

Engineers Canada's Submission to the Government of Canada on Community Infrastructure

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Background information

Engineers Canada is the national organization of the provincial and territorial associations that regulate the practice of engineering in Canada and license the country's 290,000 members of the engineering profession. Engineering is a self-regulated profession. Engineers Canada exists to support the provincial and territorial engineering regulatory bodies. Together, we work to advance the profession in the public interest.

Our changing climate, with its extreme weather events, is adversely impacting and threatening Canada's health and safety, and the quality of life of its citizens. Increases in the frequency and intensity of storms and extreme temperatures across Canada are damaging and destroying public infrastructure. The result is huge repair and recovery costs as well as extended disruptions of infrastructure service to Canadian citizens and businesses. The frequency and magnitude of climate change events remain uncertain. Engineers, other professionals, policy- and decision-makers need to address the changing climate and its impact on Canadians' safety and quality of life as supported by public infrastructure.

While adaptation of infrastructure has a community focus, a coordinated outlook on climate change that promotes climate resilience is warranted to improve codes, standards, climate information, policies, procedures and professional practices. It is Engineers Canada's view that climate resiliency is the ultimate goal, and adaptation is the key strategy to achieve it. Therefore all adaptation actions should lead to an outcome of improved resiliency for all communities be it municipalities, cities, towns or First Nations communities. And this needs to happen now. Building infrastructure today without considering future climate impacts creates vulnerabilities that will cause later service disruptions and failures, thus increasing costs to government, the private sector and the public.

The threat posed to Canada's public infrastructure by the effects of climate change and extreme weather is compounded by the age of Canada's infrastructure, with much of it dating back to the post-war economic boom of the 1950s and 1960s. It has reached the end of its serviceable lifespan. The quality of life of Canadians has been seriously affected by the inability of asset owners to fund routine maintenance, respond to changing weather patterns, or address the effects of urban expansion. According to the Conference Board of Canada, the municipal infrastructure deficit itself is growing across the country at the rate of \$2 billion annually. A lack of attention to our infrastructure can impede economic development, threaten business investment and decrease the quality of life of Canadians. With proper investment and planning, investments in infrastructure will enhance Canada's productivity, growth and competitiveness, and decrease the costs of repair over the longer term.

A substantial proportion of Canada's infrastructure, much of which dates back to the post-war economic boom of the 1950s and 1960s, has reached the end of its serviceable lifespan. The quality of life of Canadians has been seriously affected by the inability of asset owners to fund routine maintenance, respond to changing weather patterns, or address the effects of urban expansion. According to the Canadian Conference Board, the municipal infrastructure deficit itself is growing across the country at the rate of \$2-billion annually. A lack of attention to our infrastructure can impede economic development, threaten business investment and decrease the quality of life of Canadians. With proper investment and planning, investments in infrastructure will enhance Canada's productivity, growth and competitiveness, and decrease the costs of repair over the longer term.

Engineers Canada believes that the federal government must reach out to engineers to identify the appropriate solutions to infrastructure needs. Together with provincial and territorial governments, municipalities and stakeholders, engineers can help the federal government build a long-term strategy for infrastructure funding. This strategy must include targeted investments in critical infrastructure, the use of sound asset management practices, and priority-setting to keep our communities safe and prosperous.

Communities

From the engineering perspective, climate resilience is the ability of communities to prepare, plan for, absorb, recover from, and successfully adapt to actual or potential adverse climate events occurring over the service life of their infrastructure. As such, the government's promise to include climate resilience as a key pillar in federal infrastructure programs is a proactive and positive response to this growing threat to Canada's public infrastructure. Including a complementary climate resilience objective for public infrastructure projects at provincial/territorial and municipal levels is required to complete the implementation of this strategy. It requires coordination among all levels of government and at all stages of infrastructure procurement, construction, operation and maintenance.

Engineers Canada agrees with the Government of Canada that there is no one-size-fits-all solution to address the needs of Canada's rural and northern communities, and small and large cities. The following proposes several strategies as it relates to achieving public and First Nations infrastructure climate resiliency. The strategies and proposed initiatives include specific ideas and suggestions that Engineers Canada believes, when successfully implemented, would greatly improve the climate resilience of all communities across the country.

Recommendation #1: Develop a more comprehensive understanding of climate vulnerabilities and risks.

