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CENTRE FOR THE STUDY OF LIVING STANDARDS

An Improved Connectivity Component for an Infrastructure Index for Remote Indigenous Communities

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An Improved Connectivity Component for an Infrastructure Index for Remote Indigenous Communities

Abstract

In March 2018 a report entitled "An Infrastructure Index for Remote Indigenous Communities" was delivered to INAC. The report included discussion of the rationale and methodology for the index and estimates for the index for 236 remote communities (200 Indigenous and 36 non-Indigenous) with breakdowns by jurisdiction (province/territory) and heritage group. The Index itself consisted of seven components of infrastructure (broadband, transportation, energy, health, education, water and housing) and 15 separate indicators. A database of over 3,450 data points was constructed with publically available information. One weakness identified with the index was the broadband indicator, which focused on the availability of broadband, not its quality in remote Indigenous communities. INAC (now CIRNAC) was interested in addressing this weakness and commissioned the Centre for the Study of Living Standards (CSLS) to develop a new broadband indicator. In this report, we develop a new index for broadband connectivity, incorporating two key factors that determine the quality of broadband services in Indigenous communities in remote regions: speed and capacity.

An Improved Connectivity Component for an Infrastructure Index for Remote Indigenous Communities

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Executive Summary

This report develops a methodology to measure and quantify connectivity in remote northern communities in Canada in order to improve the broadband connectivity indicator used in the March 2018 report "An Infrastructure Index for Remote Indigenous Communities" delivered by the Centre for the Study of Living Standard to INAC. This report developed the methodology and rationale for a composite index to measure infrastructure levels in remote communities in Canada's North. The report included estimates for 236 remote communities (200 Indigenous and 36 non-Indigenous) with breakdowns by jurisdiction (province/territory) and heritage group.

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.

A weakness was identified in the indicator used to measure broadband in the March 2018 report. In the 2018 report, the connectivity indicator was based on the availability of Internet and, if available, the type of service (dial-up or broadband). A score of 0 was given to communities with no Internet service, a score of 0.5 to communities with dial-up Internet service and a score of 1 to communities with broadband services. No attention was given the quality of the service (*e.g.* download and upload speed, frequency of outages, hours of availability, reliability) or the cost of service. This report proposes a new indicator for broadband for the Indigenous Infrastructure Index and develops estimates for the indicator for all 236 communities.

This report begins by defining broadband and analyzing the significance of broadband for Canadians, with an emphasis on Canadian living in remote Northern communities. Broadband is the most widely used form of Internet access and is provided in four major forms: Digital Subscriber Line (DSL), fiber optic, cable, and satellite. In all these forms, broadband provides greater bandwidth, giving its user greater ability to multitask with several applications performing in the background (*e.g.* using the phone and listening to audio) while surfing the

Internet. In an increasingly digitized society, broadband high-speed Internet is a cross-sector enabler, impacting health services, education services and the ability to conduct business (FMCC, 2017). Broadband contributes to economic growth through easy flows of de-centralized information sharing on the Internet, leading to an exchange of ideas and information conducive to innovation (Czernich *et al.,* 2011). Moreover, this development of an information society has led to the rise of important economic activities such as e-commerce.

There are two main types of broadband: mobile broadband and fixed broadband. Mobile broadband is the type of Internet accessed through smartphones and tablets using "3G" or "LTE" mobile networks, while fixed broadband is the kind of Internet that is routed into users' homes. In this report, we focus on fixed Internet because this is the type of infrastructure that businesses and households predominantly rely on for essential tasks, while mobile Internet is less essential.

There are two key factors that determine the quality of broadband connectivity: speed and data allowance (or capacity). Remote areas are more likely to have speeds that are inadequate for currently available digital services and tools, due largely to rough terrain and lack of related infrastructure, or reliance on satellite-based networks. It is also shown that the Northern region where the average number of people per household is higher than the rest of Canada, many households share a single Internet connection, and thus likely exhaust their monthly data allowance. Inadequate speed and data capacity have both social and economic impacts on Northern communities.

In order to assess the state of broadband connectivity in Indigenous communities in remote regions, we examine two components of fixed broadband infrastructure, which have implications for speed and capacity: "backbone" infrastructure and "last-mile" infrastructure. Backbone infrastructure is the materials and equipment required to bring Internet access to a community from outside of the community, usually over a longer distance, and with relatively large capacity. Local Internet service providers build last mile infrastructure to connect households, businesses, and public institutions to this backbone. Using these two indicators of broadband connectivity, this report quantifies broadband infrastructure at the community level using the following three categories: those with both adequate backbone access and last-mile infrastructure (score of 1); those with one of the two attributes on connectivity (score of 0.5); and those with neither attribute (score of 0).

