



Rising Waters: Managing Flood Claims and Municipal Risk

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April 8, 2026



Associated
Engineering



Platinum
member



MIABC 2026

100-year Flood? Again? It's Complicated

John van der Eerden, M.Eng, P.Eng.
Vice President – Water Resources

April 8, 2026

Introduction

- Potential impacts of Climate Change on flow rates
 - Before I talk about Climate Change I want to talk about:
 - Two misconceptions about Peak Flows and Floods
 - Non-Stationarity
 - Then we can talk about the Impacts of Climate Change

Misconceptions of the ‘Design Flood’

I am in the 200-year R.P. Floodplain, so I should be ok for the next 195 years!



Misconception #1

“We just had the 100-year flood – How can we have it again?”

What is likelihood that the design flood event will happen at least once over a 30-year period?

- 100-Year Flood = 26% (1% Annual Exceedance Probability (AEP))
- 200-Year Flood = 14% (0.5% Annual Exceedance Probability (AEP))

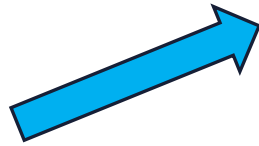
Take Away: The 100-year flood has a 1% chance of happening each and every year, on every river.



Misconception #2: Basin Response Mis-Matches = Good



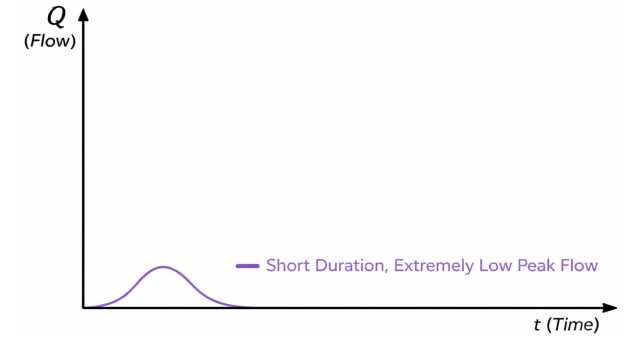
Convective Storm



Freshet – Large Rivers



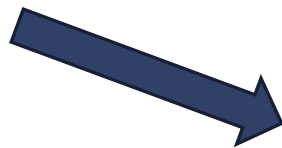
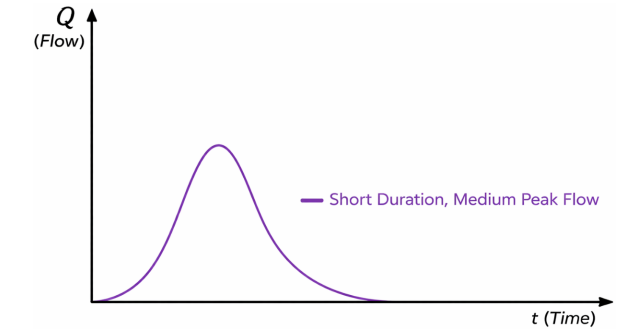
Mis-match



Regional – Intermediate Rivers



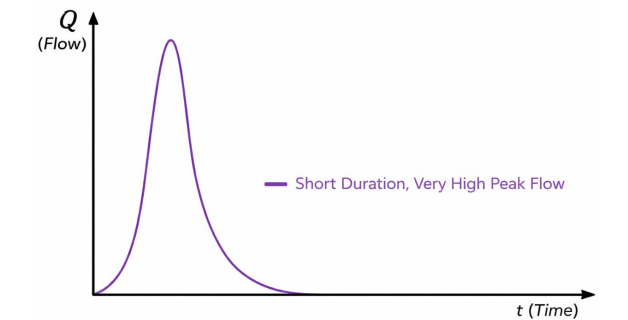
Mis-match



Local



Match



Misconception #2: Basin Response Matches – Uh oh!



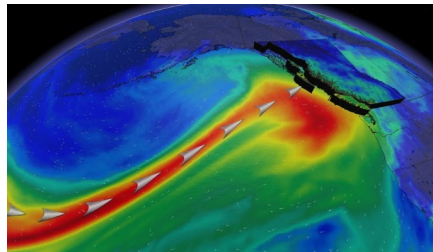
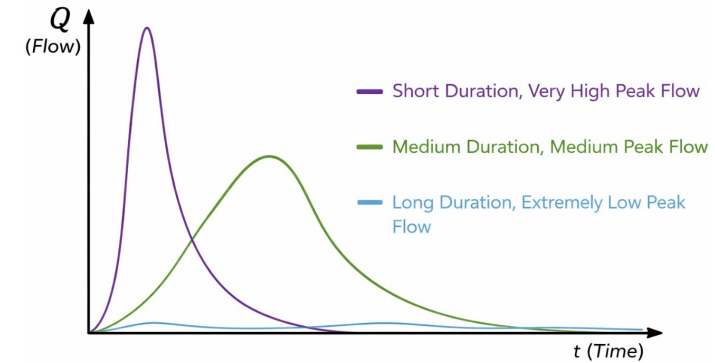
Convective Storm



Local (Urban Drainage)



Match



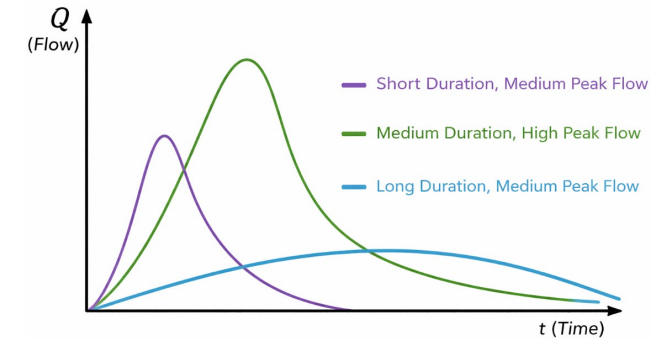
Atmospheric River



Regional (Creeks and Intermediate Size Rivers)



Match



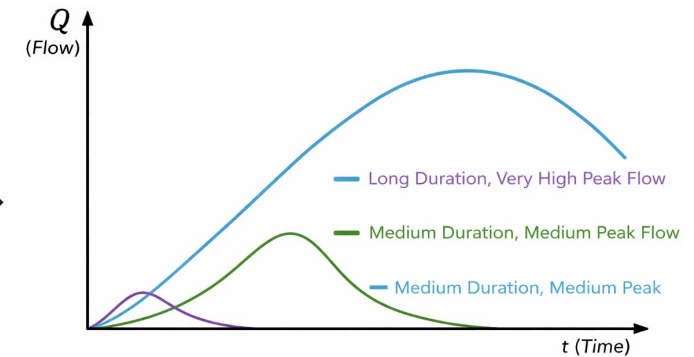
Freshet



Freshet (Larger Rivers)



Match



Multiple Flood Hazards



River Flood = 0.5% AEP
14% chance over 30-years

Urban Drainage = 10% AEP
96% chance over 30-years

Watercourse = 0.5% AEP?

