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PUBLIC SERVICES AND PROCUREMENT CANADA

CLIMATE CHANGE RISK ASSESSMENT OF PARLIAMENT HILL

Category F: Special Projects

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Project Summary

The Parliamentary Precinct is a symbol for Canada and the world, a cultural and natural heritage site, the home of Canada's Parliament, and a venue for national celebrations and global visitors. In recognition of the significant threat that climate change poses to this culturally and naturally significant area, the Government of Canada engaged Dillon Consulting Limited to develop a process for, and deliver, a Climate change risk assessment of the Parliamentary Precinct, with the ultimate goal of developing a series of adaptation measures for different types of assets (natural and engineered) that would allow for enhancing the resilience of the Parliamentary Precinct.

This project represents one of the first climate risk assessments of this scale and granularity of culturally and naturally significant assets for the Government of Canada. It also represents a portfolio based approach to climate adaptation measure development, that provides distinct approaches for heritage assets, natural assets, underground assets and new builds. The approach deployed allows for the findings to be revisited and refined periodically, in a process that crosses departments and garners broad buy-in.

PROJECT HIGHLIGHTS

Innovation and Complexity

Dillon Consulting Limited was engaged by the Science and Parliamentary Infrastructure Branch (SPIB) of Public Services and Procurement Canada (PSPC) to develop and deliver, in collaboration with SPIB, a Climate Change Risk Assessment (CCRA) that was innovative and complex. Specific key outcomes are highlighted below along with figures and descriptions of the work completed in achieving these outcomes.

Outcome 1: Appropriately delineate the Parliamentary Precinct into discrete categories of assets that would allow for detailed analysis of climate risks, without conducting an asset-by-asset risk assessment.

Outcome 2: Define representative assets within each category that would act as appropriate focal points for initial climate risk analysis, prior to the development of category level adaptation measures.

These elements of complexity and innovation speak to two of the main challenges faced in the engineering profession around the incorporation of climate change into the design, operations, and maintenance of engineering and natural systems: scaling the analysis to provide appropriate guidance, without conducting an bottom-up analysis of each asset.

SPIB completed Outcomes 1 and 2 as part of the project scope by reviewing the assets within the Parliamentary Precinct and developing a series of Asset Categories and representative assets within each, that would become the focus on the detailed analysis. The detailed analysis along with a review of the larger portfolio and extensive engagement with experts and stakeholders formed the basis for developing adaptation measures that addressed climate resilience for each Asset Category. The Asset Categories spanned new construction and buildings for which rehabilitation was not planned within 5-10 years. Therefore short term operational resilience measures were required through to new construction and planned rehabilitation.

Figure 1: Illustration of the Asset Categories used to break down the large portfolio that represents the Parliamentary Precinct, and the representative assets considered within each.

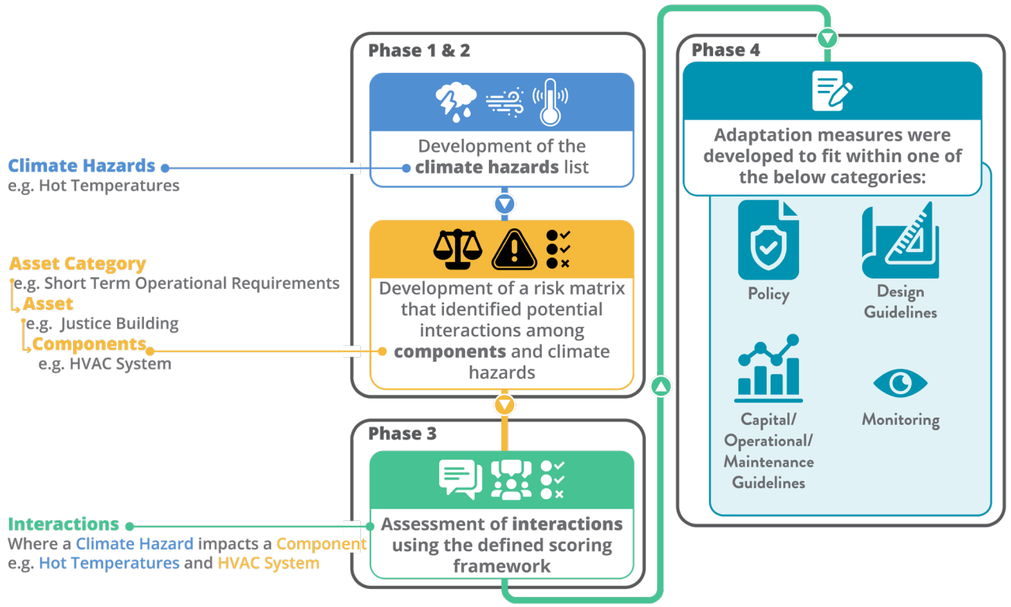

Figure 2: Illustration of the logic flow in using Asset Categories to develop portfolio wide Interactions and portfolio wide Adaptation Measures.