The scores using the updated indicator for connectivity found in this report are much lower than those found in the March 2018 report. Instead of a score or 0.99 or 1.0, the average score for remote communities is 0.56. There is also now a very large gap in scores between remote Indigenous communities and remote non-Indigenous communities: 0.44 versus 0.92. Additionally, there is a large gap in the levels of infrastructure among remote Indigenous communities across provinces with Saskatchewan scoring a high of 0.81 and Nunavut a low of 0.00. Connectivity also varies among Indigenous heritage groups with the Métis scoring 0.85 and Inuit faring the lowest at 0.11 (with First Nations at 0.59).

An analysis of the breakdown of the average scores for connectivity by the three score categories for remote non-Indigenous communities and Indigenous communities further emphasizes the gaps between Indigenous and non-Indigenous communities, and between

Indigenous Heritage groups. Remote Indigenous communities are divided equally among the three connectivity categories. For the 69 Indigenous communities missing either backbone or last mile access, for most it was it last mile access that was missing. In contrast, for the 36 remote non-Indigenous communities, not one had a lack of broadband access and only 6 were missing backbone or last mile access. The proportion of Inuk communities with no broadband access was very high at 84 per cent, while 77 per cent of Métis communities had full broadband access.

The report concludes with an agenda for future research and data collection, understanding the challenges in assessing the state of broadband connectivity using the current Index. The agenda recognizes the challenge posed by unequal access to broadband within a given geographic region, emphasizing the need to disaggregate data between Indigenous and non-Indigenous communities falling within the same geographic zone. While the data provided in this study benefits from using both capacity and speed measurements, the affordability and reliability of Internet have also been identified as key components in access to broadband that are missed in this methodology. Depending on the availability of data, a more sophisticated Index can be constructed to better reflect the quality of broadband connectivity in remote regions. One direction would be to account for other factors that illustrate the state of broadband services in remote regions.

An Improved Connectivity Component for an Infrastructure Index for Remote Indigenous Communities[1]

I. Introduction

The CSLS sets out to accomplish three tasks: propose a new broadband or connectivity indicator for the Indigenous infrastructure index to replace the indicator used in the 2018 index; develop estimates for the indicator for all 236 communities; and integrate the new connectivity indicator into the overall Indigenous infrastructure index. This document does the first two of these tasks. The third task is found in the new version of the report "An Infrastructure Index for Remote Indigenous Communities."

II. Broadband Connectivity and its Significance for Canadians

Broadband uses a high-speed transmission link to connect people to the Internet. High-speed Internet access via broadband infrastructure has developed rapidly worldwide since the late 1990s, becoming the most widely used form of Internet access. It is usually offered in four different forms: Digital Subscriber Line (DSL), fiber optic, cable, and satellite. In all these forms, broadband provides greater bandwidth, giving its user greater ability to multitask with several applications performing in the background (*e.g.* using the phone and listening to audio) while surfing the Internet.

The Canadian Radio-Television and Telecommunications Commission (CRTC) has established a "universal service objective that Canadians – in rural and remote areas as well as in urban centers – have access to voice services and broadband Internet access services on fixed and mobile wireless networks" (CRTC, 2018). In a time of increasing digitization and higher dependence on the Internet, high speed Internet access through broadband availability has come to be recognized as an essential and basic telecommunications service.

Canada's Indigenous communities have identified broadband high-speed Internet access as a cross-sector enabler. It is required for "many applications such as health services, educational videos, webinars, personal and organizational videoconferencing, cloud-based applications and software, and other bandwidth-intensive services" (FMCC, 2017). As the rest of Canada's urban population centers continue to develop broadband quality and capabilities for access to common services, it is easy for Canada's remote rural and Indigenous communities to experience greater isolation and disconnectedness from the rest of the country should they not be able to keep up with Canada's own high-speed Internet development.

