



# Standards in Action:

Building a Climate-  
Resilient Future

Standards  
Council  
of Canada

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Canada



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## About the Standards Council of Canada

Established in 1970 as a federal Crown corporation, the Standards Council of Canada (SCC) is Canada's voice on standards and accreditation on the national and international stage. SCC works closely with a vast network of partners to promote the development of effective and efficient standards that protect the health, safety and well-being of Canadians while helping businesses prosper. As Canada's leading accreditation organization, SCC creates market confidence at home and abroad by ensuring that conformity assessment bodies meet the highest national and international standards. SCC advances Canada's interest on the international scene as a member of the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) by connecting thousands of people to global networks and resources, opening a world of possibilities for Canadians and businesses.

For more information, visit <https://www.scc.ca>

# Executive summary

Today's buildings and infrastructure were built with a stable climate in mind. But as Canada's climate changes, so do the infrastructure standards we rely on to keep Canadians safe. Since 2016, the Standards Council of Canada (SCC)'s **Standards to Support Resilience in Infrastructure Program (Infrastructure Program)** has led the development of standards and related guidance to help communities, businesses, builders, and infrastructure operators adapt. The Infrastructure Program winds down in March 2021, but there is more work to do.

To help us plan for the next phase of work, SCC reached out to a range of key stakeholders to ask what else is needed to prepare the country for climate change. This outreach was done from February to August 2020 via a virtual cross-country consultation: the **Standards in Action: Building a Climate-Resilient Future** Campaign. This included online surveys that resulted in a total of 371 survey responses, and key informant interviews with more than 40 government, not-for-profit, and private sector stakeholders from across the country.

SCC received a large volume of input over the course of the campaign, with thought-provoking insights on a wide range of topics. From this input, the following key themes emerged:

1. Standards are needed to respond to all hazards, but the urgency of these hazards varies by region and sector in Canada
2. Responses to climate change in Canada are emerging and maturing, but additional standards and supporting tools are needed
3. Mobilizing standards will require more efforts on awareness, guidance, and capacity building
4. Standardization could boost the cost-effectiveness of responding to more than 35 additional adaptation, mitigation, and sustainability-related challenges
5. More than 100 standards urgently need updating for climate change
6. Canada's standardization system has room to be faster, more ambitious, and more inclusive of diverse perspectives

These themes validate SCC's work to date, while laying the blueprint for an expanded and more ambitious program on climate change and sustainability. Based on these findings, SCC will design renewed infrastructure programming. As Canada's national standards body, we look forward to leading the update and development of climate-ready standards that make a concrete difference to Canadian communities, households, and businesses. This work will also require the continuation and expansion of collaboration with partner organizations including standards development organizations, professional associations, and jurisdictions with authority.

Investing in climate-resilient standards and related technical guidance will safeguard and reduce long-term maintenance and repair costs of critical infrastructure, and protect the health and safety of Canadians.

As we seek funding for the next iteration of the program, we invite you to keep in touch by email at [infrastructure-environment@scc.ca](mailto:infrastructure-environment@scc.ca).



# Introduction and overview

## The Standards to Support Resilience in Infrastructure Program (2016–2021)

Canada's climate is changing, and warming twice as fast as the rest of the world; in the North, temperatures are rising three times as fast.<sup>1</sup> Floods, wildfires, coastal erosion, permafrost thaw, heat waves, and other weather-related events are already having significant impacts on our society and our economy. Over the last five decades, the costs of natural disasters like these have risen from tens of millions of dollars per year to billions of dollars per year.<sup>2</sup>

Much of today's buildings and infrastructure are designed, built, and operated according to standards that were written with a stable climate in mind. But as the climate changes, older standards are no longer enough to keep Canadians safe. To address this gap, since 2016 the Standards Council of Canada (SCC)'s **Standards to Support Resilience in Infrastructure Program** (or Infrastructure Program, for short) has led the development of standards and related guidance to help communities, businesses, builders, and infrastructure operators adapt. From flood risk assessment frameworks to standards for fire-resilient planning, SCC has worked with a range of partners to deliver practical, made-in-Canada guidance to enable the design, construction, and maintenance of buildings and infrastructure that can better withstand the climate conditions of the future.

<sup>1</sup> Bush, E. and Lemmen, D.S., editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p. Available: <https://changingclimate.ca/CCCR2019/>.

<sup>2</sup> Canadian Institute for Climate Choices (2020).



## What is a standard?

A **standard** is a document that provides a set of agreed-upon rules, guidelines, or characteristics for activities or their results. Standards establish accepted practices, technical requirements, and terminologies for diverse fields. They can be mandatory or voluntary and are distinct from Acts, regulations, and codes, although standards can be referenced in those legal instruments.

In the context of this report, Canada's **standardization system** refers to the network of organizations that includes SCC and the 12 standards development organizations (SDOs) that are accredited by SCC to develop National Standards of Canada.

At SCC, a key output of our activities is what we call a **standardization strategy**: an idea or action that fills a gap or solves a problem by developing, improving, or coordinating; or by using national, regional, or international standards or related tools. As of January 2021, the Infrastructure Program has advanced 41 standardization strategies, exceeding our original target of 36. These include:

- four new National Standards of Canada (NSCs) to improve access to data from non-federally owned weather stations in Canada
- two new research reports and two new NSCs on reducing flood risks in residential communities
- six new NSCs and a new guide on addressing the various climate hazards faced by northern communities
- a new research report and a new NSC on resilience to high winds
- updated standards for antennas and building foundations
- a new report on protecting children from extreme heat in public playgrounds

A full list of these projects is presented in Annex A.

In the broader federal context, the program supports the Adaptation pillar of the Pan-Canadian Framework on Clean Growth and Climate Change (2016) and contributes to goals and milestones identified in the 2016–2019 and 2019–2022 federal sustainable development strategies.<sup>3</sup> The program also aligns with federal ministerial mandate letter commitments to build climate resilience and implement the Pan-Canadian Framework, and contributes to UN Sustainable Development Goals 6 (clean water and sanitation), 9 (industry, innovation, and infrastructure), 11 (sustainable cities and communities), and 13 (climate action).<sup>4</sup>

3 Environment and Climate Change Canada (2016). *Pan-Canadian Framework on Clean Growth and Climate Change: Canada's plan to address climate change and grow the economy*; Government of Canada (2016). *Achieving a Sustainable Future: A Federal Sustainable Development Strategy for Canada 2016-2019*; Government of Canada (2019). *Achieving a Sustainable Future: A Federal Sustainable Development Strategy for Canada 2019-2022*.

4 Clean water and sanitation; Industry, innovation, and infrastructure; Sustainable cities and communities; and Climate action.

## Standards and codes

Generally, a **standard** is specific in focus, while a **code** is broader in scope and often references a large number of other standards. Although voluntary by default, codes and standards can carry the force of law when adopted by a provincial, territorial, or municipal authority.

Both can be developed as National Standards of Canada (NSCs), through the national standards development system overseen by SCC. For instance, the Canadian Electrical Code is an NSC, developed by CSA Group, an SCC-accredited standards development organization (SDO).

There are also five national model codes: the National Building Code of Canada, the National Fire Code of Canada, the National Plumbing Code of Canada, the National Energy Code of Canada for Buildings, and the National Farm Building Code. These are not part of the national standardization system. They are instead overseen and published by the National Research Council (NRC), an agency of the Government of Canada.

## The case for program renewal

The Infrastructure Program will sunset on March 31, 2021, but there is more work to do. The Council of Canadian Academies' 2019 report on climate risks identifies physical infrastructure as one of the top six areas of climate change risk in Canada, as well as one of the areas with the highest adaptation potential.<sup>5</sup> A study commissioned by the Federation of Canadian Municipalities and the Insurance Bureau of Canada estimates that an average annual investment of \$5.3 billion, or 0.26% of GDP, is needed in municipal infrastructure and local adaptation measures to minimize the worst impacts of climate change across the economy.<sup>6</sup> Indeed, because of the interconnected nature of different risks and ongoing uncertainties—around population growth, economic growth, technological change, and the trajectory of global greenhouse gas emissions—what we know about the costs of climate change is only the tip of the iceberg that looms ahead.<sup>7</sup> With the COVID-19 pandemic's devastation of the global and domestic economy, a new consensus has emerged among financial and economic leaders on the need for a sustainable, resilient recovery.<sup>8</sup>

Standards can and should be part of the solution. Formalized approaches for improving the resilience of infrastructure systems to extreme weather and climate change in Canada are increasing both in number and technical rigour. Key forms of guidance, including improvements to existing standards and the development of new ones, can help drive the use and consistent application of these resilience-based approaches. This perspective is echoed in a number of prominent expert-led reports. The Canadian Institute for Climate Choices' *Tip of the Iceberg* report (2020), for example, promotes the updating of building standards to reflect the future climate that buildings and infrastructure will need to withstand.<sup>9</sup> Similarly, the Council of Canadian Academies recommends ensuring that building codes and standards take climate projections into account, with modified design criteria for structures in coastal zones exposed to extreme weather events and rising sea levels.<sup>10</sup> The Task Force for a Resilient Recovery, an independent group of Canadian finance, policy, and sustainability leaders formed to urge governments to pursue a sustainable recovery from the COVID-19 crisis, calls for strengthened federal and provincial commitments to climate

5 Council of Canadian Academies (2019). *Canada's Top Climate Change Risks*.

6 Federation of Canadian Municipalities and Insurance Bureau of Canada (Sep. 2019). *Investing in Canada's Future: The Cost of Climate Adaptation*.