Engineers Canada strongly believes that for public and First Nations infrastructure, it is fundamental to have knowledge of the risks to the physical infrastructure as well as of the consequences that a reduction or loss of service to the infrastructure would have on the public, businesses and vulnerable populations. In Engineers Canada's brief submission to the Pan-Canadian Framework process, we recommended that the Framework include the following:

Element 1.1 - For all levels of government, incorporate climate vulnerability assessments into proposals for infrastructure design/build requests that involve new construction or refurbishment.

Engineers Canada has developed an assessment protocol that assesses current and future risk to infrastructure in the event of extreme weather and the impacts of a changing climate. The Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol is a structured, formalized and documented process for engineers, planners and decision makers to identify and recommend measures that address the vulnerabilities and risks from changes in climate design parameters and other environmental factors due to extreme climatic events. The PIEVC assessment helps justify design,

operations and maintenance recommendations, and provides documented results that fulfill due diligence requirements for insurance and liability purposes.

The federal government must support infrastructure owners, including federal departments, to develop the capacity to perform climate vulnerability assessments. The PIEVC Protocol has been used over 40 times in Canada and twice internationally. The federal government should support outreach to public infrastructure owners at all levels of government, to inform them of the benefits and outcomes of climate vulnerability and risk assessments as a first step towards resilience.

Provinces, municipalities and non-governmental organizations applying for federal government funding to build or rehabilitate infrastructure should demonstrate that they have either assessed their infrastructure climate vulnerability and service risks in advance, or require this as part of their design/build procurement process. In addition, they should demonstrate that they have taken reasonable measures to address risks through adaptation measures that assure improved resilience to protect their communities.

The implementation of a climate change vulnerability assessment during the planning stages of all infrastructure projects is a well-known and recognized practice. The federal government could assume a partnership role in working with provincial and territorial governments to ensure that the PIEVC Protocol, a free-to-use climate change vulnerability assessment tool, becomes part of the decision-making process for all new and existing infrastructures on northern and remote communities.

The PIEVC Protocol provides vulnerability and risk information to prepare decision-makers to make the best informed and responsible decisions to achieve cost-effective climate resilient infrastructure that protects and serves the public and their investment.

However, the assessment is only the first step. To truly help Canadian communities be more resilient, the government must help them build the capacity to perform the assessments and also provide sustainable funding models to execute the recommendations.

By identifying the vulnerability of new and existing infrastructure to extreme weather events and service disruptions, communities will be better able to manage the dangers to life and property as well as best using limited financial resources.

Element 1.2 - Incorporate climate vulnerability and resilience objectives into federal and provincial environmental assessment processes.

Another place to embed climate vulnerability and risk assessment is in federal and provincial environmental assessment procedures. An environmental assessment should consider all aspects of the environment, including, for example, emissions levels and changing climate conditions. The project proponent should be required to review the project and advise on those features that will reduce climate risk and improve resiliency. Engineers Canada recommends the inclusion of climate vulnerability and resilience objectives into federal and provincial environmental assessment processes.

Consideration of climate effects in the environmental assessment of proposed projects will build resilience in the local jurisdiction or community. These considerations not only define potential risks and vulnerabilities but would also propose climate adaptation measures, and their implementation during the detailed design stage of any project. In addition, where proponents do not comply with this provision, they should be required to justify the rationale and provide evidence for such a decision. This measure reinforces due diligence on the part of the federal government, and puts the onus of potential legal liability on the proponent unless they comply.

Element 1.3 – Support the Infrastructure Resilience Professional (IRP) certification to support resilient infrastructure

Climate change is here. It has already had a serious impact on our infrastructure, economy and environment and its future impacts will only grow with time. Mitigation efforts may slow the rate of change, but are unlikely to reverse the trend. The majority of Canada’s infrastructure is decades old, and was designed based on out-dated climate patterns. In light of our changing climate, design standards and existing infrastructure systems may need to be revised to ensure public safety and quality of life.

The joint efforts of engineers, architects and other infrastructure stakeholders will be required to address the combined challenges of infrastructure development and renewal in the face of climate change. Professionals must augment their skills with new information necessary to (re)design for, and adapt to, a climate-adjusted future. An understanding of climate change risks and opportunities affecting project planning, design, construction and operation will be necessary to properly execute projects going forward.

Engineers have a professional duty to protect human health, safety and welfare and are subject to legal responsibilities and standards of care, which could expose them to legal liability relating to climate impacts and associated damages if proper standards of prudence are not met. As the climate continues to change, legal duties and standards of care are also evolving. Relying on outdated standards and processes could be considered negligent. There is a need for education on climate change law and policy developments among engineers, the wider construction industry and related decision-makers to promote improved consideration of climate change in a variety of practice areas and project types.