Combined Events = ?

Frequency of Flood = ?

Take away: Compounding flood mechanisms can result in higher likelihood of total flood risk.

Non-Stationarity

Term often used in the context of a changing climate...

..but “Non-Stationarity” can also refer to a broad range of potential changes including:

- Forest fires
- Flow diversions
- Development
- Land Use changes
- Infestations
- Dams and Reservoirs
- Forestry
- ..and of course, Climate Change

Take away: Impacts of Climate Change are one component of many potential changes and cannot be looked at in isolation



Why consider climate change in our projects?

- Experiencing increased climate extremes
- Events can combine in different ways
- Expected long service life of infrastructure



..and Engineers and GeoScientists are required to consider climate change in flood hazard assessments.

Climate Change “Un”Certainty in Peak Flow Estimates

Uncertainty in the magnitude of future peak flow events is caused by three main sources:

1. Model Uncertainty
2. Emissions Uncertainty
3. Climate Variability

Each one of these uncertainties is addressed in its own way.



Single Result (i.e. One Climate Model)



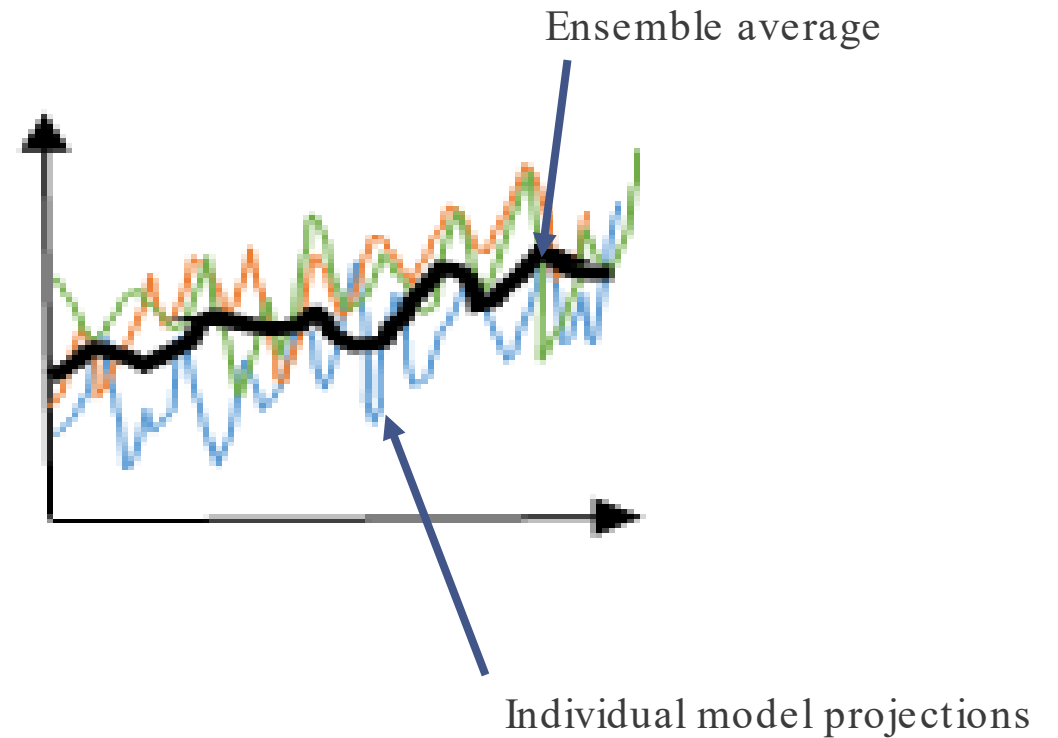
Ensemble Result (i.e. Many Climate Models)



1. Model Uncertainty

- Some models are hot..or wet..or ????

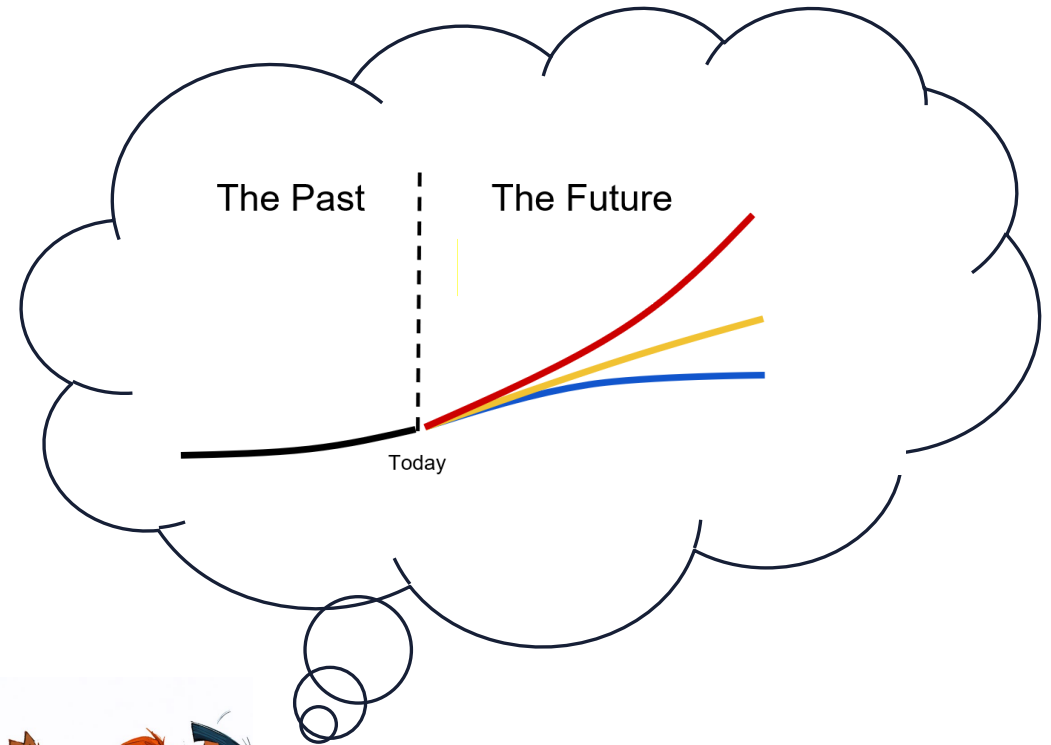
I can agree that the best answer is in this range of results



- **Solution:** Model Ensemble to understand trends and select appropriate values

2. Emissions Uncertainty

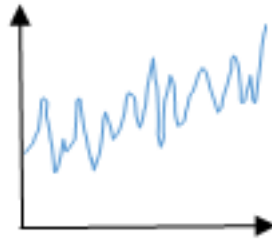
- The Paris Agreement?
- Carbon emission caps?
- EV incentives?
- Drill baby drill?
- ...???? I don't know



