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**British Columbia**
**V6Z 0B9**
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# SOLICITATION AMENDMENT
# MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

**Comments - Commentaires**

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| | |
|---|---|
| **Title - Sujet**<br>East Cache Crk. Culvert Replacement | |
| **Solicitation No. - N° de l'invitation**<br>EZ899-210904/A | **Amendment No. - N° modif.**<br>002 |
| **Client Reference No. - N° de référence du client** | **Date**<br>2020-10-30 |
| **GETS Reference No. - N° de référence de SEAG**<br>PW-$PWY-028-8847 | |
| **File No. - N° de dossier**<br>PWY-0-43075 (028) | **CCC No./N° CCC - FMS No./N° VME** |
| **Solicitation Closes - L'invitation prend fin**<br>**at - à 02:00 PM**<br>**on - le 2020-11-05** | **Time Zone**<br>**Fuseau horaire**<br>Pacific Standard Time<br>PST |
| **F.O.B. - F.A.B.**<br>**Plant-Usine:** ☐ **Destination:** ☑ **Other-Autre:** ☐ | |
| **Address Enquiries to: - Adresser toutes questions à:**<br>Isabell, Park | **Buyer Id - Id de l'acheteur**<br>pwy028 |
| **Telephone No. - N° de téléphone**<br>(604) 365-0073 ( ) | **FAX No. - N° de FAX**<br>( ) - |
| **Destination - of Goods, Services, and Construction:**<br>**Destination - des biens, services et construction:**<br>PWGSC - East Cache Creek, km 140.3 – Alaska Highway, BC | |

**Instructions: See Herein**

**Instructions: Voir aux présentes**

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Canada

**Amendment 002**
This amendment is issued to post Addendum 002.

Attachment
Addendum 002  2020-10-30

All other terms and conditions remain unchanged.

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Professional and Technical Services, Real Property Services Branch, Pacific Region

| | |
|---|---|
| Km 140.3 East Cache Creek Culvert Replacement, Alaska Highway, BC | Addendum 002 |
| Project No. R.109448.002 | 2020-10-30 |

**The following changes in the tender documents are effective immediately. This addendum will form part of the Contract documents.**

**Questions from Bidders and Responses**

Question 1: Has a geotechnical report been completed, if so can that information be provided?

Response 1: A geotechnical report is not available for this project.

Question 2: Are we able to weld temporary lifting eyes onto the Steel pipe for ease of hoisting and transport?

Response 2: Temporary lifting eyes may be used. It is the Contractor's responsibility to ensure the lug capacities and weld capacities are adequate for the weight of pipe section(s) being transported. Regardless of the method of transport used, the Contractor is responsible to ensure the pipe is not damaged during any temporary welds, the pipe is not damaged during transportation, and any temporary attachments are removed prior to pipe install.

Question 3: In BC, Archaeologists are not registered to practice. Can it be clarified whether the requirement is meant to be asking for the presence of a provincially-recognized Permit Holder in good standing, or a Field Directing Archaeologist in good standing with the BC Archaeology Branch?

Response 3: As indicated in Addendum 001, the requirement for the onsite archaeological monitoring has been removed from this project.

Question 4: In-lieu of monitoring, would it be acceptable to supply an Archaeological Overview Assessment (AOA, to BC Archaeology Branch standards) for the subject project footprint, and NOT monitor if the report identifies NO archaeological concerns within the project footprint?

Response 4: As indicated in Addendum 001, the requirement for the archaeological monitoring program has been removed from this project and there is no requirement for the Contractor to undertake an Archaeological Overview Assessment.

Question 5: Has an assessment on the creek been completed? Is there an idea of the amount of flow if any at this time of year? Can this information be provided?

Response 5: A hydrotechnical analysis was undertaken for this crossing location in May 2019. The results are found in the attached report. The culvert design options included in this report will not be considered, the construction shall be undertaken as per the design drawings and specifications.

No estimate on the expected flows can be provided.

Question 6: Will PSPC be looking after the permitting for DFO and other alike permits for this project?

