



NORTHWEST TERRITORIES

CLIMATE CHANGE STRATEGIC FRAMEWORK

2018 → 2030

CADRE STRATÉGIQUE SUR LE CHANGEMENT CLIMATIQUE

DES TERRITOIRES DU NORD-OUEST

Draft for Public Comment

Version provisoire pour commentaire par le public

Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

NORTHWEST TERRITORIES (NWT) CLIMATE CHANGE STRATEGIC FRAMEWORK

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November 2017

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MESSAGE FROM THE PREMIER

Climate change represents serious environmental, economic and social challenges for the Northwest Territories (NWT). During 2016-2017, the Government of the Northwest Territories (GNWT) engaged with Indigenous governments and the public to discuss energy and climate change issues. We gathered opinions and ideas to develop a Climate Change Strategic Framework and 2030 Energy Strategy for the NWT.

The people of the NWT told us that they have strong interest in solutions that support the transition to a lower carbon economy. However, people are also concerned how this will impact the high cost of living and doing business in the NWT. They are very interested in energy efficiency and developing renewable energy options. We heard that we need to set realistic and achievable emissions targets to address climate change. There were mixed views on carbon pricing and there were concerns about the effect carbon pricing would have on the cost of living and doing business, but general support for some carbon revenues to be allocated to improving energy efficiency and renewable energy solutions in communities.

People expressed their concerns about the impacts of climate change, including changing ice conditions and increased risks to human safety, impacts on water quality and quantity, impacts on forest, habitat and wildlife, invasive species, food security and decreased access to country foods, and loss of culturally significant sites and artifacts.

We heard the need for increased research and monitoring, with traditional knowledge highlighted as an important tool in understanding and adapting to climate change. Indigenous governments and communities indicated that they want to be more involved in identifying, planning and undertaking research and monitoring of climate change impacts. We heard that there needs to be better sharing of information and research results with communities, residents and Indigenous governments.

The NWT Climate Change Strategic Framework and 2030 Energy Strategy reflect the Priorities of the 18th Legislative Assembly. The GNWT supports the use of energy efficient technologies, increasing the production and transmission of renewable and alternative energy, and the implementation of this strategy to mitigate and adapt to climate change in collaboration with other governments and organizations.

This framework provides the territory with a strong direction between now and 2030 to act locally, while fulfilling our commitments to Canada and the world. We will continue to work to support the implementation of the Pan-Canadian Framework on Clean Growth and Climate Change, the Canadian Energy Strategy and the development of the Northern Adaptation Strategy. The actions in these initiatives contribute to Canada's commitment as signatory to the Paris Agreement.

Implementing the NWT Climate Change Strategic Framework means rolling up our sleeves and putting our words into action. Working together guided by this strategic plan, we can transition to a lower carbon economy, build a sustainable energy system and strengthen our understanding of the effects of climate change, while implementing solutions that increase our resiliency and adaptation to climate change now and for future generations.

MESSAGE FROM THE MINISTER

The NWT Climate Change Strategic Framework provides the path to address the challenges of climate change to 2030. The vast geography and remote locations of our communities and industry present challenges to responding to climate change in the NWT. Parts of the territory are warming up to four times faster than global averages, and considerable changes to the natural environment are being felt by Northerners.

Canada is committed to a 30 per cent reduction in annual greenhouse gas emissions by 2030, and the GNWT has set a similar goal for the territory. To achieve this goal we must ensure that the economy remains strong and viable while taking concrete actions to transition to a lower carbon economy. We will continue to build on the valuable experience, knowledge and past investments, such as those in energy efficiency and local renewable energy systems, to support this transition. This framework is linked to the 2030 NWT Energy Strategy, the primary mechanism that government will be using to reduce greenhouse gases.

As the northern climate continues to change, plans and operations will need to be adjusted to deal with a range of possible future conditions and unanticipated events. Resiliency and adaptation are two interrelated responses to address the various impacts of climate change on individuals, Indigenous governments, communities, ecosystems, infrastructure, industry and the economy.

It is important to note, too, that there are also benefits to a warmer climate. Warmer winters may reduce heating needs, saving the public money while reducing greenhouse gas emissions. Shrinking sea ice creates opportunities for shipping and tourism. Adaptation initiatives allow innovative solutions to lessen the negative impacts of climate change while capitalizing on opportunities.

It is understood that climate-related changes create impacts at the local and regional levels. We will continue to work with communities to improve research and monitoring, connect them to various funding programs, work with partners such as the federal government and the NWT Association of Communities, and build local capacity to support the climate change actions in this framework.

I look forward to working with communities, industry and other levels of government to move towards establishing a lower carbon economy, increasing our knowledge of climate impacts, and building our resiliency and adapting to a changing climate. By working together, we can work to support a sustainable future for the NWT.

EXECUTIVE SUMMARY

The residents of the NWT, and specifically its Indigenous Peoples, have a long-standing relationship with the natural environment. Many are concerned about the effects of climate change as the severity of environmental impacts increases, with temperatures warming faster in the north compared to the global average. Such effects include greater coastal erosion, more permafrost thawing, longer ice-free seasons, the increasing prevalence of forest fires, and new mammal, bird, insect and fish species moving northward. These can have serious implications on the health and safety of residents, culture and heritage, infrastructure and the viability of certain economic activities. Therefore, taking strong action to address climate change in the NWT is extremely important.

The NWT Climate Change Strategic Framework outlines how the territory plans to respond to challenges and opportunities associated with a changing climate, moving towards an economy that is less dependent on fossil fuels and doing its part to contribute to national and international efforts to address climate change. The Climate Change Strategic Framework is being developed at the same time as the 2030 Energy Strategy, as they are closely linked and both contribute to the Pan-Canadian Framework on Clean Growth and Climate Change, which supports Canada in meeting its international commitments to reducing greenhouse gas emissions.

Engagement on the development of the NWT Climate Change Strategic Framework and 2030 Energy Strategy took place during the fall and winter of 2016/2017 and included six regional workshops, a public survey and the opportunity to provide written submissions. Valuable input was received from representatives of Indigenous and community governments, resource management boards, non-government organizations, research institutions, schools, industry and the general public, to advance the Climate Change Strategic Framework's vision, principles and goals.

The vision of the NWT Climate Change Strategic Framework – which states that by 2030, the NWT will enjoy a strong, healthy economy that is less dependent on fossil fuels (compared to 2015) and will have developed the knowledge, tools and measures needed to increase resilience and adapt to the changing northern climate – rests on several key principles. These principles center on: including climate change considerations in planning, decision-making and operational activities; sharing responsibility for taking action on climate change; strengthening collaboration between residents and Indigenous, federal, territorial and community governments; and, recognizing the importance of traditional, local and scientific knowledge in understanding climate impacts and adaptation measures.

To achieve its vision, the NWT is focusing on three climate change goals:

Goal #1: Transition to a strong, healthy economy that uses 20% less fossil fuels by 2030 (compared to 2015);

Goal #2: Improve knowledge of the climate change impacts occurring in the NWT; and,

Goal #3: Build resilience and adapt to a changing climate.

Goal #1 is focused on transitioning to a lower carbon economy that uses less fossil fuels.

Greenhouse gas emissions are measured as carbon dioxide equivalents (CO₂e). To reach its goal of 20% less fossil fuels by 2030, the NWT needs to achieve an emission reduction of approximately 290 kilotonnes (kt) CO₂e (from a 2015 level of 1,441 kt CO₂e).

Electricity generation, space heating, transportation, industry and government are the five main sectors for fossil fuel use and emissions. Achieving Goal #1 by 2030 will require improved energy efficiency and increases in local renewable energy to gradually reduce the use of imported fossil fuels while making sure the economy remains strong. Cross-cutting measures such as carbon pricing and composting organic waste may also be important contributors. Details on the actions that can be taken to reduce fossil fuel use are available in the 2030 Energy Strategy.

Improving knowledge of climate change impacts occurring in the NWT is Goal #2 of the NWT Climate Change Strategic Framework. In order to address climate change, greater understanding of the impacts to the natural environment, to residents' health, safety, culture and heritage, and to the territory's infrastructure, is needed. The integrated use of traditional, local and scientific knowledge to determine knowledge gaps and set research and monitoring priorities is essential.

The warming climate is leading to gradual shifts to ecosystems and more abrupt extreme events affecting many components of the environment. Thawing of permafrost, changes to water quality and quantity, changes to forests and tundra vegetation, and impacts on wildlife, fish and marine mammal health and distributions, have been observed for several years and are intensifying.

The effects of climate change on the natural environment can directly impact the health of NWT residents, both physical (such as increases in respiratory problems due to extreme weather) and mental (such as impacts on mental health and well-being due to limited access to traditional harvesting sites).

Safety of the general public is also a central concern, from erosion of coastlines leading to building instability, to increased flood risks in certain communities, to less predictable winter travel conditions, all leading to heightened risk of injuries and deaths.

Effects on the territory's culture and heritage, from risks to archeological sites due to permafrost thaw and wildfires, to impacts on traditional economies such as trapping, are evident and will likely continue to increase. As Indigenous Peoples depend on the land, water and wildlife for their livelihood and sustenance, they are particularly vulnerable to climate change-driven effects.

The NWT's infrastructure (buildings, roads, transmission lines, etc.) has been and continues to be impacted by climate change. Permafrost thaw has a significant influence on the structural integrity of infrastructure and is a research and monitoring priority.

As more information and associated data is collected, proper management of the information generated from climate change research and monitoring is necessary. Communicating information, sharing results broadly and involving communities in all aspects of improving knowledge is imperative.

Goal #3 of the NWT Climate Change Strategic Framework is to build resilience and adapt to a changing climate. Building resilience focuses on finding ways to withstand the changes that are occurring. For changes that are unavoidable, adaptation efforts are required to find new ways of doing things, such as adjusting planning and operational activities.

Indigenous and community governments want and need to be involved in adaptation planning to ensure ecosystems, including the people who live in them, remain healthy and diverse. Potential actions needed to adapt to the impacts of climate change on various components of the environment include: fostering science-based decision-making tools to assist project planning or development in permafrost regions; using increasingly available satellite imagery and technology to support flood forecasting; and, considering the harvesting of new species to sustain commercial fisheries harvest and the subsistence harvest of edible species, including fish, wildlife and plants.

Potential actions needed to adapt to the impacts of climate change on human health, safety, culture and heritage, include: ensuring health facilities and services are able to withstand climate risks, particularly during extreme weather events; assessing and planning for climate change related hazards in community emergency plans; and strengthening communities from a social and cultural aspect to help build resiliency through the documentation and use of traditional and local knowledge and the involvement of youth and elders in on-the-land programming to ensure knowledge is passed on.

Potential actions needed to ensure transportation systems and community and other infrastructure are adapted to a changing climate include: improving and implementing building standards to take thawing permafrost conditions into consideration for design and construction, and upgrading some existing infrastructure to handle changing climatic conditions not contemplated when initially constructed.

A warming climate may also provide benefits or new opportunities in sectors such as agriculture, tourism and forestry.

For each of the NWT Climate Change Strategic Framework's three goals, priority areas and potential actions have been summarized. This information will be used in 2018 to develop and implement a five-year action plan. Annual reports will be released to track progress on the action plan, and following a review and evaluation of the first five-year action plan, a second five-year action plan will be developed and implemented.

Through implementation of the NWT Climate Change Strategic Framework, the NWT can respond to the challenges and opportunities associated with climate change, move towards a lower-carbon economy and do its part to contribute to national and international efforts on climate change.

RÉSUMÉ

Les résidents des Territoires du Nord-Ouest (TNO), particulièrement les peuples autochtones, sont très attachés aux milieux naturels. Bon nombre d'entre eux se préoccupent des effets des changements climatiques, de plus en plus dommageables pour l'environnement, d'autant plus que les températures augmentent plus rapidement dans le Nord que la moyenne mondiale. Ainsi, les changements climatiques entraînent l'augmentation de l'érosion côtière, une fonte accrue du pergélisol, une plus longue période sans glace, l'augmentation du risque de feux de forêt et la migration vers le nord de nouvelles espèces de mammifères, d'oiseaux, d'insectes et de poissons. Ces phénomènes risquent d'avoir de graves conséquences sur la santé et la sécurité de la population, de même que sur la culture, le patrimoine, les infrastructures et la viabilité de certaines activités économiques des TNO. Il est donc extrêmement important de lutter vigoureusement contre les changements climatiques aux TNO.

Le Cadre stratégique sur le changement climatique des TNO présente la manière dont les Territoires comptent relever les défis inhérents aux changements climatiques et en saisir les occasions afin de développer une économie moins dépendante des combustibles fossiles et soucieuse de contribuer aux efforts nationaux et internationaux de lutte contre les changements climatiques. Le Cadre stratégique sur le changement climatique est mis au point simultanément à la Stratégie énergétique 2030, puisqu'ils sont étroitement liés et s'inscrivent tous deux dans le Cadre pancanadien sur la croissance propre et les changements climatiques, qui aide le Canada à respecter ses engagements internationaux en matière de réduction des émissions de gaz à effet de serre.

L'engagement à l'égard de l'élaboration du Cadre stratégique sur le changement climatique et de la Stratégie énergétique 2030 des TNO a été pris à l'automne 2016 et à l'hiver 2017. Six ateliers régionaux, un sondage public et un appel de commentaires écrits en ont découlé. Les précieux commentaires reçus des représentants des gouvernements autochtones, des administrations communautaires, des offices de gestion des ressources, des organisations non gouvernementales, des établissements de recherche, des écoles, des industries et du grand public ont contribué à la progression de la vision, des principes et des objectifs du Cadre stratégique sur le changement climatique.

La vision du Cadre stratégique sur le changement climatique des TNO est la suivante : d'ici 2030, les TNO auront une économie saine et forte qui ne reposera plus autant sur les combustibles fossiles, par rapport à 2015. De plus, ils auront acquis le savoir, créé les outils et mis en place les mesures nécessaires pour accroître leur résilience aux changements du climat nordique et s'y adapter. Cette vision repose sur plusieurs grands principes : la prise en compte des changements climatiques dans la planification, les processus décisionnels et les activités opérationnelles; la responsabilisation commune à l'égard des mesures de lutte contre les changements climatiques; la collaboration accrue entre les résidents, les administrations communautaires et les différents ordres de gouvernement (autochtones, territorial et fédéral); et la reconnaissance de l'apport des savoirs traditionnels, locaux et scientifiques dans la compréhension des effets des changements climatiques et la mise en place de mesures d'adaptation.

Pour mettre en œuvre cette vision, les TNO concentrent leurs efforts sur trois objectifs :

Objectif no 1 : Avoir une économie saine et forte, où l'utilisation des combustibles fossiles sera réduite de 20 % d'ici 2030 (par rapport à 2015);

Objectif no 2 : Acquérir de nouvelles connaissances sur les effets des changements climatiques aux TNO;

Objectif no 3 : Favoriser la résilience et l'adaptation aux changements climatiques.

Le premier objectif vise à assurer la transition vers une économie plus sobre en carbone, caractérisée par une utilisation moindre des combustibles fossiles.

Les émissions de gaz à effet de serre sont mesurées en équivalent CO₂ (éq. CO₂). Pour réduire de 20 % leur utilisation de combustibles fossiles d'ici 2030, les TNO devront réduire leurs émissions d'environ 290 kilotonnes (kt) éq. CO₂ (en 2015, les émissions s'élevaient à 1 441 kt éq. CO₂).

La production d'électricité, le chauffage local, les transports, l'industrie et le gouvernement sont les cinq principaux secteurs consommateurs de combustibles fossiles et émetteurs de gaz à effet de serre. L'atteinte du premier objectif d'ici 2030 nécessitera une amélioration de l'efficacité énergétique et une utilisation accrue des ressources énergétiques renouvelables locales, de manière à réduire graduellement le recours aux combustibles fossiles importés tout en préservant une économie forte. Des mesures transversales telles que la tarification du carbone et le compostage des déchets organiques pourraient aussi y contribuer. La Stratégie énergétique 2030 expose plus précisément les mesures visant à réduire l'utilisation des combustibles fossiles.

L'acquisition de nouvelles connaissances sur les effets des changements climatiques aux TNO constitue le deuxième objectif du Cadre stratégique sur le changement climatique. Pour lutter contre les changements climatiques, il faut d'abord en comprendre les effets sur les milieux naturels, sur les infrastructures du territoire et sur la santé, la sécurité, la culture et le patrimoine de la population. Par ailleurs, il est essentiel de se servir des connaissances traditionnelles, locales et scientifiques pour en relever les lacunes, et fixer les priorités de recherche et les éléments à surveiller.

Le réchauffement du climat entraîne une mutation des écosystèmes et l'intensification d'événements extrêmes susceptibles d'altérer de nombreuses composantes de l'environnement. On assiste déjà, depuis plusieurs années et avec une intensité croissante, à la fonte du pergélisol, à des fluctuations du niveau et de la qualité de l'eau, à la modification de la flore (forêts et toundra) et à des effets sur la faune, notamment en ce qui a trait à la santé et à la chorologie des mammifères marins et des poissons.

Les effets des changements climatiques sur les milieux naturels peuvent influencer directement sur la santé physique et mentale des Tenois, en se manifestant notamment par une augmentation des troubles respiratoires dus aux températures extrêmes ainsi que par une santé mentale et un bien-être moindre en raison d'un accès restreint aux terres d'exploitation traditionnelles.

La sécurité du public est également au cœur des préoccupations, puisque l'érosion des côtes nuit à la stabilité des bâtiments, augmente le risque d'inondation dans certaines collectivités et rend

imprévisibles les conditions de déplacement en hiver; ce sont là des facteurs qui augmentent les risques pour les résidents.