7 Council of Canadian Academies (2019); Canadian Institute for Climate Choices (2020). *Tip of the Iceberg: Navigating the Known and Unknown Cost of Climate Change for Canada*.

8 Task Force for a Resilient Recovery (Sep. 2020). *Bridge to the Future: Final Report from the Task Force for a Resilient Recovery*.

9 Canadian Institute for Climate Choices (Dec. 2020).

10 Council of Canadian Academies (2019).



action, including advanced codes and standards so that the roughly 200,000 buildings that are constructed in Canada every year produce less pollution, are more resilient to extreme weather events, and have lower energy costs.<sup>11</sup> The same theme appears internationally—in its 2019 *Call to Action* report, the Global Commission on Adaptation called on governments to develop and update national technical codes and standards to account for physical climate risks.<sup>12</sup>

As Canada's national standards body, SCC's mandate is to promote efficient and effective standardization to support sustainable development, advance the national economy, and benefit the health, safety, and welfare of Canadians. So, we will continue leading efforts to fill these gaps. To date, the work of our Infrastructure Program has been well received and our outputs are seeing increasing uptake and use. Conversations with stakeholders have clearly indicated appetite for more. The big question, however, is where to focus efforts and limited resources. So from February to August 2020, we reached out to a range of key stakeholders—engineers, builders, planners, policy-makers, and other professionals who rely on standards to design, build, and maintain Canada's buildings and infrastructure—to ask what else is needed to prepare the country for climate change. We conducted this outreach via a virtual cross-country consultation: the ***Standards in Action: Building a Climate-Resilient Future*** campaign.

## ***The Standards in Action: Building a Climate-Resilient Future*** campaign

The purpose of the *Standards in Action* campaign was 1) to increase awareness and uptake of Infrastructure Program deliverables, so that Canadian households, communities, and businesses are better armed to withstand climate impacts; and 2) to identify additional gaps in standards, codes, and practices that leave Canadians vulnerable to climate change. We were also interested in stakeholders' views on expanding our scope beyond climate adaptation to include climate change mitigation and sustainable development.

To achieve this purpose, our campaign included these six components:

1. **Short digital surveys**, open to all Canadians through an online engagement platform
2. **Key informant interviews**, conducted remotely<sup>13</sup>
3. **Capstone focus groups**, to provide an additional layer of expert review and validation of the outputs of the above components
4. **Standards catalogue reviews** by SCC-accredited standards development organizations (SDOs), to identify existing consensus standards that should be updated to reflect climate change
5. **A risk prioritization framework**, a customized tool to analyze and prioritize potential new areas of standards work
6. **An economic impact analysis**, to begin quantifying the impacts of implementing climate-resilient standards

<sup>11</sup> Task Force for a Resilient Recovery (Sep. 2020).

<sup>12</sup> Report available at <https://gca.org/global-commission-on-adaptation/report>.

<sup>13</sup> Originally this component was to entail the hosting of six interactive workshops in five provinces, but was replaced by virtual stakeholder interviews and capstone focus groups due to the limits on domestic travel and meetings brought on by the COVID-19 pandemic.

We engaged several professional firms to assist with the campaign.<sup>14</sup>

The campaign kicked off with the launch of an online engagement platform and series of **short digital surveys**. Questions were organized into four categories:

1. *You and SCC* (relating to basic demographics as well as level of familiarity with SCC and standards)
2. *Adaptation to the impacts* (relating to climate change adaptation)
3. *Reducing emissions* (relating to climate change mitigation)
4. *Sustainability* (relating to other environment-related topics)

The engagement platform link was published on SCC’s website, newsletters, and social media channels; circulated to federal-provincial climate change working groups and their distribution lists; and promoted via [Canada’s Climate Change Adaptation Platform](#). Survey invitations were also sent to more than 350 individuals representing federal, provincial, territorial, and municipal governments; industry and professional associations; think tanks and centres of excellence; engineering firms; Indigenous organizations; academia; and SDOs. Many of these organizations further promoted the survey—for example, in industry association newsletters. The four surveys ran from March 3rd to June 8th and received a total of 371 responses. Survey results are summarized in Annex B.

In conducting the **key informant interviews**, we reached out to more than 40 government, not-for-profit, and private sector stakeholders from across the country. Figure 1 shows the types of organizations represented.

**Figure 1: Types of organizations interviewed for the *Standards in Action* campaign**



Respondents included people whose work relates to built and green infrastructure, climate change adaptation and/or mitigation, sustainability, and environmental policy. Professions represented included engineers, geoscientists, architects, planners, builders, biologists, meteorologists, climatologists, accountants, standards development professionals, policy analysts, and program managers. Annex C contains a full list of interviewed organizations.

<sup>14</sup> The online engagement platform was designed by 76Engage; the key informant interviews and focus groups were conducted by the Climate Risk Institute; the Risk Prioritization Framework was developed by Risk Sciences International and Dillon Consulting; and the economic impact analysis was performed by Golder Associates.



Results of the interview process were then compiled and presented to four **capstone focus groups**, in which interviewees were also invited to participate to validate and hone preliminary findings. A small number of key stakeholders who were unable to participate in the interviews joined the focus groups instead.

To identify opportunities for updating existing NSCs, SCC's accredited SDOs were invited to submit proposals to conduct **standards catalogue reviews**. SDOs were asked to determine whether any NSCs in their catalogues should be updated in consideration of one or more of the following objectives:

- Adaptation to climate change impacts
- Mitigation of greenhouse gas emissions
- Reducing negative effects and impacts on the environment
- Sustainability and/or sustainable development

Four SDOs participated in the project, reviewing a combined total of 714 standards. These SDOs were the CSA Group, the Canadian General Standards Board (CGSB), the International Association of Plumbing and Mechanical Officials (IAPMO), and the Bureau de normalisation du Québec (BNQ). Findings are summarized in Annex E.

Recognizing that the above activities could result in a large number of ideas for new standardization strategies, we commissioned the development of a **risk prioritization framework** (Annex D). The tool was developed based on existing knowledge about climate change risks to infrastructure and shaped by expert feedback during the consultation, and would help identify which proposals to tackle first based on risk, feasibility, equity, stakeholder readiness, and a variety of other considerations.

Finally, an **economic impact analysis** was commissioned to model the costs and benefits to Canada's economy of implementing climate-resilient standards (Annex F). The study analyzed impacts on a 20-year time horizon and, for feasibility purposes, limited its scope to two NSCs funded by SCC's Infrastructure Program: CSA W204 *Flood resilient design of new residential communities* and CAN/BNQ 2501-500/2017 *Geotechnical Site Investigations for Building Foundations in Permafrost Zones*.



# Key themes: What we heard

We received a large volume of input over the six months of the campaign, with thought-provoking insights on a wide range of topics. In terms of ideas to guide renewal of the Infrastructure Program, the following key themes emerged:

1. Standards are needed to respond to all hazards, but the urgency of these hazards varies by region and sector in Canada
2. Responses to climate change in Canada are emerging and maturing, but additional standards and supporting tools are needed
3. Mobilizing standards will require more efforts on awareness, guidance, and capacity building
4. Standardization could boost the cost-effectiveness of responding to more than 35 additional adaptation, mitigation, and sustainability-related challenges
5. More than 100 standards urgently need updating for climate change
6. Canada's standardization system has room to be faster, more ambitious, and more inclusive of diverse perspectives

## Theme #1: Standards are needed to respond to all hazards, but the urgency of these hazards varies by region and sector in Canada

As other national climate assessments have found, Canada is exposed to nearly every hazard linked to climate change, from flooding to wildfire to permafrost thaw to extreme heat.<sup>15</sup> In our consultation, we asked experts across the country to tell us which hazards should be of top priority. These included:



Extreme **precipitation** and **flooding** (including increased winter precipitation, hail, ice storms, and rain-on-snow events; as well as including pluvial, riverine, and spring-summer flooding)



Sea-level rise and **coastal** hazards (including erosion and storm surge)



Slow **degradation** processes such as permafrost change, freeze-thaw cycles, and sea-ice change



Extreme **winds** and tornadoes



Extreme **heat**, drought, and water availability



**Wildfire** and related interactions at the wildland-urban interface

<sup>15</sup> Bush, E. and Lemmen, D.S., editors (2019). *Canada's Changing Climate Report*. Government of Canada, Ottawa, ON; Auditors General of Canada (2018). *Perspectives on Climate Change Action in Canada—A Collaborative Report from Auditors General of Canada*; Council of Canadian Academies (2019). *Canada's Top Climate Change Risks*.