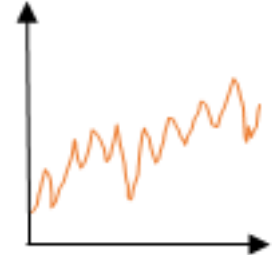
- **Solution:** Include a range of possible future emission scenarios in the ensemble

Multi-Model Ensembles

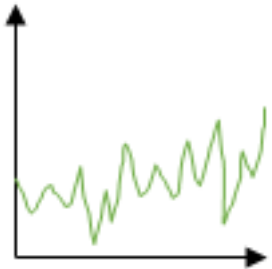
Future
Projection 1



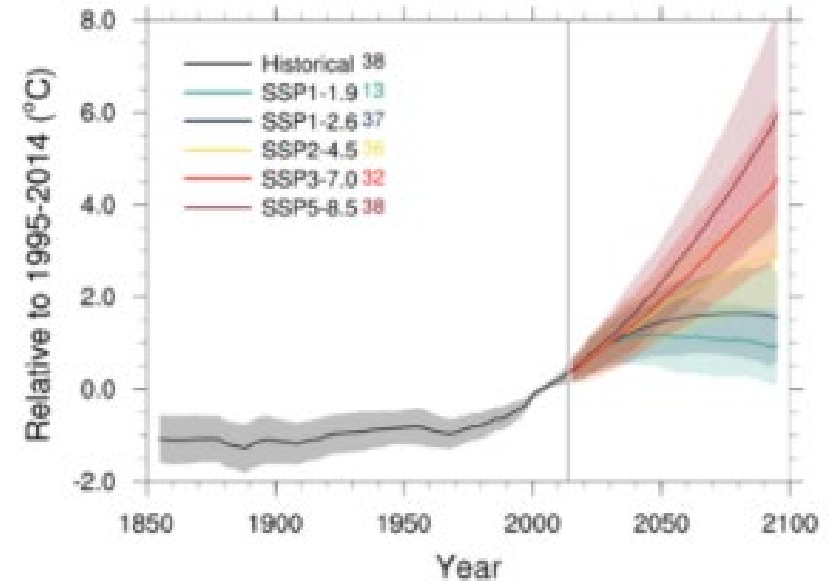
Future
Projection 2



Future
Projection nth



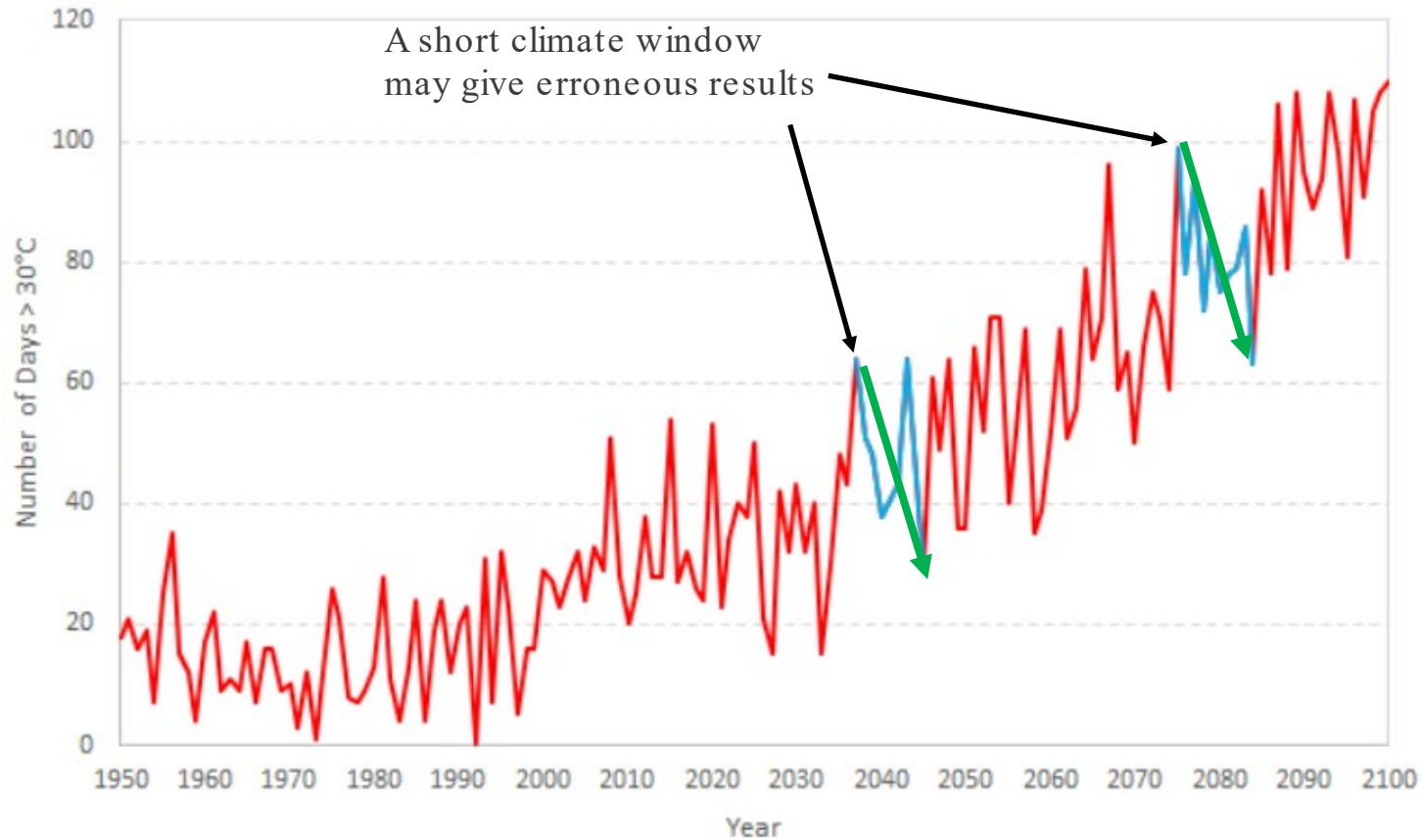
Surface Air Temperature (land only)



“I wish I could give you a more precise answer, but I can agree that the best answer is in this plot of projections.”

