Technical Circular T-06/15
Date: June 22, 2015
(Revised August 11, 2016)

To:

Executive Directors	Ministry Traffic & Highway Safety Engineers
Regional Directors	Ministry Environmental Engineers
Directors of Engineering Services	Ministry Electrical Engineers
District Managers, Transportation	Operations, Planning & Major Projects
Ministry Structural Engineers	BCMoTI Maintenance Contractors
Ministry Geotechnical Engineers	BCMoTI Design Consultants
Ministry Highway Design & Survey Engineers	Field Services Branch

Subject: Climate Change and Extreme Weather Event Preparedness and Resilience in Engineering Infrastructure Design

Purpose:
This Technical Circular outlines climate change adaptation considerations in engineering design for the BC Ministry of Transportation and Infrastructure. It serves as a directive to consider climate change and extreme weather events in infrastructure project design. It thus supports the BC Climate Action Plan - in developing strategies to help BC adapt to the effects of climate change and extreme weather events.

The BC Ministry of Transportation and Infrastructure is requiring engineering design work to evaluate and consider vulnerability associated with future climate change and extreme weather events and to include appropriate adaptation measures when feasible, for the design life of infrastructure. Vulnerability assessment methodologies, practice guidance, as well as engineering project examples, can be obtained from other agencies such as professional associations. Climate information can be obtained from climate resource providers.

This directive applies to all new projects, as well as rehabilitation and maintenance projects. In so doing, the Ministry will continue to provide a provincial transportation system that is resilient, reliable and efficient regardless of unfolding climate change and extreme weather events.

Background:
The design life of transportation infrastructure is inherently long, and service requirements for roads, bridges, tunnels, railways, ports and runways may be required for decades, while rights-of-way and specific facilities may continue to be used for transportation purposes for much longer.

In addition to usual deterioration, transportation infrastructure is subject to a range of environmental risks over long time spans, including flood, wildfire, landslide, geologic subsidence, earthquakes, rock falls, avalanche, snow, ice, extreme temperatures and precipitation, and storms of various intensities. When global climate change enters this mix, it can create additional challenges for the transportation system.

Infrastructure designers and operators must consider the magnitude of environmental stress that any particular project will be expected to withstand over its design life. Transportation infrastructure is currently designed to handle a broad range of impacts based on historic climate; therefore, preparing for future climate change and extreme weather events is a relatively new concept. Consequences of climate change and extreme weather events present significant and growing risks to the reliability, effectiveness, and sustainability of the Province's transportation infrastructure and operations. Thus, preparing for

implications regarding the design, construction, operation, and maintenance of transportation systems to future conditions is critical to protecting the integrity of the transportation system and the investment of taxpayer dollars.

Given the potential for climate change to impact transportation infrastructure in BC, it is prudent to develop directives and guidance for incorporating climate adaptation into engineering designs provided to the BC Ministry of Transportation and Infrastructure. Climate change adaptation is the practice of implementing actions to address projected climate changes and impacts; thus adapting transportation infrastructure to climate impacts is critical to alleviating potential damage, disruption in service, and other concerns. Responding to potential climate impacts, along with associated economic, social and environmental repercussions presents additional challenges to the responsibility of developing resilient transportation infrastructure and reliably maintaining operational capacity - however this will result in wise use of resources to protect current and future investments.

What is the scope and application of this guidance? This directive pertains to transportation infrastructure engineering design work by BCMoTI staff and by engineering design consultants and others working on projects for BCMoTI. Many parameters, such as type, location, traffic volume, and design life of transportation infrastructure will determine the climate change and extreme weather event analysis required. For example, an infrequently used road may only require a summary analysis, while a major highway with structures having a long design life would require rigorous analysis.

In general, for transportation engineering design projects BCMoTI will require:

- Consideration of climate change and extreme weather events
- Assessment of Infrastructure and climate vulnerability for the design life of components, indicating relevant information and sources
- Design that incorporates climate change and extreme weather event information, analyses and projections, where feasible
- Development of practical and affordable project design criteria which takes adaptation to climate change into account
- *BCMoTI Design Criteria Sheet for Climate Change Resilience* to summarize engineering design parameter evaluation and modification for adaptation to climate change

What is the timeline? Effective immediately for all new engineering design assignments

What are the expectation of BCMoTI for engineering design staff and engineering consultants? Consultants and staff of BCMoTI involved in new design, rehabilitation and maintenance projects will integrate consideration of climate change and extreme weather event impacts into design parameters and adaptation responses in the delivery of engineering design for Provincial highway projects by:

1. Reasonable consideration of climate change and extreme weather events appropriate to the scale of the project
2. Using vulnerability assessment methodologies and climate information for design work from sources such as those providers listed in Appendix 2 (and on the BCMoTI Climate Change and Adaptation website)
3. At the concept stages, the project designer will identify the design components most at risk from climate change and extreme weather events over the expected project design life
4. At the concept stages, the project designer will summarize changes in temperature, precipitation and other climatic variables over the expected project design life

5. The project designer will identify the vulnerabilities to project design components from these projected climate changes
6. The project designer will develop adaptation design strategies to address climate change vulnerabilities for the project
7. Based on evaluation of climate change effects, the project designer will develop a project-appropriate set of design criteria for climate change and extreme weather event preparedness and resiliency
8. Engineering design parameter evaluation and modification for adaptation to climate change will be summarized and listed on *BCMoTI Climate Change Design Criteria Sheet for Climate Resilience* (Appendix 1)
9. The design team will implement the developed design criteria into the project

Where can I obtain guidance, climate resources and vulnerability analysis tools? For more information and links to resources and tools related to climate change and extreme weather event adaptation, please see Appendix 2 (and the BCMoTI website on climate adaptation). These contain links to climate information providers such as the Pacific Climate Impacts Consortium and vulnerability analysis protocols such as the Public Infrastructure Engineering Vulnerability Committee.

