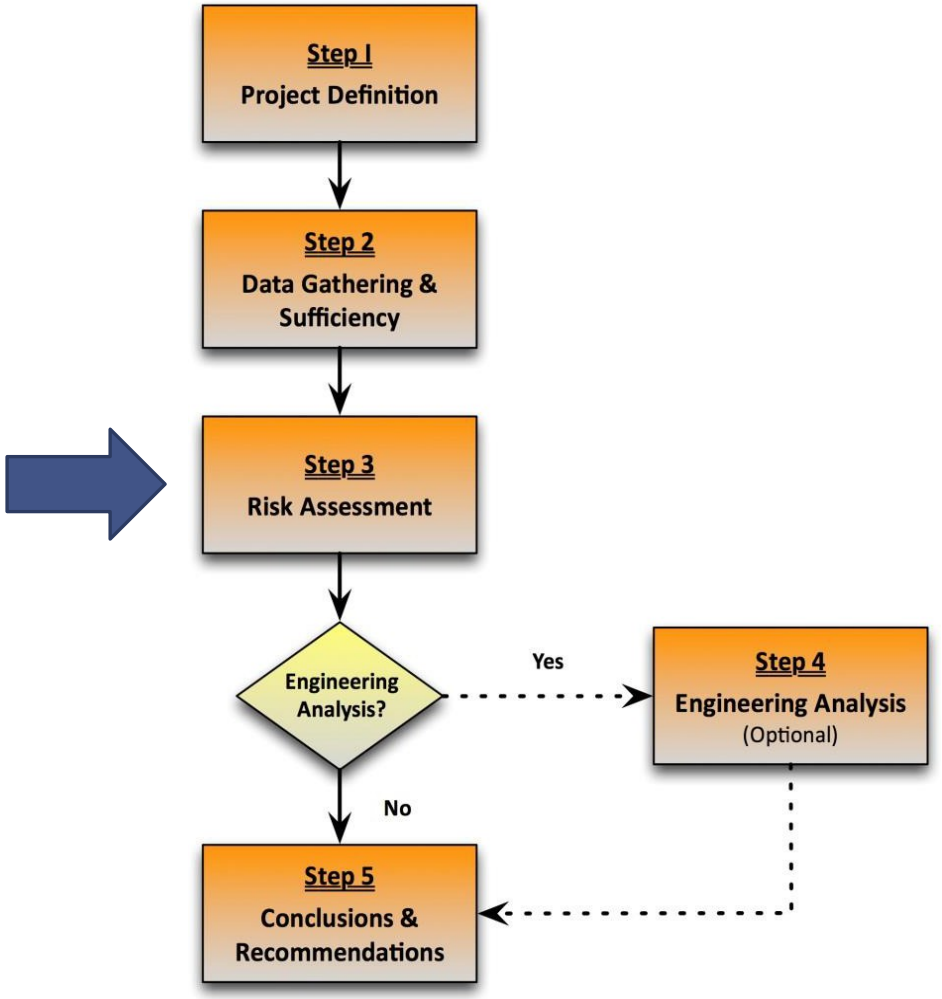
	Precipitation					
	Annual	Intensity	Intensity	Drought Conditions	Winter Precipitation	Ice Storms

	Temperature											
	Annual		Summer		Winter		Extreme		Extreme		Freeze Thaw	
	Mean Temperature (deg C)		**Mean Temperature (deg C)**		**Mean Temperature (deg C)**		**Very Hot Days (+30 deg C)**		**Very Cold Days (-30 deg C)**		**Freeze Thaw Cycles**	
Present	1.9	3	15	3	-13	3	2	3	15	3	86.5	3
2050	3.9	4	17	4	-10.6	2	7	4	8	2	75.3	2
2080	6	5	19.1	5	-8.2	2	18	5	4	1	67.2	2

Assessing Risk

Assessing Risk

- Important considerations:
  - Risk tolerance
  - Are climate interactions possible?
  - Cumulative or combination events
  - Likelihood scoring
  - Consequence scoring
  - Judgments on uncertainties



Risk Assessment

- Risk (R) is defined as the product of the Likelihood (L) of an event and the consequence (C) of that event – should it occur.