Response 6: No permitting from DFO is expected on this project.

As indicated in the contract specifications, PSPC has applied for and obtained a Change Approval permit under Section 11 of the provincial Water Sustainability Act for this project. The Departmental Representative will liaise with the province to complete the final step of this permitting process which includes submission of the Contractor's Environmental Protection Plan (as noted in the specifications the Contractor's Environmental Protection Plan shall be reviewed and once accepted by the Departmental Representative, submitted to the province 15 days prior to the start of any construction work within 30 m of the water crossing).

As indicated in the contract specifications, the Contractor is responsible for obtaining all other permits, including obtaining a fish salvage permit (should it be needed).

Question 7: I've just received the dimensions of the jacking pit from the line bore contractor.

The base of the boring/Jacking equipment is ±0.5m below invert of culvert, and they have stated that they will require a minimum additional 0.3m of clear crush as a working floor below the equipment.

As such, we would need to install 15m x 5m x ±1.0m deep jacking pit footprint, with sloped walls (from 1.5m behind the inlet headwall to 13.5m behind the inlet headwall).

Please confirm the Owner's requirement for backfill material in the stream bed, below the armor rock, to backfill the jack pit void (±275 tonne). Is drain rock acceptable (Freeze heave concerns).

Please advise.

Response 7: As shown on the contract drawings, the full extent of any excavation above, below, and behind the concrete headwalls shall be backfilled Crushed Base Gravel material. Additionally, on the inlet side of the culvert, the full extent of any excavation of native ground beyond the requirements shown on the contract drawings within 5 m of the outside face of the concrete headwall shall be backfilled with Crushed Base Gravel material and compacted per the compaction requirements for Crushed Base Gravel provided in the contract specifications.

The use of drain rock as backfill in other areas of over excavation beyond what is shown on the contract drawings is acceptable provided:

- A drawing markup of the proposed use of drain rock and drain rock gradation details are provided to the Departmental Representative prior to undertaking the work.
- Any drain rock remining in place is wrapped in nonwoven geotextile.

TETRA TECH

May 2, 2019

ISSUED FOR USE
FILE: TRN.VHWY03146-01
Via Email: Reza.Haghighi@pwgsc-tpsgc.gc.ca

Public Services and Procurement Canada
219 - 800 Burrard St.
Vancouver, BC V6Z 0B9

**Attention:** Reza Haghighi

**Subject:** East Cache Creek (km 140.3, Alaska Highway, BC) Hydrotechnical Analysis

# 1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Public Services and Procurement Canada (PSPC) to complete a hydrotechnical analysis of East Cache Creek which crosses the Alaska Highway alignment at km 140.3.

The crossing is currently serviced by a 1500 mm diameter circular CSP culvert which has failed at the outlet due to extensive bank erosion and embankment scour. PSPC are planning to complete culvert upgrade works and required a hydrotechnical assessment of the crossing to evaluate future design options.

Our hydrotechnical analysis included two main components, a hydrological analysis to estimate the 1 in 100 year return period flow of the creek, inclusive of estimate climate change effects, and a hydraulic analysis to explore possible design options which will satisfy BC MoTI design guidelines being used on this PSPS project, as well as BC MoTI Technical Circular T-06/15 regarding climate change preparedness. This report discusses the methodologies and findings of our analysis.

# 2.0 HYDROLOGICAL ANALYSIS

East Cache Creek crosses the Alaska Highway at km 140.3. Downstream of the crossing, East Cache Creek flows south, reaching its confluence with West Cache Creek approximately 20 km downstream of the highway crossing. The watershed draining to the Alaska Highway crossing was delineated from 1:50,000 National Topographic System maps for a total watershed area of 7.2 $km^2$. This watershed is situated in rolling hills and is comprised of 70% forest coverage and 30% field and meadow coverage. Figure 2-1 presents an outline of the project watershed and crossing location.

