August 2019

604-170 Laurier Ave. West
Ottawa, Ontario
K1P 5V5

613-233-8891
csls@csls.ca

CENTRE FOR THE STUDY OF LIVING STANDARDS

An Infrastructure Index for Remote Indigenous Communities

Nicole Johnston and Andrew Sharpe

August 2019

CSLS Research Report 2019-04

Prepared for the National Indigenous Economic Development Board

An Infrastructure Index for Remote Indigenous Communities

Abstract

This report sheds light on the deficiencies in infrastructure faced by Canada's remote Indigenous communities by quantifying the level of infrastructure in 236 remote communities in Canada's North. This quantification is done through a composite index based on 13 infrastructure indicators, including availability of broadband, roads, airports, the electrical grid, health care, education, water, and housing, with values ranging from 0 to 1. This report compares the level of infrastructure found in remote Indigenous communities both with remote non-Indigenous northern communities and southern cities. Indigenous communities are broken down by the three heritage groups: First Nations, Inuit and Métis. While the southern cities identified in the 2016 Census as Census Metropolitan Areas have an average index score of 0.97, remote Indigenous communities saw a score of 0.45 and remote non-Indigenous communities a score of 0.82. Inuit communities face the lowest level of infrastructure (an index score of 0.31), and remote Indigenous communities in Nunavut fared the lowest of the jurisdictions with a score of 0.30.

An Infrastructure Index for Remote Indigenous Communities

Table of Contents

An Infrastructure Index for Remote Indigenous Communities

Executive Summary

This report develops an infrastructure index for Canada's remote Indigenous communities. Remote communities were identified on the basis of physical geography, climate and latitude. The basic unit of analysis for the index is the community, with community data aggregated into sub-provincial/territorial data, provincial/territorial data and national data. Of these 236 communities, 200 were identified as Indigenous (over 50% of the population identifying as Aboriginal in Census 2016) and 36 were identified as non-Indigenous. Within these Indigenous communities, 134 were identified as predominantly First Nations, 17 as Métis, and 49 as Inuk/Inuit.

The infrastructure index itself was developed using 13 indicators of infrastructure, which comprised seven types of infrastructure: access to basic broadband, transportation (comprised of roads, ports/harbors, and airports), access to the electrical grid, health care, education (comprised of on-site schools and community colleges), water (comprised of water treatment, water distribution, and water quality), and housing (comprised of housing quantity and housing quality). These types of infrastructure can be further aggregated to form the two sub-indices of economic infrastructure and quality of life infrastructure, which then comprise the overall index.

A system of coding was used to rank-order and enumerate the response categories for each of these infrastructure indicators. This system assigned values from 0 to 1 to each category, creating a numerical score for each indicator in each community, which could be used to calculate scores for the seven types of infrastructure, two sub-indices and the overall index. These calculations used a system of weighting that assigns equal value to each of the sub-components within the types of infrastructure, equal weighting to each type of infrastructure in a sub-index, and equal weighting to the sub-indices comprising the overall index.

All data were gathered from open-source documentation, including publically accessible federal and provincial/territorial government resources. For certain indicators in the territories and the provinces of Quebec and Newfoundland and Labrador, the dataset associated with the report *Study on Addressing the Infrastructure Needs of Northern Aboriginal Communities* developed for the National Aboriginal Economic Development Board by Centre for the North at the Conference Board of Canada was consulted.

The main focus in the analysis of this report is the gap between the infrastructure in remote Indigenous communities and that in southern Canada, the benchmark for the overall infrastructure index, the seven types of infrastructure, and the 13 infrastructure indicators. To understand this gap, the average infrastructure index score for the 32 communities in southern Canada identified as Census Metropolitan Areas has been calculated to be 0.97. Comparisons are also be made between territories and provinces, between Indigenous communities and non-Indigenous communities in remote areas, and between specific Indigenous heritage groups for

the overall infrastructure index, the seven types of infrastructure, and the 13 infrastructure indicators.

In an analysis of national averages, the report finds that for the 200 Indigenous communities that have been defined as remote for the purposes of this report, the average infrastructure index in 2018 (or the latest data available) is 0.45 on a scale from 0 to 1 on an unweighted basis (i.e. communities of all sizes are treated equally) and 0.47 on a population-weighted basis. While there is a clear gap present between these remote Indigenous communities and the benchmark of 0.97, this is not a particularly useful value if not disaggregated as it masks disparities related to size of community.

As noted, there are significant differences in the infrastructure index between Indigenous remote communities and non-Indigenous remote communities. On an unweighted basis the index value for Indigenous communities was 0.37 points lower than for non-Indigenous communities (0.45 versus 0.82). The gap was even greater on a population-weighted basis, 0.47 points (0.47 versus 0.94).

To explain these results, it is natural to look to community size as a possible explanation for these infrastructure deficiencies. In small, remote communities with a population of fewer than 1,000, the feasibility of sustaining a school or hospital may be quite low. While size does explain some of the difference, it does not account for the entire gap. The unweighted score of the 11 remote non-Indigenous remote communities with a population under 1,000 (seven of which are in Yukon) was 0.68, closer to the average for Indigenous communities of the same size (0.44). Although the gap between Indigenous and non-Indigenous of this size and remoteness is smaller than the overall infrastructure gap, it still clearly exists in all provinces and territories included in this study.

The value of the infrastructure index varies by heritage groups. The 17 Métis communities in the dataset of remote communities have an unweighted index value of 0.64, the highest, followed by the 134 First Nations communities at 0.48 and then the 49 Inuit communities at 0.31.

The comparison of index values between Indigenous and non-Indigenous groups can continue at that sub-index level. Non-Indigenous communities fare nearly the same in both Economic Infrastructure (0.81) and Quality of Life Infrastructure (0.83). On average, Indigenous communities demonstrate a similar pattern with Economic Infrastructure scoring 0.48 and Quality of Life Infrastructure 0.42; however, this is not indicative of the situation for all Indigenous groups, as seen when the data is disaggregated by heritage group. While this pattern holds true for First Nations communities (0.56 versus 0.39) and Métis communities (0.78 versus 0.50), Inuit communities see a higher Quality of Life Index than Economic Index (0.14 versus 0.48), due largely to their lack of roads, access to the electricity grid, and access to adequate broadband.

Among the three components of the Economic Infrastructure sub-index, access to the energy grid scores the highest with a value of 0.56 for Indigenous communities. While transportation scores the lowest for Indigenous communities at 0.39, it is important to analyze the sub-components of this type of infrastructure to understand the causes of this value. The

score for transportation infrastructure in Indigenous communities comes from three sub-components: roads (0.52), water transportation (0.50) and airports (0.22). While Indigenous communities on average score lowest for access to an on-site airport with regularly scheduled passenger flights (0.22), so do non-Indigenous communities (0.33). Conversely, non-Indigenous remote communities score quite well at 0.97 for access to the Canadian National Roads System, whereas Indigenous communities fall short of this score at only 0.52. The largest disparities for the sub-component of energy are seen between heritage groups wherein Métis communities score at 1.00 and Inuit communities score 0.00, with First Nations scoring an average of 0.70.

The quality of life infrastructure sub-index consists of four components: health care, education, water, and housing. The latter three of these components are in turn made up of sub-components or indicators. In terms of the four components, the quality of life infrastructure gap or deficit between remote Indigenous communities and Canadian CMAs (index value of 0.97) is the least for water (an index value of 0.71), followed by education (0.44), health care (0.39), and housing (0.16). This pattern is similar for the three heritage groups.

The largest deficit in water infrastructure between Indigenous communities and benchmark communities in southern Canada is in water distribution, with the former at 0.57, followed by water treatment (0.61) and water quality (0.94).

In terms of schools, the average score for remote Indigenous communities is 0.67, not too far behind that for remote non-Indigenous communities (0.93). Not surprisingly, the presence of or access to communities colleges is limited in remote communities, whether Indigenous or non-Indigenous. The score for Indigenous communities is 0.20; however, non-Indigenous communities still fare better with a score of 0.60.

The health care indicator for remote Indigenous communities scored 0.39, less than one half that of remote non-Indigenous communities (0.83).

The lowest scores comprising the quality of life infrastructure belong to the indicators comprising housing infrastructure. The score for housing quantity in Indigenous communities is 0.23. The situation is even worse for housing quality at 0.09. The picture is much less bleak in remote non-Indigenous communities for housing quantity at 0.92 and somewhat less bleak for housing quality at 0.69.

The index values can also be compared across the 10 jurisdictions represented in the selection of the 236 communities in this report. The jurisdiction that has the highest index value, meaning the smallest infrastructure deficit between Indigenous communities and cities in southern Canada, was Saskatchewan at 0.58. Second was Yukon (0.56), followed by Alberta (0.54), British Columbia (0.51), Manitoba (0.46), and Northwest Territories (0.45). The jurisdiction with the lowest score was Nunavut at 0.30, followed by Newfoundland and Labrador (0.32), Quebec (0.36), and Ontario (0.41).

This report represents a first attempt to construct an infrastructure index for remote communities in Canada. It is a work in progress. The report has developed a composite infrastructure index for 236 remote communities. Estimates or scores out of 1.0 are provided for

the overall infrastructure index, the economic and quality of life infrastructure sub-indexes, the seven types or components of infrastructure and 13 infrastructure indicators by province and territory, with disaggregation by Indigenous and non-Indigenous communities, and by heritage group. These results, over 3,000 community-indicator data points, are contained in a large Excel file accompanying this report.