## The challenge of ranking hazards

In our key informant interviews, participants were able to identify climate change hazards of consequence for their region or sector with relative ease, but often struggled to rank hazards by importance or priority. Some participants saw the rank ordering of hazards as difficult or problematic, for several reasons:

- **All hazards are relevant.** The extent to which a hazard is consequential can be highly contextual and depends on the exposure and sensitivity characteristics of different systems, communities, and regions.
- **All hazards are here.** Participants reported responding to multiple climate-related hazards. Taken together, the participants named all hazards that could reasonably be expected of a national survey, or a review of relevant literature.
- **All hazards are connected.** Furthermore, participants noted that hazards, and the sectors, assets, or places at risk, are very often interconnected, challenging the notion of responding to hazards on an individual basis.

Interestingly, though participants were able to identify climate change hazards of consequence for their region or sector with relative ease, they often struggled to rank hazards by importance or priority from a national perspective. This was because the relative importance of a hazard varies greatly between regions and sectors. The box above further explains the challenge of ranking hazards.

Some participants also identified certain climate hazards and their consequences as especially relevant to their sector or region. This included:

- wind, fire, hail, and flooding in the insurance sector
- freezing rain, flooding, and high winds (e.g. tornadoes, post-tropical storms) in the electricity sector
- extreme heat events in large municipalities
- coastal flooding, storm surge, and erosion in coastal areas
- permafrost thaw, freeze-thaw cycles, and sea-ice decline in northern regions
- drought and water availability in the Prairies

Respondents also emphasized the additional risk posed by the **interconnectivity of critical assets**; in other words, due to the interdependence of infrastructure systems, the failure of one system could lead to cascading impacts on others. These stakeholders expressed the need for cross-sectoral, cross-hazard vulnerability and risk assessment (VRA) approaches.

**What SCC has done:** Over the last five years, the work of SCC's Infrastructure Program has touched on nearly all of these hazards, as seen in the list of projects in Annex A. This includes a dedicated stream for northern regions: the [Northern Infrastructure Standardization Initiative](#). Our work has also begun to expand into coastal flood resilience measures.

**Where SCC could go next:** The above feedback on hazards underscores the need for more tools and approaches tailored to specific geographic contexts, as well as standards that help industries understand and respond to risks specific to their assets and operations. The observations about interconnected risks and cascading impacts strongly suggest the need for standards for systems-level approaches, and robust data-sharing between asset owners. Finally, they validate the need for a more granular analysis of potential standards-based responses—an exercise that our Risk Prioritization Framework, presented in Annex D, is uniquely designed to support.



## Theme #2: Responses to climate change in Canada are emerging and maturing, but additional standards and supporting tools are needed

In our interviews and focus groups, experts painted a diverse picture of actions already being taken across Canada in response to the hazards and impacts noted above:

- **New and emerging requirements.** Legislation and regulations, funding programs, and guidelines of professional practice increasingly require the consideration of climate risks and resilience
- **Capacity building.** New positions and roles are being created in public and private sector organizations to help advance climate resiliency, and training programs are being developed to build the knowledge and skills required by these and other professionals
- **Hazard and risk assessments.** Numerous types of climate change assessments, including hazard, impact, vulnerability, risk, and adaptive capacity, are happening across the country

- **Action planning and implementation.** Climate change response plans are being developed and implemented in both public and private sectors
- **Hazard- or context-specific responses.** Adaptation and resilience measures are being developed and applied to address risks identified by private companies, agencies, and governments at all levels
- **Mainstreaming (adaptation through existing plans, programs).** In the public and private sector, climate change responses are being incorporated into regular business activities across organizational units

In several cases, respondents provided specific examples of interventions, many of which could be useful starting points for exploring the uptake of existing climate-resilient standards. While all the above are positive developments, respondents identified many gaps that standards could help fill. In compiling and analyzing the input we received, we noted calls for greater clarity, comparability, consistency, measurability, robustness, and scalability in Canada's adaptation efforts. Table 1 lists specific examples of where these objectives were mentioned by participants.

**Table 1: Identified objectives and examples of where they are desired**

Objective	Examples of areas where this is desired
<b>Clarity</b>	<ul style="list-style-type: none"> <li>• Adaptation-related requirements in regulations</li> <li>• Rules for infrastructure practitioners to limit their liability</li> </ul>
<b>Comparability</b>	<ul style="list-style-type: none"> <li>• Climate change vulnerability and risk assessment (CCVRA) approaches across different critical infrastructure sectors</li> <li>• Performance of interventions across different areas or cities, to support planning and decision-making</li> <li>• Emerging materials, technologies, and approaches for climate and low carbon resilience</li> </ul>
<b>Consistency</b>	<ul style="list-style-type: none"> <li>• Climate information—for example, future-projected rainfall intensity-duration-frequency (IDF) curves</li> <li>• Approaches to risk assessment and management across sectors</li> <li>• Approaches to greenhouse gas (GHG) life cycle assessment, to support (for example) bid evaluation and comparison</li> <li>• Expectations of the competences of climate change mitigation and resilience professionals</li> </ul>
<b>Measurability</b>	<ul style="list-style-type: none"> <li>• Impact reporting</li> <li>• Nature-based solutions to flood risk</li> <li>• Infrastructure performance</li> <li>• Levels of resilience</li> <li>• Levels of service</li> </ul>
<b>Robustness</b>	<ul style="list-style-type: none"> <li>• Formal climate resilience training</li> </ul>
<b>Scalability</b>	<ul style="list-style-type: none"> <li>• Climate risk assessment across systems</li> <li>• Actions need to match the scale and pace of the climate crisis</li> </ul>

**What SCC has done:** The work of the Infrastructure Program is already addressing some of the above objectives. For example, the updated [CSA PLUS 4013:19 Technical guide: Development, interpretation and use of rainfall intensity-duration-frequency \(IDF\) information: Guideline for Canadian water resources practitioners](#) reflects the latest scientific understanding of climate change, helping bring clarity to users on how to incorporate climate change into the formulation and application of IDF information.

**Where SCC could go next:** Each of the objectives in Table 1 could be further supported through standardization. Standards can serve a range of functions, such as variety reduction, information, reference, compatibility, measurement, classification, and codification of behaviour protocols.<sup>16</sup> Building on strong working relationships and our experience in developing standardization strategies, SCC is well placed to help Canadian stakeholders navigate the different functions of standards, and use standardization to enhance existing responses to climate change.

<sup>16</sup> Egyedi, T.M. and Ortt, J.R. "Towards a functional classification of standards for innovation research", Ch. 6 in *Handbook of Innovation and Standards* (2017) edited by Hawkins, R., Blind, K., Page, R.



### Theme #3: Mobilizing standards will require more efforts on awareness, guidance, and capacity building

When asked about the current level of awareness of SCC-funded standards and guidance, responses were mixed. Some respondents were able to name standards that were enabled by SCC's Infrastructure Program. In other cases, respondents expressed the need for standards that already exist or have been recently updated. This suggests that more outreach and communication is needed to increase awareness and uptake of existing standards and guidance.