Les effets des changements climatiques sur la culture et le patrimoine des TNO sont manifestes et risquent de s'accroître, qu'il s'agisse de la dégradation de sites archéologiques causée par la fonte du pergélisol et les feux de forêts, ou de répercussions négatives sur les économies traditionnelles telles que le piégeage. Puisque les peuples autochtones dépendent de la terre, de l'eau et de la faune pour leur subsistance, les changements climatiques les rendent particulièrement vulnérables.

Les infrastructures des TNO (bâtiments, routes, lignes de transport, etc.) subissent également les contrechocs des changements climatiques. La fonte du pergélisol affaiblit grandement leur intégrité structurelle; celui-ci doit donc faire l'objet d'une surveillance étroite et constitue une priorité dans le domaine de la recherche.

Plus on recueille des données liées aux changements climatiques, plus il devient nécessaire de traiter avec soin les renseignements tirés des études et des activités de surveillance réalisées sur le sujet. Il faut à tout prix diffuser largement l'information et mobiliser les collectivités dans tous les aspects de cette quête d'acquisition de nouvelles connaissances.

Le troisième objectif du Cadre stratégique sur le changement climatique des TNO est de favoriser la résilience et l'adaptation aux changements climatiques, c'est-à-dire de trouver des façons de faire face aux changements qui ont lieu actuellement. Il est nécessaire de s'adapter aux changements inévitables, ce qui requiert la création de nouvelles façons de faire, notamment en ce qui a trait à la planification et aux activités opérationnelles.

Les gouvernements autochtones et les administrations communautaires veulent et doivent être impliqués dans la planification des mesures d'adaptation afin que les écosystèmes, y compris les peuples qui y habitent, demeurent sains et diversifiés. Ainsi, les TNO peuvent adopter différentes mesures pour s'adapter aux effets des changements climatiques sur différents aspects de l'environnement, notamment les suivantes : la mise en place de processus décisionnels fondés sur des données scientifiques en ce qui a trait à la planification et au développement de projets dans les zones de pergélisol; l'utilisation de l'imagerie satellitaire et des technologies connexes – qui sont de plus en plus accessibles – pour améliorer la capacité à prévoir les inondations; et l'exploitation de nouvelles espèces afin de subvenir aux besoins de la pêche commerciale et d'assurer la subsistance des espèces comestibles animales (terrestres et marines) et végétales.

Il est également possible de mettre en place différentes mesures pour s'adapter aux effets des changements climatiques sur la santé, la sécurité, la culture et le patrimoine de la population : l'adoption d'initiatives visant à protéger les établissements et les services de santé des risques liés aux changements climatiques, surtout dans le cadre de phénomènes météorologiques extrêmes; l'évaluation des risques liés aux changements climatiques et la planification en conséquence des plans d'urgence des collectivités; et pour finir, le renforcement, d'un point de vue social et culturel, de l'esprit de communauté afin de favoriser la résilience par la documentation, l'utilisation et la transmission de

savoirs traditionnels et locaux entre les aînés et les jeunes en ce qui a trait à la vie sur les terres ancestrales.

Enfin, les TNO peuvent recourir à plusieurs mesures pour faire en sorte que les systèmes de transport, les collectivités et les infrastructures s'adaptent au climat en mutation : l'amélioration et la mise en œuvre de normes de construction pour que la fonte du pergélisol soit prise en compte dans les étapes de conception et de construction des bâtiments; et l'amélioration des infrastructures existantes en fonction des conditions climatiques qui n'avaient pas été anticipées lors de leur construction.

Le réchauffement climatique pourrait toutefois avoir quelques avantages et permettre le développement de certains secteurs, tels que l'agriculture, le tourisme et la foresterie.

Des résumés rendant compte des principales préoccupations et des mesures envisagées ont été produits pour chacun des trois objectifs du Cadre stratégique sur le changement climatique. Ces renseignements serviront, en 2018, à l'élaboration et à la mise en œuvre d'un plan d'action quinquennal. Les progrès réalisés dans le cadre de ce plan seront détaillés dans des rapports annuels. De plus, un rapport d'évaluation final sera produit à la fin des cinq années visées, à la suite de quoi sera élaboré et mis en œuvre un second plan quinquennal.

Les TNO comptent sur le Cadre stratégique sur le changement climatique pour surmonter les difficultés posées par les changements climatiques et en saisir les occasions, passer à une économie plus sobre en carbone et contribuer aux efforts nationaux et internationaux de lutte contre les changements climatiques.

1 INTRODUCTION

The NWT is a largely undisturbed landscape with unique ecosystems that have supported Indigenous people for millennia. The NWT's vast landscape of over more than one million square kilometers is home to approximately 44,000 people who are spread across the territory in thirty-three communities.

The residents of the NWT have a long-standing relationship with the land. Many people draw their spiritual and cultural identity from the land and live a traditional way of life that includes hunting, fishing, trapping and gathering.

The NWT has world-class mineral and petroleum deposits and significant renewable energy resources that offer great potential for development and lasting economic benefit and opportunities.

Despite abundant renewable and non-renewable resource potential, the NWT economy depends heavily on imported fossil fuels to meet its energy needs. This dependence on fossil fuels results in significant greenhouse gas emissions (on a per-capita basis) and contributes to the high cost of living and doing business in the NWT.

The science is clear that human activities, particularly the burning of fossil fuels, are a major contributor to increasing global average temperatures and are causing climate change.

Climate change is a long-term shift in weather conditions identified by changes in temperature, precipitation, winds, and other indicators. Climate change can involve both changes in average conditions and changes in variability, including for example, extreme events.

In the northern part of the NWT, average temperatures are warming up to four times faster than global average temperatures while the southern NWT is warming about two times faster. Ecosystems, wildlife, water, infrastructure, human health, economic opportunities, public safety, housing, food security, cultures and heritage are all experiencing pressures and changes due to a warming climate.

The NWT Climate Change Strategic Framework outlines how the NWT plans to respond to challenges and opportunities associated with climate change, move towards a lower-carbon economy and do its part to contribute to national and international efforts on climate change.

1.1 International and National Context

During the 21st session of the United Nations' Conference of the Parties, held in December 2015, representatives of 195 countries reached agreement on a new global climate change accord known as the Paris Agreement. Key objectives of the Paris Agreement include greenhouse gas emissions mitigation, adaptation and finance, starting in 2020. Specifically:

- Holding the increase in global average temperature to well below 2°C (above pre-industrial levels) and pursuing efforts to limit the temperature increase to 1.5°C; and,
- Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience.

Under the Paris Agreement, Canada is committed to a 30% reduction in annual emissions from 2005 levels, by 2030. To implement this commitment, the federal government, provinces and territories worked together to develop the Pan-Canadian Framework on Clean Growth and Climate Change, which was released in December 2016.

The Pan-Canadian Framework has four main pillars for addressing climate change:

- Pricing carbon pollution;
- Measures to reduce greenhouse gas emissions;
- Measures to adapt to the impacts of climate change and build resilience; and,
- Actions to accelerate innovation, support clean technology and create jobs.

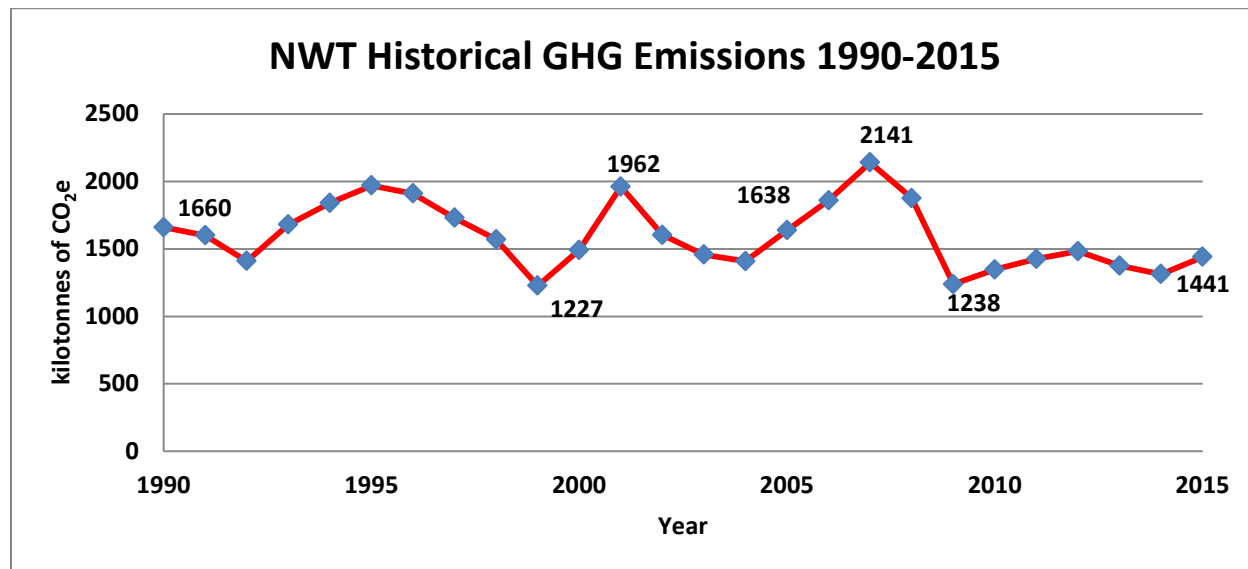
The Pan-Canadian Framework provides broad direction and guidance relevant to all Canadian jurisdictions. The NWT will build upon these efforts to address climate change within our territory.

1.2 NWT Greenhouse Gas Emissions

The science is clear that human activities, particularly the burning of fossil fuels, are causing unprecedented changes to the Earth's climate. Greenhouse gas (GHG) emissions are increasing average global temperatures and causing climate change. Taking strong action to address climate change is critical, and the need to act is urgent.

Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride are the six main GHGs. Each of these gases persists for a different length of time in the atmosphere and has a different global warming potential. All GHG emissions are converted into carbon dioxide equivalents (CO₂e) to allow for comparison.

Figure 1 below shows the NWT's total annual GHG emissions from 1990 to 2015, measured in kilotonnes (kt) of CO₂e:



Since 2009, the NWT's total annual GHG emissions have been relatively stable, varying between 1,225 and 1,500 kt CO₂e, due to annual fluctuations in economic activity and fossil fuel consumption. Approximately 96% of the NWT's annual emissions are due to fossil fuel use. The other 4% comprises emissions from minor sources such as waste and the oil and gas industry.

In 2015, the most recent year for which data are available, the NWT's GHG emissions were 1,441 kt CO₂e – representing less than two-tenths of one percent (<0.2%) of Canada's annual GHG emissions of 722,000 kt CO₂e.

More information on the sources of NWT GHG emissions is provided in Appendix A.

While the NWT is not a large contributor to national or global emissions, it is still very important that the NWT economy continues to move away from a dependence on imported fossil fuels to an increased use of local energy sources that are environmentally and economically beneficial.

1.3 Understanding Climate Change

The NWT has a cold, Arctic climate. The plants, wildlife and people that live here have adapted to this cold climate and depend on it to maintain the conditions needed to thrive.

Over the past 100 years, global average surface temperatures have warmed by about 1° C. In Arctic and sub-Arctic regions, average surface temperatures have increased much faster than the global average due to differences in atmospheric conditions and reduced sea ice coverage. This phenomenon is known as Arctic amplification.

The northern NWT is now experiencing rapid average annual temperature increases – up to four times faster than global averages – while the southern NWT is warming about two times faster.

Computer model projections indicate that without global action to reduce GHG emissions, average annual temperatures in the northern NWT could increase by as much as 8° to 10° C by 2100. If global efforts to significantly reduce emissions are successful, the northern NWT may experience less severe temperature increases – likely in the range of 4° to 6°. The southern NWT is not predicted to exhibit the same level of warming as northern areas. However, it is still anticipated to experience greater warming than other parts of Canada or much of the world.

While future temperature increases cannot be predicted with certainty, it is clear that warming trends being experienced in the NWT will continue over the long-term, and will be most pronounced during winter months.

The NWT has been experiencing detrimental effects from climate change for decades. The impacts, which are increasing in severity as the warming progresses, include thawing permafrost, shrinking sea ice, coastal erosion, and impacts on water levels, habitat and wildlife. The extent and rate of the changes have serious implications for the NWT, including territorial and community infrastructure, the health and safety of residents and the viability of some economic activities.

The NWT can address climate change by doing its part to reduce fossil fuel use and GHG emissions. As the northern climate continues to warm, the NWT must prepare to increase the resilience of our communities, and find ways to adapt to the changes already happening or yet to come.

1.4 Links with Other Plans and Strategies

The NWT must take action to address climate change but such efforts need to be balanced with other important goals and considerations in the territory.

To the greatest extent possible, the development and implementation of the NWT Climate Change Strategic Framework is intended to be consistent with, and supportive of, the objectives and actions in other relevant strategies and plans, including:

- Paris Agreement
- Pan-Canadian Framework on Clean Growth and Climate Change
- 2030 Energy Strategy
- GNWT Knowledge Agenda
- NWT Water Stewardship Strategy and Action Plan
- GNWT Land Use and Sustainability Framework
- NWT Economic Opportunities Strategy
- NWT Mineral Development Strategy
- NWT Oil and Gas Strategy
- NWT Agriculture Strategy
- Healthy Land, Healthy People: GNWT Priorities for Advancement of Conservation Network Planning 2016-2021
- Strategy for Revitalizing the Great Slave Lake Commercial Fishery
- NWT Geological Survey Strategic Plan 2017-2022
- NWT Waste Resource Management Strategy (under development)
- Manufacturing Strategy (under development)
- Northern Adaptation Strategy (under development)

In particular, the 2030 Energy Strategy and NWT Climate Change Strategic Framework were developed at the same time and are closely linked across key areas, including their respective vision statements, goals and objectives, and GHG emissions targets.

2 NWT CLIMATE CHANGE STRATEGIC FRAMEWORK

Climate change represents a very serious challenge for the NWT. The GNWT understands the implications of climate change and is committed to working with Indigenous, community, provincial, territorial and federal governments to address these challenges.

2.1 What We Heard

The GNWT conducted a series of engagement activities during the fall and winter of 2016/2017 to gather input on both the NWT Energy Strategy and the NWT Climate Change Strategic Framework. These engagement activities included a public survey, six regional workshops and written submissions.

Some of the key input the GNWT received about climate change included:

- *Set GHG emissions targets* – there was general agreement that the NWT should set GHG emissions reduction targets to demonstrate its intention to address climate change. A few respondents disagreed with setting targets, either because of concerns about the potential impact on the already high cost of living or because they felt it is not necessary for a small jurisdiction;
- *Reduce fossil fuel use* – there was a strong interest in energy efficiency and the development of local renewable energy options to reduce fossil fuel use, both in communities and by industry;
- *Discuss carbon pricing* – there was a mixed response to carbon pricing. Some respondents expressed concern about potential increases to the costs of living and doing business. Ideas on how the GNWT should use carbon tax revenues included rebates to residents and making investments in initiatives that reduce fossil fuel use and/or build resilience to climate change impacts;
- *Increase research and monitoring efforts* – respondents expressed concern about numerous climate change impacts. There is a strong interest in additional research and monitoring initiatives to better understand and predict how the NWT is being impacted by a warming climate.
- *Involve communities in research and monitoring* – communities want to be much more involved in the identification, planning and completion of research and monitoring work. Specific suggestions included better partnerships between communities and researchers, building community capacity, increasing the use of traditional or local knowledge, and better communications and outreach on findings and trends;
- *Build resilience and adapt to changes* – key areas of concern include ecosystem and environmental management, better planning for future infrastructure and addressing impacts to people such as food security, air and water quality, access to the land (e.g., as ice conditions change), and emergency preparedness.

2.2 2030 Milestone

The year 2030 is an important milestone for measuring progress of both the Paris Agreement and the Pan-Canadian Framework on Clean Growth and Climate Change.

For Canada, the 2030 GHG emissions target is 523 Mt (megatonnes). To reach this target, the actions taken in all federal, provincial and territorial jurisdictions, collectively, will need to reduce GHG emissions in Canada by about 30% from current levels.

To ensure consistency with Canada's overall efforts to address climate change, the NWT is adopting 2030 as a milestone year for setting targets and measuring progress. For planning and tracking purposes, the time from now to 2030 will be divided into several distinct phases:

2018:	Develop a five-year action plan;
2019 to 2023:	Implement the first five-year action plan;
2024:	Complete a review of the NWT Climate Change Strategic Framework and develop a new five-year action plan;
2025 to 2029:	Implement the second five-year action plan;
2030:	Conduct a second review of the NWT Climate Change Strategic Framework and update and renew accordingly.

These timeframes are utilized in section 3.1 for setting GHG emissions targets and in section 7.3 for action planning and strategy renewal.

2.3 Key Principles

The NWT Climate Change Strategic Framework rests on several key principles:

- The NWT is experiencing significant climate change impacts and must take immediate action. Climate change considerations need to be included in all relevant planning exercises, decision-making processes and operational activities;
- The NWT has a responsibility to contribute to national and international efforts to address climate change, particularly in reducing fossil fuel use and GHG emissions;
- The responsibility for taking action on climate change is shared by all segments of NWT society, including governments, businesses and residents;
- Strengthening the collaboration between governments, including Indigenous governments, and residents on mitigation and adaptation actions, based on recognition of rights, respect, cooperation and partnership; and,
- Recognizing the importance of traditional, local and scientific knowledge for understanding climate impacts and adaptation measures.

2.4 Vision and Goals

Vision

By 2030, the NWT will enjoy a strong, healthy economy that is less dependent on fossil fuels (compared to 2015) and will have developed the knowledge, tools and measures needed to increase resilience and adapt to the changing northern climate.