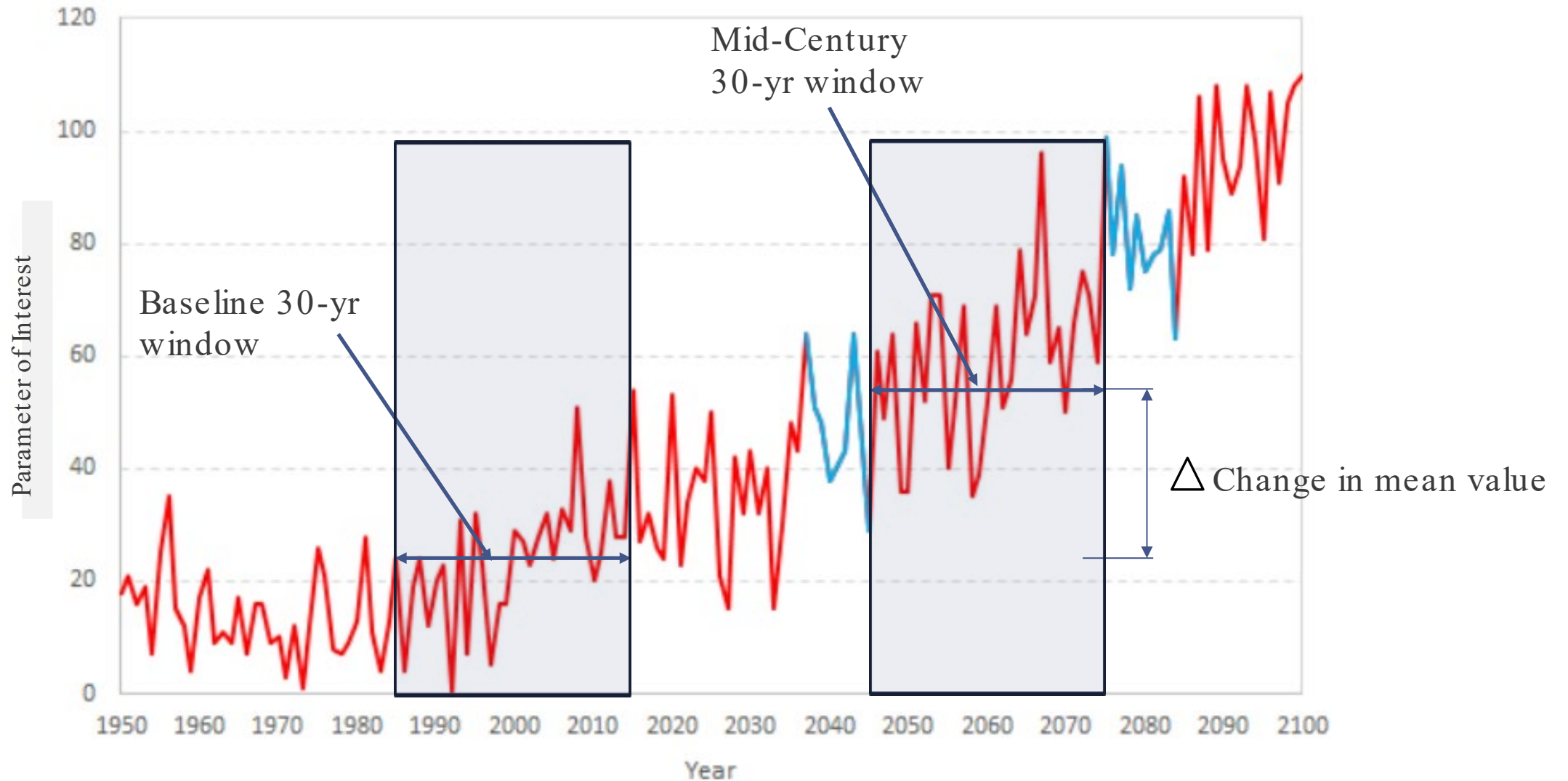
Credit: climatedata.ca

3. Climate Variability



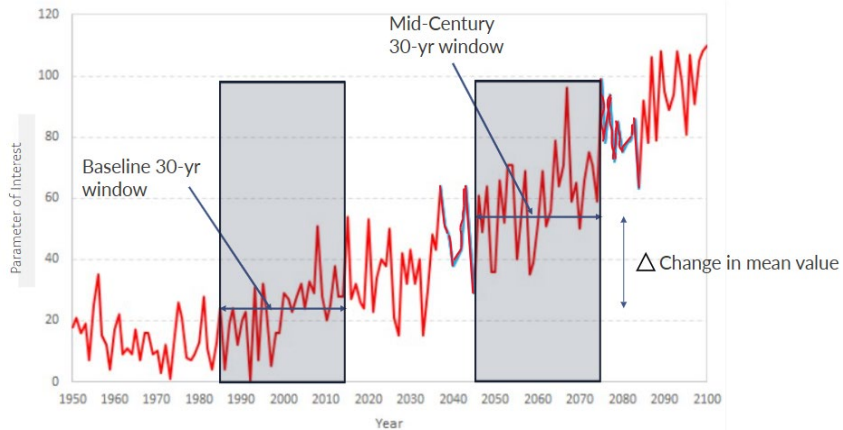
Solution: Consider changes over a long enough window that short-term climate variability does not significantly skew results