$$R = L \times C$$

5	CONSEQUENCE	Catastrophic	0	5	10	15	20	25
4		Major	0	4	8	12	16	20
3		Moderate	0	3	6	9	12	15
2		Minor	0	2	4	6	8	10
1		Insignificant	0	1	2	3	4	5
0		No Effect	0	0	0	0	0	0
			Negligible Not Applicable	Highly Unlikely Improbable	Remotely Possible	Possible Occasional	Somewhat Likely Normal	Likely Frequent
			LIKELIHOOD					
			0	1	2	3	4	5

Risk Assessment Worksheet

Climate Parameters

Infrastructure Components

Consequence Score
- 0 - No Effect
- 1 - Insignificant
- 2 - Minor
- 3 - Moderate
- 4 - Major
- 5 - Catastrophic

Climate Parameter

Temperature

		Annual				Summer				Winter				Extreme				Extreme				Freeze Thaw			
		Mean Temperature (deg C)				Mean Temperature (deg C)				Mean Temperature (deg C)				Very Hot Days (+30 deg C)				Very Cold Days (-30 deg C)				Freeze Thaw Cycles			
Climate Projections (Climate Atlas - RCP 8.5)	Presen	1.9	3			15	3			-13	3			2	3			15	3			86.5	3		
	2050	3.9	4			17	4			-10.6	2			7	4			8	2			75.3	2		
	2080	6	5			19.1	5			-8.2	2			18	5			4	1			67.2	2		
Infrastructure Components		Y/N	L	C	R	Y/N	L	C	R	Y/N	L	C	R	Y/N	L	C	R	Y/N	L	C	R	Y/N	L	C	R
Highway																									
Road																									
1 Pavement Structure	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		4		0		2		0		4		0		2		0		2		0
	2080		5		0		5		0		2		0		5		0		1		0		2		0
2 Embankments	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		4		0		2		0		4		0		2		0		2		0
	2080		5		0		5		0		2		0		5		0		1		0		2		0
Drainage																									
3 Culverts	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		4		0		2		0		4		0		2		0		2		0
	2080		5		0		5		0		2		0		5		0		1		0		2		0
4 Ditches	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		4		0		2		0		4		0		2		0		2		0
	2080		5		0		5		0		2		0		5		0		1		0		2		0
Highway Safety																									
5 Maintenance	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		4		0		2		0		4		0		2		0		2		0
	2080		5		0		5		0		2		0		5		0		1		0		2		0
6 Guardrails	Present		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		4		0		2		0		4		0		2		0		2		0
	2080		5		0		5		0		2		0		5		0		1		0		2		0
7 Signage	Present		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		4		0		2		0		4		0		2		0		2		0
	2080		5		0		5		0		2		0		5		0		1		0		2		0
Bridge																									

Precipitation

		Annual				Intensity				Intensity				Drought Conditions				Winter Precipitation				Ice Storms			
		Annual Precipitation (mm)				Five Day Max Precipitation (mm)				Heavy Precipitation Days (20 mm)				Dry Days				Snow (mm)				Ice Storms			
Climate Projections (Climate Atlas - RCP 8.5)	Presen	444	3			51	3			1.8	3			238.9	3			83	3				3		
	2050	470	4			54	3			2.1	4			238.2	3			90	4			+	4		
	2080	498	5			57	3			2.3	4			238.1	3			96	4			+	5		
Infrastructure Components		Y/N	L	C	R	Y/N	L	C	R	Y/N	L	C	R	Y/N	L	C	R	Y/N	L	C	R	Y/N	L	C	R
Highway																									
Road																									
1 Pavement Structure	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		3		0		4		0		3		0		4		0		4		0
	2080		5		0		3		0		4		0		3		0		4		0		5		0
2 Embankments	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		3		0		4		0		3		0		4		0		4		0
	2080		5		0		3		0		4		0		3		0		4		0		5		0
Drainage																									
3 Culverts	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		3		0		4		0		3		0		4		0		4		0
	2080		5		0		3		0		4		0		3		0		4		0		5		0
4 Ditches	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		3		0		4		0		3		0		4		0		4		0
	2080		5		0		3		0		4		0		3		0		4		0		5		0
Highway Safety																									
5 Maintenance	Prese		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		3		0		4		0		3		0		4		0		4		0
	2080		5		0		3		0		4		0		3		0		4		0		5		0
6 Guardrails	Present		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		3		0		4		0		3		0		4		0		4		0
	2080		5		0		3		0		4		0		3		0		4		0		5		0
7 Signage	Present		3		0		3		0		3		0		3		0		3		0		3		0
	2050		4		0		3		0		4		0		3		0		4		0		4		0
	2080		5		0		3		0		4		0		3		0		4		0		5		0
Bridge																									