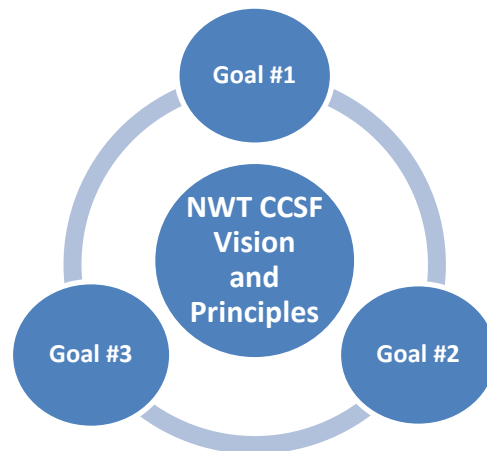
Goals

The NWT is focusing on three climate change goals:

Goal #1: Transition to a strong, healthy economy that uses 20% less fossil fuel by 2030 (compared to 2015);

Goal #2: Improve knowledge of the climate change impacts occurring in the NWT; and,

Goal #3: Build resilience and adapt to a changing climate.



Significant progress on all three goals is required if the NWT is to achieve its stated vision by 2030.

With respect to Goal #1, previous versions of the NWT Greenhouse Gas Strategy and the NWT Energy Strategy have helped the NWT become more energy efficient and improve its energy supply systems over the last twenty years. The NWT has gained valuable experience and knowledge that can be used to continue making progress on energy efficiency and local renewable energy systems, while ensuring the NWT economy is strong and healthy.

For Goal #2, numerous research and monitoring projects or programs have been undertaken in recent years but the NWT still has a long way to go toward fully understanding the impacts and opportunities associated with a warming climate. Developing a better understanding of current and future impacts and opportunities is the NWT's most critical climate change priority for the next ten years and supports Goal #3.

Goal #3 describes the overall outcome that the NWT is striving to achieve over the long-term. While there are resilience and adaptation actions that can and should be implemented today, many of the potential impacts and opportunities from climate change are complex and not yet sufficiently understood. Further progress towards Goal #2 is essential to provide the informational foundation needed to build resilience and adapt to a changing climate over the long term.

Sections 3 to 5 below provide detailed information on the importance of these Goals, and outline numerous priority areas and the key actions needed to achieve them.

3 TRANSITION TO A LOWER CARBON ECONOMY – GOAL #1

The Priorities of the 18th Legislative Assembly were tabled in December 2015. Under Economy, Environment and Climate Change, the Legislative Assembly noted several priorities including making investments in renewable resources, improving coordination and effectiveness in sustainable resource management systems, and implementing a strategy to mitigate emissions and adapt to climate change.

To achieve Goal #1 by 2030, the NWT must ensure the economy remains strong and viable while taking concrete actions to gradually reduce the use of imported fossil fuels. This will require significant capital investments in energy efficiency and local supplies of renewable and lower carbon energy sources.

3.1 NWT GHG Emissions Targets

Under the Paris Agreement, Canada is committed to a 30% reduction in annual GHG emissions from 2005 levels, by 2030.

The NWT's annual GHG emissions are calculated as part of Canada's *National Inventory Report*. In 2005, the NWT's total GHG emissions were 1,638 kt CO₂e. To contribute fully to Canada's efforts to reduce emissions, the NWT has set a 30% emissions reduction target. To achieve this target, the NWT's total annual emissions need to be reduced from the current level of 1,441 kt CO₂e (as of 2015) to about 1,150 kt CO₂e by 2030.

Given that the NWT's current emissions level is already below the 2005 emissions level, achieving a 2030 target of 1,150 kt CO₂e means the NWT needs to reduce fossil fuel consumption by about 20%.

The following sub-sections outline emissions milestones by year and sector. Establishing these milestones is critical to promote actions and to track and report on progress.

3.1.1 Territorial Targets

From 2015 emissions of 1,441 kt CO₂e, the NWT needs to achieve a reduction of approximately 290 kt CO₂e to reach a target of 1,150 kt CO₂e by 2030.

Emissions milestones for the years 2020 and 2025 are shown below. The 2020 milestone reflects a modest reduction in emissions as it is based only on actions that can be implemented immediately. The 2025 and 2030 milestones are more ambitious, as these reflect actions that require longer to plan and implement but result in bigger reductions in emissions:

2020 milestone target = 1,400 kt CO₂e (41 kt or 2.8% reduction from 2015)

2025 milestone target = 1,300 kt CO₂e (100 kt or 7.1% reduction from 2020)

2030 final target = 1,150 kt (150 kt CO₂e or 11.5% reduction from 2025)

The 2025 and 2030 emissions targets will help inform the development of successive five-year action plans (2019-2023 and 2025-2029) and provide the basis for measuring progress.

3.1.2 Targets by Sector

Section 3.1.1 outlines the emissions milestones that the NWT needs to achieve to ensure that its total annual emissions will be reduced by approximately 290 kt CO₂e by 2030.

The summary below indicates how the territorial reduction target of 290 kt CO₂e by 2030 can be achieved on a sector-by-sector basis:

Electricity generation:	25% reduction (15 kt reduction from a 2015 level of 60 kt CO ₂ e)
Space heating:	27% reduction (50 kt reduction from a 2015 level of 184 kt CO ₂ e)
Transportation:	8% reduction (40 kt reduction from a 2015 level of 509 kt CO ₂ e)
Industry:	16% reduction (100 kt reduction from a 2015 level of 613 kt CO ₂ e)
GNWT:	25% reduction (8 kt reduction from a 2015 level of 32 kt CO ₂ e)
Cross-cutting measures:	Apply to all sectors (77 kt reduction)

3.2 Sector-Specific GHG Emissions Reduction Priorities and Actions

The following priorities and actions are key initiatives for the NWT to reach its objective of achieving a 290 kt CO₂e reduction in annual GHG emissions by 2030, while at the same time growing and strengthening the economy.

3.2.1 Electricity

Each year, about 11% of the NWT's energy requirements are used to provide electricity to communities. The electricity sector only contributes 6% (60 kt CO₂e) to the NWT's annual GHG emissions, as the electric loads in our largest communities are served mostly through hydropower.

There are three ways to reduce GHG emissions from diesel electricity generation – encourage energy conservation, improve energy efficiency and install renewable or lower-carbon energy solutions to replace diesel generation.

To achieve a 25% reduction (15 kt CO₂e) in emissions from this sector by 2030, the GNWT will seek federal government support, establish partnerships with community and Indigenous governments and provide resources to ensure renewable and alternative projects can continue to proceed.

The GNWT estimates that, given current technology, as much as a \$75 million capital subsidy may be required to reach this objective without increasing existing electricity rates. Solutions will differ by community, but may include wind, solar, small hydro, liquefied natural gas, transmission lines, combined heat and power, energy storage, variable speed generators and other innovative solutions as they become available.

Other significant projects that have the potential to reduce fossil fuel use and strengthen the NWT economy include the Taltson hydroelectric transmission interconnection to southern Canada and connecting three diesel communities (Fort Providence, Kakisa and Whati) to the NWT hydroelectric grid. The Taltson project would not reduce NWT emissions but would reduce emissions in southern Canada by an estimated 360 kt CO₂e per year.

3.2.2 Space Heating

The space heating of buildings and housing in the NWT is primarily done with heating oil, propane, natural gas and biomass (cord wood and wood pellets). Heating by fossil fuels creates about 184 kt CO₂e or 13% of our annual GHG emissions. By 2030, the NWT is striving to double the amount of renewable energy used for heating – from 20% to 40%, which would eliminate an estimated 50 kt CO₂e of annual emissions.

Achieving this target will require greater use of biomass as well as solar heating and district heating.

Key measures to be implemented include:

- Develop and implement a Forest Industry Development Strategy;
- Create a community-based firewood harvesters support program;
- Identify large buildings in the NWT for biomass heating potential;
- Continue Arctic Energy Alliance wood stove program;
- Continue to expand the biomass supply chain;
- Assess the potential use of solar heating;
- Continue to convert GNWT buildings to biomass (or renewable-based electric heating); and,
- Support district heating (for biomass and residual heat) where feasible.

3.2.3 Transportation

The NWT's transportation system is made up of 2,200 kilometers of all-weather highway, 1,625 kilometers of seasonal winter roads, 27 airports and various marine assets (ferries, tugs and barges). The reliable and efficient operation of this network is essential but the high cost of transportation contributes to the high cost of living in NWT communities.

The vast size of the NWT and the fact that many communities are not connected to the all-weather road system makes it very difficult to reduce fuel use, costs and emissions from the transportation sector.

At a national level, eventual improvements in efficiency and clean fuel standards for aviation, marine fleets and road vehicles will reduce fuel use and emissions over time. The GNWT will continue to work with the federal government to improve vehicle efficiency standards and ensure that renewable fuel standards are appropriate for the NWT. The GNWT will also upgrade its marine fleet over time so it has higher efficiency vessels and can take advantage of new technologies and alternative fuels.

The following measures can be implemented to achieve a 40 kt CO₂e reduction in transportation emissions by 2030 (mostly from on-road and off-road activities):

- Support community-based transportation initiatives such as active transport, public transportation and car-sharing programs;
- Lead by example, implementing fleet management for vehicles, heavy equipment and the marine fleet;
- Pilot a grant program for hybrid plug-in electric-gasoline vehicles and charging stations for hydro communities;

- Support the installation of in-line auxiliary heaters for fleet vehicles and heavy-duty vehicles to reduce idling;
- Undertake an education and awareness campaign to encourage efficient vehicle choice, “Smart Idling”, efficient driving practices and alternative transportation choices; and,
- Periodically assess the status of biofuels for transportation use in the NWT and work with the federal government to ensure that renewable fuel standards are applicable to the north.

3.2.4 Industry

The industrial sector, which includes mining, oil and natural gas development, is a very important segment of the NWT economy – about 25% of the NWT’s annual Gross Domestic Product (GDP).

The GNWT remains committed to supporting sustainable development by the industry sector, to realize the full potential of the NWT’s mineral and petroleum resources, and provide lasting prosperity for NWT residents and communities. Equally, the GNWT recognizes that progress must be made to reduce fossil fuels use and emissions from this sector, both from existing operations as well as future projects.

Industry-related emissions (i.e., for power generation, space heating, heavy equipment use on site, and transport to remote sites) account for 43% (613 kt CO₂e) of the NWT’s annual GHG emissions.

To achieve a 16% (100 kt CO₂e) reduction in industry-related emissions by 2030, the GNWT recognizes that it must work collaboratively with industry to ensure that mining, oil and natural gas projects remain cost competitive and economically viable.

To help reduce emissions from the industrial sector, the GNWT will work collaboratively with industry on three key actions:

Carbon Pricing – under the Pan-Canadian Framework on Clean Growth and Climate Change, all jurisdictions in Canada are required to implement some form of carbon pricing by 2018 (see section 3.3). The GNWT recognizes that the existing mines in the NWT will be required to contribute significantly once a carbon pricing system is in place. To ensure the continued economic viability of the mining sector, the GNWT is working to implement a carbon pricing system that is fair and can help industry implement energy efficiency, renewable energy and other initiatives to reduce the reliance on diesel fuel and reduce its carbon footprint.

Federal Funding Programs – the Government of Canada is developing and implementing a suite of funding programs to support the actions in the Pan-Canadian Framework on Clean Growth and Climate Change. Two programs of particular interest to the NWT include the Low Carbon Economy Fund and the Green Infrastructure Fund. As further information becomes available on these programs, the GNWT will seek to access federal funding that can be used by industry to implement various measures to reduce reliance on diesel fuel and reduce its carbon footprint.

New Projects – in the NWT, proposed resource development projects are often evaluated through an environmental impact assessment process administered by either the Mackenzie Valley Environmental Impact Review Board or the Environmental Impact Review Board

(Inuvialuit Settlement Region). There are three possible steps in the process; a preliminary screening, an environmental assessment and an environmental impact review. The level of scrutiny involved increases with each step but most projects undergo only a preliminary screening or environmental assessment. Relatively few projects proceed to an environmental impact review. To ensure that future resource development projects take all reasonable steps to minimize their carbon footprints at the outset, the GNWT will work with both Boards, as well as with industry, to determine how fossil fuel use and GHG emissions can be formally incorporated into the environmental assessment process.

With respect to oil and natural gas, the NWT is continuing to experience reductions in operations and projects as a result of low commodity prices. In addition, there is a high degree of uncertainty about the future of the Norman Wells oilfield. This oilfield, which has been in operation since the 1920s, is experiencing an ongoing decline in production. GHG emissions from the Norman Wells oilfield are currently about 80 kt CO₂e per year (i.e., about 5% of the NWT's total emissions). If the Norman Wells oilfield ceases operation, this would represent a major negative impact on the NWT economy, but would result in a significant reduction in GHG emissions produced by industry.

3.2.5 Government

While GNWT's annual energy use in buildings and mobile assets is responsible for only 32 kt CO₂e of emissions per year, the GNWT recognizes that it needs to lead by example.

To realize its target of achieving a 25% reduction in government emissions, the GNWT will implement the following measures:

- Continue installing biomass heating systems in government buildings (where feasible to do so);
- Continue to promote green procurement practices, as outlined in the GNWT's Green Procurement Guide;
- Continue improving the energy efficiency of existing government facilities through the Capital Asset Retrofit Fund; and,
- Continue retrofitting the least energy efficient units in its public housing portfolio.

3.3 Cross-Cutting Measures

In addition to the sector-specific measures described above, the NWT can also reduce territorial GHG emissions by an estimated 77 kt CO₂e (or more) by 2030 through cross-cutting measures that apply to all sectors of the economy.

Carbon Pricing

The Government of Canada considers carbon pricing to be an effective and transparent policy approach to reduce GHG emissions.

The pricing of carbon pollution is one of four main pillars in the Pan-Canadian Framework on Clean Growth and Climate Change. Annex 1 of the Pan-Canadian Framework outlines the federal government's benchmark for carbon pricing across Canada. Each jurisdiction can design and implement

its own carbon pricing scheme so long as it applies to a broad set of emission sources and increases over time, starting in 2018.

As the NWT relies on southern suppliers for virtually all its required supplies and materials, the GNWT and the Government of Canada worked together to address the unique circumstances in the NWT, including the high costs of living, challenges with food security and emerging economies.

The GNWT also developed and released a Discussion Paper on carbon pricing and conducted community workshops to obtain public input on how carbon pricing should be implemented in the NWT. The GNWT's overriding objective is to introduce a carbon pricing system that provides a price incentive to reduce carbon-based fuel use while as much as possible not affecting the local cost of living for NWT residents or creating further barriers to economic development and doing business.

Over time, the implementation of carbon pricing in the NWT will contribute to the goal of transitioning to a lower-carbon economy. Once completed, the details of carbon pricing in the NWT will be provided elsewhere.

Energy Efficiency

The GNWT recognizes that energy efficiency is key to addressing both energy affordability and reducing GHG emissions in the NWT. The GNWT already provides energy efficiency programs and services to residents, business, communities, and Indigenous governments through the Arctic Energy Alliance.

In the 2030 Energy Strategy, the GNWT set an objective to increase commercial, residential and government building energy efficiency by 15% over 2015 levels by 2030. Key measures to be implemented to achieve this target include:

- Enhance energy efficiency and conservation education and outreach;
- Enhance support to the Arctic Energy Alliance's existing energy efficiency and conservation programs;
- Introduce new Arctic Energy Alliance programs such as a whole building retrofit energy-rating grant program and support for low-income homeowners; and,
- Engage with the tax-based communities around potential changes to the *Cities, Towns and Villages Act* that would enable community governments to set up programs that help finance energy efficiency retrofits.

Composting Organic Waste

In 2015, an estimated 6,335 tonnes of CO₂e were emitted from solid waste disposal in the NWT. These emissions are the result of landfill gas (primarily methane and carbon dioxide), which is created from the anaerobic decomposition of organic wastes in landfills. Diverting organic waste from landfills and into composting programs can decrease the GHG emissions from organic waste.

Composting organic wastes is beneficial as it results in organic matter that can be used to fertilize gardens to grow food locally. Rich organic soils are not common in many parts of the NWT, presenting challenges for local agriculture, but the production of compost can enrich soil for local food production. Growing food locally can reduce GHGs emissions from the transportation of food from southern provinces and can also improve food security in the NWT.

Due to the remote nature of industrial developments in the NWT, these sites have historically incinerated organic wastes, using diesel as the combustion source. In 2015, Dominion Diamond Corporation installed an in-vessel composter at the Ekati Diamond Mine to reduce the volume of waste incinerated. After 3 months of operation, the company saved more than 25,000 litres of diesel and reduced GHG emissions by 80 tonnes CO₂e.

A number of schools and communities in the NWT have implemented composting projects with support from the GNWT. Continued composting at remote industrial sites and at the community level will help reduce GHG emissions and increase local food production.

In total, cross-cutting measures such as carbon pricing, energy efficiency and composting have the potential to reduce annual territorial emissions by an estimated 5 to 10% (i.e., 72 to 144 kt CO₂e).

3.4 Emissions Tracking and Reporting

Accurate tracking of GHG emissions is an important part of assessing the NWT's environmental performance and measuring progress towards our GHG reduction targets. The GNWT and large emitters in the NWT report emissions to various agencies to comply with federal reporting requirements and/or for voluntary reasons.

3.4.1 3.4.1 GNWT Emissions Reporting

The GNWT voluntarily reports its GHG inventory, as it recognizes its role in leading by example to reduce GHG emissions. The Climate Registry is a recognized non-profit organization that designs and operates voluntary and compliance GHG reporting programs globally. Each year since 2011, the GNWT has prepared and submitted a GHG inventory to The Climate Registry. Tracking its emissions allows the GNWT to assess its progress towards achieving its GHG reduction targets.