[1] Contributions to this document were made by the following CSLS staff: James Ashwell, Nicole Johnston, Myeonwan Kim and Sebastian Tansil under the supervision of CSLS Executive Director Dr. Andrew Sharpe. We would like to thank Dr. Adam Fiser from the Conference Board of Canada for comments on the proposed connectivity indicator. This report was prepared as a supplementary report for the August 2019 CSLS report "An Infrastructure Index for Remote Indigenous Communities Incorporating an Improved Connectivity Indicator".
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More than just generic entertainment, broadband access has been key to economic, cultural, and community development. Broadband infrastructure has come to be an important study for policymakers due to its capability to foster economic growth (Ford and Koutsky, 2005; Koutroumpis, 2009). A quality broadband infrastructure allows for easy flows of de-centralized information sharing on the Internet, leading to an exchange of ideas and information conducive to innovation (Czernich *et al.,* 2011). Moreover, this development of an information society has led to the rise of important economic activities such as e-commerce.

New forms of social and economic transactions derived from ongoing Internet access have increased the demand for the development of broadband communication infrastructures and broadband Internet connections (Umino, 2002). Additionally, policymakers are interested in gauging the effects of the speed of broadband Internet access. This is because the quality of broadband Internet speed affects the quality of the individual's experience and thereby, to a significant extent, can determine the quality of certain kinds of services offered through it, such as education and health (OECD, 2014).

III. A New Connectivity Index for Remote Indigenous Communities

In this section, we introduce our new measure of connectivity for remote Indigenous (and non-Indigenous) communities in Canada. We differentiate between backbone infrastructure and last-mile infrastructure, as the components are distinct. Both are important for the overall quality of connectivity for a community as they imply the state of speed and capacity of broadband services in a given community.

We first provide background for focusing on the two types of infrastructure to construct the index for broadband connectivity for Indigenous communities in remote regions. We also review the availability of data related to the state of the two types of infrastructure for remote communities in Canada. Then, we describe how the index for broadband connectivity is constructed.

There are two main types of broadband: mobile broadband and fixed broadband. Mobile broadband is the type of Internet accessed through smartphones and tablets using "3G" or "LTE" mobile networks, while fixed broadband is the kind of Internet that is routed into users' homes. In this report, we focus on fixed Internet because this is the type of infrastructure that businesses and households predominantly rely on for essential tasks, while mobile Internet is less essential.

1. Background

There are two key factors that determine the quality of broadband connectivity: speed and data allowance (or capacity). First, high-speed Internet is crucial for households to enjoy increasingly digitized services related to education, public information, and media. Moreover, small businesses and employees working remotely require high-speed connection to exploit digital business tools and applications (*e.g.* conference calls, real-time collaborative work, and cloud-based tools). This implies that not only the download speed but also the upload speed is

crucial.[2] According to CRTC (2018), "some representatives of smaller communities and communities outside large urban centres submitted that the lack of availability of higher speeds constitutes a barrier to attracting businesses and investors into their communities." Therefore, speed is a crucial factor that determines the quality of broadband connectivity.

Remote areas are more likely to have speeds that are inadequate for currently available digital services and tools. Due to rough terrains and lack of related infrastructures, communities in remote areas are likely to have poor or minimal broadband infrastructure (*i.e.* backbone and last-mile infrastructure). Or, they are more likely to rely on satellite-based networks. Canadian households that rely on satellite services for their telecommunications needs tend to be in Canada's most remote regions since terrestrial transport infrastructure is minimal or non-existent (CRTC, 2018). Satellite-based communication is best suited for areas with rough terrains where it is difficult to lay wires (*e.g.* fiber optic). However, satellite-based communications have much lower data rates (*i.e.* the speed with which data can be transmitted from one device to another) and more propagation delays, compared to cable- or fiber-based communications. The large distance from communities on the earth to the satellites introduces significant delays in data transfer.

Second, digital services offered over the Internet increasingly require substantial amounts of download and upload capacity. Not only adequate speed but also data allowance (or capacity) is crucial for communities in remote regions to consume data required to satisfy their educational, cultural, and social needs.

However, it is shown that the Northern region where the average number of people per household is higher than the rest of Canada, many households share a single Internet connection. This implies that they quickly exhaust their monthly data allowance, making access to broadband less effective in participating in today's digital economy (*e.g.* e-health, e-finance, online learning platforms, streaming media sites). The Nunavut Broadband Development Corporation, for example, claims that consumers in satellite-served, remote, and predominantly indigenous communities face the most restrictive data allowances among Canada's peers in the Group of Eight and in the OECD.[3]

Moreover, while almost all cable- and fibre-based broadband Internet service subscribers in urban centres can choose various data allowance packages including packages with an unlimited data allowance or data add-ons, many Canadians in rural or remote areas do not have these choices (CRTC, 2018).