As this report is starting point for future work, an agenda of future work has been created to allow for an expansion of this project. Understanding the limits of the data collected, the agenda proposes a refinement of the 13 indicators and the scoring scheme to account for additional information and more granular details rather than access to basic forms of infrastructure (i.e. including seasonal road access, services provided by and quality of health care, etc.). The agenda also proposes expanding the communities used to include non-Indigenous communities in northern Quebec and northern Newfoundland and Labrador, as well as remote communities on the BC coast and non-remote Indigenous communities. The agenda also proposes a longitudinal study to ensure that the data is updated while tracking trends in infrastructure changes. This study could include historical estimates. Finally, analytical work could be done to better understand the infrastructure gaps between Indigenous and non-Indigenous communities, with a focus on controlling for community size and other factors that may in part or fully explain these gaps.

An Infrastructure Index for Remote Indigenous Communities[1]

Introduction

In order to produce a more complete picture of the Indigenous economy in Canada, there is a need to develop tools and metrics to more accurately measure and understand the infrastructure supporting the economic participation of Indigenous populations in Canada.

There is a broad consensus in both the theoretical and empirical literature that the infrastructure endowment of a country or community represents a critical factor for sustainable economic growth. The report *Methodological Issues in the Construction of an Indigenous Infrastructure Index* produced by the Centre for the Study of Living Standards and delivered to INAC in early January 2018 reviewed the relationship between infrastructure and economic development in the context of Indigenous communities and concluded there was a strong rationale for a focus on infrastructure in any benchmarking of Indigenous progress indicators.

Established in 1990, the National Aboriginal Economic Development Board (NAEDB) is a Governor in Council appointed board mandated to provide advice and guidance to the federal government on issues related to Indigenous economic development. The Aboriginal Economic Benchmarking Report, published in 2012, was the first document to assemble a comprehensive group of indicators and to establish benchmarks to measure the social and economic well-being for First Nations, Inuit, and Métis. In 2015, the NAEDB released the Aboriginal Economic Progress Report, the first update to the *Aboriginal Economic Benchmarking Report.* The NAEDB is committed to preparing a second *Aboriginal Economic Progress Report* to track and assess advancements made in 2018 on closing the gaps. The NAEDB is considering the inclusion of an Indigenous Infrastructure Index in that report.

Based on the methodology developed in the report *Methodological Issues in the Construction of an Indigenous Infrastructure Index*, this report empirically develops an

[1]Contributions to this document were made by the following CSLS staff: James Ashwell, Nicole Johnston, Myeonwan Kim, Sebastian Tansil and John Tsang under the supervision of CSLS Executive Director Dr. Andrew Sharpe. The CSLS would like to thank Elizabeth Logue and Sandra Romain at Indigenous Services Canada for comments on initial drafts of the report. This report was prepared in Spring 2018 using the most recent publically available and was prepared for the National Indigenous Economic Development Board to be referenced in the 2019 Indigenous Economic Progress Report. This report is available online on the NAEDB website: http://www.naedb-cndea.com/wp-content/uploads/2019/06/NIEDB-2019-Indigenous-Economic-Progress-Report.pdf. In August 2019, the CSLS published a supplementary report titled "An Improved Connectivity Component for an Infrastructure Index for Remote Indigenous Communities," developing the indicator used to measure broadband in this report.
Emails: njohn070@uottawa.ca, andrew.sharpe@csls.ca.

Infrastructure Index for Remote Indigenous Communities. The Index includes regional disaggregation and disaggregation by heritage group. To allow comparability with similarly situated non-Indigenous communities, the Index is also calculated for remote non-Indigenous communities.

The report consists of three main sections. The first section will lay out the methodology for the Infrastructure Index for Remote Indigenous Communities (IIRIC), including the definition of Indigenous communities, types of infrastructure and infrastructure indicators, geographical coverage, weighting schemes, and data sources. The second section will provide the estimates of the index for the latest data for 236remote communities. The results will be first examined at the national level for the overall index, sub-indices, and components and sub-components with a focus on differences between remote Indigenous and non-Indigenous communities and differences among heritage groups. The results will then be analyzed at the level of the provinces and territories for the overall index and two sub-indices for economic and quality of life infrastructure. The third and final section will conclude and outline avenues to improve the Index.

Methodology

The following section will outline the methodology used in the creation of the Infrastructure Index for Remote Indigenous Communities. The basic structure for the IIRIC was first proposed in the report *Methodological Issues in the Construction of an Indigenous Infrastructure Index*, delivered to INAC by the Centre for the Study of Living Standards in early January 2018. That report included experimental estimates for such an index for the three territories and Northern Quebec and Labrador based on information found in the 2014 NIEDB report on Northern infrastructure. This report modifies those experimental estimates by extending the geographical coverage to all remote Northern regions of Canada, by distinguishing Indigenous and non-Indigenous communities, by disaggregating Indigenous communities by heritage groups, and by adding housing infrastructure to the types of infrastructure included and water quality as a sub-category under water facilities.

Key Characteristics

The key characteristics of the index are as follows.

- The basic unit for the index is the community in remote areas. Communities are defined as either Indigenous (50 per cent or more of the population self-identifies as Indigenous) or non-Indigenous. Indigenous communities can be disaggregated into First Nations, Inuit and Métis communities. Community level data can then be aggregated into sub-provincial/territorial data, provincial/territorial data or national data for both Indigenous and non-Indigenous communities and populations. Data can be aggregated on a community basis where each community has equal weight or on a household or population weighted basis.

- The index can be used both for comparisons across jurisdictions and Indigenous heritage groups. Going forward, a time series for each community can be built to track progress. It may also be possible to develop a historical series.

- The index is based on data for 13 indicators for seven types of infrastructure and can be aggregated to infrastructure indicators and infrastructure types primarily related to economic development and indicators primarily related to quality of life.

Methodology of selection of communities

Definition of Indigenous communities

For the purpose of this study, an Indigenous community is defined as a community in which over 50% of the population has self-identified as Aboriginal in the 2016 Census. The term Aboriginal encompasses Métis, First Nations and Inuk (Inuit) populations. The Indigenous communities in the dataset have been further disaggregated into the heritage groups of Métis, First Nations, and Inuit (Inuk) by determining the heritage group with the largest population in each Indigenous community. The focus of the Index is to quantify any difference in infrastructure between Indigenous and non-Indigenous remote communities in Canada's North.

The unweighted average for the overall index value of Census Metropolitan Areas in Canada is 0.97 (Table 1). Therefore, it will be relatively straightforward to make comparison of the overall infrastructure gap between remote Indigenous communities and southern cities, assuming that southern cities have an index score of close to 1. But it is also important to compare infrastructure between remote Indigenous communities and non-Indigenous communities. For these reasons, the index is also calculated for non-Indigenous communities in the remote regions covered by the index.

Table 1: Economic and Quality of Life Infrastructure Sub-Indexes and Total Index for Census Metropolitan Areas (unweighted)

	Economic Infrastructure Index	Quality of Life Infrastructure Index	Total Index
Halifax	1.00	1.00	1.00
Moncton	1.00	1.00	1.00
Saint John	0.96	1.00	0.98
Saguenay	1.00	0.96	0.98
Québec	1.00	1.00	1.00
Sherbrooke	0.83	0.96	0.90
Trois-Rivières	0.83	1.00	0.92
Montréal	1.00	1.00	1.00
Ottawa-Gatineau	1.00	1.00	1.00
Kingston	0.89	1.00	0.94
Peterborough	0.83	1.00	0.92
Oshawa	0.83	1.00	0.92
Toronto	1.00	0.96	0.98
Hamilton	1.00	1.00	1.00
St. Catharine's-Niagara	0.89	1.00	0.94
Kitchener-Cambridge-Waterloo	1.00	1.00	1.00
Brantford	0.83	1.00	0.92
Guelph	0.83	1.00	0.92
London	1.00	1.00	1.00
Windsor	1.00	1.00	1.00
Barrie	0.83	1.00	0.92
Greater Sudbury	1.00	1.00	1.00
Thunder Bay	0.95	1.00	0.97
Winnipeg	1.00	0.96	0.98
Regina	1.00	0.96	0.98
Saskatoon	1.00	0.96	0.98
Calgary	1.00	1.00	1.00
Edmonton	1.00	1.00	1.00
Kelowna	1.00	0.96	0.98
Abbotsford-Mission	1.00	0.96	0.98
Vancouver	1.00	0.96	0.98
Victoria	1.00	0.92	0.96
Canada Average	0.95	0.99	0.97

Selection of communities and geographic coverage

Two separate methods were used for selecting the communities used in this report. First, for the communities in the Yukon, Northwest Territories, Nunavut, Quebec and Newfoundland and Labrador, data was provided from a NIEDB report published in 2014 titled *Study Addressing the Infrastructure Needs of Northern Aboriginal Communities*.[2] This dataset included information for 100 northern communities and 39 indicators, which represent 9 forms of infrastructure. The 100 northern communities were allocated between the regions of the Yukon (23), Northwest Territories (32), Nunavut (25), Quebec (23) and Newfoundland and Labrador (5). Since this dataset included all of the major communities with accessible data in Canada's northern most regions, the list of communities provided by the NIEDB was used for the creation of the Infrastructure Index for Remote Indigenous Communities. However, three of the communities from this original dataset had to be removed, as information was not available for all of the indicators included in the Index.