From 2001 to 2011, the GNWT's emissions were reduced by about 30%, to 37.4 kt CO₂e. Since 2011, the GNWT's emissions have continued to decline, and were approximately 31.6 kt in 2016.

3.4.2 3.4.2 Facility-Level Reporting

Since 2004, the Government of Canada has required facilities that emit 50 kt CO₂e or more per year to submit a report through the Greenhouse Gas Emissions Reporting Program (GHGRP). For the 2015 reporting year, five facilities in the NWT submitted annual reports to the GHGRP:

1. Diavik Diamond Mines Inc – Lac de Gras – Diavik Diamond Mines Inc.
2. Ekati Diamond Mine – Dominion Diamond Ekati Corporation
3. Jackfish Plant – NWT Power Corporation
4. Norman Wells Central Processing Facility – Imperial Oil Resources N.W.T. Limited
5. Snap Lake Mine – De Beers Canada Incorporated

Environment and Climate Change Canada (ECCC) is in the process of expanding the requirements under the GHGRP to obtain a more comprehensive picture of emissions by Canadian facilities.

The proposed changes, anticipated to take effect in 2018, will include:

- Lowering the reporting threshold from 50 kt to 10 kt. All facilities that emit 10 kt or more of CO₂e per year will be required to submit a report; and,
- Requiring facilities to provide additional data and apply specific quantification methods to determine emissions. These new requirements will be gradually phased in.

Once these new reporting requirements are implemented, additional facilities in the NWT will need to track and report their annual emissions. When additional information is available from ECCC, the GNWT will work to identify those NWT facilities that may be affected by these changes and communicate with these facilities to ensure they are aware of the new reporting requirements.

3.4.3 3.4.4 Cross-Cutting Initiatives

For initiatives such as a carbon tax, energy efficiency and composting, it can be challenging to determine the extent to which any specific measure has contributed to overall reductions in territorial emissions. The GNWT needs to complete additional work to determine how to best track and report on these types of initiatives.

3.4.4 3.4.5 NWT Annual Reporting

Each year the GNWT prepares and releases a Northwest Territories Greenhouse Gas Emissions Summary Report. Data in this report comes from ECCC's annual submission of the National Inventory Report (NIR). Canada prepares the NIR in accordance with international emissions reporting guidelines.

The NWT's annual GHG emissions summary report compiles NWT-specific data from the NIR and outlines the NWT's emissions, by sector. Facility-level reporting from the GHGRP is incorporated to summarize emissions from industry. The NWT summary report compares the NWT's annual emissions to emissions targets.

Over time, the GNWT will continue to develop and refine its reporting methods to incorporate new emissions data, as it becomes available. These data will improve the consistency, accuracy and reliability of the NWT's emissions inventory and give the public a clearer picture of the NWT's emissions by sector.

The NWT's annual reporting will provide information on the progress being made to reduce territorial emissions and achieve specific targets by sector.

4 IMPROVE KNOWLEDGE OF CLIMATE CHANGE IMPACTS - GOAL #2

Due to accelerated atmospheric warming, the NWT is already experiencing numerous changes and increasing impacts to its environment, infrastructure and residents' health, safety, culture and heritage.

4.1 Climate Change Knowledge

To begin addressing climate change, increased knowledge of related impacts is imperative to determine options to build resilience and/or adapt to impacts. Traditional, local and scientific knowledge can be utilized to identify current and predict future changes in the NWT.

4.1.1 NWT Knowledge Agenda

The NWT is experiencing a number of dynamic changes and challenges including climate change, economic change, sustainable resource development, new technologies, health risks and social change. The GNWT believes decisions required to adapt to these changes should be based on the best available evidence and knowledge as derived from experience, investigation and research.

The NWT Knowledge Agenda, released in 2017, aims to position the NWT as an active leader, practitioner, partner and promoter of all forms of research, including western science methods, traditional and local knowledge and community-based research.

Understanding the impacts and extent of the changes already occurring in the NWT will require collaboration between research institutions, governments, communities and traditional and local knowledge holders. The NWT Knowledge Agenda identifies key themes where research needs to be focused to address NWT interests, improve the quality of life of NWT residents and maintain the integrity of NWT cultures, communities, ecosystems and environments. Achieving the goals outlined in the NWT Knowledge Agenda will require that the impacts of climate change be considered in research across all themes. Ensuring resulting information is reported back to the public will continue to be extremely important.

4.1.2 Traditional and Local Knowledge

Traditional knowledge is defined in the GNWT Traditional Knowledge Policy as “knowledge and values, which have been acquired through experience and observation, from the land or from spiritual teachings, and handed down from one generation to another.”

Key elements of traditional knowledge include knowledge about the environment, knowledge about the use and management of the environment and values about the environment.

As outlined in the NWT Knowledge Agenda, it is recognized that traditional knowledge and traditional knowledge-based research need to play a key role in identifying and understanding the changes occurring on the landscape and the implications of these changes for wildlife, traditional activities and human health and well-being.

It is critically important that traditional knowledge be accessed and utilized in appropriate and respectful ways, as agreed upon with traditional knowledge holders.

During the regional engagement workshops conducted in 2016/17, Indigenous participants offered the following suggestions regarding the use of traditional knowledge:

- Researchers should be trained to properly access and use traditional knowledge;
- Research results derived from the use of traditional knowledge should be reported back to the communities involved for their consideration and comment; and;
- Traditional knowledge can be used to help establish baselines to determine environmental and health trends.

Local knowledge differs from traditional knowledge in that it is not bound in a spiritual connection and is often more recent. Like traditional knowledge, it is acquired through experience and observation, and can be handed down from one generation to another.

Ensuring traditional and local knowledge and western science perspectives are considered and relied upon in climate change research, monitoring, mitigation and adaptation will benefit all NWT residents and result in a more robust knowledge base.

4.2 Community Involvement

NWT communities want to be much more involved in, and influence, the identification, planning and completion of climate change-related research and monitoring efforts.

During the regional engagement workshops conducted in 2016/17, communities made a number of specific requests related to their role in research and monitoring work. These include:

- Establishing better partnerships between communities and researchers;
- Leading research and monitoring related to local/regional climate change priorities;
- Being involved at the outset of projects led by researchers to identify community concerns and make sure the intended results address community interests;
- Receiving training and support to build community capacity, to allow community residents to participate in and to lead the work being done;
- Integrating schools and youth in research and monitoring;
- Increasing the use of traditional or local knowledge; and,
- Receiving better communications and outreach on findings and trends.

The GNWT recognizes that many of the climate-related changes occurring in the NWT create impacts that are experienced to the greatest extent at the local or regional level. Efforts to address such impacts require local leadership and involvement. The GNWT can build on the work already being done to support community involvement through initiatives such as the NWT Water Strategy, the Cumulative Impact Monitoring Program, the Environmental Studies Research Fund, wildlife co-management efforts, and partnerships with academic institutions.

At the federal level, initiatives are already underway to help support community involvement in understanding impacts and finding ways to build resilience or adapt. These include Indigenous and Northern Affairs Canada's Climate Change Preparedness in the North program and Health Canada's Climate Change and Health Adaptation program.

4.3 Climate Change Impacts, Knowledge Gaps and Research and Monitoring Priorities

Continuing warming trends indicate that the NWT will likely experience numerous and significant changes and impacts over the next 50 to 100 years, in addition to what is already happening in the territory.

It is clear that the unprecedented pace and extent of the impacts already occurring must be better understood so that the NWT can build resilience or find ways to adapt to changes that are unavoidable. A significant amount of research, monitoring and assessment work is taking place in the NWT ranging from community-based projects to territory-wide investigations.

Input provided by GNWT subject matter specialists and input from public engagement efforts identified many knowledge gaps that need to be addressed. An overview of climate change impacts, knowledge gaps and research and monitoring priorities (over the next five to ten years) related to: 1) the environment, 2) human health, safety and culture and heritage, and 3) infrastructure are discussed below and elaborated upon in Appendix B.

4.3.1 Environment

The warming climate is causing two different types of changes in the NWT – gradual shifts in the physical landscape and ecosystems (e.g., slow thawing of permafrost) and more abrupt extreme events (e.g., thaw slumps, floods and forest fires). Combined, these gradual and abrupt environmental changes have serious consequences that need to be better understood. An overview of the changes and impacts is provided below.

4.3.1.1 *Changing Climate and Weather*

The rapid warming underway in the north is directly affecting the climate (weather patterns over a long period of time) and weather (day to day state of the atmosphere) in the NWT.

Weather is becoming more uncertain and storms are more severe. Winter freeze-up dates are occurring later, spring thaw is occurring earlier and travel on the land, water and ice is becoming more dangerous and difficult. All of these changes make it more difficult for people to pursue traditional harvesting and trapping activities.

Long-term climate and weather research and monitoring is essential for determining the health of ecosystems and to better understand causes of climate-related impacts. Climatic information, including trends, is required to inform adaptation planning including the design of new infrastructure, modification of existing infrastructure, and sustainable resource management decisions related to wildlife, forests, water, and contaminated sites.

Climate and weather research and monitoring is being undertaken in the NWT by the federal government, GNWT, Indigenous governments, communities, industry and academics, but these efforts are somewhat limited. Monitoring stations are lacking, some stations are not ideally located and coordination of monitoring efforts is limited.

Changes in climate and weather directly impact all environmental components described below. More detailed information on impacts, knowledge gaps and research and monitoring priorities pertaining to climate and weather is provided in Appendix B.

4.3.1.2 Thawing Permafrost

Permafrost is frozen ground that underlies most of the NWT's communities, transportation infrastructure and natural environments. It can be thought of as the cement that holds northern landscapes together. This frozen layer of earth materials can be tens to hundreds of metres thick and can contain large volumes of ground ice. Thawing of permafrost and the melting of ground ice causes the ground surface to subside and reduces the stability of the terrain.

Permafrost thaw is significant to northern communities because it can damage overlying infrastructure including roads and buildings, as well as impact heritage resources and culturally significant sites. The degradation of permafrost can cause rapid erosion and affect the quality of water and impact wildlife. Thawing of frozen organic materials releases GHGs which contribute to overall global climate warming.

Long-term permafrost research and monitoring is underway, however, due to limited northern capacity, the majority of GNWT activities rely on academic partnerships or collaboration with federal researchers. Northern-based technical capacity is needed to address research and monitoring gaps, support decision making and provide technical advice within government and to residents, as climate-driven permafrost thaw continues to increase infrastructure, terrestrial and aquatic ecosystem stresses.

More detailed information on permafrost related climate change impacts, knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.1.3 Changes to Water

The NWT relies on water and aquatic ecosystems for sustenance, transportation, energy production, economic growth, recreation, culture and spirituality. Climate change affects the NWT's water quality and quantity through extreme weather events, changes in flood or drought severity, increased variability in precipitation, thawing of permafrost and melting of glaciers and polar ice sheets.

Long-term water quality and quantity monitoring is led predominantly by the GNWT and also undertaken by Indigenous governments, federal departments, industry, academia, non-government organizations and communities. Climate change related impacts include altered water chemistry, varying river and groundwater flows, reduced ice coverage and drying of wetlands. Gaps in the monitoring network will need to be addressed, particularly in areas more vulnerable to the effects of climate change, to further understand climate change impacts.

The NWT is the ultimate downstream jurisdiction in the Mackenzie River Basin, where water flows from Alberta, British Columbia, Yukon and Saskatchewan into the NWT. Consequently, climate impacts and human activity in those jurisdictions can affect aquatic ecosystems, including water quality and quantity, in the NWT. To address the transboundary challenge of climate change, bilateral water management agreements with those jurisdictions enable collaborative work to conduct research and monitoring for the purposes of understanding and potentially mitigating and adapting to climate change in the basin.

More detailed information on water related climate change impacts, knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.1.4 *Changes to Forests and Tundra Vegetation*

The NWT has about 80 million hectares of forested land, representing about 20% of the Canadian boreal forest. It also has a significant tundra ecosystem that includes important plant and lichen species. Residents depend on the forest and tundra as critical habitats and breeding grounds for wildlife, as well as for subsistence harvesting, recreation and sustainable resource development. In the boreal forest, natural disturbances, such as wildfires and insect outbreaks, are necessary for forest renewal, therefore understanding the disturbance frequency, severity and distribution is essential to be able to recognize abnormal trends that may result from climate change. Climate impacts include shifting vegetation, for example, the tree line moving northwards and forests replacing the tundra, and competition from new species moving into the NWT.

Long-term forest and tundra monitoring in the NWT is undertaken predominantly by the GNWT, but it is also conducted by Indigenous governments, federal departments and academia. Climate change related impacts include increases in forest fire occurrence and severity, compromised forest productivity, and shifts or expansions in ranges of tree and plant species, diseases and pest. The growth response of NWT forests and tundra vegetation to a changing climate remains uncertain due to significant knowledge gaps, thus long-term monitoring and research is necessary. For example, annual forest health surveys have provided some information on early signs of forest ecosystem conditions and will be needed over the long term to understand how climate change is impacting forest dynamics.

More detailed information on forest and tundra vegetation related climate change impacts, knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.1.5 *Changes to Wildlife*

The NWT is one of the few remaining regions in the world with herds of wild migratory caribou, muskoxen, bison, healthy populations of top predators, and rich northern biodiversity. Indigenous people and NWT residents rely on wildlife to maintain subsistence lifestyles. Wildlife populations, health, distribution and habitat are affected by warming temperatures, increased variability in precipitation, extreme weather events and increases in forest fires. Existing wildlife may face competition from new species moving into the NWT (such as deer). Climate change may also result in a mismatch between the timing of biological events (such as flowering and the emergence of insects) and species that depend on those events.

Although wildlife has evolved and adapted to a variable climate, when combined with natural fluctuations and other disturbances, the impacts of climate change on certain species will likely become more severe. Climate-related stresses can lead to changes in the natural ranges of mammals, birds and insects, establishment of new parasites in wildlife species, and challenges accessing food sources.

Long-term wildlife monitoring in the NWT is undertaken predominantly by the GNWT, and also by Indigenous governments, wildlife co-management boards, federal departments, communities, industry and academia. The GNWT addresses the effects of climate change on wildlife at a species level. Knowledge gaps and research and monitoring priorities that need to be addressed include determining areas and species that may be more vulnerable to the effects of climate change and monitoring to assess changes to wildlife health, populations and distribution.

Climate change is also a significant threat to several species at risk (e.g., boreal caribou, Peary caribou, Dolphin and Union caribou, polar bear, and various bird and plant species). Ongoing monitoring of these and other species at risk will be necessary, as their protection is a legislated responsibility through the territorial *Species at Risk (NWT) Act* and federal *Species at Risk Act*.

More detailed information on wildlife related climate change impacts, knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.1.6 Changes to Fish and Marine Mammals

Fish and marine mammals are a vital traditional food source for residents of the NWT. Fish such as lake trout, Arctic char, whitefish and burbot are harvested in numerous lakes and rivers, and marine mammals, namely ringed seal and beluga, are harvested in the Beaufort Sea.

Healthy and abundant fish populations are critical to the NWT's economy, as evidenced by an active Great Slave Lake commercial fishery, and outfitters that host tourists for recreational and trophy fishing. Climate change can affect fish and marine mammal habitat, health, food sources, populations and distribution, due to altered water quality and quantity, increased water temperature, ocean acidification and extreme weather events.

Long-term fish and marine mammal monitoring in the NWT is led predominantly by the federal government, and also by Indigenous governments, wildlife co-management boards, the GNWT, and academia. There are knowledge, research and monitoring gaps that need to be addressed, particularly for species more vulnerable to the effects of climate change. For example, in some areas new fish species being observed may threaten native species and affect traditional harvests.

Climate change is also a significant threat to several fish and marine mammal species at risk (e.g., grey whale, bull trout, and Dolly Varden). Ongoing monitoring of these and other species at risk will be necessary as their protection is a legislated responsibility through the *Species at Risk (NWT) Act* and federal *Species at Risk Act*.

More detailed information on fish and marine mammal related climate change impacts, knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.2 Human Health, Safety, Culture and Heritage

Many of the changes to the environment now occurring can have an impact on human health, safety, culture and heritage. As discussed above, impacts currently being experienced include unpredictable weather events, drought, shorter winter conditions, increased and more severe wildfires, and changing water conditions, all of which can have profound effects on quality of life for the people of the NWT. This is especially evident in the NWT where traditional livelihoods and relationships with the land and water are intrinsic to Indigenous people.

4.3.2.1 Human Health

The health of NWT residents is integrally linked to the health of water, wildlife, vegetation and air. Climate change-related impacts such as changing weather, water and ice conditions, increases in forest fires and associated smoke, increases in invasive species, altered wildlife and fish ranges, and expansion and migration of infectious disease or outbreaks are all factors that can impact the health and general well-being of NWT residents. Impacts can range from effects on physical human health, to food security, to mental, social and cultural wellbeing, to delivery of health and social services.

Long-term monitoring of the health of NWT residents is led predominantly by the GNWT and is also undertaken by Indigenous governments, federal departments, and academia. There are, however, gaps in knowledge, research and monitoring that need to be addressed to better understand the implications on human health, particularly in populations more vulnerable to the effects of climate change, such as Indigenous people who depend on the natural environment for their livelihood and sustenance.

More detailed information on human health related climate change impacts, knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.2.2 Public Safety

Public safety is a key consideration in the context of climate change. As conditions change harvesters are experiencing increasing difficulties and taking on greater risks in accessing country foods and pursuing traditional economies and activities. In communities or built environments, infrastructure may be at risk due to thawing of permafrost, forest fires or flooding, causing public safety concerns. For example, use of both all season and winter roads is becoming less predictable and more unsafe due to the impacts of thawing permafrost and lengthened ice free seasons.