Engineers Canada has developed the Infrastructure Resilience Professional (IRP) certification program that recognizes an engineer’s additional knowledge in planning, designing and managing resilient infrastructure and building assets and components in the face of extreme weather and changing climates. This two-day professional course will be recognized as part of the IRP program and aims to educate engineers on climate change law issues and the associated implications on their practice.

The need to properly consider climate to improve resiliency to impacts over the service life of infrastructure in communities across Canada has never been greater given the projected changes in Canada’s climate. Therefore, Engineers Canada strongly recommends that the federal government support Engineers Canada’s Infrastructure Resilience Professional (IRP) Certification program to protect the service life, maintenance and continued assessment of infrastructure across Canada, as well as to support resilient infrastructure across Canadian communities in order to protect public safety and the quality of life.

Element 1.4- Implement Qualifications-Based-Selection to Protect Public Safety

It is also recommended that qualifications-based selection criteria that include standards to evaluate improvements to climate resilience be incorporated into all phases of procurement for services in the infrastructure life cycle (i.e. design, construction, operations and maintenance contracts).

Services for infrastructure that are procured solely on the lowest bid can lead to cost savings initially. However, this process can also lead to higher construction, operation and maintenance costs over the lifespan of the infrastructure by encouraging the replication of older, cheaper technologies that will not be resilient to the inevitable future changes in climate. A selection method that attaches an overriding significance to infrastructure costs, such as the cost of engineering fees, can result in a situation where design-time limitations restrict the engineer's professional autonomy to find the best solutions to improve infrastructure climate resilience and protect public safety.

Qualifications-based selection is a transparent procurement process used for the selection of architectural and engineering services for public infrastructure construction projects. Under this system, the infrastructure owner considers a variety of competing engineering firms and selects a qualified firm, and then negotiates the project scope of work, schedule, budget, and fees. Adopting a qualifications-based selection process significantly enhances the prospects for innovative approaches that include climate adaptation. This will benefit taxpayers through improved reliability, climate resiliency, safety and long-term savings.

Qualifications-based selection maximizes the value of the engineer's contribution to a project while reducing the project's life cycle costs. Design engineering typically accounts for only about 2 per cent of the life cycle cost of infrastructure, but dramatically impacts the cost, climate resilience and quality of the remaining 98 per cent.

Therefore, Engineers Canada strongly recommends that the federal government support the requirement of qualifications-based selection with a climate resilience component for the procurement of all infrastructure services (e.g. engineering design) in order to protect public safety throughout all Canadian communities.

Recommendation #2 – Undertake an initial five-year dedicated program on infrastructure codes, standards and related instruments (CSRI) to incorporate climate resiliency

National and provincial codes, standards and policies are key foundations that support integration of climate change adaptation into standard practices to improve community resiliency. Engineers Canada is aware that efforts are underway to incorporate climate change considerations into the National Building Code of Canada (NBCC). We fully endorse these efforts and suggest that the federal government acknowledge and confirm its support for this important work.

Engineers Canada suggests that the scope of CSRI be extended to include maintenance standards that are infrastructure-specific. Aside from public use, our changing climate and extreme weather events present a huge problem that diminishes infrastructure capacity over the life cycle unless proper maintenance procedures are continuous. Insufficient maintenance has led to the infrastructure deficit

that exists today within several Canadian communities and increases our vulnerability to extreme weather events in the shorter term.

In order to protect Canadian communities, scheduled infrastructure maintenance should be a part of the delivered infrastructure design that would provide an important tool for communities to maintain operations and maintenance budgets. However, the maintenance schedule should adhere to national or provincial and territorial standards that must be developed to reflect current and anticipated climate extremes.

Engineers Canada recommends:

- By 2020, make amendments to national-, provincial-, territorial- and municipal-level infrastructure design standards, by-laws and other mechanisms to incorporate climate resiliency and provide guidance.
- By 2020, develop the first generation of national and provincial and territorial infrastructure maintenance standards that recognize climate resiliency as a prime objective. These should complement the climate resiliency provisions in building and infrastructure construction design codes and standards.

Recommendation #3 – Improve climate science, climate-related information, climate services and improve utilization of climate tools

There are many types of science, information and decision support tools governments of all levels must invest in and better use to help all communities improve resilience to adapt to climate changes.