Outcome 3: Integrate a multi-level engagement process that maps key stakeholders and defines tactics and timing for engagement.

The integration of data, engineering analysis, expert experience, management perspective, and operational experience was critical to the development of a CCRA and adaptation measures that were relevant, implementable, and backed by the buy-in of all stakeholders.

The project entailed engagement with multiple internal stakeholders within SPIB and PSPC, as well as a variety of external stakeholders. The number of stakeholders engaged totalled approximately 30 distinct government groups, departments and external organizations.

These technical engagement sessions took the form of interviews, in-person analysis workshops, virtual workshops, small group engagements, hosted site visits and presentations. These tactics were deployed throughout the project, and were led by engineers and analysts skilled in engineering climate risk assessment and public engagement.

Outcome 4: Identified key climate hazards and potential changes that could affect the Precinct.

Climate change data exists in the public domain for many basic hazards. However it is recognized that an engineering analysis of risk requires customized climate hazards that align with design and operational parameters. The project team therefore drew upon their collective engineering expertise to identify the most impactful hazards for the engineered and natural assets that comprise the Parliamentary Precinct, and developed site-specific climate projections for each.

This type of data can be daunting to stakeholders, especially in terms of being able to contextualize the changes in climate from current to the 2050s and the 2080s. It was therefore important to provide complex and scientifically sound information, in a digestible format - especially when discussing climate change projections and future climate conditions. The consulting team developed plain language infographics to help with broad communication of the changes to climate within the Parliamentary Precinct, and to support the analysis.

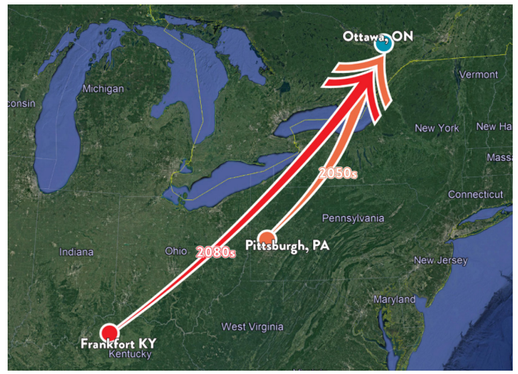

Figure 3: Climate "proxy" cities for Ottawa in the 2050s (Pittsburgh) and the 2080s (Frankfort).

Outcome 5: Identified the building Components, including heritage features, that are at risk of failure, damage and/ or accelerated deterioration from changes in climate.

The CCRA successfully identified and prioritized climate risks for each Asset Category, considering both engineering and natural systems. High Level Summaries of the Priority Risks for each Asset Category are presented in the graphics below. Detailed analysis and risks are considered to be confidential.

Outcome 6: Determined how to increase the resilience and adaptive capacity of the Precinct.

Outcome 7: Helped build future resilience of government operations to extreme weather events.

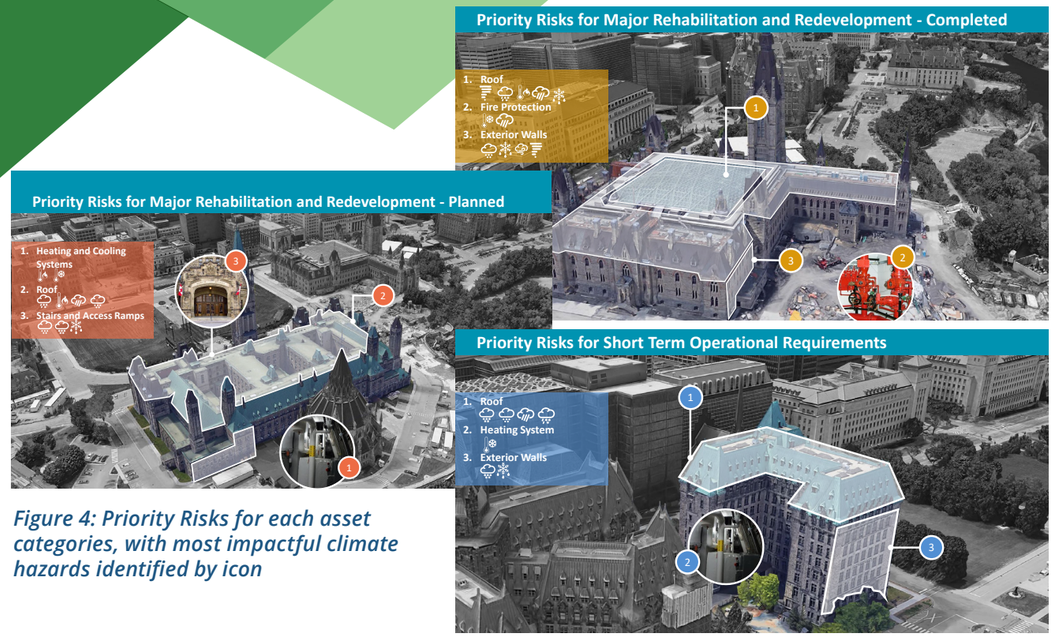

Figure 4: Priority Risks for each asset categories, with most impactful climate hazards identified by icon

Outcome 8: Provided policy, design, capital/operations and monitoring guidance to plan and guide rehabilitation, new construction, operation and maintenance.