3. Climate Variability

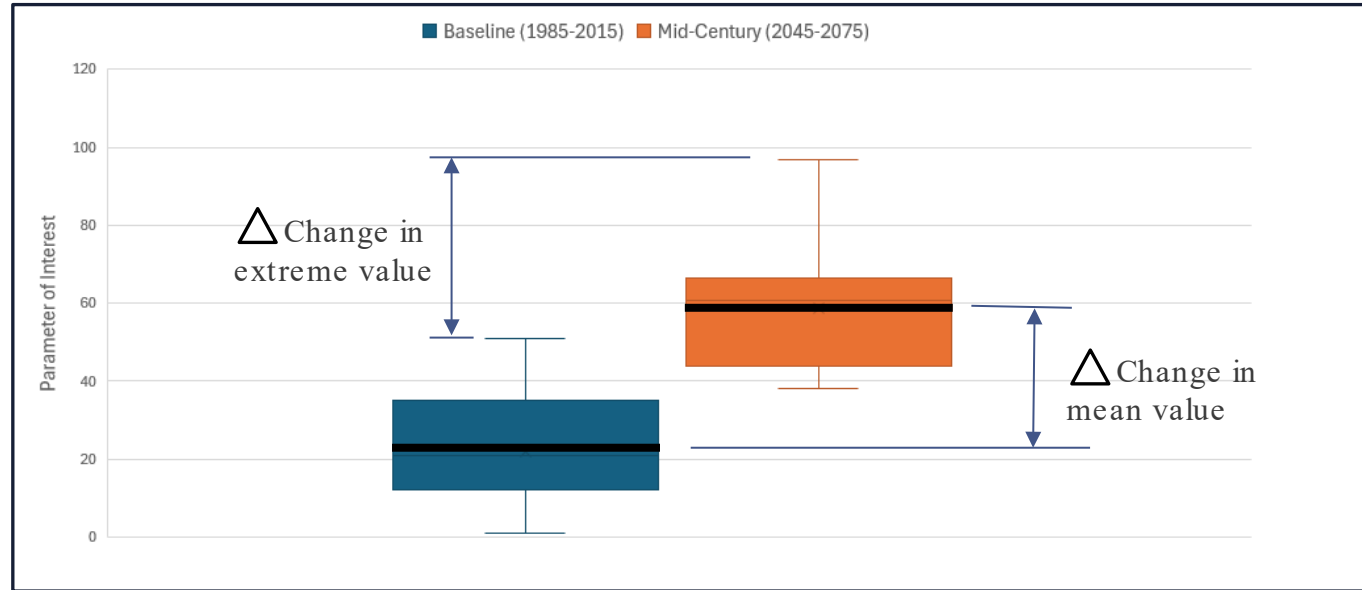


Impacts of Climate Change

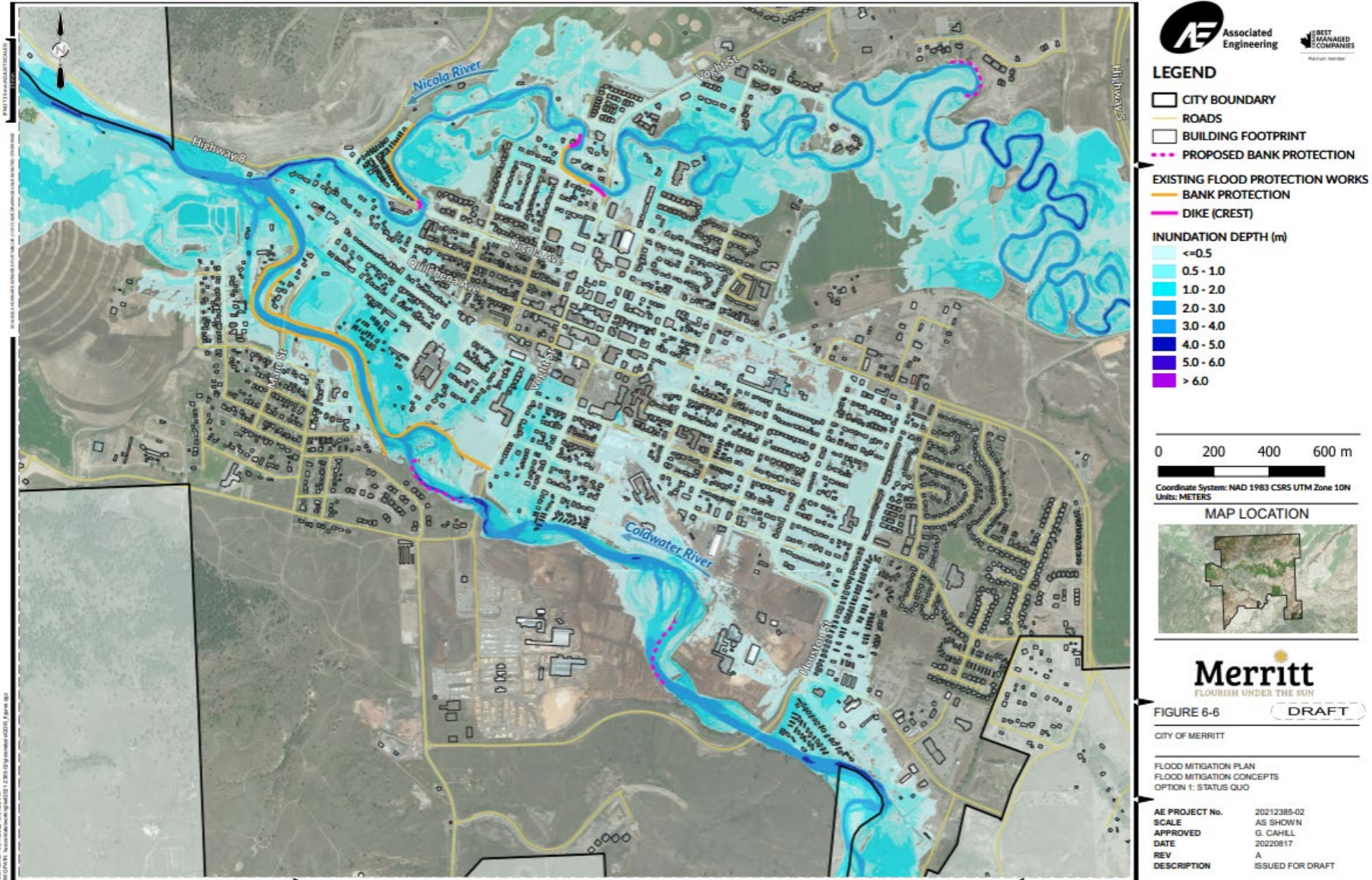
Model results from gridded data



Estimated Change of Parameter, x



Inundation Map

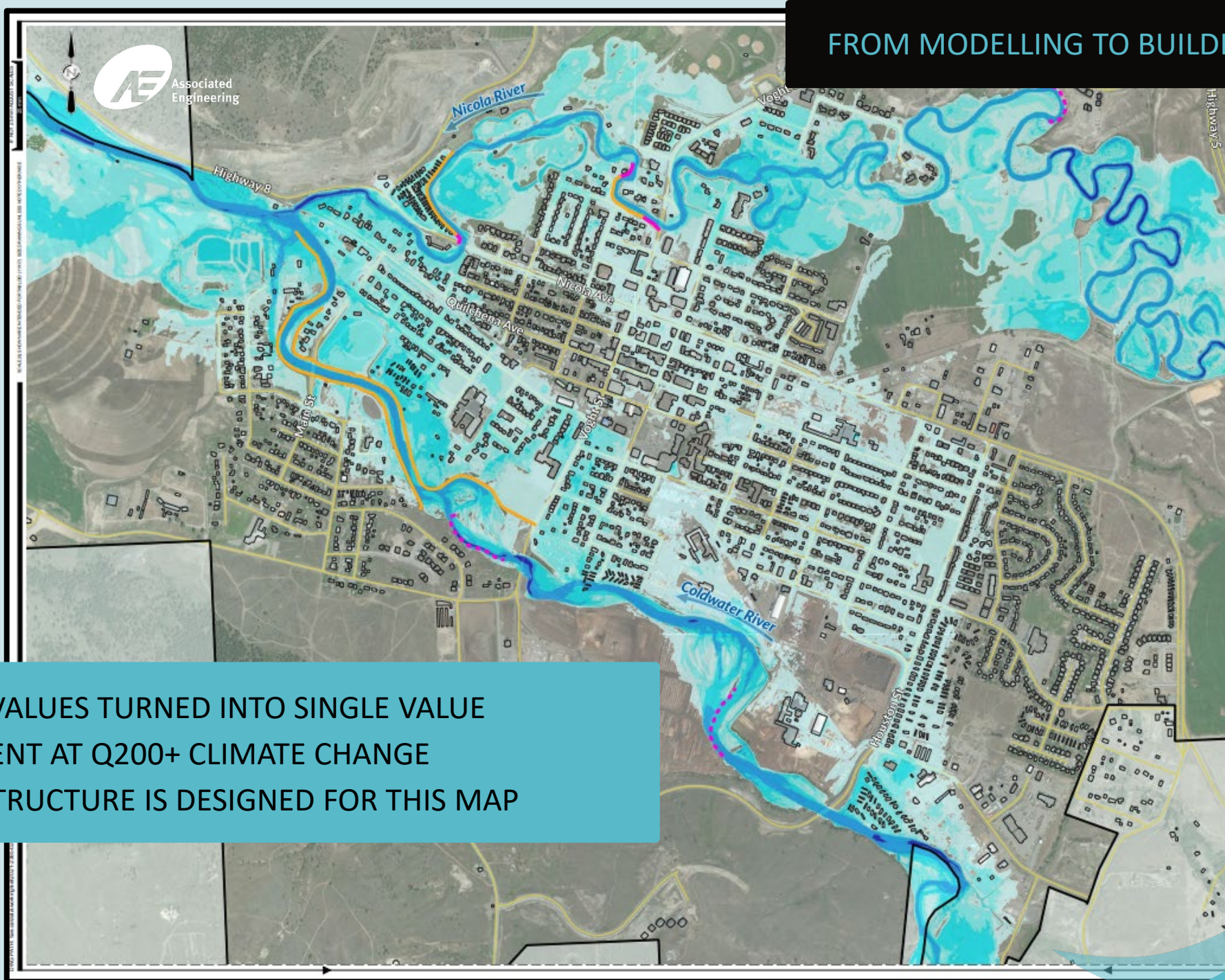