For example, certain areas of Canada are vulnerable to floods and, in some cases, new developments are being built, unknowingly, on flood plains. Building near a flood plain can be disastrous on various levels, especially if major flooding is not taken into account during the design phase of infrastructure. Flood mapping is an important tool in the assessment and management of flood risks. These maps constitute a basis for land use and planning, infrastructure maintenance and development and emergency planning. It is therefore vital information to planning a more **resilient community**. To better equip planners, engineers and communities as a whole, flood plain maps should be updated regularly, especially following a flood, to communicate accurate and reliable information to those who manage the development and continue to live within the area.

Environment and Climate Change Canada should restore its leadership role in collecting, analyzing, standardizing and freely sharing climate data with public and private agencies, particularly at the provincial level. This should include, but should not be limited to, a significant expansion and coordination of the network of climate and weather stations operated by Environment and Climate Change Canada and by others across the country. Engineers Canada also recommends improved support for the development of provincial and territorial climate data sets and scientifically defensible climate projections for use by many sectors of the economy.

Engineers Canada therefore strongly recommends that the federal government include improvements to climate science, climate-related information and climate services including:

- Continued development of ensemble approaches to climate projections that reduce or better define uncertainties.
- Consulting with climate data users to recommend and implement an initial research program for future projections of climate parameters other than, but in addition to, temperature and precipitation.
- Updated flood mapping prioritized to flood-prone or flood-risk communities and areas that include improved digital elevation models.
- Enhanced and easily accessible historical weather and climate data.
- A program to update outdated Intensity, Duration and Frequency curves to present time coupled with an ongoing program to update them every five to ten years.
- Implement an enhanced and cooperative climate and watershed data collection program among all levels of government and the private sector that meets national standards.
- Development of provincial and territorial future climate data sets at a community level of resolution based on projections that focus on extreme values and percentiles, using scientifically defensible methodologies.

Improving the utilization of climate tools at the community level requires not only financial resources, but also human resources. This is particularly necessary for small and remote First Nations communities that often do not have the professional expertise on staff.

Capacity-building, community outreach, and training are all fundamental strategies that must be embraced by the federal government in order to achieve climate resiliency. To improve climate resiliency, adaptation actions must be fully embraced and implemented. Proactive outreach and consultation on infrastructure climate vulnerabilities and risks, as well as understanding needs and priorities with a focus on smaller and First Nations communities, is a first step. This would be followed by capacity-building that includes training of individuals engaged in planning and operating infrastructure for their communities through a learn-by-doing approach.

It is suggested that funding be provided to support the completion of pilot projects and demonstration projects in a few communities across Canada as a first phase approach. The learning outcomes would be developed into a replicable process that could be applied jointly or separately to small and remote First Nations communities.

The outcomes could also serve as a very compelling source of information to support public infrastructure decision-makers as well as Indigenous decision-makers. These projects would provide great hands-on learning opportunities for the participants, but more importantly can provide powerful evidence to prove the application and improve the transferability of climate resilient solutions across the country.

Recommendation #4 – Support funding for infrastructure on First Nations Reserves and in remote communities

The deteriorating condition of Canada's infrastructure poses serious risks to the health, safety and environment of Canadians. Roads and bridges, water and wastewater treatment facilities and transit and energy systems must be maintained regularly. Engineers can help decision-makers develop and put in place long-term solutions that improve public safety. Education and regulatory requirements ensure that engineers have the knowledge, skills and experience they need to create a safer, more sustainable and prosperous future for Canada.

The deficit for on-reserve and remote community infrastructure is estimated at several billions of dollars by the First Nations Financial Management Board. Ageing, inadequate and poor infrastructure has had a significant impact on the social and economic outcomes of communities. In this respect, infrastructure is about meeting the most basic needs of individuals, families and communities—putting a safe, resilient roof over a family's head and making sure that they have access to clean drinking water.

Infrastructure deficits in Canada are not exclusive to Indigenous communities, but the differences in the level of deficiencies compared to off-reserve communities are significant. For example, a CBC News investigation revealed that two-thirds of all First Nation communities in Canada have been under at least one drinking water advisory at some time in the last decade. It also found that 400 out of 618 First Nations communities had some kind of water problem between 2004 and 2014. The Neskantaga First Nation in Ontario, for example, has been under a boil water advisory for the past 20 years.