The comprehensive set of adaptation measures developed for the most vulnerable and high risk assets from each of the asset categories, included measures in the following categories:

- design/redesign;
- capital/operational/maintenance;
- monitoring; and
- policy measures.

The goal of all adaptation measures is to increase the resilience of the SPIB portfolio to climate change. Measures were developed in collaboration with subject matter experts (SME) from all areas of expertise. This allowed for a comprehensive set of measures delivering an array of opportunities for SPIB to implement.

In addition to the development of adaptation measures for each Asset Category, portfolio-wide overarching adaptation measures were identified along with interdependencies for consideration/focus. These interdependencies represent where SPIB's assets within the Parliamentary Precinct interact with services and assets owned by third parties (e.g. utilities) that warrant resilience planning.

One of the adaptation measures developed to reduce impact from increasing frequency of extreme temperatures and heavy/intense rainfall events, included a design load table from the National Building Code, with projected design loads for building HVAC and structural systems, out to the 2050s and 2080s. This is an innovative engineering design guideline that will allow HVAC and structural designers to consider future climate change impact for new design and for retrofits.

The work also built capacity across multiple Federal Government departments on incorporating climate change considerations into planning, design, operations and maintenance of assets; thereby enhancing the human capital aspect of climate resilience.

Projections Confidence Level	Climatic Design Load Definition			"Best Available" Values	
				2050s	2080s
High Confidence	Design Temperature	January	2.5% °C	-25°C	-18°C
			1% °C	-27°C	-21°C
		July 2.5%	Dry °C	34°C	39°C *or* New analysis recommended
			Wet °C	26°C	New analysis recommended
Medium Confidence	15 Min Rain, 1/10, mm			28 mm	31 mm
	One Day Rain, 1/50, mm			100 mm	New analysis recommended
Very Low Confidence	Driving Rain Wind Pressures, Pa, 1/5			170 Pa	N/A
	Snow Load kPa, 1/50		S_s	2.4 kPa	N/A
			S_r	0.4 kPa	N/A
	Hourly Wind Pressures, kPa		1/10	Tornado resistant cladding and roofing measures (Sandink et al., 2019)	
			1/50	Update baseline with peak gust extreme value analysis; Incorporate wind tunnel studies; Incorporate "climate change safety factor" when available	

Table 1: NBC design loads with 2050s and 2080s projections for climate change (based on RCP8.5).

Social and Economic Benefits

In the past, engineering design and construction relied heavily upon past conditions to predict future operating conditions. In the era of climate change, the past can no longer predict the future - high variability and more intense peaks and valleys of operating conditions are to be expected, potentially putting past designs at risk of failure. Design loads are changing, and it is incumbent upon the engineering community to consider climate change impacts on the future of our built environment.

The Parliamentary Precinct is a National Historic Site, and an icon of Canada. Preserving its cultural and natural heritage is of utmost importance, along with managing future climate impacts on the safety of visitors, and the tenants that occupy the site.

According to the World Bank, and the Insurance Board of Canada, every dollar spent on adaptation can result in $4 to $7 dollars in avoided costs. Given the cultural and natural heritage within the Precinct and the function of the Precinct at the home of Canada's Parliament, it may be reasonably assumed that the financial benefit would lie on the higher end of the World Bank's range. This is compelling evidence for the economic benefits of Climate change risk assessment and adaptation measure implementation.

The consequence criteria measured in this study were:

- Disruption to Parliamentary Operations;
- Impact to Tenant/Public Safety;
- Financial Loss (Operational, Capital); and
- Disruption to Environment.

Implementing recommended adaptation measures designed to reduce financial loss will enhance the SPIB portfolio's performance, and provide additional security for public and tenant safety.

Environmental Benefits

The cultural heritage value of the Parliamentary Precinct results from the sum of its parts - all the elements of the Grounds are important features to be nurtured and maintained. Climate change imposes risks, from an environmental damage perspective, on all assets on the Grounds.