Long-term monitoring of the safety of NWT residents is led predominantly by the GNWT and also undertaken by Indigenous governments, federal departments, and academia. In 2014, the GNWT released the NWT Hazard Identification Risk Assessment Report, which considered climate change impacts when assessing hazards. Floods and wildfires were deemed very high hazards in the NWT. It is therefore important that gaps in knowledge, research and monitoring for these high hazards, as well as other hazards, be addressed, particularly for communities that are increasingly vulnerable to the effects of climate change.

More detailed information on public safety related climate change impacts, knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.2.3 Culture and Heritage

Culture is the living and evolving expression of values. Heritage encompasses things from the present and the past that people wish to bring to the future. Together, culture and heritage are vitally important to Indigenous people and all residents of the NWT. The numerous climate-related changes occurring on the landscape are a threat to important archeological sites, artifacts and cultural practices. Impacts range from transportation challenges in accessing traditional hunting and trapping grounds leading to decreases in traditional economies (e.g., sale of wild furs), to losses of cultural and heritage sites due to changes in the environment such as coastal erosion, permafrost thaw slumping and wildfires.

Long-term monitoring of the culture and heritage of NWT residents is led predominantly by the GNWT and also undertaken by Indigenous governments, federal departments and academia. There are however, gaps in knowledge, research and monitoring that need to be addressed to ensure that resiliency is strengthened to sustain Indigenous peoples' culture and heritage in light of the effects of climate change.

More detailed information on culture and heritage climate change impacts, knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.3 Infrastructure

The NWT's built infrastructure, including buildings, houses and facilities, is being impacted by the many alterations to the environment resulting from climatic change. Thawing permafrost is of particular concern, as it underlies much of the NWT's infrastructure, within communities and on the broader landscape.

Monitoring of impacts on infrastructure and buildings is led predominantly by the GNWT and also undertaken by federal departments, communities, industry and academia. There are gaps in knowledge and research and monitoring priorities that need to be addressed, particularly in regions and communities that are more vulnerable to the effects of climate change.

More detailed information on climate change impacts to infrastructure, along with knowledge gaps and research and monitoring priorities is provided in Appendix B.

4.3.4 General Priorities – Linkages and Cumulative Impacts

Sub-sections 4.3.1 to 4.3.3 describe various impacts, knowledge gaps and research and monitoring priorities related to the environment, to human health, public safety, culture and heritage and to infrastructure. In addition to these specific impacts and priorities, it is also important to consider related linkages and interconnections between different processes and impacts.

Two general priorities that will need to be addressed over time include:

- Determining and understanding the feedbacks, linkages and interactions among ecological processes (including terrestrial, aquatic and air) and the effects of climate related changes; and,

- Determining what the cumulative impacts of all these changes are on human and community health, cultural and heritage resources, and the built environment within the NWT.

The GNWT, Indigenous governments, federal departments, industry and academia conduct or contribute to a variety of monitoring and research on these priorities. For example, the NWT Cumulative Impact Monitoring Program (NWT CIMP) coordinates, conducts and funds the collection, analysis and reporting of information related to environmental conditions in the NWT, using scientific, traditional and local knowledge. This territorial program is guided by a steering committee of Indigenous, federal and territorial government representatives. By furthering an understanding of cumulative impacts, NWT CIMP aims to support sustainable resource management decision-making and development.

Currently the focus of the program is on caribou, water and fish, and there is an increasing awareness of the impacts to these ecosystem components that are related to climate change (e.g., habitat suitability, permafrost slumps, forest fires). As cumulative impact monitoring and assessment evolves in the NWT, the impacts from climate change will continue to be monitored and included in cumulative effects assessments conducted for the program's identified valued ecosystem components.

4.4 Information Management, Communication and Outreach

Communicating relevant climate change information to NWT residents in an understandable and useable manner is critically important. To do so effectively and efficiently, the vast amount of data and information must first be properly managed. The management of environmental data and the sharing of climate change-related information are discussed below.

4.4.1 Environmental Data Management

The amount of environment-related research, monitoring and assessment work underway in the NWT is generating enormous amounts of information in the form of physical samples, data, products and tools, much of which is relevant to climate change.

Key practitioners involved in research, monitoring and assessment work include territorial, federal and Indigenous governments, academic researchers, regional and community-based organizations, non-governmental organizations and industry. Each year, numerous environmental programs and projects are being undertaken throughout the NWT but no central authority tracks or coordinates this activity, resulting in challenges related to the storage, management, analysis, and sharing of data and information.

As more research, monitoring and assessment work needs to be done to address climate change-related knowledge gaps, it is clear that steps are needed to improve the capacity to manage and make use of the data and information being generated.

4.4.2 Outreach and Sharing of Climate Change Information

One of the most common topics raised during the regional engagement workshops was the need for better sharing of research and monitoring results with community and Indigenous governments and residents.

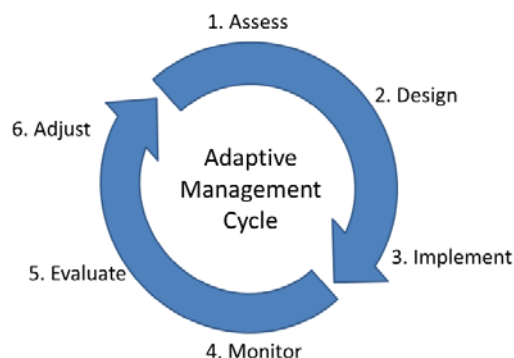
While vast amounts of climate change-related information pertaining to the environment, human health, safety, culture and heritage, and infrastructure are being generated, there is often a lack of access to this information in a useable and understandable format. Developing best practices, decision support tools and innovative forms of communication for sharing climate change-related information with residents will be necessary.

The GNWT needs to continue to play an active role in increasing public awareness and education about climate change and sharing information with community members and local decision-makers to assist them in adapting to climate change.

5 BUILD RESILIENCE AND ADAPT TO A CHANGING CLIMATE - GOAL #3

Integrating or “mainstreaming” climate change considerations into plans, policies, practices and management functions is vitally important.

As the northern climate continues to change, decision-makers will need to adjust plans and operations to deal with a wide range of possible future conditions and unanticipated events. To address the degree of uncertainty on how climate changes may affect the NWT, an adaptive management cycle, as shown on the right, can be implemented.



Efforts to increase resilience or adapt are required in four broad areas – ecosystems; environment; human health, safety, culture and heritage; and infrastructure.

5.1 Sustainability of Ecosystems

To respond to current and future changes in the environment, the approaches and methods for decision-making and management of the NWT’s ecosystems need to be improved or modified to ensure sustainability into the future.

The NWT already has numerous processes, plans and actions in place that govern and support the management of its ecosystems and natural resources. Over the next ten years, it is anticipated that many of these will need to be modified to better account for climate change-related impacts and opportunities.

Ensuring that ecosystems remain healthy and diverse is a priority for the NWT, as food security and non-traditional economies rely on the maintenance of the NWT’s biodiversity. There are several integral components that make up the NWT’s overall land, water and sustainable resource management regime, including the Land Use and Sustainability Framework, conservation network planning and regional land use planning. Each can contribute to improving ecological, social and economic resilience and adaptation to climate change. Additional information on these contributions is provided in Appendix C.

5.2 Environment

As discussed under Goal 2, many current or potential impacts to the environment due to climate change have been identified, ranging from gradual shifts in the physical landscape and ecosystems, to more abrupt extreme events. For many of these impacts, resilience and adaptation measures will be required.

As research and monitoring is undertaken over the next ten years, important knowledge gaps will be filled and the results can be integrated into climate change planning and adaptation to better protect the NWT’s environment.

5.2.1 Climate and Weather

With more extreme weather conditions and changes in climate over time, the NWT will need to build resilience and work towards adapting to these changes. Key efforts will include better monitoring, undertaking vulnerability assessments and developing predictive climate modeling to anticipate extreme weather events. Preliminary adaptation efforts to address impacts related to climate and weather are provided in Appendix D.

5.2.2 Permafrost

The quality of life of residents and wildlife will depend on the territory's ability to adapt to changes in permafrost. To support the NWT's efforts in adapting to changing permafrost conditions due to climate change, improved monitoring and assessment and fostering of science based decision making is needed. Preliminary adaptation efforts to address climate change related impacts to permafrost are provided in Appendix D.

5.2.3 Water Quality and Quantity

The quality of life of residents, wildlife, fish and marine mammals will depend on their ability to adapt to changes in water quality and quantity, in all its forms, due to the likely increased frequency of natural events such as forest fires, thaw slumps, extreme weather events, frequency and severity of droughts and floods, and increased water temperatures.

The NWT Water Stewardship Strategy's Action Plan 2016-2020 outlines actions that consider the effects of climate change and assess the vulnerability of watersheds to climate change, to ensure the waters of the NWT remain clean, abundant and productive for all time, as per the Water Stewardship Strategy's vision. Preliminary adaptation efforts to address climate change impacts to water quality and quantity are provided in Appendix D.

5.2.4 Forest and Tundra Vegetation

The quality of life of residents and wildlife depend on the NWT's ability to adapt to changes to its forests and tundra due to the likely increased frequency of natural events such as wildfires and insect and disease disturbances.

The effects of climate change on NWT forests and tundra are currently difficult to predict due to knowledge gaps and uncertainties about the extent and direction of changes. Several integrated management approaches to address climate change adaptation need to be employed. Preliminary adaptation efforts to address climate change related impacts to forest and tundra vegetation are provided in Appendix D.

5.2.5 Wildlife

The NWT's wildlife have adapted to their northern climate. However, with more extreme weather conditions and accelerated changes in climate it is still unknown and difficult to predict how wildlife will be able to continually adapt to increases in forest fires, changes in water quality and quantity, increased

temperatures, landscape changes due to thawing permafrost, and potential increases in diseases and parasites.

Maintaining healthy and resilient wildlife populations in the NWT, for ongoing biodiversity, vital traditional foods, and valuable sources of income (e.g., trapping for the harvest of wild furs), is important. Preliminary adaptation efforts to address climate change related impacts to wildlife are provided in Appendix D.

5.2.6 Fish and Marine Mammals

A warming climate is contributing to changing water quality, quantity and temperature in the NWT, which in turn affects fish and marine mammals. It is important to maintain healthy and resilient fish and marine mammal populations in the NWT for ongoing biodiversity, vital traditional foods, and valuable sources of income. Preliminary adaptation efforts related to fish and marine mammals is provided in Appendix D.

5.3 Human Health, Public Safety, Culture and Heritage

Protection of the public is of paramount importance. This responsibility is shared by residents, Indigenous and community governments, the GNWT and federal government. As the climate changes, various levels of government must be able to anticipate, address and minimize emerging risks and associated impacts to health, safety, culture and heritage. Climate change is resulting in increased unpredictability in seasonal weather, affecting decision-making in certain aspects of northerners' lives, such as determining whether travelling on the land for subsistence harvesting is safe.

NWT communities are generally more vulnerable than southern Canadian communities. This is due to a lack of back-up or redundant infrastructure and systems, remoteness, socio-economic challenges and limited local capacity. On the other hand, residents of the NWT also have advantages to overcoming impacts of natural hazards or disasters, as they are self-reliant and are used to extreme weather conditions and related disruptions. Building resilience and adapting to climate change impacts will be critically important for NWT residents.

5.3.1 Human Health

Health adaptation is defined as action taken by health sector officials, in collaboration with other sectors, to understand, assess, prepare for and help prevent the health impacts of climate change, particularly on the most vulnerable in society.

In the NWT, current and emerging human health risks resulting from climate change include food safety and security, air quality concerns, exposure to environmental contaminants, spread of infectious diseases and outbreaks and deterioration of physical and mental health. Preliminary adaptation efforts to address climate change related impacts to human health are provided in Appendix D.

5.3.2 Public Safety

Severe events, such as flooding and wildfires, may increase in severity and frequency due to climate change and necessitate changes in the NWT's approach to emergency management. Their identification as very high hazards in the 2014 NWT Hazard Identification Risk Assessment Report is a driving factor leading to ongoing updates to the NWT Emergency Management System. Numerous other hazards, such as extreme weather (including increasing snow loads), transportation incidents, critical infrastructure failure, drought (i.e., low water levels), human disease and permafrost degradation need to be considered, and thus planning for adaptations is needed. Preliminary adaptation efforts to address climate change related impacts to public safety are provided in Appendix D.

5.3.3 Culture and Heritage

The GNWT Culture and Heritage Strategic Framework identifies goals and priorities to help protect and support the NWT's rich heritage and diverse cultural practices. One of the goals - *Safeguarding Heritage* - is particularly relevant in the context of a rapidly warming climate and numerous changes occurring on the landscape.

Under this goal, specific priorities include protecting culturally significant places, preserving heritage objects and records, supporting the preservation of traditional skills and practices and engaging in culture and heritage research. Stewardship and the protection of culture and heritage helps protect and preserve the landscape for future generations. Preliminary adaptation efforts to address climate change related impacts to culture and heritage are provided in Appendix D.

5.4 Infrastructure

Infrastructure, such as houses, buildings and facilities, which exist within communities, on the landscape and at remote locations can be referred to as the built environment. The built environment is critically important and must be protected as it supports all aspects of daily life including transportation, shelter, essential services and economic and social activity.

In the NWT, the replacement value for the built environment is roughly estimated to be \$8 to \$10 billion. Some of this investment is relatively new, but much of it was built in previous decades based on engineering designs, practices and building codes and standards of the day.

As the NWT continues to warm and experience significant changes (i.e., increasing snow loads, permafrost instability, coastal erosion, potential flooding), two distinct challenges with respect to the NWT's built environment have been created:

- A need to upgrade some of the existing infrastructure and facilities to handle emerging conditions never contemplated when the assets were originally designed and constructed; and,
- A need to re-think the standards and practices to use when designing and constructing new assets with long service lives (i.e., 50 years or more). This is challenging as there is uncertainty about the range and extent of the climate impacts that may occur in future decades and thus uncertainty about how to plan today to address such possibilities.

Ensuring the NWT's built environment is capable of dealing with current and future climate change impacts is a major technical and economic challenge that all levels of government, industry and the private sector must address.

While the challenge is somewhat daunting, this is not a new problem in the NWT. Professionals such as architects, engineers, capital planners and others are well aware of the challenges and have been taking steps to address such issues.

5.4.1 Transportation System

The NWT's transportation system is made up of all-weather roads, seasonal winter roads, airports and ferry crossings. Climate-related changes, particularly thawing permafrost and winter ice conditions, are impacting how the transportation system is planned, operated and maintained.

The GNWT has completed a considerable amount of internal work in recent years to identify emerging issues and potential adaptation actions. Current efforts are focused on planning, replacing winter roads with all-season roads and updating aging infrastructure. Preliminary adaptation efforts are provided in Appendix D.

5.4.2 Community Infrastructure

NWT communities are responsible for infrastructure that may be vulnerable to, or affected by, climate change impacts. This includes roads, recreation facilities, other municipal buildings, water supply systems and waste management systems. Preliminary adaptation efforts to help communities address climate change related impacts such as thawing permafrost, flooding, wildfire risks and coastal erosion are provided in Appendix D.

5.4.3 Other Infrastructure

Within the NWT, there are different types of infrastructure that span the landscape (i.e., telecommunications, electric transmission lines, pipelines) or are situated on the landscape (i.e., hydroelectric generating stations, mining and oil and gas facilities, monitoring stations and legacy contaminated sites).

This vital infrastructure may also be vulnerable to climate change impacts, in particular risks of wildfire, thawing permafrost, or flooding, depending on where the infrastructure is located. The responsibility for the care and maintenance of such infrastructure lies with the owner, (e.g., the GNWT, the federal government or the private sector). Impacts to this vital infrastructure in remote parts of the NWT could adversely impact NWT communities, residents or businesses. Ensuring infrastructure is resilient or adapted to the effects of a changing climate will be necessary. Preliminary adaptation efforts are provided in Appendix D.

5.5 Capacity Building

To be prepared to build resilience and adapt to a changing climate, increased capacity is needed at many levels, from communities, to governments (Indigenous, federal, territorial), to research and academic institutions.

Increasing community capacity, through training, funding for full-time positions and partnerships with research organizations will allow communities to properly monitor, understand and adapt to their changing local environments and to help establish stronger communications between organizations and community members. These actions will build awareness and understanding of climate change impacts and resilience and adaptation measures.

Increasing traditional, local and scientific knowledge capacity will allow for enhanced and more frequent climate change related research and monitoring which is essential for informing planning and policy decisions and determining necessary adaptations (e.g., mitigating infrastructure impacts due to permafrost thaw).

5.6 Community Adaptation Planning

Community governments in the NWT are responsible for providing a wide range of programs and services. Adaptation planning and action at a local level is urgently required to help community governments address the impacts of climate change and identify potential future opportunities. Community governments require support to develop and implement adaptation plans.

Key aspects of community adaptation planning typically include hazard mapping, a thorough evaluation of all community infrastructure and a review of all municipal policies, plans and operations that may be affected by climate change. As noted in sub-section 5.3.2, the NWT Hazard Identification Risk Assessment (2014) identified numerous hazards that are strongly affected by climate change.

The following initiatives are aimed at helping communities build resilience and finding ways to adapt to the impacts of climate change:

- Indigenous and Northern Affairs Canada's Climate Change Preparedness in the North program (2016-2021) supports communities to undertake risk and vulnerability assessments, develop hazard maps, identify adaptation options and develop adaptation plans;
- Health Canada's Climate Change and Health Adaptation Program for Northern First Nations and Inuit Communities funds community-led research projects aimed at addressing anticipated health impacts of climate change; and,
- In 2017/18, the GNWT is implementing a new initiative to help communities build climate change-focused partnerships with researchers, undertake local adaptation planning and directly apply to relevant federal funding opportunities.