Tetra Tech completed a hydrological analysis of the East Cache Creek watershed in order to estimate the magnitudes of 1 in 100-year flood event to be used in subsequent hydraulic design (Section 3.0). The hydrological analysis was completed through the development of a rainfall-runoff model and was validated through a regional hydrology analysis method. Compensation was provided in the analysis to account for the estimated future effects of climate change as recommended in BC MoTI Technical Circular T-06/15 (included as Appendix A).

## 2.1 Rainfall-Runoff Model

In order to estimate the peak flows at the crossing during a 1:100 year storm event, a hydrologic model of the site was produced using PCSWMM software. The following subsections outline the various parameter inputs which were used in the model and the results of the analysis.



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Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

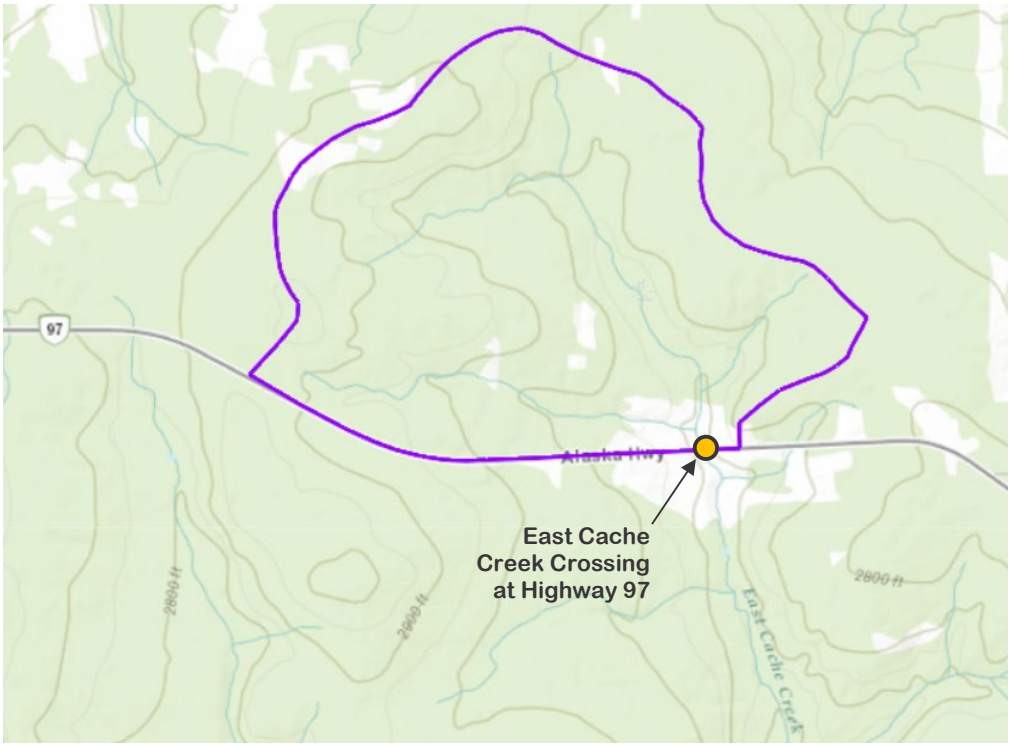


**Figure 2-1: Watershed Area (7.2 km$^2$) for East Cache Creek at Hwy 97**

### 2.1.1 Watershed and Channel Delineation

Sub-watershed areas and channel alignments were delineated from topographic information available from National Topographic Systems (NTS) mapping and verified with Google Earth satellite imagery.

Slopes for each drainage area and channel reaches were also calculated based upon the available NTS information.

Channel geometry and channel roughness for East Cache Creek were estimated based on site visit observations.

### 2.1.2 Soil Characteristics

Soil infiltration rates play a large role in dictating the quantity of rainfall which emerges as runoff from the site during a storm event. Soil parameters for the site were selected based on available surficial soil reports for Northern British Columbia, soil properties visible in site photographs, and vegetative cover visible in satellite imagery and site photographs.