Inadequate speed and data capacity could potentially limit both social and economic development in those areas. For example, limited data capacity and inadequate speed may prevent farmers in remote areas from adopting increasingly digitalized operations in agriculture (e.g. computerized farm systems which require high data capacity). Hence, they become less efficient than those in areas with access to higher quality broadband services. In general, remote

[2] Moreover, it is increasingly the case that households participate in creating digital services (*e.g.* YouTube and personal blogs).

[3] The Group of Eight (G8) includes: Canada, France, Germany, Italy, Japan, Russia, and the United Kingdom, and the United States.

areas would be less attractive to businesses, talents, and tourists due to poor broadband services, hampering economic activities and innovation.

2. Two Criteria for Determining the Index for Broadband Connectivity

In order to assess the state of broadband connectivity in Indigenous communities in remote regions, we examine two components of fixed broadband infrastructure, which have implications for speed and capacity: "backbone" infrastructure and "last-mile" infrastructure. Backbone infrastructure is the materials and equipment required to bring Internet access to a community from outside of the community, usually over a longer distance, and with relatively large capacity. Local Internet service providers build last mile infrastructure to connect households, businesses, and public institutions to this backbone. Where backbone infrastructure ends and last-mile infrastructure begins is called a “point of presence” (PoP).

Criteria for the adequacy of backbone access include the availability of broadband of a certain *capacity* (*e.g.*1 GBPS) within a certain distance from the community (*e.g.* 2 Km). Criteria for the adequacy of the last-mile infrastructure include the availability of broadband for households of a certain Internet *speed* (*e.g.* 5/1 Mbps) from terrestrial infrastructure.

Table 1: Old Connectivity Index for Remote Indigenous and Non-Indigenous Communities, by Province/Territory, Canada, 2018

	Total remote		Indigenous		Non-Indigenous	
	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted
Alberta	1.00	1.00	1.00	1.00	1.00	1.00
British Columbia	1.00	1.00	1.00	1.00	1.00	1.00
Manitoba	1.00	1.00	1.00	1.00	1.00	1.00
Newfoundland and Labrador	1.00	1.00	1.00	1.00	n/a	n/a
Northwest Territories	1.00	1.00	1.00	1.00	1.00	1.00
Nunavut	1.00	1.00	1.00	1.00	n/a	n/a
Ontario	0.94	0.94	0.89	0.93	1.00	1.00
Quebec	1.00	1.00	1.00	1.00	n/a	n/a
Saskatchewan	1.00	1.00	1.00	1.00	1.00	1.00
Yukon	1.00	1.00	1.00	1.00	1.00	1.00
Canada	1.00	0.99	0.99	0.99	1.00	1.00

Communities can be classified into three groups: those with both adequate backbone access and last-mile infrastructure; those with one of the two attributes on connectivity; and those with neither attribute.

In the 2018 report, the connectivity indicator was based on the availability of internet and, if available, the type of service (dial-up or broadband). A score of 0 was given to communities with no internet service, a score of 0.5 to communities with dial-up internet service and a score of 1 to communities with broadband services. No attention was given the quality of

the service (*e.g.* download and upload speed, frequency of outages, hours of availability, reliability) or the cost of service.

As some form of broadband access appears to be available in virtually all remote communities in Canada, it turned out that the score for connectivity in the 2018 report were extremely high, generally 0.99 or 1.0, as seen in Table 1. This was the case even in remote Inuit communities. While technically correct, this is not particularly useful information for assessing the connectivity gap between remote Indigenous communities and remote non-Indigenous communities, and between remote Indigenous communities and cities in Southern Canada.

3. Data availability

In order to increase access to high speed Internet, the federal government has allocated $500 million in funding for ISED to distribute to improve backbone and last-mile infrastructure under the "Connect to Innovate" program. ISED has collected data on Internet access in communities across Canada to determine eligibility for these funds, which we propose we use to improve the broadband component of the Indigenous Infrastructure Index.

ISED proposes five types of funding eligibility, three for backbone and two for last-mile. Useful data is provided by ISED on community eligibility for two of these funding streams: new backbone and new last-mile funding. The other types of funding require communities to provide proof of eligibility, so no useful public data can be obtained from those requirements.