Health Canada (2016) reports that as of June 2016, there have been a total of 134 drinking water advisories in effect in 93 Indigenous communities across Canada—excluding British Columbia. Advisories are initiated for a number of reasons. A community in Canada may issue an advisory "if there are problems in the overall water system, such as line breaks, equipment failure or poor filtration/disinfection during water treatment" (Health Canada, 2016). Indigenous and rural communities across Canada may also issue a water boil advisory as a precaution. These occur when repairs to a water distribution system need to be immediately repaired or if "a community does not have a trained Water System Operator or Community-based Drinking Water Quality Monitor in place" (Health Canada, 2016).

Engineers Canada supports the federal government's 2016 investment of \$8.4 billion over five years, beginning in the 2016-2017 fiscal year, towards improvements of socio-economic conditions of Indigenous populations and communities. The infrastructure that many First Nations reserves lack reflects what is usually provided by municipalities or provinces and territories; however, under the Indian Act, this is the federal government's responsibility. The federal government must fulfill its promise to establish a new fiscal relationship that gives First Nations communities sufficient, predictable and sustained funding. This funding must focus largely on resilient and sustainable public infrastructure.

This will greatly help the state of infrastructure on First Nations reserves and in rural and remote communities, as well as help the government deliver on their promise to have clean drinking water on reserves within five years of forming government. Cultural practices must be incorporated into the design of infrastructure and the subsequent training in order to maintain the sustainability of infrastructure in place.

This will require engineers and Indigenous and Northern Affairs Canada employees to undergo training in cultural awareness. On top of funding projects, the federal government must help build the capacity

for Indigenous communities to assess, plan and manage their infrastructure. The government can help Indigenous communities build capacity by supporting the training and education of Indigenous people to foster and maintain expertise. This will better equip communities to build capacity, increase infrastructure resilience and improve sustainability.

Engineers Canada therefore strongly recommends that the federal government includes improvements to infrastructure on First Nations reserves and in remote communities including:

- Adequate resources on First Nations reserves and in remote communities for ongoing maintenance and operations covering the full service life of these infrastructures.
- Essential infrastructure on First Nations reserves and in remote communities—such as safe drinking water, access to stable sources of electricity, wastewater treatment, waste management, information technology and schools and housing—must be properly funded, built to industry standards and climate resilient.
- Identical high-level services to infrastructure design, construction and maintenance related to roads, policing, community centres, education and healthcare on First Nations reserves and in remote communities as in the rest of Canadian communities.
- Honoured traditional and cultural practices while working with Indigenous peoples to address infrastructure design, construction and maintenance.

Recommendation #5 –Federal support for public safety and emergency preparedness strategies throughout Canadian communities

When disasters occur it is the community's first responders, including engineers, who take an active role in responding to a crisis immediately. Examples of disasters include Calgary's 2014 flood and the 2016 Fort McMurray fire. Often, municipal responders cannot face these incidents and disasters alone. As the Federation of Canadian Municipalities (FCM) outlines in their 2015 report entitled: 'Public Safety and Emergency Preparedness,' first responders "need an active federal partner to prepare for and respond to large-scale incidents..." (2015).

Without active federal support, many communities across Canada are ultimately unable to invest in and strengthen their emergency preparedness for disastrous events; hindering their ability to uphold the safety of their citizens during times of crisis.

In order to uphold public safety and improve emergency preparedness strategies across the country, Engineers Canada strongly believes that the federal government must:

- Work collaboratively with Engineers Canada in order to implement the PIEVC Protocol in the design, development and continued maintenance of infrastructure within rural and remote communities in order to better protect vulnerable infrastructure during an emergency.
- Take additional measures to improve awareness and development of emergency plans in communities across Canada.

- Consult and collaborate with the engineering profession on climate change and emergency preparedness policies. The engineering profession can provide the federal government with technical expertise and advice on adaptation, risk assessment and mitigation strategies that the federal government requires to develop and implement sound policies and strategies.
- Fund public safety and emergency preparedness research in vulnerable communities across Canada to assess the impacts and adaptation required, and thereby increase the reliability of scientific data used by engineers.
- Promote an awareness of climate change impacts, emergency preparedness policies and adaptation to communities and industry in order to better prepare communities for emergency situations.
- Work collaboratively with provincial and territorial governments, in partnership with Indigenous community leaders, to understand, assess and adapt to changes in Canada's climate, including specific challenges in Canada's North.
- Update flood mapping, prioritizing it to flood-prone or flood-risk communities and areas that include improved digital elevation models.