Soil maps classify the surficial soils in this area as being a “till veneer”. Site photographs support this classification, particularly within the scour pocket at the downstream end of the culvert where vertical eroded channel banks appear to be composed of consolidated silts with gravels (Photo 1). Based on these observations we classified the watershed soils under Hydrologic Soil Group C. Group C soils are regarded as possessing “slow infiltration rates when thoroughly wetted. These consist chiefly of soils with a layer that impedes downward movement of water of soils with moderately fine to fine textures” (USDA, 2017).

Ground cover for the watershed can be classified as primarily woods with some meadows.

An SCS Curve Number (CN) of 71 was applied within the model for all sub-watershed areas. This number is estimated to be reflective of Antecedent Moisture Condition II, the moisture condition prescribed for non-Coastal BC in the BC Supplement to TAC Geometric Design Guide.


**Photo 1:** Scour Pocket and Culvert Failure at Outlet

### 2.1.3 Rainfall Depth - Including Projected Climate Change Effects

Rainfall input to the model was based on data available from two nearby Environment Canada meteorological stations; Sikanni Chief and Fort St. John airport. These stations are 97 kilometres northwest and 68 kilometres southeast of the culvert crossing respectively and both have Intensity-Duration-Frequency (IDF) curves available which quantify rainfall depths for various return periods and storm durations.

Linear interpolation between the two Environment Canada gauges was used to synthesize IDF values representative of the culvert crossing watershed location for a 24-hour duration storm.

The rainfall depths were then scaled to account for the projected effects climate change in this part of Northern BC. Based on review of available climate change reports on the area, extreme precipitation depths are projected to increase by 25% by 2050-2059. (Picketts, 2014). This scaling factor of 1.25 was applied to rainfall depths synthesized for the km 140.3 culvert crossing (Table 2-1).

**Table 2-1: Rainfall Depths for 24-Hour Duration Storm – Present Day and Projected IDFs**

| Storm Return Period (years) | Sikanni Chief IDF (mm) | Fort St John IDF (mm) | Present Day East Cache Creek IDF (mm) | Climate Change Projection East Cache Creek IDF (mm) |
|---|---|---|---|---|
| 2 | 42.6 | 35.6 | 38.5 | 48.1 |
| 5 | 55.7 | 44.6 | 49.2 | 61.5 |
| 10 | 64.4 | 50.5 | 56.2 | 70.3 |
| 25 | 75.3 | 58.0 | 65.1 | 81.4 |
| 50 | 83.5 | 63.6 | 71.8 | 89.8 |
| 100 | 91.5 | 69.1 | 78.3 | 97.9 |

### 2.1.4 Rainfall Hyetograph Development

Selection of an appropriate rainfall distribution (hyetograph) over the 24-hour storm period is critical in a hydrologic model as a wide range in peak runoff rates are possible from different distributions of the same rainfall depth, depending on how constant or consistent rainfall intensities are throughout the storm.

Rainfall hyetograph selection for was completed through analysis of storm patterns typically observed during the largest storm events at Fort St. John airport. Hourly precipitation data for the six largest storm events occurring at Fort St. John airport was isolated, unitized, and plotted on an hourly graph. Standardized storm distributions for SCS Type 1 and SCS Type 1A storms were also graphed to identify if either were representative of typical storm patterns at this location (Figure 2-2).

We note the SCS Type 1 distribution correlates reasonably well both in terms of peak magnitude and peak duration with the rainfall patterns observed at Fort St.John Airport. For this reason the SCS Type 1 distribution was selected as the hyetograph for the modelled rainfall inputs.