In order to include remote northern communities from other regions in Canada, a second method of data selection was used to select communities in British Columbia, Alberta, Saskatchewan, Manitoba, and Ontario. The objective of this data selection was to identify northern remote Indigenous communities in each province. As such, a definition of what is considered "northern" was needed. The considerations made while understanding what is northern can be framed in the concept of Nordicity. Nordicity refers to our understanding of what comprises the differences between Canada's regions marked by latitude. While these differences may be either perceived or real, they all contribute to Canada's imaginary of the North.[3]

In the context of remoteness and infrastructure, the term "northern" can be considered through variety of variables. The variables encompassed in this selection included physiographic, climactic and geographic factors. However, exact indicators were created to be regionally specific to each province in order to account for the vastness of Canada's geography and the regionally indicative signifiers of "northern." It should also be noted that in the case that a regional centre was located just outside of the region defined as "northern," this community was still included to offer important comparisons with the nearby Indigenous communities.

In British Columbia, Alberta, Saskatchewan and Manitoba, the border for the Circumpolar Region was used to define the northern region. This is the area north of approximately 55 degrees latitude. This boundary was chosen because it is an international standard of what constitutes "northern" while also being broad enough to include an adequate sample of communities. In Saskatchewan, special attention was paid to communities identified as "Northern Village" or "Northern Settlement" in the Census 2016. As permafrost is linked to a variety of infrastructure challenges, the region considered northern in Manitoba was extended slightly below the boundary of the Circumpolar Region to include areas outside of the region that experience permafrost.

Only a small portion of Ontario is included in the Circumpolar Region, thus producing an inadequate sample of communities. Therefore, the boundary of the Canadian Shield was adopted

[2] http://www.naedb-cndea.com/reports/northern-infrastructure-report.pdf
[3] http://www.thecanadianencyclopedia.ca/en/article/nordicity/

for the selection of communities in Ontario, with an emphasis on communities above the permafrost line.

Within these boundaries, communities were chosen based off their latitude (selecting the northernmost communities) and remoteness. The focus of the study is on remote communities because the adequacy of infrastructure is much greater in non-remote communities, even in rural areas of southern Canada. As can be seen in Table 1, the value of the index is near one for all cities in southern Canada and averages 0.97 for the 32 identified Census Metropolitan Areas. Certain communities were also excluded from the index as adequate publically accessible data was not available.[4]

Table 2: Number of Communities by Jurisdiction and Heritage Group

Jurisdiction	Total	% Distribution	Non-Indigenous	Indigenous	First Nations	Métis	Inuk
Alberta	41	17.4	12	29	22	7	0
British Columbia	11	4.7	3	8	8	0	0
Manitoba	28	11.9	4	24	24	0	0
Newfoundland and Labrador	5	2.1	0	5	0	0	5
Nunavut	24	10.2	0	24	0	0	24
NWT	30	12.7	3	27	20	1	6
Ontario	31	13.1	4	27	27	0	0
Quebec[5]	23	9.7	0	23	9	0	14
Saskatchewan	28	11.9	1	27	18	9	0
Yukon	15	6.4	9	6	6	0	0
total	**236**	**100.0**	**36**	**200**	**134**	**17**	**49**

[4] The communities with incomplete data sets that were excluded from the overall index and compilation of this report are: Lower Post, BC (lack of information on sewage system); Buffalo Lake, AB (lack of information on sewage system); Bushe River 207, AB (lack of information on sewage system); Child Lake 164A, AB (lack of information on sewage and water distribution systems); South Indian Lake, MB (lack of information on sewage and water distribution systems); York Landing, MB (lack of information on sewage and water distribution systems); Abitibi 70, ON (lack of information on sewage and water distribution systems); and Minaki, ON (lack of information on water distribution system).

[5] The province of Quebec has been further disaggregated in the dataset to include specific data on communities belonging to the Inuk region Nunavik (14 communities) and communities belonging to the First Nations (Cree) region Eeyou-Istchee (9).

Table 3: Total Population by Jurisdiction and Heritage Group

Jurisdiction	Total	% Distribution	Non-Indigenous	Indigenous	First Nations	Métis	Inuk
Alberta	171,421	38.1	153,289	18,132	13,986	4,146	0
British Columbia	36,701	8.1	34,836	1,865	1,865	0	0
Manitoba	61,376	13.6	31,294	30,082	30,082	0	0
Newfoundland and Labrador	2,558	1.0	n/a	2,558	0	0	2,558
Nunavut	27,214	6.0	10,545	16,669	0	0	34,800
NWT	34,437	7.6	n/a	34,437	11,492	435	5,495
Ontario	27,602	6.1	10,933	16,669	16,669	0	0
Quebec[6]	30,329	6.7	n/a	30,329	17,141	0	13,188
Saskatchewan	27,723	6.3	1,402	26,321	19,043	7,278	0
Yukon	30,607	6.8	28,874	1,733	1,733	0	0
total	**449,968**	**100.0**	**271,173**	**178,795**	**112,011**	**11,859**	**56,041**

Using these boundaries, 31 communities in Ontario, 28 in Manitoba, 28 in Saskatchewan, 41 in Alberta, and 11 in British Columbia were selected, making a total of 139 additional communities for a grand total of 236 (Table 2).

Coverage over time

The purpose of the Index is to compare the state of infrastructure in remote Indigenous communities with that of non-Indigenous communities, both in southern Canada and remote, and to use these community estimates of the Index as a benchmark to monitor progress in closing the Indigenous infrastructure gap. Thus, the indicators in the Index have been based on the most currently available publically accessible data. At this stage of development of the Index, no time series has been proposed, but this is a possibility for future stages.

[6] The province of Quebec has been further disaggregated in the dataset to include specific data on communities belonging to the Inuk region Nunavik (14 communities) and communities belonging to the First Nations (Cree) region Eeyou-Istchee (9).

Table 4: Average Population by Jurisdiction and Heritage Group

Jurisdiction	Total	Non-Indigenous	Indigenous	First Nations	Métis	Inuk
Alberta	4,181	12,774	625	636	592	n/a
British Columbia	3,336	11,612	233	233	n/a	n/a
Manitoba	2,192	7,824	1,253	1,253	n/a	n/a
Newfoundland and Labrador	512	n/a	512	n/a	n/a	n/a
Nunavut	907	n/a	695	n/a	n/a	1,450
NWT	1,435	n/a	1,275	575	435	916
Ontario	890	2,733	617	617	n/a	n/a
Quebec[7]	1,319	n/a	1,319	1,905	n/a	942
Saskatchewan	990	1,402	975	1,058	809	n/a
Yukon	2,040	3,208	289	289	n/a	n/a
total	**1,907**	**7,533**	**894**	**836**	**698**	**1,144**

Constraints on Infrastructure Related to Community Size and Remoteness

The Index includes many small communities, which do not have hospitals or high schools. One might argue that it is unfair to score these communities poorly because they lack these types of infrastructure, as communities of similar size in southern Canada also do not have such facilities. There is an element of truth in this, but it ignores the fact that in southern Canada residents of small communities can drive to hospitals and high schools. In many cases, this is not possible in remote communities.

Some may argue that because of the remoteness, it is unrealistic to expect that remote communities would have comparable infrastructure facilities to southern Canada. For example, the great distance between communities and the rough terrain make construction of year-round roads very expensive, especially on a per capita basis given the small population. Again there is an element of truth in this. Nevertheless, it is still instructive to know the size of the gap for these types of infrastructure, especially transportation infrastructure between southern Canada and more remote areas of the country.

The provision of certain types of infrastructure is a basic right of all communities in Canada and constraints related to community size and remoteness, while a reality, must be overcome. For example, all Canadians have a right to adequate housing, safe drinking water, and access to the broadband.

[7] The province of Quebec has been further disaggregated in the dataset to include specific data on communities belonging to the Inuk region Nunavik (14 communities) and communities belonging to the First Nations (Cree) region Eeyou-Istchee (9).

Several of the communities without certain types of infrastructure neighbor communities that do have this infrastructure available. Specifically, it is common for a reserve to be located near or border a non-Indigenous municipality with publically accessible infrastructure. However, it is important to consider the value of having on-reserve services and infrastructure for those who are unable or do not wish to travel to access services. Therefore, only services available within the legal boundaries of each identified community are considered as on-site. However, if services are located just off the legal reserve-land and are not a part of a bordering community (i.e. clearly designated for the reserve), these services are considered on-site.

Methodology of creation of the Index

Selection of indicators

The methodology of the selection of each indicator has been further developed in the report *Methodological Issues in the Construction of an Indigenous Infrastructure Index*, prepared by the Centre for the Study of Living Standards (2018). On January 23, 2018, Indigenous Services Canada released a backgrounder on reliable infrastructure.[8] It noted the current challenges facing First Nations for seven different types of infrastructure: housing, water and wastewater, health facilities, roads, education facilities, energy systems, and broadband. The Infrastructure Index for Remote Indigenous Communities thus includes all seven of these types of infrastructure. These types of infrastructure have then been further aggregated to those primarily related to economic development (broadband, transportation, and energy) and those primarily related to quality of life (health facilities, education facilities, water facilities and housing).