One of the asset categories assessed as part of this project was the Grounds of the Parliamentary Precinct. This includes specimen trees, the lawns, and the escarpment vegetation. Several important impacts from climate change were identified, including the effects of road/walkway salt resulting from snow and ice events, on the health of trees and other vegetation on the Grounds. Eighty seven percent of the total risk scores for flora and fauna came from consequences related to environmental impacts resulting from the climate hazards studied. Forty four percent of total risk scores were associated with environmental damage for the escarpment, which includes slope vegetation and stability. Some of the adaptation measures developed to reduce environmental impact related to climate change and the use of the Grounds include:

- **Select plants that are tolerant of future warmer temperatures**, site conditions, current (5B) and potential future (6A, 6B) plant hardiness zones, and Ontario Seed Zone 36.
- Monitor invasive plant species and continue with long term management programs to **replace invasive vegetation species with native species**.
- Consider preparing **operations and management policies (**similar to National Mall in Washington, DC) that include strategies for monitoring for over use and employing “rest periods” (where possible) to limit the duration that temporary Structural/Architectural are allowed on the Parliament Hill lawn.
- **Reconstruct the formal lawns** used for public events with high performance turf that includes subsurface drainage, appropriate soil depth and irrigation. Consider engineered soils to resist compaction.
- Develop policies that **establish no-net increase in run-off from future development**. Reduce impervious surfaces to minimize the use of deicing chemicals. Consider redeveloping and/or updating De-Icing Use Policy to include new innovative solutions for sensitive or

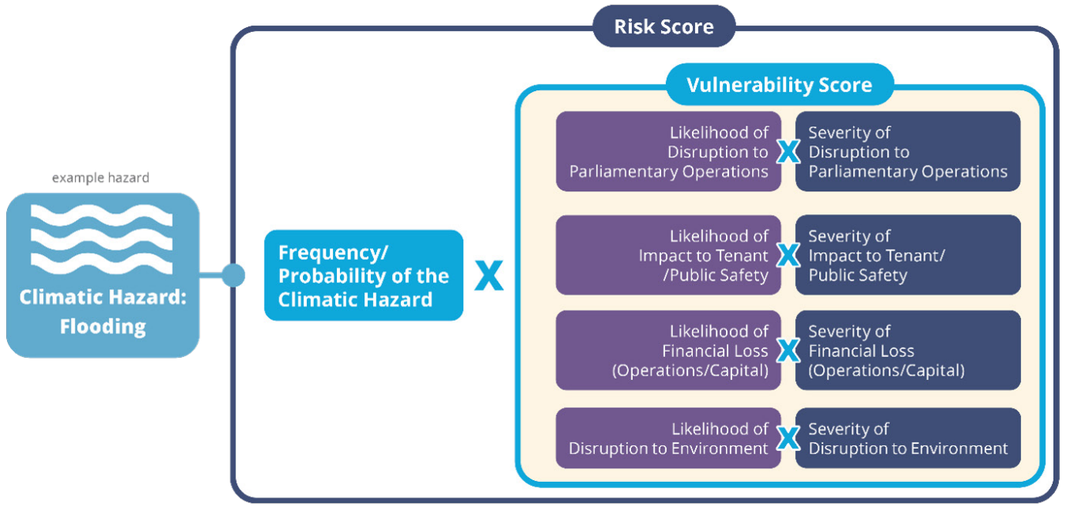

Figure 5: Illustration of consequence criteria, including social and environmental criteria, within the analysis of vulnerability

challenging zones including evaluating heated surfaces and pre-treating with brine, and defining deicing chemicals.

- **Evaluate options for pre-treatment of stormwater discharge on site in a manner that does not disrupt the heritage character of the grounds**. Rationalize stormwater water quality treatment for the entirety of the stormwater and encourage infiltration in natural areas where appropriate. Include material choices that are salt resistant to minimize the impacts on the underground infrastructure.

Providing the SPIB with adaptation measures that build upon current programs in place and prioritize areas for focus, supports the preservation of cultural and natural heritage of Parliament Hill, resulting also in environmental benefits for the site.

Meeting Client's Needs

In the 2017 report entitled "Adapting to the Impacts of Climate Change", the Federal Commission of the Environment and Sustainable Development concluded that federal departments "... did not take appropriate measures to adapt to climate change impacts..... Stronger federal leadership is needed."

Through the collaborative delivery of the CCRA and the development of Adaptation Measures by Dillon and SPIB, the Federal Government has now shown leadership in defining a path to climate resilience through:

- Identifying where priority climate risks exist within the Parliamentary Precinct;
- Identifying policy, design, capital/ operations and monitoring guidance for assets across the Precinct;
- Identifying these adaptation measures for New Construction, Rehabilitation projects, ongoing Operations and Maintenance, Underground Systems and the Natural Capital within the Parliamentary Precinct; and
- Building the skills and knowledge within SPIB on climate risk assessment and integration of climate resilience into planning, design, operations and maintenance of engineering and natural assets.

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