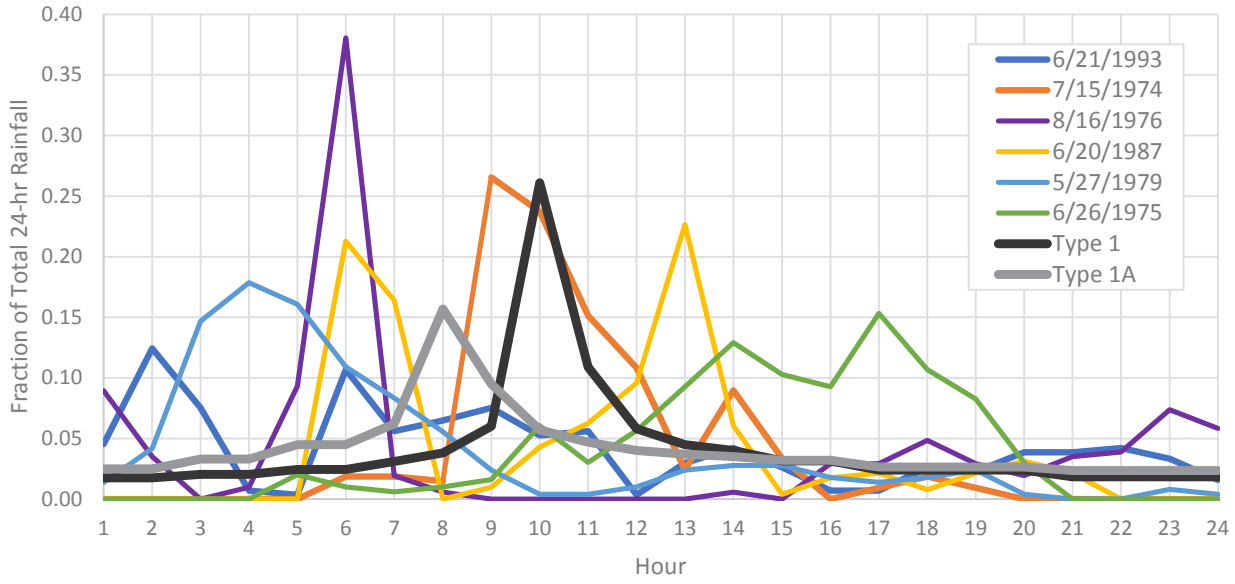


**Figure 2-2: Evaluation of Unitized Rainfall Hyetograph at Fort Saint John Airport**

### 2.1.5 Model Results

The hydrologic model was assembled with the parameters mentioned above and run for the 100-year event, both for present day scenario and future scenario accounting for estimated effects of climate change. This yielded expected peak flows of 7.3 $m^3/s$ and 14.1 $m^3/s$ at the culvert crossing for present day and climate change scenarios respectively.

## 2.2 Validation from BC Streamflow Inventory Analysis

In order to provide validity to the results of the PCSWMM rainfall-runoff model, a second short hydrologic analysis was completed by referring to British Columbia Streamflow Inventory hydrological maps (Coulson, C. H., and Obedkoff, W. 1998). These maps were developed in the late 1990's based on all WSC hydrometric data available at the time. Statistical analysis was conducted on the datasets for each station with the resulting 10-Year and 100-Year peak flows then being spatially analyzed to develop a contoured map of British Columbia with isolines indicating the expected runoff for a watershed area of 100 $km^2$ at all points in the province. Flow estimates from this method could then be scaled to watersheds of differing areas through the equation below:

$$Q_2 = Q_1 \times \frac{A_2}{A_1}^{0.785}$$

Where:

Q = 100-year Peak Flow ($m^3/s$)

A = Watershed Area ($km^2$)

Subscript 1 and 2 denote watersheds of differing size.

Based on the map, a 100-year flow of 60 $m^3/s$ is predicted in the East Cache Creek region for a watershed area of 100 $km^2$. Scaling this to the East Cache Creek watershed area of 7.2 $km^2$ results in an estimated 100-year flow of 7.6 $m^3/s$, 4% greater than our rainfall-runoff estimate unadjusted for climate change. This gives good confidence in the results of the rainfall-runoff model. As such, subsequent hydraulic modelling of potential crossing options was undertaken utilizing a design flow of 14.1 $m^3/s$ which is the modelled 100-year flow, inclusive of estimated climate change effects.

# 3.0 HYDRAULIC ANALYSIS

Recognizing that PSPC are looking to design a new culvert crossing at this location, Tetra Tech completed hydraulic analysis of the watercourse to develop several potential design alternatives which could be installed to meet BC MoT design standards.