Extreme Event

		Extreme Winds				Lightning				Flo	
		Tornado				Lightning				Flood Ri / Ice	
Climate Projections (Climate Atlas - RCP 8.5)	Presen		3				3				3
	2050	+	4			+	4			+	4
	2080	+	5			+	5			+	5
Infrastructure Components		Y/N	L	C	R	Y/N	L	C	R	Y/N	L
Highway											
Road											
1 Pavement Structure	Prese		3		0		3		0		3
	2050		4		0		4		0		4
	2080		5		0		5		0		5
2 Embankments	Prese		3		0		3		0		3
	2050		4		0		4		0		4
	2080		5		0		5		0		5
Drainage											
3 Culverts	Prese		3		0		3		0		3
	2050		4		0		4		0		4
	2080		5		0		5		0		5
4 Ditches	Prese		3		0		3		0		3
	2050		4		0		4		0		4
	2080		5		0		5		0		5
Highway Safety											
5 Maintenance	Prese		3		0		3		0		3
	2050		4		0		4		0		4
	2080		5		0		5		0		5
6 Guardrails	Present		3		0		3		0		3
	2050		4		0		4		0		4
	2080		5		0		5		0		5
7 Signage	Present		3		0		3		0		3
	2050		4		0		4		0		4
	2080		5		0		5		0		5
Bridge											

Group Exercise (25 mins)

Group Exercise

- Working as a Group
  - Review infrastructure components and climate data
  - Evaluate if each infrastructure component will interact with/exposed to a given climate parameter (Y / N)
  - Evaluate the consequence of the climate interaction. Assign a Consequence Score (C)
  - Review risk assessment results and discuss how the risks could be addressed

Risk Assessment

1. Evaluate if a given infrastructure component will interact with a given climate parameter (Yes / No)

2. Evaluate the consequence of the climate interaction. Assign a Consequence Score (C)

Score	Consequence
	Method D
0	No Effect
1	Insignificant
2	Minor
3	Moderate
4	Major
5	Catastrophic