5.7 Cost of Inaction

Sections 5.1 to 5.4 outline a wide-ranging number of issues and potential responses that the NWT could take to address climate change concerns and opportunities. In future, territorial, federal and Indigenous governments, businesses and industry, communities and NWT residents will all need to make various decisions about their priorities and where to best allocate resources to address the impacts of climate change.

To inform the NWT's overall efforts to address climate change impacts and opportunities, the GNWT will undertake a comprehensive assessment of the projected economic impacts of climate change in the NWT over the next twenty years. This study will attempt to estimate the overall cost of the combined impacts that may occur due to climate change, if no actions are taken. Understanding the cost of inaction is critically important to provide context for funding decisions and resource allocations.

6 ECONOMIC DEVELOPMENT OPPORTUNITIES

While the NWT is facing many risks and vulnerabilities due to a changing climate, there may also be opportunities, some of which could result in economic benefits.

Some of the actions that the NWT must implement to reduce GHG emissions have tangible economic benefits. Examples include:

- *Energy efficiency and renewable energy projects* – retrofitting existing homes and buildings or installing local biomass and renewable energy projects helps stimulate local economies through the purchase of equipment, building materials and the hiring of engineers, contractors and skilled labour;
- *Biomass supply* – increasing the use of biomass energy for space heating and potentially power generation will increase the demand for biomass supplies in NWT communities. The harvesting, storage and distribution of biomass (cordwood, pellets) provides local business and employment opportunities;
- *Hydroelectric projects and/or transmission lines* – such projects are capital-intensive and require professional support at all stages of the project including planning, design, permitting, construction, operation and maintenance;
- *Resource development projects* – finding ways to reduce fossil fuel consumption at remote sites can help reduce GHG emissions and energy costs. Reducing energy costs can help lower overall mine operating costs and improve the economic viability of resource development projects; and,
- *Knowledge economy* – the climate change challenges that need to be addressed represent opportunities for research, development and innovation. Identifying and implementing practical adaptive measures for communities and industry contributes to the NWT's knowledge economy.

Looking into the future, the warming climate is expected to result in longer growing seasons and milder winters, which should provide more opportunities for the agriculture, forestry and tourism sectors within the NWT. As more information becomes available on climate projections, assessments of new opportunities will be conducted in these and potentially other sectors.

7 IMPLEMENTATION

To achieve the goals laid out in this NWT Climate Change Strategic Framework by 2030, the GNWT will develop and implement an initial five-year action plan, track and report on the progress being made and conduct a review of the Climate Change Strategic Framework (after five years).

The results of the review will be used to update the Climate Change Strategic Framework and develop a second five-year action plan.

7.1 Shared Responsibility

The Pan-Canadian Framework on Clean Growth and Climate Change is Canada's collective plan to address climate change and grow a clean economy. The Pan-Canadian Framework provides broad direction and guidance that is relevant to the development and implementation of the NWT Climate Change Strategic Framework.

The Government of Canada is finalizing several significant funding programs or initiatives to support the four main areas of focus in the Pan-Canadian Framework. Federal funding programs of particular interest to the NWT include:

- *Low Carbon Economy Fund* – funding is being provided to support a variety of actions to reduce GHG emissions;
- *Green Infrastructure Fund* – funding is expected to support projects involving GHG emissions reductions, clean water and wastewater and electricity systems;
- *Arctic Energy Fund* – funding is expected to be focused on addressing energy security for communities north of the 60th parallel;
- *Canadian Centre for Climate Services* – the federal government is establishing this Centre to provide climate information to support adaptation decision-making;
- *Resilience and Adaptation Measures* – this funding is to help Indigenous and northern communities use traditional knowledge to understand and prepare for climate change, improve emergency management and enhance resilience in northern communities;
- *Disaster Mitigation and Adaptation Fund* – funding will be allocated for built and natural large-scale infrastructure projects that support climate resilience and mitigation of natural disasters and extreme weather events.

As the details of these various funding opportunities become available, the GNWT will work collaboratively with Indigenous and community governments, non-governmental organizations and the private sector to identify and scope out potential projects and actions that can be supported using federal funds.

7.2 Action Plans and Strategy Renewal

A detailed five-year action plan will be developed to support the implementation of all the priorities and activities outlined in this Framework. As actions are implemented, annual tracking and reporting is required to measure progress and prepare for a formal review and renewal of the NWT Climate Change Strategic Framework.

Following is a general planning timeline from 2018 to 2030:

2018	Develop a comprehensive five-year action plan for the NWT. This plan will include actions undertaken by the GNWT, Indigenous and community governments, industry, researchers, non-government organizations and other stakeholders. This action plan will focus on the years 2019 to 2023;
2019 to 2023:	Implement the first five-year action plan. The GNWT will be responsible for implementing some of the actions and will strive to provide leadership and guidance. It is expected that Indigenous and community governments, industry, researchers, non-government organizations and other stakeholders will all play critical roles in implementing climate change-related actions that fall within their mandates and providing information for annual reporting;
2024	Complete a 5 year review of the NWT Climate Change Strategic Framework and develop a new five-year action plan. The data and information needed for the review will be collected through the annual reporting that will occur from 2019 to 2023. The development of a new action plan for 2025 to 2029 will be based on the results of the 2024 review and allow for the emergence of new issues, new opportunities and new technologies;
2025 to 2029:	Implement the second five-year action plan and track and report on results;
2030:	Conduct a second 5 year implementation review of the NWT Climate Change Strategic Framework and update and renew accordingly.

The GNWT recognizes that climate change is an urgent concern and that there are numerous initiatives already underway or planned.

Table 1 below summarizes actions that are considered most urgent to implement over the next few years. This summary is intended to provide some initial priorities for GNWT Departments, Indigenous and community governments, industry, researchers and other stakeholders, and along with the detailed information in Appendices B to D, will serve as the starting point for the development of a comprehensive five-year action plan in 2018.

Table 1: Summary of Urgent Actions (from 2017 to 2023)

Goal #1 Transition to a Lower Carbon Economy	
Priorities	Urgent Actions
#1.1 GHG emission targets	• Improve tracking and reporting
#1.2 Carbon pricing	• Implement a carbon pricing system
#1.3 Energy measures	• Improve energy efficiency in all sectors
	• Install renewable energy projects in thermal communities
	• Support the use of renewable energy for heating
	• Assist the resource extraction industries to reduce fossil fuel use
Goal #2 Improve Knowledge of Climate Change Impacts	
Priorities	Urgent Actions
#2.1 Use of traditional, local and scientific knowledge	• Document baseline environmental conditions through improved monitoring and use of traditional, local and scientific knowledge
#2.2 Community involvement	• Support improved community participation in research and monitoring initiatives
	• Determine trends in environmental variables, including climate, and provide projections of future conditions to guide future adaptation decision-making
#2.3 Knowledge of impacts to the environment	• Improve monitoring and research and complete vulnerability assessments to identify locations susceptible to extreme weather or other natural hazards
	• Invest in permafrost technical capacity (science and engineering) to better predict future impacts on infrastructure and identify solutions
	• Undertake flood forecasting for vulnerable communities
	• Complete climate change forest vulnerability assessments in selected areas
	• Complete climate change vulnerability analyses for all valued species and species at risk
#2.4 Knowledge of impacts on human health, safety and culture and heritage	• Complete hazard mapping for vulnerable communities
	• Inventory and monitor country food sources, including their health, abundance and distribution to determine availability and quality of food sources
	• Develop detection or surveillance systems to support predictions of species distribution changes and associated public health impacts (e.g., appearance of

	species carrying diseases that can be transmitted to humans, new and re-emerging infectious diseases)
	• Conduct surveys to understand where archaeological sites are at greatest risk of impact due to coastal erosion, thawing permafrost, melting alpine ice, and forest fires
#2.5 Knowledge of impacts to infrastructure and buildings	• Increase monitoring of key environmental components, such as permafrost and water levels, which can impact infrastructure and buildings • Increase monitoring of climate change impacts on community shorelines, transportation system assets and building foundations (in vulnerable areas)
Goal #3 Build Resilience and Adapt to a Changing Climate	
Priorities	Urgent Actions
#3.1 Maintain ecosystem sustainability	• Incorporate climate change considerations in conservation network planning and the establishment of existing candidate areas and new protected areas
#3.2 Manage impacts occurring in the environment	• Undertake predictive climate modeling to anticipate extreme weather events
	• Develop predictions on landscape, ecosystem and water quality changes that will likely result from permafrost thaw, to inform environmental management and decision making
	• Increase the resilience of wildlife populations to climate change by mitigating other impacts and stressors
#3.3 Protect human health, safety and culture and heritage	• Ensure health facilities, and the services they provide, are able to withstand climate risks and have access to essential services, particularly during extreme weather events
	• Improve wildfire suppression planning and adoption of FireSmart principles in communities
	• Complete implementation of a modernized NWT Emergency Plan
#3.4 Protect buildings and infrastructure	• Continue making investments in the transportation system (e.g., permanent bridges, all-weather roads, airport runways)
	• Enhance building codes and standards (existing and new)
	• Ensure water intake, water treatment, sewage systems and lagoons and waste management systems are resilient to emerging climatic conditions
#3.5 Determine cost of inaction	• Undertake a comprehensive assessment of the projected economic impacts of climate change in the NWT over the next twenty years

7.3 Governance and Coordination

The GNWT recognizes that it needs to play a leadership role for the governance and coordination of all the priorities and actions contained in the NWT Climate Change Strategic Framework.

Within the GNWT, three different committees are in place to support the overall governance and coordination of climate change-related programs and projects across departments and manage linkages with other relevant initiatives such as the NWT Energy Strategy. These are:

- Assistant Deputy Minister Climate Change Committee
- Deputy Minister Energy and Climate Change Committee
- Committee of Cabinet – Energy and Climate Change

The Department of Environment and Natural Resources (ENR) serves as the lead GNWT Department for climate change. ENR fulfills several roles that support information-sharing and coordination of climate change efforts within the NWT, including:

- Tracking and reporting on GHG emissions;
- Identifying emerging issues;
- Sharing information on climate change trends and topics;
- Providing technical expertise;
- Building partnerships (within the GNWT and with external parties) to support cross-cutting initiatives;
- Distributing adaptation funding;
- Representing the NWT at national and international meetings and forums; and,
- Tracking results.

Looking forward, the GNWT recognizes that stronger partnerships, better coordination on climate change efforts and improved information-sharing will be needed to effectively develop action plans, secure federal funding and implement actions.

The 2019-2023 NWT Climate Change Action Plan will include the identification of specific mechanisms to support interactions on climate change actions between different levels of government, industry, non-governmental organizations, researchers and residents.

Two examples that can be built upon include:

- Intergovernmental Forum
- Northern Adaptation Strategy – NWT Technical Committee (under development)

7.4 Tracking and Reporting

Each year, the GNWT will produce and distribute an Annual Report on the progress being made to address climate change. Each annual report will outline strategy inputs and activities, as well as report on outputs and outcomes.

The Annual Report will communicate Climate Change Strategic Framework successes to a range of interested parties, including Indigenous governments, communities, other climate change stakeholders, GNWT departments, Members of the Legislative Assembly, the Financial Management Board Secretariat, and the general public. Information and results contained in the annual reports will enable adjustments to be made to the Action Plan and support the evaluation of the Climate Change Strategic Framework in 2024.

A template for the annual report will be developed in 2018, in tandem with the development of the 2019-2023 Action Plan and the 2024 evaluation plan.

7.5 Evaluation

At the conclusion of the 2019-2023 Action Plan, a formal evaluation will be conducted in 2024 to determine the overall progress being made towards the stated goals and long-term vision, update the NWT Climate Change Strategic Framework and prepare a new 2025-2029 Action Plan.

To ensure that informed and evidence-based program and policy decision making is possible over the longer-term, the GNWT will develop an evaluation plan that describes what indicators to use, what data are available, how data will be collected and how the evaluation in 2024 will be conducted. The evaluation plan will be developed in 2018, following the finalization of the 2019-2023 Action Plan.

8 LOOKING FORWARD

The NWT's climate is expected to continue to warm in the coming decades. This warming trend will continue to influence and change the ecosystems, wildlife, water, infrastructure, health, safety, cultures and heritage in the NWT. NWT residents and communities need to prepare for these changes by building resilience and finding ways to adapt, when necessary.

Through implementation of the NWT Climate Change Strategic Framework, the NWT can respond to the challenges and opportunities associated with climate change, move towards a lower-carbon economy and do its part to contribute to national and international efforts on climate change.

Collaborative efforts and partnerships over the next ten years will be the key to achieving the vision and goals outlined in this framework. The GNWT, Indigenous and community governments, federal government, industry, businesses, researchers, non-governmental organizations and residents all have a vital role to play to reduce GHG emissions and adapt to current and future changes.

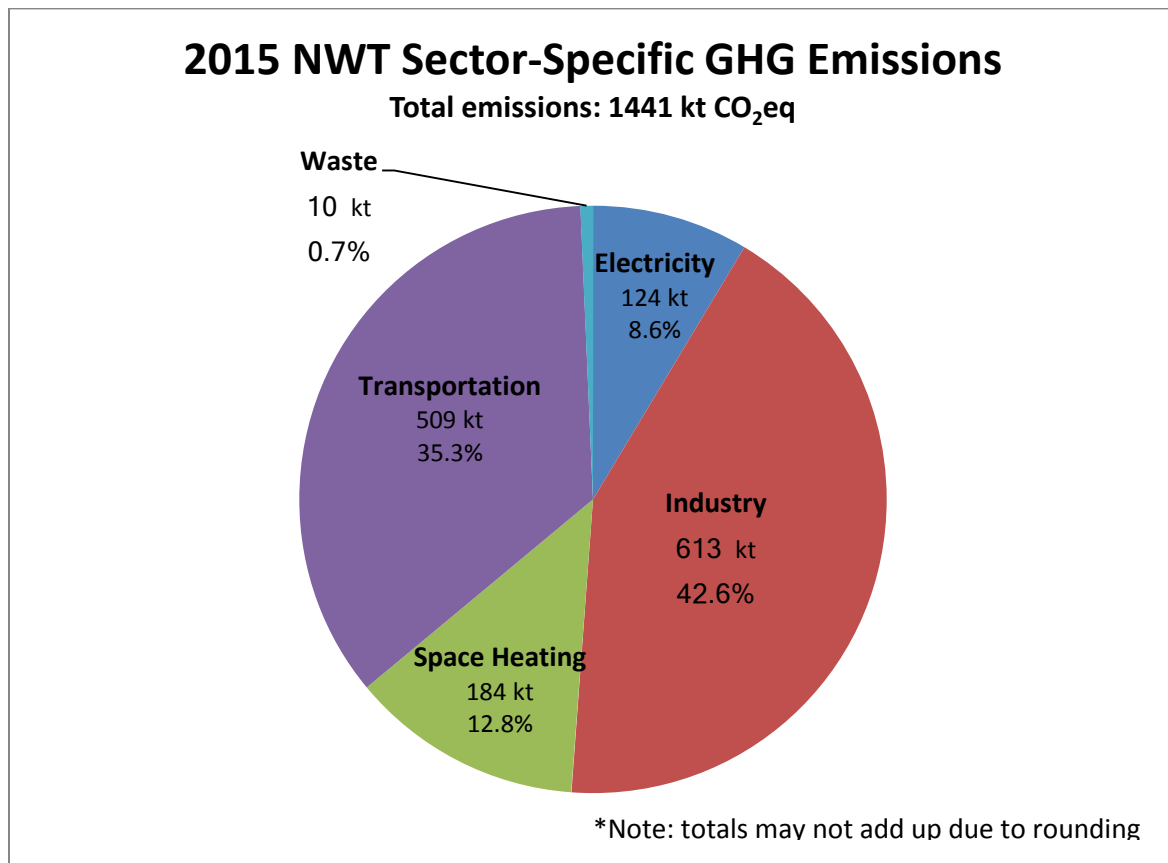
By working together, the NWT can address climate change and ensure a safe and prosperous future for the NWT.

APPENDIX A: NWT GREENHOUSE GAS EMISSIONS PROFILE

Each year, Environment and Climate Change Canada (ECCC) prepares the National Inventory Report (NIR) to summarize national GHG emissions. ECCC also requires facilities that emit 50 kt or more of GHGs in CO₂e per year to submit a report as part of the Greenhouse Gas Reporting Program (GHGRP).

Data from the NIR and the GHGRP are used to estimate the NWT's sector-specific emissions. The chart below shows the NWT GHG emissions, by sector, for 2015:

2015 NWT Sector-Specific GHG Emissions



Notes:

Industry – the industry sector includes emissions from mining, oil, and natural gas facilities, as reported in the GHGRP.

Transportation – the transportation sector includes emissions from domestic aviation, rail transportation, marine transportation and road transportation.

Space Heating – the space heating sector includes emissions generated from fuels consumed by commercial and institutional buildings and residential housing.

Electricity – the electricity sector includes emissions from power generation in thermal communities.

Waste – the waste sector includes emissions from the treatment and disposal of wastes, including landfills, biological treatment of solid waste, incineration and open burning of waste, and wastewater treatment and discharge.

APPENDIX B: CLIMATE CHANGE IMPACTS, KNOWLEDGE GAPS AND RESEARCH AND MONITORING PRIORITIES

To improve knowledge of climate change impacts, as per Goal #2 of the NWT Climate Change Strategic Framework, the specific impacts of climate change on the environment, human health, safety, culture and heritage, and infrastructure need to be documented to determine knowledge gaps and set future research and monitoring priorities.