The index in this paper builds on work in the NIEDB report *Study on Addressing the Infrastructure Needs of Northern Aboriginal Communities*[9]that provided information on the state of 11 infrastructure indicators for 100 communities in the Yukon (15), Northwest Territories (32), Nunavut (25), Nunavik/Eeyou-Istchee (23), and Nunatsiavut (5). All but one of the infrastructure indicators from that study (solid waste management) are included in the Infrastructure Index for Remote Indigenous Communities. More specifically, these indicators have been created with the aid of the NIEDB report data set. This data set included 39 indicators, which were further aggregated to establish 9 types of infrastructure. From this set of indicators, the 11 infrastructure indicators used in the NIEDB report were used in the creation of the Index. However, many of the response categories from the original NIEDB report were further aggregated in order to create a dataset cohesive with the information available for the supplementary communities, while ensuring that an inherent rank-order exist between response categories. The response categories for broadband/telecommunication backbone facilities were also further developed in order to reflect *adequacy* of broadband access at a more granular level. These indicators, and the different categories of the state or condition of infrastructure, are:

- Community access to telecommunications backbone facilities, categorized by insufficient backbone infrastructure *and* insufficient last-mile infrastructure, insufficient backbone

[8] https://www.canada.ca/en/indigenous-services-canada/news/2018/01/reliable_infrastructure.html
[9] http://www.naedb-cndea.com/reports/northern-infrastructure-report.pdf

infrastructure *or* insufficient last-mile infrastructure, or *sufficient* backbone *and* last-mile infrastructure;

- Road infrastructure, categorized by access to the Canadian National Roads Network or local roads only;

- Access to water transportation in coastal communities directly adjacent to an ocean, bay or inlet,[10] categorized by a deep water port with supportive infrastructure, a harbour or shallow water port with limited supporting infrastructure, or no port or harbour in the community;

- Air transportation infrastructure, categorized by no airport, scheduled flights to other local airports or a regional air transit hub, scheduled flights to cities outside of the region with or without local flights, or a large national or international airport;

- Primary sources of community energy, categorized by diesel generated local power or connection to the North American power grid;

- Community access to health care facilities, categorized by hospital on site, Community Health Centre (CHC) on-site, or no hospital and CHC on-site;

- Community access to secondary school facilities, categorized by high school available in the community (K-11/12), either junior school (K-6) or up to middle school available in the community (K-9), or no high school available in the community;

- Community access to college facilities, categorized by no facilities on-site, Community Learning Centres (access to virtual campus and distance learning), or physical college campus on-site;

- Drinking water distribution, categorized by trucked water distribution or piped water distribution;

- Wastewater/sewage treatment, categorized by sewage treatment via sewage treatment plant, limited treatment via lagoon or wetland, or no sewage/wastewater treatment and raw discharge into a water body.

The Index adds three additional indicators to the set of indicators found in the 2014 NIEBD report, two related to housing and one related to water quality. The first is the quality of housing as represented by the proportion of the population living in housing facilities that require

[10] A value of n/a (not applicable) was given to communities not adjacent to an ocean, bay or ocean inlet. This value was then excluded from the calculation of the overall index (i.e. the transportation sub-component of roads and airports each received a weighting of 1/2 and water transportation was not used in the calculation of the Index).

a certain threshold of major repairs. The second is the proportion of housing defined as overcrowded, as measured by having more than one person per room. Unlike the other indicators, which are discrete, the data for the two housing indicators are continuous. They can be made discrete by defining a threshold for the adequacy of housing quality and quantity, related to the national average.

- Quality of housing infrastructure categorized by the state of repair of the housing stock. A community is defined as having an adequate quality of housing when the proportion of population living in housing requiring major repairs is at or below 150 per cent of the national average, as inadequate when the proportion is between 151 and 250 per cent of the national average, as very inadequate when the proportion is between 251 and 350 per cent and as extremely inadequate when the proportion exceeds 351 per cent of the national average. The national average for housing needing major repairs in 2016 was 6.5 per cent of the population.

- Quantity of housing infrastructure is categorized by the state of overcrowding. A community is defined to have an adequate quantity of housing when the proportion of households with more than one person per room is at or below 150 per cent of the national average, as inadequate when the proportion is between 151 and 250 per cent of the national average, as very inadequate between 251 and 350 per cent of the national average, and as extremely inadequate when the proportion exceeds 351 per cent of the national average. The national average for overcrowding in 2016 was 1.9 per cent.

The third additional indicator is water quality, which is categorized by no drinking water advisory, a boil water advisory, or a do not consume warning.

Allocation of values

The infrastructure index for each community is estimated by allocating scores to the status or condition of the community infrastructure for the different infrastructure indicators and then averaging these scores for the community. The top score (1) goes to the highest quality infrastructure. Scores less than one are allocated to communities not having the highest quality infrastructure based on the number of discrete categories. When there are two categories, scores of 1 and 0 are allocated, for three categories 1, 0.5 and 0, and for four categories 1, 0.67, 0.33, and 0. The enumeration of the discrete categories for the state or condition of the infrastructure for each indicator for scoring purposing is provided below (Exhibit 1).

Exhibit 1: Index Values and Definitions

Infrastructure Indicator	Number of Categories	Possible Scores	Definitions of Scores
Economic Infrastructure			
Broadband	3	0.00	inadequate backbone infrastructure (lacks 1Gbps backbone access within 2 km of the community) *and* inadequate last-mile infrastructure (no households with 5/1 Mbps internet speeds from terrestrial infrastructure)
		0.50	inadequate backbone infrastructure (lacks 1Gbps backbone access within 2 km of the community) *or* inadequate last-mile infrastructure (no households with 5/1 Mbps internet speeds from terrestrial infrastructure)
		1.00	adequate backbone infrastructure (1Gbps backbone access within 2 km of the community) *and* adequate last-mile infrastructure (5/1 Mbps internet speeds from terrestrial infrastructure)
Transportation	-	-	-
Road	2	0.00	local roads only
		1.00	connected to the Canadian National Roads Network
Air	4	0.00	no airport
		0.33	scheduled flights to other local airports and/or an air transit hub
		0.67	scheduled flights to cities outside the region and/or an airport which is an air transit hub with flights to outside the region as well as local flights
		1.00	a large international airport
Water	3	0.00	indicates no port or harbour in a coastal community
		0.50	indicates a harbour or shallow water port with limited supporting infrastructure in a coastal community
		1.00	indicates a deep water port with supporting infrastructure in a coastal community
Energy	2	0.00	diesel generated local power
		1.00	power supplied through the grid

Quality of Life Infrastructure			
Health care	3	0.00	no hospital or community health centre (or equivalent service) on-site
		0.50	community health centre or equivalent service on-site
		1.00	hospital on-site
Education	-	-	-
School	3	0.00	no school in the community, students bussed to a nearby location
		0.50	junior school only available in the community (K-6), or indicates up to middle school available in the community (K-9)
		1.00	high school available in the community (K-11/12)
College	3	0.00	no community college campus in the community
		0.50	satellite video conferencing availability to the college campus at another location
		1.00	a community college campus in the community
Water	-	-	-
Treatment	3	0.00	no sewage/wastewater treatment and raw discharge into a water body
		0.50	limited treatment via sewage lagoon or wetland
		1.00	sewage treatment via sewage treatment plant
Distribution	2	0.00	fresh water is trucked to buildings individually
		1.00	water is supplied on a central system
Quality	3	0.00	do not consume
		0.50	boil water advisory
		1.00	no water advisory
Housing	-	-	-
Quantity	4	0.00	extremely inadequate; 6.66% or more houses have more than one person per room
		0.33	very inadequate; 4.76-6.65% houses have more than one person per room
		0.67	inadequate; 2.86-4.75% houses have more than one person per room
		1.00	adequate; 2.85% or fewer houses have more than one person per room

Quality	4	0.00	extremely inadequate; 22.76% or more houses in need of major repair
		0.33	very inadequate; 16.26-22.75% houses in need of major repair
		0.67	inadequate; 9.76%-16.25% houses in need of major repair
		1.00	adequate;9.75% or fewer houses in need of major repair

Weighting of indicators

The basic Index can be broken down into four levels. The highest three levels of infrastructure in the Index have been termed: the Overall Index, the sub-indices (Economic Infrastructure and Quality of Life Infrastructure), and the components (broadband, transportation, energy, health care, education, water, and housing). In order to develop components indicative of the real state of community infrastructure, several of these components were further disaggregated to create sub-components. Specifically, these are: transportation (comprised of roads, air transportation and water transportation), education (comprised of school and college), and water (comprised of treatment, distribution, and quality). Within each component, each sub-component is equally weighted. Similarly, each component is equally weighted within its respective sub-index. The sub-indices are then equally weighted. This weighting scheme was created to ensure that each of the two main categories of infrastructure (Economic Infrastructure and Quality of Life Infrastructure) would receive equal weighting. Similarly, certain components include disaggregated sub-components to ensure the integrity of equal weighting between forms of infrastructure within the index.

Formula

The formula for the index constitutes an arithmetic mean, wherein the value of 1 represents the highest value that can be ascribed to a community. An arithmetic mean is calculated by adding each of the values and dividing this sum by the total number of values, thus giving the 'average' value of any case. Conversely, a geometric mean is defined as the n^{th} root of a set of n numbers, thus ensuring that there is not linear substitutability between factors, while also equalizing the weighting. While a geometric mean was considered in order to account for principles of substitutability wherein no form of infrastructure can fully substitute another, this created a formula too sensitive to values of zero, a common value in many of the components of this Index. An arithmetic mean was instead chosen to provide an accurate and balanced overview of the amount of infrastructure present in each community and certain measures (i.e. aggregating sub-components and components) were used to ensure equal weighting between types of infrastructure. The formula can be written as follows:

Exhibit 2: Equation for Calculating the Infrastructure Index for Remote Indigenous Communities, Calculated at the Sub-Index Level

$$EconomicInfrastructure = (0.33)broadband + (0.33)transportation + (0.33)energy$$
$$QualityofLifeInfrastructure = (0.25)healthcare + (0.25)eduction + (0.25)water + (0.25)housing$$
$$\boldsymbol{InfrastructureIndexforRemoteIndigenousCommunities} = (0.50)\{Economic\ Infrastructure\} + (0.50)\{Quality\ of\ Life\ Infrastructure\ \}$$

This equation can be further simplified by defining each type of infrastructure by its components.