New backbone eligibility: Communities are eligible for new backbone projects, in communities where current backbone capacity is less than one Gigabit per second (1 Gbps), or the nearest access to backbone infrastructure of that capacity is more than 2 km away.

New last-mile eligibility: Communities are eligible for new last-mile projects if, within a populated 25km square hexagon (as defined by ISED), there are zero households with access to terrestrial internet infrastructure providing internet of speeds greater than 5 megabits per second download and 1 megabit per second upload (5/1 Mbps). Hexagons meeting this eligibility requirement are identified by a unique ID as shown on ISED's eligibility map.

Sources used by ISED to ascertain eligibility: Backbone and last-mile coverage information has been collected by ISED through consultation with ISPs, the CRTC, industry associations, provinces and territories, and other stakeholders – Broadband Internet Services in Canada.[4]

[4] The eligibility map is available at http://www.ic.gc.ca/app/sitt/ibw/hm.html?lang=eng.

4. New Index for Broadband Connectivity

Using the lists of communities and areas in which backbone and last-mile infrastructure are lacking, we propose that the broadband measure be broken down into three levels as follow. Note that the example communities presented in the bracket can be found in Table A1 in the Appendix.

0.0: Community lacks a 1 Gbps backbone access within 2 km of the community (the community is eligible for new backbone funding) AND the hexagonal area in which the community is situated has no households with 5/1 Mbps Internet speeds from terrestrial infrastructure (the community is eligible for new last-mile funding) (*e.g.* Cambridge Bay, NU)

0.5: The community lacks a 1 Gbps backbone access within 2 km of the community (the community is eligible for new backbone funding) BUT there is at least one household within the 25km hexagon in which the community is situated which has access to 5/1 Mbps internet speeds from terrestrial infrastructure (the community is NOT eligible for new last-mile funding).

OR the community has a 1Gbps backbone but some or all of the community is situated in an area in which no household has access to speeds of 5/1 Mbps (*e.g.* St. Theresa Point (Reserve), MB)

1.0: The community has a 1 Gbps backbone access AND at there is least one household within the 25km hexagon in which the community is situated which has access to 5/1 Mbps internet speeds from terrestrial infrastructure (community not eligible for new backbone NOR new last-mile funding) (*e.g.* Sioux Lookout, ON)

For more examples, we present the connectivity scores for selected communities by province and territory in Table A1 in the Appendix.

IV. Estimates of the New Connectivity Index

The new estimates of connectivity for the 236 remote Indigenous and non-Indigenous communities are found in Table 2 and Table 2-1, with breakdowns by province for Indigenous and non-Indigenous communities based on the most recent data and breakdowns by heritage ground at the national levels (breakdown by heritage group by province/territory can be compiled from the database). Two sets of scores are provided: weighted, where each community is given the weight of its population in the total population of the jurisdiction or group, and unweighted, where the scores of each community are averaged irrespective of the size of the communities. Following the practice in the report, unweighted estimates are used more frequently as they give a more accurate depiction of the situation in the average community.

Not surprisingly, the scores for the connectivity for remote communities are much lower with this new definition. Instead of a score or 0.99 or 1.0, the average score for remote communities is 0.56. There is also now a very large gap in scores between remote Indigenous communities and remote non-Indigenous communities: 0.44 versus 0.92.

In addition, large gaps in connectivity in Indigenous communities among provinces and territories now appear, ranging from a high of 0.81 in Saskatchewan to a score on 0.00 in Nunavut. Other jurisdictions where remote Indigenous communities fare very poorly in terms of connectivity are Quebec (0.15), Newfoundland and Labrador (0.20) and British Columbia (0.25).

Table 2: New Connectivity Index for Remote Indigenous and Non-Indigenous Communities, by Province/Territory, Canada, 2018

	Total remote		Indigenous		Non-Indigenous	
	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted
Alberta	0.97	0.83	0.72	0.76	1.00	1.00
British Columbia	0.96	0.45	0.27	0.25	1.00	1.00
Manitoba	0.63	0.41	0.32	0.33	0.92	0.88
Newfoundland and Labrador	0.09	0.20	0.09	0.20	n/a	n/a
Northwest Territories	0.93	0.72	0.84	0.69	1.00	1.00
Nunavut	0.00	0.00	0.00	0.00	n/a	n/a
Ontario	0.67	0.61	0.64	0.59	0.71	0.75
Quebec	0.17	0.15	0.17	0.15	n/a	n/a
Saskatchewan	0.89	0.82	0.88	0.81	1.00	1.00
Yukon	0.98	0.80	0.83	0.75	0.99	0.83
Canada	0.76	0.56	0.44	0.49	0.98	0.92

Connectivity varies very significantly among heritage groups (see Table 2). The Métis have the highest score of the three heritage groups at 0.85, while the Inuit fare lowest at 0.11. The First Nations are roughly mid-way between these two groups with a score of 0.59.