It is important to note that impacts of rising temperatures, ice melt, coastal erosion or thawing permafrost are easier to measure than impacts in areas of biology, ecology and productivity. The latter impacts are harder to measure as these tend to be indirect (i.e., impacts are seen in secondary factors), take longer to occur and can be the result of many interacting factors including climate change.

The table below outlines important climate change impacts, knowledge gaps and research and monitoring priorities for key components over the next ten years. These knowledge gaps and research and monitoring priorities will help inform the development of the first action plan for the NWT Climate Change Strategic Framework, as well as action plans for the NWT Knowledge Agenda and other relevant initiatives.

	CLIMATE CHANGE IMPACTS, KNOWLEDGE GAPS AND RESEARCH AND MONITORING PRIORITIES
Overarching	To address climate change impacts, knowledge gaps, and research and monitoring priorities on the environment, human health, public safety, culture and heritage, and infrastructure, it will be necessary to develop NWT-based technical capacity. This will increase the NWT's overall capacity to partner in a meaningful way with funding agencies as well as to formulate important partnerships with Indigenous, federal and territorial governments, academic institutions, and other organizations to undertake research and monitoring and support climate change related adaptation. Increasing capacity for the processing and management of the data and information collected to inform knowledge gaps and research and monitoring priorities is also necessary to ensure its usefulness and availability.
Environment	
<i>Changes to climate and weather</i>	<i>Impacts:</i> • Storms are becoming more severe. • Precipitation is increasingly unpredictable. • Winter freeze-up dates are occurring later, spring thaw is occurring earlier. • Increasing snow loads can lead to increased spring run-off and flood risks, as well as impede the movement of people and wildlife on the

	land. <i>Knowledge gaps and research and monitoring priorities:</i> • Addressing gaps and deficiencies in the existing monitoring network, particularly in areas more vulnerable to the effects of climate change. • Increasing snow monitoring and winter climate monitoring. • Coordinating monitoring efforts between federal, territorial and other partners. • Collecting data such that it can be easily compared and readily accessible by researchers.
Thawing permafrost	<i>Impacts:</i> • Thawing permafrost can result in ground subsidence, landslides and thaw slumps, landscape change and coastal erosion. • The structural integrity of much of the NWT's built environment, which relies on frozen ground as a foundation, will be increasingly vulnerable in future decades. The cost of maintaining infrastructure and mitigating impacts can be expected to increase significantly with acceleration of climate-driven permafrost thaw. • Water quality can be greatly impacted by thawing permafrost because sediment, soluble materials (including metals) and organic carbon can be released into nearby water bodies, potentially affecting the surrounding ecosystem and its traditional uses. • Thawing permafrost can transform landscapes and overlying ecosystems. The most notable impacts are associated with permafrost thaw in expansive peat plateau woodlands which are converted to wetlands or fens following thaw. Thaw slumping and transfer of large volumes of sediments downslope is reconfiguring landscapes across northwestern NWT. Downstream effects may include shifts in water quality and changes in aquatic ecology. • Numerous contaminated sites, drilling mud sumps, tailings and impoundment structures (including waste water lagoons) utilize permafrost as a containment medium and will be increasingly at risk with climate-driven permafrost thaw. • Cultural heritage is at risk from thawing permafrost affecting heritage resources and culturally significant sites. <i>Knowledge gaps and research and monitoring priorities:</i> • Providing baseline data to support infrastructure planning, community decision making and ecosystem management. • Developing a state of the art permafrost monitoring network which integrates new data collection and management methods, modeling and remote sensing. • Developing an information base on likely landscape, ecosystem and water quality changes that will result from permafrost thaw to inform environmental management and decision making. • Developing a permafrost data management system and the capacity to

	support the system to manage GNWT and partner information. • Supporting mapping initiatives and modeling that can evaluate landscape and ecosystem change and geohazards. • Developing requirements for the consideration of permafrost thaw in all development and adaptation planning for NWT infrastructure. • Developing key research topics and climate change research corridors (e.g., Dempster and Inuvik to Tuktoyaktuk Highways) to guide internal and external research effort toward NWT needs.
<i>Changes to water quality and quantity</i>	<i>Impacts:</i> • Water quality can change as water chemistry is altered due to the release of nutrients and metals from forest fires, erosion and permafrost thaw. • Changes in water quality can affect drinking water sources and harvesting practices. • Changes in water quantity can lead to low water levels in some areas which can impact important wetlands, fishing areas and marine transportation. • Changes in water quantity can lead to flooding in some areas which can affect the safety and well-being of residents as well as surrounding ecosystems. • Increases in groundwater flow due to thawing permafrost in certain regions can lead to increased winter flow and changes in water chemistry. • Reduced ice coverage, duration and thickness on many lakes and rivers can affect the viability of winter ice roads and traditional harvesting practices. • Changes in water quality and quantity can impact the aquatic ecosystem as a whole, including insects and invertebrates which form a critical part of the food chain. <i>Knowledge gaps and research and monitoring priorities:</i> • Expanding water quality and quantity monitoring in areas more vulnerable to the effects of climate change. • Ongoing water monitoring, including community-based monitoring to answer questions from community members, including whether stressors such as climate change are affecting water quality. • Ongoing monitoring of drinking water and supply to provide baseline information on the health of aquatic ecosystems and to measure potential impacts from climate change. • Determining appropriate biological indicators for aquatic ecosystem health monitoring to provide early warnings about changes that may be related to climate change. • Completing vulnerability assessments for aquatic ecosystems at greater risk of climate change impacts, and expanding monitoring as necessary. • Assessing the cumulative impacts to water from multiple stressors, including climate change, as reflected in the NWT Water Stewardship

	Strategy Action Plan 2016-2020. • Understanding impacts of climate change on water quality and quantity for mining, oil and gas, hydroelectric or other developments. • Understanding impacts of climate change on water quality and quantity for legacy contaminated sites or industrial developments undergoing reclamation as certain site management approaches are based on the temperature remaining cold enough (e.g., frozen core dams), or the water level and quality remaining relatively constant. • Understanding the implications of flooding on communities and aquatic ecosystems. • Understanding the impacts of thawing permafrost on near-surface groundwater. • Ongoing monitoring of water quantity, snow, and ice conditions to provide important planning information for marine transport (river and lake barges), land transport (all-season and winter roads), and for residents undertaking traditional and recreational activities on the land and water. • Understanding climate change impacts on wetlands (remote sensing can be used to provide a baseline for assessing changes to wetlands). • Determining how bilateral jurisdictions can take account of the effects of climate change in setting and monitoring transboundary objectives as part of current and future transboundary bilateral management agreements.
<i>Changes to forests and tundra vegetation</i>	<i>Impacts:</i> • Forest ecosystems in the NWT have been experiencing unprecedented changes in natural disturbance regimes, particularly in the last 10 years, likely caused by the changing climate. Warming temperatures, changing precipitation levels, flooding and thawing permafrost are all factors impacting forests. • Changes to forest ecosystems are affecting forest productivity, composition and distribution, increasing the frequency and severity of forest fires, and increasing the prevalence of insect and disease disturbances. • Changes in wildfire regimes are creating challenges for fire management and community protection, in addition to impacting water, permafrost, wildlife and traditional activities on the land. • Changes in forest insect and disease regimes, such as northern shifts in pest ranges, pest behavior, and invasive and new species, are causing damage to trees. • Changes in tundra vegetation include an increase in shrubs being observed near the tree line and the tundra becoming greener, with more growth in vascular vegetation but less growth in lichen-dominated areas. • Drying of tundra vegetation is also occurring due to longer warm periods, increasing the risk of tundra fires that in turn can leave the surfaces of pingos (unique permafrost formations) vulnerable to

	erosion. <i>Knowledge gaps and research and monitoring priorities:</i> • Understanding the changing wildfire regime and potential implications for NWT residents and communities. • Understanding forest and tundra vegetation renewal and growth dynamics after natural and human-caused disturbances in a changing climate. • Enhanced monitoring of changes in forest productivity, condition and carbon dynamics as climate change progresses (e.g., annual forest health surveys, network of permanent sample plots). • Mapping permafrost extent and characteristics in forested ecosystems to help understand the implications of permafrost thaw. • Enhanced monitoring of changes in tundra vegetation condition as climate change progresses. • Utilizing remote sensing techniques to assist with informed decision-making over the large vegetated land mass in the NWT. • Creating a baseline vegetation classification scheme for the entire NWT (across forested, tundra and wetland areas). • Completing forest inventories to provide detailed information on vegetation composition and structure in specific areas/ times to serve as a baseline on key conditions that can be measured against as climate change progresses.
<i>Changes to wildlife</i>	<i>Impacts:</i> • New mammal, bird and insect species (e.g., deer, elk, magpie, ticks) are moving northward into the NWT as the climate continues to warm. Other species are experiencing changes in their ranges within the NWT (e.g., muskox, bison, grizzlies) and some have more limited ranges (e.g., polar bears due to melting sea ice). • Changes in migrations and movements of wildlife due to extreme weather events or forest fires are apparent. • New diseases and parasites have been observed that might become established in resident wildlife species. • Changes in the types and distribution of wildlife parasites as well as the frequency, intensity and rate of development of infections are a concern as wildlife parasites are strongly influenced by relatively subtle changes in climate. There is also evidence that host-pathogen interactions for species already present in the NWT are changing in such a way that may lead to unprecedented host population declines. • Shifting of the timing of insect hatch has resulted in some bird species arriving on their breeding grounds too late to take advantage of the peak insects. Over time this will likely lead to population declines for some boreal birds, insectivores and shorebirds. • The ability of wildlife to adapt to natural processes such as forest fires will likely be compromised as these processes increase in intensity due to climate change.

	• The ability of caribou to forage for winter food sources has and could continue to be affected by increased snowfall in regions of the NWT. • Changes in permafrost and resulting altered habitat are impacting wildlife that prefer lichens, forested areas and bogs. The scale of these changes is uncertain but some evidence show that it is large and significant in the Taiga Plains region of the NWT. <i>Knowledge gaps and research and monitoring priorities:</i> • Performing climate change vulnerability analyses for all valued species and species at risk to inform better wildlife management decisions. • Tracking trends and changes in wildlife populations, health and distribution to determine impacts of climate change. • Continuing research and monitoring on changes to caribou food sources in the NWT and circumpolar countries based on a suite of climatic indicators. • Applying the suite of climatic indicators relevant to caribou to other species that are vulnerable to climate change. • Monitoring, and in particular community-based monitoring, to track and manage invasive alien species (mammals, birds, insects, amphibians and plants) which can pose a threat to native wildlife and biodiversity as they extend their ranges and become established in the NWT. • Determining whether or not wildlife species and populations are adapting to changes such as increases in parasites. • Completing NWT landscape monitoring at regular intervals (i.e., every ten to fifteen years) to assess changes to baseline conditions and help predict potential impacts to wildlife. • Ongoing use of remote sensing techniques to assess wildlife habitat and impacts due to climate change (e.g., landscape change resulting from increased forest fires). • Updating the 2006 NWT Biodiversity Action Plan with a new gap analysis to ensure actions for maintaining biodiversity in light of a changing climate are in place. • Understanding cumulative impacts of climate change, industrial development and other impacts on wildlife species.
<i>Changes to fish and marine mammals</i>	<i>Impacts:</i> • New fish and marine mammal species are being observed more frequently by residents and researchers as their ranges expand. Colonization by new species may threaten native species due to increased competition for habitat. • Declines in sea ice can lead to reduced birthing habitat for seals, likely impacting their populations. • Ocean acidification is happening faster in the Beaufort Sea than predicted. Acidification (as a result of global increases in carbon dioxide in the atmosphere) will result in profound changes to marine ecosystems, including fish and marine mammals.

	• The NWT's fish and marine mammals have adapted to cold water, thus increases in water temperature will have a significant impact on their habitat and health, including changes to spawning and rearing habitat, food availability and predators. • Increases in contaminant loads in fish and marine mammals from long-range and local sources could occur. • Lower levels of dissolved oxygen in lakes in winter due to climate change can negatively impact fish populations. • Increases in predation, disease and parasitism, have the potential to affect the abundance and distribution of native fishes. <i>Knowledge gaps and research and monitoring priorities:</i> • Improving baseline information to better understand the impacts of climate change on fish species, health and distribution in the north is needed (as highlighted in Fisheries and Oceans Canada's <i>Climate Change and Arctic Fisheries Research Program</i>). • Ongoing monitoring of contaminants in ringed seal, beluga, and subsistence fish species as temperature increases can lead to more contaminants such as mercury being released into water due to melting permafrost and associated dissolved organic matter. • Ongoing monitoring of new fish and marine mammal species and associated diseases or parasites. • Understanding the impacts of ocean acidification on fish and marine mammals. • Monitoring marine mammal abundance and composition in the Beaufort Sea as sea ice declines in extent, duration and thickness, negatively affecting habitat for some species and potentially expanding ranges for others. • Understanding climate change impacts on aquatic ecosystems and fisheries for Great Slave and Great Bear Lakes (i.e., a greater understanding of temperature profile changes being observed in Great Bear Lake is necessary). • Addressing knowledge gaps on the cumulative impacts of multiple stressors, including climate change, on fish. • Determining appropriate biological indicators to assess fish health and provide early warnings about changes that may be related to climate change.
Human Health, Public Safety, Culture and Heritage	
<i>Human health</i>	<i>Impacts:</i> 1) Negative impacts on physical human health: • Zoonotic infectious diseases (transmitted from wildlife to humans) or outbreaks may spread northward. These could include Lyme Disease, West Nile Virus, Malaria, Hantavirus, Dengue Fever, Rocky Mountain Spotted Fever, and Zika Virus among others. In the past,

	human diseases or reservoir species might not have survived in the cold temperatures but as the region warms, new diseases could emerge. These may be food and waterborne transmitted by insects, ticks and rodents, or the result of exposure to wildlife through hunting. Re-emergence of other diseases no longer common in the NWT is also likely (e.g., brucellosis, anthrax). • Increased risk of illness or death in people with heart and respiratory problems due to higher temperatures and extreme weather. • Increased human exposure and associated health risks (e.g., sunburns, skin cancers, cataracts and eye damage) due to elevated ultraviolet radiation levels resulting from stratospheric ozone depletion. • Increases in eye, nose, and throat irritation, and shortness of breath, exacerbation of respiratory conditions and allergies, chronic obstructive pulmonary disease and asthma, due to negative impacts of forest fires on air quality. • Increased production of pollens and spores by plants which can cause more and heightened allergic reactions due to longer growing seasons. • Health impacts due to drinking water contamination could increase due to extreme weather events, floods or forest fires leading to source water contamination. • Concerns with food safety and potential health impacts resulting from increases in contaminant loads (from long-range and local sources) in country foods due to climate change. Contaminants such as mercury and persistent organic pollutants pose risks to human health. • Concerns with food safety resulting from increases in wildlife diseases or parasites which, in turn, impact wildlife populations and health, thereby decreasing the availability of country foods for subsistence users. 2) Negative impacts on food security and mental, social and cultural wellbeing: • Limitations to traditional harvesting and cultural/land-based activities, leading to altered lifestyles which have negative impacts on mental health (e.g., lack of social and cultural activities) and well-being (e.g., decreased physical activity, greater reliance on store bought food). • Decreased food security due to changes in ecosystems and wildlife, fish and plant habitat and health affecting the availability of country foods, which is of utmost importance to Indigenous peoples who have depended on country food sources for generations. • Psychological health effects including mental health problems and stress-related illnesses. 3) Negative impacts on delivery of health and social services: • Indirect impacts from ecological changes on the health and social
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	services system, including disruptions in service delivery, increased emergency preparedness and response capacity, and damages to infrastructure (technology, buildings, etc.). 4) Potentially new opportunities for growing local food: • A positive impact can be increases in some food sources, such as cultivated crops in community gardens, as a result of longer growing seasons. <i>Knowledge gaps and research and monitoring priorities:</i> • Further research and monitoring of country food sources, including their health, abundance and distribution, will be needed to determine availability and quality of food sources for generations to come. • Surveillance systems that enhance the ability to support predictions of species distribution changes and associated public health impacts (e.g., appearance of species carrying diseases that can be transmitted to humans, new and re-emerging infectious diseases) associated with climate change are needed. • An improved understanding of environmental toxicology and greater risk communications capacity to address human health implications associated with long-range and local environmental contaminants, particularly as it relates to changing climate, is a priority. • Source water protection for NWT communities, including linkages with the monitoring of drinking water quality and safety of water supplies in reservoirs, is needed. • Assessments of risks to human health arising from air quality issues related to forest fires, as well as flood prediction, assessment of land cover changes, and associated implications for the safety and security of local food and water resources for communities, are necessary.
Public Safety	<i>Impacts:</i> • Physical injuries, illnesses, and deaths from extreme weather events, floods, wildfires, erosion, thaw slumps, critical infrastructure failure, and transportation accidents. • New risks to the people, property, environment and economy of the NWT could arise as new opportunities and commercial activity potentially increases. • Increased erosion has led to the removal and closure of buildings close to shorelines (ocean and river) and increased risk to infrastructure. • Deterioration of transportation infrastructure, such as roads, bridges, and airstrips, as well as changes to navigable waters and air space. • Evacuation of communities, damage to property and infrastructure, contamination of surrounding water, disruption of essential services, can all result from significant hazards such as forest fires and floods. • Food security is a cross-cutting concern that also impacts the safety of residents and wildlife. • Drought can impact on the production of hydroelectricity, water navigation, food availability and wildlife patterns.