Interviewed experts who were familiar with SCC's Infrastructure Program, or who were briefed on the program, were overall supportive of the work. They advised us on several ways we could further increase the uptake of climate-resilient standards:

- **Reduce the costs of standards.** Small businesses, small municipalities and resource management agencies, and many NGOs can be constrained by budgets in their ability to access standards. This, in turn, affects the ability of these groups to better inform their own practices, to make appropriate demands of their contractors, and to contribute to the advancement of standards by communicating about them to stakeholders, respectively. Providing low- or no-fee access to standards for certain “amplifying” organizations like the Federation of Canadian Municipalities (FCM) or ICLEI Canada would also ensure these groups are positioned to encourage uptake across their networks.
- **Incorporate standards into procurement and funding processes.** Municipalities, other levels of government, and large corporations are constantly procuring infrastructure and related services. Federal and provincial governments will continue to fund projects. More can be done to educate and raise awareness, provide guidance for procurers, and draw attention to “no-regrets” options.<sup>17</sup>

- **Conduct economic analysis.** Decision-makers rely on economic data. To best make the case for climate and low carbon resilience standards, their impacts must be quantified—and the results shared with influential bodies like the Canadian Association of Municipal Administrators (senior municipal staff), FCM (elected officials), and the Canadian Business Council (private sector).
- **Advocate and raise awareness.** Report on the benefits of climate-resilient standards among audiences with policy-making, decision-making, and financial influence, as well as procurement professionals, home and property owners, and other diverse audiences. Include case studies and testimonials.
- **Embed standards in requirements for professional practice.** Further mobilize climate and low carbon resilience infrastructure standards by making these standards key requirements for professionals such as engineers.
- **Provide more training and capacity building for the use of standards.** This is especially important in northern and remote regions, where staff turnover tends to be high, capacity limited, and travel expensive.
- **Make standards mandatory.** Introducing standards in regulations, policy, and mandatory requirements remains the best—and fastest—way to overcome adoption barriers. This is especially important given the urgency of climate change and the time it takes to build and retrofit infrastructure.

**What SCC has done:** These points reflect efforts that SCC and partner organizations are already pursuing to increase the uptake of standards. In 2019–2020 for example, SCC funded the delivery of five webinars and one capacity building report; and commissioned an economic impact analysis as part of this campaign.

<sup>17</sup> In the context of climate adaptation, “no-regrets” options are responses that deliver net benefits irrespective of whether the climate impact occurs.

As of January 2021, climate-resilient Canadian standards developed under SCC's Infrastructure Program are now included in the Canadian Centre for Climate Service (CCCS)'s online library of climate resources. This "library" is an online database of datasets, tools, guidance, and other resources that Canadian organizations can use for impact, vulnerability, and risk assessments, and for climate adaptation planning.<sup>18</sup> SCC is also working on making standards more accessible—for instance, by negotiating with some SDOs to provide free online view-access to standards, or free downloads of first-edition standards.

**Where SCC could go next:** SCC will continue to work with the CCCS and other partners to ensure that entries for climate-resilient standards in the library of climate resources are up to date; and with accredited SDOs to support the availability of standards at reasonable or no cost. We will also continue working with federal departments to explore how climate-resilient standards can support procurement and funding processes. Raising awareness, embedding standards in professional practice, providing more training, and making standards mandatory are worthwhile goals; they will require collaboration with and strong support from partner organizations such as professional associations, SDOs, and jurisdictions with authority.

Based on conversations with other organizations interested in standards and climate resilience, there is keen interest in conducting economic analysis of the impacts of climate-resilient standards, and sharing that information more widely. The results and lessons learned of this campaign's economic analysis report (Annex F) are a valuable contribution to that collective effort.



<sup>18</sup> Government of Canada. *Library of climate resources*. <https://climate-change.canada.ca/climate-library/?ResourceType=Guidance&q=stand&rd&sort=asc>.

## Theme #4: Standardization could boost the cost-effectiveness of responding to more than 35 additional adaptation, mitigation, and sustainability-related challenges

Our campaign engagement yielded more than 35 suggestions—some very specific, others quite general—of additional areas for advancing mitigation, adaptation, and sustainability through standardization (see Table 2). These topics can be broadly grouped under seven sub-themes:

- **Foundational standards.** “Foundational” standards are those that provide overlapping support for several other standards.<sup>19</sup> Additional work in this area could include new standards to a) make climate data and information more accessible, of more uniform quality, and easier to interpret; b) support the mapping and assessment of climate hazards; c) support the assessment of climate vulnerability or risk, and d) support the assessment of system-wide and cascading impacts.
- **Asset management standards.** The integration of climate change considerations in asset management, supported by new standards, is needed to support asset planning and management.
- **Planning and design standards for specific sectors and hazards.** New standards are needed to help address the risks of climate change associated with specific sectors or climate events.
- **Standards for northern and remote communities.** Northern and remote communities face unique challenges linked to factors such as geography, climate, accessibility, and cost of living. There is a continued need for standards tailored to these contexts.
- **Standards for green infrastructure.** To support green infrastructure as a viable climate solution, there is a need for new standards that support all phases of its life cycle, including evaluation, planning, design, implementation, and operation and maintenance.
- **Quantification and verification methods.** The emergence of new technologies, materials, and approaches to address climate challenges requires new standards, developed in a responsive and timely manner, to support the quantification of benefits and verification of performance.
- **Accreditation and capacity building for professionals.** Supporting the expansion of professional training and certification through new standards will improve and standardize climate resilience and mitigation work among practitioners. These would strengthen and popularize roles such as resilience practitioner, climate solutions engineer, municipal greenhouse gas (GHG) auditor, and climate resilience lead. It might also involve developing new guidance and standards to strengthen capacity for financial analysts to assess and compare different climate risks and resilience measures.

<sup>19</sup> An example of a foundational standard is CSA PLUS 4013 *Technical Guide: Development, Interpretation and Use of Rainfall Intensity-Duration-Frequency (IDF) Information: Guideline for Canadian water resources practitioners*. The standard provides support for all other design codes and standards that make use of IDF rainfall design curves for drainage, water storage, etc.

**Table 2: List of suggested areas to address through standardization**

No.	Topic / Suggested area	No.	Topic / Suggested area	No.	Topic / Suggested area
<b>Foundational standards</b>		<b>Planning and design standards for specific sectors and hazards</b>		<b>Standards for northern and remote communities</b>	
1	Flood mapping standards capturing multiple types and causes of flooding (e.g. ice jams, large-scale riverine flooding), and at different time scales and levels of granularity	11	Environmental assessment	29	Emergency responses for northern and remote communities
2	Vulnerability and risk assessment (VRA) methods and their application	12	Planning	30	Greenhouse gas reduction standards relevant to northern and remote communities
3	Adoption of ISO 14090 and ISO 14091 for Canada <sup>20</sup>	13	Operation of health care facilities during extreme weather events	31	Other unique northern standardization issues
4	Guidance on changing climate science, models, uncertainties, communication of uncertainties, ranges	14	Community spaces for the most vulnerable populations	<b>Standards for green infrastructure</b>	
<b>Asset management standards</b>		15	Safety from heat-related risks, especially daycares and long-term care homes	32	Integrating natural assets (green infrastructure) into asset management and municipal planning
5	Updated climate guidance for critical community and energy utilities	16	Community water conservation and water quality standards	33	Green infrastructure performance
6	Integrated coastal management and ports	17	Emergency management for climate hazards	34	Low impact development
7	Dams and their maintenance	18	Residential emergency management	<b>Quantification and verification methods</b>	
8	Landfills	19	Coastal flooding	35	Standards on sustainability of buildings
9	Conservation of historical sites and assets	20	Technologies to respond to flood risks (e.g. flood protection barriers)	36	Materials standards that include climate change, sustainability considerations
10	Best practices for sustainability and resilience in asset management	21	Rain and snowmelt runoff management	<b>Accreditation and capacity building for professionals</b>	
		22	Soil stabilization	37	Accreditation for new areas of practice—climate resiliency, climate solutions engineer, GHG auditor, large city climate resiliency lead
		23	Landscaping		
		24	Design in modular construction		
		25	Reducing bird collisions with buildings and structures		
		26	Resilient transportation systems		
		27	Mine operations and closure		
		28	Adopt CSA S502 for provinces <sup>21</sup>		

20 ISO 14090 *Adaptation to climate change—Principles, requirements, and guidelines*; ISO 14091 *Adaptation to climate change—guidelines on vulnerability, impacts and risk assessment*.

21 CSA S502 *Managing changing snow load risks for buildings in Canada's North*.



**What SCC has done:** These ideas reflect and validate many past and existing projects under the Infrastructure Program. Foundational standards we have enabled include the development of ISO Guide 84:2020 *Guidelines for addressing climate change in standards*, as well as [CSA PLUS 4013:19 Technical guide: Development, interpretation and use of rainfall intensity-duration-frequency \(IDF\) information: Guideline for Canadian water resources practitioners](#). We have demonstrated the need for *asset management standards for municipal stormwater systems* through the development of a foundational report, and then facilitated the development of a standard to address that need: CSA W211 Management standard for stormwater systems (in progress). Foundational documents and standards covering a range of sectors and hazards have been commissioned, such as [Reducing the risk of inflow and infiltration in new sewer construction](#), and [CSA W204:19 Flood resilient design of new residential communities](#). A dozen North-specific standards and guides have been launched or completed since 2016, addressing erosion, wildfire, snow loads, permafrost, and other hazards.