Table 2-1: New Connectivity Index for Remote Indigenous and Non-Indigenous Communities, by Heritage Group, Canada, 2018

	Weighted	Unweighted
First Nations	0.57	0.59
Métis	0.92	0.85
Inuk	0.09	0.11
All Indigenous	0.44	0.49
Non-Indigenous	0.98	0.92
Total remote	0.76	0.56

Table 3 provides a breakdown of the average scores for connectivity by the three scores categories (0 no broadband access, 0.5 no backbone or last mile, and 0 no backbone and last mile) for remote non-Indigenous communities and Indigenous communities, with the latter broken down by heritage group. For the intermediate category the table also indicates whether it is backbone or last mile access which is missing.

Remote Indigenous communities are divided equally among the three connectivity categories. For the 69 Indigenous communities missing either backbone or last mile access, for most it was it last mile access that was missing. In contrast, for the 36 remote non-Indigenous communities, not one had a lack of broadband access and only 6 were missing backbone or last mile access.

Again reflecting the average scores the proportion on Inuk communities with no broadband access was very high at 84 per cent. Only 2 per cent, or one Inuk community has full broadband access. It was the opposite for Métis communities where 77 per cent had full broadband access and 6 per cent or one community has no access. Just over one third (37 per cent) of First Nations communities had full broadband access, with 19 per cent with no access, and 44 per cent missing backbone or last mile.

Table 3: Distribution of New Connectivity Scores by Availability of Broadband Backbone and Last mile Infrastructure, by Heritage Group, Canada, 2018

		Panel A: Counts		
	0	0.5		1
Heritage group (# communities)		Lack backbone	Lack last mile	
First Nations (134)	26	22	39	47
Métis (17)	1	3	0	13
Inuk (49)	41	0	7	1
All Indigenous (200)	68	25	46	61
Non-Indigenous (36)	0	2	4	30
Total remote (236)	68	27	50	91
		Panel B: Shares (per cent)		
	0	0.5	1	1
Heritage group (# communities)		Lack backbone	Lack last mile	
First Nations (134)	19.4	16.4	29.1	35.1
Métis (17)	5.9	17.6	0.0	76.5
Inuk (49)	83.7	0.0	14.3	2.0
All Indigenous (200)	34.0	12.5	23.0	30.5
Non-Indigenous (36)	0.0	5.6	11.1	83.3
Total remote (236)	28.8	11.4	21.2	38.6

V. Conclusion

In this report, we briefly review the state of broadband connectivity for Indigenous communities in remote regions and introduce our new Index for Broadband Connectivity. Compared to the CSLS 2018 report, the new Index better reflects the quality of broadband services as it is constructed based on the adequacy of backbone and last-mile infrastructure within communities in remote regions. These two indicators of infrastructure development reflect

the two most important factors that determine the quality of broadband connectivity: speed and capacity.

With the new index for broadband connectivity, we find that remote communities have much lower scores for broadband connectivity compared to the scores reported the CSLS 2018 report. Importantly, we find a quite large gap in scores between Indigenous and non-Indigenous remote communities, which does not exist with the old index -- 0.44 versus 0.92.

The connectivity scores vary greatly across provinces/territories and heritage groups. Across provinces and territories, Nunavut and Quebec exhibit very low scores (0.00 and 0.15) while Alberta and Saskatchewan exhibit very high scores (0.83 and 0.82). Across heritage groups, we find that Inuk fared very poorly compared to other heritage groups. For example, Métis have the highest score of 0.85 while Inuk have the lowest score of 0.15. First Nations is located in between with a score of 0.59. Among Inuk communities, it is found that all the communities that have at least one broadband infrastructure (i.e. a score of 0.5) have inadequate last mile but have adequate backbone infrastructure.