Exhibit 3: Equation for Calculating the Infrastructure Index for Remote Indigenous Communities, Calculated at the Component Level

$$Transportation = [(0.33)roads + (0.33)watertransportation + (0.33)airtransportation]$$
$$Education = [(0.50)school + (0.50)college]$$
$$Water = [(0.33)watertreatment + (0.33)waterdistribution + (0.33)waterquality]$$
$$Housing = [(0.50)housingquantity + (0.50)housingquality]$$

$$\boldsymbol{InfrastructureIndexforRemoteIndigenousCommunities} = (0.50)\{(0.33)broadband + (0.33)transportation + (0.33)energy\} + (0.50)\{(0.25)healthcare + (0.25)eduction + (0.25)water + (0.25)housing\ \}$$

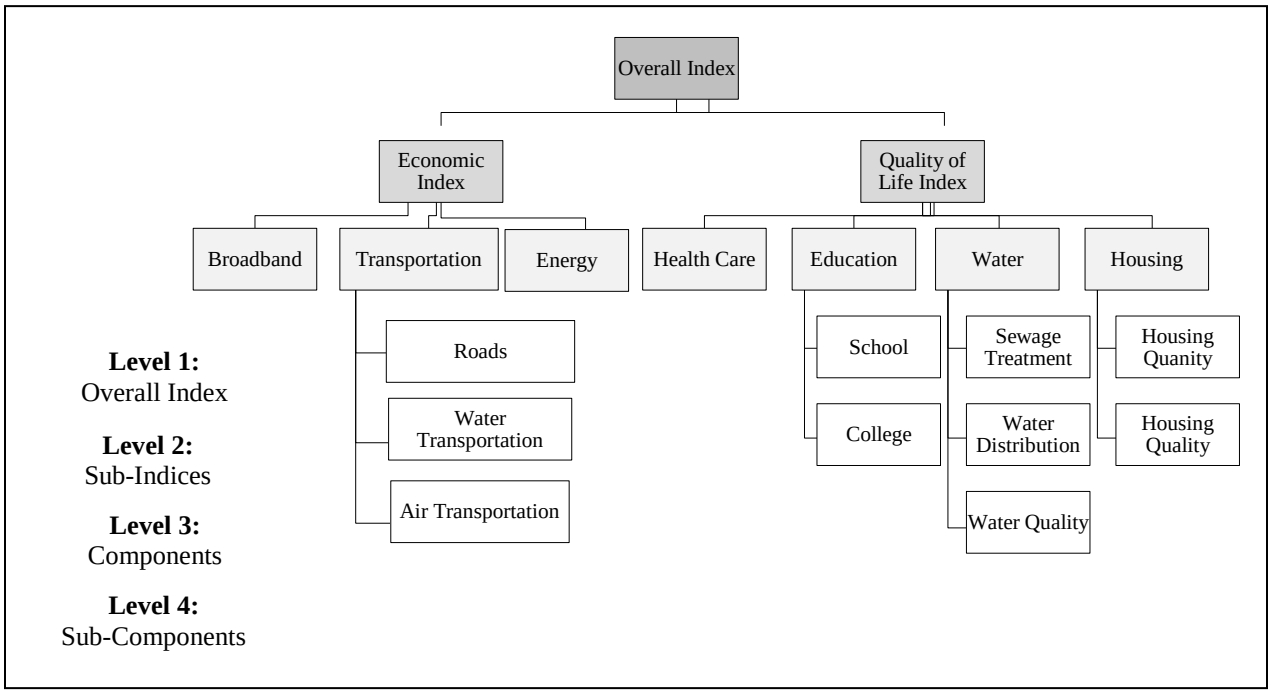
A more complex version of this formula can be created by defining each of the components by their subcomponents.

Exhibit 4: Equation for Calculating the Infrastructure Index for Remote Indigenous Communities

$$\boldsymbol{InfrastructureIndexforRemoteIndigenousCommunities} = (0.50)\{(0.33)broadband + (0.33)[(0.33)roads + (0.33)water\ transportation + (0.33)air\ transportation] + (0.33)energy\} + (0.50)\{(0.25)health\ care + (0.25)[(0.50)school + (0.50)college] + (0.25)[(0.33)watertreatment + (0.33)waterdistribution + (0.33)waterquality] + (0.25)[(0.50)housingquantity + (0.50)housingquality]\ \}$$

The following diagram includes a visual representation of the logic of this formula.

Figure 1: Diagrammatic Representation of the Infrastructure Index for Remote Indigenous Communities



Weighted averages

There are several considerations that must be made before determining the weighting scheme for the creation of population averages. The first option considered is unweighted data that gives an equal weight to each community. The second option is population weighted data, which assigns a larger value to those communities with larger populations. In using unweighted data, certain individuals are inherently more influential in the overall index, due to their residence in a smaller community. Thus, an average weighted by population may be more appropriate to assign equal influence over the overall index to all members of the population. However, these weights allow very large communities to heavily influence the average index values. Often, larger communities have more infrastructure, meaning that weighting the data by population can create higher average scores. This report includes both weighted and unweighted data. However, unweighted data is used more frequently as it gives a more accurate depiction of the situation in the average community.

Exhibit 5: Formulae Used to Calculate Index Averages

$Unweighted\ mean: \bar{x} = (\Sigma x_i) / n$

$Weighted\ mean: \bar{x} = w_1x_1 + w_2x_2 \ldots w_nx_n$

$w = relative\ weight\ determined\ by\ population\ of\ community\ as\ a\ share\ of\ total\ population$

$x = infrastrusture\ index\ value\ the\ unit\ of\ analysis$

$n = number\ of\ communities$

Data Sources

Data collection methods

The data used to create this index was gathered from a variety of federal, provincial and local sources. As the nature of this data was primarily qualitative, a quantifiable coding system was created to rank the response categories within each indicator. This coding system was then organized hierarchically to establish a rank order and transformed into the values ranging from 0-1 that comprise the overall index (see Exhibit 1).

Data sources

All data was retrieved from publically accessible, open-source documents. As previously stated, all of the values excluding those for water quality and housing for the Yukon, Northwest Territories, Nunavut, Newfoundland and Labrador, and Quebec were sourced from the report *Study on Addressing the Infrastructure Needs of Northern Aboriginal Communities* developed for the National Aboriginal Economic Development Board by Centre for the North at the Conference Board of Canada. However, this data was then verified using the methodology created to research the supplementary regions, when possible. In all cases, the newest data was used and in cases of discrepancy between the NAEDB dataset at the data identified by CSLS, corroborating sources were consulted before making changes to the dataset. The data for housing was retrieved using the methodology to be described below under "Housing Quantity and Quality."

The following data sources and methodology were used to obtain the data required to create the Index.

- Broadband: The Government of Canada online database for *Areas eligible for funding to enhance broadband access*[11] was consulted for each community. The online database measures eligibility for funding to increase backbone and last mile infrastructure. The eligibility standards were used to categorize and code the standards for adequate and

[11] www.ic.gc.ca/app/sitt/ibw/hm.html?lang=eng

inadequate broadband infrastructure. Each individual community's eligibility for funding to increase each type of broadband infrastructure was consulted and coded.

- Roads**:** To evaluate a community's access to the Canadian National Roads Network, Google Maps[12] was used. Instances where the community has a road leading to another community, but does not connect to the Canadian National Roads Network were marked as having local roads only. Similarly, Google Maps does generally does not include ice roads or seasonal roads. Therefore, only year-round road access was evaluated.

- Water Transportation: Access to water transportation was evaluated in a two-step process. First, Google Maps[13] was used to evaluate the community's proximity to an ocean, bay or inlet. If the community was not determined to be coastal, it was given a value of "n/a" and this value was not included in the calculation of the index. For communities deemed to be coastal, the Department of Fisheries and Oceans Canada *List of Harbours and Harbour Authorities*[14] was consulted.

- Air Transportation**:** No comprehensive federal source was found to indicate the flight destinations of each airport. Therefore, a two-step process was developed. First, the *Canada Flight Supplement*[15] as published by NAV Canada was consulted to identify communities with on-site aerodromes. A search engine was then used to locate the website of each aerodrome and the information on these websites was used to classify each airport into one of the categories outlined in Exhibit 1. Only those aerodromes with regularly scheduled passenger flights were categorized because private flights and chartered flights are not reliable or accessible sources of transportation for much of the population.

- Energy**:** The document *Status of Remote/Off-Grid Communities in Canada*[16] published by Aboriginal Affairs and Northern Development Canada and Natural Resources Canada was consulted in the evaluation of energy in remote communities. For those communities identified as off the grid, open source research of news sources was done to account for any changes since the document's 2011 publishing date.