In an effort to characterize the cost-effectiveness of using these standards, the economic impact analysis component of this campaign focused on the economy-wide impacts of deploying two of these standards (details in Annex F). The modelling showed that the widespread implementation of the CSA W204:19 *Flood resilient design of new residential communities* standard would have negligible impacts on development costs but could provide a cumulative increase in Canada's GDP by up to \$234 million (2015\$) between 2020 and 2035 through avoided flood damages. Beyond the avoided flood damage, the analysis noted that use of the flooding standard would help to build overall community resilience, and would likely reduce social and community disruptions and improve mental health of community members, due to limiting residential impacts during extreme weather events. NSC development costs are negligible in the context of these savings, demonstrating the significant ROI associated with developing and deploying similar standards.

The analysis also quantified the costs of implementing CAN/BNQ 2501-500/2017 *Geotechnical Site Investigations for Building Foundations in Permafrost Zones* but did not show a GDP increase over the study period, due to the benefits of avoided permafrost damage likely occurring beyond 2035. This highlighted the need for further life cycle analysis to quantify the benefits of this standard and avoided costs from slow degradation processes like permafrost thaw.

**Where SCC could go next:** The above list represents a wide range of potential areas for future work. As a next step, these ideas can be further explored and scoped with relevant stakeholders, and/or analyzed for project readiness using the Risk Prioritization Framework (Annex D) to consider factors such as urgency, feasibility, stakeholder support, and potential impact.

## Theme #5: More than 100 standards urgently need updating for climate change

Four SCC-accredited SDOs reviewed a combined total of **714 standards** related to infrastructure and buildings, and identified **63 standards highly recommended for update** to address one or more of the following issues: adaptation to climate change impacts; mitigation of greenhouse gas emissions; reducing negative effects and impacts on the environment; and sustainability and/or sustainable development (see Annex E for more details). Combined with the results of similar reviews conducted in 2016 by CSA Group and UL/ULC Standards for the National Research Council,<sup>22</sup> and with the standards identified in a separate proposal prepared in 2018 for SCC by the Health Standards Organization, there are **more than 100 standards** that have been assessed since 2016 as needing an urgent update to address climate change adaptation.

As these reviews represent only a portion of the standards currently in use in Canada, the actual number of standards that would benefit from considering climate change in coming years is likely much larger. This message was echoed in our expert interviews and focus groups. Participants were aware of considerable amounts of work under way to renew infrastructure design standards in light of climate change. They noted, however, that most of this work is focused on specific sets of standards in the National Building Code of Canada (NBCC), and various aspects of the Electrical Code, leaving many hundreds of other infrastructure standards to be assessed for renewal based on climate change considerations.

This finding supports another key message from interviews and focus groups, which is that **Canada needs a consistent, coordinated, and predictable process for updating standards for climate considerations**. A management framework laying out requirements for climate change considerations at the review stage of an NSC's five-year life cycle would be

helpful in this regard. The Risk Prioritization Framework would be a key supporting tool in this process. Such a framework could also include a monitoring and evaluation aspect to verify the effectiveness of implementing climate-updated standards.

**What SCC has done:** SCC-accredited SDOs are not currently required to consider climate change when reviewing an NSC that is reaching the end of its five-year cycle. To date, reviewing and updating NSCs for climate change or sustainability considerations have been largely conducted on an ad-hoc basis and are usually driven by stakeholder demand. SCC has facilitated reviews and updates to several existing standards, such as the addition of a climate change annex to [CSA S37-18 Antennas, towers, and antenna-supporting structures](#). Building on the lessons learned from these projects and others, and by working closely with SDOs to understand the needs of their technical committees, SCC is developing a pair of voluntary guidance documents for standards writers. The first, to be published in April 2021, provides guidance on how to incorporate climate change adaptation considerations into the development of Canadian standards. The second will provide more detailed guidance on understanding the climate information and is planned for publication in early 2022.

**Where SCC could go next:** At time of writing, the Infrastructure Program has enabled the delivery of more than 40 standardization strategies over its five-year lifespan. Only eight of these, however, are updates to previously existing standards or guidance. Meeting the demand for updating more than 100 standards for climate change considerations will require significant additional resources in terms of funding, expert time, contracting, and project management. An additional consideration is that updates to NSCs can be completed only by the SDOs to whom the copyright belongs, so projects will need to be staggered in order to avoid overwhelming SDO personnel, as well as the volunteers who contribute their time and expertise to writing the standards

<sup>22</sup> These reviews were part of the National Research Council's Climate Resilient Buildings and Core Public Infrastructure Initiative. Some of the standards identified by these reviews have undergone update under the same initiative. For more information: <https://www.infrastructure.gc.ca/plan/crbcp-i-irccipb-eng.html#2>.



## Theme #6: Canada's standardization system has room to be faster, more ambitious, and more inclusive of diverse perspectives

Finally, our campaign generated valuable feedback about the structure and functioning of Canada's standards system itself. Advice from interview and focus group participants revolved around the following sub-themes:

- **Indigenous knowledge and engagement.** Focus group participants and individual interviewees noted a lack of integration of traditional knowledge within infrastructure standards. This is particularly important for supplementing climate information and backfilling data gaps in Canada's remote regions, and to promote buy-in and use of standards by Indigenous stakeholders.
- **System-wide research function.** Stakeholders recommended establishing a system-wide research function to help identify and prioritize among key areas for standards development and renewal and more rapidly advance the climate and low carbon resilience of infrastructure in Canada.
- **Accelerating standards development, renewal, and mobilization.** Participants called for a change in pace to address rapidly evolving practices, technologies, and materials; and more specifically, to reflect the urgency of the climate crisis.
- **Raising the bar through step-change opportunities.** Given the urgency of the climate crisis, the standards system could take a more aggressive role in driving change. For example, it could apply a stronger human health and equity lens in selecting standards to develop or renew, and in developing the content of the standards itself.

**What SCC has done:** These perspectives are in line with thinking and conversations already under way at SCC and with key partners. Involving more Indigenous perspectives and expertise in standards development aligns with a broader goal at SCC to make standardization more inclusive of groups that have, to date, been underrepresented in these initiatives. SCC is also actively working with relevant government departments to integrate climate-resilient standards in policy and requirements; has published guidelines for incorporating standards by reference in policy; and maintains a Monitoring Standards in Regulations database of thousands of federal, provincial, and territorial laws and regulations.<sup>23</sup>

**Where SCC could go next:** Standards development is best served by considering the full range of potential end-users; with respect to Canadian infrastructure standards for climate resilience, Indigenous users are no exception. In scoping new NSCs or updates to existing NSCs, SCC should apply equity lenses such as gender-based analysis plus (GBA+) to consider how Indigenous and other underrepresented communities or demographics are likely to be impacted by the implementation of those standards. This might involve, for example, ensuring that SDOs that take on this work include representatives from those communities or demographics on the relevant technical committees.

With respect to the pace of standards development, engaging the relevant stakeholders and conducting the foundational research to ensure that a potential standard is adequately scoped is often the most time-consuming step. The nature of consensus-based standards development, and the process' reliance on expert volunteers, also means that an NSC—even if it is an adoption or modification of an existing standard—takes time. Nonetheless, this is a challenge that several of our international partners are also seeking to address. SCC will engage with them on this topic to explore ways to streamline the journey from idea to published NSC without diminishing quality or usability.

In regard to the recommendation for a system-wide research function to inform future standards development and renewal, SCC could explore this idea with more research-oriented federal partners such as NRC. SCC could also strengthen existing relationships with academia, research institutions, and centres of excellence to ensure that future projects are informed by the most up-to-date research on climate resilience and sustainability. Continued proactive engagement with SDOs, many of which run their own research functions, will also be essential to ensuring that standards work benefits from the latest knowledge of climate and sustainability solutions. Greater efforts to gather strategic insight would also allow SCC to identify those step-change opportunities that raise the bar on climate action.



<sup>23</sup> Standards Council of Canada (2018). *Guidelines for Incorporating Standards by Reference in Regulations to Support Public Policy Objectives*. <https://www.scc.ca/en/about-scc/publications/documents-de-politique/guidelines-for-incorporating-standards-reference-regulations-support-public-policy-objectives>; Standards Council of Canada. *Monitoring Standards in Regulation*. <https://www.scc.ca/en/information-for/regulators/tools-and-services>.