3. Review Likelihood (L) value provided.

4. Review Risk Scores (R) for each item

   Risk (R) = Likelihood x Consequence

Risk = Likelihood x Consequence
Low Risk
Medium Risk
High Risk

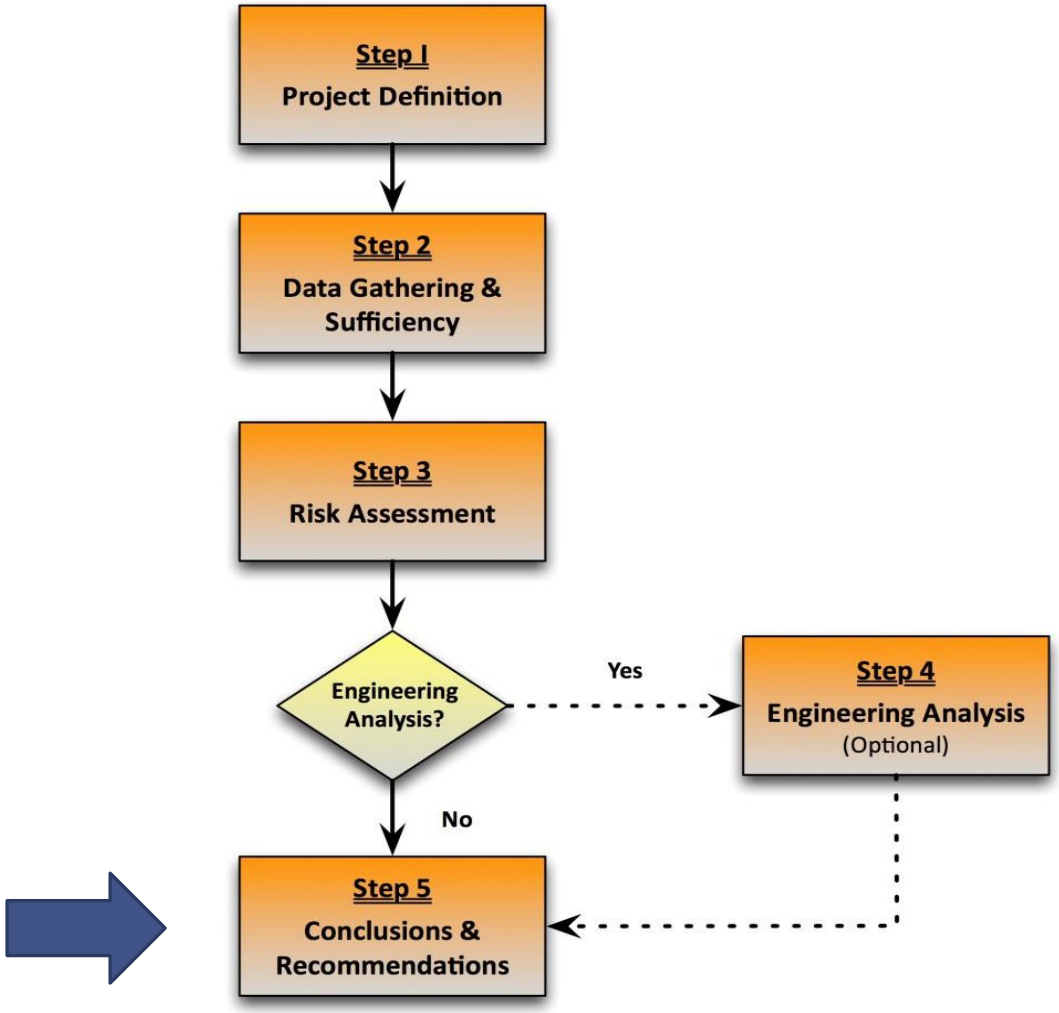
Reporting from Exercise 1 (5 mins)

Break (5 mins)

Risk Evaluation and Treatment

Risk Evaluation and Treatment

- Evaluate Risk:
  - Summaries / Prioritize Risks (Low/ Medium High)
  - Review rational for consequent scoping
  - Begin to develop treatment options



Risk Evaluation and Treatment

Evaluate Risk:

- Risk Mitigation / adaptation actions
    - No further action
    - Remedial action
    - Management action
    - Additional Study

5	CONSEQUENCE	Catastrophic	0	5	10	15	20	25
4		Major	0	4	8	12	16	20
3		Moderate	0	3	6	9	12	15
2		Minor	0	2	4	6	8	10
1		Insignificant	0	1	2	3	4	5
0		No Effect	0	0	0	0	0	0
			Negligible Applicable Not	Highly Unlikely Improbable	Remotely Possible	Possible Occasional	Somewhat Likely Normal	Likely Frequent
			LIKELIHOOD					
			0	1	2	3	4	5

Avoid
Protect
Accommodate
Retreat

Risk Evaluation and Treatment

Risk Treatment:

- Further risk assessment on high and medium risk
- Inform concept or planning phases of infrastructure on areas to adapt
- Use the climate data and risks to inform design
- Inform operation and maintenance activities
- Inform infrastructure upgrades on areas to adapt
- Inform adaptation plans

Framework (clause 5)

Risk Evaluation and Treatment

Communication

- Reporting / Presentations / Workshops / Stakeholder Engagement
- Decision Making (Context)
    - Financial case study
    - Cost benefit analysis
    - Triple Bottom Line analysis
- Opportunities to integrate sustainable infrastructure

Framework (clause 5)

Group Exercise (15 mins)

Group Exercise

Working as a Group

- Comment on risk actions
  - No further action
  - Remedial action
  - Management action
  - Additional Study
- Comment on how to communicate or report

Avoid
Protect
Accommodate
Retreat

	Risk Action Remedial Acrtion Management Action No Further Action Further Study or Work Requires	Comments	Communication
Highway			
Road			
Pavement Structure			
Embankments			
Drainage			
Culverts			
Ditches			
Highway Safety			
Maintenance			
Guardrails			
Signage			
Bridge			
Bridge			
Bridge Substructure/ Foundation			
Bridge Superstructure			

Reporting from Exercise 2 (5 mins)

Polling and Q&A Session (15 mins)

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