- Health Care: As health care is a provincially administered service, no comprehensive federal sources were found. Research was conducted through the use of provincial databases on health care services found online through each province's respective health authority. As not every province uses the term "Community Health Centre" as was used

[12] https://www.google.ca/maps
[13] https://www.google.ca/maps
[14] http://www.dfo-mpo.gc.ca/sch-ppb/list-liste/harbour-list-liste-port-eng.html
[15] http://www.dfo-mpo.gc.ca/sch-ppb/list-liste/harbour-list-liste-port-eng.html
[16] https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/files/pubs/2013-118_en.pdf

in the NAEDB report, this definition was extended to include all health centres administering services equivalent to or in a similar nature to a Community Health Centre.

- School and College: As education is a provincially administered service, no federal database was found to indicate the presence of primary, secondary and post-secondary schools in each community. Instead, the Ministry of Education responsible for each province was consulted. Each province provided a list of primary and secondary schools, which was then consulted in relation to each community. Similarly, provincial lists of community colleges were also available. To locate all campuses and satellite campuses of each college, the specific college websites were consulted.

- Water Treatment and Distribution: To evaluate water and wastewater systems, the "Regional Roll-Up Reports" included in the *National Assessment of First Nations Water and Wastewater Systems*[17] published by Indigenous and Northern Affairs Canada were consulted. For those communities not included in the document, municipal websites and other local, open-source data products were consulted.

- Water Quality[18]: To evaluate Water Quality, the regularly updated independent media source WaterToday[19] was consulted. Only those water advisories currently in place at time of consultation and affecting a substantial proportion of the community (i.e. does not include campgrounds, isolated fishing lodges, etc.) were included.

- Housing Quantity and Quality**:** As previously mentioned, the indicators for Housing Quantity and Housing Quality were developed using national averages and data retrieved from the Census 2016, published by Statistics Canada. Specifically, the Census Profile[20] for each community was consulted and all proportions were calculated as a measure of all respondents in the category of interest from the total respondents to the census question of interest. To calculate Housing Quantity, the variable "Private households by number of persons per room" was used to calculate the proportion of respondent households with more than one person per room. Similarly, Housing Quality was measured using the variable "Occupied private dwellings by dwelling condition" to calculate the proportion of respondent households responding that their home is in need of major repairs.

[17] https://www.aadnc-aandc.gc.ca/eng/1313426883501/1313426958782

[18] Although the frequency of boil water advisories included in the index may be contrary to patterns and statistics included in media reports, it must be remembered that the communities included in this index are in a very specific geographic area. This region is seemingly less prone to drinking water advisories and is not indicative of patterns of the frequency of drinking water advisories in all of Canada.

[19] www.watertoday.ca

[20] http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E

Analysis of the Estimates of the Infrastructure Index for Indigenous Communities

This section of the report will provide a detailed analysis of the estimates. The focus will be on the gap between the infrastructure in remote Indigenous communities and that in southern Canada, the benchmark, for the overall infrastructure index, the seven types of infrastructure, and the 13 infrastructure indicators. Therefore, the difference between the 0.97 average index value the Census Metropolitan Areas and the northern remote communities will be analyzed to determine the infrastructure gap in Canada. Comparisons will also be made between territories and provinces, between Indigenous communities and non-Indigenous communities in remote areas, for the overall infrastructure index, the seven types of infrastructure, and the 13 infrastructure indicators.

This project has generated estimates of an Infrastructure index for 236 remote communities (200 Indigenous and 36 non-Indigenous) in 10 jurisdictions (7 provinces and 3 territories) based on 13 separate infrastructure indicators, a total of 3,068 data points. Tables 1-10 in Appendix 1 provide the estimates for all 13 indicators for the 10 jurisdictions as well as aggregates for economic infrastructure and social infrastructure.[21] It is beyond the scope of this report to provide a detailed discussion of the results for all indicators for all provinces and territories. This section of the report will provide an analysis of the results at the national level and highlight the differences between provinces and territories and between Indigenous and non-Indigenous communities as well as within heritage groups.

The results are very sensitive to the weighting scheme. Weighting for the calculation of the Infrastructure Index for a jurisdiction can be done on a community basis (each community receiving equal weight), which reduces the importance of large communities and increases the importance of small communities or population basis (each person receives equal weight within a jurisdiction), which increases the importance of the large communities and reduces the importance of small communities).

[21] In addition, Appendix I provides data on each individual community. The Appendix is available at: http://www.csls.ca/reports/csls2019-04-data.xlsx.

Aggregate Results

Results for Canada

Overall Index

Table 5: Overall Infrastructure Index for Remote Communities in Canada, 2018

	Unweighted	Population Weighted
All Communities (100%)	0.51	0.76
Indigenous Communities (39.7%)	0.45	0.47
First Nations (25.2%)	0.48	0.51
Métis (2.6%)	0.64	0.67
Inuit (12.0%)	0.31	0.35
Non-Indigenous Communities (60.3%)	0.82	0.94

For the 236 communities that have been defined as remote for the purpose of this report the average infrastructure index in 2018 (or the latest data available) was 0.51 on a scale from 0 to 1 on an unweighted basis and 0.76 on a population-weighted basis (Table 5). This all-remote-communities infrastructure index value is not particularly useful as it masks significant differences between Indigenous and non-Indigenous communities and is sensitive to the definition of remote communities, which is particularly important for the inclusion or exclusion of *large* remote non-Indigenous communities such as Fort McMurray and Grand Prairie. This value is also not representative of all northern remote communities as this data is unweighted and there are more Indigenous communities in the dataset than non-Indigenous communities, thus giving greater influence over the index value to Indigenous communities.

Consequently, the report will largely focus on the index values for Indigenous communities, which represent 200 of the 236 (84.7 per cent) communities defined as remote (although only 39.7 per cent of the population defined as remote[22]), with comparisons where appropriate to non-Indigenous communities. As there are not large population differences between remote Indigenous communities (unlike remote non-Indigenous communities), the differences between population weighted and unweighted index values are small. To reduce the quantity of numbers in the report, the discussion will focus on the unweighted average where communities are not weighted by their population.

As noted, there were significant differences in the infrastructure index between Indigenous remote communities and non-Indigenous remote communities. On an unweighted basis the index value for Indigenous communities was 0.37 points lower than for non-Indigenous communities (0.45 versus 0.82). The gap was even greater on a population-weighted basis, 0.47 points (0.47 versus 0.94).

[22]This calculation was made using the populations of the 236 communities identified in this report. The proportion of the remote population defined as Indigenous has been calculated as the share of the population living in communities defined as Indigenous from the total population of all communities in the report.

The average size of a remote Indigenous community in our data set at only 899 is much less than in a remote non-Indigenous community, at 7,903. This size difference explains some of the difference in index values. Certain types of infrastructure, such as schools and hospitals, require a minimum community size to be cost effective. Consequently, such infrastructure is not found in small communities, whether Indigenous or non-Indigenous, remote or non-remote. Indeed, the unweighted score of the 11 remote non-Indigenous remote communities with a population under 1,000 (seven of which are in Yukon) was 0.68, closer to the average for Indigenous communities of the same size (0.44). Although the gap between Indigenous and non-Indigenous of this size and remoteness is smaller than the overall infrastructure gap, it still clearly exists in all provinces and territories included in this study (Table 6). Much of this difference was due to the higher quality of housing in small remote non-Indigenous communities compared to that in Indigenous communities.

Table 6: Infrastructure Index for Remote Communities (population under 1000) by Province and Territory (unweighted)

	Indigenous	Non-Indigenous	Total
British Columbia	0.51	n/a	0.51
Alberta	0.55	0.81	0.58
Saskatchewan	0.54	n/a	0.54
Manitoba	0.46	n/a	0.46
Ontario	0.40	0.68	0.41
Quebec	0.33	n/a	0.33
Newfoundland and Labrador	0.33	n/a	0.33
Yukon	0.56	0.64	0.60
Northwest Territories	0.40	0.57	0.41
Nunavut	0.29	n/a	0.29
Canada	0.44	0.68	0.46

The value of the infrastructure index varies by heritage groups. The 17 Métis communities in the dataset of remote communities had an unweighted index value of 0.64, the highest, followed by the 134 First Nations communities at 0.48 and then the 49 Inuit communities at 0.31.

Sub-Indexes for Economic and Quality of Life Infrastructure

Table 7: Economic and Quality of Life Infrastructure Sub-Indexes for Indigenous and Non-Indigenous Remote Communities (unweighted by population)

	Economic Infrastructure	Quality of Life Infrastructure
Indigenous Communities	0.48	0.42
First Nations	0.56	0.39
Métis	0.78	0.50
Inuit	0.14	0.48
Non-Indigenous Communities	0.81	0.83

As was discussed in the methodology section, the 13 indicators in the Infrastructure Index are first aggregated into economic and quality of life infrastructure before the final aggregation into the overall index. This section looks at the index values for these two types of infrastructure.

The economic infrastructure sub-index consists of three components or types of infrastructure: broadband, energy, and transportation, with the latter divided into three sub-components: roads, water, and airports. The quality of life infrastructure sub-index consists of our components: health care, education, water, and housing.

The unweighted value for the economic infrastructure sub-index for Indigenous communities is 0.48. Two observations are germane here. First, this value is well below that for non-Indigenous communities at 0.81. Second, this index value is not far above the value for the quality of life infrastructure at 0.42.

Similarly, the index value for the non-Indigenous quality of life infrastructure is very close to that for economic infrastructure (0.81 versus 0.83). Thus, there is a very large gap between the index value for quality of life infrastructure between Indigenous and non-Indigenous communities: 0.42 versus 0.83. However, the patterns demonstrated at the aggregate level of Indigenous and non-Indigenous are misleading as to the relationship between economic infrastructure and quality of life infrastructure at the level of heritage groups.