For future agenda for research and data collection, we conclude our report by describing some challenges in assessing the state of broadband connectivity using our new index:

- If just one household in a hexagon has access to 5/1 Mbps internet speeds then that hexagon is not identified by ISED as being eligible for new last-mile funding. Internet access is heavily variable and dependent on geographic features such as hills and trees, so this list likely overstates access to 5/1 Mbps Internet. as one household having access does not mean all households in the hexagon have it.

- One implication of this is that if a reserve falls within the same 25km hexagon as a non-Indigenous community, or even a non-Indigenous household, which has access to 5/1 Mbps speeds then the community is not identified as deficient in this area (see Dease Lake 9 for example in Table A1 in the Appendix). Given that many Indigenous communities are geographically near to non-Indigenous communities this could lead to underestimation of the broadband gap between Indigenous and non-Indigenous communities.

- ISED states that the eligibility data has been collected with the CRTC, Internet Service Providers (ISPs), and others. It is not clear how reliable these data sources are, and what incentives may be operating to skew reporting of these numbers.

- Given that this data was compiled to establish eligibility for a one-time infrastructure funding initiative, it is not likely that such data will be compiled consistently in the future.

- While our methodology benefits from using both capacity and speed measures (albeit at different levels), the affordability and reliability of internet have been identified as key

components in access to broadband, and this data does not include any information on these factors.

- Most recently, the CRTC has declared Internet access a basic service and increased their target for providing broadband to all Canadians, from 5/1 Mbps to 50/10 Mbps, which would arguably make the 5/1 speed target out of date. However, it is estimated that 18% of the Canadian population doesn't have access to the new speed targets, and among all Canadian internet users only 26% subscribe to a service with 50 Mbps download speed. Conversely, the FCC in the U.S. has declared a target of 25/3 Mbps as of 2015. Therefore, the new CRTC target can be viewed as largely aspirational, rather than descriptive of basic Internet access, making our 5/1 threshold an adequate basis for considering basic Internet access. As such, our measure risks only speaking to the most basic level of Internet service.

The above challenges should be resolved over time as more and better data become available. Depending on the availability of data, a more sophisticated Index can be constructed to better reflect the quality of broadband connectivity in remote regions. One direction would be to account for other factors that illustrate the state of broadband services in remote regions. One factor is the price of broadband services in Indigenous communities in remote regions. Even if a community is given a score of 1 for the new Connectivity Index, it does not necessarily mean that all households in the community can easily access the services. High prices could prevent a significant number of households from using these services.

Both provincial/territorial governments and consumer groups representing remote areas recognize that prices for broadband internet services, if available, are substantially higher than those in non-remote areas or urban centres (CRTC, 2018). Vast land mass and low population density constitute challenges in establishing high-quality broadband networks for households and businesses in remote regions. The costs associated with building modern networks in these regions are much higher than those in urban centres due to lack of transport infrastructure, harsh terrain, and short construction seasons.

References

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V. Appendix

Table A1: New Connectivity Index, Selected Remote Communities, by Province and Territory, Canada, 2018

Ontario	**Index**
Sandy Lake 88 (reserve)	1
Abitibi 70 (reserve)	0
Moosonee (town)	0.5
Sioux Lookout (municipality)	1
Pickle Lake (township)	1
Manitoba	
St Theresa Point (Reserve)	0.5
Opaskwayak Cree Nation 21I (reserve)	0.5
Ilford (Indian settlement)	0.5
Churchill (town)	0.5
Gillam (town)	0.5
Saskatchewan	
Pelican Narrows 184B (reserve)	0.5
Turnor Lake 193B (reserve)	1
La Loche (northern village)	0.5
Green Lake (northern village)	1
Alberta	
Sturgeon Lake 154 (reserve)	0.5
Horse Lake 152B (reserve)	1
Fort Vermillion (unincorporated place)	1
Rainbow lake (town)	1
BC	
Fort Nelson 2 (reserve)	0.5
Dease Lake 9	0.5
Lower post (Indian settlement)	1
Dawson Creek (city)	1
Yukon	
Beaver Creek (settlement)	0.5
Watson Lake (town)	1
NWT	
Colville Lake (settlement)	0
Hay River (town)	1
Lutselk'e (settlement)	0.5
Nunavut	
Cambridge Bay (hamlet)	0
Iqaluit (city)	0.5
Resolute bay (hamlet)	0