## 3.1 Hydraulic Model Development

A 1D hydraulic model of the crossing was prepared using HEC-RAS software. Channel geometry and roughness inputs to the model were estimated based on visual observations made during site visits and site survey data, while channel slopes were obtained from National Topographic System topography data.

Available culvert geometries and roughness values were obtained from catalogues available from popular pipe suppliers (Armtec and Atlantic Industries).

The 100-year climate change adjusted flow (14.1 $m^3/s$) developed through Tetra Tech's hydrological analysis was used as the design event. This is aligned with the BC MoTI Supplement to TAC Geometric Design Guide which states that the 100-year flood is to be used as the design event for culverts under 3.0 metres in span.

Culvert capacity is deemed to be reached when the headwater depth reaches the crown of the pipe (HW/D = 1.00). This limitation is as per the BC MoTI Supplement to TAC and was used when determining the capacities of each modelled scenario.

## 3.2 Hydraulic Analysis of Potential Crossing Options

Tetra Tech completed hydraulic model runs using HEC-RAS to develop various preliminary design alternatives which could be installed to safely pass the estimated 100-year peak flow, as shown in Table 3-1.

| Crossing Type | Culvert Dimensions | HW/D | Exit Velocity (m/s) |
|---|---|---|---|
| Single Circular CSP - no embedment | Ø 2.77 m | 0.97 | 4.35 |
| Single Circular CSP with 0.3 m embedment | Ø 2.77 m | 1.00 | 3.74 |
| Twin Circular CSP – no embedment | Ø 2.00 m | 1.00 | 3.72 |
| Twin Circular CSP with 0.3 m embedment | Ø 2.20 m | 0.92 | 2.54 |

If the watercourse is deemed to be fish bearing a culvert configuration inclusive of embedment should be considered.

Additional crossing geometries are possible and may be evaluated as during the detailed design phase of the project.

## 4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Public Services and Procurement Canada and their agents. Tetra Tech Canada Inc. (operating as Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Public Services and Procurement Canada, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech Canada Inc.'s Services Agreement. Tetra Tech's General Conditions are provided in Appendix B of this report.

## 5.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

Prepared by:
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Water and Marine Engineering
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Reviewed by:
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/db

# REFERENCES

Coulson, C. H., and Obedkoff, W. 1998. British Columbia Streamflow Inventory, Water Inventory Section - Resources Inventory Branch

Picketts, I. 2014. Backgrounder: Future Climate in Northeastern British Columbia, prepared for Fraser Basin Council and BC Ministry of the Environment.

USDA (United States Department of Agriculture) 2017 – Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at HTTP://WEBSOILSURVEY.NRCS.USDA.GOV/. ACCESSED 01/29/2019.

# APPENDIX A

## BC MOTI – TECHNICAL CIRCULAR T-06/15

**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?

**Contact:**
Dirk Nyland, P. Eng.
Chief Engineer
BCMoTI Engineering Services Branch
Tel: (250) 356-0723
Dirk.Nyland@gov.bc.ca

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

# APPENDIX B

## TETRA TECH'S GENERAL CONDITIONS

# LIMITATIONS ON USE OF THIS DOCUMENT

## HYDROTECHNICAL

### 1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the “Professional Document”).

The Professional Document is intended for the sole use of TETRA TECH’s Client (the “Client”) as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the “Contract” herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an “Authorized Party”), consideration for such authorization is the Authorized Party’s acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the “Limitations on Liability”). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party’s express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH’s professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

### 1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH’s “Instruments of Professional Service”), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH’s Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

### 1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

### 1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

### 1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

### 1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

### 1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless expressly agreed to in the Services Agreement, TETRA TECH was not retained to investigate, address or consider, and has not investigated, addressed or considered any environmental or regulatory issues associated with the project.

### 1.8 LEVEL OF RISK

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design, in consideration of the level of the hydrotechnical information that was reasonably acquired to facilitate completion of the design.