What is the BCMoTI Design Criteria Sheet for Climate Change Resilience (included below)? This documents implications to engineering project infrastructure components from climate change and extreme weather events. This sheet will list infrastructure components most at risk of being impacted by climate change and extreme weather events and detail adaptation measures included in the infrastructure design. One criteria sheet is required per discipline involved in design work.

Appendix 1: BCMoTI Design Criteria Sheet for Climate Change Resilience
Appendix 2: Climate Adaptation and Vulnerability Analysis Sources
Appendix 3: What definitions are used in this directive?

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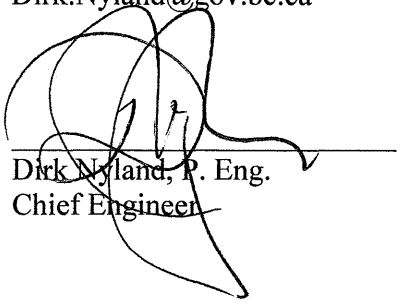

Dirk Nyland, P. Eng.
Chief Engineer

Design Criteria Sheet for Climate Change Resilience

Highway Infrastructure Design Engineering and Climate Change Adaptation
BC Ministry of Transportation and Infrastructure
(Separate Criteria Sheet per Discipline)

Project:	*(i.e. Project Name and Number)*
Type of work:	*(i.e. Capital/Rehab/Reconstruction, Bridge Structures, Culverts, Interchange/Intersection/Access Improvement, Corridor Improvement, etc.)*
Location:	*(i.e. GPS, LKI Segment and km reference, Road Names (Major/Minor), Cardinal Directions, Municipality, Electoral District, etc.)*
Discipline:	

Design Component	Design Life or Return Period	Design Criteria + (Units)	Design Value Without Climate Change	Change in Design Value from Future Climate	Design Value Including Climate Change	Comments / Notes / Deviations / Variances
e.g. Culvert <3m	50yr	Flow Rate (M^3/S)	20	+10%	22	- See Work including climate projections
e.g. Culvert >3m						

Explanatory Notes / Discussion:

(Provide brief scope statement, purpose of project and what is being achieved. Enter comments for clarification where appropriate and provide justification and evidence of engineering judgment used for items where deviations are noted in the design parameters listed above or any other deviations which are not noted in the table above.)

Recommended by: Engineer of Record: _____
(Print Name / Provide Seal & Signature)

Date: _____

Engineering Firm: _____

Accepted by BCMoTI Consultant Liaison: _____
(For External Design)

Deviations and Variances Approved by the Chief Engineer: _____
Program Contact: Dirk Nyland, Chief Engineer BCMoTI

Appendix 2

Climate Adaptation and Vulnerability Analysis Sources

BCMoTI Climate Adaptation site

APEGBC - Climate Change

Pacific Climate Impacts Consortium

- **Analysis Tools - Plan2Adapt etc**

Pacific Institute for Climate Solutions

- **Climate Insights 101**

Public Infrastructure Engineering Vulnerability Committee

IDF_CC Tool (Western University Ontario)

Ouranos (Quebec)

Intergovernmental Panel on Climate Change (IPCC)

Federal Highway Administration – Climate Adaptation (USA)

AASHTO – Transportation and Climate Change Resource Center (USA)

Appendix 3

What definitions are used in this directive?

1. **Climate Change.** Climate change refers to any significant change in the measures of climate lasting for an extended period of time. Climate change includes major variations in temperature, precipitation, or wind patterns, among other environmental conditions, that occur over several decades or longer. Changes in climate may manifest as a rise in sea level, as well as increase the frequency and magnitude of extreme weather events now and in the future

2. **Extreme Weather Events.** Extreme weather events can include significant anomalies in temperature, precipitation and winds and can manifest as heavy precipitation and flooding, heatwaves, drought, wildfires and windstorms. Consequences of extreme weather events can include reliability concerns, damage, destruction, and/or economic loss. Climate change can also cause or influence extreme weather events

3. **Extreme Events.** For the purposes of this directive, the term "extreme events" refers to risks posed by climate change and extreme weather events. The definition does not apply to other uses of the term nor include consideration of risks to the transportation system from other natural hazards, accidents, or other human induced disruptions

4. **Preparedness.** Preparedness means actions taken to plan, organize, equip, train, and exercise to build, apply, and sustain the capabilities necessary to prevent, protect against, ameliorate the effects of, respond to, and recover from climate change related damages to life, health, property, livelihoods, ecosystems, and national security

5. **Resilience.** Resilience or resiliency is the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions

6. **Adaptation.** Adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects

7. **PIEVC**. Public Infrastructure Engineering Vulnerability Committee

8. **PCIC**. Pacific Climate Impacts Consortium