Among the heritage groups there are significant differences in values for the economic infrastructure sub-index, much less for quality of life infrastructure. The index value for economic infrastructure for Métis was 0.78, only 0.03 index point below the remote non-Indigenous communities. Conversely, the economic index value for Inuit was 0.14. For quality of life infrastructure, the Métis had the highest index value (0.50), followed by the Inuit with the next highest index value (0.48) and the First Nations communities had the lowest index score (0.39). It should be noted that all of these scores are well below that of remote non-Indigenous communities (0.83). It should also be noted that the First Nations and Métis communities have higher average index scores for economic infrastructure than quality of life infrastructure, whereas the Inuit score 0.34 points higher for quality of life infrastructure than they do for economic infrastructure. The reasons for this discrepancy will be explored later in this paper. The key takeaway is that remote First Nations communities experience the greatest quality of life infrastructure deficit while the Inuit communities, all of which are remote, experience the greatest economic infrastructure deficit.

Components of the Economic Infrastructure Sub-Index

The economic infrastructure sub-index consists of three components: broadband transportation and energy (Table 8). The transportation component is in turn made up of sub-components for road access, water access and air access.

The energy component of the economic infrastructure sub-index is the highest scoring on average for remote northern Indigenous communities. The energy component of economic infrastructure is defined as access to the North America power grid. Without this access communities are forced to use generators to produce electricity. The value for this index for

remote Indigenous communities is 0.56, well below that for remote non-Indigenous communities (0.86). However there are extreme differences in the index by heritage groups, from 1.00 for Métis communities to 0.00 for Inuit communities. The lack of access to the North American power grid in Nunavut reflects its remote location. The location of the vast majority of Métis communities (16 out of 17) in the provinces, as opposed to the more remote territories, explains the high value of the energy index for this group.

Access to adequate broadband also contributed to the infrastructure deficit across all Indigenous communities. The Métis exhibit the smallest deficit, scoring 0.85, just 0.07 points below non-Indigenous remote communities. The First Nations communities demonstrate a sizeable deficit, scoring 0.59. The lowest scoring heritage group for this indicator is by far the Inuit at 0.11. It is important to note the difference in scores between the three Indigenous groups analyzed. Not only do Inuit communities face a large deficit when compared with remote non-Indigenous communities (0.92), but there is also a clear deficit when comparing the gap between Inuit access to and adequacy of broadband and that of Métis communities (0.85).

The transportation component of the economic infrastructure for remote indigenous communities exhibits the greatest deficit at 0.39 among the three economic infrastructure components, far lower than the index value for remote non-Indigenous communities (0.65). Within heritage groups, Métis communities had the best transportation infrastructure at 0.50, above Inuit communities, the lowest, at 0.32. Since the transportation component includes three sub-components, analysis of these sub-components is needed to understand the differences at the component level (Table 9). While these disparities are very large, non-Indigenous communities face many of the same challenges with an index score of 0.65, which is notably below the national benchmark.

The first sub-component of the transportation component is all-season access of the community to the National Road Network. The index value for remote Indigenous communities is 0.52, around one-half the value for remote non-Indigenous communities (0.97). There are extremes in road access among the heritage groups, from 1.00 for Métis communities (higher, even, than remote non-Indigenous communities) to 0.04 for Inuit communities, given the absence of links to the national road system in Nunavut.

The second sub-component of the transportation component is access to water transportation in coastal communities. Communities not on the coast are excluded from this calculation. Since remote Métis communities and non-Indigenous communities are not on the coast, there are no index values for these groups. The value for First Nations is 0.40 and for Inuit 0.51.

The third sub-component of the transportation component is airports, with communities categorized by no airport, airport with local flights, airport with flights outside the region, and airport with national and international flights. The value for Indigenous communities was 0.22, below that of remote non-Indigenous communities (0.33). Much of this difference reflects the much larger size of the latter category of communities. Within Indigenous communities, the Inuit have by far the best access to air services (0.42), reflecting the lack of roads and hence necessity

for air transport. Métis communities have the worst air access (0.00), reflecting both their small size and road access.

Table 8: Components of the Economic Infrastructure Sub-Index for Indigenous and Non-Indigenous Remote Communities (unweighted by population)

	Broadband	Transportation	Energy
Indigenous Communities	0.49	0.39	0.56
First Nations	0.59	0.40	0.70
Métis	0.85	0.50	1.00
Inuit	0.11	0.32	0.00
Non-Indigenous Communities	0.92	0.65	0.86

Table 9: Sub-Components for the Transportation Component of the Economic Infrastructure Sub-Index for Indigenous and Non-Indigenous Remote Communities (unweighted by population)

	Roads	Water	Airports
Indigenous Communities	0.52	0.50	0.22
First Nations	0.63	0.40	0.17
Métis	1.00	n/a	0.00
Inuit	0.04	0.51	0.42
Non-Indigenous Communities	0.97	n/a	0.33

Components of the Quality of Life Infrastructure Sub-Index

The quality of life infrastructure sub-index consists of four components: health care, education, water, and housing (Table 10). The latter three of these components are in turn made up of sub-components or indicators.

In terms of the four components the quality of life infrastructure gap or deficit between remote Indigenous communities and Canadian CMAs (index value around 1.0) the gap is the least for water (an index value of 0.71), followed by education (0.44), health care (0.39),and housing (0.16). This pattern is similar for the three heritage groups.

Heath care infrastructure

Health care infrastructure is captured by the availability in a community of a hospital or Community Health Centre. The value of this indicator for remote Indigenous communities at 0.39 is less than one half that of remote non-Indigenous communities (0.83), largely reflecting the much greater average community size for the latter. Inuit communities have a higher score for health care facilities at 0.54 than either First Nations (0.34) or Métis (0.35). The isolation of many Inuit settlements may make Community Health Centres more essential than in Métis and First Nations communities with road access to larger centres with hospitals.

Table 10: Components of the Quality of Life Infrastructure Sub-Index for Indigenous and Non-Indigenous Remote Communities (unweighted by population)

	Heath Care	Education	Water	Housing
Indigenous Communities	0.39	0.44	0.71	0.16
First Nations	0.34	0.35	0.75	0.15
Métis	0.35	0.47	0.82	0.33
Inuit	0.54	0.67	0.55	0.15
Non-Indigenous Communities	0.83	0.76	0.90	0.81

Table 11: Sub-Components for the Education Component of the Quality of Life Infrastructure Sub-Index for Indigenous and Non-Indigenous Remote Communities (unweighted by population)

	School	College
Indigenous Communities	0.67	0.20
First Nations	0.55	0.14
Métis	0.68	0.26
Inuit	0.99	0.35
Non-Indigenous Communities	0.93	0.60

Education infrastructure

Education infrastructure is captured by the availability of schools (primary schools or high schools) and community colleges (college facilities on site or access to virtual colleges and distance learning). In terms of schools, the average score for remote Indigenous communities is 0.67 (Table 11), behind that for remote non-Indigenous communities (0.93). Inuit communities have the highest score at 0.99, implying 48 of the 49 Inuit communities have high schools. Métis communities scored 0.68, followed by First Nations communities at 0.55.

Not surprisingly, the presence of or access to communities colleges is limited in remote communities, whether Indigenous or non-Indigenous. The score for Indigenous communities is 0.20; however, non-Indigenous communities still fare better with a score of 0.60. Among Indigenous communities, Inuit have the highest score for community college access at 0.35, followed by Métis (0.26) and First Nations (0.14).

Water Infrastructure

Water infrastructure is captured by water treatment facilities (full, limited, or no treatment), water distribution (piped or trucked), and water quality (do not consume warning, boil water advisory, or no advisory). The largest deficit in water infrastructure between Indigenous communities and benchmark communities in southern Canada, which all score around 1, is in water distribution, with the former at 0.57, followed by water treatment (0.61) and water quality (0.94) (Table 12). Water treatment is a problem for some remote Non-Indigenous communities (0.76). Among heritage groups, the Métis have the best water treatment facilities (0.74), followed by First Nations (0.65) and Inuit (0.47).

Water distribution is not much of a problem for remote non-Indigenous communities, with a score of 0.94. Among heritage groups, it is much more an issue for Inuit (0.21) than for First Nations (0.68) and Métis (0.76). It should also be noted that the presence of permafrost largely determines the method of water distribution used in northern communities where it is often impractical to install pipes that either cannot be easily installed in the frozen ground or will be highly susceptible to bursts caused by freezing water.

Water quality is not at all a problem for remote non-Indigenous communities, with a score of 1.00. In First Nations and Métis communities, the score of 0.97 suggests that few communities in this region have problem with water quality. The water quality situation is slightly less positive in Inuit communities, with a score of 0.92.

Housing Infrastructure

Housing infrastructure has both a housing quality and housing quantity dimension. Housing quality is captured by the state of repair of the housing stock. Housing quantity is captured by the state of overcrowding, with overcrowding defined as more than one person per room. Remote Indigenous communities have very large housing infrastructure gaps. The score for housing quality is 0.23. The situation is even worse for housing quantity at 0.09. All communities that are within 150 per cent of the national average score 1.0. The picture is much less bleak in remote non-Indigenous communities for housing quality at 0.92 and somewhat less bleak for housing quantity at 0.69.