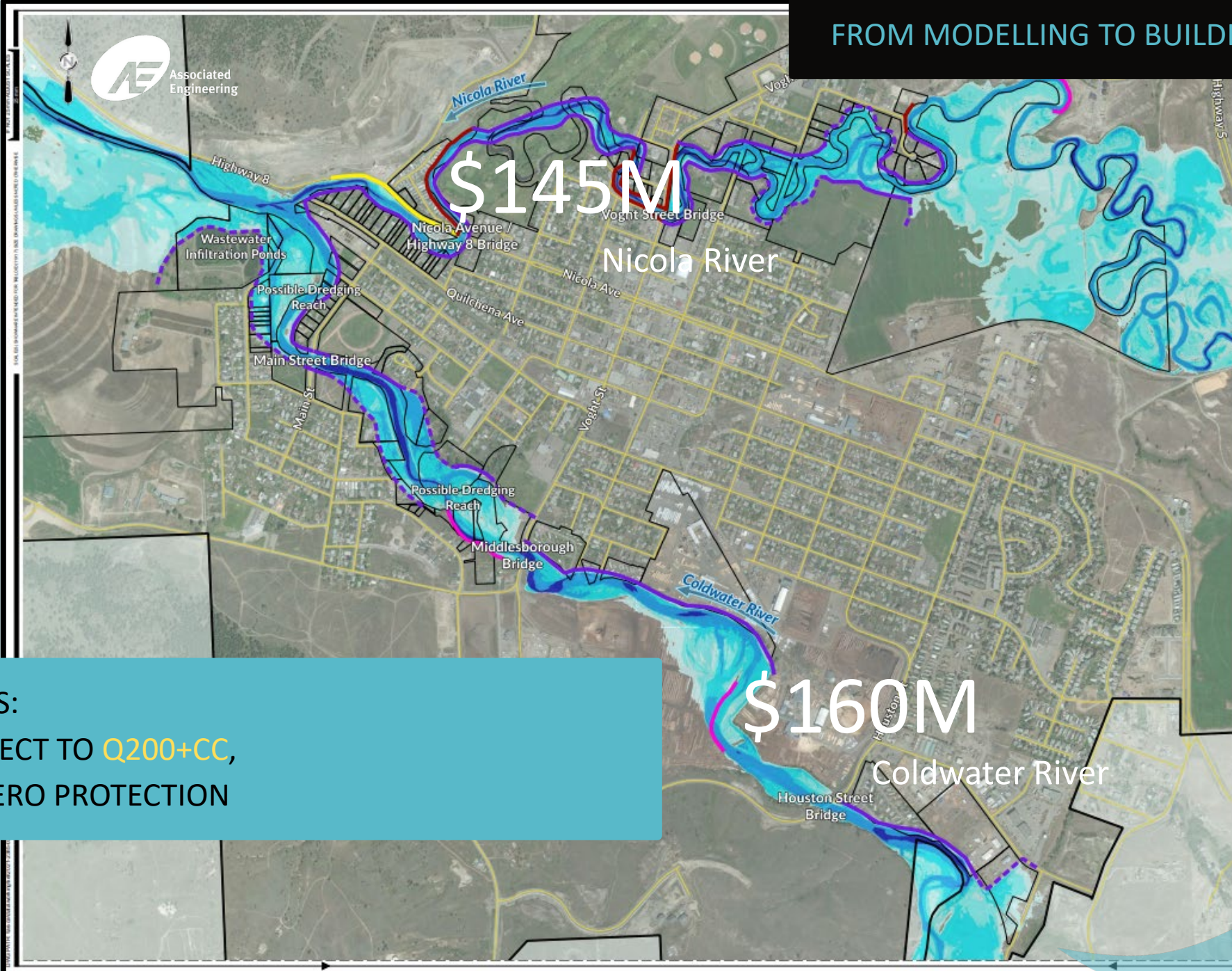
RESPONSE
RECOVERY
MITIGATION

**SEAN STRANG,
DIRECTOR OF RECOVERY
AND MITIGATION**





- RANGE OF VALUES TURNED INTO SINGLE VALUE
- FLOOD EXTENT AT Q200+ CLIMATE CHANGE
- ALL INFRASTRUCTURE IS DESIGNED FOR THIS MAP



\$145M

\$160M

TWO OPTIONS:

- PROTECT TO Q200+CC,
- OR ZERO PROTECTION

November 2021

FROM MODELLING TO BUILDING



FROM MODELLING TO BUILDING

DECIDING WHAT TO BUILD

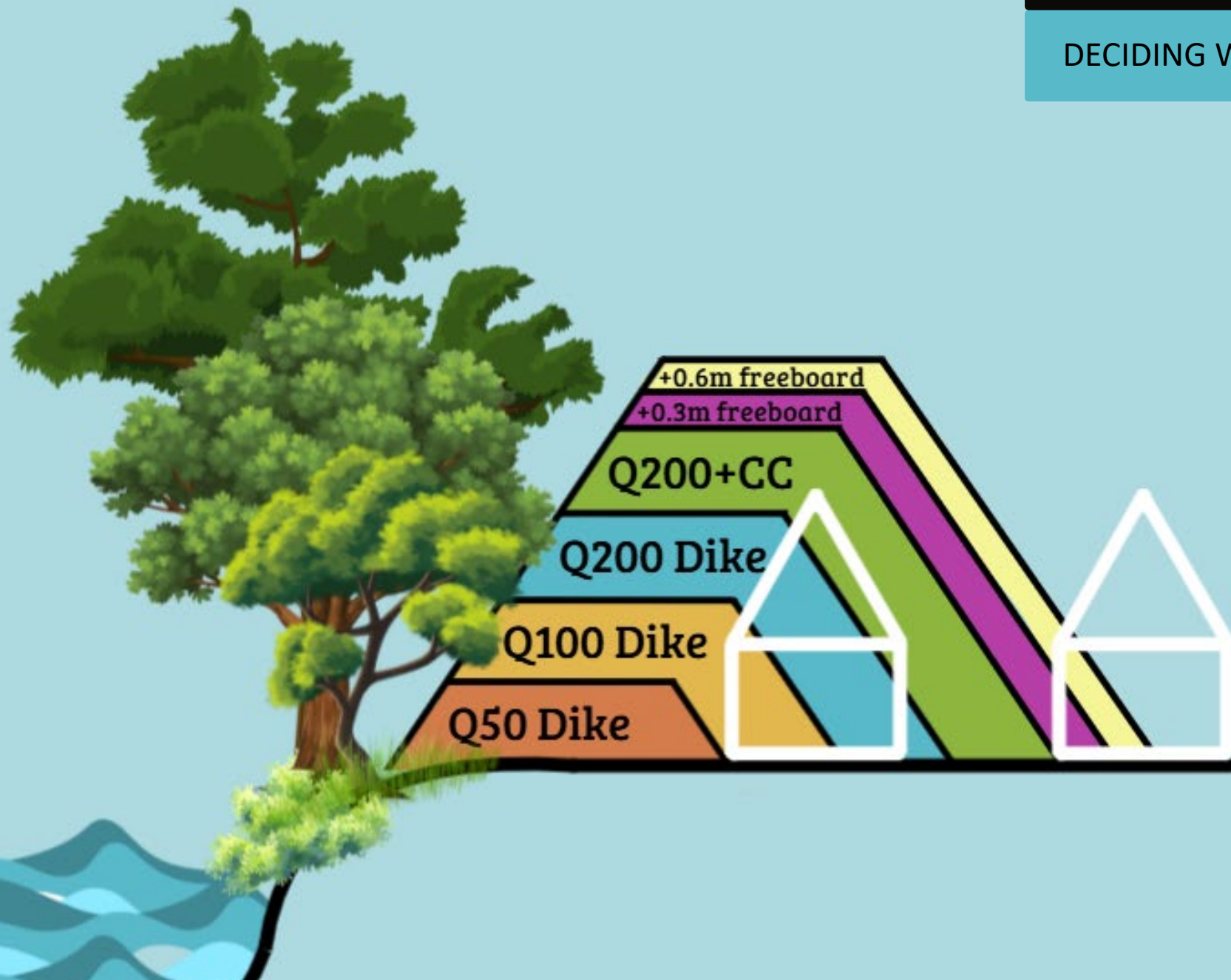


OLD BRIDGE
REPLACEMENT
\$7.4 MILLION

NEW BRIDGE
Q200 + CC
\$14.6 MILLION



CHOOSING IN BC TO BUILD FEWER PROJECTS TO A VERY HIGH FLOOD LEVEL, RATHER THAN MANY PROJECTS AT A LOWER LEVEL



FROM MODELLING TO BUILDING

DECIDING WHAT TO BUILD

1-IN-100 YEAR EVENT



PROTECT THE SOUTH TO 1:200?

1-IN-200 YEAR EVENT



PROTECT THE NORTH TO 1:100?

City of Merritt CBA and ROI of Flood Disaster Risk Management on the Coldwater River

Submitted to:
City of Merritt

Submitted by:
Nichols Applied Management Inc.
Management and Economic Consultants
Suite 302, 11523 – 100 Avenue NW
Edmonton, Alberta T5K 0J8
July 11, 2023

FROM MODELLING TO BUILDING

DECIDING WHAT TO BUILD- USE NPV

Table 5-13 Total Estimated Damages, City of Merritt (10-Year to 200-Year Events)

Damage Category		10-Year	20-Year	50-Year	100-Year	200-Year
Direct Damages	Residential	\$18,200,000	\$41,200,000	\$82,900,000	\$155,300,000	\$271,800,000
	Non-residential	\$300,000	\$400,000	\$5,000,000	\$24,600,000	\$63,500,000
	Municipal assets/infrastructure	\$4,000,000	\$8,900,000	\$14,100,000	\$27,100,000	\$46,500,000
Indirect Damages	Residential displacement	\$1,020,000	\$2,360,000	\$4,710,000	\$8,390,000	\$14,120,000
	Business disruption	\$600,000	\$900,000	\$2,000,000	\$6,000,000	\$14,600,000
	Emergency services/clean-up	\$1,500,000	\$3,400,000	\$7,100,000	\$14,500,000	\$27,100,000
Intangible Damages	Public health and quality of life	\$1,900,000	\$1,900,000	\$1,900,000	\$1,900,000	\$1,900,000
	School closures	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative
	Environmental impacts	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative
	Heritage/cultural impacts	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative
Total Damages		\$27,520,000	\$59,060,000	\$117,710,000	\$237,790,000	\$439,520,000

Table 5-15 Estimated Net Present Value for Coldwater River Flood Mitigation Project, City of Merritt (\$ millions)

Mitigation Option	7% Discount Rate			4% Discount Rate			3% Discount Rate		
	PV Benefits	PV Costs	NPV	PV Benefits	PV Costs	NPV	PV Benefits	PV Costs	NPV
Option 5: Combination diking (preferred option)	\$96.5	\$105.1	-\$8.6	\$180.0	\$115.9	\$64.1	\$238.1	\$121.4	\$116.7