# Conclusions and next steps

The *Standards in Action* consultation campaign has been an invaluable initiative for SCC. Participants across Canada have provided us with a wealth of information, insights, and recommendations.

We heard from stakeholders the importance of climate-resilient standards for specific regions or sectors, as well as guidance and tools to better manage interconnected assets and the risks of cascading impacts. We learned about the many private- and public-sector policies, tools, and practices emerging across Canada to advance climate resilience, as well as the need for additional standards and supporting tools. We found, through SDO reviews and surveys, more than 100 standards that need urgent updating for climate change; as well as more than 35 potential areas for boosting adaptation, mitigation, and sustainability-related objectives. And we heard calls for the standardization network to step up its efforts to mobilize standards, as well as to move faster, aim higher, and to be more inclusive.

Campaign outreach has also allowed us to strengthen existing relationships and establish new connections. These partnerships will be essential as we seek to expand the tent of standardization to include Indigenous perspectives and those

of other previously underrepresented groups, including visible minority persons, people living with disabilities, members of the LGBTQ2 community, as well as First Nations, Inuit, and Métis peoples. It has stimulated new ways of thinking as well. SDOs, for instance, said that reviewing their catalogues through a climate-change lens was “eye-opening” and “much needed,” clearly pointing to opportunities for future collaborations and workstreams.

All the above validates SCC’s work to date, while laying the blueprint for an expanded and more ambitious program on climate change and sustainability. SCC has already begun to propose the broad outlines of a renewed infrastructure program to our partners, aligned with the findings in this report. As Canada’s national standards body, we look forward to leading the update and development of climate-ready standards that make a concrete difference to Canadian communities, households, and businesses. Increasing the pace, ambition, and reach of the standardization network will require additional resources. Investing in climate-resilient standards and related technical guidance will safeguard and reduce long-term maintenance and repair costs of critical infrastructure, and protect the health and safety of Canadians. As this campaign has made clear, this investment is both **urgent** and **necessary**.



# Annex A:

## List of projects under the Standards to Support Resilience in Infrastructure Program (2016–2021)

SCC's Infrastructure Program is delivering concrete standardization strategies and tools to help Canadians adapt to climate change. Below is a full list of completed, ongoing, and planned projects. They are generally organized by the following themes:

- Arming standards writers with the tools to fight climate change
- Getting the most out of weather and climate data
- Helping northern communities adapt to a rapidly changing climate
- Designing infrastructure that can stand up to extreme weather events

Additional activities undertaken as part of SCC's *Standards in Action* stakeholder engagement campaign are listed separately.

### Legend

#### Type of deliverable

S = standard

US = updated standard

F = foundational document

G = guidance document

UG = updated guidance document

#### Status

P = planned

I = in progress

C = completed

### Arming standards writers with tools to fight climate change

Title	Type	Status	Hazards addressed
<a href="#">ISO Guide 84:2020 Guidelines for addressing climate change in standards</a>	G	C	General
Guide for integrating climate change adaptation considerations into Canadian standards	G	I	
New guidance on understanding climate change models for standards development	G	I	

## Getting the most out of weather and climate data

Title	Type	Status	Hazards addressed
<a href="#">Standardization guidance for weather data, climate information and climate change projections</a>	F	C	General
Development and implementation of an engagement strategy with weather monitoring stations owners and operators	F	C	
Risk assessment of the effects of climate change on the Rideau Canal Skateway	F	I	
<a href="#">CSA R100:20 Canadian metadata standard for hydrometeorological monitoring stations</a>	S	C	General/ Data collection and use
CSA R101 Siting, operations and maintenance of Canadian automated hydrometeorological monitoring stations	S	I	
CSA R102 Data quality of Canadian hydrometeorological stations	S	I	
[Designation number TBD] Protocols for sharing atmospheric meteorological data	S	I	
Indigenous community-based physical climate monitoring best practices guide	G	I	Extreme Precipitation / Flooding
<a href="#">CSA PLUS 4013:19 Technical guide: Development, interpretation and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian water resources practitioners</a>	UG	C	

## Helping northern communities adapt to a rapidly changing climate

Title	Type	Status	Hazards addressed
<a href="#">CSA S500:14 (R2019) Thermosyphon foundations for buildings in permafrost regions</a>	US	I	Permafrost thaw
<a href="#">CSA S501:14 (R2019) Moderating the effects of permafrost degradation on existing building foundations</a>	US	I	
<a href="#">CSA S503:20 Community drainage system planning, design, and maintenance in northern communities</a>	US	I	
<a href="#">CSA W203:19 Planning, design, operation, and maintenance of wastewater treatment in northern communities using lagoon and wetland systems</a>	S	I	
BNQ 9701-500 Risk-based approach for community planning in northern regions	S	I	
<a href="#">CSA PLUS 4011:19 Technical guide: Infrastructure in permafrost: A guideline for climate change adaptation</a>	UG	C	
<a href="#">CSA Plus 4011.1:19 Technical Guide: Design and construction considerations for foundations in permafrost regions</a>	G	C	
CSA R111 Solid waste sites in northern communities: From design to closure	S	I	Extreme precipitation (snow)
<a href="#">CSA S502:14 (R2019) Managing changing snow load risks for buildings in Canada's North</a>	US	I	
<a href="#">CSA W205:19 Erosion and sedimentation management for northern community infrastructure</a>	S	C	Erosion
<a href="#">CSA S504:19 Fire resilient planning for northern communities</a>	S	C	Fires
<a href="#">CSA S505:20 Techniques for considering high winds and snow drifting and their impact on northern infrastructure</a>	S	C	High winds

## Designing infrastructure that can stand up to extreme weather events

Title	Type	Status	Hazards addressed
<a href="#">CSA S37-18 Antennas, towers, and antenna-supporting structures</a>	US	C	General
<a href="#">CSA Z240.10.1:19 Site preparation, foundation, and installation of buildings</a>	US	C	
<a href="#">Developing a stormwater quality management standard (QMS) in light of a changing climate</a>	F	C	Extreme precipitation / Flooding
CSA W211 Management standard for stormwater systems	S	I	
<a href="#">Weathering the storm: Developing a Canadian standard for flood-resilient existing communities</a>	F	C	
CSA W210 Prioritization of Flood Resilience Work in Existing Residential Communities	S	I	
<a href="#">Preventing disaster before it strikes: Developing a Canadian standard for new flood-resilient residential communities</a>	F	C	
<a href="#">CSA W204:19 Flood resilient design of new residential communities</a>	S	C	
<a href="#">Under one umbrella: Practical approaches for reducing flood risks in Canada</a>	G	C	
<a href="#">Federal flood mapping guidelines series standardizations workshop summary report</a>	F	C	
<a href="#">Reducing the risk of inflow and infiltration in new sewer construction</a>	F	C	
Best practices to reduce inflow and infiltration in new sanitary sewers	S	P	
Developing an Efficient and Cost-Effective Inflow and Infiltration (I/I) Reduction Program	F	I	
Best practices to reduce inflow and infiltration in existing sanitary sewers	S	P	
Coastal flood resilience guideline	F	I	
<a href="#">Increasing high wind safety for Canadian homes: A foundational document for low-rise residential and small buildings</a>	F	C	High winds
CSA S520 High wind safety for low-rise residential and small buildings	S	I	
<a href="#">Developing a method for conducting wildland/urban interface fire case study research: A foundational document</a>	F	C	Wildfire
<a href="#">Thermally comfortable playgrounds: A review of literature and survey of experts</a>	F	C	Extreme heat
Thermally comfortably playgrounds: A standardization workshop summary report	F	I	

### Activities under the Standards in Action stakeholder engagement campaign

Title	Type	Status	Hazards addressed
Canadian General Standards Board (CGSB) catalogue review for environmental impacts	F	C	General
Catalogue review project: Review of CSA group health and safety standards and climate change impacts	F	C	
International Association of Plumbing and Mechanical Officials (IAPMO) standards catalogue review	F	C	
Projet d'examen du catalogue de normes du Bureau de normalisation du Québec (BNQ) en infrastructures dont l'efficacité peut être affectée par les changements climatiques et certains enjeux environnementaux	F	C	
Prioritization framework for improving and developing climate-sensitive standards	F	C	



# Annex B:

## National survey results

For this component of the campaign, 76Engage, a subcontractor of the Climate Risk Institute (CRI), developed a digital engagement platform with four short surveys. These surveys elicited feedback under four topic areas: familiarity with the Standards Council of Canada (“You and SCC”), adaptation to climate change, mitigation of climate change, and sustainability. A total of 371 responses were received: 132 responses to the adaptation survey, 95 responses to the “You and SCC” survey, 73 responses to the mitigation survey, and 71 responses to the sustainability survey. Below is a summary of the results.