In terms of the extent of need for major repair for housing infrastructure, Inuit communities fare worst at 0.15, followed by First Nations (0.24) and Métis (0.45). In terms of overcrowding, it is First Nations communities that do the worst at 0.05, followed by Inuit (0.15) and Métis (0.22).

Table 12: Sub-Components for the Water Component of the Quality of Life Infrastructure Sub-Index for Indigenous and Non-Indigenous Remote Communities (unweighted by population)

	Treatment	Distribution	Quality
Indigenous Communities	0.61	0.57	0.94
First Nations	0.65	0.68	0.92
Métis	0.74	0.76	0.97
Inuit	0.47	0.21	0.98
Non-Indigenous Communities	0.76	0.94	1.00

Table 13: Sub-Components for the Housing Component of the Quality of Life Infrastructure Sub-Index for Indigenous and Non-Indigenous Remote Communities (unweighted by population)

	In Need of Repair	Crowding
Indigenous Communities	0.23	0.09
First Nations	0.24	0.05
Métis	0.45	0.22
Inuit	0.15	0.15
Non-Indigenous Communities	0.92	0.69

Results for the Provinces and Territories

Overall Index

Table 14 presents the scores for the infrastructure index for remote Indigenous and non-Indigenous communities by province and territory. The jurisdiction that has the highest index value for Indigenous communities, meaning the smallest infrastructure deficit between Indigenous communities and cities in southern Canada, was Saskatchewan at 0.58. Second was Yukon (0.56), followed by Alberta (0.54), British Columbia (0.51), and Manitoba (0.46).The jurisdiction with the lowest score was Nunavut (0.30), followed by Newfoundland and Labrador (0.32),Quebec (0.36), and Ontario (0.41).

It is telling to highlight the infrastructure gap between Indigenous and non-Indigenous communities in remote areas, although some of this gap reflects the larger size of non-Indigenous communities. The largest gap in the infrastructure index is in British Columbia (0.44 points). By far the smallest gap was in Yukon, at only 0.15 points, but it should be noted that the non-Indigenous communities in the Yukon fared worse than their counterparts in other jurisdictions with a score of 0.71. It should also be noted that there were no non-Indigenous communities included in the sample from Quebec, Newfoundland and Labrador and Nunavut.

Table 14: Infrastructure Index for Remote Communities by Province and Territory (unweighted)

	Indigenous	Non-indigenous	Gap
British Columbia	0.51	0.95	0.44
Alberta	0.54	0.89	0.35
Saskatchewan	0.58	0.83	0.25
Manitoba	0.46	0.87	0.41
Ontario	0.41	0.74	0.33
Quebec	0.36	n/a	n/a
Newfoundland and Labrador	0.32	n/a	n/a
Yukon	0.56	0.71	0.15
Northwest Territories	0.45	0.78	0.33
Nunavut	0.30	n/a	n/a
Canada	0.45	0.82	0.37

Economic versus Quality of Life Infrastructure

Table 15 reports on the values for the economic and quality of life infrastructure sub-indexes for remote Indigenous communities by province and territory. At the national level the economic infrastructure score at 0.48 is above (0.06 points) the score for quality of life infrastructure (0.42). The results for the jurisdictions vary greatly from the national average, both in terms of the absolute scores and in terms of which sub-index has the highest score. Indeed, unlike at the national level where the score for economic infrastructure exceeds that for quality of life infrastructure, in five of the 10 jurisdictions, quality of life sub-index exceeds the economic infrastructure sub-index, sometimes by a substantial amount.

The highest scores for economic infrastructure are in the four most western jurisdictions. Saskatchewan is number one at 0.78, followed closely by Alberta at 0.75. The Yukon followed at 0.62 and British Columbia scored similarly at 0.58.The lowest score is in Nunavut at 0.11, followed by Newfoundland and Labrador (0.16), and Quebec (0.31).

In terms of quality of life infrastructure, the highest score was in Yukon at 0.49. It should be noted that the difference between this score and the national average was much less than the difference between the highest score for a jurisdiction in economic infrastructure and the national average (0.07 point versus 0.30 points). The three provinces that had the lowest scores were: Alberta at 0.33, followed by Saskatchewan (0.37) and Quebec (0.42).

Given the high scores for economic infrastructure and the much lower scores for quality of life infrastructure in western Canada, the gap between the two sub-indexes is very high in this part of the country. Alberta has the largest gap between economic and quality of life infrastructure at 0.42, followed by Saskatchewan at 0.41. While Alberta and Saskatchewan both saw higher scores for economic infrastructure, Nunavut's large gap was in the inverse direction with quality of life scoring higher than the economic indicators. Many jurisdictions demonstrated only marginal gaps; notably Manitoba (0.06), Ontario (-0.07), and Northwest Territories (-0.04) all had very small gaps between the two sub-indices.

Table 15: Economic and Quality of Life Infrastructure Sub-Indexes for Remote Indigenous Communities by Province and Territory (unweighted)

	Economic (1)	Quality of Life (2)	Gap ((1)-(2)
British Columbia	0.58	0.44	0.14
Alberta	0.75	0.33	0.42
Saskatchewan	0.78	0.37	0.41
Manitoba	0.49	0.43	0.06
Ontario	0.38	0.45	-0.07
Quebec	0.31	0.42	-0.11
Newfoundland and Labrador	0.16	0.48	-0.32
Yukon	0.62	0.49	0.13
Northwest Territories	0.43	0.47	-0.04
Nunavut	0.11	0.48	-0.37
Canada	0.48	0.42	0.06

Conclusion and Future Work

This report represents a first attempt to construct an infrastructure index for remote communities in Canada. It is a work in progress. The report has developed a composite infrastructure index for 236 remote communities. Estimates or scores out of 1.0 are provided for the overall infrastructure index, the economic and quality of life infrastructure sub-indexes, the seven types or components of infrastructure and 13 infrastructure indicators by province and territory, with disaggregation by Indigenous and non-Indigenous communities, and by heritage group. These results, over 3,000 community-indicator data points, are contained in a large Excel file accompanying this report.

This concluding section highlights some of the key findings of the report and outlines a number of long-term extensions to the infrastructure index that could be made.

Key Findings

The report has identified significant infrastructure gaps between remote Indigenous communities and non-Indigenous communities. Major cities in Canada have an overall infrastructure index value of around one, about double the value or score for Indigenous communities (0.45). Remote non-Indigenous communities also have a much higher level of infrastructure (0.82) than remote Indigenous communities do. A detailed examination of the reasons for the differences in infrastructure deficiencies in remote communities is beyond the scope of this report, as is a discussion of policies to reduce the infrastructure gap between remote Indigenous communities and non-Indigenous communities.

Some of the most salient findings of the report are highlighted below.

- Among the three heritage groups, the infrastructure gap is greatest for Inuit (0.31), followed by First Nations (0.48) and Métis (0.64).

- Métis have the best economic infrastructure (0.78), followed by First Nations (0.56), and Inuit (0.14).

- For quality of life infrastructure, Métis fare best (0.50), and First Nations the worst (0.39), with Inuit in middle position (0.48).

- Because of lack of access to both the national electricity grid, adequate broadband and the national road system, Inuit communities are particularly disadvantaged in the sub-index for economic infrastructure. It must also be noted that Inuit communities in Nunavut, Newfoundland and Labrador, Quebec and the Northwest Territories all lacked these forms of infrastructure.

- Among the seven types of infrastructure included in the infrastructure index, by far the largest gap is for housing (index score of 0.16). This is true for First Nations (0.15) and

Métis (0.33), but Inuit fare worse in both broadband (0.11) and energy (0.00) than they do in housing (0.15).

- The infrastructure gap for remote Indigenous communities is, in general, smaller west of the Ontario border. Saskatchewan has the lowest gap (index value of 0.58). Nunavut has the largest gap (index value of 0.30)

- There is also great variance in the gap between economic infrastructure and quality of life infrastructure, with five of 10 jurisdictions scoring higher in economic infrastructure than quality of life infrastructure.

- The jurisdiction with the poorest quality of life infrastructure is Alberta and the jurisdiction with the poorest economic infrastructure is Nunavut.

Future Work

This report was produced in a short time frame. Future versions of the report would benefit from peer review by infrastructure experts in a number of areas. For example, can the selection of the seven types of infrastructure and the 13 infrastructure indicators be improved upon? Can scoring scheme for particular indicators incorporate additional information? For example, can the road access indicators be improved by adding a category for seasonal road access? Should the indicator for health better encompass services offered and quality of health care? Are there data sources not used in the reports that would improve the quality of the estimates?

Another concern is whether the coverage of remote communities is comprehensive enough. We note that there are no non-Indigenous communities in Quebec and Newfoundland and Labrador included in the report's data set. In addition, remote communities on the BC coast are excluded.

Infrastructure deficits are not just a problem for Indigenous communities in remote parts of the country, but for many other Indigenous communities. To assess the extent of this infrastructure gap for all Indigenous Canadians, it would be useful to also develop estimates of the index for non-remote Indigenous communities.

The index captures the current infrastructure picture for remote Indigenous communities in Canada. It would be useful to update the index on a regular basis (every year or two years) to measure progress in reducing the Indigenous infrastructure gap. In addition it would be useful to develop historical estimates of the index to see what progress has been made over time.

This report is largely descriptive in nature. More analytical work is needed to better understand these infrastructure gaps between Indigenous and non-Indigenous communities (both remote and non-remote). In particular the role of community size in explaining infrastructure

gaps needs further examination. Calculation of scores for all infrastructure variables by community size would be a useful way to start such analysis.