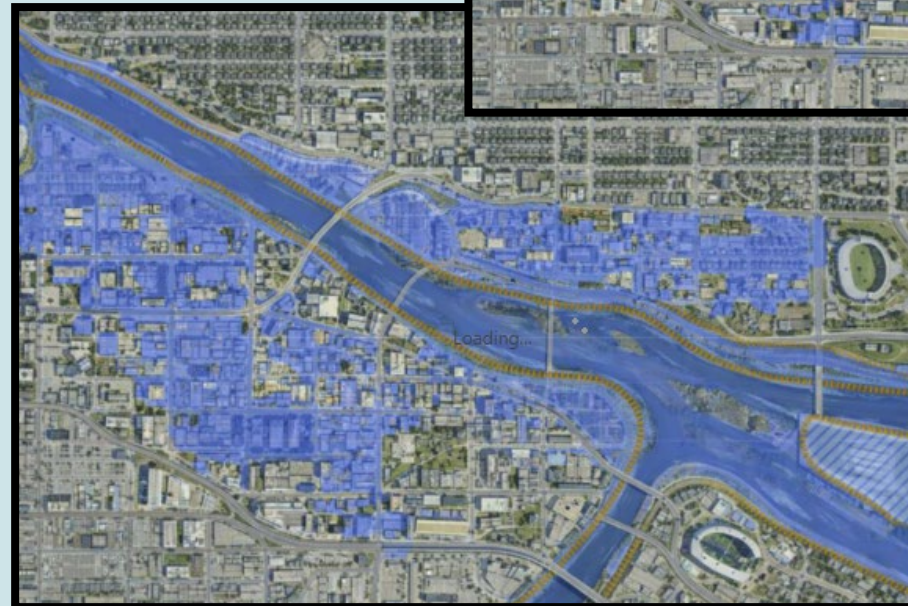
NORTH

- PROTECT TO 1:100
- PV COST: \$10 MILLION
- PV BENEFITS: \$18 MILLION
- NPV: \$8 MILLION



SOUTH

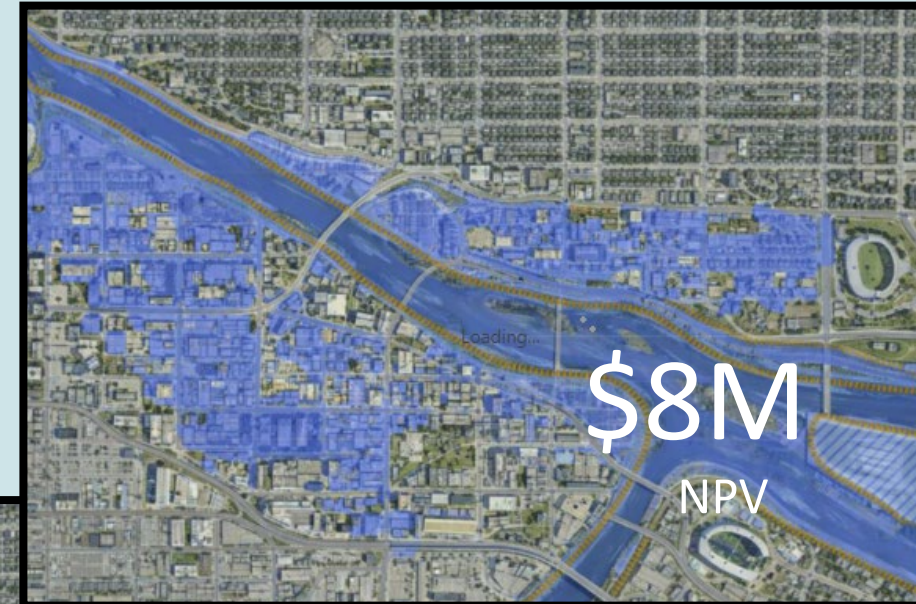
- Protect to 1:200
- PV Cost: \$10 million
- PV Benefits: \$11 m
- NPV: \$1 million



RISK OR REGULATION?

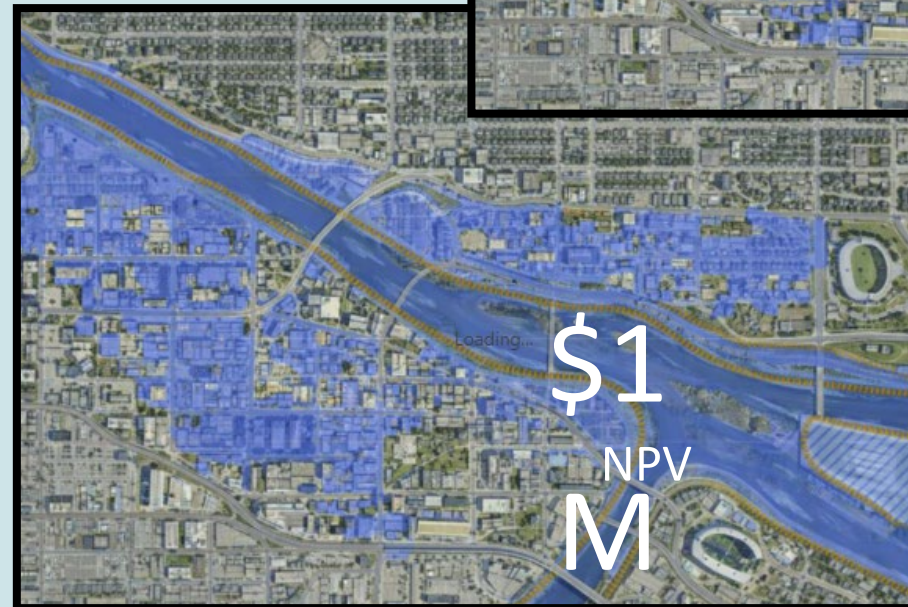
NORTH

- NON COMPLIANT WITH REGULATION
- CAN NOT BUILD IN BC



SOUTH

- COMPLIANT WITH REGULATION
- BUILDABLE IN BC



FROM MODELLING TO BUILDING

RISK OR REGULATION?

**Merritt**
FLOOD MITIGATION



RISK BASED APPROACHES

- INCREASES RISK
- UNLOCKS HIGHER NPV PROJECTS
- REQUIRE LEGAL PROTECTIONS



FLOODING, DRAINAGE AND WATER MANAGEMENT

Legal Considerations

Presented By: Jeremy Poole



YOUR **PERSPECTIVE** OUR **FOCUS**™

Two Main Scenarios

Protection against
"natural" flooding from
watercourses

Municipal stormwater
drainage works

Natural Flooding



Liability risks may be limited



Have there been any improvements or alterations to the natural watercourse flow?

Drainage Works

Bridges, culverts, managed storm water flows

Potential legal responsibility for:

Planning

Design

Construction

Inspection/Maintenance

Response to events

Liability in Nuisance

Strict liability Tort

Liability based on connection between damage and works or activity, not proof of wrongdoing

Applicable principles come from:

1. Common law (case law precedent)
2. Statute – section 29 of Water Sustainability Act

Defences to Nuisance

Common law defences:

1. Act of God - potentially available in the most severe of circumstances
2. Exercise of Statutory Authority - available but narrowly interpreted by the courts

Statutory defences:

1. Section 744 Local Government Act - no liability for breakdown or malfunction of a sewer system, a water or drainage facility or system, a dike or a road
2. Section 639 Local Government Act - protection for a District Municipality draining highways into a watercourse

Liability in Negligence

- Duty of care owed to the public and to individuals
- Standard of care – reasonableness, not perfection
- What does it mean to be reasonable?
- Identify, plan, implement and document

Policy Decision Immunity



Judicial deference to government policy decisions based on social, political and economic factors



Protects local governments from liability for difficult choices and competing priorities



What is policy? What is operational?

THANK YOU

ALEXANDER
HOLBURN

Contact



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QUESTIONS?

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Please seek legal advice if you have a particular
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