### You and SCC

- 88% of respondents had heard of SCC before this survey
- 65% rated their familiarity with the voluntary standardization system as somewhat familiar, moderately familiar, or extremely familiar
- 52% reference or rely on standards and codes in their work, and 47% have participated in a technical committee or working group for standards development

### Adaptation

- In response to the question, “**Which types of infrastructure and buildings most urgently need to consider and become adapted to the impacts of climate change?**” the most frequent selections by respondents were:
  1. drinking water, wastewater, and stormwater infrastructure
  2. residential buildings
  3. roads
  4. electrical infrastructure (generation, transmission, distribution)
  5. commercial buildings
  6. natural/green infrastructure (such as forests, riverine water resources, marshes, natural spillways, etc.)
- Regardless of infrastructure type, the adaptation-related **hazards** selected most frequently by respondents were:
  1. extreme precipitation events and flooding (overland, riverine, flash, ice jam flooding)
  2. sea-level rise and coastal flooding
  3. extreme wind events (storm, tornado, hurricane)

- Regardless of infrastructure type, the adaptation-related **supports** selected most frequently by respondents were:

1. climate risk assessments
2. risk management and adaptation plans
3. new standards or guidelines
4. funding support

### Mitigation

- In response to the question “**Which types of infrastructure and buildings most urgently need to make reductions to their greenhouse gas emissions?**” the most frequent selections by respondents were:

1. ground transportation (cars, roads, bridges, rail)
2. residential buildings
3. commercial buildings
4. electricity generation, distribution, and transmission
5. natural resources sector
6. other industrial/manufacturing

### Sustainability

- In response to the question “**Which types of infrastructure and buildings most urgently need to integrate more sustainable development approaches or sustainability practices?**” the most frequent selections by respondents were:

1. residential buildings
2. ground transportation (cars, roads, bridges, rail)
3. commercial buildings
4. drinking water, wastewater, and stormwater infrastructure
5. natural resources sector
6. solid waste management, landfills

# Annex C:

## Interviewed organizations

In consultation with SCC, CRI identified and secured key informant interviews with representatives of more than 40 organizations across Canada. Upon request, some interviews were conducted with up to three representatives from the same organization. SCC thanks these organizations for their time and contributions to the *Standards in Action* campaign.

Alberta Professional Planners Institute	Government of Alberta
Alliance of Canadian Building Officials Association	Government of Manitoba
Assembly of First Nations	Government of Newfoundland and Labrador
Building Owners and Managers Association	Government of Nova Scotia
Canada Green Building Council	Government of Saskatchewan
Canadian Association of Homes and Property Inspectors	ICLEI Canada
Canadian Cement Association	Infrastructure Canada
Canadian Electricity Association	Institute for Catastrophic Loss Reduction
Canadian Institute of Planners	Insurance Bureau of Canada
Canadian Standards Association	Intact Centre for Climate Adaptation
Canadian Water and Wastewater Association	Inuvialuit Regional Corporation
Canadian Wood Council	Métis National Council
City of Calgary	National Research Council Canada
City of Toronto	Natural Resources Canada
Climate Change Secretariat (NB)	Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists
Crown-Indigenous Relations and Northern Development Canada	Ouranos
Dillon Consulting	Public Safety Canada
Engineers and Geoscientists of British Columbia	Stantec Inc.
Engineers Canada	Transport Canada
Environment and Climate Change Canada	
Federation of Canadian Municipalities	
Gouvernement du Québec	

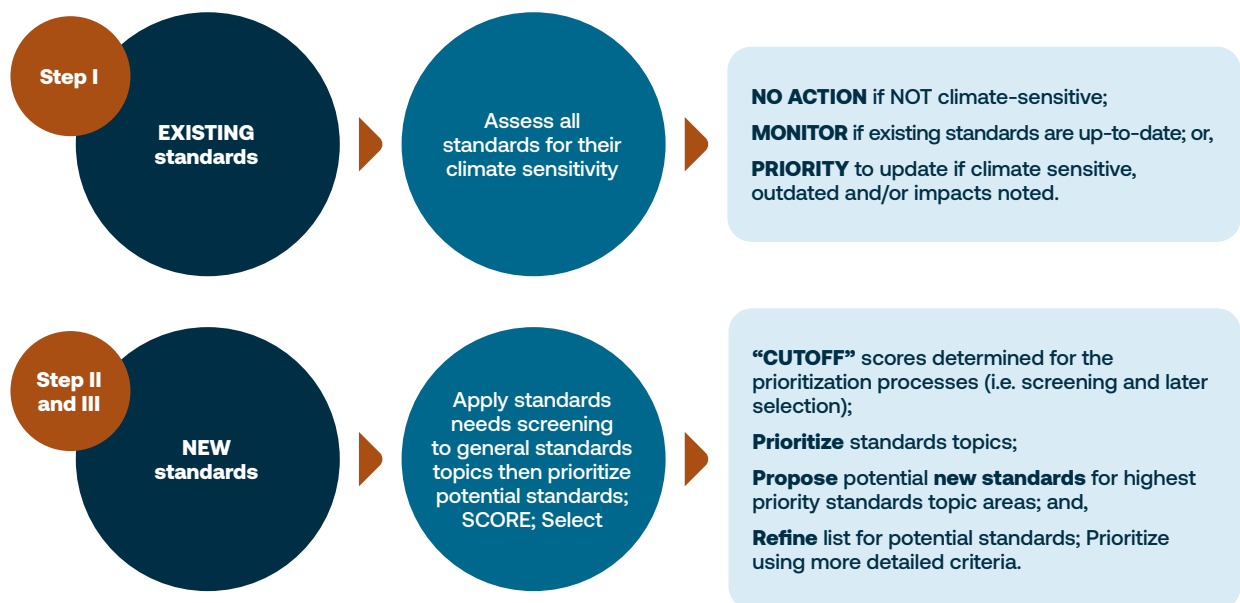


# Annex D:

## Risk prioritization framework

As part of the *Standards in Action* campaign, SCC commissioned the development of an analytical framework to help prioritize proposed areas of activity under the next iteration of the Infrastructure Program. The project was delivered by Risk Sciences International and Dillon Consulting Limited. The resulting framework provides SCC with a reproducible, structured process to assess standards prioritization needs for existing standards, to screen potential new topics for standardization, and to then prioritize those new topic areas. Figure 2 shows the framework's high-level decision-making process for assessing both existing standards (Step I) and potential new topic areas for standards (Step II and III).

**Figure 2: High-level decision-making process for assessing climate sensitivity of existing standards and new standards**