	<i>Knowledge gaps and research and monitoring priorities:</i> • The NWT Hazard Identification Risk Assessment Report (2014) assessed current hazards considering climate change, projecting which hazards could occur more frequently or become more extreme in the future. As a result, two hazards - floods and wildfires - are deemed the top hazards in the NWT, and therefore a priority for research and monitoring to ensure public safety. • The ability to predict and monitor flood activity is lacking. • Ongoing research and monitoring of other hazards identified in the NWT Hazard Identification Risk Assessment Report, such as coastal erosion, thawing permafrost, invasive species, etc., will be needed to support planning for public safety.
<i>Culture and heritage</i>	<i>Impacts:</i> • Transportation challenges being experienced when traveling on the land for hunting, fishing, trapping and going to camps directly impact the traditional and cultural activities and economies (e.g., sale of wild furs) of Indigenous people by limiting the amount of time being spent doing these activities. • Stresses to country food sources due to climate change impact cultural activities as harvesting may have to be limited due to limited wildlife or fish populations. • Culturally significant places, including archaeological sites, are at risk from landscape disturbances related to climate change, particularly thawing permafrost. Coastal erosion is also erasing archaeological evidence of camps and dwellings constructed near shorelines. • As local climates change, the ability for traditional and local knowledge holders to utilize their knowledge on the land becomes more limited as knowledge is eroded or not as relevant. <i>Knowledge gaps and research and monitoring priorities:</i> • Understanding the impacts of climate change on traditional customs and practices of Indigenous people. • Understanding where archaeological sites are at greatest risk from climate change related disturbances.
Infrastructure	
	<i>Impacts:</i> • Potential loss of infrastructure and buildings in the four NWT coastal communities along the Beaufort Sea due to coastal erosion. • Several NWT communities are subject to flood risk from river flooding due to ice jams or sea level rise, both of which may increase due to climatic change. • Droughts are impacting the ability to generate hydroelectricity and for sufficient water flow for the passage of river barges and ferries.

	• Decreasing snow and ice is resulting in a decrease in both the length of the winter road season and the long term viability of winter roads. • Linear infrastructure such as highways and transmission lines, and isolated infrastructure such as mines, hydroelectric facilities and radio/microwave transmission towers are potentially at risk from thawing permafrost and increased frequency and severity of wildfires. <i>Knowledge gaps and research and monitoring priorities:</i> • Increased monitoring of key environmental components, such as permafrost, forest composition and water levels, to better understand potential impacts on infrastructure and buildings. • Long-term monitoring of building stability in NWT communities. • Long-term monitoring of impacts of climate change on linear infrastructure (e.g., the new all-season highway from Inuvik to Tuktoyaktuk). • Long-term monitoring of impacts of climate change on isolated infrastructure.
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APPENDIX C: SUSTAINABILITY OF ECOSYSTEMS AS A RESPONSE TO CLIMATE CHANGE

To respond to the current and future changes in the environment, the approaches and methods for decision-making and management of the NWT's ecosystems need to be improved or modified to ensure sustainability into the future.

Land Use Sustainability Framework

The Land Use and Sustainability Framework sets out a vision, guiding principles, and land interests to guide how the GNWT manages land and resources. It seeks to balance economic, environmental, and cultural interests in land and resource management decisions.

In support of the vision set out in the Land Use and Sustainability Framework, the GNWT is developing of a suite of government-wide land use and sustainability objectives to be incorporated into government decision processes. This will ensure a consistent GNWT-wide approach to implementing the Land Use and Sustainability Framework is achieved. Including climate change considerations in land and resource decision making will be key in adapting to the changing climate.

Conservation Network Planning

Northern ecosystems are diverse and particularly sensitive to climate change. Conservation network planning involves the protection of biodiversity, through the establishment and management of protected areas and conservation areas, while recognizing the relationship among social wellbeing, ecological health, sustainable livelihoods and economic prosperity. A conservation network ensures that protected areas fall within a broader land management framework including land use planning, regulatory requirements, monitoring activities and best practices, to ensure they do not become isolated and less resilient to changes.

The inclusion of healthy populations and ecosystems, ecological representation, enduring landscape features, and traditional knowledge in protected areas are important aspects of conservation network planning. They can help maintain and build both ecological and social resilience to a changing climate. Connectivity of the conservation network can support the adaptation and survival of species in the face of climate change, by facilitating their movement to more suitable environments.

The protection of biodiversity ensures the continuation of vital ecosystem services, such as clean water and climate stabilization, but it also protects cultural and spiritual pursuits, increases social wellbeing, provides food provisioning services, cultural and eco-tourism business opportunities and commercial renewable resource harvesting opportunities, and contributes to the arts and crafts industry and the traditional economy.

Healthy Land, Healthy People outlines the GNWT's priorities for the advancement of conservation network planning from 2016 to 2021, based on the principles and objectives of the Land Use Sustainability Framework. Continuing to incorporate climate change considerations based on the best

science, traditional and local knowledge into conservation network planning is imperative, and will support the establishment of existing candidate areas and new areas.

Integrating climate change considerations will be undertaken through careful adaptive management and monitoring of protected areas and conservation areas to detect impending changes in ecosystems, and adjusting flexibly as new knowledge becomes available.

Regional Land Use Planning

Regional land use planning is an ongoing process in the NWT. Regional land use plans define where and how certain land use activities can take place. Land use plans are statutory requirements in the Gwich'in and Sahtu Settlement Areas, flowing from comprehensive lands and resources agreements. Pursuant to these agreements and as set out in the *Mackenzie Valley Resource Management Act*, land use planning is a shared responsibility in the NWT. The GNWT, along with Canada and Indigenous governments, have authorities respecting the approval of regional land use plans. Other settled and unsettled land claim regions have or are pursuing land use planning initiatives.

Climate change is changing the way land is used. Conversely, the way land is used has an impact on GHG emissions and climate change. Land use plans are an important policy tool to respond to climate change. Climate change considerations can be incorporated into the vision and objectives of a plan and built into legally binding conformity requirements, which can help with climate change adaptation on a regional level.

APPENDIX D: PRELIMINARY ADAPTATION EFFORTS TO ADDRESS CLIMATE CHANGE IMPACTS

For many of the impacts to the environment, human health, public safety, culture and heritage, and infrastructure identified in Appendix B, resilience and adaptation measures will be required. The preliminary adaptation efforts listed in the table below will help inform the development of the first action plan for the NWT Climate Change Strategic Framework.

	PRELIMINARY ADAPTATION EFFORTS TO ADDRESS CLIMATE CHANGE IMPACTS
Environment	Examples of adaptation efforts to address changes to specific environmental components are outlined below.
<i>Climate and weather</i>	• Enhancing community-based monitoring and management to better inform communities and gain an understanding of potential adaptations required due to climate change; • Completing vulnerability assessments to identify locations in the NWT susceptible to extreme weather or other natural hazards; • Undertaking predictive climate modeling to anticipate extreme weather events; • Adjusting harvesting practices due to changes in water levels or ice-free periods (e.g., fish or trap in new locations or for different periods of time throughout the year); and, • Ensuring infrastructure capacity/readiness (e.g., adequate community emergency shelters for climate change related events and facilities with capability to offer indoor clean air shelters for sustained forest fire smoke events).
<i>Permafrost</i>	• Enhancing community-based monitoring and management to better inform communities and gain an understanding of potential adaptations required due to climate change; • Developing a permafrost data management system to inform planning, adaptation and mitigation related to permafrost thaw; • Fostering science based decision making tools to assist project planning or development in permafrost regions; • Improving and implementing building standards so that thawing permafrost conditions can be taken into consideration for all infrastructure design and construction; • Considering the effects of climate change in planning for industrial development (both infrastructure and closure and reclamation) by fully integrating permafrost thaw and climate change into project planning and environmental assessments; • Considering impacts to cultural and heritage resources and traditional

	harvesting and determining adaptations accordingly; and, • Developing methodologies and technologies to maintain and enhance permafrost on the landscape as long as climatically possible.
<i>Water quality and quantity</i>	• Enhancing community-based monitoring and management to better inform communities and gain an understanding of potential adaptations required due to climate change; • Adjusting harvesting practices due to changes in water level and ice quality (e.g., fishing or trapping in safer areas or for different periods of time throughout the year); • Infrastructure planning to ensure local water treatment plants are able to ensure safe and adequate supplies of drinking water, where changes to water quality and quantity have a negative impact on source water; • Addressing source water protection for NWT communities, including linkages with the monitoring of drinking water quality and safety of water supplies in reservoirs, in light of climate change; • Flood forecasting in communities at risk, as flooding could impact infrastructure, public safety, human and wildlife health, and drinking water quality; • Using increasingly available satellite imagery and technology to monitor ice cover to support flood forecasting, spring breakup predictions, and determination of sediment loads in rivers, all of which will provide valuable information for those using the land for traditional and recreational activities; • Modifying transportation methods and infrastructure due to shorter or non-existent transportation seasons and changes to freeze-up/breakup patterns; • Monitoring of groundwater flow changes due to thawing permafrost, to determine required infrastructure adaptations; • Changing community services due to varying or extreme weather events (e.g., ensuring plows and staff are in place to deal with greater snowfalls); • Infrastructure and emergency planning to address potential flooding; • Increasing water flow and level monitoring to inform future hydroelectric development planning and flood forecasting; • Water conservation and drought management planning; and, • Considering predicted changes due to climate change when setting terms and conditions in water licences.
<i>Forests and tundra vegetation</i>	• Enhancing community-based monitoring and management to better inform communities and gain an understanding of potential adaptations required due to climate change; • Undertaking forest health monitoring across the NWT to serve as an early detection system for rapid changes occurring on the forested landscape, such that planning can be completed; • Utilizing remote sensing techniques to track changes in vegetation, hydrology, land cover and other factors over large areas to identify landscape-level changes and inform decision-making;

	• Completing vulnerability assessments which integrate research, monitoring and traditional knowledge to develop effective adaptation strategies in specified areas of interest; and, • Collaborating with the federal government, Indigenous governments, communities, academic institutions and others to conduct research into fire regimes, forest recovery patterns and the effects of permafrost and hydrology changes.
<i>Wildlife</i>	• Enhancing community-based monitoring and management, particularly through wildlife co-management boards and systems in place in unsettled land claim areas, to better inform communities and gain an understanding of potential adaptations required due to climate change; • Protecting biodiversity through the establishment and management of a conservation network will support wildlife. An NWT barren-ground caribou management strategy is currently being updated with actions to include monitoring and managing for cumulative effects, including climate change effects, being a priority. Sustainable use of caribou will continue to be managed collaboratively with co-management partners and Indigenous governments. • Careful management of wildlife species will be an important adaptation strategy as restrictions on both commercial hunting and subsistence harvesting may become necessary (through co-management by the GNWT, wildlife co-management boards and Indigenous governments); • Undertaking a new gap analysis for the NWT Biodiversity Action Plan with a focus on climate change impacts, and potential adaptations; • Ongoing dissemination of current and new information on the health and distribution of wildlife, including diseases and parasites, is necessary such that harvesters and residents can adapt to possible changes in wildlife due to warming temperatures; • Facilitating the adaptation of residents and non-residents to climate-related changes in wildlife (e.g., restrictions in hunting certain species may be needed and new species expanding their ranges may instead be harvested to provide a new food source to residents); and, • Planning for the enhanced resilience of wildlife populations by better understanding impacts and stressors and the effects of climate change on mitigation measures.
<i>Fish and marine mammals</i>	• Enhancing community-based monitoring and management to better inform communities and gain an understanding of potential adaptations required due to climate change; • Disseminating fish and marine mammal consumption advisories due to potential increases in contaminants in fish and marine mammals. These advisories could require residents to adapt by making changes to their diets, carefully considering alternative fish species, other food sources or fishing from lakes with lower contaminant concentrations in fish; • Considering harvesting new species to sustain fisheries for commercial and subsistence harvest, should the abundance of traditional fish species decrease in some areas;

	• Conducting research to understand the impacts of climate change and develop adaptation tools and strategies to enable the integration of climate change considerations (e.g., through Fisheries and Oceans Canada's Aquatic Climate Change Adaptation Services Program) will provide key considerations for strategic adaptations; and, • Fisheries and Oceans Canada is developing an ecosystem-based adaptive management strategy for adaptation to climate effects on some northern aquatic ecosystems. This work will allow scientists to develop models of freshwater and marine ecosystems that support important fisheries, so as to better understand the effects of climate change and lead to the development of tools for fishery managers and policy makers to aid in decision making.
Human Health, Public Safety, Culture and Heritage	Examples of adaptation efforts to address changes to human health, public safety, and culture and heritage are outlined below.
<i>Human health</i>	• Developing the capacity of the health workforce to address climate risks by supporting capacity-building through setting of norms and standards, development of technical guidance and training courses and integrating climate change and health topics into medical and public health training to enhance health preparedness; • Enhancing health information systems and investments in research on risks and responses to protect human health from the effects of climate change; • Ensuring health facilities, and the services they provide, are able to withstand climate risks and have access to essential services, particularly during extreme weather events; • Strengthening the management of environmental determinants of health, climate-informed health programming and emergency preparedness; • Wildfire suppression planning and adoption of FireSmart principles (strategies and planning measures to help reduce the risk and minimize the unwanted effects of wildfires) in communities to help adapt to negative impacts of wildfires, such as air quality concerns; • A reliable system for determining and releasing health alerts and advisories to minimize impacts on human health; • Improving geo-mapping to identify and communicate trends in potential contaminants (to better support the dissemination of public health advisories for consumption of traditional foods with elevated levels of contaminants); • Developing and delivering educational and public outreach materials to support communities in building resilience and adapting to human health concerns; • Supporting access to traditional foods where access has become limited due to climate change impacts; and, • A positive adaptation may be the improved ability to grow a variety of food as a result of a lengthier growing season (e.g., community gardens)

	and raise animals (e.g., chickens and goats), thereby increasing local food security.
<i>Public Safety</i>	• Ensuring community emergency plans include approaches for assessing climate change related hazards and planning to adapt to the increase in frequency and severity of such hazards. The GNWT supports communities with this planning by providing guidance and a template for community emergency plans. When there is an identified need, the GNWT provides community emergency planning workshops that include assessment of risks relevant to the community and development of emergency plans that include mitigation, preparedness, response and recovery activities; • For the very high hazard of wildfire, mitigation strategies such as adopting FireSmart principles and considering the implementation of FireSmart programs for all communities have been identified. Creating wildfire education training and awareness sessions for first responders and the public and implementing fire prevention practices are also possible adaptations; • For the very high hazard of flooding, flood plain hazard maps are needed to support the development of land use and building bylaws and ensure infrastructure is located to minimize flooding and subsequent erosion. The establishment of flood watch committees to monitor changing ice breakup or flooding conditions is a specific adaptation to be better prepared for floods; and, • Residents, first responders, communities and the GNWT will need to be better prepared to deal with the impacts of all hazards ranging from low through to very high risks. Examples of adaptation approaches include the development of educational resources, training and preparedness programs and plans.
<i>Culture and heritage</i>	• Conducting research to understand where archaeological sites are at greatest risk of impact from processes such as coastal erosion, landscape disturbances caused by thawing permafrost, melting alpine ice, and wildfires will assist in prioritizing resources to mitigate impacts on archaeological sites; • Prioritizing excavating and collecting information from archaeological sites at greatest risk of impact from climate change (this will depend on access to high quality environmental data); • Potentially moving traditional cabins to protect them from climate-related risks such as eroding river banks; • Support for traditional economies such as trapping for the harvest of wild furs; and, • Strengthening communities from a social and cultural aspect to help build resiliency through the documentation and use of traditional knowledge and the involvement of youth and elders in on the land programming to ensure local and traditional knowledge is passed on along with Indigenous languages.

Infrastructure	Examples of adaptation efforts to address changes to various types of infrastructure are outlined below.
<i>Transportation system</i>	• Installation of permanent bridges to replace ferry crossings (where these are vulnerable to fluctuating water levels); • Installation of permanent bridges to extend the seasons for winter roads; • Construction of all-season roads to replace winter roads; and, • Implementing measures to address permafrost instability under airport runways.
<i>Community infrastructure</i>	• Enhancing building codes and standards (existing and new); • Ensuring water intake, water treatment, sewage systems and lagoons and waste management systems are resilient to emerging climatic conditions; • Ensuring that private sector investments (businesses, housing) are resilient to emerging climatic conditions; and, • Supporting emergency preparedness and developing enhanced community emergency response plans.
<i>Other infrastructure</i>	• Enhanced codes and standards for infrastructure such as hydro-electric, mining, and oil and gas facilities; • Enhanced codes and standards for linear infrastructure such as transmission lines; and, • Long-term planning for the management of climate change impacts on the remediation of contaminated sites.

APPENDIX E: GLOSSARY AND ACRONYMS

Glossary

Term	Definition
Greenhouse gas	Gas that traps heat in the atmosphere. The six main greenhouse gases are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.
Carbon dioxide equivalent (CO ₂ e)	A unit for quantifying greenhouse gas emissions. Because different gases have different global warming potentials, greenhouse gas emissions are converted into carbon dioxide equivalents for comparison.
Climate change mitigation	Reducing man-made effects on the climate system.
Climate change adaptation	Making changes to prepare for and negate the effects of climate change and reduce vulnerability of communities and ecosystems.
Climate resilience	The capacity to maintain function in the face of stresses imposed by climate change. Resilience can be built when actions are taken to address and adapt to the effects of climate change.
District heating	A system for distributing heat generated in a centralized location for residential, commercial and/or municipal heating requirements.

Acronyms

CCSF – Climate Change Strategic Framework

CO₂ – Carbon dioxide

CO₂e – Carbon dioxide equivalent

ECCC – Environment and Climate Change Canada

ENR – Department of Environment and Natural Resources

NWT – Northwest Territories

GDP – Gross domestic product

GHG – Greenhouse gas

GHGRP – Greenhouse Gas Emissions Reporting Program

GNWT – Government of the Northwest Territories