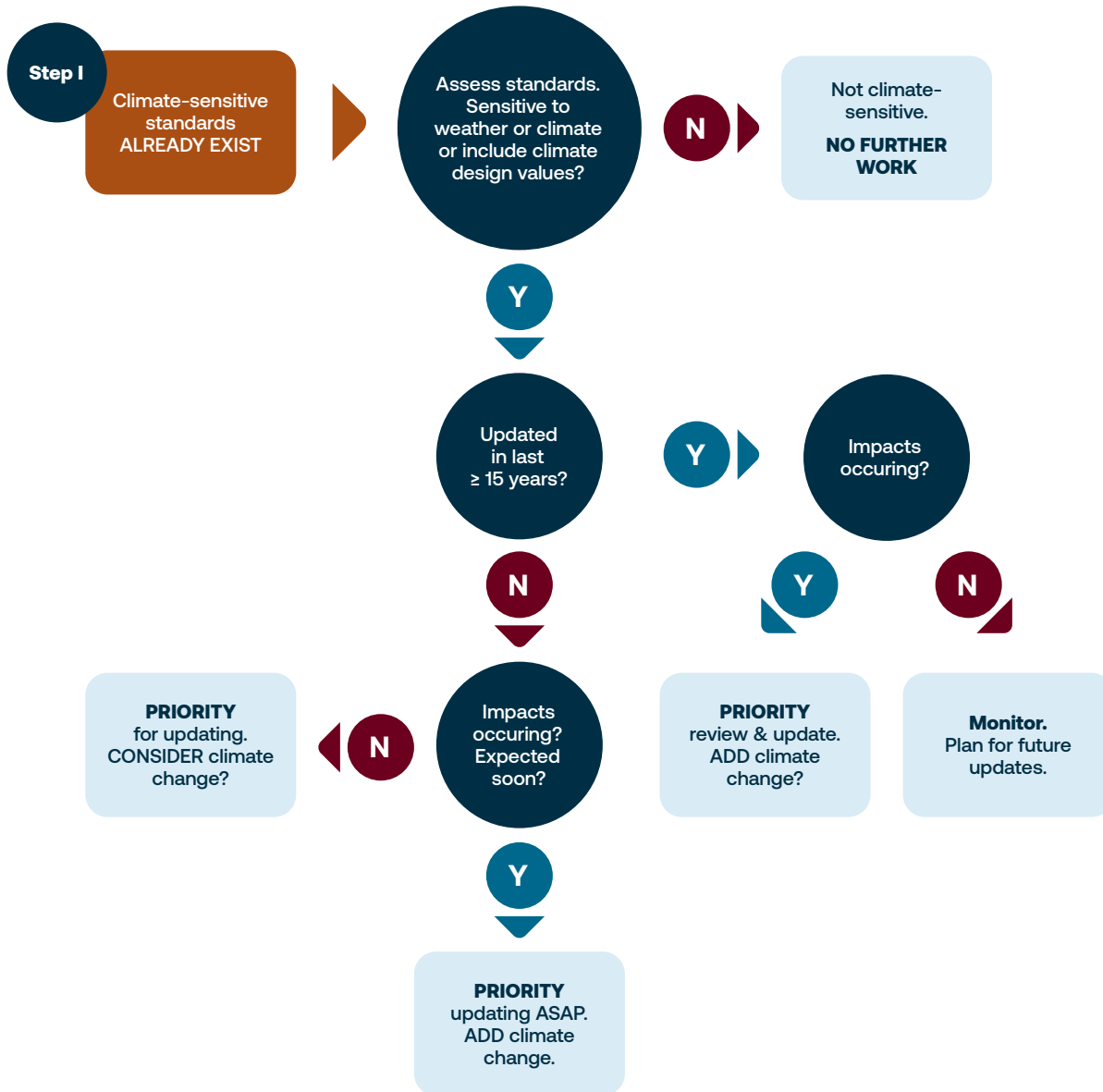


Step I involves applying three simple criteria to assess the climate sensitivity of existing standards and whether they should be updated:

1. Standards and any embedded climate data are outdated by 15 years or more
2. Relevant climate-related impacts are noted or are increasing (e.g. the climate thresholds assumed by the standards may require adjustments)
3. Climate-related impacts are anticipated to increase or begin to occur within the next 15–20 years

Figure 3 illustrates the logical sequence to be followed for existing standards under this Step I approach.

**Figure 3: Detailed decision tree for assessing climate sensitivity of existing standards**



As for potential new topics for standardization, the framework offers a scoring scheme across seven criteria: urgency, sensitivity, serviceability, interdependencies, feasibility, scope, and co-benefits. The higher the total score, the higher priority that topic area would represent for standardization. The criteria are evenly weighted, though weightings can be adjusted based on strategic considerations. Figure 4 presents a summary of this scheme.

Figure 4: Summary of scoring scheme for potential new standards areas



# Annex E:

## Summary of SDO catalogue reviews



For this component of the campaign, SCC issued a call for proposals via the Standards Development Organizations Advisory Council (SDOAC) to its 11 accredited SDOs to conduct a focused review of their standards catalogues. SDOs were invited to propose reviews of standards through the lens of one or more of four key considerations:

1. Adaptation to climate change impacts
2. Mitigation of greenhouse gas emissions
3. Reduction of negative effects and impacts on the environment
4. Sustainability and/or sustainable development considerations

A committee of SCC staff evaluated each bid based on previously established criteria, and awarded contracts to qualifying proposals.

Four SDOs participated in the initiative: Bureau de normalisation du Québec (BNQ), the Canadian General Standards Board (CGSB), the Canadian Standards Association (CSA) Group, and the International Association for Plumbing Mechanics Operators (IAPMO). These SDOs reviewed a combined total of **714 standards** related to infrastructure and buildings, and identified **63 standards highly recommended for update**, specifically:

- BNQ reviewed 54 standards and identified seven as having a high level of environmental risk that could be addressed by updates; a further 14 were identified as moderate environmental risk and 35 as low environmental risk

- CGSB reviewed 135 standards and identified 25 as high environmental consideration that could have impactful updates; a further 15 were identified as moderate environmental consideration and 38 as low environmental consideration
- CSA Group reviewed 301 standards and identified 75 standards requiring climate change modifications: 25 standards were rated high priority, 25 were rated moderate priority, and 25 were rated as low priority for update
- IAPMO reviewed 244 standards and identified six where major updates could be considered for environmental protection

Combined with the results of similar reviews conducted in 2016 by CSA Group and UL/ULC Standards for the National Research Council (and noting that some those have already been updated), and with the standards identified in a separate proposal prepared in 2018 for SCC by the Health Standards Organization, there are **more than 100 standards** that have been assessed since 2016 as needing an urgent update to address climate change adaptation.

# Annex F:

## Economic impact analysis: Summary of findings

As part of the *Standards in Action* campaign, SCC engaged Golder Associates Ltd. to complete an economic analysis of two standards that were developed through the Standards to Support Resilience in Infrastructure Program:

- CSA W204:19, *Flood Resilient Design for New Residential Communities*, which presents several criteria and recommendations to reduce risks and help design new communities that are more resilient
- CAN/BNQ 2501-500/2017, *Geotechnical Site Investigations for Building Foundations in Permafrost Zones*, which establishes a consistent approach for geotechnical site investigations that take into consideration changing climatic factors

To understand the quantitative costs and benefits associated with implementing these two standards, Golder's analysis estimated the direct costs of increased flooding and permafrost degradation on Canadian residential buildings over a 15-year period (2020–2035) due to climate change, and the economic impacts of implementing both standards for the same period. The CSA W204:19 standard was considered for southern Canada, while the BNQ 2501-500-2017 standard was evaluated for communities in Canada's North (notably those with permafrost).

A summary of the conclusions of Golder's assessment is as follows:

### **CSA W204:19, Flood Resilient Design for New Residential Communities**

- The costs of implementing the flood standard were found to be negligible for most typical residential developments across Canada, with only benefits to be gained. This is because many of the requirements of the standard come at low cost (e.g. installing bigger stormwater pipes than typically used, and ensuring the use of backflow preventers in a residence) when compared to the overall cost of new buildings and communities. The benefits are directly linked to projected changes in precipitation—mostly through the prevention of basement flooding events.
- The economic model suggests that implementation of the standard could provide an increase in Canada's GDP by up to \$234 million (2015\$) in 2035. The exact value of the benefit would depend on 1) the share of buildings that adopt the standard and 2) avoided flood damages.

### **CAN/BNQ 2501-500/2017, Geotechnical Site Investigations for Building Foundations in Permafrost Zones**

- The cost of implementing the geotechnical site investigations standard was estimated to be a blend of costs across the three northern territories. There are substantial territorial differences that would affect the actual costs for any geotechnical site investigation, relating mainly to the accessibility of sites (e.g. fly-in fly-out communities would have larger costs than road-accessible communities because of the need to fly in specialized equipment). Despite these differences, the benefits would apply consistently across the northern territories, due to projected changes in temperature and, in turn, changes in the stability of permafrost.



- Benefits were less clear-cut at the macroeconomic level, mainly due to the limited timeframe of the study because the impacts of permafrost thaw tend to be felt over a longer time period than extreme weather events. The economic model suggested that implementing the standard could reduce territorial GDP in the study period 2020–2035. This is because the standard would impose immediate costs on all building construction (as geotechnical site investigations are an initial step in design and construction), whereas the benefits of avoided permafrost damage occur in the future—long after the building has been constructed. In other words, the benefits of the standard’s implementation would accrue beyond the study’s 2035 timeframe.

Notably, benefits for both standards were expected to increase after 2035, as more buildings are built to new standards and avoided damages increase.

While the focus of the analyses was on the economic costs of implementing these two standards, it noted many other, non-financial, benefits to implementation, which should be factored into any decision to use them. These include:

- building and infrastructure design improvements
- improvements to the standards themselves as lessons are learned through implementation
- improved awareness by the engineering community of climate change and resilience
- improved overall community resilience
- improved mental health of community members when flood events occur because of decreased impacts to homeowners
- improved confidence in resource allocation
- fewer legal challenges in the future associated with flooding events specifically

For further details on the methodology, conclusions, or other aspects of this study, please contact SCC at [infrastructure-environment@scc.ca](mailto:infrastructure-environment@scc.ca).